Heterocycles of biological importance: Part 7.  
Synthesis of biologically active pyrimido[2,1-b]benzothiazoles from acetylenic acids and 2-aminobenzothiazoles

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\textbf{Abstract}

Conjugate addition of the imino nitrogen of 2-aminobenzothiazoles 1 to the alkyne $\beta$-carbon atom of acetylenic acids 2 followed by ring closure gives rise to novel 2$H$-pyrimido[2,1-b]-benzothiazol-2-ones in good yield.

\textbf{Keywords:} Michael addition, amidines, fused nitrogen heterocycles, cyclocondensation

\textbf{Introduction}

Condensed pyrimidine compounds have been shown to exhibit interesting pharmacological properties\textsuperscript{2} and a number of synthetic methods\textsuperscript{3-11} has been reported for their preparation. As a part of an ongoing study of the syntheses of heterocyclic compounds of potential biological activity from allenic and acetylenic compounds,\textsuperscript{12-13} we have shown recently\textsuperscript{14} that substituted and unsubstituted 2$H$-pyrimido[2,1-b]benzothiazol-2-ones are a new group of GABA\textsubscript{A}/benzodiazepine receptor ligands. In this paper we wish to present the preparation of these compounds.

\textbf{Results and Discussion}
The conjugate addition of 2-aminobenzothiazole 1 to the acetylenic acids 2 in butanol, followed by cyclocondensation, gave the corresponding 2H-pyrimido[2,1-b]benzothiazol-2-ones 6-8 in 68–86% yield (Scheme 1).

![Scheme 1](image)

The structures of these compounds were established beyond any doubt by their 1H-NMR and 13C-NMR spectra and by additional COSY, HMQC (Heteronuclear Multiple-Quantum Correlation) and HMBC (Heteronuclear Multiple-Bond Correlation) experiments.

When 2-aminobenzothiazoles 1a–1d were allowed to react with phenyl propiolic acid (2c), 4-phenyl-2H-pyrimido[2,1-b]benzothiazol-2-ones 8a-8d were obtained. The NMR spectra of the 8-methoxy compound 8c and the 8-ethoxy compound 8d showed singlets at δ 6.20 ppm and δ 6.15 ppm, respectively, attributed to 3-H, and doublets at δ 6.01 ppm and δ 5.96 ppm, respectively, for 6-H. The shielding effects observed for the 6-H in the compounds 8a-8d is due to the diamagnetic effect of the phenyl group attached to C-4.
The above data exclude the formation of the isomeric 2-phenyl-4H-pyrimido[2,1-b]benzothiazole-4-ones 9 which should exhibit a deshielded proton (6-H) near δ 9 ppm resulting from the anisotropic effect of the carbonyl group\(^5\). Further evidence for the formation of the 2-one derivatives was obtained from the fact that no shielding effect was noticed in compounds 6a-d and 7a-d where the phenyl group was replaced by H or 1-pentyl, respectively.

The reaction of 2-aminobenzothiazoles 1 with acetylenic acids 2 is rationalized as shown (Scheme 1), whereby the alkynoic acid is first attacked at the β-carbon atom by the ring nitrogen atom of the benzothiazole. An attack of the 2-amino group of 1 on the β-carbon of 2 which eventually would generate the isomeric product 9 definitely does not occur\(^15,16\) (Scheme 2).

\[
\begin{align*}
R^1 & \quad S \quad \text{NH}_2 \quad + \quad \text{R}^3 \quad \equiv \quad \text{COOH} \\
\text{1} & \quad \text{2} \quad \text{\rightarrow} \quad \text{9} \\
\end{align*}
\]

Scheme 2

**Experimental Section**

**General Procedures.** All the melting points were determined with a Reichert Thermovar microscope and are uncorrected. Electron impact mass spectra (direct inlet, 70 eV) were recorded with a Jeol JMS-SX102 spectrometer. The Ultraviolet (UV) spectra were determined in an ethanol-chloroform mixture (1:1) on a Perkin – Elmer 554 instrument and the Infrared (IR) spectra were recorded with a Varian Cary 2290 and Perkin Elmer 298 spectrometers. \(^1\)H-NMR (500 MHz) and \(^{13}\)C-NMR spectra (125 MHz) were recorded at room temperature with a Bruker instrument using an inverse 5 mm probe equipped with a shielded gradient coil. Chemical shifts (δ) are given in ppm and coupling constants (in brackets) are reported in Hz. COSY, HMQC and HMBC experiments were performed with gradient enhancements using sine shaped gradient pulses, and for the 2D heteronuclear correlation spectroscopy, the refocusing delays were optimised for \(J_{CH} = 145\) Hz and \(J_{CH} = 10\) Hz. The raw data were transformed and the spectra were evaluated with the standard Bruker UXNMR software (rev. 941001). Combustion analyses were performed with CHN + O/S elemental analyser “CARLO ERBA” model 1106. The purity of the samples was checked routinely by TLC.

