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A CONVENIENT SYNTHESIS OF 1,3-DISUBSTITUTED 4-THIOXO-3,4-DIHYDROPYRIDO[2,3-*d*]PYRIMIDIN-2(1*H*)-ONES AND 4-THIOXO-3,4-DIHYDROPYRIDO[4,3-*d*]PYRIMIDIN-2(1*H*)-ONES

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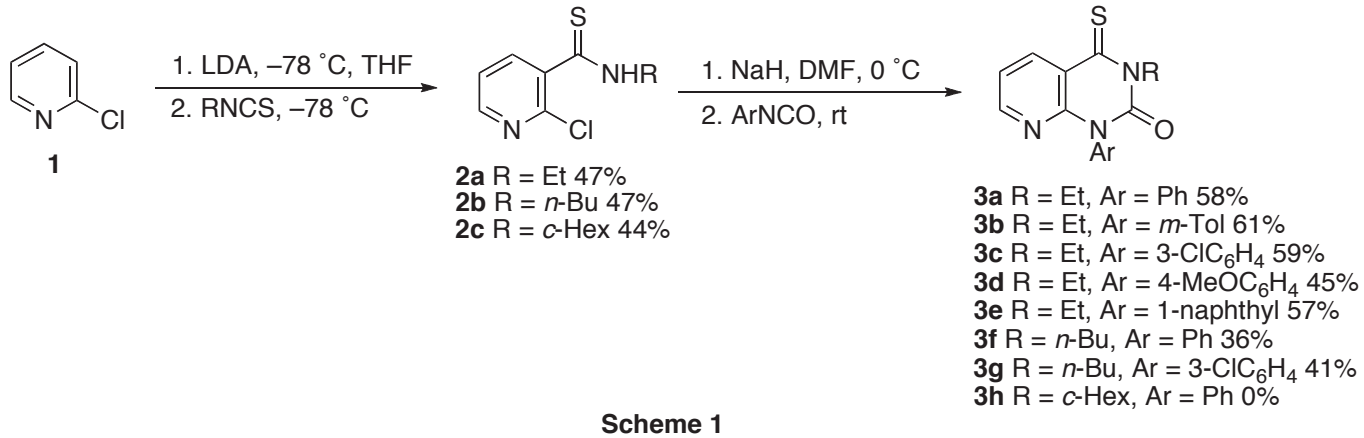
Abstract – The reaction of 2-chloro-3-lithiopyridine with alkyl isothiocyanates gave the corresponding *N*-alkyl-2-chloropyridine-3-thiocarboxamides, which in turn were allowed to react with aryl isocyanates in the presence of sodium hydride as a base to give 3-alkyl-1-aryl-4-thioxo-3,4-dihydropyrido[2,3-*d*]pyrimidin-2(1*H*)-ones. A similar sequence starting from 4-chloro-3-lithiopyridine and ethyl isothiocyanate gave 1-aryl-3-ethyl-4-thioxo-3,4-dihydropyrido[4,3-*d*]pyrimidin-2(1*H*)-ones, *via* 4-chloro-*N*-ethylpyridine-3-thiocarboxamide.

A survey of the literature revealed that there have been few efficient methods for the preparation of 4-thioxo-3,4-dihydropyrido[2,3-*d*]pyrimidin-2(1*H*)-ones, so far. For example, some of these derivatives have been prepared using the reaction of benzylidenemalononitriles with 6-amino-4-thioxo-1,2,3,4-tetrahydropyrimidin-2-one.[1] However, this method requires long reaction times and suffers from less availability of 6-amino-4-thioxo-1,2,3,4-tetrahydropyrimidin-2-one. On the other hand, we recently reported a synthesis of 1,3-disubstituted 4-thioxo-3,4-dihydroquinazolin-2(1*H*)-ones by the reaction of *N*-alkyl-2-fluorobenzothioamides with isocyanates in the presence of sodium hydride.[2] Therefore, we became interested in developing a new and facile method for their preparation, and expected that it should be achieved *via* the reaction of secondary 2-chloropyridine-3-thiocarboxamides with isocyanates in the presence of an appropriate base, such as sodium hydride. In this paper we wish to report the results of our investigation, which provide an efficient method for preparing 3-alkyl-1-aryl-4-thioxo-3,4-dihydropyrido[2,3-*d*]pyrimidin-2(1*H*)-ones. The synthesis of 1-aryl-3-ethyl-4-thioxo-3,4-dihydropyrido[4,3-*d*]pyrimidin-2(1*H*)-ones from secondary 4-chloropyridine-3- thiocarboxamides is also described. These thioxopyridopyrimidinone derivatives are of potential interest since some compounds having the related 4-thioxo-3,4-dihydrobenzoquinazolin-2(1*H*)-one skeleton have been reported to exhibit

