Supporting Information

Synthesis of furo[3,4-c]quinolin-3(1H)-one derivatives through TMG Catalyzed Intramolecular aza-MBH Reaction based on the furanones

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General information

Unless otherwise stated, all reagents were purchased from commercial suppliers and were used without further purification. 2(5H)-furanone derivatives I was not commercially available and was prepared in our lab. Reactions were monitored by thin layer chromatography (TLC) on GF$_{254}$ silica gel plates. $^1$H NMR spectra and $^{13}$C NMR spectra were recorded on a Bruker AVANCE III 400 (400 MHz) spectrometer in needful D-reagents with tetramethylsilane (TMS) as an internal reference. Data for $^1$H NMR were reported as follows: chemical shift (ppm), and multiplicity (s = singlet, d = doublet, t = triplet, dd = double of doublet, m = multiplet), coupling constants (Hz) and integration; Data for $^{13}$C NMR were reported as ppm. Melting points were measured on an X$_4$-type micro-melting point apparatus and were uncorrected.
Synthesis of 2(5H)-furanone derivatives I

\[
\begin{align*}
\text{A} & \quad \text{Br}_2 \quad \text{ZnCl}_2 \quad \text{CHCl}_3 \\
& \quad \text{r.t.} \\
\rightarrow & \quad \text{Br} \\
\text{B} & \quad \text{NO}_2
\end{align*}
\]

To the solution of A (57.6mmol) and ZnCl\(_2\) (100mg) in chloroform (100ml) was added the solution of Br\(_2\) (3ml 57.6mmol) in chloroform (20ml) dropwise for a period of 2h at room temperature. The mixture was stirred at room temperature for another 10h. Then, the reaction was quenched with 10% (w/w) NaHCO\(_3\) aq. (50ml) and extracted with chloroform (3\(\times\)30ml). The combined organic layer was dried by Na\(_2\)SO\(_4\), filtered and concentrated in vacuo. The residue was recrystallized to give the desired product B (yield 79%) as white solid.

\[
\begin{align*}
\text{B} & \quad \text{Br} \\
\text{NO}_2 & \quad \text{HOOC} \quad \text{POEt} \quad \text{OEt} \\
\rightarrow & \quad \text{K}_2\text{CO}_3 \quad \text{DMF} \\
& \quad 0^\circ\text{C} \\
\rightarrow & \quad \text{NaO\text sub{Bu}} \quad \text{THF} \\
& \quad -78^\circ\text{C}
\end{align*}
\]

To the solution of B (10mmol) and C (10mmol) in DMF (10ml) was added K\(_2\)CO\(_3\) (10.5mmol) at 0\(^\circ\)C. After 1h, water (40ml) was poured into the reaction mixture. Then 20% (w/w) HCl aq. was added to the solution to adjust pH between 4 and 5. The mixture was extracted with ethyl acetate (3\(\times\)20ml). The combined organic layer was dried by Na\(_2\)SO\(_4\), filtered and concentrated in vacuo. The residue was dissolved in dry THF (80ml) and stirred at -78\(^\circ\)C for 10 minutes. Then, the suspending solution of NaO\textsubscript{t}-Bu (12mmol) in dry THF (25ml) was added dropwise into the reaction mixture for a period of 30mins. After that, the reaction mixture was stirred at -78\(^\circ\)C for 1h and warmed to room temperature for another 1h. Then 20% (w/w) HCl aq. was added to adjust the pH between 5 and 6. After removed the solvent, the residue was treated with water (50ml) and extracted with ethyl acetate (3\(\times\)20ml). The combined organic layer was dried by Na\(_2\)SO\(_4\), filtered and concentrated in vacuo. The residue was purified by silica gel column chromatography to give the desired product D (50% for 2 steps) as yellow solid.
To the solution of D (5.4mmol) in ethanol (27ml) was added water (3ml), powder Fe (21.6mmol), and NH₄Cl (21.6mmol) subsequently. After 8 hours’ reflux, the mixture was filtered and the filtrate was treated with water (50ml) and extracted with CH₂Cl₂ (25ml×3). The combined organic layer was dried by Na₂SO₄, filtered and concentrated in vacuo. The residue was recrystallized by ethanol to give the desired product E (yield 71%) as red solid.

To the solution of E (0.5mmol), PTSA (0.025mmol) and Na₂SO₄ (1.5g) in toluene (5ml) was added the corresponding aldehyde. After stirred at 55°C for 6h, the mixture was cooled to room temperature. Then the solvent was removed and the residue was dissolved in hot ethanol and filtered. The filtrate was concentrated in vacuo and the residue was recrystallized by ethanol to give the desired product 1 (yield 60%-82%) as solid.

