Russian Journal of General Chemistry, Vol. 74, No. 7, 2004, pp. 1115–1121. Translated from Zhurnal Obshchei Khimii, Vol. 74, No. 7, 2004, pp. 1206–1212.

Syntheses of Functionalized Pyrimidines from the Products of Addition of Triphenylphosphoranylideneacetonitrile to Acyl Isothiocyanates

L. V. Muzychka, O. B. Smolii, and B. S. Drach

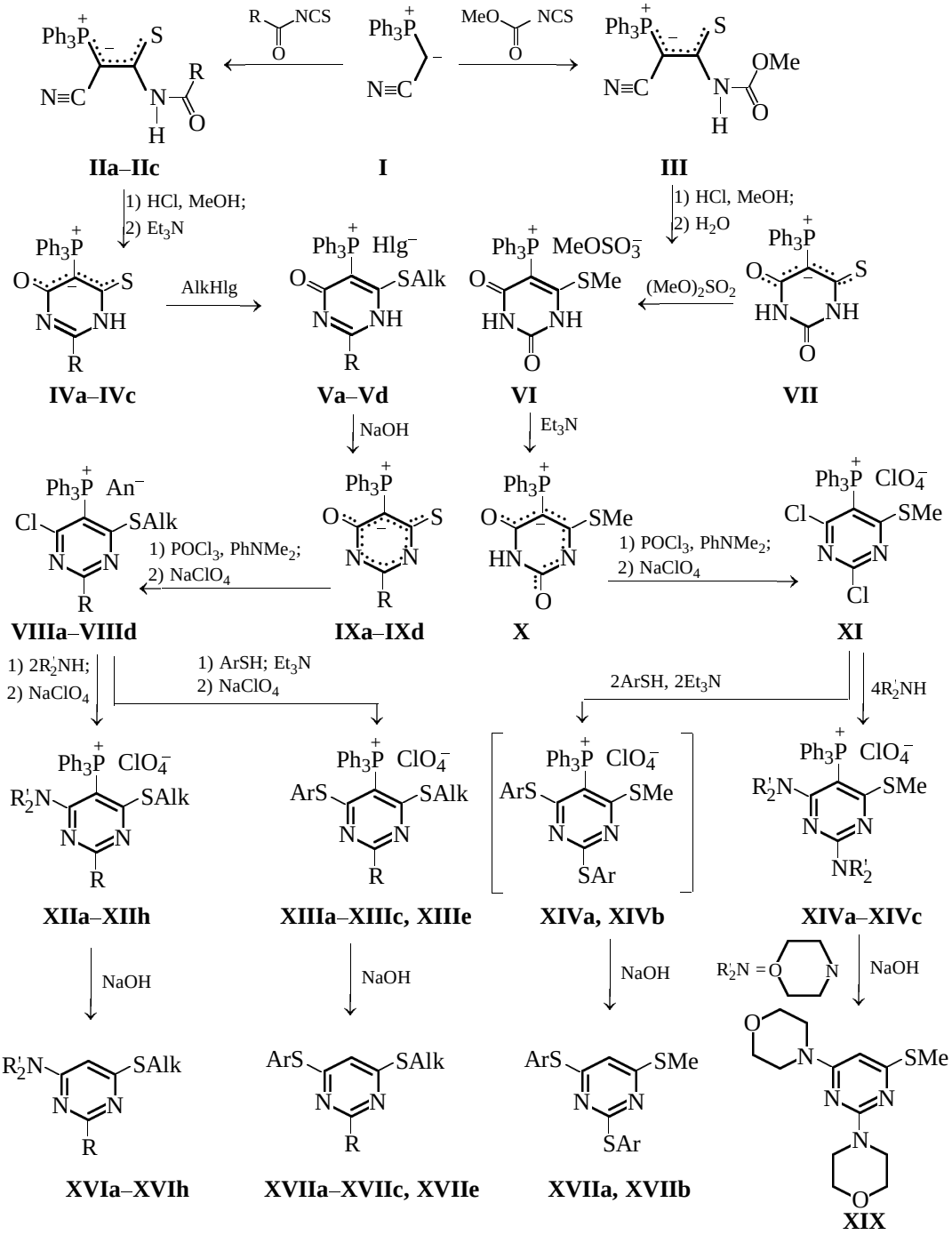
Institute of Bioorganic and Petroleum Chemistry, National Academy of Sciences of Ukraine, Kiev, Ukraine

Received July 15, 2002

Abstract — The products of addition of accessible phosphorus-containing ylide $Ph_3\overset{+}{P}–\overline{C}HCN$ to acyl and alkoxycarbonyl isocyanates readily cyclize under the action of methanolic HCl. This reaction was used for preparing a broad range of new 5-phosphonium derivatives of di- and trifunctionalized pyrimidine bases. Among them, the corresponding tertiary phosphonium salts containing no labile hydrogen atoms are especially important. Under mild conditions, they undergo dephosphorylation in the presence of alkalis to give 4-mercapto, 4,6-dimercapto-, and 2,4,6-trimercaptopyrimidine derivatives which are difficult or impossible to prepare by traditional routes.

