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Synthesis of spiro[pyrazolo[3,4-*b*] pyridine-4,3′-indoline] and spiro [benzo[*h*]pyrazolo[3,4-*b*]quinoline-4,3′-indoline] derivatives using wet cyanuric chloride under solvent-free conditions

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Abstract. A simple and efficient synthesis of spiro[pyrazolo[3,4-*b*]pyridine-4,3′-indoline] and spiro[benzo[*h*] pyrazolo[3,4-*b*]quinoline-4,3′-indoline] derivatives has been accomplished by the one-pot condensation of isatins, 3-methyl-1-phenyl-1*H*-pyrazol-5- amine and Meldrum's acid or 2-hydroxy-1,4-naphthoquinone in the presence of wet cyanuric chloride as a catalyst under solvent-free conditions.

Keywords. Cyanuric chloride; spiro[benzo[*h*]pyrazolo[3,4-*b*]quinoline-4,3′-indoline]; spiro[pyrazolo[3,4-*b*] pyridine-4,3′-indoline]; solvent-free; green synthesis.

1. Introduction

Multi-component reactions (MCRs) are highly important because of their wide range of applications in pharmaceutical chemistry for the rapid generation of structural diversity in combinatorial libraries for drug discovery.[1,2] MCRs are extremely convergent, producing a remarkably high increase of molecular complexity in just one step.[3–6] Pyrazolo[3,4-*b*]pyridines are gaining importance in medicinal and organic chemistry. They have displayed broad spectrum of pharmacological and biological activities such as antibacterial,[7] antimicrobial,[8] antiviral,[9] oncogenic Ras-inhibiting[10] and cyclooxygenase inhibiting activities.[11]

The heterocyclic spirooxindole ring system is a widely distributed structural framework present in a number of pharmaceuticals and natural products,[12] including such cytostatic alkaloids as spirotryprostatins A,[13] B[14] and strychnophylline.[15] The unique structural array and highly pronounced pharmacological activity displayed by the class of spirooxindole compounds have made them attractive synthetic targets.[16]

Cyanuric chloride (TCT) is a stable, non-volatile, inexpensive and safe reagent which has been used synthetically for the preparation of various types of compounds such as 2-aryl-2,3-dihydroquinolin-4(1*H*)-ones,[17] bis(indolyl)methanes,[18] N-sulphonyl imines,[19] 14-aryl or alkyl-14*H*-dibenzo[*a*, *j*]xanthenes,[20] 1,5-benzothiazepines,[21] and 2*H*-indazolo [2,1-*b*]phthalazine-1,6,11(13*H*)-trione.[22] In this paper, we wish to report, a simple and facile synthesis of 3-methyl-1-phenyl-1, 5-dihydro-spiro[pyrazolo[3,4-*b*] pyridine-4,3′-indoline]-2′, 6(7*H*)-dione derivatives under solvent-free conditions using wet TCT as a catalyst. During our study, we also observed formation of 3-methyl-1-phenyl-1, 11-dihydrospiro[benzo[*h*]pyrazolo[3,4-*b*]quinoline-4,3′-indoline]-2′,5,10-triones in excellent yields by one-pot condensation of 2-hydroxy-1, 4-naphthoquinone with isatins, 3-methyl-1-phenyl-1*H*-pyrazol-5-amine in the presence of wet TCT (scheme 1).

2. Experimental

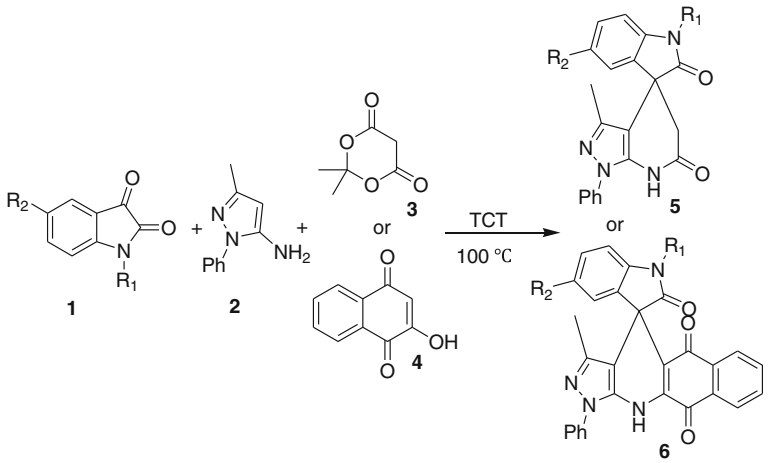
2.1 *Materials, methods and instruments*