General procedure for the synthesis of the 4,5-dihydrofuro[3,4-c]quinolin-3(1H)-one derivatives

Compound 1 (0.2mmol), TMG (0.04mmol) was dissolved in o-xylene (2ml). After 7 hours’ reflux, the reaction mixture was cooled to room temperature. Then the solvent was removed and the residue was purified by silica gel column chromatography to give the pure intermediate 2. Later on, the intermediate 2 was dissolved in CH₂Cl₂ and DDQ (1eq.) was added, stirred for five
minutes at room temperature. The solution was washed by saturated NaHCO₃ solution; the organic layer was dried by Na₂SO₄, filtered. The filtrate was concentrated to give the final product 3 as solid.

Scope of the highly substituted quinoline derivatives

![3a]

2-Phenylfuro[3,4-c]quinolin-3(1H)-one 3a: Obtained in 69% yield; white solid; m.p. 241.5-244.7°C; ¹H NMR (400 MHz, DMSO): δ 8.22 (d, J = 8.4 Hz, 1H), δ 8.13 (d, J = 8.0 Hz, 1H), δ 8.01 (t, J = 7.6 Hz, 1H), δ 7.88-7.94 (m, 2H), δ 7.79 (t, J = 7.6 Hz, 1H), δ 7.50-7.56 (m, 3H), δ 5.86 (s, 2H); ¹³C NMR (100 MHz, CDCl₃): δ 169.0, 158.1, 157.1, 149.1, 136.3, 133.1, 130.7, 130.0, 130.0, 128.1, 128.1, 123.0, 121.0, 116.5, 67.4; ES-HRMS: Calcd for C₁₇H₁₂NO₂ [M+H⁺], 262.0868, Found 262.0860.

![3b]

2-(3-Methylphenyl)furo[3,4-c]quinolin-3(1H)-one 3b: Obtained in 70% yield; yellow solid; m.p. 184.6-185.6°C; ¹H NMR (400 MHz, DMSO): δ 8.23 (d, J = 8.4 Hz, 1H), δ 8.15 (d, J = 7.6 Hz, 1H), δ 7.99-8.06 (m, 1H), δ 7.81 (t, J = 7.6 Hz,1H), δ 7.68-7.74 (m, 2H), δ 7.41 (t, J = 7.6 Hz,1H), δ 7.35 (d, J = 7.6 Hz,1H), δ 5.87 (s, 2H); δ 2.42(s, 3H); ¹³C NMR (100 MHz, DMSO): δ 169.0, 159.7, 156.0, 148.1, 136.8, 136.4, 133.3, 130.4, 130.1, 129.5, 128.0, 127.5, 127.3, 124.6, 120.7, 116.0, 68.1, 21.0; ES-HRMS: Calcd for C₁₈H₁₄NO₂ [M+H⁺], 276.1025, Found 276.1025.

![3c]

2-(4-Methylphenyl)furo[3,4-c]quinolin-3(1H)-one 3c: Obtained in 64% yield; yellow solid; m.p.
204.6-205.9°C; ¹H NMR (400 MHz, DMSO): δ 8.20 (d, J = 8.4 Hz, 1H), δ 8.12 (d, J = 8.0 Hz, 1H), δ 8.00 (t, J = 7.6 Hz, 1H), δ 7.83 (d, J = 8.0 Hz, 2H), δ 7.77 (t, J = 7.6 Hz, 1H), δ 7.33 (d, J = 8.0 Hz, 2H), δ 5.85 (s, 2H); δ 2.41(s, 3H); ¹³C NMR (100 MHz, DMSO): δ 169.5, 160.1, 156.3, 148.7, 139.7, 134.2, 133.7, 130.4, 130.0, 128.8, 128.3, 125.0, 121.1, 116.4, 68.6, 21.5; ES-HRMS: Caled for C₁₈H₁₄NO₂ [M+H]+, 276.1025, Found 276.1025.

