Supporting Information For

Rhodium(III)-catalyzed C2-selective carbenoid functionalization and subsequent C7-alkenylation of indoles

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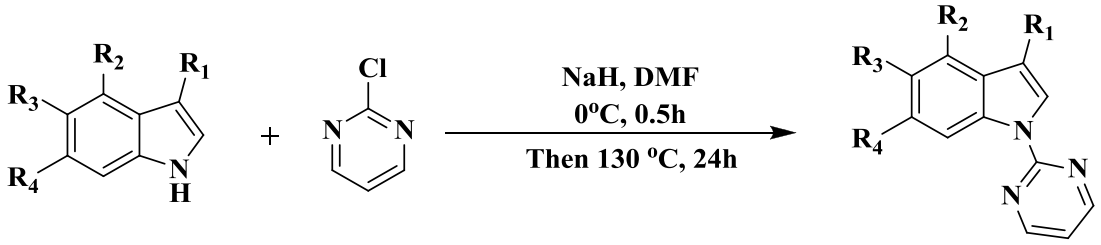
General methods and materials:

$[Cp^*Rh(MeCN)_3](SbF_6)_2$ and $[Cp^*RhCl_2]_2$,[S1] substrate 1-(Pyrimidin-2-yl)-1H-indole[S2-4] and α-diazotized meldrum's acid[S5] were synthesized according to published procedures. Other chemicals were purchased from commercial suppliers and were dried and purified when necessary. The water used was re-distillated and ion-free.

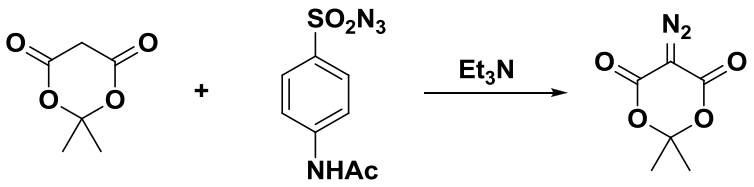
^1H and ^{13}C NMR spectra were recorded on Varian Mercury-Plus 400 NMR and Varian Mercury-Plus 500 NMR instruments (^1H 400 MHz; ^{13}C 100 or 125 MHz) in $CDCl_3$ or DMSO-d_6. Abbreviations for data quoted are s, singlet; brs, broad singlet; d, doublet; t, triplet; dd, doublet of doublets; m, multiplet. High-resolution mass spectra were measured on a agilent TOF-G6230B mass spectrometer. Thin-layer chromatographies were done on pre-coated silica gel 60 F254 plates (Merck). Silica gel 60H (200-300 mesh) manufactured by Qingdao Haiyang Chemical Group Co. (China) was used for general chromatography.

General procedure for synthesis of the starting materials 1: [S2-S4]



NaH (60% dispersion in mineral oil, 11.0 mmol) was added in portions at 0 ℃ to a stirred solution of indoles (10.0 mmol) in dry DMF (25 mL). After stirring for 30 min at 0 ℃, 2-chloropyrimidine (12.0 mmol) was added and then the mixture was stirred at 130 ℃ for 24 h. Then, the reaction mixture was cooled to ambient temperature, poured into H_2O (300 mL) and extracted with EtOAc (250 mL). The organic phase was dried over anhydrous Na_2SO_4. After evaporation of the solvents under reduced pressure, the crude product was purified on a silica gel column using EtOAc/petroleum ether (1:10) to get the corresponding product. Characterization of these compounds have been described in the previous report.[S2-4]

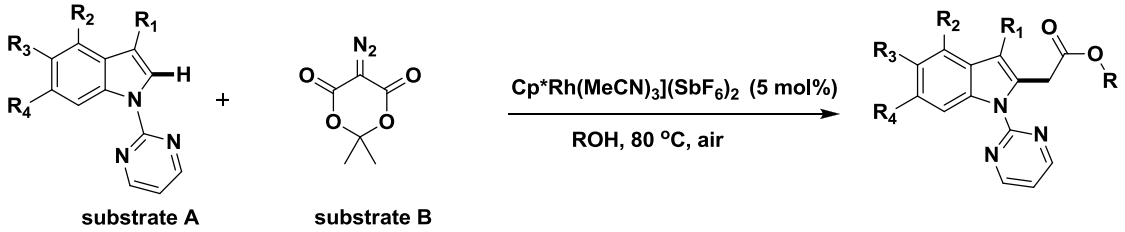
General procedure for synthesis of the starting materials 2:



Meldrum's acid (2.9 g, 20 mmol, 1.0 eq.), triethylamine (3.1 mL, 22 mmol, 1.1 eq.) and 4-acetamidobenzenesulfonyl azide (5.3 g, 22 mmol, 1.1 eq.) were dissolved in acetonitrile (200

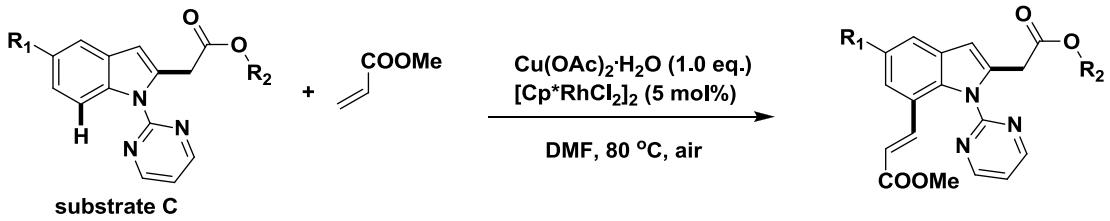
mL) at room temperature. After stirring the resulting mixture overnight, the suspension was filtered through a plug of cotton wool and the solvent was removed under reduced pressure. The crude was partitioned between dichloromethane (200 mL) and water (200 mL), and filtered through a plug of cotton wool. The two layers were separated and the aqueous layer was extracted with dichloromethane (200 mL). The combined organic layers were dried over MgSO4, concentrated under reduced pressure and dried under vacuum. Purification by flash column chromatography (silica, pentane/ethyl acetate 8:1) afforded the compound as a colorless solid. Characterization of this compound has been described in the previous report.[S5]

General procedure for C2-alkylation reaction:



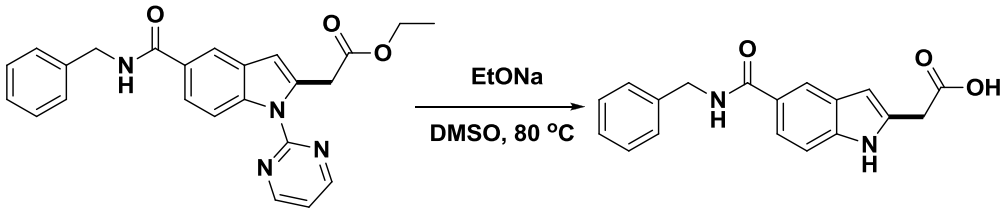
The mixture of $[Cp^*Rh(MeCN)_3](SbF_6)_2$ (4.0 mg, 0.005 mmol, 0.05 eq.), substrate **A** (0.12 mmol, 1.2 eq.), **B** (0.10 mmol, 1.0 eq.) and ROH (0.5 mL) were stirred at 80 ℃ for 15 h under air. The resulting mixture was cooled to room temperature, silica gel column directly to give the desired product.

General procedure for C7-alkenylation reaction:



The mixture of $[Cp^*RhCl_2]_2$ (3.0 mg, 0.005 mmol, 0.05 eq.), $Cu(OAc)_2{\cdot}H_2O$ (20mg, 0.10 mmol, 1.0 eq.), substrate **C** (0.10 mmol, 1.0 eq.), methyl acrylate (0.15 mmol, 1.5 eq.) and DMF (0.5 mL) were stirred at 80 ℃ for 6 h under air. The resulting mixture was cooled to room temperature, diluted with EtOAc (10 mL) and washed brine (10 mL × 2). The organic phase was dried (Na_2SO_4). After evaporation of the solvents under reduced pressure, silica gel column directly to give the desired product.

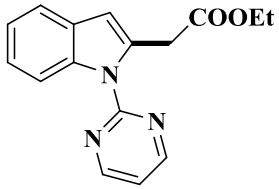
Procedure for deprotection:



A suspension of **3l** (414 mg, 1 mmol) and NaOEt (340 mg, 5 mmol) in dry DMSO (5 mL) under N_2 was stirred at 80 ^{o}C until consumption of the starting material (typically 10 min). It was allowed to reach room temperature, 2N HCl was added, diluted with EtOAc (40 mL) and washed brine. The combined organic phase was dried (Na_2SO_4). After evaporation of the solvents under reduced pressure, the crude product was purified on a silica gel column on a silica gel column to afford the product **7**.

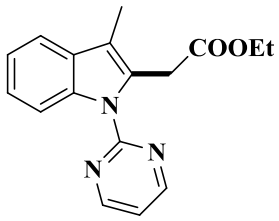
Characterizations of products 3a-3u and 4-7:

Ethyl 2-(1-(pyrimidin-2-yl)-1H-indol-2-yl)acetate (3a)



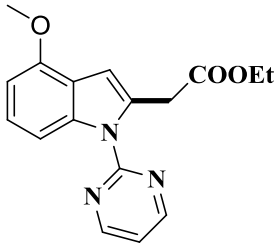
This compound was obtained in 89% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.71 (d, *J* = 4.8 Hz, 2H), 8.57 (d, *J* = 8.4 Hz, 1H), 7.57 (dd, *J* = 7.6, 0.8 Hz, 1H), 7.32-7.28 (m, 1H), 7.24-7.20 (m, 1H), 7.08 (t, *J* = 4.8 Hz, 1H), 6.60 (s, 1H), 4.20 (s, 2H), 4.09 (q, *J* = 7.2 Hz, 2H), 1.13 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (125MHz, $CDCl_3$) δ: 170.3, 157.8, 157.3, 136.4, 133.1, 128.6, 122.9, 121.7, 119.7, 116.1, 114.9, 109.3, 60.2, 36.8, 13.7; HRMS (ESI) calcd for 281.1164 ($[M+H]^+$), found 281.1169 ($[M+H]^+$).

Ethyl 2-(3-methyl-1-(pyrimidin-2-yl)-1H-indol-2-yl)acetate (3b)



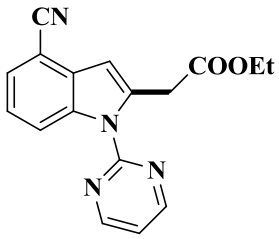
This compound was obtained in 85% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.68 (d, *J* = 4.8 Hz, 2H), 8.54 (d, *J* = 8.0 Hz, 1H), 7.55 (dd, *J* = 8.0, 1.2 Hz, 1H), 7.33-7.28 (m, 1H), 7.26-7.23 (m, 1H), 7.04 (t, *J* = 4.8 Hz, 1H), 4.16 (s, 2H), 4.10 (q, *J* = 7.2 Hz, 2H), 2.33 (s, 3H), 1.15 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (125MHz, $CDCl_3$) δ: 170.8, 158.2, 157.6, 136.0, 130.3, 129.0, 123.5, 121.7, 118.3, 116.1, 115.8, 114.9, 60.5, 34.0, 14.2, 8.9; HRMS (ESI) calcd for 295.1321 ($[M+H]^+$), found 295.1327 ($[M+H]^+$).

Ethyl 2-(4-methoxy-1-(pyrimidin-2-yl)-1H-indol-2-yl)acetate (3c)



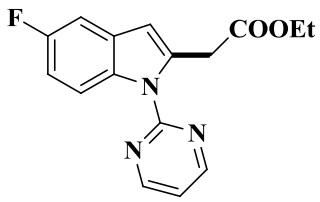
This compound was obtained in 91% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.69 (d, *J* = 4.8 Hz, 2H), 8.15 (d, *J* = 8.4 Hz, 1H), 7.21 (t, *J* = 8.0 Hz, 1H), 7.07 (t, *J* = 4.8 Hz, 1H), 6.72 (d, *J* = 0.4 Hz, 1H), 6.66 (d, *J* = 8.0 Hz, 1H), 4.18 (s, 2H), 4.07 (q, *J* = 7.2 Hz, 2H), 3.95 (s, 3H), 1.11 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (125MHz, $CDCl_3$) δ: 170.7, 158.3, 157.7, 152.4, 138.1, 131.9, 124.0, 119.3, 116.6, 108.5, 106.5, 102.3, 60.5, 55.3, 37.1, 14.1; HRMS (ESI) calcd for 311.1270 ($[M+H]^+$), found 311.1273 ($[M+H]^+$).

Ethyl 2-(4-cyano-1-(pyrimidin-2-yl)-1H-indol-2-yl)acetate (3d)



This compound was obtained in 76% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.79 (d, *J* = 8.4 Hz, 1H), 8.75 (d, *J* = 4.8 Hz, 2H), 7.54 (dd, *J* = 7.6, 0.8 Hz, 1H), 7.32 (dd, *J* = 8.4, 1.2 Hz, 1H), 7.18 (t, *J* = 4.8 Hz, 1H), 6.83 (s, 1H), 4.26 (s, 2H), 4.10 (q, *J* = 7.2 Hz, 2H), 1.15 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (125MHz, $CDCl_3$) δ: 170.1, 158.0, 157.8, 136.6, 130.8, 126.8, 123.1, 120.1, 118.3, 117.6, 107.8, 102.7, 100.0, 60.9, 37.1, 14.2; HRMS (ESI) calcd for 306.1117 ($[M+H]^+$), found 306.1126 ($[M+H]^+$).

