Transformation of 6-Methylthiopyrimidines. Preparation of New Pyrimidine Derivatives and Fused Azolopyrimidines

Maria Teresa Cocco, Cenzo Congiu, and Valentina Onnis

Dipartimento di Tossicologia, Università di Cagliari, Via Ospedale 72 - 09124 Cagliari, Italy

Received January 14, 2000

Dedicated to Professor Raymond N. Castle

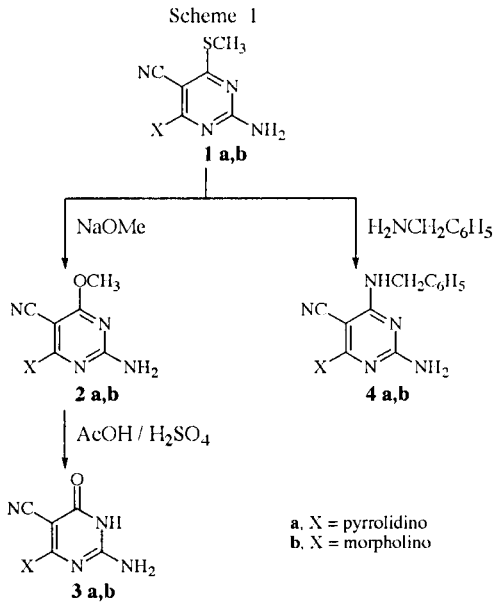
2,4-Diamino-6-methylthiopyrimidines **1** reacted with sodium methoxyde and benzylamine to give the corresponding 6-methoxypyrimidine and 6-benzylaminopyrimidine derivatives **2** and **4** respectively. The reaction of **1** with hydrazine hydrate, in ethanol, gave 6-hydrazino derivatives **6**. However, by treating pyrimidines **1** in boiling hydrazine hydrate 3,6-diamino-4-hydrazino-1*H*-pyrazolo[3,4-*d*]pyrimidine **5** was obtained. The 6-hydrazinopyrimidines **6** could be converted into the pyrazolo[3,4-*d*], triazolo[4,3-*c*] and tetrazolo-[1,5-*c*]pyrimidines **7**, **8** and **9** by the action of heating, trimethyl orthoformate and nitrous acid, respectively.

J. Heterocyclic Chem., **37**, 707 (2000).

Pyrimidines and fused pyrimidines play an essential role in several biological processes and have considerable chemical and pharmacological importance. Particularly, the pyrimidine ring can be found in a broad variety of antibacterial and antitumor agents as well as agrochemical and veterinary products [1-12].

Since the direct introduction of some specific substituents into pyrimidine nucleus is not always easy, new methods of synthesis of the ring bearing useful functionalized groups have been developed. In a previous paper we have described a general method for the synthesis of 2,4-diamino-6-methylthiopyrimidine-5-carbonitriles **1** by reacting 3-amino-3-(dialkylamino)propenenitriles with *N*-[bis(methylthio)methylene]cyanamide [13]. The electron deficient nature of the pyrimidine ring and high reactivity of the methylthio group towards nucleophilic reagents facilitate the synthesis of a large number of pyrimidine derivatives through nucleophilic aromatic substitution [14-16]. In continuation of our interest in the synthesis of substituted pyrimidines and fused pyrimidines, here we describe ulterior transformations of pyrimidines **1**.

