# Synthesis of 3-Hydroxypyrimidine-2,4-diones. Addition of Anilines to Benzyloxy Isocyanate Synthons to Give *N*-Hydroxyureas

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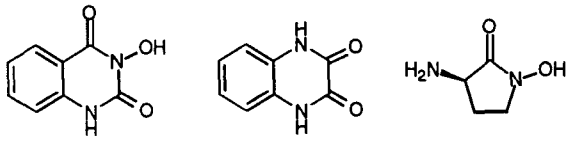
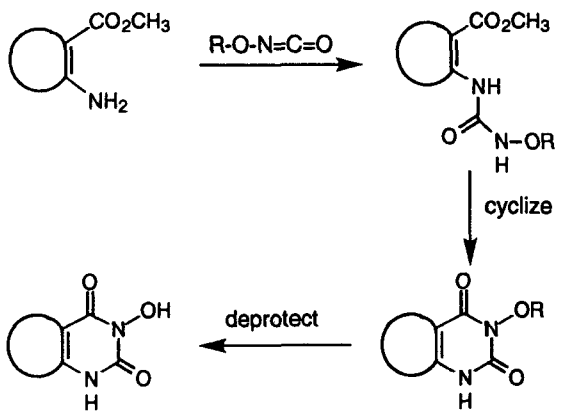
A new method, the addition of *N*-benzyloxychloroformate to methyl anthranilate followed by base-catalyzed cyclization, has been employed to synthesize the *N*-hydroxyquinazolinedione **1** and heterocyclic derivatives. *N*-Benzyloxycarbonylimidazole is a useful synthon to prepare *N*-hydroxyureas.

As a part of a program aimed at the discovery of antagonists of the glycine site associated with the NMDA receptor complex,[1] we became interested in preparing derivatives of *N*-hydroxyquinazolinedione **1**.[2] This ring system embodies structural elements common to both quinoxalinediones and HA-966,[3] compounds that have been shown to act as antagonists at the glycine site and have been examined as potential therapeutic agents for the treatment of stroke and other neurodegenerative disorders.[3] We found that **1** is a reasonably potent glycine site antagonist[4] and sought to prepare heterocyclic analogs of **1** with the goal of identifying more potent agents. We report here a new and efficient method for the synthesis of 3-hydroxypyrimidine-2,4-diones.

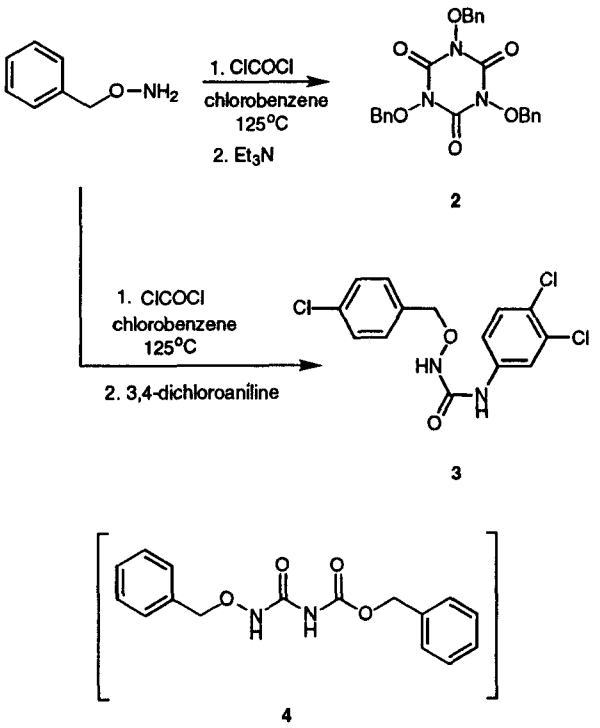



We envisioned that the addition of benzyloxy isocyanate to methyl anthranilate would provide the corresponding *O*-benzylhydroxylurea as depicted in Scheme 1. Cyclization upon exposure of the urea to base and subsequent removal of the protecting group would then produce the target compounds.




