5-Acetyl-6-amino-4-methylthio-2-phenylpyrimidine and its use in the synthesis of functionalized pyrido[2,3-d]pyrimidines and pyrimido-[4,5-d]pyrimidines

*A. V. Komkov, A. M. Sakharov, V. S. Bogdanov, and V. A. Dorokhov**

N. D. Zelinsky Institute of Organic Chemistry, Russian Academy of Sciences, 47 Leninsky prosp., 117913 Moscow, Russian Federation. Fax: +7 (095) 135 5328

Schemes for the synthesis of MeS-substituted pyrido[2,3-d]pyrimidin-5-one, pyrimido-[4,5-d]pyrimidine, and 4-methylenepyrimido[4,5-d]pyrimidin-2-one based on 5-acetyl-6-amino-4-methylthio-2-phenylpyrimidine, which was prepared from the adduct of benzoyl isothiocyanate with acetylketene *N*-benzoylaminal, were suggested.

Key words: 5-acetyl-6-amino-4-methylthio-2-phenylpyrimidine, pyrido[2,3-d]pyrimidin-5-one, pyrimido[4,5-d]pyrimidine, 4-methylenepyrimido[4,5-d]pyrimidin-2-one, acetylketene aminal, benzoyl isothiocyanate, phenyl isocyanate, dimethylformamide dimethylacetal, dimethylacetamide dimethylacetal.

One of the convenient ways for building fused nitrogen-containing cyclic systems involves annelation of a pyridine or pyrimidine ring to a molecule of a heterocyclic compound containing vicinal NH_2 and RCO groups. Previously we used this approach to prepare 1,2,3-triazolo[4,5-d]pyrimidines (8-azapurines)[1] from 5-acyl-4-aminotriazoles, pyrazolo[3,4-d]pyrimidines[2] from 4-acetyl-5-amino-1,3-dimethylpyrazole, and pyrido-[2,3-d]pyrimidin-5-ones[3,4] from 5-acetyl-4-amino-pyrimidines or from 3-acetyl-2-amino-6-phenylpyridin-4-one.

In the previous paper[5] it was shown that acetylketene *N*-benzoylaminal[6] reacts with benzoyl isothiocyanate as a C-nucleophile to give the corresponding adduct, *N*-benzoylthioamide (**1**), which was subsequently used to prepare 5-acetyl-6-benzoylamino-2-phenyl-3*H*-pyrimidine-4-thione (**2**) and its S-methyl derivative (**3**) (Scheme 1). It has been of interest to convert the latter compound into pyrimidine containing an unsubstituted NH_2 group, which can be used to annelate the second nitrogen-containing ring. However, when we attempted to debenzoylate compound **3** through the action of MeONa in MeOH, competing intramolecular cyclization involving the benzoyl group and giving 4-methylthio-2,7-diphenyl-8H-pyrido[2,3-d]pyrimidin-5-one occurred (in boiling BuOH, this process predominates[5]).

Nevertheless, in the present work we were able to carry out the conversion of thioamide **1** to pyrimidines with vicinal NH_2 and MeCO groups and further to synthesize derivatives of pyrido[2,3-d]pyrimidine and pyrimido[4,5-d]pyrimidine (Scheme 1). It turned out that when compound **1** is boiled with two equivalents of MeONa in MeOH, the closure of the pyrimidine ring is accompanied by debenzoylation. The resulting salt **(4)** incorporating an unsubstituted NH_2 group can be easily converted into pyrimidinethione **(5)** or its S-methyl derivative **(6)** when treated with AcOH or MeI, respectively. Pyrimidinethione **2**, unlike 4-methylthiopyrimidine **3**, can be converted into compound **5** or **6** *via* salt **4**. In this case, no intramolecular cyclization occurs.

The structures of the products were confirmed by spectral methods.

Similarly to the previously described 5-acetyl-4-aminopyrimidines,[3] 4-methylthiopyrimidine **6** is converted into the corresponding amidine (**7**) by boiling in benzene with DMF dimethylacetal. The treatment of amidine **7** with MeONa in MeOH results in cyclization to give 4-methylthio-2-phenylpyrido[2,3-d]pyrimidin-5-one (**8**) (Scheme 2). The latter is also formed from *N*-benzoylaminopyrimidine **3** and DMF acetal.[5]

Boiling amidine **7** with ammonium acetate in BuOH gave 5-methyl-4-methylthio-2-phenylpyrimido[4,5-d]-pyrimidine (**9**), whose structure was confirmed by spectral data. Condensation of compound **5** with DMF dimethylacetal is accompanied by the methylation at the S atom, which also affords amidine **7** (for methylation of pyrimidinethiones with amide acetals, see Refs. 5 and 7).

