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A Simple One-Pot, Three Component Synthesis of 3-Arylpyrimido[4,5-*c*]pyridazine-5,7(6*H*,8*H*)-diones and their Sulfur Analogues as Potential Monoamine Oxidase Inhibitors

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Several new 3-arylpyrimido[4,5-*c*]pyridazine-5,7(6*H*,8*H*)-diones and 3-aryl-5-oxo-7-thioxo-7,8-dihydropyrimido[4,5-*c*]pyridazin-5(6*H*)-ones have been synthesized by a three-component reaction of barbituric acid or thiobarbituric acid with arylglyoxals in the presence of a catalytic amount of pyridine and hydrazine hydrate at room temperature in water.

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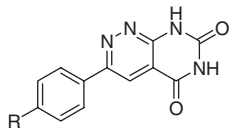
Introduction

Pyridazine derivatives and heterocyclic annelated pyridazines continue to attract attention due to their wide variety of interesting biological activities.[1] The synthesis and utility of many pyridazine derivatives as analgesics, insecticidals,[2] fungicidals[3,4] cardiotonics,[5] and bacteriocides[6] have been reported. In particular, pyrimido[4,5-*c*]pyridazine-5,7(6*H*,8*H*)-diones are common sources for the development of new potential therapeutic agents.[7–9] In addition, some derivatives of 6,8-dimethylpyrimido[4,5-*c*]pyridazine-5,7(6*H*,8*H*)-dione undergo new heterocyclizations based on S_N^H methodology.[10–14]

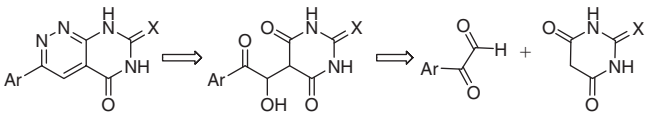
Monoamine oxidase (MAO) is an enzyme of the outer mitochondrial membrane that catalyzes the oxidative deamination of various neurotransmitters and dietary amines.[15] MAO exists in two enzymatic forms, MAO-A and MAO-B, differing in their substrate specificity, sensitivity to inhibitors[16] and amino acid sequence.[17,18] As pointed out by Carotti and coworkers,[19] there has been a renewed interest in MAO since the discovery that the neurotoxin 1-methyl-4-phenyl-1,2,3,6-tetrahydropyridine (MPTP) causes the death of dopaminergic neurons and induces symptoms very similar to Parkinson's disease in humans.[20] In addition, the selective and reversible inhibitors of MAO-A or MAO-B may be useful therapeutic agents devoid of undesirable side-effects.[21] In humans, MAO-B inhibitors (e.g. deprenyl) are useful in the treatment of Parkinson's disease,[22–24] whereas MAO-A inhibitors are valuable antidepressant and anti-anxiety agents.[25–27] Carotti and coworkers have demonstrated that the 3-arylpyrimido[4,5-*c*]pyridazine-5,7(6*H*,8*H*)-diones **1**–**2** (Scheme 1) have MAO inhibitory activity, and substituents on the diazine nucleus modulate the inhibitory activity.[19]

In view of the above, we report herein a novel mild one-pot synthesis of new 3-aryl pyrimido[4,5-*c*]pyridazine-5,7(6*H*,8*H*)-diones **3** and the corresponding 5-oxo-7-thioxo-6,8-dihydropyrimido[4,5-*c*]pyridazin-5(6*H*)-ones **4** by condensation



1 R = H
2 R = CF_3

Scheme 1.



3 X = O
4 X = S

7

5 X = O
6 X = S

Scheme 2.

of barbituric acid **5** or thiobarbituric acid **6** with arylglyoxals **7** (Scheme 2) in the presence of excess hydrazine hydrate, and traces of pyridine. Previous methods of synthesis[19,28] involve treating alloxan with acetophenones and hydrazine in a two-step, one-pot sequence. The method reported in this paper has the advantage of using barbituric or thiobarbituric acids as reagents, possibly offering broader applications, offering milder conditions for the formation of 3-arylpyrimido[4,5-*c*]pyridazine-5,7(6*H*,8*H*)-diones and their sulfur analogues. Only the synthesis of compounds **1**–**2** has been previously reported,[19] and the yield of compound **1** herein reported (83%) is higher than that (76%) reported previously.[19]