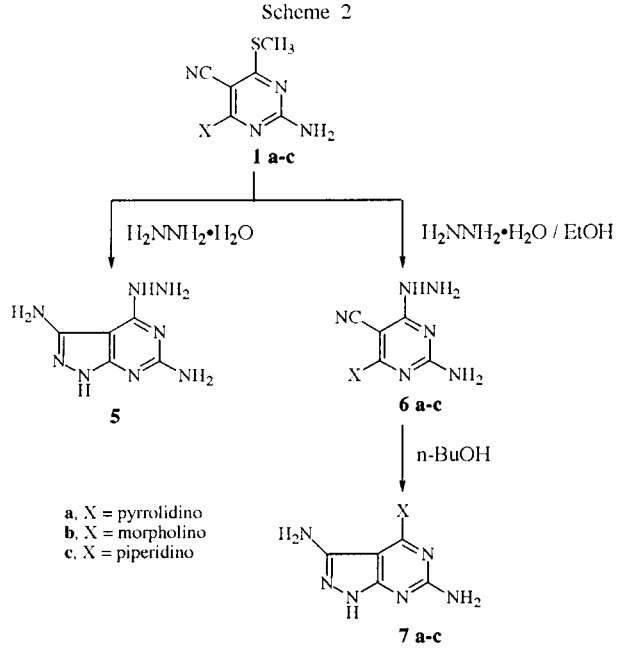
Scheme 1



Treatment of pyrimidines **1** with sodium methoxyde (1:4 ratio) in methanolic solution at reflux for 36 hours gave 6-methoxypyrimidine derivatives **2** (Scheme 1). It is interesting to note that under the conditions employed the cyano group in the molecule is not affected. Compounds **2** were smoothly transformed in pyrimidine-6-ones **3** by treatment with a mixture of acetic acid and sulfuric acid.

Although the presence of electron-withdrawing substituent in 5-position enhances the aminolysis of 4-(or 6-)-methylthiopyrimidines [17] the reaction of pyrimidines **1** with alkyl amines failed. Only the 6-(benzylamino)pyrimidines **4** were obtained by treatment of **1** with an excess of benzylamine.

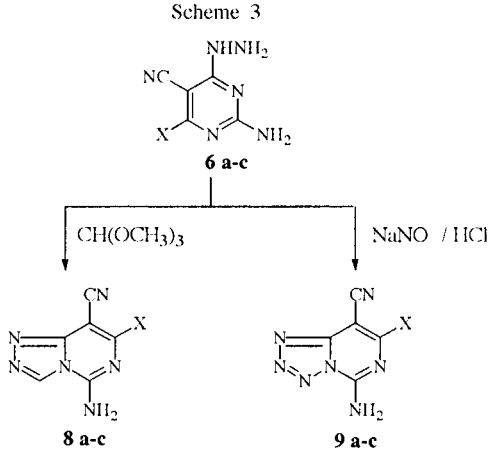
Scheme 2



Pyrimidines **1** react with a large excess of hydrazine hydrate at reflux leading to a solid with the empirical formula $C_5H_8N_8$ and whose mass spectrum shows a strong molecular ion peak at m/z 180 (base peak) (Scheme 2). The ir spectrum displays lack of absorption of the CN

group and presence of different bands in the region between 3360 and 3170 cm^{-1} (NH_2 and $NHNH_2$). Moreover the presence of the latter groups is confirmed by the ^1H nmr spectrum which consists of a series of D_2O exchangeable signals that present different chemical shifts. From all these spectral data the compound can be identified as 3,6-diamino-4-hydrazino-1*H*-pyrazolo[3,4-*d*]-pyrimidine **5**. The formation of this compound can follow two different pathways: by action of hydrazine hydrate pyrimidines **1** undergo nucleophilic substitution of both 6-thiomethyl and the 4-dialkylamino groups. Subsequently one of the two hydrazine moieties reacts with the cyano group in *ortho* leading to fused pyrimidine **5**. Alternatively the cyclization to pyrazolo[3,4-*d*]pyrimidine could take place before attack of the second equivalent of hydrazine. With the aim to obtain selective displacement of the thiomethyl group by hydrazine we have tested several reaction conditions changing the molar ratio between reagents and the solvent. The best yield of 6-hydrazinopyrimidines **6** were obtained by refluxing for 3 hours an ethanolic solution of **1** and hydrazine hydrate. When hydrazinolysis was performed using 1-butanol as solvent and heating at reflux for 3 hours the reaction mixture, besides derivatives **6** a small amount of 4-dialkylamino-3,6-diamino-1*H*-pyrazolo[3,4-*d*]pyrimidine **7** was isolated. Derivatives **7** were selectively obtained by thermal cyclization of hydrazinopyrimidines **6**.

Scheme 3



a, X = pyrrolidino
b, X = morpholino
c, X = piperidino

The 6-hydrazinopyrimidines **6** were transformed into a series of azolopyrimidines (Scheme 3). Upon treatment of compounds **6** with trimethyl orthoformate the cyclization between the 6-hydrazino group and N-3 position occurred to give 1,2,4-triazolo[4,3-*c*]pyrimidine derivatives **8**. When a hydrochloric acid solution of **6** was allowed to react with an aqueous solution of sodium nitrite at 0-5 °C tetrazolo[1,5-*c*]pyrimidines **9** were obtained in good yields.