Nuclear magnetic resonance (NMR) spectra were determined on Bruker AV-400 Spectrometer at room temperature using tetramethylsilane (TMS) as internal standard, coupling constants (J) were measured in Hz; elemental analysis were performed by a Vario-III Elemental Analyser; melting points were determined on a XT-4 Binocular Microscope and were uncorrected; commercially available reagents were used throughout without further purification unless otherwise stated.

2.2 *General procedure for the preparation of* **5** *and* **6**.

A mixture of isatins (1 mmol), 3-methyl-1-phenyl-1*H*-pyrazol-5-amine (1 mmol), and Meldrum's acid

*For correspondence



Scheme 1. Synthesis of spiro[pyrazolo[3,4-*b*] pyridine-4,3′-indoline] and spiro[benzo[*h*] pyrazolo[3,4-*b*]quinoline-4,3′-indoline] derivatives.

or 2-hydroxy-1,4-naphthoquinone (1 mmol), TCT (0.04 mmol) and H_2O (3 drops) was heated at 100 °C for appropriate time. The reaction was monitored by thin layer chromatography (TLC). After completion of the reaction, the mixture was cooled to room temperature and washed with water. The solid products were purified by recrystallization from ethyl alcohol (EtOH).

2.3 *Spectroscopic data*

2.3a *3-Methyl-1-phenyl-1,5-dihydro-spiro[pyrazolo[3,4-b]pyridine-4,3′-indoline]-2′,6(7H)-dione (**5a**)*: Canary yellow powder, m.p. 236–237°C; ^{1}H NMR (400 MHz, DMSO-d_6) δ: 10.71 (s, 1H, NH), 10.63 (s, 1H, NH), 7.50–7.46 (m, 4H, Ar–H), 7.37–7.22 (m, 3H, Ar–H), 7.02–6.92 (m, 2H, Ar–H), 2.99 (d, 1H, J = 15.6 Hz, CH_2), 2.65 (d, 1H, J = 15.6 Hz, CH_2), 1.50 (s, 3H, CH_3); ^{13}C NMR (100 MHz, DMSO-d_6) δ: 178.7, 169.5, 144.6, 142.0, 140.8, 138.2, 131.7, 129.7, 129.3, 127.5, 124.3, 123.4, 122.6, 110.4, 100.8, 46.2, 30.7, 12.2; Anal. calcd. for $C_{20}H_{16}N_4O_2$: C 69.76 H 4.68, N 16.27; found: C 69.60, H 4.72, N 16.20.

2.3b *5′-Chloro-3-methyl-1-phenyl-1,5-dihydro-spiro[pyrazolo[3,4-b]pyridine-4,3′-indoline]-2′, 6(7H)-dione (**5b**)*: Orange red powder, m.p. 181–183 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ: 10.77 (s, 1H, NH), 10.71 (s, 1H, NH), 7.60–7.47 (m, 4H, Ar–H), 7.38–7.31 (m, 3H, Ar–H), 6.95–6.86 (m, 1H, Ar–H), 3.08 (d, 1H, J = 16 Hz, CH_2), 2.68 (d, 1H, J = 15.6 Hz, CH_2), 1.53 (s, 3H, CH_3); ^{13}C NMR (100 MHz, DMSO-d_6) δ: 178.4, 169.3, 144.4, 141.0, 140.9, 138.1, 133.8, 129.7, 129.2, 127.6, 126.6, 124.5, 123.4, 111.9, 100.2, 46.5, 30.9, 12.3; Anal. calcd. for $C_{20}H_{15}ClN_4O_2$: C 63.41, H 3.99, N 14.79; found: C 63.36, H 4.05, N 14.85.