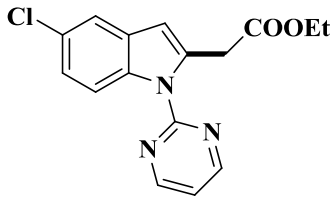
Ethyl 2-(5-fluoro-1-(pyrimidin-2-yl)-1H-indol-2-yl)acetate (3e)



This compound was obtained in 92% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.69 (d, *J* = 4.8 Hz, 2H), 8.54 (q, *J* = 4.8 Hz, 1H), 7.21 (dd, *J* = 8.8, 2.8 Hz, 1H), 7.09 (t, *J* = 4.8 Hz, 1H), 7.01 (dt, *J* =

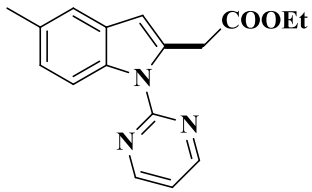
9.2, 2.8 Hz, 1H), 6.55 (d, *J* = 0.8 Hz,1H), 4.18 (s, 2H), 4.10 (q, *J* = 7.2 Hz, 2H), 1.15 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (125MHz, $CDCl_3$) δ: 170.1, 155.5 (d, *J* = 236.4 Hz), 157.6, 157.3, 134.7, 132.8, 129.3 (d, *J* = 10.1 Hz), 116.3, 116.1 (d, *J* = 8.9 Hz), 110.6 (d, *J* = 24.5 Hz), 109.0 (d, *J* = 3.9 Hz), 104.8 (d, *J* = 23.4 Hz), 60.2, 36.8, 13.7; HRMS (ESI) calcd for 299.1070 ($[M+H]^+$), found 299.1072 ($[M+H]^+$).

Ethyl 2-(5-chloro-1-(pyrimidin-2-yl)-1H-indol-2-yl)acetate (3f)



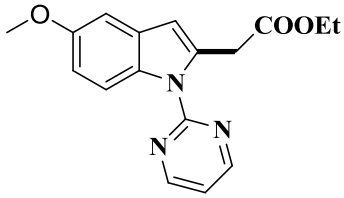
This compound was obtained in 86% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.70 (d, *J* = 4.8 Hz, 2H), 8.51 (d, *J* = 8.8 Hz, 1H), 7.51 (d, *J* = 2.0 Hz, 1H), 7.22 (dd, *J* = 8.8, 2.0 Hz, 1H), 7.10 (t, *J* = 4.8 Hz, 1H), 6.53 (s, 1H), 4.18 (s, 2H), 4.09 (q, *J* = 7.2 Hz, 2H), 1.14 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (125MHz, $CDCl_3$) δ: 170.0, 157.6, 157.3, 134.8, 134.5, 129.7, 127.1, 122.9, 119.1, 116.4, 116.2, 108.6, 60.3, 36.8, 13.7; HRMS (ESI) calcd for 315.0775 ($[M+H]^+$), found 315.0779 ($[M+H]^+$).

Ethyl 2-(5-methyl-1-(pyrimidin-2-yl)-1H-indol-2-yl)acetate (3g)



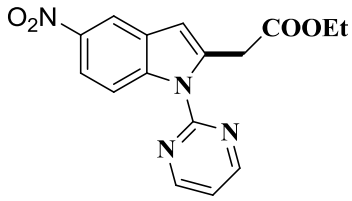
This compound was obtained in 83% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.68 (d, *J* = 4.8 Hz, 2H), 8.46 (d, *J* = 8.8 Hz, 1H), 7.35 (d, *J* = 0.8 Hz, 1H), 7.11 (dd, *J* = 8.4, 2.0 Hz, 1H), 7.05 (t, *J* = 4.8 Hz, 1H), 6.52 (s, 1H), 4.18 (s, 2H), 4.09 (q, *J* = 7.2 Hz, 2H), 2.46 (s, 3H), 1.13 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (125MHz, $CDCl_3$) δ: 170.4, 157.8, 157.2, 134.7, 133.1, 131.0, 128.9, 124.3, 119.5, 115.9, 114.7, 109.1, 60.1, 36.9, 20.9, 13.7; HRMS (ESI) calcd for 295.1321 ($[M+H]^+$), found 295.1326 ($[M+H]^+$).

Ethyl 2-(5-methoxy-1-(pyrimidin-2-yl)-1H-indol-2-yl)acetate (3h)



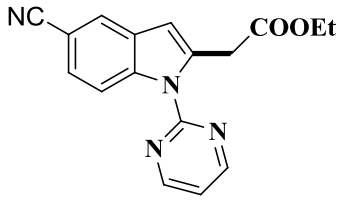
This compound was obtained in 82% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.68 (d, *J* = 4.8 Hz, 2H), 8.54 (d, *J* = 9.2 Hz, 1H), 7.05 (dd, *J* = 4.8 and 3.6 Hz, 2H), 6.94 (dd, *J* = 9.2 and 2.8 Hz, 1H), 6.55 (s, 1H), 4.20 (s, 2H), 4.11 (t, *J* = 7.2 Hz, 2H), 3.89 (s, 3H), 1.16 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 170.8, 158.2, 157.7, 155.5, 134.2, 131.8, 129.9, 116.6, 116.3, 112.3, 109.7, 102.5, 60.6, 55.7, 37.4, 14.2. HRMS (ESI) calcd for 311.1270 ($[M+H]^+$), found 311.1276 ($[M+H]^+$).

Ethyl 2-(5-nitro-1-(pyrimidin-2-yl)-1H-indol-2-yl)acetate (3i)



This compound was obtained in 85% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.78 (d, *J* = 4.8 Hz, 2H), 8.61 (d, *J* = 9.2 Hz, 1H), 8.48 (d, *J* = 2.4 Hz, 1H), 8.17 (dd, *J* = 9.2, 2.4 Hz, 1H), 7.23 (t, *J* = 4.8 Hz, 1H), 6.74 (s, 1H), 4.23 (s, 2H), 4.09 (q, *J* = 7.2 Hz, 2H), 1.15 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (125MHz, $CDCl_3$) δ: 169.6, 157.6, 157.2, 142.7, 139.4, 136.5, 128.1, 118.1, 117.4, 116.1, 115.0, 109.7, 60.5, 36.5, 13.7; HRMS (ESI) calcd for 326.1015 ($[M+H]^+$), found 326.1022 ($[M+H]^+$).

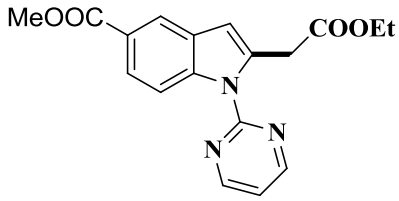
Ethyl 2-(5-cyano-1-(pyrimidin-2-yl)-1H-indol-2-yl)acetate (3j)



This compound was obtained in 62% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.76 (d, *J* = 4.8 Hz, 2H), 8.61 (d, *J* = 8.8 Hz, 1H), 7.89 (d, *J* = 0.8 Hz, 1H), 7.52 (dd, *J* = 8.8, 2.0 Hz, 1H), 7.20 (t, *J* = 4.8 Hz, 1H), 6.65 (s, 1H), 4.22 (s, 2H), 4.08 (q, *J* = 7.2 Hz, 2H), 1.14 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (125MHz, $CDCl_3$) δ: 170.2, 158.1, 157.8, 138.6, 136.1, 128.9, 126.4, 125.1, 120.3, 117.7,

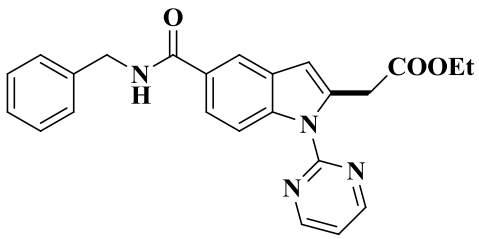
116.2, 109.2, 105.2, 60.9, 36.9, 14.2; HRMS (ESI) calcd for 306.1117 ($[M+H]^+$), found 306.1112 ($[M+H]^+$).

Methyl 2-(2-ethoxy-2-oxoethyl)-1-(pyrimidin-2-yl)-1H-indole-5-carboxylate (3k)



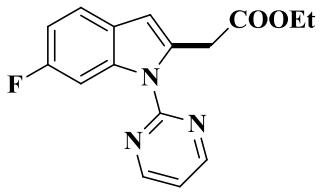
This compound was obtained in 86% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.73 (d, *J* = 4.8 Hz, 2H), 8.55 (d, *J* = 8.8 Hz, 1H), 8.29 (d, *J* = 2.0 Hz, 1H), 7.98 (dd, *J* = 8.8, 2.0 Hz, 1H), 7.14 (t, *J* = 4.8 Hz, 1H), 6.66 (s, 1H), 4.20 (s, 2H), 4.07 (q, *J* = 7.2 Hz, 2H), 3.94 (s, 3H), 1.13 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (125MHz, $CDCl_3$) δ: 170.0, 167.3, 157.5, 157.4, 139.0, 134.5, 128.2, 124.2, 123.5, 122.1, 116.8, 114.5, 109.6, 60.3, 51.5, 36.6, 13.7; HRMS (ESI) calcd for 339.1219 ($[M+H]^+$), found 339.1221 ($[M+H]^+$).

Ethyl 2-(5-(benzylcarbamoyl)-1-(pyrimidin-2-yl)-1H-indol-2-yl)acetate (3l)



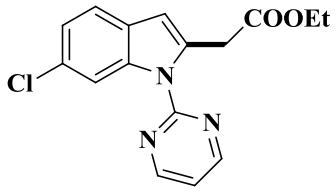
This compound was obtained in 83% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.73 (d, *J* = 4.8 Hz, 2H), 8.57 (d, *J* = 8.8 Hz, 1H), 8.04 (d, *J* = 1.2 Hz, 1H), 7.73 (dd, *J* = 8.8, 2.0 Hz, 1H), 7.42-7.29 (m, 5H), 7.14 (t, *J* = 4.8 Hz, 1H), 6.64 (s, 1H), 6.48 (t, *J* = 6.4 Hz, 1H), 4.70 (d, *J* = 6.4 Hz, 2H), 4.20 (s, 2H), 4.09 (q, *J* = 7.2 Hz, 2H), 1.12 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (125MHz, $CDCl_3$) δ: 170.0, 167.4, 157.6, 157.4, 138.2, 138.0, 134.6, 128.4, 128.3, 127.8, 127.5, 127.1, 121.7, 119.0, 116.7, 114.9, 109.5, 60.3, 43.7, 36.6, 12.7; HRMS (ESI) calcd for 414.1692 ($[M+H]^+$), found 414.1695 ($[M+H]^+$).

Ethyl 2-(6-fluoro-1-(pyrimidin-2-yl)-1H-indol-2-yl)acetate (3m)



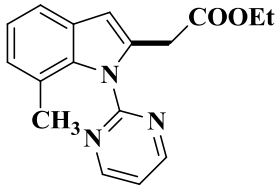
This compound was obtained in 81% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.70 (d, *J* = 4.8 Hz, 2H), 8.37 (dd, *J* = 11.2, 2.0 Hz, 1H), 7.46 (dd, *J* = 4.8, 3.2 Hz, 1H), 7.09 (t, *J* = 4.8 Hz, 1H), 6.97 (dd, *J* = 8.8, 2.4 Hz, 1H), 6.56 (s, 1H), 4.18 (s, 2H), 4.09 (q, *J* = 7.2 Hz, 2H), 1.14 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (125MHz, $CDCl_3$) δ: 170.3, 160.5 (d, *J* = 236.0 Hz), 157.7, 157.3, 136.4 (d, *J* = 13.0 Hz), 133.5 (d, *J* = 3.9 Hz), 124.9, 120.1 (d, *J* = 9.9 Hz), 116.3, 109.9 (d, *J* = 24.1 Hz), 109.0, 102.4 (d, *J* = 28.9 Hz), 60.2, 36.8, 13.7; HRMS (ESI) calcd for 299.1070 ($[M+H]^+$), found 299.1074 ($[M+H]^+$).

Ethyl 2-(6-chloro-1-(pyrimidin-2-yl)-1H-indol-2-yl)acetate (3n)



This compound was obtained in 78% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.71 (d, *J* = 4.8 Hz, 2H), 8.64 (d, *J* = 2.0 Hz, 1H), 7.46 (d, *J* = 8.0 Hz, 1H), 7.19 (dd, *J* = 8.4, 2.0 Hz, 1H), 7.11 (t, *J* = 4.8 Hz, 1H), 6.56 (s, 1H), 4.18 (s, 2H), 4.08 (q, *J* = 7.2 Hz, 2H), 1.13 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (125MHz, $CDCl_3$) δ: 170.1, 157.5, 157.4, 136.7, 133.9, 128.7, 127.1, 122.2, 120.3, 116.5, 115.2, 109.0, 60.2, 36.7, 13.7; HRMS (ESI) calcd for 315.0775 ($[M+H]^+$), found 315.0777 ($[M+H]^+$).

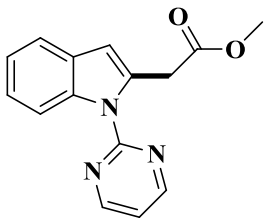
Ethyl 2-(7-methyl-1-(pyrimidin-2-yl)-1H-indol-2-yl)acetate (3o)



This compound was obtained in 88% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.80 (d, *J* = 5.2 Hz, 2H), 7.46 (d, *J* = 7.6 Hz, 1H), 7.22 (t, *J* = 5.2 Hz, 1H), 7.12 (t, *J* = 7.6 Hz, 1H), 7.03 (d, *J* = 7.2 Hz, 1H), 6.60 (s, 1H), 4.01 (q, *J* = 7.2 Hz, 2H), 3.95 (s, 2H), 2.07 (s, 3H), 1.12 (t, *J* = 7.2 Hz, 3H); ^{13}C

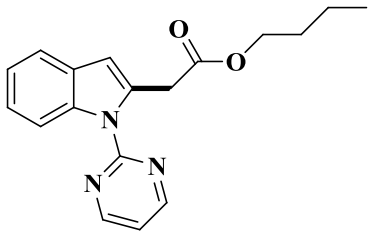
NMR (125MHz, $CDCl_3$) δ: 170.1, 158.3, 136.6, 133.9, 129.5, 126.0, 122.6, 121.8, 118.6, 118.3, 107.3, 60.9, 34.7, 20.9, 14.2; HRMS (ESI) calcd for 295.1321 ($[M+H]^+$), found 295.1328 ($[M+H]^+$).