The structure of fused pyrimidines was assigned on the basis of elemental analysis and spectral data.

EXPERIMENTAL

Melting points were determined on a Kofler hot stage and are uncorrected. Ir spectra were obtained in Nujol with a Perkin-Elmer 398 spectrophotometer. ^1H-nmr spectra were recorded on a Varian Unity 300 spectrometer, the chemical shifts are given in δ (ppm) downfield from the internal standard hexamethyldisiloxane (HMDSO) and coupling constants in Hz. Mass spectra were taken *via* the solid inlet from solid samples in glass capillary sealed on the other end with excitation energies 70 eV with a Fisons QMD spectrometer in EI mode. Elemental analyses were carried out with a Carlo Erba Model 1106 Elemental Analyzer.

2-Amino-4-dialkylamino-6-methylthiopyrimidine-5-carbonitriles **1** were prepared according to previously described procedure [13].

General Procedure for the Synthesis of 2-Amino-4-dialkylamino-6-methoxypyrimidine-5-carbonitriles **2**.

The appropriate pyrimidine **1** (2.5 mmoles) was added with stirring to a solution of sodium methoxyde (10 mmoles) obtained from metallic sodium (0.23 g) in anhydrous methanol (10 ml). The resulting solution was refluxed for 36 hours. After cooling the precipitate that formed was filtered off, washed with water and recrystallized from the appropriate solvent.

2-Amino-6-methoxy-4-pyrrolidinopyrimidine-5-carbonitrile (**2a**).

This compound was obtained from pyrimidine **1a** in a yield of 73%, mp 189-190 °C (Acetonitrile); ir: ν 3500, 3340, 3210, 2195, 1620, 1590, 1540 cm^{-1}; ^1H nmr (DMSO-d_6): δ 1.80, 3.56 (m, 8H, pyrrolidinyl), 3.78 (s, 3H, CH_3), 6.85 (s, 2H, NH_2).

Anal. Calcd. for $C_{10}H_{13}N_5O$: C, 54.78; H, 5.98; N, 31.94. Found: C, 54.83; H, 6.00; N, 31.90.

2-Amino-6-methoxy-4-morpholinopyrimidine-5-carbonitrile (**2b**).

This compound was obtained from pyrimidine **1b** in a yield of 95%, mp 209-210 °C (Acetonitrile); ir: ν 3410, 3390, 3340, 3220, 2200, 1650, 1570 cm^{-1}; ^1H nmr (DMSO-d_6): δ 3.58, 3.68 (m, 8H, morpholinyl), 3.80 (s, 3H, CH_3), 7.05 (s, 2H, NH_2).

Anal. Calcd. for $C_{10}H_{13}N_5O_2$: C, 51.06; H, 5.57; N, 29.77. Found: C, 51.00; H, 5.58; N, 29.74.

General Procedure for the Synthesis of 2-Amino-5-cyano-4-dialkylamino-1*H*-pyrimidine-6-ones **3**.

The appropriate 6-methoxypyrimidine **2** (1 mmole) was added to acetic acid (2 ml) and 98% sulfuric acid (2 ml). The resulting mixture was stirred in a water bath at 90 °C for 15 minutes. After cooling the reaction mixture was neutralized with 20% aqueous sodium hydroxide solution. The formed precipitate was filtered off and purified by recrystallization.

2-Amino-5-cyano-4-pyrrolidino-1*H*-pyrimidine-6-one (**3a**).

This compound was obtained from pyrimidine **4a** in a yield of 70%, mp 269-270 °C (Ethanol); ir: ν 3350, 3175, 2190, 1655, 1630, 1560 cm^{-1}; ^1H nmr (DMSO-d_6): δ 1.79, 3.56 (m, 8H, pyrrolidinyl), 6.74 (br s, 2H, NH_2), 10.37 (s, 1H, NH).

Anal. Calcd. for $C_9H_{11}N_5O$: C, 52.67; H, 5.40; N, 34.13. Found: C, 52.73; H, 5.39; N, 34.17.