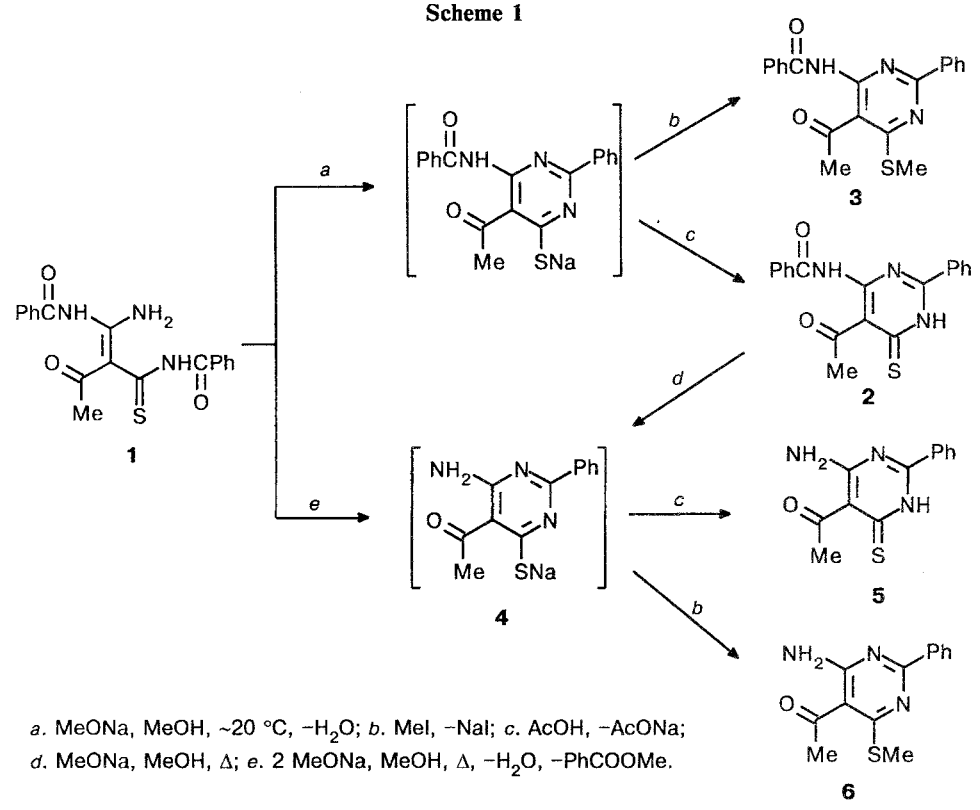
The reaction of aminopyrimidine **6** with dimethylacetamide (DMA) acetal under conditions similar to those of its reaction with DMF acetal gives, in addition to acetamidine (**10**), acetimidate (**11**) (Scheme 3). Compounds **10** and **11** were isolated by chromatography in 55 and 36 % yields, respectively.

The competing elimination of dialkylamino and alkoxy groups is not typical of transformations of amide acetals.[8] However, it has been shown recently[9] that the condensation of DMA diethylacetal with indolin-

Translated from *Izvestiya Akademii Nauk. Seriya Khimicheskaya,* No. 7, pp. 1324—1328, July, 1995.