Methyl 2-(1-(pyrimidin-2-yl)-1H-indol-2-yl)acetate (3p)



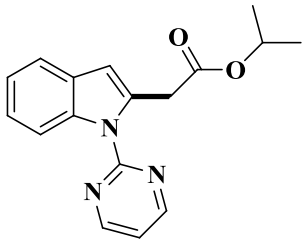
This compound was obtained in 83% yield. ^1H NMR (400 MHz, $CDCl_3$) δ: 8.73 (d, *J* = 4.8 Hz, 2H), 8.61 (d, *J* = 8.4 Hz, 1H), 7.59 (d, *J* = 7.6 Hz, 1H), 7.36-7.30 (m, 1H), 7.27-7.22 (m, 1H), 7.11 (t, *J* = 4.8 Hz, 1H), 6.63 (s, 1H), 4.21 (s, 2H), 3.65 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 171.3, 158.2, 157.8, 136.9, 133.4, 129.1, 123.4, 122.2, 120.2, 116.6, 115.4, 109.8, 51.9, 37.1; HRMS (ESI) calcd for 267.1008 ($[M+H]^+$), found 267.1003 ($[M+H]^+$).

Butyl 2-(1-(pyrimidin-2-yl)-1H-indol-2-yl)acetate (3q)



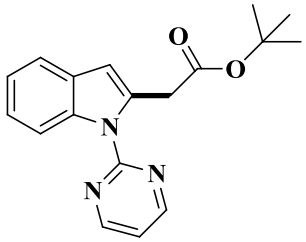
This compound was obtained in 86% yield. ^1H NMR (400 MHz, $CDCl_3$) δ: 8.70 (d, *J* = 4.8 Hz, 2H), 8.57 (d, *J* = 8.4 Hz, 1H), 7.56 (dd, *J* = 8.0, 0.8 Hz, 1H), 7.29 (dt, *J* = 7.2, 1.6 Hz, 1H), 7.22 (dt, *J* = 7.6,1.2 Hz, 1H), 7.08 (t, *J* = 4.8 Hz, 1H), 6.59 (s, 1H), 4.21 (s, 2H), 4.02 (d, *J* = 6.8 Hz, 2H), 1.48 (m, 2H), 1.25 (m, 2H), 0.85 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (125MHz, $CDCl_3$) δ: 170.9, 158.3, 157.8, 136.9, 133.6, 129.1, 123.4, 122.1, 120.1, 116.6, 115.4, 109.8, 64.6, 37.2, 30.6,19.0, 13.7; HRMS (ESI) calcd for 309.1477 ($[M+H]^+$), found 309.1479 ($[M+H]^+$).

Isopropyl 2-(1-(pyrimidin-2-yl)-1H-indol-2-yl)acetate (3r)



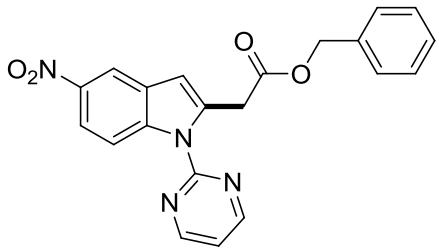
This compound was obtained in 82% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.71 (d, *J* = 4.8 Hz, 2H), 8.56 (d, *J* = 8.4 Hz, 1H), 7.56 (dd, *J* = 7.6, 0.8 Hz, 1H), 7.29 (dt, *J* = 7.2, 1.2 Hz, 1H), 7.21 (dt, *J* = 7.2,1.2 Hz, 1H), 7.09 (t, *J* = 4.8 Hz, 1H), 6.59 (s, 1H), 4.96 (m, 1H), 4.18 (s, 2H), 1.12 (d, *J* = 6.4 Hz, 6H); ^{13}C NMR (125MHz, $CDCl_3$) δ: 169.8, 157.9, 157.3, 136.4, 133.2, 128.6, 122.8, 121.6, 119.6, 116.1, 114.9, 109.2, 67.4, 37.0, 21.3; HRMS (ESI) calcd for 295.1321 ($[M+H]^+$), found 295.1329 ($[M+H]^+$).

Tert-butyl 2-(1-(pyrimidin-2-yl)-1H-indol-2-yl)acetate (3s)



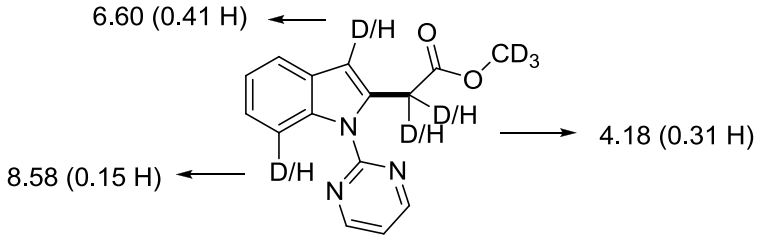
This compound was obtained in 63% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.73 (d, *J* = 4.8 Hz, 2H), 8.53 (d, *J* = 8.4 Hz, 1H), 7.55 (dd, *J* = 7.6, 0.8 Hz, 1H), 7.27 (dt, *J* = 7.2, 1.2 Hz, 1H), 7.19 (dt, *J* = 7.2, 0.8 Hz, 1H), 7.09 (t, *J* = 4.8 Hz, 1H), 6.57 (s, 1H), 4.14 (s, 2H), 1.34 (s, 9H); ^{13}C NMR (125MHz, $CDCl_3$) δ: 170.0, 158.4, 157.8, 136.9, 134.1, 129.1, 123.2, 122.0, 120.1, 116.5, 115.2, 109.4, 80.5, 38.2, 28.0; HRMS (ESI) calcd for 309.1477 ($[M+H]^+$), found 309.1473 ($[M+H]^+$).

Benzyl 2-(5-nitro-1-(pyrimidin-2-yl)-1H-indol-2-yl)acetate (3t)



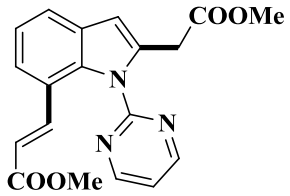
This compound was obtained in 79% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.65 (d, *J* = 9.2 Hz, 1H), 8.50 (dd, *J* = 6.8, 3.6 Hz, 3H), 8.18 (dd, *J* = 9.2, 2.4 Hz, 1H), 7.40 – 7.28 (m, 5H), 7.06 (t, *J* = 4.8 Hz, 1H), 6.77 (s, 1H), 5.13 (s, 2H), 4.28 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 169.9, 157.9, 157.5, 143.2, 139.8, 136.7, 135.8, 128.8, 128.6, 128.6, 128.3, 118.6, 117.7, 116.5, 115.6, 110.4, 66.6, 37.0; HRMS (ESI) calcd for 389.1250 ($[M+H]^+$), found 389.1253 ($[M+H]^+$).

Compound 3u



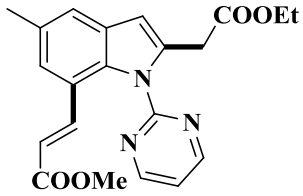
This compound was obtained in 81% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.70 (d, *J* = 4.8 Hz, 2H), 8.58 (d, *J* = 8.4 Hz, 0.15H), 7.57 (dd, *J* = 7.6, 1.2 Hz, 1H), 7.33-7.27 (m, 1H), 7.22 (t, *J* = 7.6 Hz, 1H), 7.08 (t, *J* = 4.8 Hz, 1H), 6.60 (s, 0.41H), 4.18 (m, 0.31H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 171.3, 158.2, 157.8, 136.9, 136.8, 133.4, 133.3, 129.1, 129.0, 123.4, 123.3, 122.2, 120.2, 120.2, 116.6, 115.4, 115.2, 115.0, 109.8; HRMS (ESI): $C_{15}H_6D_7N_3O_2$ calcd for 275.1525 ($[M+H]^+$), found 275.1531 ($[M+H]^+$) 100%; $C_{15}H_7D_6N_3O_2$ calcd for 274.1463 ($[M+H]^+$), found 274.1463 ($[M+H]^+$) 88.0%; $C_{15}H_8D_5N_3O_2$ calcd for 273.1395 ($[M+H]^+$), found 273.1400 ($[M+H]^+$) 27.8%.

(E)-methyl 3-(2-(2-methoxy-2-oxoethyl)-1-(pyrimidin-2-yl)-1H-indol-7-yl)acrylate (4)



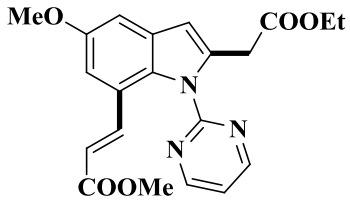
This compound was obtained in 68% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.70 (d, *J* = 4.8 Hz, 2H), 7.54 (dd, *J* = 7.6 and 0.8 Hz, 1H), 7.34 (d, *J* = 7.6 Hz, 1H), 7.26-7.17 (m, 2H), 7.13 (t, *J* = 7.6 Hz, 1H), 6.56 (s, 1H), 6.13 (d, *J* = 15.6 Hz, 1H), 3.93 (s, 2H), 3.61 (s, 3H), 3.46 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 170.4, 167.4, 158.6, 158.3, 143.5, 135.2, 134.5, 130.1, 123.1, 122.5, 121.9, 120.7, 118.9, 116.4, 107.5, 52.1, 51.4, 34.6; HRMS (ESI) calcd for 351.1219 ($[M+H]^+$), found 351.1225 ($[M+H]^+$).

(E)-methyl 3-(2-(2-ethoxy-2-oxoethyl)-5-methyl-1-(pyrimidin-2-yl)-1H-indol-7-yl)acrylate (5)



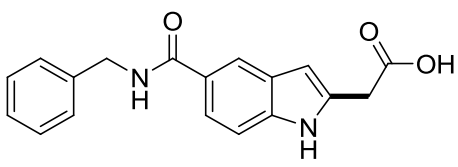
This compound was obtained in 78% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.74 (d, *J* = 4.8 Hz, 2H), 7.40 (s, 1H), 7.33 (d, *J* = 15.6 Hz, 1H), 7.23 (t, *J* = 4.8 Hz, 2H), 6.54 (s, 1H), 6.19 (d, *J* = 15.6 Hz, 1H), 4.02-3.94 (m, 4H), 3.68 (s, 3H), 2.44 (s, 3H), 1.09 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 167.0, 167.4, 158.5, 158.4, 143.7, 134.8, 133.7, 131.2, 130.5, 124.3, 122.5, 120.3, 118.6, 116.1, 107.3, 60.9, 51.4, 34.9, 21.2, 14.1; HRMS (ESI) calcd for 379.1532 ($[M+H]^+$), found 379.1536 ($[M+H]^+$).

(E)-methyl 3-(2-(2-ethoxy-2-oxoethyl)-5-methoxy-1-(pyrimidin-2-yl)-1H-indol-7-yl)acrylate (6)



This compound was obtained in 76% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.73 (d, *J* = 4.8 Hz, 2H), 7.32 (d, *J* = 15.6 Hz, 1H), 7.23 (t, *J* = 4.8 Hz, 1H), 7.10 (d, *J* = 2.4 Hz, 1H), 7.03 (d, *J* = 2.4 Hz, 1H), 6.55 (s, 1H), 6.19 (d, *J* = 15.6 Hz, 1H), 4.02-4.00 (m, 4H), 3.86 (s, 3H), 3.68 (s, 3H), 1.10 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 167.0, 167.3, 158.5, 158.3, 155.2, 143.3, 135.5, 131.1, 130.5, 121.5, 118.6, 116.7, 111.5, 107.6, 105.3, 60.9, 55.9, 51.5, 35.0, 14.1; HRMS (ESI) calcd for 395.1481 ($[M+H]^+$), found 395.1485 ($[M+H]^+$).

2-(5-(benzylcarbamoyl)-1H-indol-2-yl)acetic acid (7)



This compound was obtained in 68% yield. ^{1}H NMR (400 MHz, DMSO-d_6) δ: 12.56 (s, 1H), 11.28 (s, 1H), 8.87 (t, J = 6.0 Hz, 1H), 8.11 (s, 1H), 7.65 (dd, J = 8.5, 1.6 Hz, 1H), 7.43 – 7.17 (m, 6H), 6.38 (s, 1H), 4.50 (d, J = 6.0 Hz, 2H), 3.78 (s, 2H); ^{13}C NMR (100 MHz, DMSO-d_6) δ: 171.8, 167.8, 140.7, 138.2, 134.6, 128.7, 127.9, 127.7, 127.0, 125.7, 120.7, 119.8, 110.8, 102.0, 43.1, 34.1; HRMS (ESI) calcd for 309.1239 ($[M+H]^+$), found 309.1245 ($[M+H]^+$).

References

S1 Y. Li, B.-J. Li, W.-H. Wang, W.-P. Huang, X.-S. Zhang, K. Chen and Z.-J. Shi, *Angew. Chem. Int. Ed*., 2011, **50**, 2115.

S2 L. Ackermann and A. V. Lygin, *Org. Lett*., 2011, **13**, 3332.