biological properties.[3]

First, we searched for a method for the preparation of secondary 2-chloropyridine- 3-thiocarboxamides (**2**), which could serve as precursors for the desired 4-thioxo-3,4-dihydropyrido[2,3-*d*]pyrimidin-2(1*H*)-ones (**3**), and expected that the reaction of 2-chloro-3-lithiopyridine, generated from 2-chloropyridine (**1**) and LDA under conditions reported by Gribble and Saulnier,[4] with isothiocyanates should give the desired thiocarboxamides (**2**) as shown in Scheme 1. As expected, the reaction of 2-chloro-3-lithiopyridine with alkyl isothiocyanate, such as ethyl, *n*-butyl, and cyclohexyl isothiocyanates gave the corresponding thiocarboxamides (**2**) in moderate yields. However, in the cases of using benzyl and allyl isothiocyanate the corresponding thiocarboxamides could not be obtained at all, probably due to deprotonation of the benzylic and allylic hydrogen.

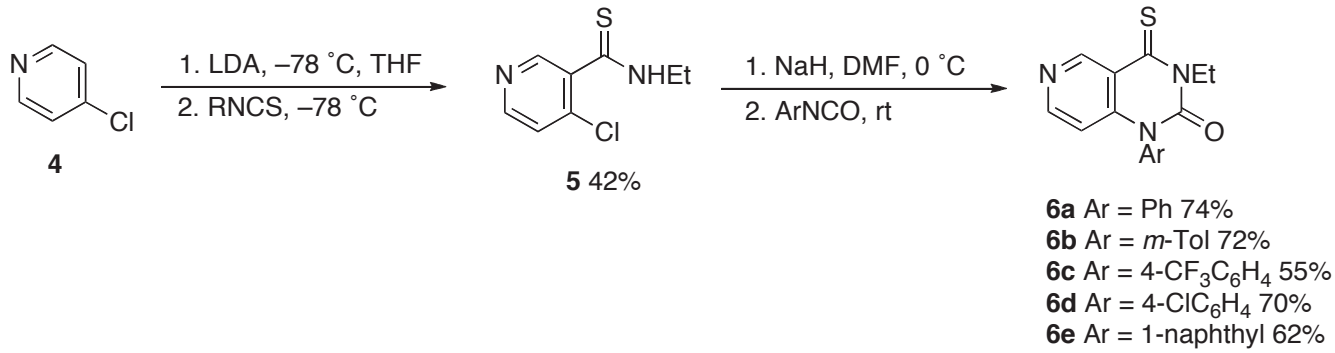


Scheme 1

The synthesis of 3-alkyl-1-aryl-4-thioxo-3,4-dihydropyrido[2,3-*d*]pyrimidin-2(1*H*)-ones (**3**) from 2-chloro-*N*-ethylpyridine-3-thiocarboxamide (**2a**) and *N*-butyl-2-chloropyridine-3-thiocarboxamide (**2b**) was achieved as illustrated in Scheme 1. Thus, these thiocarboxamides (**2**) were treated with sodium hydride at 0 ˚C. After the evolution of hydrogen gas had ceased, the temperature was raised to room temperature and isocyanates were added. At this temperature the reaction mixture was stirred overnight. Addition of the amide anion to isocyanate and intramolecular substitution of the resulting urea anion intermediate on the 2-chloro substituent proceeded gradually. The desired products (**3**) were isolated after usual workup and the subsequent purification by recrystallization. The yields are shown in Scheme 1. Although the yields of the products (**3**) were generally moderate, when **2b** was used, the yields of the corresponding desired products were somewhat lower than those from **2a**. It was found that the reaction of **2a** with an aliphatic isocyanate, such as *n*-butyl isocyanate, did not give the desired products; **2a** was recovered almost quantitatively. It was also found that 2-chloro-*N*-cyclohexylpyridine-3-thiocarboxamide (**2c**) did not undergo the present reaction sequence and that **2c** was recovered almost quantitatively after an extended reaction time at a higher temperature. This could be attributed to the steric bulkiness of

cyclohexyl substituent, which obstructs the addition of the respective amide anion to isocyanates.