2.3c *3,5′-Dimethyl-1-phenyl-1,5-dihydro-spiro[pyrazolo[3,4-b]pyridine-4,3′-indoline]-2′, 6(7H)-dione(**5c**)*: Orange powder, m.p. 234–235 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ: 10.70 (s, 1H, NH), 10.54 (s, 1H, NH), 7.55–7.45 (m, 4H, Ar–H), 7.37–7.36 (m, 1H, Ar–H), 7.07–7.02 (m, 2H, Ar–H), 6.86–6.81 (m, 1H, Ar–H), 2.90 (d, 1H, J = 15.6 Hz, CH_2), 2.65 (d, 1H, J = 15.6 Hz, CH_2), 2.23 (s, 3H, CH_3), 1.53 (s, 3H, CH_3); ^{13}C NMR (100 MHz, DMSO-d_6) δ: 178.7, 169.5, 144.6, 140.7, 139.4, 138.2, 131.9, 131.5, 129.7, 129.5, 127.5, 124.7, 123.4, 110.2, 101.0, 46.2, 30.9, 21.1, 12.3; Anal. calcd. for $C_{21}H_{18}N_4O_2$: C 70.38, H 5.06, N 15.63; found: C 70.33, H 4.99, N 15.56.

2.3d *5′-Fluoro-3-methyl-1-phenyl-1,5-dihydro-spiro[pyrazolo[3,4-b]pyridine-4,3′-indoline]-2′, 6(7H)-dione (**5d**)*: Orange powder, m.p. 144–145 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ: 10.71 (s, 1H, NH), 10.64 (s, 1H, NH), 7.50–7.38 (m, 4H, Ar–H), 7.37–7.35 (m, 1H, Ar–H), 7.21–7.19 (m, 1H, Ar–H), 7.13–6.93. (m, 1H, Ar–H), 6.92–6.91 (m, 1H, Ar–H), 3.11 (d, 1H, J = 16 Hz, CH_2), 2.63 (d, 1H, J = 15.6 Hz, CH_2), 1.52 (s, 3H, CH_3); ^{13}C NMR (100 MHz, DMSO-d_6) δ: 178.7, 169.3, 157.5, 144.5, 140.8, 138.4, 133.4, 133.3, 129.7, 127.6, 123.4, 115.8, 112.3, 111.3, 100.3, 46.7, 30.9, 12.3; Anal. calcd. for $C_{20}H_{15}FN_4O_2$: C 66.29, H 4.17, N 15.46; found: C 66.32, H 4.09, N 15.52.

2.3e *5′-Bromo-3-methyl-1-phenyl-1,5-dihydro-spiro[pyrazolo[3,4-b]pyridine-4,3′-indoline]-2′, 6(7H)-dione (**5e**)*: Orange powder, m.p. 198–200°C; ^{1}H NMR

(400 MHz, DMSO-d_6) δ: 10.78 (s, 1H, NH), 10.71 (s, 1H, NH), 7.50–7.44 (m, 6H, Ar–H), 7.39–7.36 (m, 1H, Ar–H), 6.91–6.89 (m, 1H, Ar–H), 3.07 (d, 1H, J = 15.6 Hz, CH_2), 2.69 (d, 1H, J = 15.6 Hz, CH_2), 1.53 (s, 3H, CH_3); ^{13}C NMR (100 MHz, DMSO-d_6) δ: 178.3, 169.3, 144.4, 141.4, 140.8, 138.1, 134.2, 132.0, 129.7, 127.6, 127.1, 123.7, 123.4, 114.2, 112.4, 100.3, 46.4, 30.9, 12.3; Anal. calcd. for $C_{20}H_{15}BrN_4O_2$: C 56.75, H 3.57, N 13.24; found: C 56.71, H 3.49, N 13.32.

2.3f *1′, 3-Dimethyl-1-phenyl-1,5-dihydro-spiro[pyrazolo[3,4-b]pyridine-4,3′-indoline]-2′, 6(7H)-dione (**5f**)*: Blackish green powder, m.p. 110–112 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ: 10.75 (s, 1H, NH), 7.50–7.46 (m, 4H, Ar–H), 7.39–7.28 (m, 3H, Ar–H), 7.13–7.07 (m, 2H, Ar–H), 3.18 (s, 3H, CH_3), 3.04 (d, 1H, J = 16 Hz, CH_2), 2.67 (d, 1H, J = 16 Hz, CH_2), 1.44 (s, 3H, CH_3); ^{13}C NMR (100 MHz, DMSO-d_6) δ: 176.8, 169.4, 144.5, 143.6, 140.8, 138.2, 130.9, 129.7, 129.4, 127.5, 123.9, 123.4, 123.2, 109.5, 100.6, 45.8, 30.9, 26.7, 12.2; Anal. calcd. for $C_{21}H_{18}N_4O_2$: C 70.38, H 5.06, N 15.63; found: C 70.40, H 5.02, N 15.50.