2-(2-Methylphenyl)furo[3,4-c]quinolin-3(1H)-one 3d: Obtained in 75% yield; yellow solid; m.p. 176.2-177.7°C; ¹H NMR (400 MHz, DMSO): δ 8.20 (dd, J = 13.7, 4.8 Hz, 2H), 8.04 (m, 1H), 7.82 (m, 1H), 7.44 – 7.37 (m, 1H), 7.36 – 7.27 (m, 3H), 5.90 (s, 1H), 2.16 (s, 2H). ¹³C NMR (100 MHz, DMSO): δ 169.2, 159.2, 157.1, 148.7, 137.2, 136.3, 133.6, 130.2, 130.1, 130.0, 129.1, 128.6, 125.6, 125.2, 121.4, 117.5, 68.8, 19.8. ES-HRMS: Caled for C₁₈H₁₄NO₂ [M+H]+, 276.1019.

2-(3-Methoxyphenyl)furo[3,4-c]quinolin-3(1H)-one 3e: Obtained in 65% yield; yellow solid; m.p. 176.9-178.2°C; ¹H NMR (400 MHz, DMSO): δ 8.24 (d, J = 8.4 Hz, 1H), δ 8.16 (d, J = 8.0 Hz, 1H), δ 8.03 (t, J = 7.6 Hz, 1H), δ 7.82 (t, J = 7.6 Hz,1H), δ 7.41-7.52 (m,3H), δ 7.11 (d, J = 8.4 Hz,1H), δ 5.88 (s, 2H); δ 3.84(s, 3H); ¹³C NMR (100 MHz, DMSO): δ 169.4, 160.2, 159.1, 156.1, 148.6, 138.2, 133.8, 130.1, 129.3, 128.6, 125.1, 122.7, 121.3, 116.6, 116.0, 115.7, 68.6, 55.7; ES-HRMS: Caled for C₁₈H₁₄NO₃ [M+H]+, 292.0974, Found 292.0973.

2-(4-Methoxyphenyl)furo[3,4-c]quinolin-3(1H)-one 3f: Obtained in 35% yield; yellow solid;
2-(4-fluorophenyl)furo[3,4-c]quinolin-3(1H)-one 3g: Obtained in 44% yield; yellow solid; m.p. >250°C; 1H NMR (400 MHz, DMSO): δ 8.24 (d, J = 8.4 Hz, 1H), δ 8.17 (d, J = 8.0 Hz, 1H), δ 7.96-8.07 (m, 3H), δ 7.82 (t, J = 7.6 Hz, 1H), δ 7.37 (t, J = 8.8 Hz, 2H), δ 7.50-7.56 (m, 3H), δ 5.90 (s, 2H); 13C NMR (100 MHz, DMSO): δ 169.5, 160.2, 155.1, 148.6, 133.8, 133.3 (d, 2.6Hz), 132.8 (d, 8.6Hz), 130.0, 128.6, 125.1, 121.3, 116.5, 115.2 (d, 21.5Hz), 68.7; ES-HRMS: Calcd for C_{17}H_{10}FNO_{2} [M+H]^+, 280.0774, Found 280.0771.

2-(4-bromophenyl)furo[3,4-c]quinolin-3(1H)-one 3h: Obtained in 53% yield; yellow solid; m.p. >235°C; 1H NMR (400 MHz, CDCl₃): δ 8.34 (d, J = 8.5 Hz, 1H), 7.98 (t, J = 7.8 Hz, 1H), 7.92 (dd, J = 12.0, 8.6 Hz, 3H), 7.75 (t, J = 7.5 Hz, 1H), 7.70 (d, J = 8.4 Hz, 2H), 5.72 (s, 2H); 13C NMR (100 MHz, DMSO): δ 169.5, 160.2, 155.1, 148.6, 136.1, 133.9, 132.5, 131.2, 130.1, 128.7, 125.2, 123.9, 121.4, 116.6, 68.8; ES-HRMS: Calcd for C_{17}H_{11}BrNO_{2} [M+H]^+, 339.9973, Found 339.9966.

2-(2-chlorophenyl)furo[3,4-c]quinolin-3(1H)-one 3i: Obtained in 52% yield; red solid; m.p.
156.5-158.5°C; ¹H NMR (400 MHz, CDCl₃) δ 8.38 (d, J = 8.5 Hz, 1H), 8.06 – 7.90 (m, 2H), 7.80 (t, J = 7.5 Hz, 1H), 7.55 (m, 2H), 7.51 – 7.42 (m, 2H), 5.73 (s, 2H). ¹³C NMR (100 MHz, CDCl₃): δ 168.3, 156.7, 155.0, 149.1, 135.9, 133.3, 133.0, 130.8, 129.5, 128.6, 126.9, 123.2, 121.6, 118.1, 109.9, 67.6. ES-HRMS: Calcd for C_{17}H_{11}ClNO₂ [M+H]⁺, 296.0472, Found 296.0476.