Results and Discussion

The arylglyoxals **7a**–**h** were prepared from commercially available acetophenones **8a**–**h** as outlined in Scheme 3.[29]

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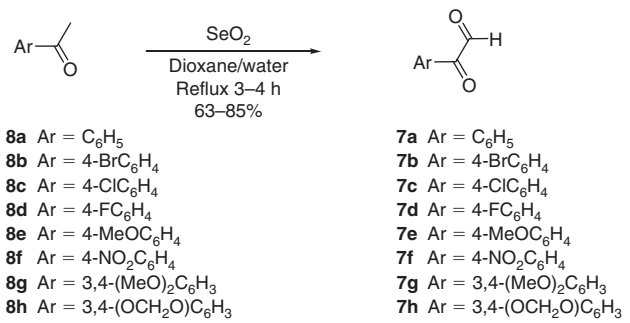
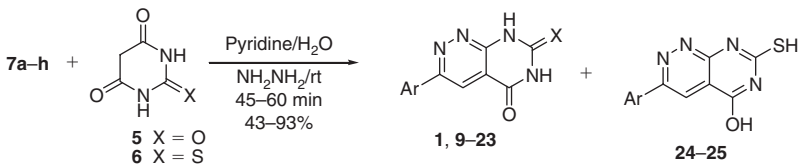
The reactions were performed by adding arylglyoxals **7a**–**h** to the mixture of barbituric acid **5** or thiobarbituric acid **6** and a catalytic amount of pyridine in water at room temperature in the presence of excess hydrazine hydrate (Scheme 4). In the absence of pyridine, yields were uniformly lower, being contaminated by hydrazone products before purification. For example, with 4-fluorophenylglyoxal, the yield of **11** in the absence of pyridine was 80% (91% with pyridine) and with phenylglyoxal, the yield of **16** in the absence of pyridine was 62% (93% with pyridine). In the case of arylglyoxals **7e**–**h**, in the presence of pyridine, the desired pyrimidopyridazines **12**–**15** and their sulfur analogues **20**–**23** were obtained in moderate to good yields 43–83% (Scheme 4), whereas in the absence of pyridine, the products were chiefly the corresponding mono-hydrazones **26**–**29** in high yields and both barbituric and thiobarbituric acids were mainly recovered (Scheme 5). We believe that the presence of pyridine increases the proportion of the barbituric (thiobarbituric) acid enolate, necessary for reaction with the glyoxal.

As shown in Scheme **4**, most of the derivatives exist solely as the lactam tautomers, but two of the thio compounds were isolated as a mixture of both lactam **17**–**18** and lactim **24**–**25** tautomers. The structures of the products follow simply from consideration of the ^{1}H NMR data, which are consistent with that of analogues previously published by Carotti and coworkers.[28] In particular, the singlet around δ 8.6 in the diones, δ 8.5 in the thione, and δ 7.6 in the enol tautomers, was diagnostic of H-4 in the newly formed pyridazine ring.

The proposed mechanism of the reaction involves the initial aldol condensation and subsequent dehydration reaction of **5** with the phenylglyoxal **7a** as shown in Scheme 6, followed by reaction of the intermediate **30** with hydrazine, leading to the formation of the pyridazine ring after dehydration.



Scheme 3.



1 X = O, Ar = C_6H_5 (83%)
9 X = O, Ar = 4-BrC_6H_4 (78%)
10 X = O, Ar = 4-ClC_6H_4 (80%)
11 X = O, Ar = 4-FC_6H_4 (91%)
12 X = O, Ar = 4-$MeOC_6H_4$ (77%)
13 X = O, Ar = 4-$NO_2C_6H_4$ (43%)
14 X = O, Ar = 3,4-$(MeO)_2C_6H_3$ (81%)
15 X = O, Ar = 3,4-$(OCH_2O)C_6H_3$ (78%)
16 X = S, Ar = C_6H_5 (93%)
17 X = S, Ar = 4-BrC_6H_4 (total yield of **17** + **24**, 74%)
18 X = S, Ar = 4-ClC_6H_4 (total yield of **18** + **25**, 65%)
19 X = S, Ar = 4-FC_6H_4 (77%)
20 X = S, Ar = 4-$MeOC_6H_4$ (73%)
21 X = S, Ar = 4-$NO_2C_6H_4$ (46%)
22 X = S, Ar = 3,4-$(MeO)_2C_6H_3$ (83%)
23 X = S, Ar = 3,4-$(OCH_2O)C_6H_3$ (70%)

Scheme 4.