2.3g *3-Methyl-1-phenyl-1,11-dihydrospiro[benzo[h]pyrazolo[3,4-b]quinoline-4,3′-indoline]-2′, 5, 10-trione (**6a**)*: Purple red powder, m.p. 295–296 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ: 10.67 (s, 1H, NH), 9.75 (s, 1H, NH), 8.07 (d, 1H, J = 6.8 Hz, Ar–H), 7.85–7.79 (m, 3H, Ar–H), 7.60–7.58 (m, 4H, Ar–H), 7.47–7.44 (m, 1H, Ar–H), 7.20 (t, 1H, J = 7.2 Hz, Ar–H), 7.05 (d, 1H, J = 7.2 Hz, Ar–H), 6.94–6.87 (m, 2H, Ar–H), 1.64 (s, 3H, CH_3); ^{13}C NMR (100 MHz, DMSO-d_6) δ: 181.1, 179.9, 179.3, 145.5, 141.8, 141.5, 138.7, 137.2, 136.6, 135.7, 133.8, 132.3, 130.3, 130.0, 128.6, 127.7, 126.5, 126.3, 124.4, 123.4, 122.3, 115.8, 109.5, 101.8, 50.3, 11.8; Anal. calcd. for $C_{28}H_{18}N_4O_3$: C 73.35 H 3.96, N 12.22; found: C 73.30, H 4.06, N 12.24.

2.3h *5′-Chloro-3-methyl-1-phenyl-1,11-dihydrospiro[benzo[h]pyrazolo[3,4-b]quinoline-4,3′-indoline]-2′, 5, 10-trione (**6b**)*: Red powder, m.p. 286–287°C; ^{1}H NMR (400 MHz, DMSO-d_6) δ: 10.82 (s, 1H, NH), 9.84 (s, 1H, NH), 8.07 (d, 1H, J = 6.8 Hz, Ar–H), 7.84–7.82 (m, 3H, Ar–H), 7.60–7.58 (m, 4H, Ar–H), 7.47–7.45 (m, 1H, Ar–H), 7.26–7.18 (m, 2H, Ar–H), 6.94 (d, 1H, J = 8.0 Hz, Ar–H), 1.67 (s, 3H, CH_3); ^{13}C NMR (100 MHz, DMSO-d_6) δ: 180.9, 179.8, 179.1, 145.3, 141.2, 140.8, 138.9, 138.6, 136.7, 135.6, 133.8, 132.3, 130.5, 130.0, 128.5, 127.8, 126.5, 126.4, 126.2, 124.7, 123.6, 115.2, 110.9, 101.2, 50.5, 11.8; Anal. calcd. for $C_{28}H_{17}ClN_4O_3$: C 68.23 H 3.48, N 11.37; found: C 68.22, H 3.52, N 11.28.

2.3i *3,5′-Dimethyl-1-phenyl-1,11-dihydrospiro[benzo[h]pyrazolo[3,4-b]quinoline-4,3′-indoline]- 2′, 5, 10-trione (**6c**)*: Red powder, m.p. 270–271 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ: 10.56 (s, 1H, NH), 9.77 (s, 1H, NH), 8.06 (d, 1H, J = 7.2 Hz, Ar–H), 7.87–7.79 (m, 3H, Ar–H), 7.60–7.58 (m, 4H, Ar–H), 7.47–7.43 (m, 1H, Ar–H), 6.99 (d, 1H, J = 7.2 Hz, Ar–H), 6.87–6.80 (m, 2H, Ar–H), 2.15 (s, 3H, CH_3), 1.65 (s, 3H, CH_3); ^{13}C NMR (100 MHz, DMSO-d_6) δ: 181.1, 179.9, 179.3, 145.5, 141.5 , 139.4, 138.7, 137.3, 136.2, 135.7, 133.8, 132.3, 131.1, 130.4, 130.0, 128.8, 127.7, 126.5, 126.3, 125.0, 123.3, 115.3, 109.2, 101.9, 50.3, 21.0, 11.8; Anal. calcd. for $C_{29}H_{20}N_4O_3$: C 73.72 H 4.27, N 11.86; found: C 73.70, H 4.39, N 11.88.