2-(3-chlorophenyl)furo[3,4-c]quinolin-3(1H)-one 3j: Obtained in 40% yield; white solid; m.p. >210°C; ¹H NMR (400 MHz, DMSO): δ 8.27 (d, J = 8.4 Hz, 1H), δ 8.19 (d, J = 8.0 Hz, 1H), δ 8.06 (t, J = 7.2 Hz, 1H), δ 7.98 (s, 1H), δ 7.91 (t, J = 7.2 Hz, 1H), δ 7.85 (d, J = 7.2 Hz, 1H), δ 7.55-7.65 (m, 2H), δ 5.91 (s, 2H); ¹³C NMR (100 MHz, DMSO): δ 169.5, 160.1, 154.6, 148.5, 138.8, 136.7, 133.9, 132.9, 132.6, 130.1, 129.8, 129.1, 128.8, 125.1, 121.4, 116.7, 68.84; ES-HRMS: Calcd for C_{17}H_{11}ClNO₂ [M+H]⁺, 296.0478, Found 296.0481.

2-(benzo[d][1,3]dioxol-5-yl)furo[3,4-c]quinolin-3(1H)-one 3k: Obtained in 40% yield; yellow solid; m.p. 219.8-221.2°C; ¹H NMR (400 MHz, DMSO): δ 8.19 (d, J = 8.4 Hz, 1H), δ 8.12 (d, J = 8.0 Hz, 1H), δ 7.97-8.03 (m, 1H), δ 7.75-7.80 (m, 1H), δ 7.49-7.54 (m, 2H), δ 7.07 (d, J = 8.0 Hz, 1H), δ 6.14 (s, 2H), δ 5.85 (s, 2H); ¹³C NMR (100 MHz, DMSO): δ 169.6, 160.2, 155.6, 149.1, 148.6, 147.3, 133.7, 130.9, 129.9, 128.3, 125.2, 125.0, 121.1, 116.4, 110.7, 108.2, 101.9, 68.6; ES-HRMS: Calcd for C_{18}H_{12}NO₄[M+H]⁺, 306.0766, Found 306.0768.

2-(furan-2-yl)furo[3,4-c]quinolin-3(1H)-one 3l: Obtained in 50% yield; brown solid; m.p. >250°C; ¹H NMR (400 MHz, DMSO): δ 8.18 (d, J = 8.5 Hz, 1H), 8.09 (dd, J = 8.9, 5.9 Hz, 2H),
8.04 – 7.96 (m, 2H), 7.75 (t, \( J = 7.5 \) Hz, 1H), 6.77 (m, 1H), 5.87 (s, 2H). \(^{13}\)C NMR (100 MHz, DMSO): \( \delta \) 169.4, 160.6, 150.1, 148.4, 146.2, 144.8, 134.0, 129.7, 128.3, 125.1, 120.8, 117.5, 115.0, 112.8, 68.8. ES-HRMS: Calcd for C\(_{15}\)H\(_{10}\)NO\(_3\) [M+H]\(^+\), 252.0655, Found 252.0655.

![3m](image)

2-(thiophen-2-yl)furo[3,4-c]quinolin-3(1H)-one 3m: Obtained in 39% yield; yellow solid; m.p. >210°C; \(^1\)H NMR (400 MHz, DMSO): \( \delta \) 8.82 (dd, \( J = 3.8, 1.0 \) Hz, 1H), 8.13 – 8.05 (m, 2H), 7.99 (m, \( J = 8.5, 6.9, 1.4 \) Hz, 1H), 7.83 (dd, \( J = 5.1, 1.0 \) Hz, 1H), 7.75 (m, \( J = 8.1, 7.0, 1.1 \) Hz, 1H), 7.27 (dd, \( J = 5.1, 3.9 \) Hz, 1H), 5.89 (s, 2H). \(^{13}\)C NMR (100 MHz, DMSO): \( \delta \) 169.9, 160.9, 149.2, 148.2, 142.7, 134.1, 132.4, 131.7, 129.3, 129.0, 128.2, 125.1, 120.9, 115.3, 68.9. ES-HRMS: Calcd for C\(_{15}\)H\(_{10}\)NO\(_{2}\)S [M+H]\(^+\), 268.0429, Found 268.0426.