Recently we found that successive treatment of well studied triphenylphosphoranylideneacetonitrile first with acyl isothiocyanates and then with hydrogen chloride yields phosphorus-containing derivatives of 4-hydroxy-6-mercaptopyrimidine [1, 2]. In this work we substantially expanded the sphere of application of this approach. Starting from accessible ylide betaines **II** and **III** obtained from benzoyl, anisyl, 2-thiophenoyl, and methoxycarbonyl isocyanates, we prepared a variety of new pyrimidine derivatives **IV**–**XIX** (see scheme). These compounds can be subdivided into three groups. The first group includes the stabilized phosphonium ylide betaines of the pyrimidine series: **IV**, **VII**, **IX**, and **X**. The second group consists of 5-pyrimidinylphosphonium salts **V**, **VI**, **VIII**, and **XI**–**XV**. The third group includes phosphorus-free functionalized pyrimidines **XVI**–**XIX**. The majority of transformations used to prepare these three groups of compounds are quite routine and do not deserve detailed consideration. Nevertheless, we must briefly describe the key reactions. The main of them is the heterocyclization of **II** to **IV**, which was described in detail previously [1, 2], and the structure of one of the parent representatives of ylide betaines, **IV**, in which R is CH_3, was confirmed by X-ray structural and quantum-chemical studies [2, 3]. The cyclization of **III** into **VII**, studied for the first time in this work, resembles the above-described cyclization **II** → **IV**, but is complicated by demethylation. This fact was established by ^{1}H NMR spectroscopy (Table 1).

In spite of the mesomeric character of related ylide betaines **IV** and **VII**, they are regioselectively methylated at the sulfur atom, which was proved by the ^{1}H NMR spectra. The SCH_3 signal in the spectra of **V**, **VI**, **IX**, and **X** is located in the range 2.1–2.5 ppm, whereas for the isomeric N- or O-methylation products the CH_3 signal should be observed at $\delta > 3$ ppm [2]. Both sequences of quite selective transformations **IV** → **V** → **IX** and **VII** → **VI** → **X** are typical examples of using the Umpolung methodology based on the alternate change of the chemical nature of each paticipant of the consecutive process. It results in formation of ylide betaines **IX** and **X**, polycentral nucleophilic substrates that do not enter the Wittig reaction with aromatic aldehydes but readily react with alkylating agents. Some of these reactions were studied previously [1, 2], and here we studied the reactions of ylide betaines **IX** and **X** with phosphorus oxychloride, which proceed quite regioselectively to give electrophilic substrates **VIII** and **IX** containing one or two labile chlorine atoms in the pyrimidine moiety. The substitution of these groups with the residues of various N- and S-nucleophiles is a convenient route to a series of functionalized derivatives of 5-pyrimidinylphosphonium salts **XII**–**XV** containing no labile hydrogen atoms. In all of them, the C–P bond is readily cleaved with sodium hydroxide, which was used for the preparative synthesis of many new derivatives of 4-mercapto-, 4,6-dimercapto-, and 2,4,6-trimercaptopyrimidine (see the transformations **XII** → **XVI**, **XIII** → **XVII**, **XIV** → **XVIII**, and **XV** → **XIX**. These reactions significantly supplement the traditional methods for preparing substituted