**Scheme 1**

A review of the literature yielded few reports that dealt with the utility of alkoxy isocyanates.[5] This is because most attempts to generate them have been unsuccessful due to their tendency to trimerize.[6] In 1960, McKay isolated the 1,3,5-tribenzyloxyisocyanuric acid **2** when triethylamine was added to a solution of benzyloxyamine hydrochloride and phosgene which had been heated at reflux in chlorobenzene[7] (Scheme 2). In the absence of triethylamine, heating benzyloxyamine with phosgene under the same conditions followed by the addition of 3,4-dichloroaniline gave trichloride **3**, where chlorination had occurred under the reaction conditions. Furthermore, Mckay also found that the reactive intermediate in this process was neither an alkoxy isocyanate nor chloroformate, but rather the allophanate **4**.




**Scheme 2**

The most general synthesis of *N*-hydroxyureas is the addition of hydroxylamine to an isocyanate.[8] For the reasons stated above, the alternative approach, addition of an aniline to an alkoxy isocyanate, or a synthetic equivalent, has not been thoroughly studied. We sought a reagent that would allow efficient and rapid preparation of *N*-hydroxyurea derivatives, particularly using alkyl anthranilates in order to prepare derivatives of **1**. Examination of several coupling agents including the recently disclosed 2(*S*),3-pyridinediyl thiocarbonate (PTC),[9] carbonyldiimidazole,[10] and (*p*-nitrophenoxy)-carbonyl chloride[11] revealed the imidazole carbonyl synthon **5** to be the superior synthetic equivalent of the alkoxy isocyanate. Thus, dropwise addition of *O*-benzylhydroxylamine (free base) to a THF solution of carbonyldiimidazole at 0 °C, followed by the addition of an

amine provided the corresponding substituted *N*-hydroxyureas shown in Table 1. From these results, it is apparent that this procedure provides ureas in good to excellent yield using a variety of substituted anilines and alkylamines.

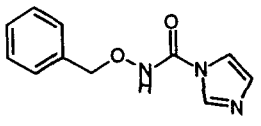


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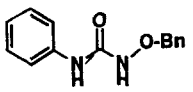
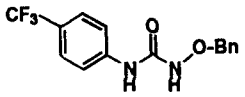
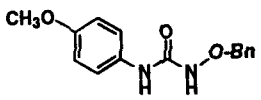
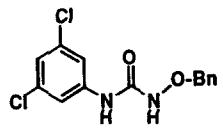
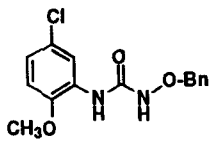
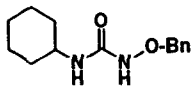
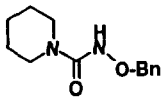
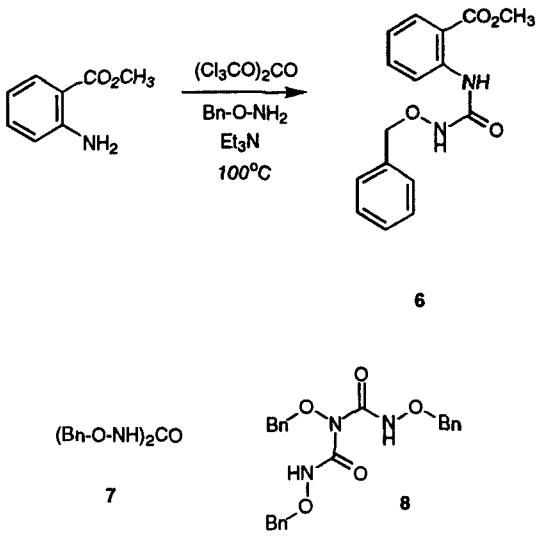
**Table 1.** Preparation of *N*-hydroxyureas

| Entry | Yield (%) | Product |
|---|---|---|
| 1 | 92 |  |
| 2[a] | 81 |  |
| 3 | 91 |  |
| 4[a] | 78 |  |
| 5[a] | 82 |  |
| 6[a] | 78 |  |
| 7[a] | 72 |  |

[a] Satisfactory elemental analysis obtained for product: C, H, N ±0.2%.