Next, we were interested in investigating the use of 4-chloropyridine (**4**) for synthesizing 4-thioxo-3,4-dihydropyrido[4,3-*d*]pyrimidin-2(1*H*)-ones (**6**) *via* 4-chloro-3-lithiopyridine[4] and 4-chloro-*N*-ethylpyridine-3-thiocarboxamide (**5**) as shown in Scheme 2. The synthesis of **6** could also be achieved under conditions similar to those described above for the preparation of 4-thioxo-3,4-dihydropyrido[2,3-*d*]pyrimidin-2(1*H*)-ones (**3**). The yields of the products **6** are summarized in Scheme 2.



Scheme 2

In conclusion, we have demonstrated an efficient method for the preparation of 4-thioxo-3,4-dihydropyrido[2,3-*d*]pyrimidin-2(1*H*)-one derivatives from 2-chloropyridine using a two-step sequence. We have applied this method to 4-chloro-*N*-ethylpyridine-3-thiocarboxamide to lead to the first construction of 4-thioxo-3,4-dihydropyrido[4,3-*d*]pyrimidin-2(1*H*)-ones. The present method may find usefulness in the ready availability of the starting materials as well as the simplicity of the operations.

EXPERIMENTAL

The melting points were obtained on a Laboratory Devices MEL-TEMP II melting apparatus and are uncorrected. IR spectra were recorded with a Shimadzu FTIR-8300 spectrophotometer. The ^{1}H NMR spectra were recorded using TMS as an internal reference with a JEOL ECP500 FT NMR spectrometer operating at 500 MHz. The ^{13}C NMR spectra were recorded using TMS as an internal reference with a JEOL ECP500 FT NMR spectrometer operating at 125 MHz. Low-resolution MS spectra (EI, 70 eV) were measured by a JEOL JMS AX505 HA spectrometer. TLC was carried out on a Merck Kieselgel 60 PF_{254}. Column chromatography was performed using WAKO GEL C-200E. All of the organic solvents used in this study were dried over appropriate drying agents and distilled prior to use.

Starting Materials. All chemicals used in this study were commercially available.

Typical Procedure for the Preparation of 2-Chloropyridine-3-thiocarboxamides (2) and 4-Chloro-*N*-ethylpyridine-3-thiocarboxamide (5). 2-Chloro-*N*-ethylpyridine-3-thiocarboxamide (2a).

To a stirred solution of LDA (25 mmol), generated by the standard method, in THF (25 mL) at –78 ˚C was added 2-chloropyridine (**1**) (1.1 g, 10 mmol); the mixture was stirred for 1.5 h at the same temperature.[4] Ethyl isothiocyanate (2.2 g, 25 mmol) was added and stirring was continued for an additional 10 min before adding saturated aqueous NH_4Cl. The mixture was extracted with AcOEt three times (20 mL each), and the combined extracts was washed with brine and dried over anhydrous Na_2SO_4. After evaporation of the solvent the residue was purified by column chromatography on silica gel to give **2a** (0.94 g, 47%); a brown oil; R_f 0.29 (1:2 THF–hexane); IR (neat) 3208, 1559, 1398 cm^{-1}; ^1H NMR δ 1.39 (t, *J* = 7.3 Hz, 3H), 3.85–3.91 (m, 2H), 7.29 (dd, *J* = 7.8, 5.0 Hz, 1H), 7.59 (br s, 1H), 7.96 (dd, *J* = 7.8, 2.3 Hz, 1H), 8.39 (dd, *J* = 5.0, 2.3 Hz, 1H). Anal. Calcd for $C_8H_9ClN_2S$: C, 47.88; H, 4.52; N, 13.96. Found: C, 47.79; H, 4.77; N, 13.87.