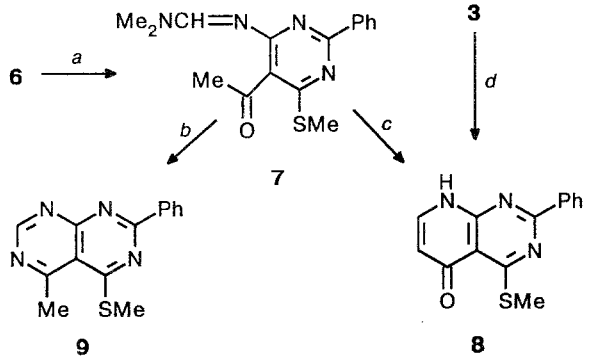
1066-5285/95/4407-1278$12.50

Scheme 1



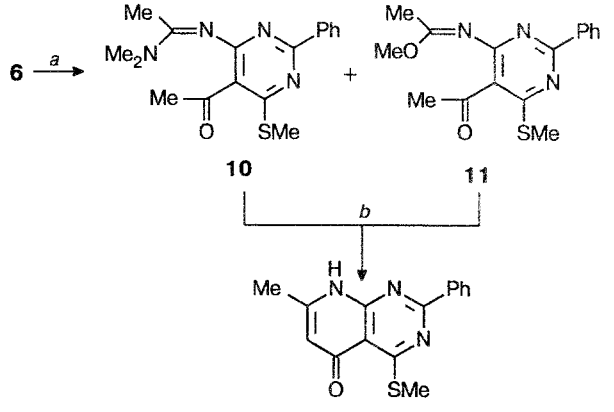
a. MeONa, MeOH, ~20 °C, $-H_2O$; *b*. MeI, –NaI; *c*. AcOH, –AcONa;
d. MeONa, MeOH, Δ; *e*. 2 MeONa, MeOH, Δ, $-H_2O$, –PhCOOMe.

Scheme 2



a.$(MeO)_2CHNMe_2$, C_6H_6, Δ; –2 MeOH;
b. $AcONH_4$, BuOH, Δ; $-Me_2NH$, $-H_2O$;
c. 1. MeONa, MeOH, Δ; 2. AcOH; $-Me_2NH$;
d. $(MeO)_2CHNMe_2$, MePh, Δ; –PhCONMe$_2$.

Scheme 3



a. $(MeO)_2CNMe_2$, C_6H_6, Δ; –2 MeOH or –MeOH, $-Me_2NH$;
b. 1.MeONa, MeOH, Δ; 2. AcOH; $-Me_2NH$ or –MeOH.

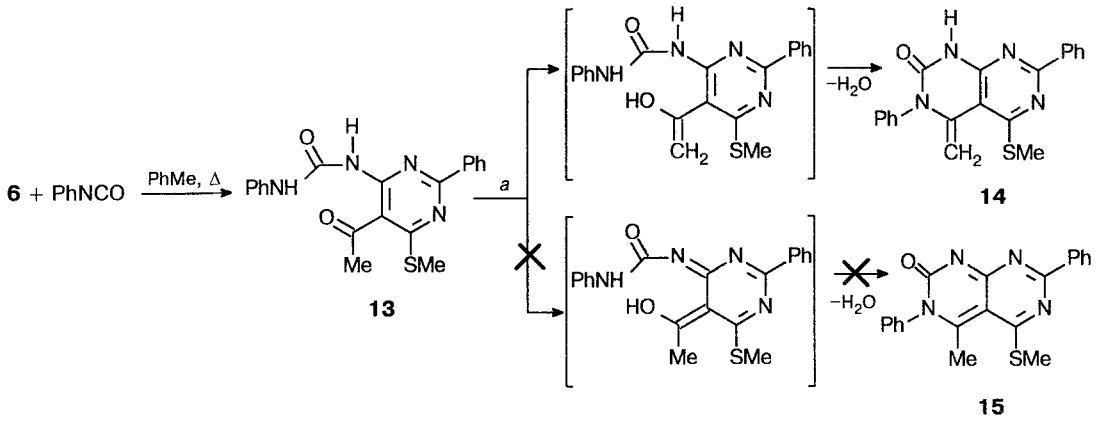
2-one predominantly occurs with the elimination of Me_2NH.

The above-mentioned peculiarity of the reaction of compound **6** with DMA acetal does not interfere with its efficient use in the construction of the pyridopyrimidine system, because amidine **10** and imidate **11** when treated by MeONa in boiling MeOH give the same product of cyclization, *viz.*, 7-methyl-4-methylthio-2-phenylpyrido-[2,3-d]pyrimidin-5-one (**12**) (Scheme 3).

Unlike imidate **11**, which is readily soluble almost in all of the organic solvents, amidine **10** is poorly soluble in petroleum ether. The structures of compounds **10**—**12** was confirmed by spectral methods.

Further we considered the route to the pyrimido-[4,5-d]pyrimidine system starting from pyrimidine **6** and phenyl isocyanate. We found that boiling these reactants in toluene results in the formation of urea (**13**) (Scheme 4). However, it has been shown previously that

Scheme 4



a. MeONa, MeOH, Δ.