2.3j *5′-Fluoro-3-methyl-1-phenyl-1,11-dihydrospiro[benzo[h]pyrazolo[3,4-b]quinoline-4,3′-indoline]-2′, 5, 10-trione (**6d**)*: Red powder, m.p. 270–271 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ: 10.70 (s, 1H, NH), 9.83 (s, 1H, NH), 8.07 (d, 1H, J = 7.2 Hz, Ar–H), 7.84–7.81 (m, 3H, Ar–H), 7.61–7.58 (m, 4H, Ar–H), 7.47–7.44 (m, 1H, Ar–H), 7.05–7.00 (m, 2H, Ar–H), 6.92–6.89 (m, 1H, Ar–H), 1.66 (s, 3H, CH_3); ^{13}C NMR (100 MHz, DMSO-d_6) δ: 181.1, 179.8, 179.3, 157.6, 145.4, 141.7, 138.7, 138.1, 136.7, 135.7, 133.8, 132.3, 130.4, 130.0, 127.8, 126.5, 126.4, 123.5, 115.2, 114.7, 112.5, 112.2, 110.1, 101.3, 50.8, 11.8; Anal. calcd. for $C_{28}H_{17}FN_4O_3$: C 70.58 H 3.60, N 11.76; found: C 70.53, H 3.66, N 11.70.

2.3k *5′-Bromo-3-methyl-1-phenyl-1,11-dihydrospiro[benzo[h]pyrazolo[3,4-b]quinoline-4,3′-indoline]-2′, 5, 10-trione (**6e**)*: Red powder, m.p. 270–271 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ: 10.81 (s, 1H, NH), 9.81 (s, 1H, NH), 8.07 (d, 1H, J = 7.2 Hz, Ar–H), 7.84–7.79 (m, 3H, Ar–H), 7.60–7.58 (m, 4H, Ar–H), 7.47–7.45 (m, 1H, Ar–H), 7.39–7.37 (m, 1H, Ar–H), 7.30–7.28 (m, 1H, Ar–H), 6.90 (d, 1H, J = 8.0 Hz, Ar–H), 1.67 (s, 3H, CH_3); ^{13}C NMR (100 MHz, DMSO-d_6) δ: 181.2, 179.8, 178.9, 145.3, 141.7, 141.2, 139.3, 138.6, 136.7, 135.7, 133.8, 132.3, 131.3, 130.5, 130.0, 127.8, 127.4, 126.5, 126.4, 123.6, 115.0, 114.0, 111.5, 101.2, 50.5, 11.8; Anal. calcd. for $C_{28}H_{17}BrN_4O_3$: C 62.58 H 3.19, N 10.43; found: C 62.35, H 3.11, N 10.42.

2.3l *1′, 3-Dimethyl-1-phenyl-1,11-dihydrospiro[benzo[h]pyrazolo[3,4-b]quinoline-4,3′-indoline]-2′, 5, 10-trione (**6f**)*: Red powder, m.p. 270–271°C; ^{1}H NMR

(400 MHz, DMSO-d_6) δ: 9.87 (s, 1H, NH), 8.06 (d, 1H, J = 7.2 Hz, Ar–H), 7.83–7.79 (m, 3H, Ar–H), 7.59–7.57 (m, 4H, Ar–H), 7.47–7.44 (m, 1H, Ar–H), 7.31 (t, 1H, J = 7.6 Hz, Ar–H), 7.15–7.11 (m, 2H, Ar–H), 6.97 (t, 1H, J = 7.2 Hz, Ar–H), 2.50 (s, 3H, CH_3), 1.53 (s, 3H, CH_3); ^{13}C NMR (100 MHz, DMSO-d_6) δ: 181.1, 179.8, 177.7, 145.3, 143.2, 141.6, 138.7, 136.7, 136.3, 135.7), 133.8, 132.2, 130.4, 130.0, 128.8, 127.7, 126.5, 126.3, 124.2, 123.6, 123.4, 123.0, 115.5, 108.4, 101.6, 49.8, 26.8, 11.7; $C_{29}H_{20}N_4O_3$: C 73.72 H 4.27, N 11.86; found: C 73.79, H 4.30, N 11.85.