***N*-Butyl-2-chloropyridine-3-thiocarboxamide (2b):** a yellow oil; R_f 0.28 (1:2 THF–hexane); IR (neat) 3207, 1557, 1398 cm^{-1}; ^1H NMR δ 1.00 (t, *J* = 7.3 Hz, 3H), 1.46–1.51 (m, 2H), 1.74–1.80 (m, 2H), 3.84 (q, *J* = 7.3 Hz, 2H), 7.29 (dd, *J* = 7.3, 4.6 Hz, 1H), 7.61 (br s, 1H), 7.96 (dd, *J* = 7.3, 1.8 Hz, 1H), 8.39 (dd, *J* = 4.6, 1.8 Hz, 1H). Anal. Calcd for $C_{10}H_{13}ClN_2S$: C, 52.51; H, 5.73; N, 12.25. Found: C, 52.45; H, 5.75; N, 12.22.

2-Chloro-*N*-cyclohexylpyridine-3-thiocarboxamide (2c): a yellow solid; mp 192–195 ˚C (hexane–AcOEt); IR (KBr) 3200, 1536, 1397 cm^{-1}; ^1H NMR δ 1.23–1.31 (m, 1H), 1.33–1.40 (m, 2H), 1.44–1,52 (m, 2H), 1.68–1.72 (m, 1H), 1.77–1.82 (m, 2H), 2.19–2.22 (m, 2H), 4.50–4.57 (m, 1H), 7.29 (ddd, *J* = 8.2, 4.6, 0.9 Hz, 1H), 7.44 (br s, 1H), 7.95 (dd, *J* = 8.2, 1.8 Hz, 1H), 8.38 (dd, *J* = 4.6, 1.8 Hz, 1H). Anal. Calcd for $C_{12}H_{15}ClN_2S$: C, 56.57; H, 5.93; N, 11.00. Found: C, 56.48; H, 5.93; N, 10.97.

4-Chloro-*N*-ethylpyridine-3-thiocarboxamide (5): a yellow solid; mp 121–124 ˚C (hexane–THF); IR (KBr) 3161, 1545, 1393 cm^{-1}; ^1H NMR δ 1.39 (t, *J* = 7.3 Hz, 3H), 3.85–3.90 (m, 2H), 7.31 (d, *J* = 5.5 Hz, 1H), 7.54 (br s, 1H), 8.44 (d, *J* = 5.5 Hz, 1H), 8.69 (s, 1H). Anal. Calcd for $C_8H_9ClN_2S$: C, 47.88; H, 4.52; N, 13.96. Found: C, 47.71; H, 4.63; N, 13.89.

Typical Procedure for the Preparation of 4-Thioxo-3,4-dihydropyrido[2,3-*d*]pyrimidin-2(1*H*)-ones (3) or 4-Thioxo-3,4-dihydropyrido[4,3-*d*]pyrimidin-2(1*H*)-ones (6). 3-Ethyl-1-phenyl-4-thioxo-3,4-dihydropyrido[2,3-*d*]pyrimidin-2(1*H*)-one (3a). To a stirred suspension of NaH (60% in oil; 30 mg, 0.75 mmol) in DMF (1.5 mL) at 0 ˚C was added a solution of **2a** (0.15 g, 0.75 mmol) in DMF (1.5 mL). After ceasing evolution of H_2 gas the reaction temperature was raised to rt and PhNCO (89 mg, 0.75 mmol) was added; stirring was continued overnight at the same temperature. Saturated aqueous NH_4Cl (15 mL) was added and the mixture was extracted with AcOEt three times (10 mL each). The combined extracts were washed with water three times and then brine once, dried over anhydrous Na_2SO_4, and concentrated by evaporation. The residual solid was recrystallized from hexane–CH_2Cl_2 to afford **3a** (0.12 g, 58%); a yellow solid; mp 165–167 ˚C; IR (KBr) 1703, 1583, 1330 cm^{-1}; ^1H NMR δ 1.40 (t, *J* = 7.3 Hz, 3H), 4.76 (q, *J* = 7.3 Hz, 2H), 7.19 (dd, *J* = 7.8, 4.6 Hz, 1H), 7.32 (dd, *J* = 7.8, 1.4 Hz, 2H), 7.52 (tt, *J* =