Conclusion

The procedure outlined provides a very straightforward route to various 3-aryl substituted pyrimido[4,5-*c*]pyridazine-5,7(6*H*,8*H*)-diones and 7-thioxo-7,8-dihydropyrimido[4,5-*c*]pyridazin-5(6*H*)-ones. The compounds are currently being assessed as potential MAO inhibitors.

Experimental

General Procedures

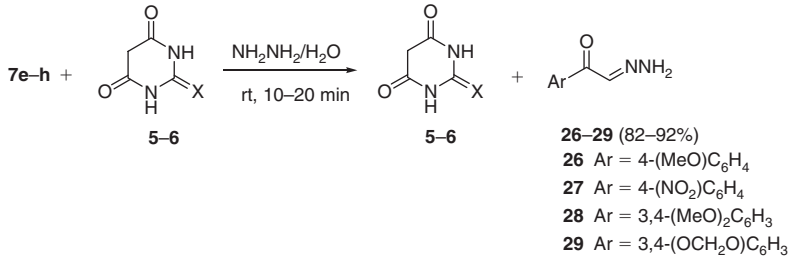
Melting points were determined on a Philip Harris C4954718 apparatus and are uncorrected. Infrared spectra were recorded on a Thermonicolet (Nexus 670) Fourier transform (FT) infrared spectrometer, using sodium chloride cells and measured as film or KBr discs. ^{1}H (300 MHz) and ^{13}C (75.5 MHz) NMR spectra were recorded on a Bruker 300 spectrometer in [D_6]DMSO using TMS as the internal reference. Mass spectra were recorded on a Varian Matt 311 spectrometer and relative abundances of fragments are quoted in parentheses after the *m/z* values. Microanalyses were performed on a Leco Analyzer 932.

General Procedure for the Synthesis of 3-Arylpyrimido[4,5-c]pyridazine-5,7(6H,8H)-diones and their Sulfur Analogues

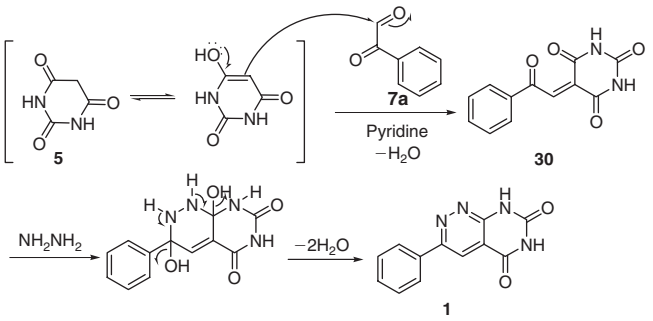
To a mixture of barbituric acid or thiobarbituric acid (1 mmol) and arylglyoxal (1 mmol) in water (10 mL), was added pyridine (two drops) at room temperature. The resultant mixture was stirred for 20 min. After the appropriate time, hydrazine hydrate was added to the reaction mixture and it was stirred until further precipitation of product ceased. The product was then collected, washed with water (3 × 10 mL), and purified by recrystallization from methanol.

3-Phenylpyrimido[4,5-*c*]pyridazine-5,7(6*H*,8*H*)-dione (1): pink solid, 83%, mp 271°C (dec.) (Found C 60.14, H 3.42, N 23.23%. $C_{12}H_8N_4O_2$ requires C 60.00, H 3.36, N 23.32%).[19] δ_H 14.24 (1H, bs), 11.38 (1H, s), 8.60 (1H, s), 7.91 (2H, dt, J_1 7.5, J_2 1.8), 7.48–7.55 (3H, m). δ_C 126.3, 128.5, 129.5, 130.2, 133.2, 134.3, 145.8, 153.1, 160.7, 162.8. ν_{max}(KBr)/cm^{-1} 3387, 3123, 1701, 1645, 1580, 1496, 1373, 799, 621, 602. *m/z* [%]: 241 ([$M^+ + 1$], 100), 240 ([M^+], 4), 213 (18), 199 (30), 187 (25), 172 (25), 158 (20), 115 (42), 77 (26).