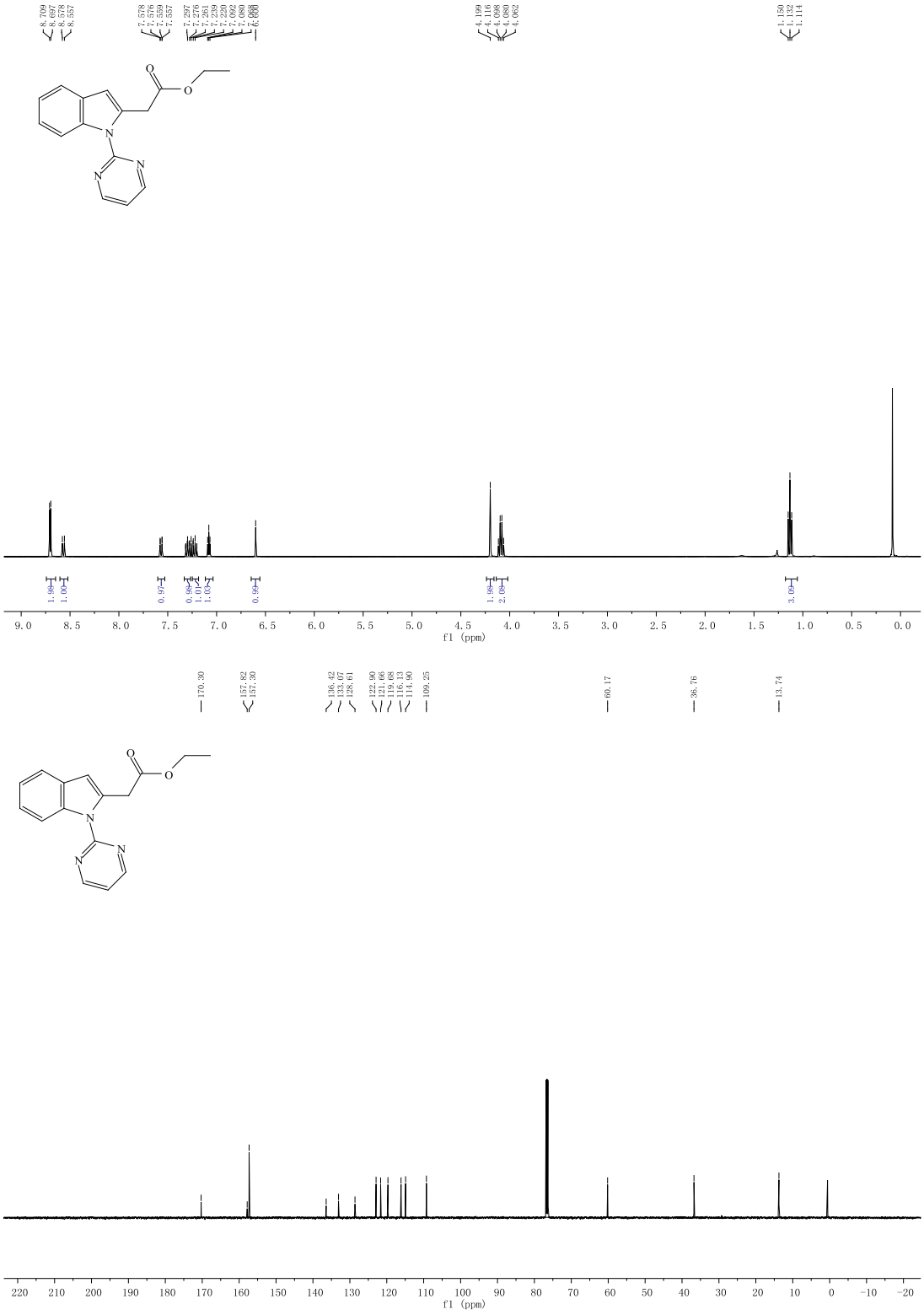
S3 J.-J. Shi, B. Zhou, Y.-X. Yang and Y.-C. Li, *Org. Biomol. Chem*., 2012, **10**, 8953.

S4 C.-D. Pan, H.-M. Jin, P. Xu, X. Liu, Y.-X. Cheng and C.-J. Zhu, *J. Org. Chem*., 2013, **78**, 9494.

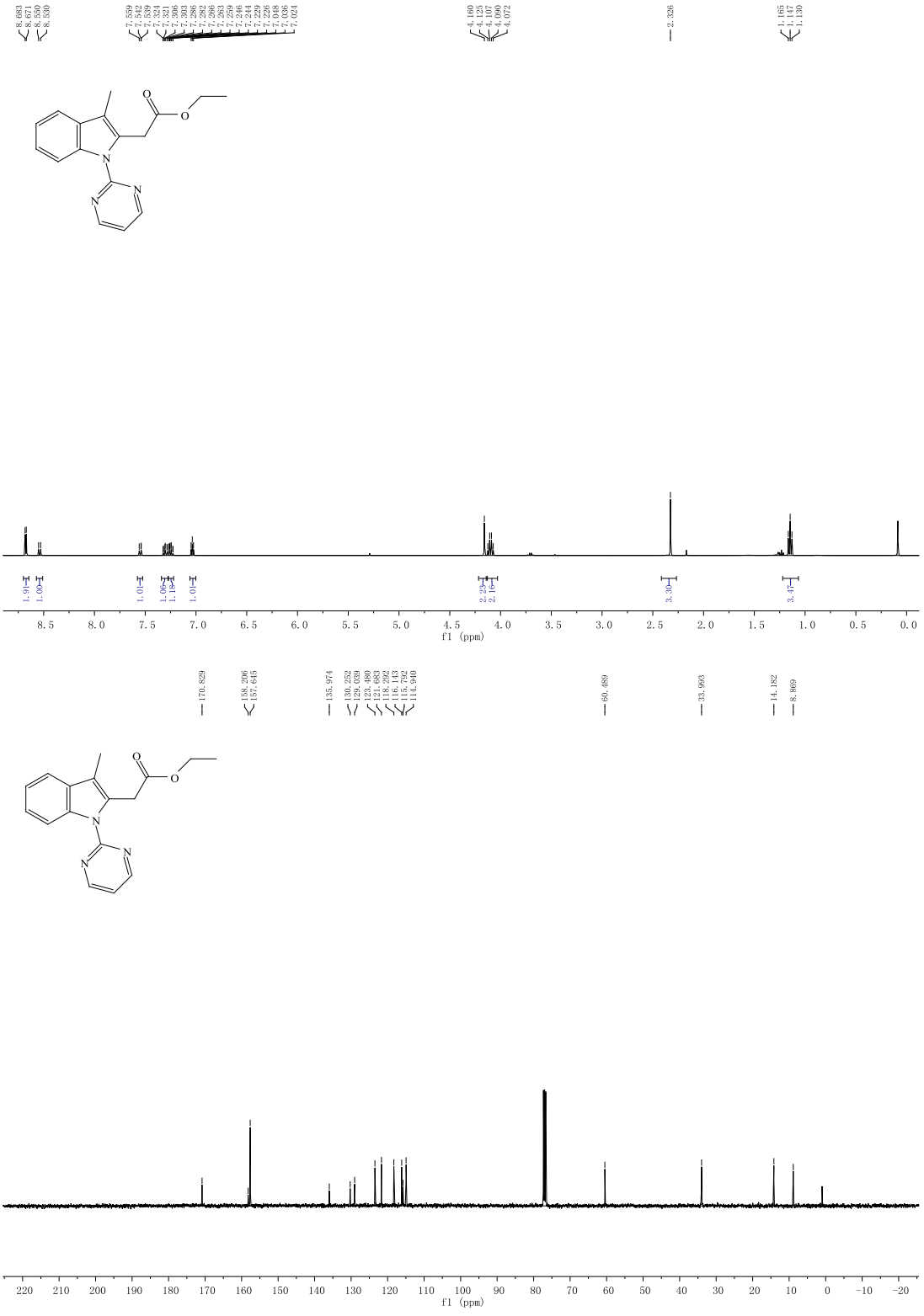
S5 A. Bogdanova and V. V. Popik, *J. Am. Chem. Soc.*, 2013, **125**, 14153.

^{1}H and ^{13}C NMR spectra of products **3a-3u** and **4-7:**

3a



3b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4.090
4.072
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N
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1.00
1.01
1.06
1.18
1.01
2.24
2.16
3.30
3.47
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8.0
7.5
7.0
6.5
6.0
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f1 (ppm)
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N
N
N
220
210
200
190
180
170
160
150
140
130
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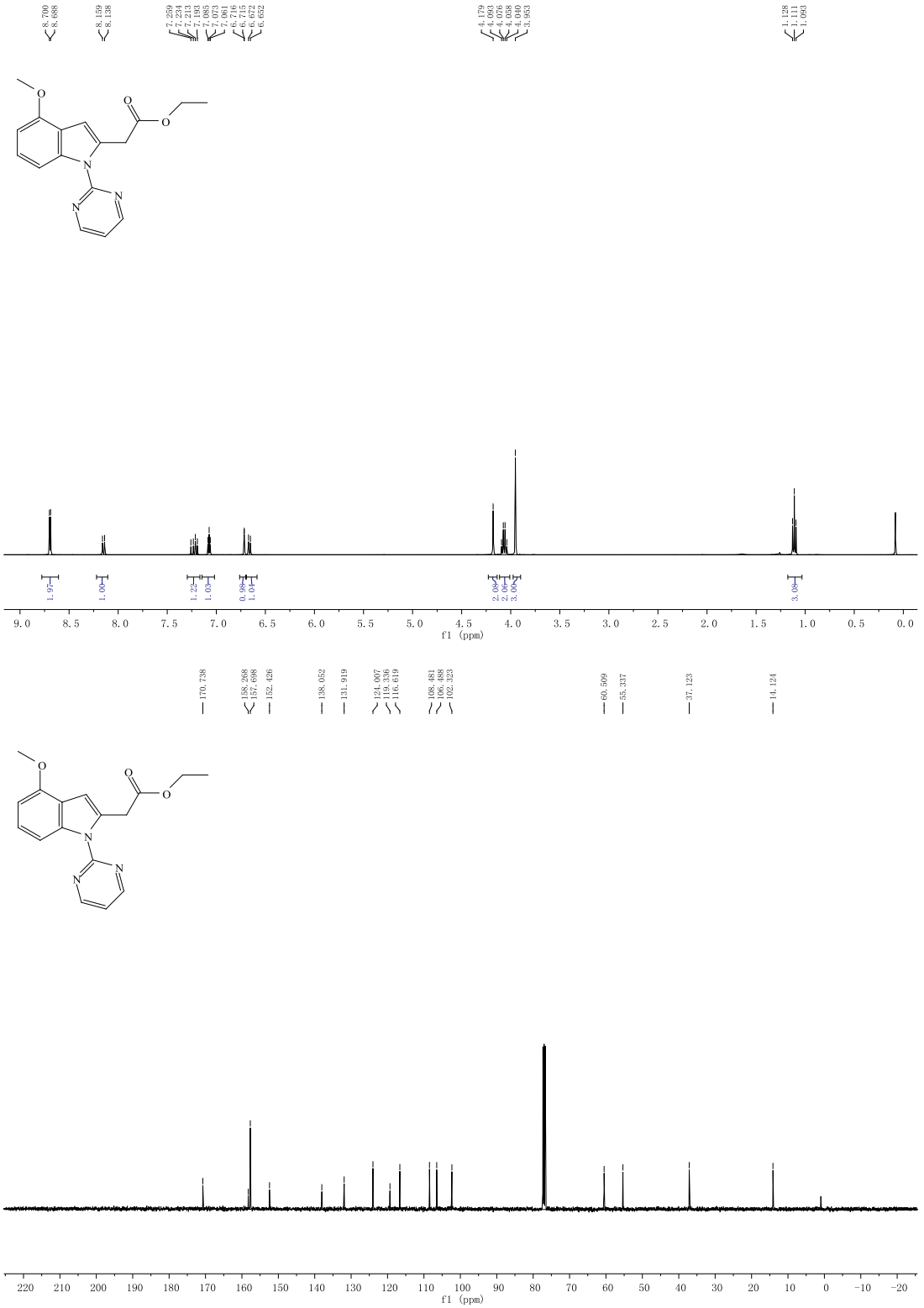
60
50
40
30
20
10
0
−10
−20
f1 (ppm)