2-Amino-5-cyano-4-morpholino-1*H*-pyrimidine-6-one (**3b**).

This compound was obtained from pyrimidine **2b** in a yield of 66%, mp 329-330 °C (Acetic acid); Lit. 327 °C [17], ir: ν 3320, 3200, 2200, 1670, 1585 cm^{-1}; ^1H nmr (DMSO-d_6): δ 3.58, 3.72 (m, 8H, morpholinyl), 7.00 (br s, 2H, NH_2), 10.75 (s, 1H, NH).

Anal. Calcd. for $C_9H_{11}N_5O_2$: C, 48.87; H, 5.01; N, 31.66. Found: C, 48.82; H, 5.02; N, 31.70.

General Procedure for the Synthesis of 2-Amino-6-benzylamino-4-dialkylaminopyrimidine-5-carbonitriles **4**.

A solution of 6-methylthiopyrimidine **1** (0.0025 mol) in 5 ml of benzylamine was refluxed for 5 hours. After cooling the formed precipitate was collected by filtration, dried and recrystallized from the solvent indicated.

2-Amino-6-benzylamino-4-pyrrolidinopyrimidine-5-carbonitrile (**4a**).

This compound was obtained starting from pyrimidine **1a** in quantitative yield, mp 222-223 °C (1-Propanol); ir: ν 3290, 3170, 2180, 1640 cm^{-1}; ^1H nmr (DMSO-d_6): 1.79, 3.54 (m, 8H, pyrrolidinyl), 4.50 (d, J = 5.9 Hz, 2H, CH_2), 6.36 (s, 2H, NH_2), 7.05-7.25 (m, 6H, Ar + NH).

Anal. Calcd. for $C_{16}H_{18}N_6$: C, 65.28; H, 6.16; N, 28.55. Found: C, 65.34; H, 6.15; N, 28.52.

2-Amino-6-benzylamino-4-morpholinopyrimidine-5-carbonitrile (**4b**).

This compound was obtained starting from pyrimidine **1b** in quantitative yield, mp 147-148 °C (2-Propanol); ir: ν 3500, 3420, 3350, 3220, 2170, 1620, 1570, 1555 cm^{-1}; ^1H nmr (DMSO-d_6): 3.59 (m, 8H, morpholinyl), 4.49 (d, J = 6.1 Hz, 2H, CH_2), 6.53 (s, 2H, NH_2), 7.00-7.24 (m, 6H, Ar + NH).

Anal. Calcd. for $C_{16}H_{18}N_6O$: C, 61.92; H, 5.85; N, 27.08. Found: C, 61.98; H, 5.84; N, 27.12.

3,6-Diamino-4-hydrazino-1*H*-pyrazolo[3,4-*d*]pyrimidine (**5**).

A mixture of pyrimidine **1** (2.5 mmol) and hydrazine hydrate (5 ml) was refluxed for 15 minutes. The formed precipitate was filtered off and washed with hot ethanol. Yield of 95%, mp 319-320 °C; ir: ν 3360, 3340, 3270, 3170 cm^{-1}; ^1H nmr (DMSO-d_6): δ 4.54 (br s, 2H, NH_2), 5.50 (br s, 2H, NH_2), 5.74 (s, 2H, NH_2), 7.99 (s, 1H, NH), 10.94 (s, 1H, H-1); MS: m/z (%) 180 (M^+, 100), 163 (7), 150 (20), 136 (10), 123 (22), 108 (14), 92 (18).

Anal. Calcd. for $C_5H_8N_8$: C, 33.33; H, 4.48; N, 62.20. Found: C, 33.39; H, 4.46; N, 62.18.

General Procedure for the Synthesis of 2-Amino-4-dialkylamino-6-hydrazinopyrimidine-5-carbonitriles **6**.

A mixture of pyrimidine **1** (2.5 mmol) and hydrazine hydrate (5 ml) in ethanol (5 ml) was refluxed for 3 hours. The resulting solid was collected by suction and recrystallized from the appropriate solvent.

2-Amino-6-hydrazino-4-pyrrolidinopyrimidine-5-carbonitrile (**6a**).