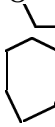
R = C_6H_5 (**IIa, IVa, Va, Vd, VIIIa, VIIId, IXa, IXd, XIIa, XIId, XIIe, XIIIa, XIIIe, XVIa, XVId, XVIe, XVIIa, XVIIe**), 4-$CH_3OC_6H_4$ (**IIb, IVb, Vb, VIIIb, IXb, XIIb, XIIf, XIIIb, XVIb, XVIf, XVIIb**),  (**IIc, IVc, Vc, VIIIc, IXc, XIIc, XIIg, XIIh, XIIIc, XVIc, XVIg, XVIh, XVIIc**); Alk = CH_3 (**Va–Vc, VIIIa–VIIIc, IXa–IXc, XIIa–XIIc, XIIe–XIIh, XIIIa–XIIIc, XIIIe, XVIa–XVIc, XVIe–XVIh, XVIIa–XVIIc, XVIIe**), $C_6H_5CH_2$ (**Vd, VIIId, IXd, XIId, XVId**); Hlg = Cl (**Vd**), I (**Va–Vc**); An = Cl (**VIIIa, VIIIb**), ClO_4 (**VIIIc, VIIId**); Ar = 4-$CH_3C_6H_4$ (**XIIIa, XIIIb, XVIIa, XVIIb, XVIIIa**), 4-ClC_6H_4 (**XIIIc, XIIIe, XVIIc, XVIIe, XVIIIb**); R'_2N =  (**XIIa–XIId, XVa, XVIa–XVId**),  (**XIIe, XIIf, XVb, XVIe, XVIf**),  (**XIIg, XVc, XVIg**),  (**XIIh, XVh**).

Table 1. ^{1}H NMR spectra of compounds obtained

Comp. no.	δ, ppm [$(CD_3)_2SO$]
IIb	3.83 s (3H, OCH_3), 7.01–7.98 m ($19H_{arom}$), 10.43 s (1H, NH)
III	3.66 s (3H, OCH_3), 7.61–7.77 m ($15H_{arom}$), 10.04 s (1H, NH)
IVb	3.84 s (3H, OCH_3), 7.04–8.09 m ($19H_{arom}$), 11.83 br.s (1H, NH)
Vc	2.44 s (3H, SCH_3), 7.37–8.37 m ($18H_{arom}$.), 13.6 br.s (1H, NH)
VII	7.51–7.74 m ($15H_{arom}$), 10.50 s (1H, NH), 11.04 s (1H, NH)
VIIId	4.52 s (2H, CH_2), 7.25–8.27 m ($25H_{arom}$)
IXb	2.35 s (3H, SCH_3), 3.82 s (3H, OCH_3), 7.03–8.31 m ($19H_{arom}$)
X	2.12 s (3H, SCH_3), 7.60–7.74 m ($15H_{arom}$), 10.28 s (1H, NH)
XIId	3.09–3.24 m (8H, $4CH_2$), 4.34 s (2H, CH_2), 6.90–8.51 m ($25H_{arom}$)
XIIIb	2.38 s (3H, CH_3), 2.41 s (3H, SCH_3), 3.84 s (3H, OCH_3), 7.02–8.16 m ($23H_{arom}$)
XVIb	2.56 s (3H, SCH_3), 3.68 s (8H, $4CH_2$), 3.82 s (3H, OCH_3), 6.52 s (1H, C^5H), 7.01 d ($2H_{arom}$, $^3J_{HH}$ 8.0 Hz), 8.28 d ($2H_{arom}$, $^3J_{HH}$ 8.0 Hz)
XVIc	2.54 s (3H, SCH_3), 3.67 s (8H, $4CH_2$), 6.51 s (1H, C^5H), 7.14–7.86 m (3H, C_4H_3S)
XVIIb	2.41 s (3H, CH_3), 2.53 s (3H, SCH_3), 3.83 s (3H, OCH_3), 6.56 s (1H, C^5H), 7.03 d ($2H_{arom}$, $^3J_{HH}$ 9.0 Hz), 7.38 d ($2H_{arom}$, $^3J_{HH}$ 7 Hz), 7.56 d ($2H_{arom}$, $^3J_{HH}$ 7 Hz), 8.21 d ($2H_{arom}$, $^3J_{HH}$ 9 Hz)
XVIIIa	2.25 s (3H, CH_3), 2.37 s (3H, CH_3), 3.38 s (3H, CH_3), 6.02 s (1H, C^5H), 7.29–7.43 m ($8H_{arom}$)
XIX	2.41 s (3H, SCH_3), 3.49 m (4H, $2CH_2$), 3.61 m (12H, $6CH_2$), 5.97 s (1H, C^5H)

mercaptopyrimidines (see reviews [4–6] and original papers [7–10]).