**Synthesis of 2H-pyrimido[2,1-b]benzothiazol-2-ones 6a-d, 7a-d and 8a-d**

The alkynoic acid 2a-c (20 mmol) and the appropriate 2-aminobenzothiazole (1a-d, 10 mmol) were heated to reflux in 1-butanol (50 mL) for 48 hours. Evaporation of solvent under reduced pressure gave the crude product which was crystallized from hexane/ethyl acetate to give the 2H-pyrimido[2,1-b]benzothiazol-2-ones.
$2H$-Pyrimido[2,1-$b$]benzothiazol-2-one (6a). From 1a and 2a, Yield: 68%; colourless crystals mp 272 – 275 °C [Lit$^4$: mp 272 – 275 °C]; IR: v/cm$^{-1}$ 1630 (C=O), 1583 (C=N), 1533 (C=C). UV (EtOH/CHCl$_3$ 1:1) $\lambda_{max}$ (nm), (log $\varepsilon$): 260 (4.03), 300 (4.11). NMR data: $\delta_H$ (CDCl$_3$) 6.32 (1H, d, $J_{3,4}$ 7.7 Hz, 3-H), 7.46 (1H, dd, $J_{7,6} = J_{7,8}$ 8.0 Hz, 7-H), 7.58 (1H, dd, $J_{9,7} = J_{9,8}$ 8.0 Hz, 8-H), 7.98 (1H, d, $J_{9,8}$ 7.9 Hz, 9-H), 8.03 (1H, d, $J_{6,7}$ 8.2 Hz, 6-H), 8.86 (1H, d, $J_{4,3}$ 7.7 Hz, 4-H). $\delta_C$ (CDCl$_3$) 110.8 (C-3), 122.9 (C-9a), 123.7 (C-6), 126.1 (C-9), 127.2 (C-7), 128.8 (C-8), 134.8 (C-4), 135.0 (C-5a), 163.6 (C-10a), 166.9 (C-2). MS (EI): $m/z$ 202.0213 (M$^+$, 100 %, C$_{10}$H$_8$N$_2$OS requires 202.0201) 176 (32), 174 (64), 150 (15), 148 (13); Anal. Calcd. for C$_{10}$H$_8$N$_2$OS: C, 59.41; H, 2.97; N, 13.86; S, 15.70. Find: C, 59.49; H, 3.03; N, 13.78; S, 15.70.

7,8-Dimethyl-$2H$-pyrimido[2,1-$b$]benzothiazol-2-one (6b). From 1b and 2a, Yield: 75%; colourless crystals, no melt below 300°C. IR: v/cm$^{-1}$ 1640 (C=O), 1617 (C=N), 1570 (C=C). UV (EtOH/CHCl$_3$ 1:1) $\lambda_{max}$ (nm), (log $\varepsilon$): 265 (4.16), 276 (4.12), 307 (4.26). NMR data: $\delta_H$ (CDCl$_3$) 2.30 (3H, s, 8-CH$_3$), 2.35 (3H, s, 7-CH$_3$), 6.41 (1H, d, $J_{3,4}$ 7.7 Hz, 3-H), 7.35 (1H, s, 9-H), 7.37 (1H, s, 6-H), 8.24 (1H, d, $J_{4,3}$ 7.7 Hz, 4-H); $\delta_C$ (CDCl$_3$) 197.7 (CH$_3$), 20.1 (8-CH$_3$), 111.5 (C-3), 112.1 (C-6), 120.6 (C-9a), 123.5 (C-9), 132.2 (C-5a), 133.1 (C-4), 136.3 (C-8), 137.0 (C-7), 164.3 (C-10a), 168.5 (C-2). MS (EI): $m/z$ 230.0513 (M$^+$, 100 %, C$_{12}$H$_{10}$N$_2$OS requires 230.0514) 204 (20), 202 (52), 189 (18), 187 (15). Anal. Calcd. for C$_{12}$H$_{10}$N$_2$OS: C, 62.61; H, 4.35; N, 12.17; O, 6.96; S, 13.91. Found: C, 62.72; H, 4.39; N, 12.11; S, 13.83.