5-acetyl-4-aminopyrimidin-2-ones, monosubstituted at the exocyclic N atom, react with isocyanates under similar conditions to directly give 4-methylene-1*H*,3*H*,6*H*-pyrimido[4,5-d]pyrimidin-2,7-dione derivatives.[10] We expected that intramolecular cyclization of urea **13** through the action of MeONa in MeOH would yield pyrimido[4,5-d]pyrimidin-2-one (**15**) (preparation of type **15** compounds from 4-*RNH*-5-acetylpyrimidin-2-ones and isocyanates is impossible). However, 4-methylene-5-methylthio-3,7-diphenyl-1*H*,3*H*-pyrimido-[4,5-d]pyrimidin-2-one (**14**) was isolated as the reaction product in 74 % yield (Scheme 4).

The structure of product **14** was confirmed by spectral methods. The **6**→**13**→**14** transformation indicates that the approach to the synthesis of pyrimido[4,5-d]pyrimidines with an exocyclic methylene group based on the reaction of pyrimidines with vicinal MeCO and NHR groups with isocyanates is a more general method.

The possibility of replacing the MeS group in the pyrimidine ring makes bicyclic compounds **8**, **9**, **12**, and **14** useful starting reactants for preparing new derivatives of pyrido[2,3-d]pyrimidine and pyrimido[4,5-d]pyrimidine. Heterocyclic compounds of these classes exhibit diversified biological properties.

Experimental

^{1}H NMR spectra were recorded on a Bruker WM-250 instrument and ^{13}C NMR spectra were obtained on a Bruker AM-300 spectrometer. IR spectra were run on UR-20 (in solutions) and Perkin-Elmer 577 (in KBr pellets) instruments. Mass spectra were obtained on a Varian MAT-311A mass spectrometer (EI, 70 eV). Preparative-scale TLC was carried out using Kieselgel 60F_{254} plates (Merck). 2-Acetyl-3-amino-3-benzoylamino-*N*-benzoylthioamide of acrylic acid **1** was synthesized according to the known procedure.[5]

5-Acetyl-6-amino-2-phenyl-3*H*-pyrimidine-4-thione (5). **a.** A mixture of thioamide **1** (0.367 g, 1 mmol) and MeONa (2 mmol) in 10 mL of MeOH was boiled for 1.5 h. The solvent was evaporated *in vacuo*, and 15 mL of H_2O and AcOH were added until pH ~5. The precipitate was filtered off and dried to give 206 mg (84 %) of pyrimidinethione **5** as a yellow crystalline solid with m.p. 241—244 °C (dec.) (from ethanol), slightly soluble in EtOH, C_6H_6, and $CHCl_3$ and insoluble in H_2O. Found (%): C, 58.85; H,4.63; N, 16.61; S, 12.58. $C_{12}H_{11}N_3OS$. Calculated (%): C, 58.75; H, 4.52; N, 17.13; S, 13.07. IR ($CHCl_3$), ν/cm^{-1}: 3470 (NH); 3370 (NH); 3280 (NH); 1623 (CO); 1600; 1578; 1525. ^{1}H NMR ($CDCl_3$), δ: 3.00 (s, 3 H, Me); 6.02 (br.s, 1 H, NH); 7.57 (m, 2 H, Ph); 7.65 (m, 1 H, Ph); 7.99 (m, 2 H, Ph); 9.90 (br.s, 1 H, NH); 10.12 (br.s, 1 H, NH). ^{13}C NMR (DMSO-d_6), δ: 32.85 (Me); 111.90 (C(5)); 128.37; 128.60; 130.76; 132.36 (Ph); 156.42 and 159.73 (C(2) and C(6)); 180.41 (C(4)); 201.64 (CO). MS, *m*/*z* (I_{rel}(%)): 245 [M]$^+$ (95), 244 [M−H]$^+$ (100), 230 [M−Me]$^+$ (21).

b. A mixture of pyrimidinethione **2** (0.349 g, 1 mmol) and MeONa (1 mmol) in 10 mL of MeOH was boiled for 1 h. Pyrimidinethione **5** (0.21 g, 87 %) was isolated as described in procedure **a**.