3-(4-Bromophenyl)pyrimido[4,5-*c*]pyridazine-5,7(6*H*,8*H*)-dione (9): white solid, 78%, mp 256°C (dec.) (Found C 45.27, H 2.25, N 17.43%. $C_{12}H_7BrN_4O_2$ requires C 45.17, H 2.21, N 17.56%). δ_H 14.28 (1H, bs), 11.36 (1H, s), 8.60 (1H, s), 7.88 (2H, d, *J* 8.7), 7.71 (2H, d, *J* 8.7). δ_C 123.7, 128.4, 128.6,



Scheme 5.



Scheme 6.

132.4, 133.0, 133.5, 144.8, 153.1, 160.7, 162.8. ν_{max}(KBr)/cm^{-1} 3417, 3122, 1723, 1701, 1649, 1594, 1570, 1492, 1396, 1371, 1244, 823, 798, 752, 620. *m/z* [%]: 321 ([M$^+$ + 2], 100), 319 ([M$^+$], 98), 295 (42), 241 (36), 227 (34), 183 (46), 115 (43), 97 (42), 83 (65), 57 (72), 43 (79).

3-(4-Chlorophenyl)pyrimido[4,5-*c*]pyridazine-5,7(6*H*,8*H*)-dione (10): beige solid, 80%, mp 264°C (dec.) (Found C 52.42, H 2.65, N 20.51%. $C_{12}H_7ClN_4O_2$ requires C 52.47, H 2.57, N 20.40%). δ_H 14.27 (1H, bs), 11.35 (1H, s), 8.59 (1H, s), 7.94 (2H, d, *J* 8.7), 7.56 (2H, d, *J* 8.4). δ_C 128.2, 128.5, 129.5, 133.0, 133.1, 135.0, 144.7, 153.1, 160.7, 162.8. ν_{max}(KBr)/cm^{-1} 3426, 3230, 3085, 1695, 1654, 1566, 1494, 1370, 1089, 836, 799, 606, 477. *m/z* [%]: 277 ([M$^+$ + 2], 50), 275 ([M$^+$], 100), 251 (33), 249 (100), 206 (39), 176 (18), 164 (17), 149 (50), 136 (68), 115 (65), 75 (40), 44 (47).

3-(4-Fluorophenyl)pyrimido[4,5-*c*]pyridazine-5,7(6*H*,8*H*)-dione (11): white solid, 91%, mp 257°C (dec.) (Found C 55.87, H 2.79, N 21.59%. $C_{12}H_7FN_4O_2$ requires C 55.82, H 2.73, N 21.70%). δ_H 14.22 (1H, bs), 11.37, (1H, s), 8.58 (1H, s), 7.94–7.98 (2H, m), 7.30–7.36 (2H, m). δ_C 116.3, 116.6, 128.5, 128.7, 128.8, 130.8, 130.9, 133.2, 145.0, 153.1, 160.6, 161.8, 162.8, 165.1. ν_{max}(KBr)/cm^{-1} 3422, 3122, 3044, 1696, 1654, 1566, 1508, 1371, 1232, 1162, 843, 610, 546. *m/z* [%]: 259 ([M$^+$ + 1], 100), 233 (33), 217 (23), 190 (22), 133 (41), 120 (30).

3-(4-Methoxyphenyl)pyrimido[4,5-*c*]pyridazine-5,7(6*H*,8*H*)-dione (12): beige solid, 77%, mp 258°C (dec.) (Found C 57.87, H 3.77, N 20.66%. $C_{13}H_{10}N_4O_3$ requires C 57.78, H 3.73, N 20.73%). δ_H 14.08 (1H, bs), 11.44 (1H, s), 8.55 (1H, s), 7.85 (2H, d, *J* 9.0), 7.05 (2H, d, *J* 9.0), 3.80 (3H, s). δ_C 55.7, 114.9, 126.7, 127.8, 128.4, 132.9, 145.6, 153.1, 160.6, 161.0, 162.9. ν_{max}(KBr)/cm^{-1} 3403, 3155, 2837, 1691, 1648, 1600, 1580, 1501, 1461, 1382, 1259, 1180, 1099, 831, 621, 561.