8-Methoxy-$2H$-pyrimido[2,1-$b$]benzothiazol-2-one (6c). From 1c and 2a, Yield: 80%; colourless crystals; no melt below 300°C (Lit$^4$: > 300°C); IR: v/cm$^{-1}$ 1636 (C=O), 1492 (C=C), 1472 (C=C). UV (EtOH/CHCl$_3$ 1:1) $\lambda_{max}$ (nm), (log $\varepsilon$): 242 (4.27), 277 (4.12), 311 (4.21). NMR data: $\delta_H$ (CDCl$_3$) 3.82 (3H, s, 8-OCH$_3$), 6.29 (1H, d, $J_{3,4}$ 7.7 Hz, 3-H), 7.16 (1H, dd, $J_{7,6} = J_{7,8}$ 9.1 Hz and $J_{7,9}$ 2.6 Hz, 7-H), 7.64 (1H, d, $J_{9,7}$ 2.6 Hz, 9-H), 7.95 (1H, d, $J_{6,7}$ 9.1 Hz, 6-H), 8.81 (1H, d, $J_{4,3}$ 7.7 Hz, 4-H); $\delta_C$ (CDCl$_3$) 55.9 (8-OCH$_3$), 108.0 (C-9), 110.6 (C-3), 113.5 (C-7), 114.4 (C-6), 124.3 (C-9a), 128.6 (C-5a), 135.0 (C-4), 157.6 (C-8), 163.2 (C-10a), 166.7 (C-2). MS (EI): $m/z$ 232.0319 (M$^+$, 100 %, C$_{11}$H$_8$N$_2$O$_2$S requires 232.0306) 206 (18), 204 (33), 191 (20), 189 (27). Anal. Calcd. for C$_{11}$H$_8$N$_2$O$_2$S: C, 56.90; H, 3.45; N, 12.07; O, 13.79; S, 13.79. Found: C, 56.85; H, 3.51; N, 12.07; S, 13.88.