Although the high yield of urea obtained for 4-trifluoromethylaniline (entry 2) suggested that electron-deficient anilines would participate in this reaction, application of this method to anthranilate derivatives was not successful. Anthranilates did not react with the carbonyldiimidazole synthon **5** under these conditions[12] and an alternative procedure was investigated. We report here that treating *O*-benzylhydroxylamine, as the free base, with triphosgene[13] under sparge[13] of nitrogen in dioxane at 100°C followed by cannulation of this solution into a mixture of methyl anthranilate and triethylamine furnished the target benzyloxyurea **6** in 72% yield. These conditions circumvent the complications seen by McKay,[7] since we saw no evidence of chlorination or isocyanuric acid formation (Scheme 3). Reversing the mode of addition, by adding the anthranilate to a solution of the benzyloxyamine, gave lower yields of **6** (65%) which was accompanied by small amounts of the by-products **7** and **8**. In addition, some of the anthranilate was consumed as its HCl salt. Greater amounts of **7** and **8** were formed when the chloroformate was generated in the presence of triethylamine, but again no isocyanuric acid **2** or allophanate **4** were observed. The debenzylated *N*-hydroxyureas are readily obtained by mild hydrogenolytic cleavage of the benzyl group, as described elsewhere.[14]

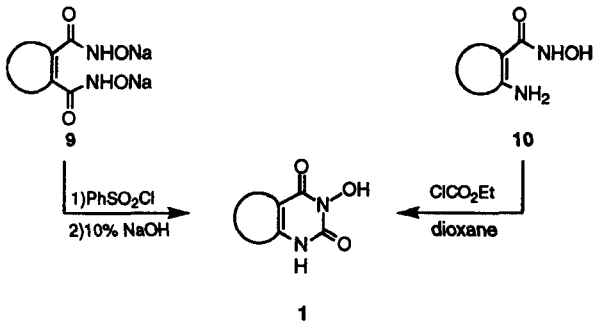


Scheme 3

A series of *N*-hydroxyureas prepared in this manner were cyclized to their corresponding pyrimidinedione derivatives by treatment with one equivalent potassium *tert*-butoxide in benzene at reflux in 85–95% yield. The benzyl group was readily removed upon heating at reflux in a 1:1 (v/v) mixture of aqueous 48% HBr and AcOH for 3 h (75–85%), Table 2.[15]

This synthetic approach to 3-hydroxypyrimidine-2,4-diones provides a useful alternative to the two previously reported routes to this class of compound. The most precedented route, described by Bauer[16] in the mid sixties (Scheme 4), involves Lossen rearrangement of bishydroxamate salts **9**, and subsequent hydrolysis to remove the activating group. We found the hydroxamate salts difficult to handle, and the yields of hydrolysis sometimes low owing to further hydrolysis of the pyrimidine nucleus. The second method, treatment of *ortho*-amino hydroxamic acids **10** with ethyl chloroformate,[17] is not readily applied to heterocyclic derivatives. This is due to the tendency of these systems to undergo facile hydrolysis and decarboxylation in their preparation.[18] Thus, the method described here offers a viable route to these compounds from a readily available pool of starting materials.

In summary, a new method has been developed to synthesize 3-hydroxypyridine-2,4-diones which employs a




**Scheme 4**

suitable benzyloxy isocyanate synthon. The method has proven more general than those published previously.

Melting points are uncorrected. $^1$H NMR and $^{13}$C NMR were obtained on a Bruker instrument (300 MHz). Anhydrous solvents (THF, 1,4-dioxane) were purchased from Aldrich (Sure-seal) and used directly without further purification. *O*-Benzylhydroxylamine was purchased as its HCl salt from Aldrich and converted into its free base as described in ref. 19. See references cited below for uncommon starting materials.

**Coupling with Carbonyldiimidazole; General Procedure:**
*O*-Benzylhydroxylamine[19] (1.5 g, 12.2 mmol) was dissolved in anhydr. THF (35 mL) and added dropwise via cannula to a cooled (0 °C) solution of carbonyldiimidazole (2.0 g, 12.2 mmol) in 100 mL of the same solvent under $N_2$. After being stirred for 0.5 h at 24 °C, the aniline was added (neat) and the reaction mixture stirred for 18 h. The solution was diluted with EtOAc (100 mL), washed with water (50 mL) and brine (50 mL), and dried ($MgSO_4$). Concentration in vacuo gave the *N*-hydroxyureas (see Table 1 for yields).