One of the characteristic features of the above-described phosphonium syntheses of pyrimidine bases is that the final dephosphorylation products contain no substituents in position 5 of pyrimidine ring, and in this respect they resemble many natural and synthetic pyrimidine derivatives exhibiting high biological activity (cf. [11]). Furthermore, by consecutive transformations **IV** → **V** → **IX** → **VIII** → **XIII** → **XVII**, we prepared the 4,6-dimercaptopyrimidine derivatives containing different residues at sulfur atoms, hardly accessible by the previously developed routes. At the same time, it is quite evident that the field of application of phosphonium syntheses of functionalized pyrimidines can be considerably expanded, because the scheme presents only the most important examples illustrating the transformations of accessible ylide betaines **IV** and **VII**. The electron density distribution in them follows not only from the consideration of the generalized mesomeric structures shown in the scheme, but also from the evaluation of increment of specific mesomeric structures. As shown previously [1–3], the most significant among them are betaines with the anionic charge on sulfur. Nonpolar phosphinomethylene structures are useful for classification and construction of the most convenient names of compounds **IV**, **VII**, **IX**, and **X** (see Experimental), but they do not make the major contribution.

EXPERIMENTAL

The ^{1}H NMR spectra were obtained on a Varian VXR-300 spectrometer in DMSO-d_6 relative to TMS. The spectral data are listed in Table 1. The constants, yields, and elemental analyses of the new compounds are presented in Table 2.

3-Acylamino-3-thioxo-2-triphenylphosphoranylidenepropionitriles IIa–IIc.[1] A solution of 0.01 mol of appropriate acyl isocyanate in 20 ml of acetonitrile was added to a suspension of 0.01 mol of triphenylphosphoranylideneacetonitrile **I** in 30 ml of acetonitrile. The mixture was kept for 1 h at 50–70°C and then for 1 h at 20–25°C. The precipitate was filtered off and recrystallized.

3-Methoxycarbonylamino-3-thioxo-2-triphenylphosphoranylidenepropionitrile III. A solution of 0.01 mol of methoxycarbonyl isothiocyanate [12] in 20 ml of acetonitrile was added to a suspension of 0.01 mol of ylide **I** in 30 ml of acetonitrile. The mixture was kept for 2 h at 20–26°C, the solvent was removed at reduced pressure, and the residue was recrystallized.

2-Aryl(2-thienyl)-4-oxo-6-thioxo-5-triphenylphosphoranylidene-1,4,5,6-tetrahydropyrimidines IVa–IVc. To a suspension of 0.01 mol of **IIa–IIc** in

[1] Here and hereinafter, the names of mesomeric compounds are given as for the nonpolar mesomeric structure.