8-Ethoxy-$2H$-pyrimido[2,1-$b$]benzothiazol-2-one (6d). From 1d and 2a, Yield: 83%; colourless crystals (83 %); no melt below 300°C. IR: v/cm$^{-1}$ 1640 (C=O), 1585 (C=N), 1500 (C=C). UV (EtOH/CHCl$_3$ 1:1) $\lambda_{max}$ (nm), (log $\varepsilon$): 240 (4.30), 278 (4.12), 313 (4.23). NMR data: $\delta_H$ (CDCl$_3$) 1.35 (3H, t, $J_{6,7}$ 6.9 Hz, 8-OCH$_2$CH$_3$), 4.09 (2H, q, $J_{6,7}$ 6.9 Hz, 8-OCH$_2$CH$_3$ ), 6.29 (1H, d, $J_{3,4}$ 7.7 Hz, 3-H), 7.15 (1H, dd, $J_{7,6} = J_{7,8}$ 2.4 Hz, 7-H), 7.61 (1H, d, $J_{9,7}$ 2.4 Hz, 9-H), 7.92 (1H, d, $J_{6,7}$ 9.0 Hz, 6-H), 8.80 (1H, d, $J_{4,3}$ 7.7 Hz, 4-H). $\delta_C$ (CDCl$_3$) 14.5 (8-OCH$_2$CH$_3$), 64.0 (8-OCH$_2$CH$_3$), 108.4 (C-9), 110.6 (C-3), 113.5 (C-7), 114.8 (C-6), 124.3 (C-9a), 128.5 (C-5a), 135.0 (C-4), 156.8 (C-8), 163.2 (C-10a), 166.7 (C-2). MS (EI): $m/z$ 246.0461 (M$^+$, 100 %, C$_{12}$H$_{10}$N$_2$O$_2$S requires 246.0463) 218 (32), 192 (21), 190 (55), 165 (10). Anal. Calcd. for C$_{12}$H$_{10}$N$_2$O$_2$S: C, 58.54; H, 4.06; N, 11.38; O, 13.01; S, 13.01. Found: C, 58.65; H, 4.04; N, 11.28; S, 13.01.
4-Pentyl-2H-pyrimido[2,1-b]benzothiazol-2-one (7a). From 1a and 2b, Yield 75%; colourless crystals, mp 138-140°C. IR: v/cm⁻¹ 1634 (C=O), 1576 (C=N), 1500 (C=C). UV (EtOH/CHCl₃ 1:1) λₘₐₓ (nm), (log ε): 225 (4.47), 262 (4.13), 293 (4.06), 301 (4.08). NMR data: δH (CDCl₃) 0.86 (3H, t, J₅',₄' 7.2 Hz, 5'-H), 1.33 (2H, m, 4'-H), 1.43 (2H, m, 3'-H), 1.70 (2H, tt, J₂',₃' 8 Hz and J₂',₂' 8 Hz, 2'-H), 3.02 (2H, t, J₁',₂' 7.5 Hz, 1'-H), 6.13 (1H, s, 3-H), 7.36 (1H, dd, J₈,₇ 9 Hz and J₆,₈ 8 Hz, 8-H), 7.42 (1H, dd, J₇,₆ 9.0 Hz and J₇,₈ 8 Hz 7-H), 7.61 (1H, d, J₉,₈ 7.8 Hz, 9-H), 7.74 (1H, d, J₆,₇ 8.6 Hz, 6-H). δC (CDCl₃) 13.7 (C-5'), 22.1 (C-4'), 26.5 (C-2'), 30.7 (C-3'), 33.5 (C-1'), 110.7 (C-3), 116.0 (C-6), 123.1 (C-9), 124.1 (C-9a), 126 (C-7), 126.9 (C-8), 135.6 (C-5a), 151.5 (C-4), 164.8 (C-10a), 167.1 (C-2). MS (EI): m/z 272.0986 (M⁺, 97 %, C₁₅H₁₆N₂O₂S requires 272.0983) 230 (39), 216 (54), 188 (43), 187 (42), 176 (100), 146 (16). Anal. Calcd. for C₁₅H₁₆N₂O₂S: C, 66.18; H, 5.88; N, 10.29; O, 5.88; S, 11.76. Found: C, 66.01; H, 5.83; N, 10.25; S, 11.76.

7,8-Dimethyl-4-pentyl-2H-pyrimido[2,1-b]benzothiazol-2-one (7b). From 1b and 2b, Yield: 77%, Colourless needles; mp 178-181°C. IR: v/cm⁻¹ 1640 (C=O), 1570 (C=N), 1500 (C=C). UV (EtOH/CHCl₃ 1:1) λₘₐₓ (nm), (log ε): 232 (4.43), 274 (4.06), 307 (4.14); NMR data: δH (CDCl₃) 0.87 (3H, t, J₅',₄' 7.3 Hz, 5'-H), 1.35 (2H, tq, J₄',₃' 8.0 Hz and J₄',₅' 7.0 Hz, 4'-H), 1.44 (2H, m, 3'-H), 1.70 (2H, tt, J₁',₂' 8.0 Hz and J₂',₃' 8.0 Hz, 2'-H), 2.28 (3H, s, 7-CH₃), 2.32 (3H, s, 8-CH₃), 2.98 (2H, t, J₆',₇' 7.6 Hz, 1'-H), 6.10 (1H, s, 3-H), 7.32 (1H, s, 9-H), 7.46 (1H, s, 6-H). δC (CDCl₃) 13.7 (C-5'), 19.4 (8-CH₃), 20.6 (7-CH₃), 22.1 (C-4'), 26.7 (C-2'), 30.8 (C-3'), 33.5 (C-1'), 110.6 (C-3), 116.8 (C-6), 121.1 (C-9a), 123.2 (C-9), 133.9 (C-5a), 135.5 (C-7), 136.0 (C-8), 151.3 (C-4), 165.0 (C-10a), 167.3 (C-2). MS (EI): m/z 300.1279 (M⁺, 100 %, C₁₇H₂₀N₂OS requires 300.1296) 258 (36), 244 (39), 216 (36), 204 (85), 189 (13), 174 (11). Anal. Calcd. for C₁₇H₂₀N₂OS: C, 68.00; H, 6.67; N, 9.33; O, 5.33; S, 10.67. Found: C, 68.00; H, 6.70; N, 9.26; S, 10.55.