This compound was obtained from pyrimidine **1a** in a yield of 93%, mp 214-215 °C (Acetonitrile); ir: ν 3440, 3400, 3340, 3200, 2180, 1660, 1610 cm^{-1}; ^1H nmr (DMSO-d_6): δ 1.85, 3.58 (m, 8H, pyrrolidinyl) 4.31 (s, 2H, NH_2), 6.50 (s, 2H, NH_2), 7.75 (s, 1H, NH).

Anal. Calcd. for $C_9H_{13}N_7$: C, 49.30; H, 5.98; N, 44.72. Found: C, 49.26; H, 5.99; N, 44.69.

2-Amino-6-hydrazino-4-morpholinopyrimidine-5-carbonitrile (**6b**).

This compound was obtained from pyrimidine **1b** in a yield of 80%, mp 204-205 °C (2-Propanol); ir: ν 3420, 3380, 3320, 2180, 1640, 1570 cm^{-1}; ^1H nmr (DMSO-d_6): δ 3.58 (m, 8H, morpholinyl) 4.29 (s, 2H, NH_2), 6.66 (s, 2H, NH_2), 8.02 (s, 1H, NH).

Anal. Calcd. for $C_9H_{13}N_7O$: C, 45.95; H, 5.57; N, 41.68. Found: C, 46.00; H, 5.56; N, 41.65.

2-Amino-6-hydrazino-4-piperidinopyrimidine-5-carbonitrile (**6c**).

This compound was obtained from pyrimidine **1c** in a yield of 87%, mp 159-160 °C (Acetonitrile); ir: ν 3450, 3430, 3350, 3220, 2180, 1630, 1610 cm^{-1}; ^1H nmr (DMSO-d_6): δ 1.50, 3.58 (m, 10H, piperidinyl) 4.26 (s, 2H, NH_2), 6.56 (s, 2H, NH_2), 7.90 (s, 1H, NH).

Anal. Calcd. for $C_{10}H_{15}N_7$: C, 51.48; H, 6.48; N, 42.03. Found: C, 51.55; H, 6.47; N, 42.00.

General Procedure for the Synthesis of 3,6-Diamino-4-dialkylamino-1*H*-pyrazolo[3,4-*d*]pyrimidines **7**.

A solution of 4-hydrazinopyrimidine **6** (2.5 mmol) in 1-butanol (10 ml) was refluxed for 5 hours. The solvent was removed at reduced pressure and the residue recrystallized.

3,6-Diamino-4-pyrrolidino-1*H*-pyrazolo[3,4-*d*]pyrimidine (**7a**).

This compound was obtained from pyrimidine **6a** in a yield of 87%, mp 284-285 °C (2-Ethoxyethanol); ir: ν 3460, 3330, 3210, 1610, 1585 cm^{-1}; ^1H nmr (DMSO-d_6): δ 1.82, 3.62 (m, 8H, pyrrolidinyl) 4.57 (s, 2H, NH_2), 5.70 (s, 2H, NH_2), 11.23 (s, 1H, NH).

Anal. Calcd. for $C_9H_{13}N_7$: C, 49.30; H, 5.98; N, 44.72. Found: C, 49.35; H, 5.96; N, 44.70.

3,6-Diamino-4-morpholino-1*H*-pyrazolo[3,4-*d*]pyrimidine (**7b**).

This compound was obtained from pyrimidine **6b** in a yield of 85%, mp 204-205 °C (Ethanol); ir: ν 3440, 3420, 3330, 3310, 3150, 1650, 1600, 1570 cm^{-1}; ^1H nmr (DMSO-d_6): δ 3.63, 3.65 (m, 8H, morpholinyl) 4.74 (s, 2H, NH_2), 5.98 (s, 2H, NH_2), 11.35 (s, 1H, NH).

Anal. Calcd. for $C_9H_{13}N_7O$: C, 45.95; H, 5.57; N, 41.68. Found: C, 45.89; H, 5.59; N, 41.73.

3,6-Diamino-4-piperidino-1*H*-pyrazolo[3,4-*d*]pyrimidine (**7c**).