Table 2. Constants, yields, and elemental analyses of compounds obtained

Comp. no.	Yield, %	mp, °C (solvent for recrystallization)	Found, %				Formula	Calculated, %			
			Cl (I)	N	P	S		Cl (I)	N	P	S
IIa	96	167–169 (ethanol)	–	6.15	6.71	6.87	$C_{28}H_{21}N_2OPS$	–	6.03	6.67	6.90
IIb	89	238–240 (acetonitrile)	–	5.92	6.21	6.53	$C_{29}H_{23}N_2O_2PS$	–	5.66	6.26	6.48
IIc	90	210–212 (ethanol–acetonitrile, 1 : 1)	–	5.89	5.63	13.61	$C_{26}H_{29}N_2OPS_2$	–	5.95	6.58	13.63
III[a]	86	175–177 (ethanol)	–	6.74	7.56	7.70	$C_{23}H_{19}N_2O_2PS$	–	6.69	7.40	7.66
IVa	90	268–270 (ethanol)	–	6.11	6.59	6.43	$C_{28}H_{21}N_2OPS$	–	6.03	6.67	6.90
IVb	82	238–240 (ethanol)	–	5.87	6.34	6.42	$C_{29}H_{23}N_2O_2PS$	–	5.66	6.26	6.48
IVc	97	253–255 (ethanol–acetonitrile, 1 : 1)	–	6.03	6.61	13.64	$C_{26}H_{19}N_2OPS_2$	–	5.95	6.58	13.68
Va	94	235–237 (ethanol)	(20.89)	4.83	5.24	5.00	$C_{29}H_{24}IN_2OPS$	(20.93)	4.62	5.11	5.28
Vb	98	198–201 (ethanol)	(19.97)	4.35	4.91	5.08	$C_{30}H_{26}IN_2O_2PS$	(19.94)	4.40	4.87	5.04
Vc	93	189–192 (ethanol)	(20.94)	4.63	4.93	10.51	$C_{27}H_{22}IN_2OPS_2$	(20.72)	4.57	5.06	10.47
Vd	85	210–212 (ethanol)	6.17	4.82	5.31	12.12	$C_{35}H_{28}ClN_2OPS$	6.00	4.74	5.24	5.42
VI	83	238–240 (ethanol–acetonitrile, 1 : 1)	–	5.33	5.80	12.04	$C_{24}H_{23}N_2O_6PS_2$	–	5.28	5.84	12.09
VII	52	290–293 (acetonitrile–dimethylformamide, 2 : 1)	–	6.87	7.89	7.92	$C_{22}H_{17}N_2O_2PS$	–	6.93	7.66	7.93
VIIIa	64	167–169 (ethanol–diethyl ether, 1 : 1)	13.32	5.57	5.74	6.07	$C_{29}H_{23}Cl_2N_2PS$	13.29	5.25	5.81	6.01
VIIIb	72	191–193 (ethanol–diethyl ether, 1 : 1)	12.43	4.84	5.65	5.71	$C_{30}H_{25}Cl_2N_2OPS$	12.58	4.97	5.50	5.69
VIIIc	95	201–203 (ethanol)	11.83	4.69	5.20	10.70	$C_{27}H_{21}Cl_2N_2O_4PS_2$	11.75	4.64	5.13	10.63
VIIId	82	138–140 (ethanol–acetonitrile, 2 : 1)	10.61	4.18	4.53	4.71	$C_{35}H_{27}Cl_2N_2O_4PS$	10.53	4.16	4.60	4.76
IXa	78	290–292 (acetonitrile)	–	5.91	6.41	6.73	$C_{29}H_{23}N_2OPS$	–	5.85	6.47	6.70
IXb[b]	93	266–268 (ethanol–acetonitrile, 1 : 1)	–	5.60	6.11	6.27	$C_{30}H_{25}N_2O_2PS$	–	5.51	6.09	6.30
IXc	86	310–312 (ethanol–acetonitrile, 1 : 1)	–	5.91	6.42	13.20	$C_{27}H_{21}N_2OPS_2$	–	5.78	6.39	13.23
IXd	97	223–225 (acetonitrile)	–	5.10	5.61	5.80	$C_{35}H_{27}N_2OPS$	–	5.05	5.58	5.78
X	72	315–318 (ethanol–acetonitrile, 1 : 1)	–	6.73	7.43	7.65	$C_{23}H_{19}N_2O_2PS$	–	6.69	7.40	7.66
XI	78	139–141 (ethanol–acetonitrile, 1 : 1)	19.19	5.09	5.61	5.80	$C_{23}H_{18}Cl_3N_2O_4PS$	19.14	5.04	5.57	5.77
XIIa	58	208–210 (ethanol)	5.51	6.52	4.83	4.99	$C_{33}H_{31}ClN_3O_5PS$	5.47	6.48	4.78	4.95
XIIb	54	298–300 (ethanol)	5.30	6.27	4.61	4.70	$C_{34}H_{33}ClN_3O_6PS$	5.23	6.20	4.57	4.73
XIIc	92	186–189 (ethanol)	5.45	6.34	4.68	9.78	$C_{31}H_{29}ClN_3O_5PS_2$	5.42	6.42	4.74	9.80
XIId	75	279–281 (ethanol–acetonitrile, 1 : 1)	4.86	5.74	4.31	4.43	$C_{39}H_{35}ClN_3O_5PS$	4.89	5.80	4.28	4.43
XIIe	90	214–217 (ethanol)	5.80	6.64	4.92	5.10	$C_{33}H_{31}ClN_3O_4PS$	5.61	6.65	4.90	5.08
XIIf	68	305–307 (ethanol–acetonitrile, 1 : 1)	5.37	6.41	4.71	4.83	$C_{34}H_{33}ClN_3O_5PS$	5.35	6.35	4.68	4.84
XIIg	86	256–258 (ethanol)	5.28	6.29	4.67	9.66	$C_{33}H_{33}ClN_3O_4PS_2$	5.32	6.31	4.65	9.63
XIIh	82	273–275 (ethanol)	5.52	6.42	4.80	9.85	$C_{32}H_{31}ClN_3O_4PS_2$	5.44	6.44	4.75	9.83
XIIIa	76	193–195 (ethanol)	5.10	4.00	4.57	9.37	$C_{36}H_{30}ClN_2O_4PS_2$	5.17	4.09	4.52	9.36
XIIIb	58	230–233 (ethanol)	4.89	3.95	4.29	8.94	$C_{37}H_{32}ClN_2O_5PS_2$	4.96	3.92	4.33	8.97
XIIIc	85	254–256 (ethanol)	10.00	3.99	4.37	13.53	$C_{33}H_{25}Cl_2N_2O_4PS_3$	9.96	3.94	4.35	13.51
XIIIe	84	165–167 (ethanol)	10.11	4.03	4.35	9.10	$C_{35}H_{27}Cl_2N_2O_4PS_2$	10.05	3.97	4.39	9.08
XVa	55	225–227 (ethanol–acetonitrile, 1 : 1)	5.41	8.49	4.75	4.86	$C_{31}H_{34}ClN_4O_6PS$	5.39	8.53	4.71	4.88
XVb	88	159–162 (ethanol)	5.72	9.01	4.98	5.16	$C_{31}H_{34}ClN_4O_4PS$	5.67	8.96	4.95	5.13
XVc	80	267–269 (ethanol)	5.47	8.63	4.70	4.90	$C_{33}H_{38}ClN_4O_4PS$	5.43	8.58	4.74	4.91

Table 2. (Contd.)