8-Methoxy-4-pentyl-2H-pyrimido[2,1-b]benzothiazol-2-one (7c). From 1b and 2c, yield: 80%; colourless crystals; mp 174-175 °C. IR: v/cm⁻¹ 1630 (C=O), 1574 (C=N), 1507 (C=C). UV (EtOH/CHCl₃ 1:1) λₘₐₓ (nm), (log ε): 231 (4.42), 285 (4.10), 308 (4.23). NMR data: δH (CDCl₃) 0.90 (3H, t, J₅',₄' 7.3 Hz, 5'-H), 1.37 (2H, tq, J₄',₃' 8.0 Hz and J₄',₅' 7.0 Hz, 4'-H), 1.45 (2H, m, 3'-H), 1.73 (2H, tt, J₂',₃' 8.0 Hz and J₂',₂' 8.0 Hz, 2'-H), 3.01 (2H, t, J₁',₂' 7.6 Hz, 1'-H), 3.85 (3H, s, 8-CH₃), 6.15 (1H, s, 3-H), 6.97 (1H, dd, J₇,₆ 9.4 Hz and J₇,₉ 2.7 Hz, 7-H), 7.12 (1H, d, J₉,₇ 2.7 Hz, 9-H), 7.65 (1H, d, J₆,₇ 9.4 Hz, 6-H). δC (CDCl₃) 13.8 (C-5') 22.2 (C-4'), 26.5 (C-2'), 30.9 (C-3'), 33.5 (C-1'), 55.8 (8-CH₃), 107.2 (C-9), 110.6 (C-3), 114.0 (C-7), 117.0 (C-6), 125.9 (C-9a), 129.6 (C-5a), 151.2 (C-4), 157.5 (C-8), 164.5 (C-10a), 167.3 (C-2). MS (EI): m/z 320.1071 (M⁺, 100 %, C₁₆H₁₈N₂O₂S requires 320.1089) 274 (6), 260 (21), 246 (32), 218 (20), 206 (81), 191 (12). Anal. Calcd. for C₁₆H₁₈N₂O₂S: C, 63.57; H, 5.96; N, 9.27; O, 10.60; S, 10.60. Found: C, 63.55; H, 5.95; N, 9.27; S, 10.60.

8-Ethoxy-4-pentyl-2H-pyrimido[2,1-b]benzothiazol-2-one (7d). From 1b and 2b, yield 84%; colourless crystals; mp 153-154°C. IR: v/cm⁻¹ 1640 (C=O), 1605 (C=N), 1580 (C=C); UV (EtOH/CHCl₃ 1:1) λₘₐₓ (nm), (log ε) : 219 (4.52), 231 (4.53), 287 (4.19), 310 (4.31). NMR data: δH (CDCl₃) 0.90 (3H, t, J₅',₄' 7.3 Hz, 5'-H), 1.36 (2H, tq, J₄',₃' 8.0 Hz and J₄',₅' 7.0 Hz, 4'-H), 1.42
(3H, t, J 7.0 Hz, 8-OCH₂CH₃), 1.45 (2H, m, 3'-H), 1.73 (2H, tt, J₂,3' 8.0 Hz and J₂,3 8.0 Hz 2'-H), 3.00 (2H, t, J₁,2' 7.6 Hz, 1'-H), 4.05 (2H, q, J 7.0 Hz, 8-OCH₂CH₃), 6.15 (1H, s, 3'-H), 6.95 (1H, dd, J₇,₈ 9.4 Hz and J₇,₉ 2.6 Hz, 7-H), 7.09 (1H, d, J₆,₇ 2.6 Hz, 9-H), 7.63 (1H, d, J₆,₇ 9.4 Hz, 6-H). δC (CDCl₃) 13.8 (C-5'), 14.6 (8-OCH₂CH₃), 22.2 (C-4'), 26.5 (C-2'), 30.9 (C-3'), 33.5 (C-1'), 64.2 (8-OCH₂CH₃), 107.6 (C-9), 110.5 (C-3), 114.0 (C-17), 117.0 (C-6), 125.9 (C-9a), 129.4 (C-5a), 151.2 (C-4), 156.9 (C-8), 164.5 (C-10a), 167.3 (C-2). MS (EI): m/z 316.1256 (M⁺, 100%, C₁₇H₂₀N₂O₂S requires 316.1245) 287 (9), 274 (23), 260 (28), 232 (20), 220 (55), 192 (18). Anal. Calcd. for C₁₇H₂₀N₂O₂S: C, 64.56; H, 6.32; N, 8.86; O, 10.13; S, 10.13. Found: C, 64.29; H, 6.39; N, 8.75; S, 10.05.