3-(4-Nitrophenyl)pyrimido[4,5-*c*]pyridazine-5,7(6*H*,8*H*)-dione (13): cream solid, 43%, mp 331°C (dec.) (Found C 50.60, H 2.51, N 24.45%. $C_{12}H_7N_5O_4$ requires C 50.53, H 2.47, N 24.55%). δ_H 14.45 (1H, bs), 11.27 (1H, s), 8.68 (1H, s), 8.32 (2H, d, *J* 8.7), 8.18 (2H, d, *J* 8.7). δ_C 124.6, 127.6, 128.2, 130.7, 140.2, 143.8, 148.3, 150.7, 160.7, 162.7. ν_{max}(KBr)/cm^{-1} 3414, 3288, 2943, 2901, 1694, 1654, 1566, 1517, 1496, 1368, 1350, 1234, 1098, 861, 609.

3-(3,4-Dimethoxyphenyl)pyrimido[4,5-*c*]pyridazine-5,7(6*H*,8*H*)-dione (14): yellow solid, 81%, mp 283°C (dec.) (Found C 56.12, H 4.10, N 18.50%. $C_{14}H_{12}N_4O_4$ requires C 56.00, H 4.03, N 18.66%). δ_H 14.09 (1H, bs), 11.43 (1H, s), 8.59 (1H, s), 7.48 (1H, dd, J_1 8.4, J_2 1.5), 7.44 (1H, d, *J* 1.8), 7.06 (1H, d, *J* 8.1), 3.82 (3H, s), 3.80 (3H, s). δ_C 56.0, 56.1, 109.2, 112.3, 119.4, 126.8, 133.1, 145.7, 149.6, 150.8, 153.1, 160.6, 163.0. ν_{max}(KBr)/cm^{-1} 3388, 3226, 2998, 1717, 1697, 1633, 1578, 1504, 1422, 1363, 1296, 1258, 1216, 1158, 1022, 801, 603, 523.

3-(Benzo[*d*][1,3]dioxol-5-yl)pyrimido[4,5-*c*]pyridazine-5,7(6*H*,8*H*)-dione (15): yellow solid, 78%, mp 282°C (dec.) (Found C 55.00, H 2.87, N 19.60%. $C_{13}H_8N_4O_4$ requires C 54.93, H 2.84, N 19.71%). δ_H 14.11 (1H, bs), 11.40 (1H, s), 8.53 (1H, s), 7.41–7.44 (2H, m), 7.03 (1H, d, *J* 8.7), 6.1 (2H, s). δ_C 102.1, 106.2, 109.1, 121.1, 128.3, 128.4, 133.1, 145.5, 148.6, 149.1, 153.1, 160.6, 162.9. ν_{max}(KBr)/cm^{-1} 3402, 3199, 2900, 1701, 1649, 1595, 1501, 1446, 1374, 1229, 1038, 617, 555.

3-Phenyl-7-thioxo-7,8-dihydropyrimido[4,5-*c*]pyridazin-5(6*H*)-one (16): pale yellow solid, 93%, mp 240°C (dec.) (Found C 56.33, H 3.20, N 21.94%. $C_{12}H_8N_4OS$ requires C 56.24, H 3.15, N 21.86%). δ_H 13.92 (1H, bs), 10.47 (1H, s), 8.49 (1H, s), 7.88 (2H, dt, J_1 7.2, J_2 1.2), 7.47–7.51 (3H, m). δ_C 126.2, 128.3, 129.5, 130.0, 131.0, 134.6, 145.6, 159.9, 160.6, 163.5. ν_{max}(KBr)/cm^{-1} 3353, 3152, 3065, 1692, 1661, 1577, 1532, 1217, 699, 601. *m/z* [%]: 256 ([M$^+$], 20), 230 (100), 199 (90), 172 (94), 143 (33), 115 (43), 100 (39), 77 (42).