Comp. no.	Yield, %	mp, °C (solvent for recrystallization)	Found, %			Formula	Calculated, %		
			Cl (I)	N	S		Cl (I)	N	S
XVIa	75	140–142 (ethanol)	–	14.65	11.12	$C_{15}H_{17}N_3OS$	–	14.62	11.16
XVIb	60	149–151 (ethanol)	–	13.30	10.12	$C_{16}H_{19}N_3O_2S$	–	13.24	10.10
XVIc	62	138–141 (ethanol)	–	14.28	21.86	$C_{13}H_{15}N_3OS_2$	–	14.32	21.86
XVId	48	111–113 (ethanol)	–	11.58	8.87	$C_{21}H_{21}N_3OS$	–	11.56	8.82
XVIe	45	121–123 (ethanol)	–	15.53	11.90	$C_{15}H_{17}N_3S$	–	15.48	11.82
XVIf	55	118–120 (ethanol)	–	14.00	10.62	$C_{16}H_{19}N_3OS$	–	13.94	10.64
XVIg	50	73–75 (ethanol)	–	14.50	21.98	$C_{14}H_{17}N_3S_2$	–	14.42	22.00
XVIh	44	67–69 (ethanol)	–	13.82	21.01	$C_{15}H_{19}N_3S_2$	–	13.76	20.99
XVIIa	67	95–97 (ethanol)	–	8.71	19.79	$C_{18}H_{16}N_2S_2$	–	8.63	19.76
XVIIb	75	87–89 (ethanol)	–	8.03	18.11	$C_{19}H_{18}N_2OS_2$	–	7.90	18.09
XVIIc	60	100–102 (ethanol)	10.15	8.03	27.37	$C_{15}H_{11}ClN_2S_3$	10.10	7.98	27.41
XVIIe[c]	82	99–101 (ethanol)	10.32	8.15	18.58	$C_{17}H_{13}ClN_2S_2$	10.28	8.12	18.59
XVIIIa	45	97–99 (acetonitrile)	–	7.53	26.00	$C_{19}H_{18}N_2S_3$	–	7.56	25.96
XVIIIb	40	68–70 (ethanol)	17.14	6.90	23.41	$C_{17}H_{12}Cl_2N_2S_3$	17.24	6.81	23.38
XIX	45	134–137 (ethanol)	–	19.01	10.82	$C_{13}H_{20}N_4O_2S$	–	18.90	10.82

[a] Found, %: C 65.96: H 4.53. Calculated, %: C 66.02; H 4.58. [b] Found, %: C 70.90: H 5.01. Calculated, %: C 70.85; H 4.95. [c] Found, %: C 59.15: H 3.74. Calculated, %: C 59.20; H 3.80.

100 ml of methanol, 2 ml of concentrated sulfuric acid was added, and the mixture was heated for 3–4 h at 45–50°C until the precipitate fully dissolved. The solvent was removed in a vacuum, and the residue was dissolved in 30 ml of methanol. A solution of 0.011 mol of triethylamine in 10 ml of ethanol was added, and the mixture was heated to 50–60°C until a precipitate formed. After that, it was left for 1 h at 20–25°C, and the precipitate was filtered off and recrystallized.

Aryl(2-thienyl)-6-methylthio-4-oxo-1,4-dihydropyrimidin-5-yltriphenylphosphonium iodides Va–Vc. To a suspension of 0.01 mol of **IVa–IVc** in 50 ml of acetonitrile, 0.011 mol of methyl iodide was added. The mixture was left at 20–25°C for 5–8 h until the precipitate fully dissolved, the solvent was removed in a vacuum, and the residue was recrystallized.

5-Benzylthio-4-oxo-2-phenyl-1,4-dihydropyrimidin-5-yltriphenylphosphonium chloride Vd. To a suspension of 0.01 mol of **IVa** in 25 ml of acetonitrile, 0.011 mol of benzyl chloride was added, the mixture was refluxed for 3 h, and the precipitate was filtered off and recrystallized.