*N-(Phenyl)-N'-phenylmethoxyurea:*

Lit. Ref. 8a.

*N-(4-Trifluoromethylphenyl)-N'-phenylmethoxyurea:*

Mp 156–157 °C.

IR (KBr): $\nu$ = 3322, 1680, 1534, 1334, 1116, 1072, 838, 756, 704 cm$^{-1}$.

$^1$H NMR (300 MHz, $CDCl_3$): $\delta$ = 4.88 (2 H, s), 7.36–7.52 (11 H, m).

$^{13}$C NMR (75 MHz, $CDCl_3$): $\delta$ = 79.31, 118.86, 126.14, 126.18, 129.04, 129.35, 129.416, 134.91, 140.41, 156.69.

MS (DCI): $m/z$ = 311 ($MH^+$).

*N-(4-Methoxyphenyl)-N'-phenylmethoxyurea:*

Lit. Ref. 8a.

*N-(3,5-Dichlorophenyl)-N'-phenylmethoxyurea:*

Mp 109–110 °C.

IR (KBr): $\nu$ = 3334, 3204, 1668, 1580, 1528, 1416, 668 cm$^{-1}$.

$^1$H NMR (300 MHz, DMSO-$d_6$): $\delta$ = 4.81 (2 H, s), 7.15 (1 H, t, $J$ = 1.9 Hz), 7.28–7.39 (3 H, m), 7.42–7.45 (2 H, m), 7.68 (2 H, d, $J$ = 1.9 Hz), 9.15 (1 H, brs), 9.82 (1 H, brs).

$^{13}$C NMR (75 MHz, DMSO-$d_6$): $\delta$ = 77.71, 117.24, 121.36, 128.17, 128.22, 128.96, 133.79, 136.13, 141.78, 156.60.

MS (DCI): $m/z$ = 311 ($MH^+$).

*N-(5-Chloro-2-methoxyphenyl)-N'-phenylmethoxyurea:*

Mp 128–129 °C.

IR (KBr): $\nu$ = 3392, 3174, 1676, 1598, 1250 cm$^{-1}$.

$^1$H NMR (300 MHz, $CDCl_3$): $\delta$ = 3.83 (3 H, s), 4.88 (2 H, s), 6.74 (1 H, d, $J$ = 8.7 Hz), 6.94 (1 H, dd, $J$ = 8.7 Hz, 2.5 Hz), 7.33–7.44 (6 H, m), 8.22 (1 H, brs), 8.26 (1 H, d, $J$ = 2.5 Hz).

$^{13}$C NMR (75 MHz, $CDCl_3$): $\delta$ = 55.92, 79.17, 110.64, 118.69, 122.51, 126.21, 128.16, 128.74, 129.07, 129.36, 134.82, 146.38, 156.57.

MS (DCI): $m/z$ = 307 ($MH^+$).

*N-(Cyclohexyl)-N'-phenylmethoxyurea:*

Mp 110–112 °C.

IR (KBr): $\nu$ = 3358, 3190, 2934, 2852, 1641, 1546, 1448, 700 cm$^{-1}$.

$^1$H NMR (300 MHz, DMSO-$d_6$): $\delta$ = 1.04–1.29 (5 H, m), 1.52 (1 H, d, $J$ = 12.8 Hz), 1.60–1.71 (4 H, m), 3.32–3.41 (1 H, m), 4.69 (2 H, s), 6.25 (1 H, d, $J$ = 8.4 Hz), 7.28–7.41 (5 H, m), 8.99 (1 H, s).

$^{13}$C NMR (75 MHz, DMSO-$d_6$): $\delta$ = 24.76, 25.18, 32.71, 47.77, 77.23, 128.01, 128.25, 128.79, 136.68, 158.85.

MS (DCI): $m/z$ = 249 ($MH^+$).