Mixture of 3-(4-bromophenyl)-7-thioxo-7,8-dihydropyrimido [4,5-*c*]pyridazin-5(6*H*)-one (17) and 3-(4-bromophenyl)-7-mercaptopyrimido[4,5-*c*]pyridazin-5-ol (24): beige solid, 74%, mp 235°C (dec.) (Found C 43.15, H 2.20, N 16.80%. $C_{12}H_7BrN_4OS$ requires C 43.00, H 2.11, N 16.72%). δ_H 13.89 (1H, bs), 10.45 (1H, s), 8.69 (1H, s), 8.48 (1H in one tautomer, s), 7.85 (2H in one tautomer, d, *J* 8.4), 7.78 (2H in other tautomer, d, *J* 8.4), 7.69 (2H in one tautomer, d, *J* 8.4), 7.64 (2H in other tautomer, d, *J* 8.4), 7.44 (1H in other tautomer, s). δ_C 121.6, 123.5, 125.7, 128.4, 129.6, 130.2, 130.9, 131.3, 131.7, 132.2, 132.4, 133.8, 137.2, 144.6, 159.8, 160.5, 188.9. ν_{max}(KBr)/cm^{-1} 3364, 3172, 3032, 1681, 1644, 1596, 1493, 1399, 1218, 1011, 830, 754, 592. *m/z* [%]: 337 ([M$^+$ + 2], 1), 335 ([M$^+$], 1), 310 (98), 308 (100), 279 (39), 277 (39), 252 (50), 250 (50), 223 (20), 221 (22), 183 (24), 142 (25), 113 (29), 57 (33), 43 (30).

Mixture of 3-(4-chlorophenyl)-7-thioxo-7,8-dihydropyrimido[4,5-*c*]pyridazin-5(6*H*)-one (18) and 3-(4-chlorophenyl)-7-mercaptopyrimido[4,5-*c*]pyridazin-5-ol (25): white solid, 65%, mp 315°C (dec.) (Found C 49.65, H 2.50, N 19.15%. $C_{12}H_7ClN_4OS$ requires C 49.57, H 2.43, N 19.27%). δ_H 13.88 (1H, bs), 10.44 (1H, s), 8.49 (1H in one tautomer, s), 8.47 (1H in

other tautomer, s), 7.93 (2H in one tautomer, d, *J* 8.4), 7.90 (2H in other tautomer, d, *J* 8.4), 7.56 (2H in one tautomer, d, *J* 8.4), 7.53 (2H in other tautomer, d, *J* 8.4). δ_C 128.1, 129.5, 129.6, 130.9, 131.5, 133.4, 134.8, 144.5, 159.8, 160.5. ν_{max}(KBr)/cm^{-1} 3170, 3033, 1682, 1591, 1528, 1496, 1404, 1090, 1015, 832, 593. *m/z* [%]: 292 ([M$^+$ + 2], 2), 290 ([M$^+$], 7), 266 (71), 264 (100), 235 (28), 233 (76), 208 (32), 206 (94), 177 (33), 149 (25), 137 (31), 113 (26).

3-(4-Fluorophenyl)-7-thioxo-7,8-dihydropyrimido[4,5-*c*]pyridazin-5(6*H*)-one (19): cream solid, 77%, mp 278°C (dec.) (Found C 52.65, H 2.65, N 20.31%. $C_{12}H_7FN_4OS$ requires C 52.55, H 2.57, N 20.43%). δ_H 13.92 (1H, bs), 10.46 (1H, s), 8.48 (1H, s), 7.93–7.98 (2H, m), 7.30–7.36 (2H, m). δ_C 116.2, 116.5, 128.6, 128.7, 129.6, 131.1, 131.2, 144.8, 159.8, 160.4, 161.7, 165.0. ν_{max}(KBr)/cm^{-1} 3224, 3105, 3055, 1701, 1601, 1514, 1460, 1244, 1159, 921, 837, 551. *m/z* [%]: 275 ([M$^+$ + 1], 100), 248 (73), 233 (28), 217 (28), 190 (41), 149 (35), 121 (34), 57 (34), 43 (34).