This compound was obtained from pyrimidine **6c** in a yield of 80%, mp 239-240 °C (Ethanol); ir: ν 3460, 3410, 3330, 3270, 3140, 1615 cm^{-1}; ^1H nmr (DMSO-d_6): δ 1.53, 3.54 (m, 10H, piperidinyl) 4.62 (s, 2H, NH_2), 5.85 (s, 2H, NH_2), 11.25 (s, 1H, NH).

Anal. Calcd. for $C_{10}H_{15}N_7$: C, 51.48; H, 6.48; N, 42.03. Found: C, 51.53; H, 6.46; N, 42.07.

General Procedure for the Synthesis of 5-Amino-7-dialkylamino-1,2,4-triazolo[4,3-*c*]pyrimidine-8-carbonitriles **8**.

A mixture of compounds **6** (2 mmol) in 10 ml of trimethyl orthoformate was heated under reflux for 10 hours. After cooling, the formed precipitate was filtered off, dried and recrystallized.

5-Amino-7-pyrrolidino-1,2,4-triazolo[4,3-*c*]pyrimidine-8-carbonitrile (**8a**).

This compound was obtained from pyrimidine **6a** in a yield of 85%, mp 249-250 °C (2-Ethoxyethanol); ir: ν 3320, 3130, 2190, 1665, 1610 cm^{-1}; ^1H nmr (DMSO-d_6): δ 1.87, 3.67 (m, 8H, pyrrolidinyl) 8.40 (br s, 2H, NH_2), 8.96 (s, 1H, H-3).

Anal. Calcd. for $C_{10}H_{11}N_7$: C, 52.39; H, 4.84; N, 42.77. Found: C, 52.45; H, 4.82; N, 42.74.

5-Amino-7-morpholino-1,2,4-triazolo[4,3-*c*]pyrimidine-8-carbonitrile (**8b**).

This compound was obtained from pyrimidine **6b** in a yield of 86%, mp 229-230 °C (2-ethoxyethanol); ir: ν 3450, 3350, 3100, 2200, 1665, 1610 cm^{-1}; ^1H nmr (DMSO-d_6): δ 3.65, 3.80 (m, 8H, morpholinyl), 8.52 (br s, 2H, NH_2), 8.99 (s, 1H, H-3).

Anal. Calcd. for $C_{10}H_{11}N_7O$: C, 48.97; H, 4.53; N, 39.98. Found: C, 48.91; H, 4.54; N, 40.02.

5-Amino-7-piperidino-1,2,4-triazolo[4,3-*c*]pyrimidine-8-carbonitrile (**8c**).

This compound was obtained from pyrimidine **6c** in a yield of 82%, mp 229-230 °C (Ethanol); ir: ν 3340, 3260, 3130, 2170, 1670, 1610 cm^{-1}; ^1H nmr (DMSO-d_6): δ 1.56, 3.79 (m, 10H, piperidinyl), 8.43 (br s, 2H, NH_2), 8.96 (s, 1H, H-3).

Anal. Calcd. for $C_{11}H_{13}N_7$: C, 54.30; H, 5.39; N, 40.31. Found: C, 54.36; H, 5.37; N, 40.28.

General Procedure for the Synthesis of 5-Amino-7-dialkylaminotetrazolo[1,5-*c*]pyrimidine-8-carbonitriles **9**.

A solution of sodium nitrite (7 mmol) in water (10 ml) was added to an ice cooled and stirred solution of compound **6** (3 mmol) in 20% aqueous hydrochloric acid (6 ml). The mixture was allowed to react for 2 hours at the same temperature. Then the formed precipitate was collected by filtration and recrystallized.

5-Amino-7-pyrrolidinotetrazolo[1,5-*c*]pyrimidine-8-carbonitrile (**9a**).

This compound was obtained from pyrimidine **6a** in a yield of 65%, mp 175-176 °C (2-Propanol); ir: ν 3460, 3430, 3060, 2190, 1745, 1675 cm^{-1}; ^1H nmr (DMSO-d_6): δ 1.88, 3.57 (m, 8H, pyrrolidinyl) 8.86 (br s, 2H, NH_2).

Anal. Calcd. for $C_9H_{10}N_8$: C, 46.95; H, 4.38; N, 48.67. Found: C, 47.04; H, 4.36; N, 48.63.

5-Amino-7-morpholinotetrazolo[1,5-*c*]pyrimidine-8-carbonitrile (**9b**).