7.3, 1.4 Hz, 1H), 7.58 (dd, *J* = 7.8, 7.3 Hz, 2H), 8.48 (dd, *J* = 4.6, 1.8 Hz, 1H), 8.96 (dd, *J* = 7.8, 1.8 Hz, 1H); ^{13}C NMR δ 11.39, 44.29, 117.31, 120.01, 128.77, 129.03, 129.61, 135.80, 142.03, 148.24, 148.78, 153.91, 189.96; MS *m/z* 283 (100, M^+). Anal. Calcd for $C_{15}H_{13}N_3OS$: C, 63.58; H, 4.62; N, 14.83. Found: C, 63.40; H, 4.69; N, 14.82.

3-Ethyl-1-(3-methylphenyl)-4-thioxo-3,4-dihydropyrido[2,3-*d*]pyrimidin-2(1*H*)-one (3b): a yellow solid; mp 173–175 °C (hexane–CH_2Cl_2); IR (KBr) 1705, 1584, 1335 cm^{-1}; ^{1}H NMR δ 1.40 (t, *J* = 7.3 Hz, 3H), 2.44 (s, 3H), 4.75 (q, *J* = 7.3 Hz, 2H), 7.12 (d, *J* = 7.8 Hz, 1H), 7.13 (s, 1H), 7.18 (dd, *J* = 7.8, 4.6 Hz, 1H), 7.32 (d, *J* = 7.3 Hz, 1H), 7.46 (dd, *J* = 7.8, 7.3 Hz, 1H), 8.50 (dd, *J* = 4.6, 1.4 Hz, 1H), 8.96 (dd, *J* = 7.8, 1.4 Hz, 1H); ^{13}C NMR δ 11.38, 21.43, 44.29, 117.28, 119.94, 125.66, 129.25, 129.40, 129.97, 135.67, 139.69, 142.01, 148.31, 148.82, 153.98, 189.96; MS *m/z* 297 (100, M^+). Anal. Calcd for $C_{16}H_{15}N_3OS$: C, 64.62; H, 5.08; N, 14.13. Found: C, 64.49; H, 5.08; N, 14.08.

1-(3-Chlorophenyl)-3-ethyl-4-thioxo-3,4-dihydropyrido[2,3-*d*]pyrimidin-2(1*H*)-one (3c): a yellow solid; mp 164–167 °C (hexane–CH_2Cl_2); IR (KBr) 1701, 1584, 1333 cm^{-1}; ^{1}H NMR δ 1.39 (t, *J* = 7.3 Hz, 3H), 4.75 (q, *J* = 7.3 Hz, 2H), 7.21 (dd, *J* = 8.2, 4.6 Hz, 1H), 7.24 (dd, *J* = 7.3, 2.3, 1.8 Hz, 1H), 7.35 (t, *J* = 1.8 Hz, 1H), 7.48–7.52 (m, 2H), 8.48 (dd, *J* = 4.6, 1.8 Hz, 1H), 8.95 (dd, *J* = 8.2, 1.8 Hz, 1H); ^{13}C NMR δ 11.39, 44.30, 117.31, 120.27, 127.26, 129.36, 129.43, 130.44, 135.07, 136.77, 142.13, 147.88, 148.55, 153.83, 189.82; MS *m/z* 317 (100, M^+). Anal. Calcd for $C_{15}H_{12}ClN_3OS$: C, 56.69; H, 3.81; N, 13.22. Found: C, 56.42; H, 3.80; N, 13.14.