4-Phenyl-2H-pyrimidino[2,1-b]benzothiazol-2-one (8a). From 1a and 2c, yield 76%, colourless needles; mp 236-238°C (Lit⁴: 237 - 238 °C). IR: ν/cm⁻¹ 1640 (C=O), 1600 (C=N), 1585 (C=C); UV (EtOH/CHCl₃ 1:1) λmax (nm) (log ε): 220 (4.52), 243 (4.39), 300 (4.12). NMR data: δH (CDCl₃) 6.10 (1H, d, J₆,₇ 8.6 Hz, 6-H), 6.16 (1H, s, 3-H), 6.95 (1H, dd, J₆,₇ 8.0 Hz and J₇,₈ 8.0 Hz 7-H), 7.21 (1H, dd, J₆,₇ 8.0 Hz and J₈,₉ 8.0 Hz, 8-H), 7.38 (2H, d, J₂,3' 7.4 Hz, 2'-H, 6'-H), 7.51 (2H, dd, J₅,₆ 7.0 Hz and J₃,₄' 8.0 Hz 3'-H, 5'-H), 7.56 (1H, d, J₉,₈ 8.0 Hz, 9-H), 7.58 (1H, t, J₉,₃' 8.0 Hz, 4'-H). δC (CDCl₃) 112.9 (C-3), 116.2 (C-6), 122.8 (C-9), 123.9 (C-9a), 125.9 (C-7), 126.0 (C-8), 128.0 (C-2', C-6'), 129.2 (C-3', C-5'), 130.7 (C-4'), 131.8 (C-1'), 135.0 (C-5a), 148.9 (C-4), 164.6 (C-10a), 166.8 (C-2). MS (EI): m/z 278.0529 (M⁺, 100%, C₁₆H₁₀N₂OS requires 278.0514) 250 (67), 237 (7), 176 (64), 150 (12), 148 (8), 102 (13). Anal. Calcd. for C₁₆H₁₀N₂O₂: C, 69.06; H, 3.60; N, 10.07; O, 5.76; S, 11.51. Found: C, 69; H, 3.60; N, 10.02; S, 11.56.

7,8-Dimethyl-4-phenyl-2H-pyrimidino[2,1-b]benzothiazol-2-one (8b). From 1b and 2c, yield 78%, colourless crystals; mp 228-230°C. IR: ν/cm⁻¹ 1635 (C=O), 1600 (C=N), 1565 (C=C). UV (EtOH/CHCl₃ 1:1) λmax (nm) (log ε): 221 (4.53), 249 (4.38), 308 (4.22). NMR data: δH (CDCl₃) 1.89 (3H, s, 7-CH₃), 2.18 (3H, s, 8-CH₃), 5.79 (1H, s, 6-H), 6.18 (1H, s, 3-H), 7.29 (1H, s, 9-H), 7.38 (2H, d, J₂,3' 7.3 Hz, 2'-H, 6'-H), 7.53 (2H, dd, J₃,₄' 7.0 Hz and J₃,₄' 8.0 Hz, 3'-H, 5'-H), 7.61 (1H, t, J₇,₃' 7.5 Hz, 4'-H). δC (CDCl₃) 19.4 (8-CH₃), 20.2 (7-CH₃), 112.6 (C-3), 117.3 (C-6), 120.9 (C-9a), 122.9 (C-9), 128.3 (C-2', C-6'), 129.1 (C-3', C-5'), 130.6 (C-4'), 132.0 (C-1'), 133.3 (C-5a), 135.2 (C-7), 135.4 (C-8), 148.9 (C-4), 164.9 (C-10a), 167.0 (C-2). MS (EI): m/z 306.0834 (M⁺, 100%, C₁₈H₁₄N₂OS requires 306.0827) 278 (53), 265 (7), 204 (50), 189 (12), 129 (6), 102 (7). Anal. Calcd. for C₁₈H₁₄N₂O₅: C, 70.59; H, 4.57; N, 9.15; O, 5.23; S, 10.46. Found: C, 70.46; H, 4.56; N, 9.27; S, 10.46.