3c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1.06
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3.08
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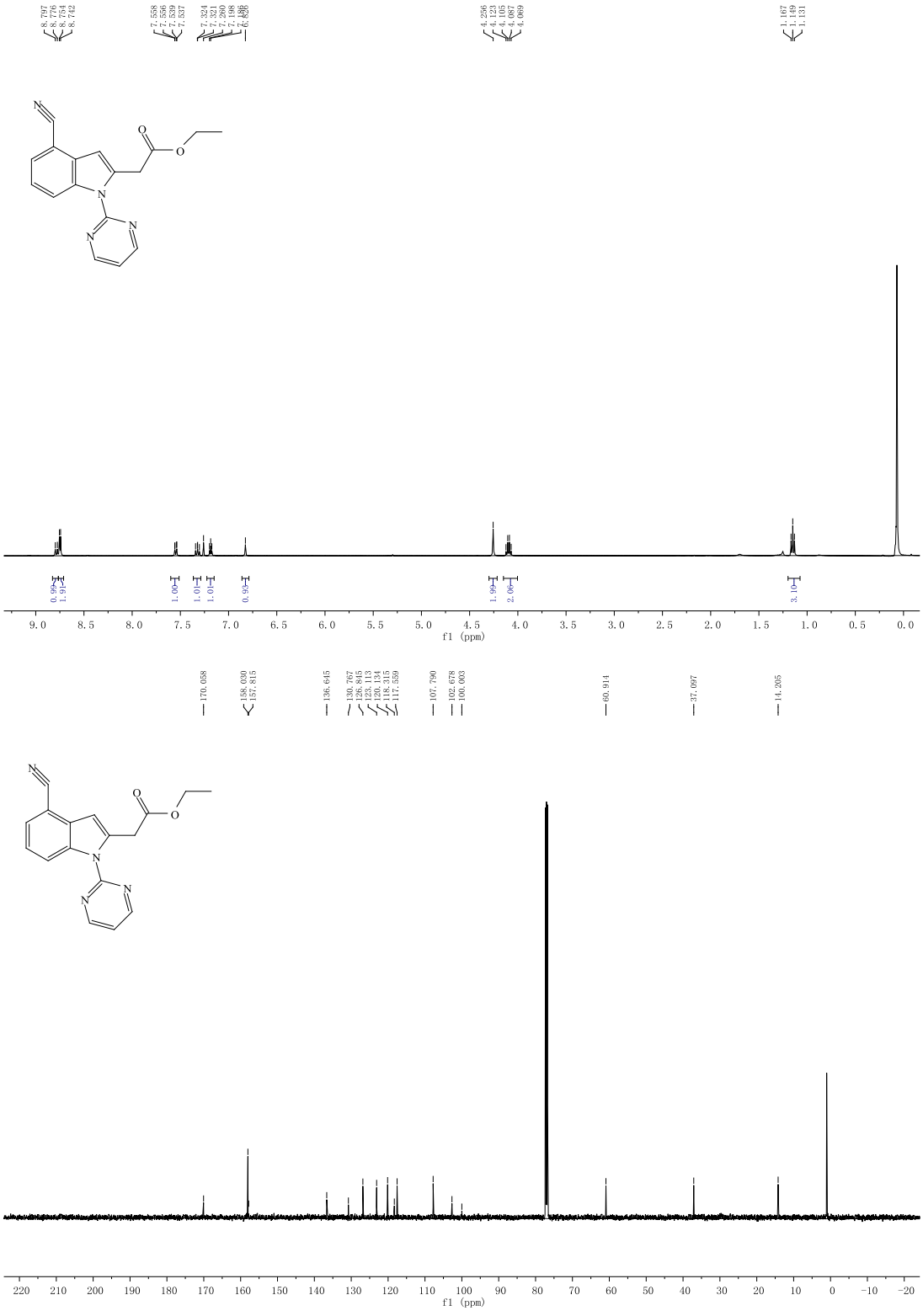
3d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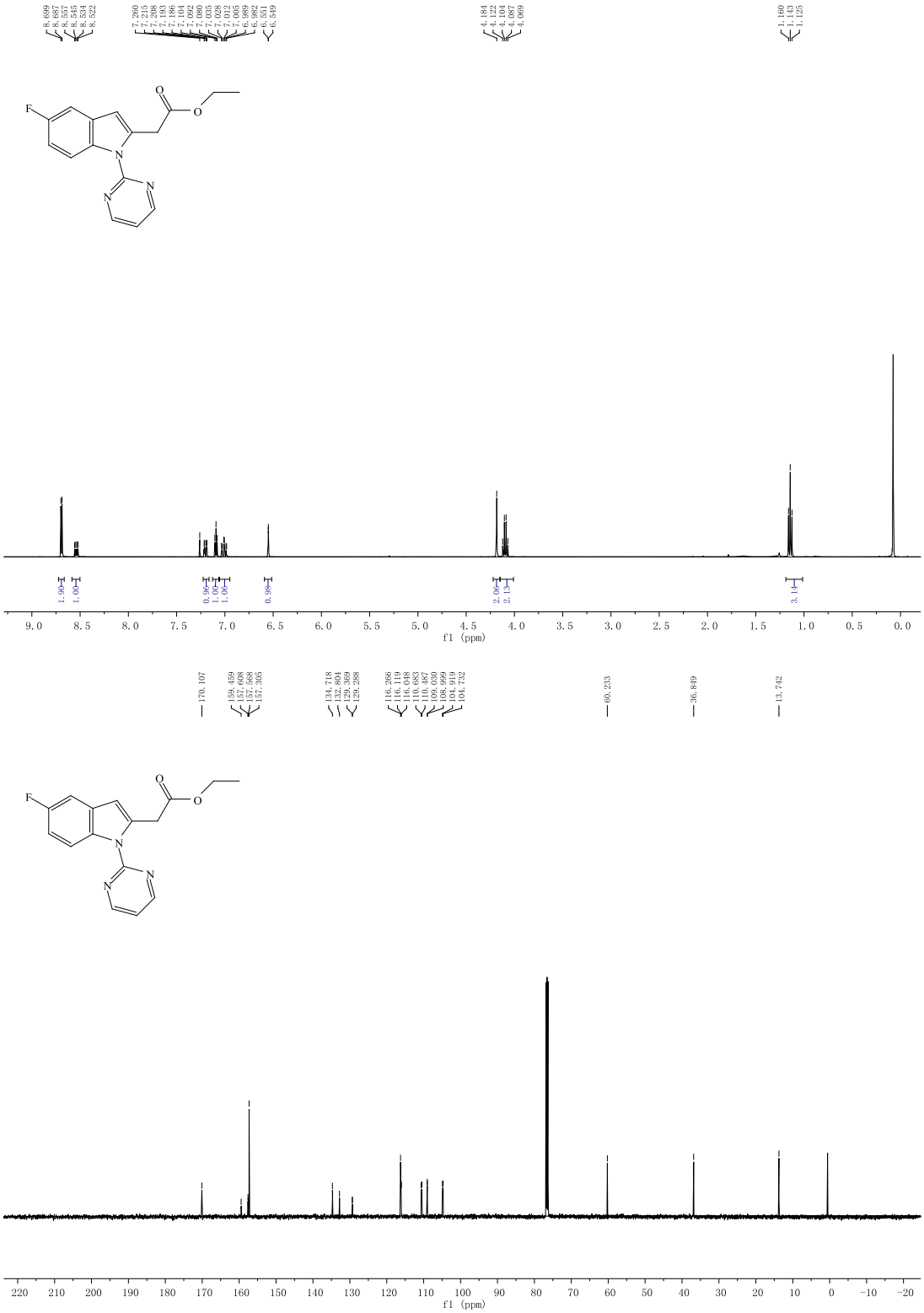
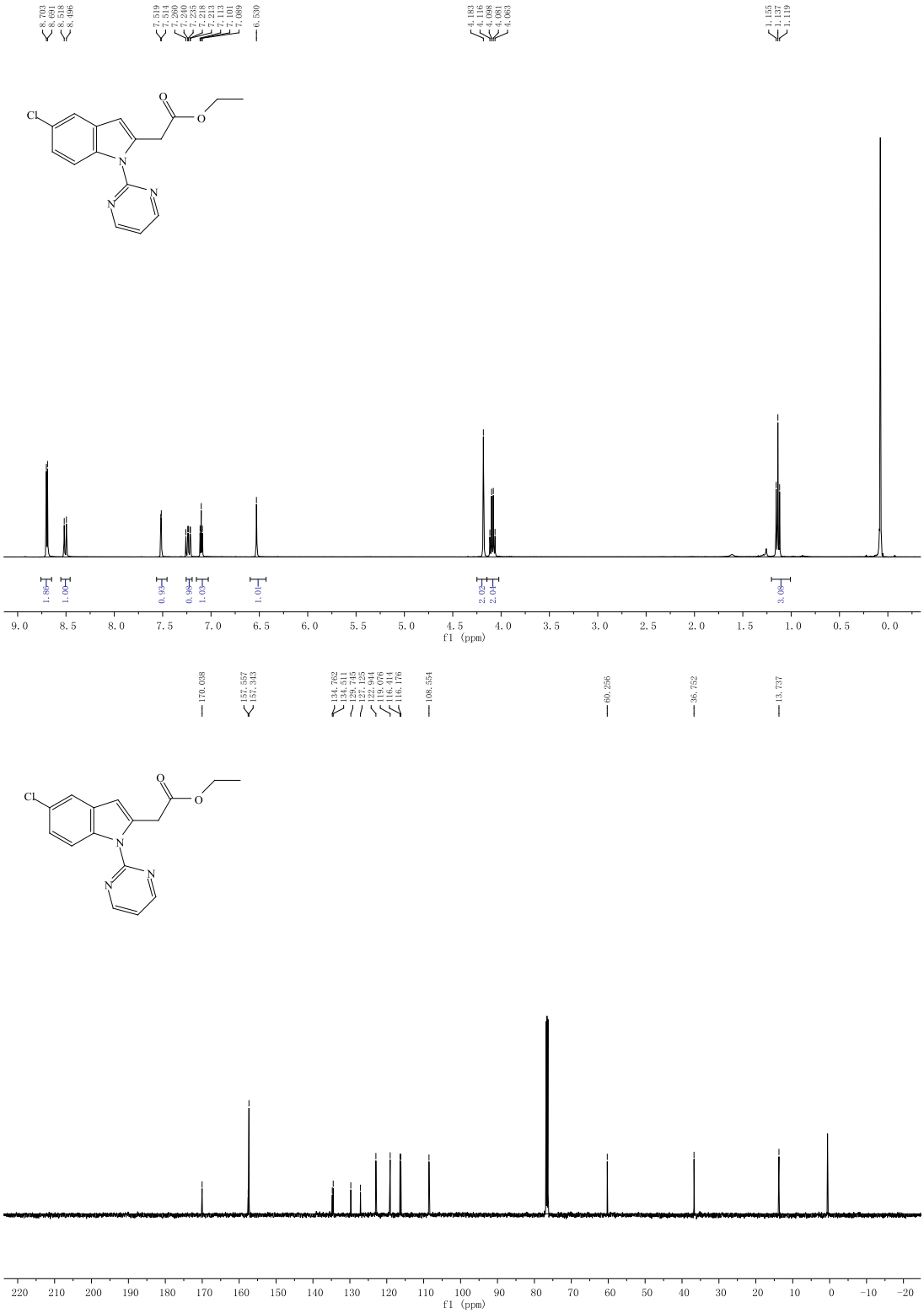
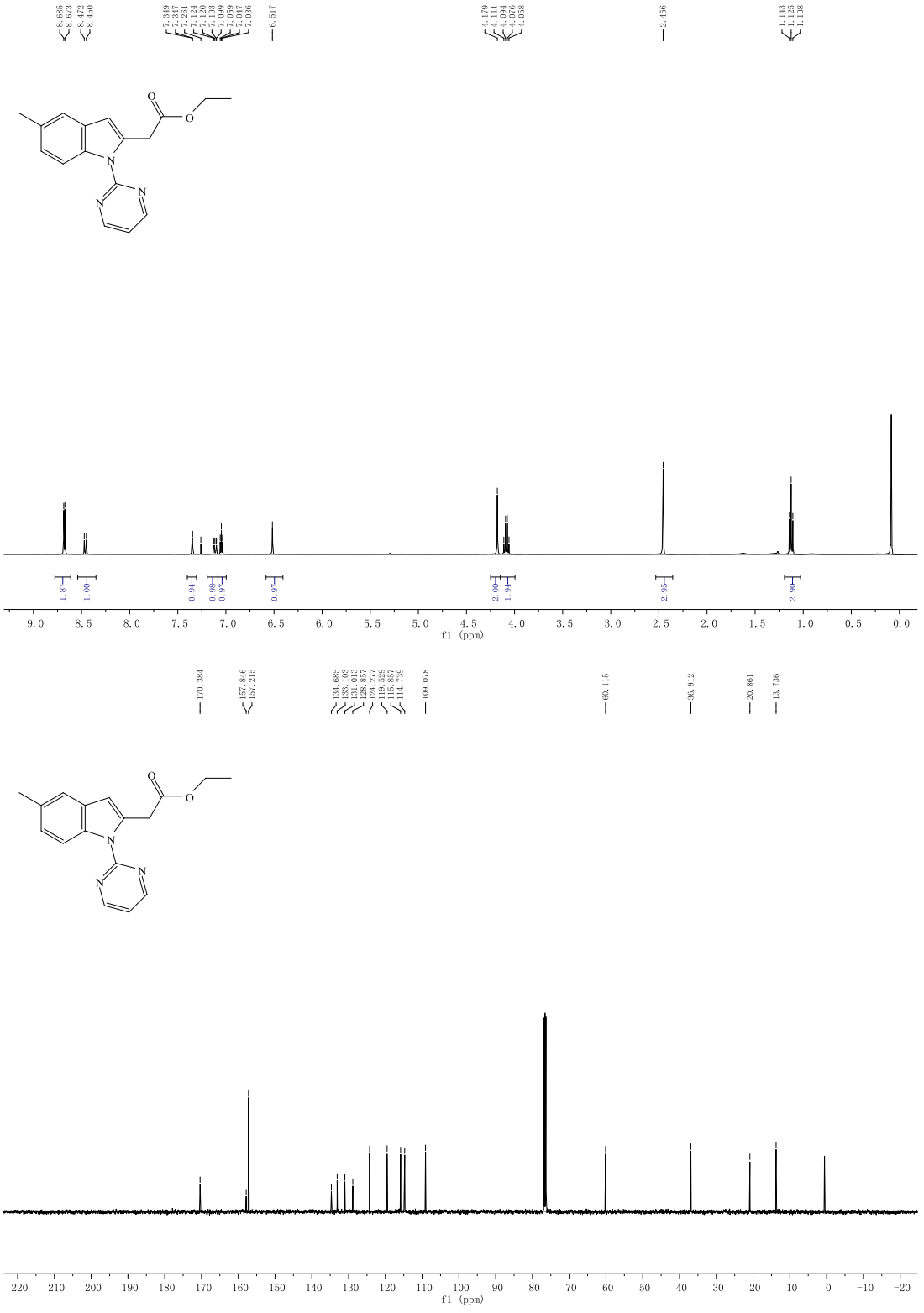
3e