5-Acetyl-6-amino-4-methylthio-2-phenylpyrimidine (6). **a.** A mixture of thioamide **1** (0.51 g, 1.4 mmol) and MeONa (2.8 mmol) in 10 mL of MeOH was boiled for 1.5 h and cooled to ~20 °C. MeI (0.35 mL, 5.6 mmol) was added, and the mixture was stirred for 30 min. The precipitate was filtered off to give 0.32 g (88 %) of pyrimidine **6** as a colorless crystalline solid, m.p. 152—153 °C (from a heptane/benzene mixture, 4 : 1) readily soluble in $CHCl_3$, C_6H_6, and Me_2CO and slightly soluble in alcohols. Found (%): C, 60.24; H, 5.26; N, 15.80; S, 12.22. $C_{13}H_{13}N_3OS$. Calculated (%): C, 60.21; H, 5.05; N, 16.20; S, 12.36. IR (CH_2Cl_2), ν/cm^{-1}: 3490 (NH); 3340 (NH); 1640 (CO); 1585; 1530; 1520. ^{1}H NMR ($CDCl_3$), δ: 2.76 (s, 3 H, Me); 2.82 (s, 3 H, Me); 7.25 (br.s, 2 H, NH_2); 7.42—7.58 (m, 3 H, Ph); 8.43 (m, 2 H, Ph). ^{13}C NMR ($CDCl_3$), δ: 14.62 (q, SMe, ^1J = 142 Hz); 33.53 (q, COMe, ^1J = 128 Hz); 109.49 (C(5)); 128.35; 128.87; 131.30; 137.09 (Ph); 161.89 (t, C(2), ^3J = 3.8 Hz); 163.12 (C(6)); 171.66 (q, C(4), ^3J = 3.8 Hz); 199.52 (q, CO, ^2J = 6.1 Hz). MS, *m*/*z* (I_{rel}(%)): 259 [M]$^{+\cdot}$ (20), 244 [M−Me]$^+$ (100), 226 [M−SH]$^+$ (27).

b. A mixture of pyrimidinethione **2** (0.349 g, 1 mmol) and MeONa (1 mmol) in 7 mL of MeOH was boiled for 1 h. Then the reaction mixture was worked-up as described in procedure **a** to give 0.21 g (83 %) of pyrimidine **6**.

***N*-(5-Acetyl-6-methylthio-2-phenylpyrimidin-4-yl)-*N',N'*-dimethylformamidine (7).** A mixture of pyrimidine **6** (0.33 g, 1.3 mmol) and DMF dimethylacetal (0.25 mL, 1.9 mmol) in 6 mL of benzene was boiled for 3 h. The solvent was evaporated *in vacuo*, and the residue was recrystallized from a 2 : 1 hexane/benzene mixture to give 0.285 g (71 %) of amidine **7**, m.p. 136—137 °C. Found (%): C, 61.25; H, 5.87; S, 10.42. $C_{16}H_{18}N_4OS$. Calculated (%): C, 61.12; H, 5.77; S, 10.20. IR (KBr), ν/cm^{-1}: 1610 (CO); 1510. ^1H NMR ($CDCl_3$), δ: 2.64 (s, 3 H, Me); 2.70 (s, 3 H, Me); 3.14 (s, 3 H) and 3.22 (s, 3 H) (NMe_2); 7.42—7.55 (m, 3 H, Ph); 8.42—8.55 (m, 2 H, Ph); 8.88 (s, 1 H, CH).

4-Methylthio-2-phenyl-8*H*-pyrido[2,3-d]pyrimidin-5-one (8). A mixture of amidine **7** (0.314 g, 1 mmol) and MeONa (1 mmol) in 7 mL of MeOH was boiled for 4 h, cooled to 20 °C, acidified with AcOH, and evaporated to dryness. The residue was washed with 15 mL of H_2O, dried, and washed with 5 mL of $CHCl_3$ to give 0.24 g (88 %) of compound **8**, m.p. 342—345 °C (dec.). The spectral characteristics of the compound obtained coincide with those reported for pyridopyrimidinone **8**,[5] synthesized from pyrimidinethione **2** or pyrimidine **3**.