3. Results and discussion

First, to achieve suitable conditions for the synthesis of spiro[pyrazolo[3,4-*b*] pyridine-4,3′-indoline] derivatives, we tested the reaction of isatin (**1a**), 3-methyl-1-phenyl-1*H*-pyrazol-5-amine (**2**) and Meldrum's acid (**3**) as a simple model system under solvent-free conditions using various catalysts (table 1). As could be seen in table 1, the best result was obtained with 4 mol% of TCT as the catalyst at 100°C (entry 4). Using less catalyst resulted in lower yields, whereas higher amounts of catalyst did not affect reaction times and yields. When this reaction was carried out without TCT or with other catalysts such as $ZnCl_2$, $FeCl_3$ and $AlCl_3$, the yield of the expected product was low. In the presence of *p*-TsOH or sulphamic acid, the product was obtained in moderate yield.

Encouraged by this success, a variety of isatins were employed under similar conditions. The corresponding spiro[pyrazolo[3,4-*b*] pyridine-4,3′-indoline] derivatives **5a–5f** were selectively synthesized by the one-pot, three-component condensation of isatins, 3-methyl-1-phenyl-1*H*- pyrazol-5-amine and Meldrum's acid in good yields. The results are summarized in table 2. The structures of compounds **5a–f** were confirmed by ^{1}H and ^{13}C NMR spectroscopy and elemental analysis. The ^{1}H NMR spectrum of **5a** exhibited two singles at δ 10.71 and 10.63 (D_2O exchangeable) due to –NH, two doubles at δ 2.99 and 2.65 due to $-CH_2$ and aromatic protons in the range δ 6.92–7.50. Resonances at δ 46.2 (spiro carbon), δ 169.5 (–C = O group) and δ 178.7 (isatin –C = O group) were observed in the ^{13}C NMR spectrum.

HCl generated *in situ*, from TCT, efficiently catalyses these reactions,[23] a plausible mechanism is shown in scheme 2. Accordingly, TCT reacts with 'incipient' moisture and releases 3 equvients of HCl and TCT (removable by washing with water) as by-product. The formation of products **5a–5f** can be rationalized by initial formation of heterodiene **7** by standard Knoevenagel condensation of Meldrum's acid **3** and isatins **1** in the presence of a catalytic amount of HCl. Subsequent Michael-type addition of 3-methyl-1-phenyl-1*H*-pyrazol-5-amine **2** to the heterodienes **7** followed by cyclization, removing CO_2 and acetone afford the corresponding products **5a–5f** (scheme 2). However, the reaction using dry TCT in the presence of MS 4Å, met with failure. Thus, it amply indicates that the 'incipient' moisture plays an important role during HCl generation *in situ* from TCT. Also, with dilute HCl, instead of TCT, the corresponding products were isolated in 51–62% yields

To further expand the scope of the present method, we investigated one-pot reactions involving 2-hydroxy-1,4-naphthoquinone. To our delight, under the above optimized conditions, the reactions proceeded smoothly and a variety of the desired spirooxindoles products **6**

Table 1. Optimization of reaction conditions[a].