*N-(Phenylmethoxy)-1-piperidinecarboxamide:*

Mp 71–76 °C.

IR (KBr): $\nu$ = 3210, 2938, 1650, 1500, 1270, 732, 692 cm$^{-1}$.

$^1$H NMR (300 MHz, DMSO-$d_6$): $\delta$ = 1.35–1.42 (4 H, m), 1.47–1.54 (2 H, m), 3.19–3.22 (4 H, m), 4.72 (2 H, s), 7.26–7.40 (5 H, m), 9.68 (1 H, s).

$^{13}$C NMR (75 MHz, DMSO-$d_6$): $\delta$ = 23.97, 25.25, 43.94, 76.80, 127.84, 128.16, 128.62, 136.87, 158.15.

MS (DCI): $m/z$ = 235 ($MH^+$).

**Addition to Benzyloxy Chloroformate; General Procedure:**
Triphosgene (600 mg, 2.05 mmol) was added to a solution of *O*-benzylhydroxylamine (500 mg, 4.1 mmol) in anhydr. 1,4-dioxane (25 mL) and immersed in an oil bath heated at 100 °C while under sparge of $N_2$. After 45 min, the hot solution was cannulated dropwise into a mixture of the anthranilate (3.15 mmol) and $Et_3N$ (12. mL, 12 mmol) at 100 °C. After being cooled to 24 °C, the precipitate was filtered ($Et_3NHCl$), and the filtrate concentrated. The residual oil was diluted with $Et_2O$ (10 mL) and 1N anhydr. HCl in $Et_2O$ (10 mL). The resulting HCl salt of unconsumed anthranilate was filtered off, the filtrate was diluted with EtOAc (50 mL), washed with aq $NaHCO_3$ (20 mL) and brine (20 mL), dried ($Na_2SO_4$). Concentration in vacuo and chromatography gave *N*-hydroxyureas (see Table 2 for yields).

*Methyl 2-[(phenylmethoxy)aminocarbonylamino]benzoate:*

Mp 81–82 °C.

IR (KBr): $\nu$ = 3192, 1696, 1588, 1268, 744, 698 cm$^{-1}$.

$^1$H NMR (300 MHz, $CDCl_3$): $\delta$ = 3.92 (3 H, s), 4.97 (2 H, s), 7.02–7.07 (1 H, m), 7.21 (1 H, brs), 7.32–7.41 (3 H, m), 7.48–7.55 (3 H, m), 8.02 (1 H, dd, $J$ = 8.0, 1.7 Hz), 8.57 (1 H, dd, $J$ = 8.5, 1.0 Hz), 11.41 (1 H, brs).

$^{13}$C NMR (75 MHz, $CDCl_3$): $\delta$ = 52.15, 78.96, 114.98, 119.57, 121.84, 128.45, 128.68, 129.41, 130.74, 134.42, 135.65, 141.17, 157.14, 168.32.

MS (DCI): $m/z$ = 301 ($MH^+$).

Anal: calc. for $C_{16}H_{16}N_2O_4$: C, 63.99; H, 5.37; N, 9.33. Found: C, 63.92; H, 5.30; N, 9.19.

*Methyl 3-[(Phenylmethoxy)aminocarbonylamino]-2-thiophenecarboxylate:*

Mp 119–121 °C.

IR (KBr): $\nu$ = 3308, 3178, 1692, 1678, 1568, 1252, 742, 698 cm$^{-1}$.

$^1$H NMR (300 MHz, DMSO-$d_6$): $\delta$ = 3.81 (3 H, s), 4.85 (2 H, s), 7.31–7.39 (3 H, m), 7.47–7.49 (2 H, m), 7.84 (1 H, dd, $J$ = 5.4, 2.4 Hz), 7.89 (1 H, dd, $J$ = 5.5, 2.4 Hz), 10.14 (1 H, brs), 10.19 (1 H, brs).

$^{13}$C NMR (75 MHz, DMSO-$d_6$): $\delta$ = 52.00, 78.06, 107.94, 121.01, 128.29, 128.47, 129.34, 133.21, 135.38, 144.62, 155.25, 163.81.

MS (DCI): $m/z$ = 307 ($MH^+$).