5-Methyl-4-methylthio-2-phenylpyrimido[4,5-d]pyrimidine (9). A mixture of amidine **7** (0.314 g, 1 mmol) and $AcONH_4$ (0.77 g, 10 mmol) in 10 mL of butanol was boiled for 2 h. The solvent was evaporated *in vacuo* and the residue was chromatographed on a column with SiO_2 (using $CHCl_3$ as the eluent) to yield 0.166 g (62 %) of pyrimidine **9**, m.p. 170—172 °C (dec.), readily soluble in organic solvents except petroleum ether. Found (%): C, 62.49; H, 5.00; N, 21.20; S, 11.37. $C_{14}H_{12}N_4S$. Calculated (%): C, 62.66; H, 4.51; N, 20.88; S, 11.95. IR (CH_2Cl_2), ν/cm^{-1}: 1560; 1540. ^1H NMR ($CDCl_3$), δ: 2.86 (s, 3 H, SMe); 3.17 (s, 3 H, Me); 7.45—7.62 (m, 3 H, Ph); 8.70 (m, 2 H, Ph); 9.28 (s, 1 H, H(7)). ^{13}C NMR ($CDCl_3$), δ: 15.11 (q, SMe, ^1J = 143 Hz); 28.05 (q, Me, ^1J = 130 Hz); 115.66 (C(4a)); 128.44; 129.41; 132.07; 136.27 (Ph); 160.32 (d, C(7), ^1J = 203 Hz); 162.30 (d, C(8a), ^3J = 10.8 Hz); 163.72 (C(2)); 169.45 (q, C(5), ^2J = 6.3 Hz, d, ^3J = 9.1 Hz); 174.51 (q, C(4), ^3J = 3.9 Hz). MS, *m/z* (I_{rel}(%)): 268 $[M]^+$ (33), 253 $[M-Me]^+$ (100).

***N*-(5-Acetyl-6-methylthio-2-phenylpyrimidin-4-yl)-*N',N'*-dimethylacetamidine (10) and *N*-(5-acetyl-6-methylthio-2-phenylpyrimidin-4-yl)-*O*-methylacetimidate (11).** A mixture of pyrimidine **6** (0.13 g, 0.5 mmol) and DMA dimethylacetal (0.15 mL, 1 mmol) in 4 mL of benzene was boiled for 2 h. The solvent was evaporated *in vacuo*, and the residue was chromatographed on a column with SiO_2 (using a 1 : 1 hexane/benzene mixture as the eluent) to isolate 0.057 g (36 %) of imidate **11**, and then (with C_6H_6 and a 1 : 1 $C_6H_6/CHCl_3$ mixture as eluents) 0.09 g (55 %) of amidine **10**, m.p. 99—100 °C (from hexane). Found (%): C, 62.58; H, 6.52; N, 16.89; S, 9.03. $C_{17}H_{20}N_4SO$. Calculated (%): C, 62.17; H, 6.14; N, 17.06; S, 9.76. IR (KBr), ν/cm^{-1}: 1650 (CO); 1580; 1500. ^1H NMR ($CDCl_3$), δ: 2.22 (s, 3 H, MeCN); 2.58 (s, 3 H, Me); 2.65 (s, 3 H, Me); 3.15 (s, 6 H, NMe_2); 7.37—7.55 (m, 3 H, Ph); 8.39—8.52 (m, 2 H, Ph). MS, *m/z* (I_{rel}(%)): 328 $[M]^+$ (89), 313 $[M-Me]^+$ (72), 295 $[M-SH]^+$ (52); 285 $[M-COMe]^+$ (100).

Imidate **11**, m.p. 78—79 °C. Found (%): C, 60.84; H, 4.99; N, 13.50; S, 10.62. $C_{16}H_{17}N_3O_2S$. Calculated (%): C, 60.93; H, 5.43; N, 13.32; S, 10.17. IR (KBr), ν/cm^{-1}: 1670 sh; 1645 (CO); 1520; 1500. ^1H NMR ($CDCl_3$), δ: 2.07 (s, 3 H, MeCN); 2.59 (s, 3 H, Me); 2.69 (s, 3 H, Me); 3.88 (s, 3 H, OMe); 7.43—7.58 (m, 3 H, Ph); 8.42—8.52 (m, 2 H, Ph). ^{13}C NMR ($CDCl_3$), δ: 13.66 (q, SMe, ^1J = 140 Hz); 17.70 (q, Me, ^1J = 130 Hz); 31.42 (q, COMe, ^1J = 128 Hz); 54.19 (q, OMe, ^1J = 146 Hz); 120.85 (C(5)); 128.42; 128.63; 131.18; 137.13 (Ph); 162.73 and 163.32 (C(2) and C(4)); 166.04 (q, Me—C=N, ^2J = 6.1 Hz, ^3J = 3.8 Hz); 169.53 (q, C(6), ^3J = 2.5 Hz); 200.58 (q, CO, ^2J = 4.0 Hz). MS, *m/z* (I_{rel}(%)): 315 $[M]^+$ (41), 300 $[M-Me]^+$ (100), 282 $[M-SH]^+$ (93).