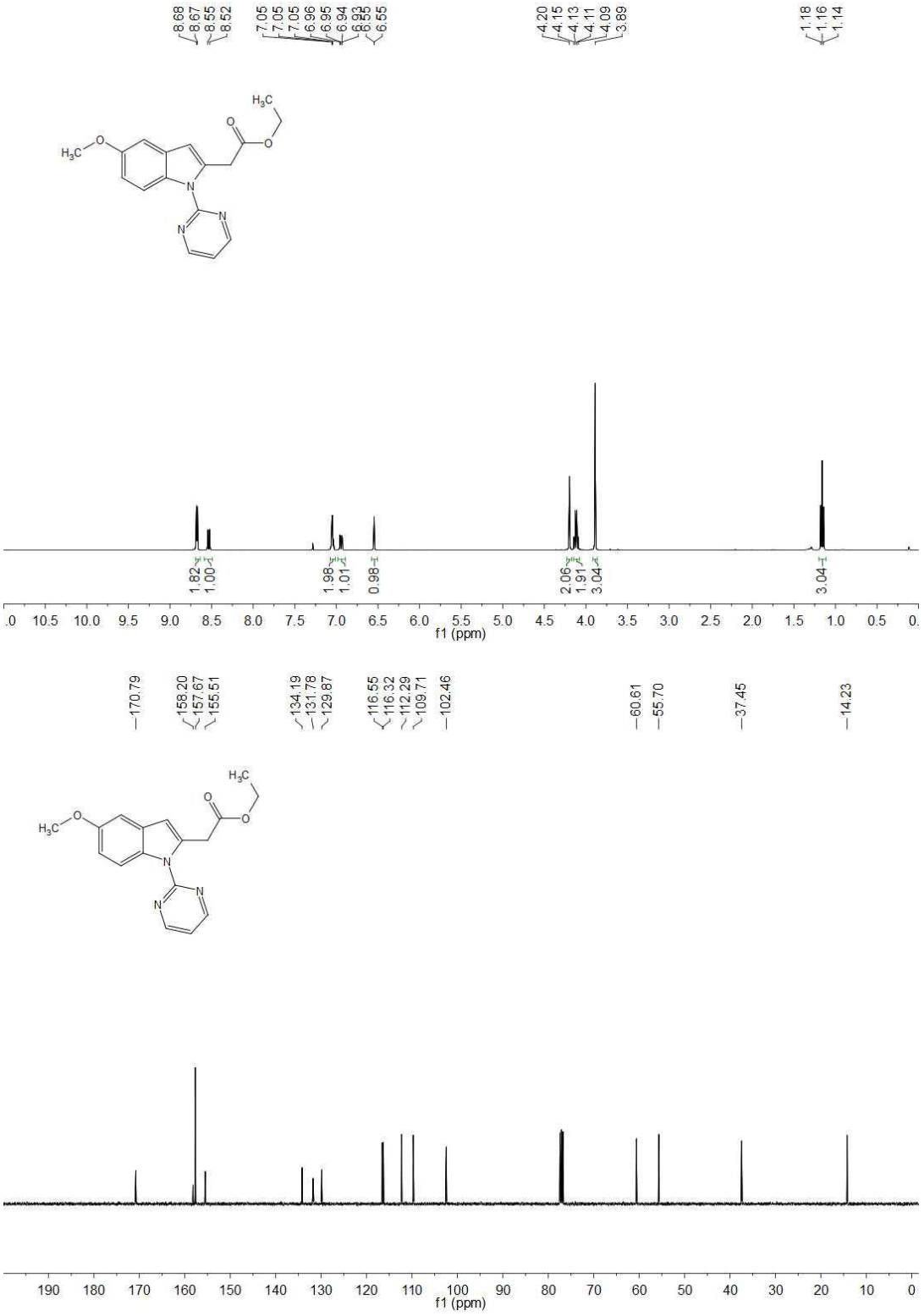
3f


8.703
8.691
8.538
8.496
7.519
7.514
7.260
7.240
7.225
7.218
7.213
7.113
7.101
7.089
6.530
4.183
4.116
4.098
4.081
4.063
1.155
1.137
1.119
Cl
O
O
N
N
N
1.80
1.00
0.99
0.98
1.05
1.01
2.02
2.04
3.06
f1 (ppm)
170.638
157.557
157.343
134.762
134.511
129.745
127.125
122.944
119.076
116.414
116.176
108.554
60.256
36.752
13.737

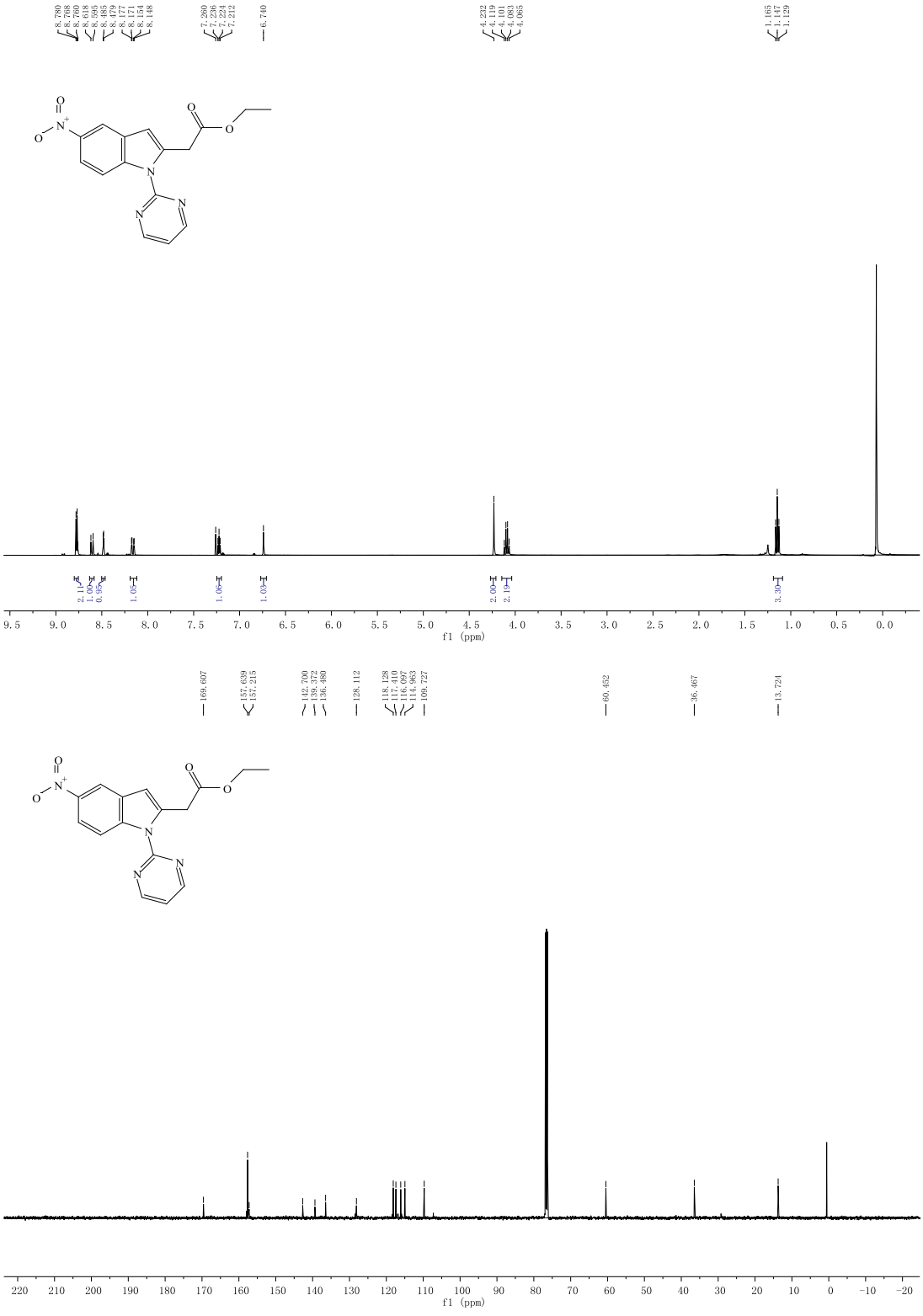
3g


8.685
8.673
8.472
8.450
7.349
7.347
7.261
7.124
7.120
7.101
7.099
7.059
7.047
7.036
6.517
4.179
4.111
4.094
4.076
4.058
2.456
1.143
1.125
1.108
1.87
1.00
0.94
0.98
0.97
0.97
2.00
1.94
2.95
2.90
f1 (ppm)
170.384
157.846
157.215
134.685
133.103
131.403
128.857
124.277
119.529
115.857
114.750
109.678
60.115
36.912
20.861
13.736
f1 (ppm)

3h


8.68
8.67
8.55
8.52
7.05
7.05
7.05
6.96
6.95
6.94
6.93
6.55
4.20
4.15
4.13
4.11
4.09
3.89
1.18
1.16
1.14
1.82
1.00
1.98
1.01
0.98
2.06
1.91
3.04
3.04
f1 (ppm)
170.79
158.20
157.67
155.51
134.19
131.78
129.87
116.55
116.32
112.29
109.71
102.46
60.61
55.70
37.45
14.23
f1 (ppm)

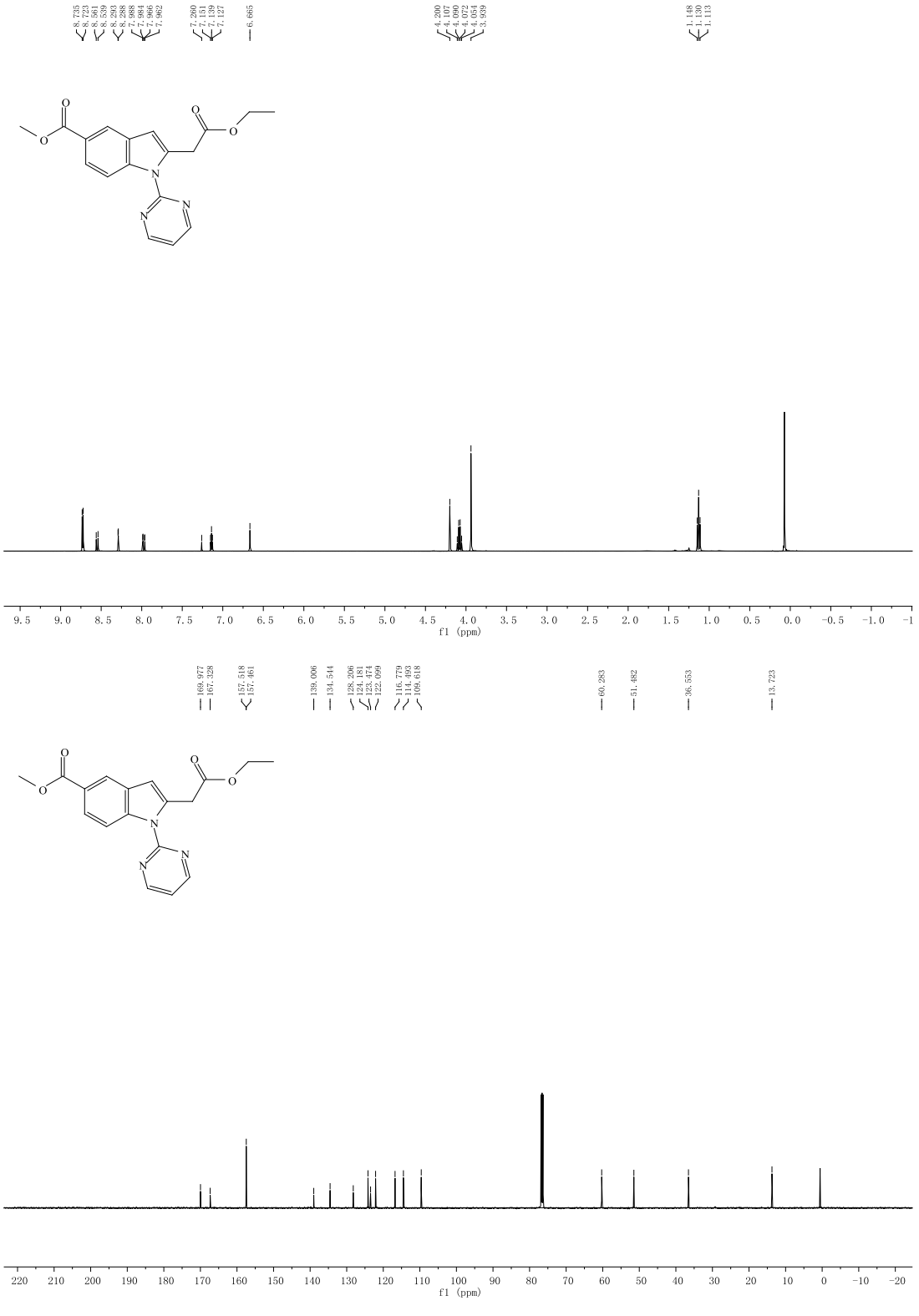
3i


8.780
8.768
8.760
8.618
8.595
8.485
8.479
8.177
8.171
8.154
8.148
7.260
7.236
7.224
7.212
6.740
4.232
4.119
4.101
4.083
4.065
1.165
1.147
1.129
2.11
1.06
0.96
1.07
1.06
1.07
2.00
2.19
3.30
f1 (ppm)
169.607
157.639
157.215
142.700
139.372
136.480
128.112
118.128
117.410
116.697
114.486
109.227
60.462
36.467
13.724
f1 (ppm)