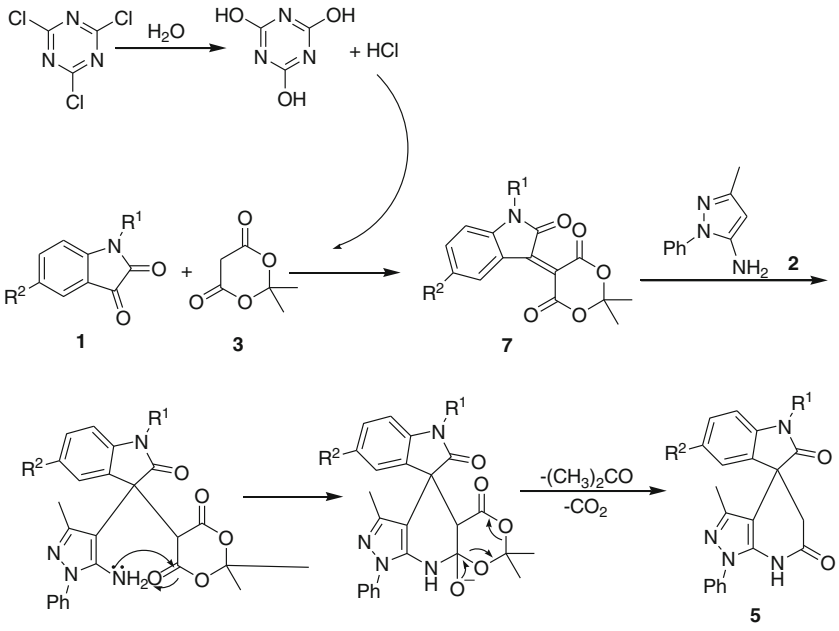
Entry	Catalyst	Mol%	Time/h	Yield/%[b]
1	-		12	Trace
2	TCT	2%	8	69
3	TCT	3%	8	80
4	TCT	4%	7	91
5	TCT	5%	7	89
6	TCT	6%	6	90
6	*p*-TsOH	4%	8	64
7	$ZnCl_2$	4%	10	25
8	$FeCl_3$	4%	9	42
9	$AlCl_3$	4%	9	39
10	Sulphamic acid	4%	9	50

[a]Reaction conditions: isatin (1 mmol); 3-methyl-1-phenyl-1*H*-pyrazol-5-amine (1 mmol); Meldrum's acid (1 mmol); H_2O (3 drops); 100 °C
[b]Isolated yield

Table 2. Preparation of spiro[pyrazolo[3,4-*b*] pyridine-4,3′-indoline] derivatives[a].

Entry	R^1	R^2	Time/h	Product	Yield/ %[b]
1	H	H	7	**5a**	91
2	H	Cl	6	**5b**	93
3	H	Me	9	**5c**	89
4	H	F	7	**5d**	90
5	H	Br	6	**5e**	92
6	Me	H	8	**5f**	85

[a]Reaction conditions: isatins (1 mmol); 3-methyl-1-phenyl-1*H*-pyrazol-5-amine (1 mmol); Meldrum's acid (1 mmol); TCT (0.04 mmol); H_2O (3 drops); 100 °C
[b]Isolated yield



Scheme 2. A plausible mechanism for this reaction.

Table 3. Preparation of spiro[benzo[*h*]pyrazolo[3,4-*b*] quinoline-4,3′-indoline] derivatives[a].

Entry	R^1	R^2	Time/h	Product	Yield/%[b]
1	H	H	6	**6a**	92
2	H	Cl	5	**6b**	86
3	H	Me	7	**6c**	86
4	H	F	5	**6d**	92
5	H	Br	6	**6e**	89
6	Me	H	8	**6f**	88

[a]Reaction conditions: isatins (1 mmol); 3-methyl-1-phenyl-1*H*-pyrazol-5-amine (1 mmol); 2-hydroxy-1,4- naphthoquinone (1 mmol); TCT (0.04 mmol); H_2O (3 drops); 100 °C
[b]Isolated yield

were obtained in good yields (table 3). When this reaction was carried out with diethyl malonate, TLC and ^{1}H NMR spectra of the reaction mixture showed a combination of starting materials and numerous products, the yield of the expected product was very poor.

4. Conclusion

In summary, a green and efficient procedure for the synthesis of spiro[pyrazolo[3,4-*b*] pyridine-4,3′-indoline] and single spiro[benzo[*h*]pyrazolo[3,4-*b*]quinoline-4,3′-indoline] derivatives was investigated *via* the one-pot three-component reaction of isatins, 3-methyl-1-phenyl-1*H*-pyrazol-5-amine and Meldrum's acid or 2-hydroxy-1,4- naphthoquinone in the presence of wet TCT as a catalyst under solvent-free conditions. This procedure offers several advantages including higher yields, mild reaction conditions, shorter reaction time, convenient procedure and environment friendliness.

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