3-Ethyl-1-(4-methoxyphenyl)-4-thioxo-3,4-dihydropyrido[2,3-*d*]pyrimidin-2(1*H*)-one (3d): a yellow solid; mp 223–225 °C (hexane–CH_2Cl_2); IR (KBr) 1692, 1582, 1337 cm^{-1}; ^{1}H NMR δ 1.39 (t, *J* = 7.3 Hz, 3H), 3.87 (s, 3H), 4.76 (q, *J* = 7.3 Hz, 2H), 7.07 (d, *J* = 8.7 Hz, 2H), 7.18 (dd, *J* = 7.8, 4.6 Hz, 1H), 7.23 (d, *J* = 8.7 Hz, 2H), 8.51 (dd, *J* = 4.6, 1.8 Hz, 1H), 8.96 (d, *J* = 7.8, 1.8 Hz, 1H); ^{13}C NMR δ 11.39, 44.34, 55.44, 114.92, 117.35, 119.94, 128.24, 129.69, 142.06, 148.50, 149.01, 153.97, 159.69, 189.95; MS *m/z* 313 (100, M^+). Anal. Calcd for $C_{16}H_{15}N_3O_2S$: C, 61.32; H, 4.82; N, 13.41. Found: C, 61.08; H, 4.87; N, 13.44.

3-Ethyl-1-(naphthalen-1-yl)-4-thioxo-3,4-dihydropyrido[2,3-*d*]pyrimidin-2(1*H*)-one (3e): a yellow solid; mp 233–236 °C (hexane–CH_2Cl_2); IR (KBr) 1697, 1585, 1337 cm^{-1}; ^{1}H NMR δ 1.42 (t, *J* = 7.3 Hz, 3H), 4.76–4.83 (m, 2H), 7.17 (dd, *J* = 8.2, 4.6 Hz, 1H), 7.43–7.44 (m, 2H), 7.48–7.53 (m, 2H), 7.65 (t, *J* = 7.8 Hz, 1H), 7.97 (d, *J* = 8.2 Hz, 1H), 8.02 (d, *J* = 8.2 Hz, 1H), 8.36 (dd, *J* = 4.6, 1.4 Hz, 1H), 9.00 (dd, *J* = 8.2, 1.4 Hz, 1H); ^{13}C NMR δ 11.47, 44.28, 117.21, 120.10, 121.76, 125.71, 126.49, 126.89, 127.35, 128.82, 129.77, 130.16, 132.62, 134.61, 142.06, 148.55, 148.67, 154.24, 190.14; MS *m/z* 333 (100, M^+). Anal. Calcd for $C_{19}H_{15}N_3OS$: C, 68.45; H, 4.53; N, 12.60. Found: C, 68.32; H, 4.62; N, 12.41.

3-Butyl-1-phenyl-4-thioxo-3,4-dihydropyrido[2,3-*d*]pyrimidin-2(1*H*)-one (3f): a yellow solid; mp 174–176 °C (hexane–CH_2Cl_2); IR (KBr) 1705, 1583, 1333 cm^{-1}; ^{1}H NMR δ 0.97 (t, *J* = 7.3 Hz, 3H), 1.41–1.47 (m, 2H), 1.79–1.85 (m, 2H), 4.65–4.68 (m, 2H), 7.19 (dd, *J* = 8.2, 4.6 Hz, 1H), 7.31 (dd, *J* =

7.8, 1.4 Hz, 2H), 7.51 (tt, *J* = 7.3, 1.4 Hz, 1H), 7.58 (dd, *J* = 7.8, 7.3 Hz, 2H), 8.49 (dd, *J* = 4.6, 1.8 Hz, 1H), 8.96 (dd, *J* = 8.2, 1.8 Hz, 1H); ^{13}C NMR δ 13.70, 20.20, 28.00, 48.85, 117.34, 120.02, 128.77, 129.03, 129.62, 135.86, 142.10, 148.22, 149.02, 153.88, 190.12; MS *m*/*z* 311 (100, M^+). Anal. Calcd for $C_{17}H_{17}N_3OS$: C, 65.57; H, 5.50; N, 13.49. Found: C, 65.48; H, 5.49; N, 13.41.