![3n](image)

2-(1H-pyrrol-2-yl)furo[3,4-c]quinolin-3(1H)-one 3n: Obtained in 59% yield; yellow solid; m.p. >210°C; \(^1\)H NMR (400 MHz, DMSO): \( \delta \) 11.93 (s, 1H), 8.07 (d, \( J = 8.5 \) Hz, 1H), 8.01 (d, \( J = 8.1 \) Hz, 1H), 7.94 (t, \( J = 7.6 \) Hz, 1H), 7.73 (s, 1H), 7.65 (t, \( J = 7.4 \) Hz, 1H), 7.13 (s, 1H), 6.29 (s, 1H), 5.88 (s, 2H). \(^{13}\)C NMR (100 MHz, DMSO): \( \delta \) 170.9, 160.8, 148.9, 146.9, 133.9, 129.7, 128.9, 126.9, 125.1, 123.5, 120.1, 115.4, 114.6, 110.3, 69.3. ES-HRMS: Calcd for C\(_{15}\)H\(_{11}\)N\(_2\)O\(_2\) [M+H]\(^+\), 251.0815, Found 251.0817.

![3o](image)

2-(1-methyl-1H-pyrrol-2-yl)furo[3,4-c]quinolin-3(1H)-one 3o: Obtained in 50% yield; yellow solid; m.p. >210°C; \(^1\)H NMR (400 MHz, DMSO): \( \delta \) 8.11 (d, \( J = 8.4 \) Hz, 1H), 8.05 (d, \( J = 8.0 \) Hz, 1H), 7.99 – 7.92 (m, 1H), 7.71 (t, \( J = 7.5 \) Hz, 1H), 7.11 – 7.02 (m, 2H), 6.17 (dd, \( J = 3.7, 2.7 \) Hz,
1H), 5.81 (s, 2H), 3.98 (s, 3H). $^{13}$C NMR (100 MHz, DMSO): δ 169.3, 160.4, 148.8, 148.2, 133.6, 129.4, 128.5, 128.0, 127.6, 124.9, 120.1, 117.5, 115.9, 107.6, 68.2, 37.1. ES-HRMS: Calcd for C$_{16}$H$_{13}$N$_2$O$_2$ [M+H]$^+$, 265.0971, Found 265.0971.

2-cyclohexylfuro[3,4-c]quinolin-3(1H)-one 3p: Obtained in 75% yield; white solid; m.p. 179.1-182.3°C; $^1$H NMR (400 MHz, CDCl$_3$): δ 8.22 (d, $J$ = 8.5 Hz, 1H), 7.92 – 7.84 (m, 1H), 7.79 (d, $J$ = 8.1 Hz, 1H), 7.63 (dd, $J$ = 11.1, 4.0 Hz, 1H), 5.60 (s, 2H), 3.84 (m, 1H), 2.05 – 1.71 (m, 7H), 1.59 – 1.49 (m, 2H), 1.43 – 1.30 (m, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$): δ 169.9, 165.0, 156.7, 149.3, 132.4, 130.3, 127.2, 123.0, 120.8, 116.5, 67.5, 58.4, 41.3, 31.5, 26.4, 26.0, 18.4. ES-HRMS: Calcd for C$_{17}$H$_{18}$NO$_2$ [M+H]$^+$, 268.1328, Found 268.1332.

2-(pentan-3-yl)furo[3,4-c]quinolin-3(1H)-one 3q: Obtained in 45% yield; white solid; m.p. 116.5-117.2°C; $^1$H NMR (400 MHz, CDCl$_3$): δ 8.24 (d, $J$ = 8.5 Hz, 1H), 7.94 – 7.87 (m, 1H), 7.83 (d, $J$ = 8.1 Hz, 1H), 7.66 (t, $J$ = 7.2 Hz, 1H), 5.63 (s, 2H), 4.02 – 3.86 (m, 1H), 2.12 – 1.94 (m, 2H), 1.93 – 1.76 (m, 2H), 0.85 (t, $J$ = 7.4 Hz, 6H). $^{13}$C NMR (100 MHz, CDCl$_3$): δ 164.7, 156.2, 149.4, 132.4, 130.3, 127.2, 123.0, 120.6, 117.7, 67.3, 44.7, 27.3, 11.9. ES-HRMS: Calcd for C$_{16}$H$_{18}$NO$_2$ [M+H]$^+$, 256.1328, Found 256.1332.