7-Methyl-4-methylthio-2-phenyl-8*H*-pyrido[2,3-d]pyrimidin-5-one (12). A mixture of amidine **10** (0.164 g, 0.5 mmol) and MeONa (0.5 mmol) in 5 mL of MeOH was boiled for 4 h. Similarly to compound **8**, 0.08 g (56 %) of pyridopyrimidinone **12** was isolated, m.p. 352—356 °C (dec.). The compound is poorly soluble in organic solvents. Found (%): C, 63.03; H, 5.21; N, 14.27; S, 10.88. $C_{15}H_{13}N_3SO$. Calculated (%): C, 63.58; H, 4.62; N, 14.83; S, 11.32. IR (KBr), ν/cm^{-1}: 3150—2500 (NH, CH); 1660 (CO); 1625; 1595; 1578; 1560; 1528. ^1H NMR (DMSO-d_6) δ: 2.28 (s, 3 H, Me); 2.52 (s, 3 H, SMe); 6.01 (s, 1 H, H(6)); 7.45—7.67 (m, 3 H, Ph); 8.40—8.58 (m, 2 H, Ph). MS, *m/z* (I_{rel}(%)): 283 $[M]^+$ (88), 250 $[M-SH]^+$ (100).

Pyridopyrimidinone **12** (0.07 g, 52 %), whose spectral characteristics correspond to those of the compound prepared from amidine **10**, was synthesized from imidate **11** (0.158 g, 0.5 mmol) in a similar way.

4-Methylene-5-methylthio-3,7-diphenyl-1*H*,3*H*-pyrimido[4,5-d]pyrimidin-2-one (14). A mixture of pyrimidine **6** (0.064 g, 0.25 mmol) and PhNCO (0.054 mL, 0.5 mmol) in 5 mL of toluene was boiled for 6 h and allowed to stand for 12 h at ~20 °C. The precipitate was filtered off to give 0.054 g (57 %) of 5-acetyl-4-methylthio-2-phenyl-6-(*N*-phenylureido)pyrimidine **13**, m.p. 173—174 °C. ^1H NMR ($CDCl_3$), δ: 2.80 (s, 3 H, Me); 2.85 (s, 3 H, Me); 7.12 (m, 1 H, Ph); 7.39 (m, 2 H, Ph); 7.51—7.70 (m, 5 H, Ph); 8.36 (m, 2 H, Ph); 10.75 (br.s, 1 H, NH); 11.87 (br.s, 1 H, NH). MeONa (0.25 mmol) in 5 mL of MeOH was added to the adduct **13** synthesized, and the mixture was boiled for 1 h, cooled to ~20 °C, and acidified with 0.2 mL of AcOH. The solvent was evaporated, and 20 mL of $CHCl_3$ was added to the residue. The precipitate of AcONa was filtered off, the filtrate was concentrated, and the residue was purified by preparative-scale chromatography on a TLC plate (using $CHCl_3$ as the eluent) to give 0.038 g (74 %) of colorless crystalline compound **14**, m.p. 244—245 °C (from MeCN), readily soluble in $CHCl_3$, Me_2CO, or EtOH. Found (%): C, 66.90; H, 4.82; N, 15.86; S, 9.10. $C_{20}H_{16}N_4OS$. Calculated (%): C, 66.65; H, 4.47; N, 15.55; S, 8.90. IR (CH_2Cl_2), ν/cm^{-1}: 3410 (NH); 1710 (CO); 1615; 1590; 1570; 1535. ^1H NMR ($CDCl_3$), δ: 2.76 (s, 3 H, Me); 4.37 (d, 1 H, J = 3.3 Hz) and 5.36 (d, 1 H, J = 3.3 Hz) (CH_2=); 7.25—7.60 (m, 8 H, Ph); 8.02 (br.s, 1 H, NH); 8.41 (m, 2 H, Ph). ^{13}C NMR ($CDCl_3$), δ: 14.36 (q, SMe, ^1J = 142 Hz); 98.96 (t, CH_2=, ^1J = 162.46 Hz); 106.71 (C(4a)); 128.47; 128.56; 129.20; 130.01; 131.26; 136.55; 139.22 (2 Ph); 137.60 (m, C(4)); 149.94; 153.72; 166.11 (C(2), C(7), C(8a)), 166.44 (q, C(5), ^3J = 3.7 Hz). MS, *m/z* (I_{rel}(%)): 360 $[M]^+$ (56), 345 $[M-Me]^+$ (100).