6-Methylthio-2,4-dioxo-1,2,3,4-tetrahydropyrimidin-5-yltriphenylphosphonium methyl sulfate VI. A suspension of 0.01 mol of **VII** (see below) in 6 ml of dimethyl sulfate was heated for 1 h at 80–90°C until the precipitate dissolved completely. The resulting mixture was poured into 150 ml of absolute diethyl ether, and the precipitate was filtered off and recrystallized.

2,4-Dioxo-6-thioxo-5-triphenylphosphoranylidene-1,2,3,4,5,6-hexahydropyrimidine VII. A suspension of 0.01 mol of **III** in 25 ml of methanol was saturated with hydrogen chloride for 5 h, the solvent and excess hydrogen chloride were removed in a vacuum, and the residue was washed with water–ethanol mixture and recrystallized.

6-Alkylthio-2-aryl-4-chloropyrimidin-5-yltriphenylphosphonium chlorides VIIIa and VIIIb. To a mixture of 0.055 mol of phosphorus oxychloride and 0.0155 mol of *N*,*N*-dimethylaniline, 0.01 mol of **IXa** or **IXb** (see below) was added under cooling with ice-cold water; the resulting mixture was kept for 3 h at 80–90°C, cooled to 20–25°C, and poured onto crushed ice. The oily residue was separated by decanting and triturated for crystallization with 30 ml of ethanol; the crystals were filtered off and recrystallized.

6-Alkylthio-2-phenyl(2-thienyl)-4-chloropyrimidin-5-yltriphenylphosphonium perchlorates VIIIc and VIIId were prepared similarly to **VIIIa** and **VIIIb**, but the residue after decanting was dissolved in 30 ml of ethanol, and 15 ml of saturated aqueous solution of sodium perchlorate was added. The precipitate was filtered off, washed with water, and recrystallized.

6-Alkylthio-2-aryl(2-thienyl)-4-oxo-5-triphenylphosphoranylidene-4,5-dihydropyrimidines IXa–IXd. To a suspension of 0.01 mol of phosphonium salts **Va**–**Vd** in 40 ml of ethanol, a solution of 0.01 mol of sodium hydroxide in 10 ml of ethanol was added; the mixture was heated for 1–3 h at 50–60°C until a new precipitate formed, which was filtered off and recrystallized.

2,4-Dioxo-6-methylthio-5-triphenylphosphoranylidene-2,3,4,5-dihydropyrimidine X. A solution of 0.011 mol of triethylamine in 10 ml of ethanol was added to a suspension of 0.01 mol of **VI** in 30 ml of acetonitrile. The mixture was left for 1 h at 20–25°C; the precipitate was filtered off and recrystallized.

4-Methylthio-2,6-dichloropyrimidin-5-yltriphenylphosphonium perchlorate XI. To a solution of 0.11 mol of phosphorus oxychloride and 0.03 mol of *N*,*N*-dimethylaniline, 0.01 mol of compound **X** was added. The mixture was heated for 2 h at 80–90°C, cooled to 20–25°C, and poured onto finely crushed ice. The precipitate was separated by decanting and dissolved in 30 ml of ethanol, and 20 ml of saturated aqueous solution of sodium perchlorate was added. The precipitate that formed was filtered off, washed with water, and recrystallized.

2-Aryl-6-methylthio-4-morpholino(pyrrolidino)-pyrimidin-5-yltriphenylphosphonium perchlorates XIIa, XIIb, XIIe, and XIIf. To a solution of **VIIIa** or **VIIIb** in 20 ml of acetonitrile, 0.004 mol of morpholine or pyrrolidine was added. The resulting mixture was heated for 3 h at 50–60°C, the solvent was removed in a vacuum, the residue was dissolved in 20 ml of ethanol, and 15 ml of saturated aqueous solution of sodium perchlorate was added. The precipitate was filtered off and recrystallized.

6-Alkylthio-2-aryl(2-thienyl)-4-morpholino-(piperidino, hexamethylenimino)pyrimidin-5-yltriphenylphosphonium perchlorates XIIc, XIId, XIIg, and XIIh were prepared similarly to **XIIa**, **XIIb**, **XIIe**, and **XIIf** using morpholine, piperidine, and hexamethylenimine. After removing acetonitrile, the residue was treated with ethanol and recrystallized.