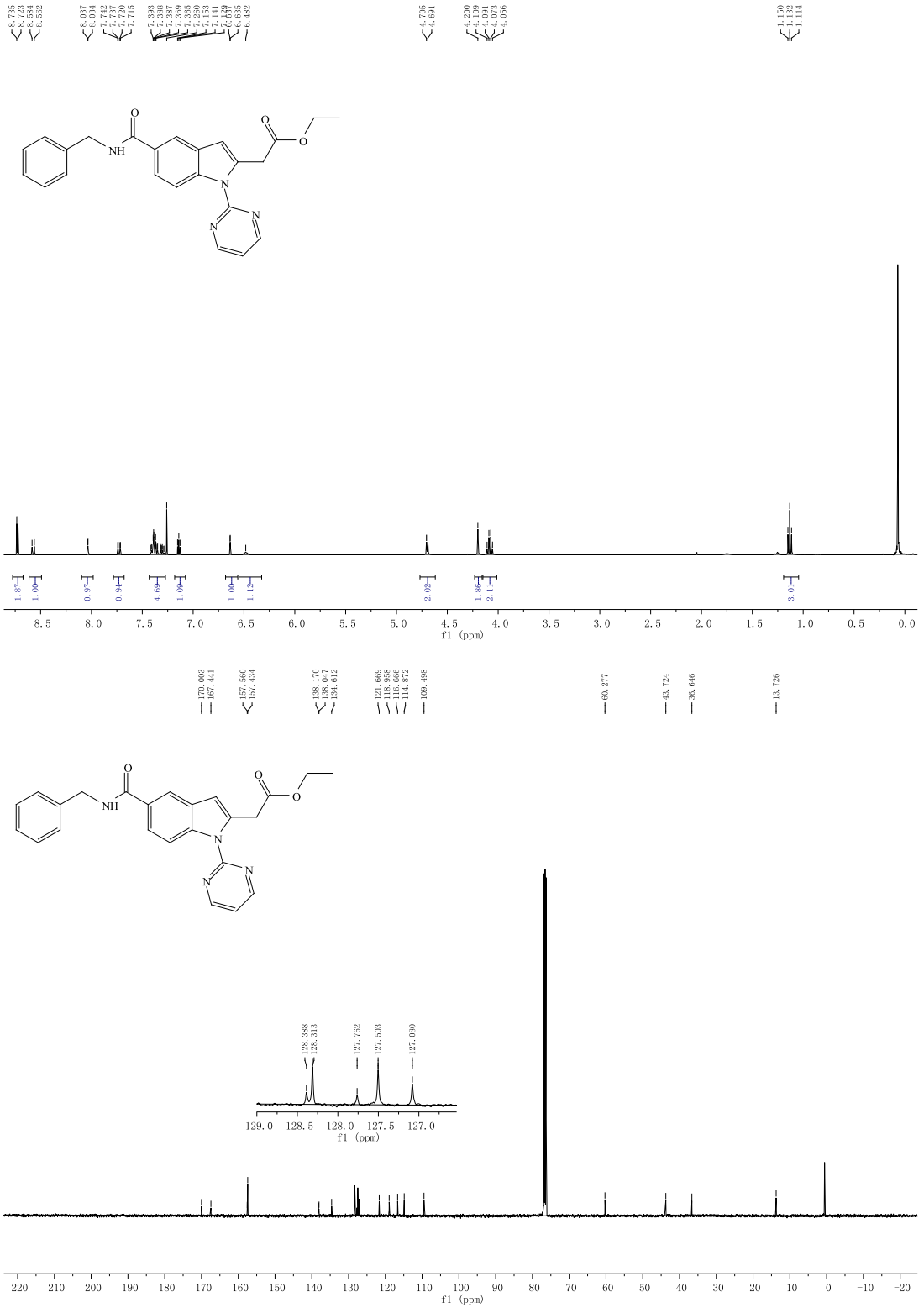
3j


8.757
8.745
8.620
8.598
7.891
7.889
7.526
7.521
7.504
7.500
7.206
7.194
7.182
6.650
6.648
4.215
4.112
4.094
4.077
4.059
1.158
1.140
1.123
2.11
1.04
0.96
1.01
1.00
1.00
2.09
2.17
3.27
f1 (ppm)
170.170
158.060
157.759
138.587
136.093
128.876
126.373
125.087
120.279
117.683
116.172
109.235
105.197
60.892
36.914
14.206
f1 (ppm)

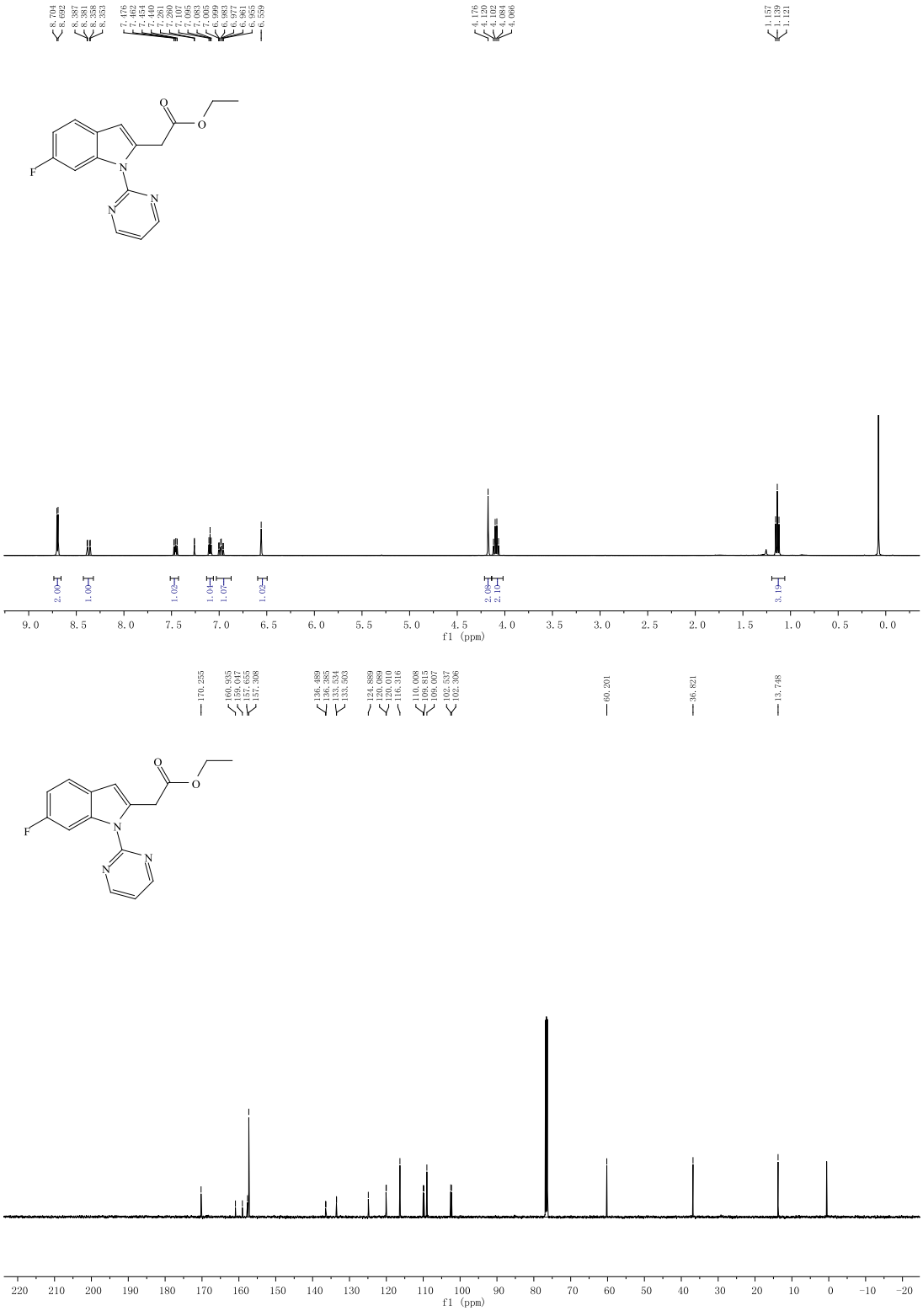
3k


8.735
8.723
8.551
8.539
8.293
8.288
7.988
7.984
7.966
7.962
7.260
7.151
7.139
7.127
6.665
4.200
4.107
4.090
4.072
4.054
3.939
1.148
1.130
1.113
f1 (ppm)
169.977
167.328
157.518
157.461
139.606
134.544
128.206
124.181
123.474
122.099
116.779
114.493
109.618
60.283
51.482
36.553
13.723
f1 (ppm)

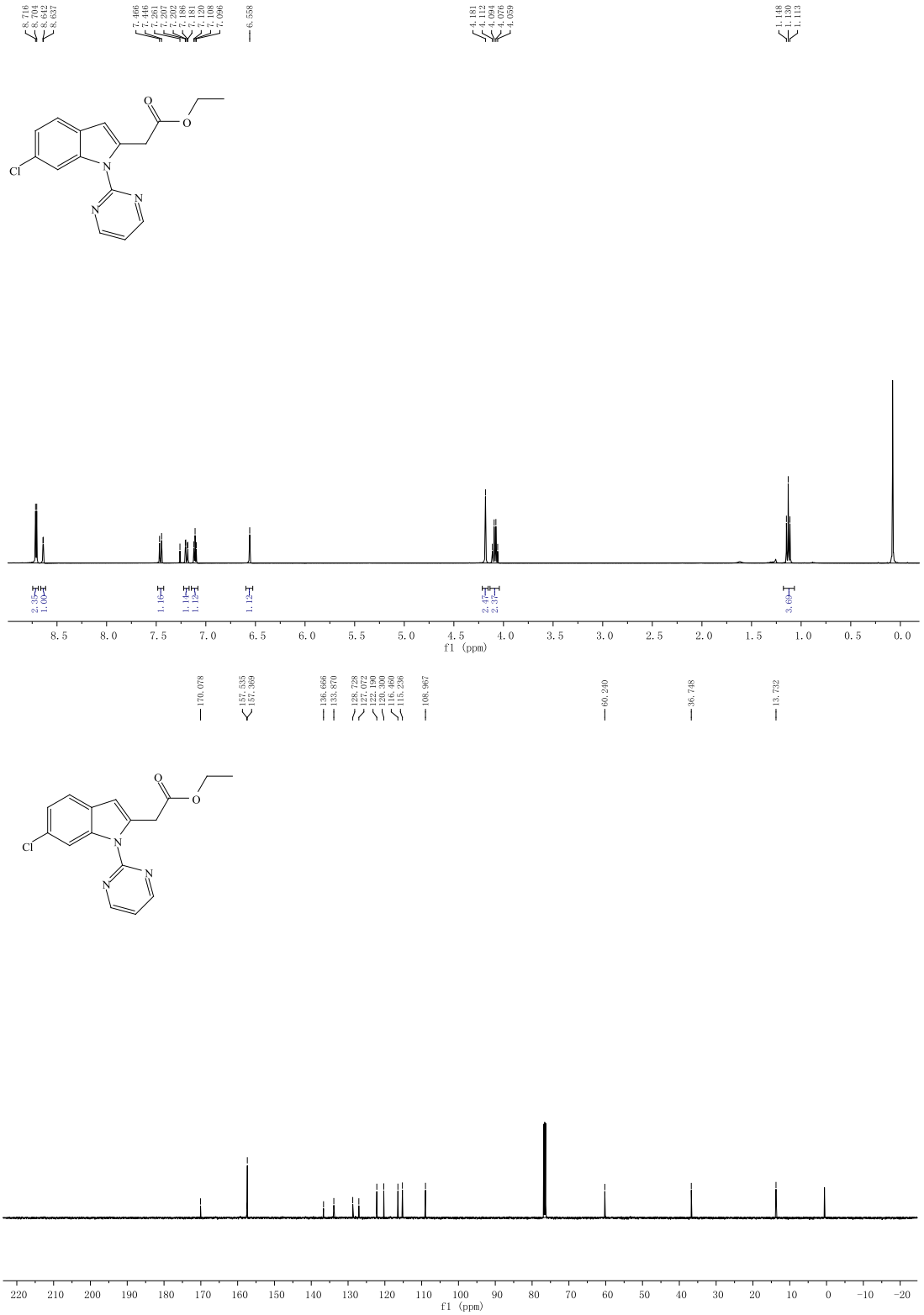
3l



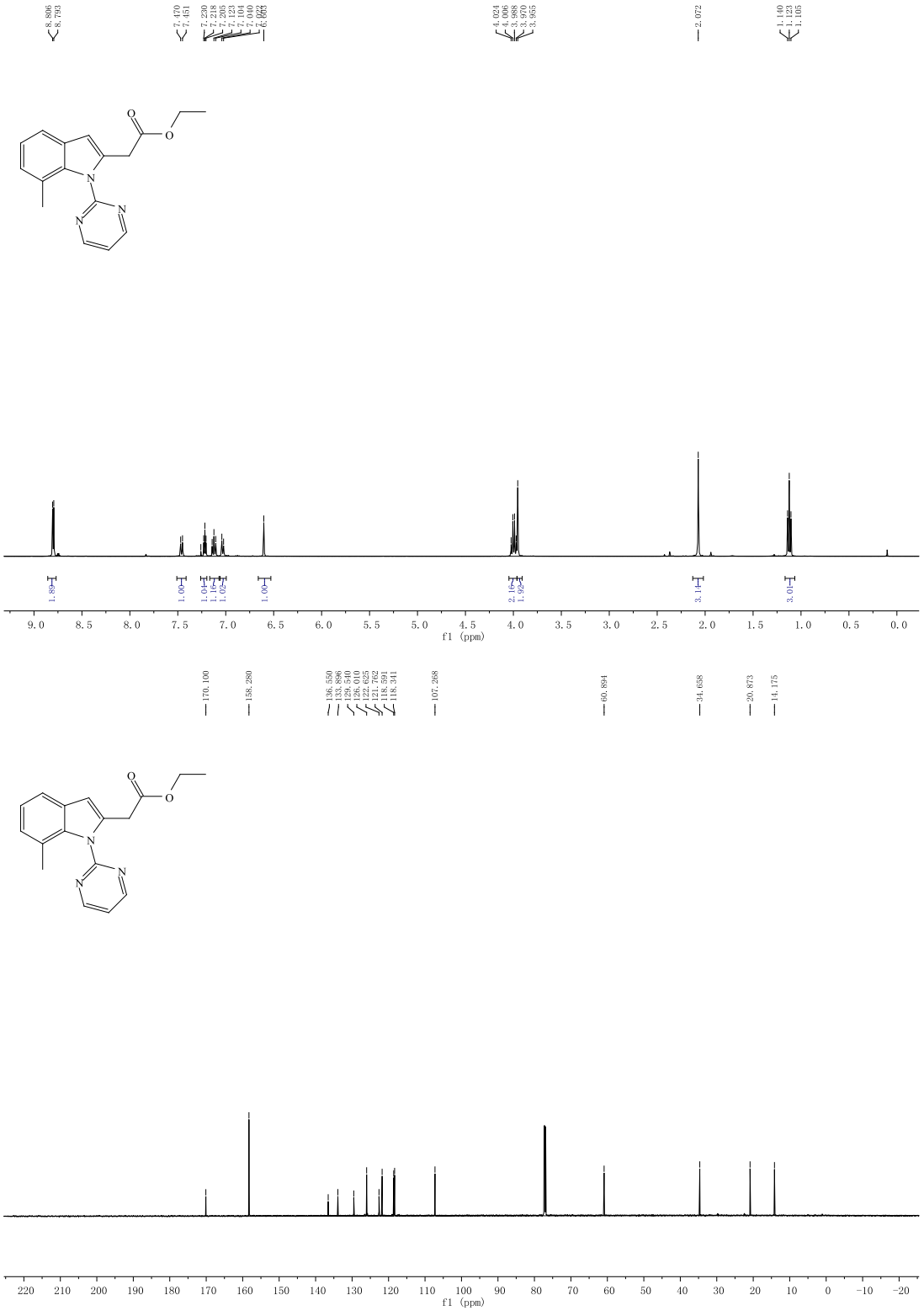
3m



3n


8.716
8.704
8.642
8.637
7.466
7.446
7.381
7.307
7.202
7.186
7.181
7.130
7.108
7.098
6.558
4.181
4.172
4.094
4.076
4.059
1.148
1.130
1.113
Cl
N
N
N
O
O
2.35
1.00
1.16
1.14
1.12
1.12
2.47
2.37
3.69
f1 (ppm)
170.078
157.535
157.369
136.666
133.870
128.738
127.072
122.190
120.300
116.460
115.256
108.867
60.240
36.748
13.732
f1 (ppm)