Along with pyrimidopyrimidinone **14**, 0.008 g of unidentified compound that contained compound **14** as an impurity was isolated.

The work was carried out with financial support from the Russian Foundation for Basic Research (Grant No. 94-03-08964).

References

1. M. F. Gordeev, A. V. Komkov, V. S. Bogdanov, and V. A. Dorokhov, *Izv. Akad. Nauk SSSR, Ser. Khim.*, 1990, 1392 [*Bull. Acad. Sci. USSR, Div. Chem. Sci.*, 1990, **39**, 1256 (Engl. Transl.)].
2. V. A. Dorokhov, A. V. Komkov, and B. I. Ugrak, *Izv. Akad. Nauk, Ser. Khim.*, 1993, 1429 [*Russ. Chem. Bull.*, 1993, **42**, 1364 (Engl. Transl.)].
3. A. V. Komkov, B. I. Ugrak, V. S. Bogdanov, and V. A. Dorokhov, *Izv. Akad. Nauk, Ser. Khim.*, 1994, 1469 [*Russ. Chem. Bull.*, 1994, **43**, 1392 (Engl. Transl.)].
4. V. L. Gein, S. G. Pitirimova, O. V. Vinokurova, Yu. S. Andreichikov, A. V. Komkov, V. S. Bogdanov, and V. A. Dorokhov, *Izv. Akad. Nauk, Ser. Khim.*, 1994, 1475 [*Russ. Chem. Bull.*, 1994, **43**, 1398 (Engl. Transl.)].
5. V. A. Dorokhov, A. V. Komkov, E. M. Shashkova, V. S. Bogdanov, and M. N. Bochkareva, *Izv. Akad. Nauk, Ser. Khim.*, 1993, 1932 [*Russ. Chem. Bull.*, 1993, **42**, 1848 (Engl. Transl.)].
6. V. A. Dorokhov, M. F. Gordeev, A. V. Komkov, and V. S. Bogdanov, *Izv. Akad. Nauk SSSR, Ser. Khim.*, 1990, 401 [*Bull. Acad. Sci. USSR, Div. Chem. Sci.*, 1990, **39**, 340 (Engl. Transl.)].
7. V. G. Granik, N. B. Marchenko, and R. G. Glushkov, *Khim. Geterotsikl. Soedin.*, 1978, 1549 [*Chem. Heterocycl. Compd.*, 1978, **14** (Engl. Transl.)].
8. V. G. Granik, *Khim. Geterotsikl. Soedin.*, 1992, 762 [*Chem. Heterocycl. Compd.*, 1992, **28** (Engl. Transl.)].
9. T. V. Golovko, N. P. Solov'eva, G. A. Bogdanova, Yu. N. Sheinker, and V. G. Granik, *Khim. Geterotsikl. Soedin.*, 1991, 1190 [*Chem. Heterocycl. Compd.*, 1991, **27**, (Engl. Transl.)].
10. V. A. Dorokhov, M. F. Gordeev, A. V. Komkov, and V. S. Bogdanov, *Izv. Akad. Nauk SSSR, Ser. Khim.*, 1991, 2593 [*Bull. Acad. Sci. USSR, Div. Chem. Sci.*, 1991, **40**, 2267 (Engl. Transl.)].
11. A. Sh. Oganisyan, A. S. Noravyan, and S. A. Vartanyan, *Usp. Khim.*, 1987, **56**, 2001 [*Russ. Chem. Rev.*, 1987 (Engl. Transl.)].
12. R. H. Gastle and S. D. Phillips, *Comprehensive Heterocyclic Chemistry*, Oxford, Pergamon Press, 1984, **3**, 368.

Received November 9, 1994