2-Aryl-4-arylthio-6-methylthiopyrimidin-5-yltriphenylphosphonium perchlorates XIIIa, XIIIb, and XIIIe. To a solution of 0.002 mol of **VIIIa** or **VIIIb** in 20 ml of acetonitrile, 0.002 mol of appropriate thiophenol and a solution of 0.002 mol of triethylamine in 10 ml of acetonitrile were added. The mixture was heated for 3 h at 50–60°C, the solvent was removed in a vacuum, the residue was dissolved in 15 ml of ethanol, and 20 ml of saturated aqueous solution of sodium perchlorate was added. The precipitate was filtered off and recrystallized.

6-Methylthio-2-(2-thienyl)-4-*p*-chlorophenylthiopyrimidin-5-yltriphenylphosphonium perchlorate XIIIc was prepared as described above, starting from **VIIIc**.

2,4-Dimorpholino(pyrrolidino, piperidino)-6-methylthiopyrimidin-5-yltriphenylphosphonium perchlorates XVa–XVc. To a solution of phosphonium salt **XI** in 15 ml of acetonitrile, 0.008 mol of appropriate nitrogen base was added. The resulting mixture was heated for 3 h at 50–60°C, the solvent was removed in a vacuum, and the residue was recrystallized.

6-Alkylthio-2-aryl(2-thienyl)-4-morpholino-(pyrrolidino, piperidino, hexamethylenimino)-pyrimidines XVIa–XVIh. To a solution of 0.001 mol of **XIIa**–**XIIh** in 15 ml of ethanol, 0.001 mol of sodium hydroxide was added. The resulting mixture was kept for 12 h at 20–25°C, the solvent was removed in a vacuum, and the residue was crystallized.

2-Aryl(2-thienyl)-4-arylthio-6-methylthiopyrimidines XVIIa–XVIIc and XVIIe were prepared similarly to **XVIa**–**XVIh**.

2,4-Di(arylthio)-6-methylthiopyrimidines XVIIIa and XVIIIb. To a solution of 0.002 mol of appropriate phosphonium salt **XI** in 10 ml of acetonitrile, 0.004 mol of appropriate thiophenol and a solution of 0.004 mol of triethylamine in 10 ml of acetonitrile were added. The mixture was heated for 3 h at 50–60°C, the solvent was removed in a vacuum, and the residue was dissolved in 15 ml of ethanol. After that, 0.002 mol of sodium hydroxide was added, the mixture was kept for 12 h at 20–25°C, the solvent was removed in a vacuum, and the residue was recrystallized.

6-Methylthio-2,4-dimorpholinopyrimidine XIX was prepared similarly to **XVIa**–**XVIh**.

REFERENCES

1. Smolii, O.B., Panchishin, S.Ya., and Drach, B.S., *Zh. Obshch. Khim.,* 1993, vol. 63, no. 9, p. 1990.
2. Van Meervelt, L., Smolii, O.B., Mishchenko, N.I., Shakhnin, D.B., Romanenko, E.A., and Drach, B.S., *Tetrahedron,* 1996, vol. 52, no. 26, p. 8835.
3. Romanenko, E.A., Shakhnin, D.B., Smolii, O.B., and Drach, B.S., *Zh. Obshch. Khim.,* 1998, vol. 68, no. 6, p. 943.
4. Brown, D.J., *The Pyrimidines: The Chemistry of Heterocyclic Compounds,* Weissberger, A., Ed., New York: Wiley, 1962, vol. 16, p. 272.
5. Brown, D.J., *The Pyrimidines: The Chemistry of Heterocyclic Compounds,* Weissberger, A., Ed., New

York: Wiley, 1970, vol. 16, suppl. I, p. 202.

6. Brown, D.J., *The Pyrimidines: The Chemistry of Heterocyclic Compounds*, Weissberger, A., Ed., New York: Wiley, 1985, suppl. II, p. 269.
7. Chaunan, S.M.S. and Junjappa, H., *Tetrahedron*, 1976, vol. 32, no. 14, p. 1779.
8. Rudorf, W.D. and Augustin, M., *J. Pr. Chem.*, 1978, vol. 320, no. 4, p. 576.
9. Potts, K.T., Cipullo, M.J., Ralli, P., and Theodoris, G., *J. Org. Chem.*, 1983, vol. 48, no. 25, p. 4841.
10. Kohra, S., Tominaga, Y., and Hosomi, A., *J. Heterocyclic Chem.*, 1988, vol. 25, no. 3, p. 959.
11. US Patent 3 498 984, 1970, *Chem. Abstr.*, 1970, vol. 72, abstr. 132 547.
12. Elmore, T.D. and Ogle, R.J., *J. Chem. Soc.*, 1960, no. 5, p. 1961.