Anal: calc. for $C_{14}H_{14}N_2O_4S$: C, 54.89; H, 4.61; N, 9.14. Found: C, 55.21; H, 4.65; N, 9.08.

*Ethyl 2-[(phenylmethoxy)aminocarbonylamino]-4,5,6,7-tetrahydrobenzo[b]thiophene-3-carboxylate*

Mp 109–111 °C.

IR (KBr): $\nu$ = 3186, 3072, 2932, 1676, 1540, 1224, 1038, 784, 696 cm$^{-1}$.

$^1$H NMR (300 MHz, DMSO-$d_6$): $\delta$ = 1.27 (3 H, t, $J$ = 7.0 Hz), 1.68 (4 H, brs), 2.54 (2 H, brs), 2.67 (2 H, brs), 4.25 (2 H, q, $J$ = 7.0 Hz), 4.83 (2 H, s), 7.31–7.39 (3 H, m), 7.46–7.48 (2 H, m), 10.38 (1 H, brs), 11.01 (1 H, brs).

$^{13}$C NMR (75 MHz, DMSO-$d_6$): $\delta$ = 14.13, 22.33, 22.51, 23.70, 25.91, 60.18, 78.10, 109.84, 124.86, 128.28, 128.55, 129.43, 130.00, 135.22, 148.10, 155.03, 165.36.

MS (DCI): $m/z$ = 375 ($MH^+$).

Anal: calc. for $C_{19}H_{22}N_2O_4S$: C, 60.94; H, 5.92; N, 7.48. Found: C, 60.87; H, 5.90; N, 7.52.

*Methyl 3-[(Phenylmethoxy)aminocarbonylamino]-2-benzo[b]furancarboxylate:*[20]

Mp 120–121 °C.

IR (KBr): $\nu$ = 3190, 1680, 1610, 1520, 1304, 1230, 754, 700 cm$^{-1}$.

$^1$H NMR (300 MHz, DMSO-$d_6$): $\delta$ = 3.87 (3 H, s), 4.91 (2 H, s), 7.26–7.42 (4 H, m), 7.49–7.56 (3 H, m), 7.63 (1 H, $J$ = 8.4 Hz), 8.29 (1 H, d, $J$ = 7.9 Hz), 9.39 (1 H, brs), 10.30 (1 H, brs).

$^{13}$C NMR (75 MHz, DMSO-$d_6$): $\delta$ = 52.74, 78.12, 112.12, 121.24, 123.04, 126.15, 128.36, 128.46, 128.98, 129.18, 129.94, 130.03, 135.55, 153.63, 155.53, 160.65.

MS (DCI): $m/z$ = 341 ($MH^+$).

Anal: calc. for $C_{18}H_{16}N_2O_5$: C, 63.52; H, 4.74; N, 8.23. Found: C, 63.51; H, 4.80; N, 8.23.

**Cyclization to *O*-Benzyl 3-Hydroxypyrimidine-2,4-diones; General Procedure:**

The *N*-hydroxyurea (2.5 mmol) was taken up in anhydr. benzene (100 mL), KOBu-*t* (280 mg, 2.5 mmol) was added, and the solution was heated at reflux for 3 h under $N_2$. Upon being cooled to 24 °C, 25 mL of aq. 1N HCl was added, and the solution was extracted with THF (2 × 100 mL). The organic phase was washed with brine (100 mL) and dried ($MgSO_4$). Concentration in vacuo gave *O*-benzyl protected 3-hydroxypyrimidine-2,4-diones.

*3-(Phenylmethoxy)-1,3-benzopyrimidine-2,4(1H,3H)-dione:*

Mp 206–209 °C.

IR (KBr): $\nu$ = 3246, 3222, 1748, 1667, 1390, 1256, 758, 732 cm$^{-1}$.

$^1$H NMR (300 MHz, DMSO-$d_6$): $\delta$ = 5.11 (2 H, s), 7.20–7.37 (2 H, m), 7.40–7.46 (3 H, m), 7.57–7.60 (2 H, m), 7.64–7.69 (1 H, m), 7.70–7.97 (1 H, m).