This compound was obtained from pyrimidine **6b** in a yield of 68%, mp 180-181 °C (2-Propanol); ir: ν 3530, 3370, 2210, 1775, 1660, 1590 cm^{-1}; ^1H nmr (DMSO-d_6): δ 3.66, 3.77 (m, 8H, morpholinyl), 4.06 (br s, 2H, NH_2).

Anal. Calcd. for $C_9H_{10}N_8O$: C, 43.90; H, 4.09; N, 45.51. Found: C, 43.96; H, 4.08; N, 45.47.

5-Amino-7-piperidinotetrazolo[1,5-*c*]pyrimidine-8-carbonitrile (**9c**).

This compound was obtained from pyrimidine **6c** in a yield of 62%, mp 194-195 °C (2-Propanol); ir: ν 2200, 1770, 1590 cm^{-1}; ^1H nmr (DMSO-d_6): δ 1.61, 3.62 (m, 10H, piperidinyl), 4.86 (s, 2H, NH_2).

Anal. Calcd. for $C_{10}H_{12}N_8$: C, 49.17; H, 4.95; N, 45.88. Found: C, 49.11; H, 4.93; N, 45.93.

Acknowledgement.

This work was supported by grants from MURST, Italy.

REFERENCES AND NOTES

[1] H. A. Daboun, A. M. El-Reedy, *Z. Naturforsch.*, **38b**, 1686 (1983).

[2] K. Suguira, A. F. Schimd, M. M. Schimd, F. G. Brown, *Cancer Chemother. Rep. Part 2*, **3**, 231 (1973).

[3] G. L. Regnier, R. J. Canevar, J. C. Le Donarec, S. Holstop, J. Daussy, *J. Med. Chem.*, **15**, 295 (1972).

[4] G. N. Pershin, L. I. Sherbakova, T. N. Zykova, V. N. Sokolova, *Farmakol. Toksicol.*, **35**, 466 (1972); *Chem. Abstr.*, **77**, 135580z (1972).

[5] G. Matolcsy, *World Rev. Pest. Contr.*, **10**, 50 (1971); *Chem. Abstr.*, **76**, 82031s (1972).

[6] L. P. Prikazchikova, B. M. Khutova, I. F. Vladimirtsev, I. V. Boldyrev, N. I. Zhuravskaya, *Fiziol. Akt. Veshchestva*, **7**, 84 (1975); *Chem. Abstr.*, **83**, 127346m (1975).

[7] G. E. Wright and N. C. Brown, *J. Med. Chem.*, **20**, 1181 (1977).

[8] G. E. Wright, E. F. Baril and N. C. Brown, *Nucleic Acid Res.*, **8**, 99 (1980).

[9] E. C. Taylor, H. H. Patel, *Tetrahedron*, **48**, 37, 8089 (1992).

[10] P. Traxler, G. Bold, J. Frei, M. Lang, N. Lydon, *J. Med. Chem.*, **40**, 22, 3601 (1997).

[11] W. A. Kleschik, Eur. Pat. Appl. EP 150,974 (1985); *Chem. Abstr.*, **104**, 5892t (1986).

[12] C. B. Vicentini, T. Poli, A. C. Veronese, V. Brandolini, M. Manfrini, M. Guarneri, P. Giori, *Pestic. Sci.*, **27**, 1, 77 (1989).

[13] M. T. Cocco, C. Congiu, A. Maccioni and V. Onnis, *Synthesis*, 529 (1991).

[14] D. J. Brown "Pyrimidines and Their Benzo Derivatives" in "Comprehensive Heterocyclic Chemistry" in Vol **3**, A. R. Katrizky and C. W. Rees, eds, Pergamon Press, Oxford, 1984, p 443.

[15] H. Yamanaka and H. Sakamoto, *Yuki Gousei Kagaku Kyokaishi*, (*J. Synth. Org. Chem. Japan*), **43**, 951 (1985).

[16] G. B. Barlin and D. J. Brown "Topics in Heterocyclic Chemistry", R. N. Castle ed, Wiley Interscience, New York, 1969, p 123.

[17] A. Kumar, V. Aggarwal, H. Ila, H. Junjappa, *Synthesis*, 748 (1980).