3-Butyl-1-(3-chlorophenyl)-4-thioxo-3,4-dihydropyrido[2,3-*d*]pyrimidin-2(1*H*)-one (3g): a yellow solid; mp 128–130 °C (hexane–CH_2Cl_2); IR (KBr) 1709, 1584, 1331 cm^{-1}; ^{1}H NMR δ 0.98 (t, *J* = 7.3 Hz, 3H), 1.41–1.55 (m, 2H), 1.78–1.84 (m, 2H), 4.65 (t, *J* = 7.8 Hz, 2H), 7.19–7.24 (m, 2H), 7.34 (br s, 1H), 7.48–7.52 (m, 2H), 8.48 (dd, *J* = 4.6, 1.8 Hz, 1H), 8.95 (dd, *J* = 7.8, 1.8 Hz, 1H); ^{13}C NMR δ 13.69, 20.18, 28.00, 48.84, 117.32, 120.27, 127.24, 129.35, 129.41, 130.44, 135.08, 136.81, 142.17, 147.85, 148.76, 153.80, 189.97; MS *m*/*z* 345 (100, M^+). Anal. Calcd for $C_{17}H_{16}ClN_3OS$: C, 59.04; H, 4.66; N, 12.15. Found: C, 58.75; H, 4.75; N, 12.23.

3-Ethyl-1-phenyl-4-thioxo-3,4-dihydropyrido[4,3-*d*]pyrimidin-2(1*H*)-one (6a): a yellow solid; mp 124–127 °C (hexane–CH_2Cl_2); IR (KBr) 1705, 1587, 1352 cm^{-1}; ^{1}H NMR δ 1.39 (t, *J* = 7.3 Hz, 3H), 4.73 (q, *J* = 7.3 Hz, 2H), 6.38 (d, *J* = 5.5 Hz, 1H), 7.32 (d, *J* = 7.3 Hz, 2H), 7.58 (t, *J* = 7.3 Hz, 1H), 7.63 (t, *J* = 7.3 Hz, 2H), 8.47 (d, *J* = 5.5 Hz, 1H), 9.74 (s, 1H); ^{13}C NMR δ 11.37, 43.66, 108.98, 117.35, 128.43, 129.98, 130.55, 135.11, 143.66, 147.67, 152.94, 155.01, 189.51; MS *m*/*z* 283 (100, M^+). Anal. Calcd for $C_{15}H_{13}N_3OS$: 63.58; 4.62; 14.83. Found: C, 63.32; H, 4.74; N, 14.77.

3-Ethyl-1-(3-methylphenyl)-4-thioxo-3,4-dihydropyrido[4,3-*d*]pyrimidin-2(1*H*)-one (6b): a yellow solid; mp 102–105 °C (hexane–CH_2Cl_2); IR (KBr) 1713, 1577, 1343 cm^{-1}; ^{1}H NMR δ 1.39 (t, *J* = 7.3 Hz, 3H), 2.45 (s, 3H), 4.73 (q, *J* = 7.3 Hz, 2H), 6.40 (d, *J* = 6.0 Hz, 1H), 7.11 (d, *J* = 7.8 Hz, 1H), 7.12 (s, 1H), 7.38 (d, *J* = 7.8 Hz, 1H), 7.50 (dd, *J* = 7.8, 7.3 Hz, 1H), 8.46 (d, *J* = 6.0 Hz, 1H), 9.73 (s, 1H); ^{13}C NMR δ 11.38, 21.33, 43.65, 109.11, 117.34, 125.27, 128.81, 130.32, 130.78, 134.99, 140.90, 143.72, 147.71, 152.93, 154.99, 189.55; MS *m*/*z* 297 (100, M^+). Anal. Calcd for $C_{16}H_{15}N_3OS$: 64.62; 5.08; 14.13. Found: C, 64.54; H, 5.28; N, 14.05.