2-phenethylfuro[3,4-c]quinolin-3(1H)-one 3r: Obtained in 49% yield; yellow solid; m.p. 166.5-169.4°C; $^1$H NMR (400 MHz, CDCl$_3$): δ 8.25 (d, $J$ = 8.5 Hz, 1H), 7.99 – 7.59 (m, 3H), 7.48 – 7.12 (m, 6H), 5.64 (s, 2H), 3.76 – 3.63 (m, 2H), 3.18 (dd, $J$ = 9.7, 6.8 Hz, 2H). $^{13}$C NMR (100 MHz, CDCl$_3$): δ 169.9, 160.0, 156.9, 149.1, 141.4, 132.8, 130.0, 128.7, 128.3, 127.6, 126.0, 124.7, 123.1,
2-(3-methylphenethyl)furo[3,4-c]quinolin-3(1H)-one 3s': Obtained in 52% yield; yellow solid; m.p. 166.5-170.1°C; ¹H NMR (400 MHz, CDCl₃): δ 8.27 (d, J = 8.5 Hz, 1H), 7.97 – 7.90 (m, 1H), 7.84 (d, J = 8.1 Hz, 1H), 7.69 (t, J = 7.5 Hz, 1H), 7.24 (d, J = 5.8 Hz, 1H), 7.21 (d, J = 4.5 Hz, 2H), 7.04 (t, J = 3.6 Hz, 1H), 5.66 (s, 2H), 3.72 – 3.65 (m, 2H), 3.19 – 3.07 (m, 2H), 2.36 (s, 3H). ¹³C NMR (100 MHz, CDCl₃): δ 160.2, 156.9, 149.2, 141.3, 137.9, 132.8, 130.0, 129.5, 128.2, 127.5, 126.7, 125.7, 124.0, 123.1, 121.1, 117.3, 67.8, 36.9, 35.0, 21.4. ES-HRMS: Calcd for C₂₀H₁₈NO₂ [M+H]⁺ 304.1332, Found 304.1326.

2-(4-fluorophenethyl)furo[3,4-c]quinolin-3(1H)-one 3t': Obtained in 49% yield; yellow solid; m.p. 187.1-190.7°C; ¹H NMR (400 MHz, CDCl₃): δ 8.24 (d, J = 8.5 Hz, 1H), 7.93 (s, 1H), 7.83 (d, J = 8.0 Hz, 0H), 7.70 (d, J = 7.5 Hz, 1H), 7.33 (dd, J = 8.2, 5.6 Hz, 1H), 6.97 (t, J = 8.7 Hz, 1H), 3.66 (dd, J = 9.5, 6.9 Hz, 1H), 3.18 – 3.10 (m, 1H). ¹³C NMR (100 MHz, CDCl₃): δ 169.8, 160.1 (d, J = 242Hz), 159.7, 156.9, 149.1, 137.0 (d, J=3.1 Hz), 132.8, 130.1 (d, J= 6 Hz), 127.6, 123.1, 121.0, 117.2, 115.1, 114.9, 67.8, 36.8, 34.1. ES-HRMS: Calcd for C₁₉H₁₅FNO₂ [M+H]⁺ 308.1081, Found 308.1075.
NMR Spectra for final Products 3a-3q, 3r’-3t’

$^1$H NMR and $^{13}$C NMR spectra of 3a
$^{1}H$ NMR and $^{13}C$ NMR spectra of 3b
$^1$H NMR and $^{13}$C NMR spectra of 3c
$^{1}H$ NMR and $^{13}C$ NMR spectra of 3d
$^1$H NMR and $^{13}$C NMR spectra of 3e
$^1$H NMR and $^{13}$C NMR spectra of 3f
$^{1}$H NMR and $^{13}$C NMR spectra of 3g
$^1$H NMR and $^{13}$C NMR spectra of 3h
$^{1}H$ NMR and $^{13}C$ NMR spectra of 3i
$^1\text{H}$ NMR and $^{13}\text{C}$ NMR spectra of 3j
$^1$H NMR and $^{13}$C NMR spectra of 3k
$^1$H NMR and $^{13}$C NMR spectra of 3l
$^1$H NMR and $^{13}$C NMR spectra of 3m
$^{1}H$ NMR and $^{13}C$ NMR spectra of 3n
$^1$H NMR and $^{13}$C NMR spectra of 3ο
$^1$H NMR and $^{13}$C NMR spectra of 3p

[Image of NMR spectra]
$^1$H NMR and $^{13}$C NMR spectra of 3q
$^1$H NMR and $^{13}$C NMR spectra of 3r$^1$
$^1$H NMR and $^{13}$C NMR spectra of 3s
$^1$H NMR and $^{13}$C NMR spectra of 3t