8-Methoxy-4-phenyl-2H-pyrimidino[2,1-b]benzothiazol-2-one (8c). From 1c and 2c, yield 81%, colourless crystals; mp 254-256°C. IR: ν/cm⁻¹ 1635 (C=O), 1600 (C=N), 1580 (C=C). UV (EtOH/CHCl₃ 1:1) λmax (nm) (log ε): 216 (4.48), 230 (4.48), 247 (3.45) 275 (4.12), 312 (4.19). NMR data: δH (CDCl₃) 3.76 (3H, s, 8-OCH₃), 6.01 (1H, d, J₆,₇ 9.4 Hz, 6-H), 6.20 (1H, s, 3-H), 6.52 (1H, dd, J₇,₈ 9.4 Hz and J₇,₉ 2.6 Hz, 7-H), 7.07 (1H, d, J₆,₇ 2.6 Hz, 9-H), 7.41 (2H, d, J₂,3' 7.3 Hz, 2'-H, 6'-H), 7.54 (2H, dd, J₃,₄' 8 Hz and J₃,₄' 7.0 Hz, 3'-H, 5'-H), 7.61 (1H, t, J₄,₃' 7.6 Hz, 4'-H). δC (CDCl₃) 55.7 (8-OCH₃), 107.0 (C-9), 112.8 (C-3), 113.5 (C-7), 117.2 (C-6), 125.6 (C-9a), 128.2 (C-2', C-6'), 129 (C-5a), 129.3 (C-3', C-5'), 130.8 (C-4'), 131.9 (C-1'), 148.8 (C-
4), 157.5 (C-8), 164.3 (C-10a), 167.0 (C-2). MS (EI): m/z 308.0629 (M+, 100 %, C_{17}H_{12}N_{2}O_{2}S requires 308.0619) 280 (32), 265 (8), 206 (54), 191 (25), 191 (25), 138 (13), 137 (13). Anal. Calcd. for C_{17}H_{12}N_{2}O_{2}S: C, 66.23; H, 3.90; N, 9.09; O, 10.39; S, 10.39. Found: C, 66.10; H, 3.97; N, 9.14; S, 10.50.

8-Ethoxy-4-phenyl-2H-pyrimido[2,1-b]benzothiazol-2-one (8d). From 1d and 2c, Yield 86%, colourless crystals; mp 211-213°C. IR: ν/cm⁻¹ 1640 (C=O), 1600 (C=N), 1580 (C=C). UV (EtOH/CHCl₃ 1:1) λ_max (nm), (log ε): 214 (4.44), 230 (4.43), 246 (4.31), 274 (4.06), 312 (4.16). NMR data: δ_H (CDCl₃) 1.31 (3H, t, J 7 Hz, 8-O CH₂C₆H₅), 3.93 (2H, q, J 7 Hz, 8-O CH₂CH₃), 5.96 (1H, d, J 6,7 9.4 Hz, 6-H), 6.15 (1H, s, 3-H), 6.47 (1H, dd, J 7,6 9.4 Hz and J 7,9 2.5 Hz, 7-H), 7.02 (1H, d, J 9,7 2.5 Hz, 9-H), 7.38 (2H, d, J 2′,3′ 7.4 Hz, 2′-H, 6′-H), 7.51 (2H, dd, J 3′,4′ 8.0 Hz and J 3′,2′ 7.0 Hz, 3′-H, 5′-H), 7.58 (1H, d, J 4′,3′ 7.5 Hz, 4′-H). δ_C (CDCl₃) 14.4 (8-OCH₂C₆H₅), 64.0 (8-OCH₂CH₃), 107.4 (C-9), 112.6 (C-3), 113.5 (C-7), 117.1 (C-6), 125.4 (C-9a), 128.1 (C-2′, C-6′), 128.6 (C-5a), 129.2 (C-3′, C-5′), 130.8 (C-4′), 131.8 (C-1′), 148.7 (C-4), 156.8 (C-8), 164.3 (C-10a), 166.9 (C-2). MS (EI): m/z 322.0777 (M+, 100 %, C_{18}H_{14}N_{2}O_{2}S requires 322.0776) 294 (22), 266 (18), 220 (28), 192 (37), 191 (29), 129 (9). Anal. Calcd. for C_{18}H_{14}N_{2}O_{2}S: C, 67.08; H, 4.35; N, 8.69; O, 9.94; S, 9.94. Found: C, 67.02; H, 4.43; N, 8.61; S, 9.92.

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References