3-Ethyl-4-thioxo-1-(4-trifluoromethylphenyl)-3,4-dihydropyrido[4,3-*d*]pyrimidin-2(1*H*)-one (6c): a yellow solid; mp 153–155 °C (hexane–CH_2Cl_2); IR (KBr) 1705, 1598, 1323 cm^{-1}; ^{1}H NMR δ 1.38 (t, *J* = 7.3 Hz, 3H), 4.72 (q, *J* = 7.3 Hz, 2H), 6.35 (d, *J* = 6.0 Hz, 1H), 7.50 (d, *J* = 8.2 Hz, 2H), 7.91 (d, *J* = 8.2 Hz, 2H), 8.50 (d, *J* = 6.0 Hz, 1H), 9.74 (s, 1H); ^{13}C NMR δ 11.37, 43.70, 108.56, 117.38, 127.76, 129.08, 129.38, 132.44, 138.27, 143.06, 147.42, 153.18, 155.21, 189.29; MS *m*/*z* 351 (100, M^+). Anal. Calcd for $C_{16}H_{12}F_3N_3OS$: 54.70; 3.44; 11.96. Found: C, 54.53; H, 3.47; N, 11.89.

1-(4-Chlorophenyl)-3-ethyl-4-thioxo-3,4-dihydropyrido[4,3-*d*]pyrimidin-2(1*H*)-one (6d): a yellow solid; mp 169–171 °C (MeOH); IR (KBr) 1705, 1597, 1348 cm^{-1}; ^{1}H NMR δ 1.38 (t, *J* = 7.3 Hz, 3H), 4.71 (q, *J* = 7.3 Ha, 2H), 6.39 (d, *J* = 6.0 Hz, 1H), 7.27 (d, *J* = 8.7 Hz, 2H), 7.60 (d, *J* = 8.7 Hz, 2H), 8.49 (d, *J* = 6.0 Hz, 1H), 9.73 (s, 1H); ^{13}C NMR δ 11.37, 43.69, 108.73, 117.38, 129.93, 130.86, 133.53, 136.16, 143.38, 147.54, 153.08, 155.14, 189.37; MS *m*/*z* 317 (100, M^+). Anal. Calcd for $C_{15}H_{12}ClN_3OS$:

56.69; 3.81; 13.22. Found: C, 56.65; H, 4.03; N, 13.25.

3-Ethyl-4-thioxo-1-(naphthalen-1-yl)-3,4-dihydropyrido[4,3-*d*]pyrimidin-2(1*H*)-one (6e): a yellow solid; mp 218–220 °C (hexane–CH_2Cl_2); IR (KBr) 1705, 1593, 1350 cm^{-1}; ^1H NMR δ 1.41 (t, *J* = 7.3 Hz, 3H), 4.74–4.81 (m, 2H), 6.17 (d, *J* = 6.0 Hz, 1H), 7.46 (d, *J* = 8.2 Hz, 1H), 7.50–7.53 (m, 2H), 7.59 (ddd, *J* = 8.2, 7.3, 1.4 Hz, 1H), 7.67 (dd, *J* = 8.2, 7.3 Hz, 1H), 8.01 (d, *J* = 8.2 Hz, 1H), 8.09 (d, *J* = 8.2 Hz, 1H), 8.37 (d, *J* = 6.0 Hz, 1H), 9.79 (s, 1H); ^{13}C NMR δ 11.47, 43.67, 109.20, 117.35, 121.35, 125.94, 126.97, 127.19, 128.14, 129.00, 129.42, 130.67, 131.47, 134.89, 143.87, 147.64, 153.15, 155.07, 189.65; MS *m/z* 333 (100, M^+). Anal. Calcd for $C_{19}H_{15}N_3OS$: 68.45; 4.53; 12.60. Found: C, 68.18; H, 4.79; N, 12.39.

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