$^{13}$C NMR (75 MHz, DMSO-$d_6$): $\delta$ = 77.39, 114.56, 115.81, 122.36, 127.17, 128.34, 128.80, 129.44, 134.57, 134.93, 139.35, 148.27, 159.12.

MS (DCI): $m/z$ = 269 ($MH^+$).

Anal: calc. for $C_{15}H_{12}N_2O_3 \cdot 0.75H_2O$: C, 66.82; H, 4.54; N, 10.39. $K_f$ 0.5% Found: C, 66.42; H, 4.48; N, 10.32. $K_f$ 0.5%.

*3-(Phenylmethoxy)thieno[3,2-d]pyrimidine-2,4(1H,3H)-dione:*

Mp 214–218 °C.

IR (KBr): $\nu$ = 3150, 3034, 1742, 1720, 1654, 750, 702 cm$^{-1}$.

$^1$H NMR (300 MHz, DMSO-$d_6$): $\delta$ = 5.06 (2 H, s), 6.92 (1 H, d, $J$ = 5.2 Hz), 7.38–7.43 (3 H, m), 7.53–7.55 (2 H, m), 8.09 (1 H, d, $J$ = 5.2 Hz), 12.10 (1 H, brs).

$^{13}$C NMR (75 MHz, DMSO-$d_6$): $\delta$ = 77.55, 110.90, 117.33, 128.36, 128.85, 129.46, 134.45, 136.64, 143.83, 148.78, 155.47.

MS (DCI): $m/z$ = 275 ($MH^+$).

Anal: calc. for $C_{13}H_{10}N_2O_3S$: C, 56.93; H, 3.67; N, 10.21. Found: C, 57.10; H, 3.65; N, 10.13.

*5,6,7,8-Tetrahydro-3-(phenylmethoxy)-[1]benzothieno[2,3-d]pyrimidine-2,4-(1H,3H)-dione:*

Mp 228–229 °C.

IR (KBr): $\nu$ = 3432, 3190, 2940, 1734, 1678, 1648, 730 cm$^{-1}$.

$^1$H NMR (300 MHz, DMSO-$d_6$): $\delta$ = 1.6–185 (4 H, m), 2.60 (2 H, brs), 2.76 (2 H, brs), 5.01 (2 H, s), 7.37–7.43 (3 H, m), 7.52–7.55 (2 H, m), 12.31 (1 H, brs).

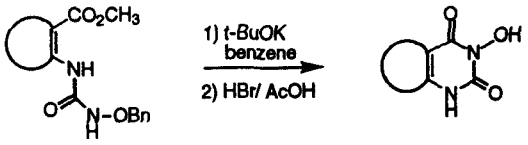
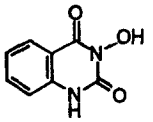
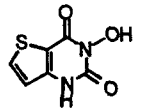
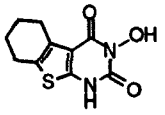
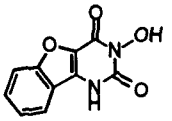



**Table 2.** *Preparation of 3-Hydroxypyrimidine-2,4-diones*

| Entry | Yield for Bn–O–NHCOCl (%) | Final Product |
|---|---|---|
| 1 | 72 |  |
| 2[a] | 65 |  |
| 3[a] | 59 |  |
| 4[a] | 62 |  |

[a] Satisfactory elemental analysis obtained for product: C, H, N ± 0.2%.

$^{13}$C NMR (75 MHz, DMSO-$d_6$): $\delta$ = 21.63, 22.64, 23.88, 24.93, 77.32, 112.63, 126.34, 128.34, 128.79, 129.40, 131.02, 134.57, 147.94, 148.09, 155.88.

MS (DCI): $m/z$ = 329 ($MH^+$).

Anal: calc. for $C_{17}H_{16}N_2O_3S$: C, 62.17; H, 4.91; N, 8.53. Found: C, 62.13; H, 4.90; N, 8.43.

*3-(Phenylmethoxy)-[1]benzofurano[3,2-d]pyrimidine-2,4(1H,3H)-dione:*

Mp > 280 °C.