3-(4-Methoxyphenyl)-7-thioxo-7,8-dihydropyrimido[4,5-*c*]pyridazin-5(6*H*)-one (20): pale green solid, 73%, mp 243°C (dec.) (Found C 54.58, H 3.55, N 19.62%. $C_{13}H_{10}N_4O_2S$ requires C 54.54, H 3.52, N 19.57%). δ_H 13.83 (1H, bs), 10.50 (1H, s), 8.45 (1H, s), 7.84 (2H, d, *J* 9.0), 7.05 (2H, d, *J* 9.0), 3.80 (3H, s). δ_C 55.7, 114.9, 127.0, 127.7, 128.4, 129.4, 130.9, 145.4, 160.0, 160.4, 160.8. ν_{max}(KBr)/cm^{-1} 3423, 3321, 3016, 2935, 2841, 1689, 1669, 1637, 1609, 1589, 1577, 1514, 1253, 1176, 1022, 831, 566.

3-(4-Nitrophenyl)-7-thioxo-7,8-dihydropyrimido[4,5-*c*]pyridazin-5(6*H*)-one (21): beige solid, 46%, mp 362°C (dec.) (Found C 47.80, H 2.37, N 23.32%. $C_{12}H_7N_5O_3S$ requires C 47.84, H 2.34, N 23.25%). δ_H 14.13 (1H, bs), 10.41 (1H, s), 8.58 (1H, s), 8.33 (2H, d, *J* 8.7), 8.18 (2H, d, *J* 8.7). δ_C 124.6, 127.5, 127.6, 129.6, 131.1, 140.6, 143.7, 148.2, 159.7, 160.5. ν_{max}(KBr)/cm^{-1} 3414, 3288, 2943, 2901, 1694, 1654, 1566, 1517, 1496, 1368, 1350, 1234, 1098, 861, 609.

3-(3,4-Dimethoxyphenyl)-7-thioxo-7,8-dihydropyrimido[4,5-*c*]pyridazin-5(6*H*)-one (22): pale yellow solid, 83%, mp 254°C (dec.) (Found C 53.26, H 3.89, N 17.58%. $C_{14}H_{12}N_4O_3S$ requires C 53.16, H 3.82, N 17.71%). δ_H 13.83 (1H, bs), 10.49 (1H, s), 8.47 (1H, s), 7.43–7.46 (2H, m), 7.05 (1H, d, *J* 8.4), 3.82 (3H, s), 3.80 (3H, s). δ_C 56.0, 56.1, 109.1, 112.2, 119.3, 127.1, 129.4, 131.0, 145.5, 149.5, 150.6, 160.0, 160.4. ν_{max}(KBr)/cm^{-1} 3319, 3251, 2996, 2937, 1682, 1638, 1584, 1519, 1466, 1382, 1266, 1228, 1137, 1020, 845, 597.

3-(Benzo[*d*][1,3]dioxol-5-yl)-7-thioxo-7,8-dihydropyrimido[4,5-*c*]pyridazin-5(6*H*)-one (23): pale green solid, 70%, mp 262°C (dec.) (Found C 52.09, H 2.76, N 18.53%. $C_{13}H_8N_4O_3S$ requires C 52.00, H 2.69, N 18.66%). δ_H 13.82 (1H, bs), 10.46 (1H, s), 8.42 (1H, s), 7.38–7.41 (2H, m), 7.02 (1H, d, *J* 8.7), 6.09 (2H, s). δ_C 102.0, 106.2, 109.0, 120.8, 128.7, 129.4, 131.1, 145.3, 148.6, 149.0, 159.9, 160.4. ν_{max}(KBr)/cm^{-1} 3317, 3238, 3058, 2917, 1685, 1663, 1572, 1508, 1491, 1443, 1254, 1231, 1033, 886, 556.

2-Hydrazono-1-(4-methoxyphenyl)ethanone (26): white solid, 92%, mp 130–131°C. δ_H 8.09 (2H, d, *J* 9.0), 7.57 (1H, s), 6.94 (2H, d, *J* 9.0), 6.35 (2H, s). δ_C 55.4, 113.4, 114.0, 129.5, 130.2, 138.3, 163.1, 188.2. ν_{max}(KBr)/cm^{-1} 3369, 3180, 1641, 1595, 1490, 1307, 1265, 1228, 1166, 1023, 834, 761, 608.

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