IR (KBr): $\nu$ = 3446, 1736, 1670, 1218, 746, 720, 696 cm$^{-1}$.

$^1$H NMR (300 MHz, DMSO-$d_6$): $\delta$ = 5.11 (2 H, s), 7.37–7.48 (4 H, m), 7.57–7.67 (3 H, m), 7.77 (1 H, d, $J$ = 8.4 Hz), 8.00 (1 H, d, $J$ = 8.0 Hz), 12.65 (1 H, brs).

$^{13}$C NMR (75 MHz, DMSO-$d_6$): $\delta$ = 77.63, 113.01, 117.42, 121.69, 124.21, 128.40, 128.91, 129.52, 130.06, 131.00, 134.40, 148.98, 152.23, 155.67.

MS (DCI): $m/z$ = 309 ($MH^+$).

Anal: calc. for $C_{17}H_{12}N_2O_4$: C, 66.23; H, 3.92; N, 9.09. Found: C, 66.29; H, 3.94; N, 9.09.

**3-Hydroxypyrimidine-2,4-diones; General Procedure:**

The *O*-benzyl protected 3-hydroxypyrimidine-2,4-dione (1.6 mmol) was partitioned between 50 mL of 48% hydrobromic acid and 50 mL of AcOH and heated at reflux for 2.5 h. Concentration in vacuo gave a solid which was washed with $Et_2O$ and recrystallized from AcOH.

*3-Hydroxy-1,3-benzopyrimidine-2,4-(1H,3H)-dione:*

Lit. Ref. 2.

*3-Hydroxythieno[3,2-d]pyrimidine-2,4(1H,3H)-dione:*

Mp > 280 °C.

IR (KBr): $\nu$ = 3088, 1720, 1700, 1650, 1194, 758 $cm^{-1}$.

$^1H$ NMR (300 MHz, DMSO-$d_6$): $\delta$ = 6.91 (1 H, d, $J$ = 5.2 Hz), 8.04 (1 H, d, $J$ = 5.2 Hz), 10.50 (1 H, brs), 11.95 (1 H, brs).

$^{13}C$ NMR (75 MHz, DMSO-$d_6$): $\delta$ = 110.80, 117.22, 135.96, 143.23, 149.54, 156.06.

MS (DCI): $m/z$ = 185 ($MH^+$).

*3-Hydroxy-5,6,7,8-tetrahydro[1]benzothien[2,3-d]pyrimidine-2,4(1H,3H)-dione:*

Mp > 280°C.

IR (KBr): $\nu$ = 3124, 2940, 1730, 1684, 1638, 1250, 1140, 756 $cm^{-1}$.

$^1H$ NMR (300 MHz, DMSO-$d_6$): $\delta$ = 1.68–1.75 (4 H, m), 2.57–2.58 (2 H, m), 2.74–2.76 (2 H, m), 10.29 (1 H, brs), 12.13 (1 H, brs).

$^{13}C$ NMR (75 MHz, DMSO-$d_6$): $\delta$ = 21.60, 22.63, 23.86, 24.98, 112.36, 126.02, 130.89, 147.31, 148.62, 156.58.

MS (DCI): $m/z$ = 239 ($MH^+$).

*3-Hydroxy[1]benzofurano[3,2-d]pyrimidine-2,4(1H,3H)-dione:*

Mp > 270°C.

IR (KBr): $\nu$ = 3490, 3184, 2568, 1710, 1668, 1226, 1136, 730 $cm^{-1}$.

$^1H$ NMR (300 MHz, DMSO-$d_6$): $\delta$ = 7.42 (1 H, t, $J$ = 7.5 Hz), 7.60 (1 H, t, $J$ = 7.3 Hz), 7.73 (1 H, d, $J$ = 8.4 Hz), 7.96 (1 H, d, $J$ = 7.8 Hz), 10.68 (1 H, brs), 12.47 (1 H, brs).

$^{13}C$ NMR (75 MHz, DMSO-$d_6$): $\delta$ = 112.91, 117.46, 121.57, 124.03, 129.74, 130.00, 130.16, 149.63, 152.75, 155.50.

MS (DCI): $m/z$ = 219 ($MH^+$).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