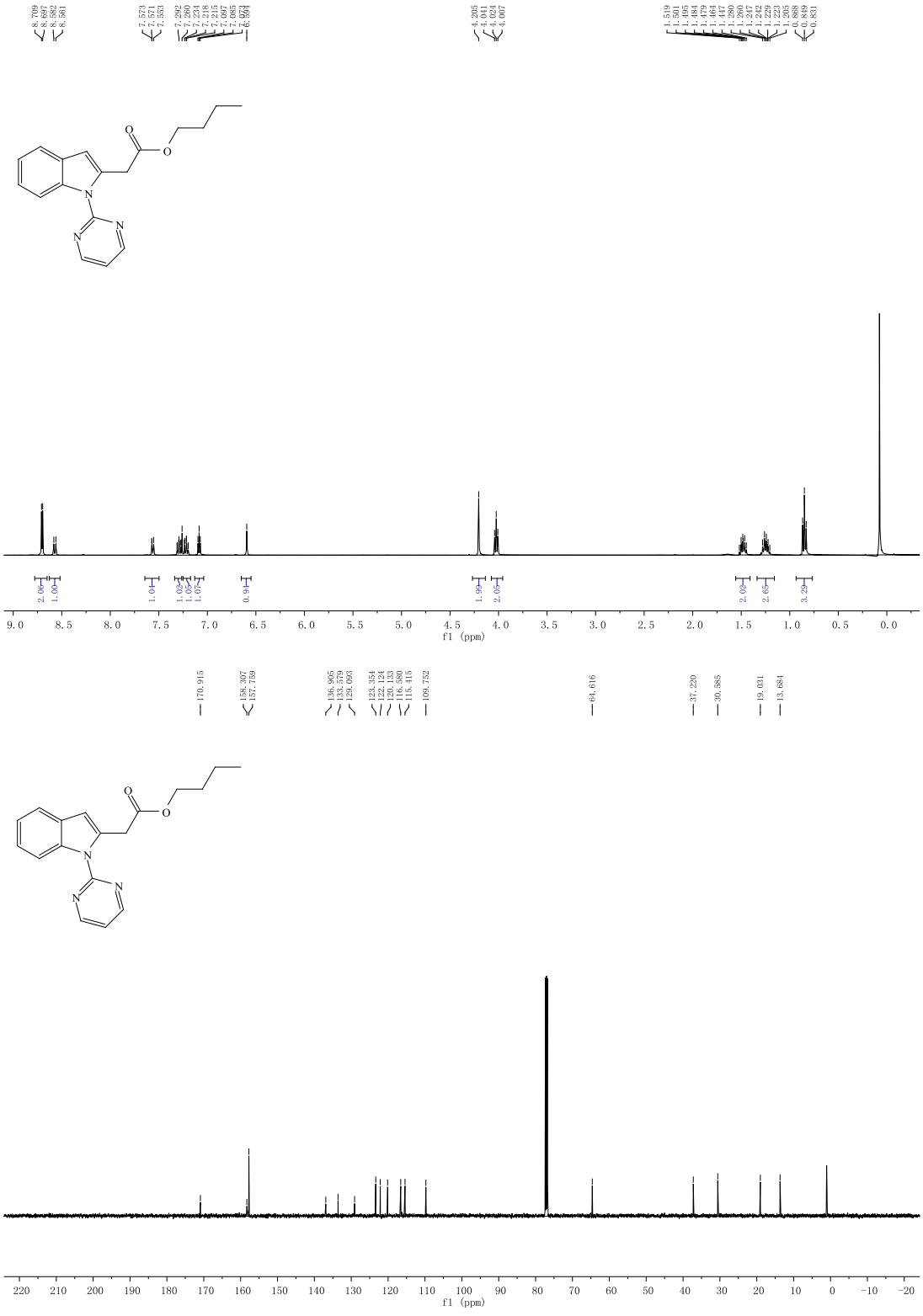
3o


8.806
8.793
7.470
7.451
7.230
7.218
7.205
7.123
7.104
7.040
7.022
6.603
4.024
4.006
3.988
3.970
3.955
2.072
1.140
1.123
1.105
O
O
N
N
N
1.89
1.00
1.04
1.14
1.02
1.00
2.16
1.92
3.14
3.01
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)
170.100
158.280
136.550
133.896
129.540
126.010
122.655
121.762
118.591
118.341
107.298
60.894
34.658
20.873
14.175
O
O
N
N
N
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
−20
f1 (ppm)

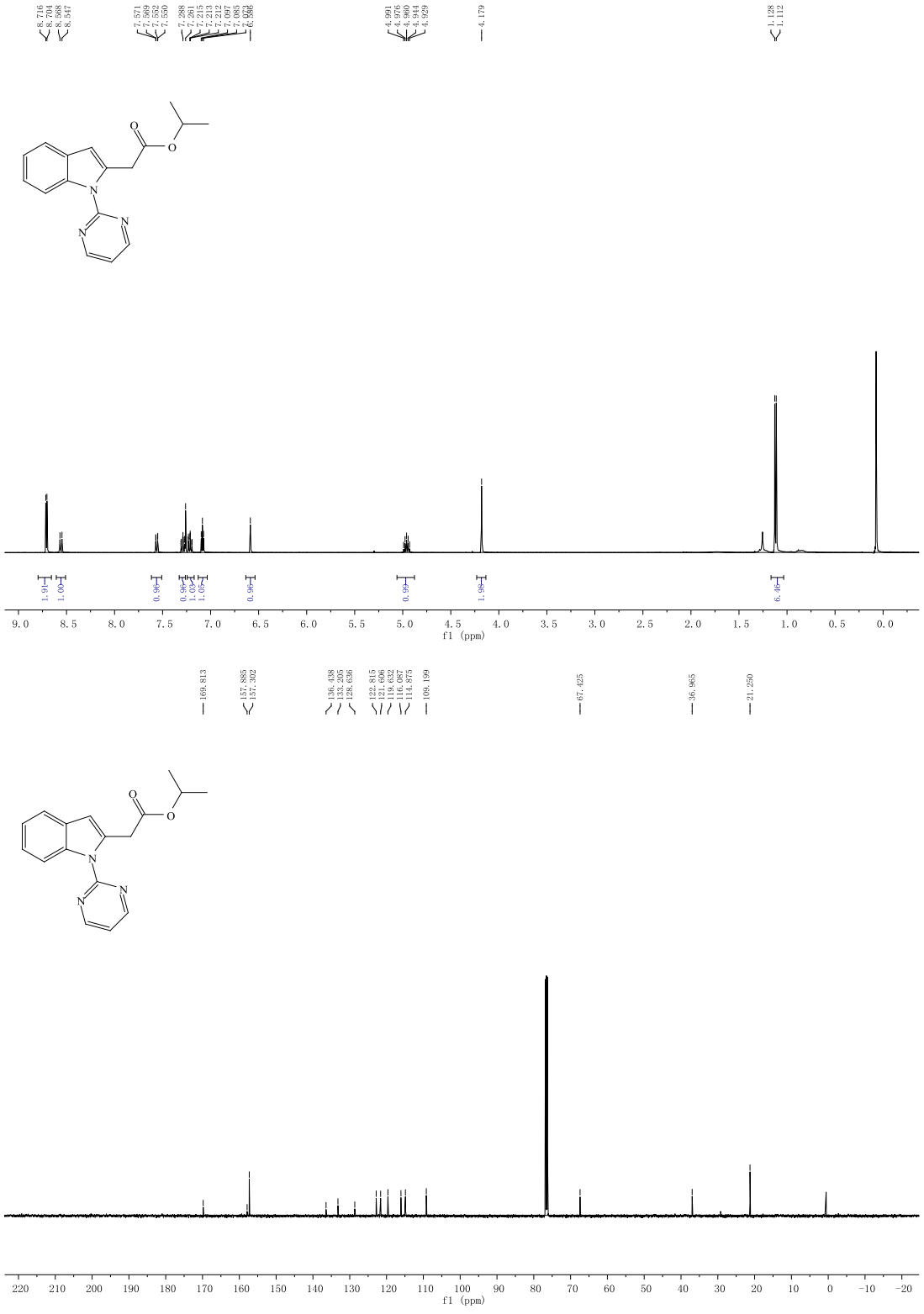
3p


8.73
8.72
8.62
8.60
7.60
7.58
7.33
7.28
7.25
7.12
7.11
7.09
6.83
4.21
3.65
O
O
CH3
N
N
N
1.95
1.00
1.01
1.02
1.01
1.02
0.99
2.10
3.09
f1 (ppm)
171.28
158.22
157.76
136.87
133.41
129.07
123.45
122.19
120.18
116.60
115.45
109.83
51.93
37.09
f1 (ppm)

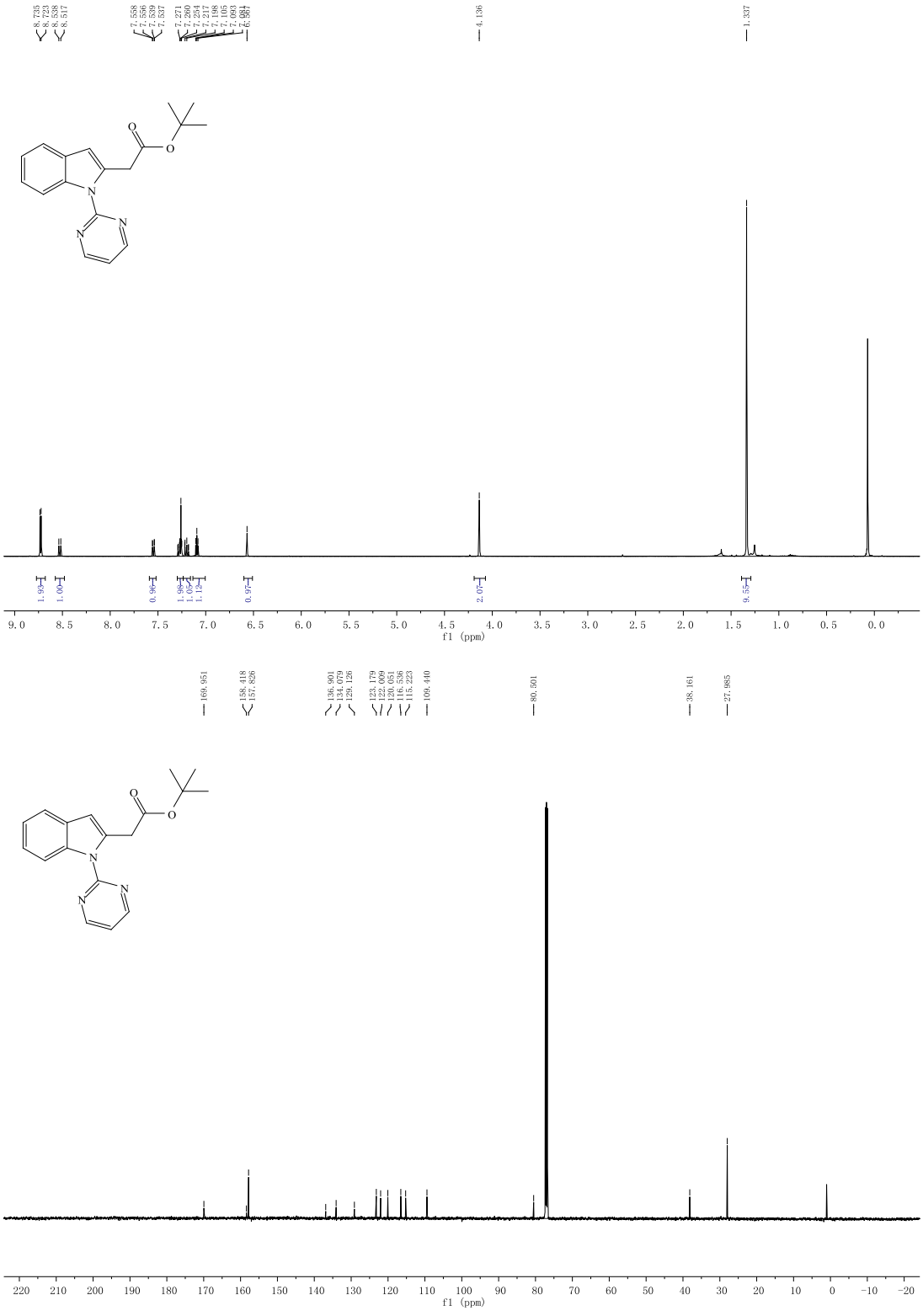
3q



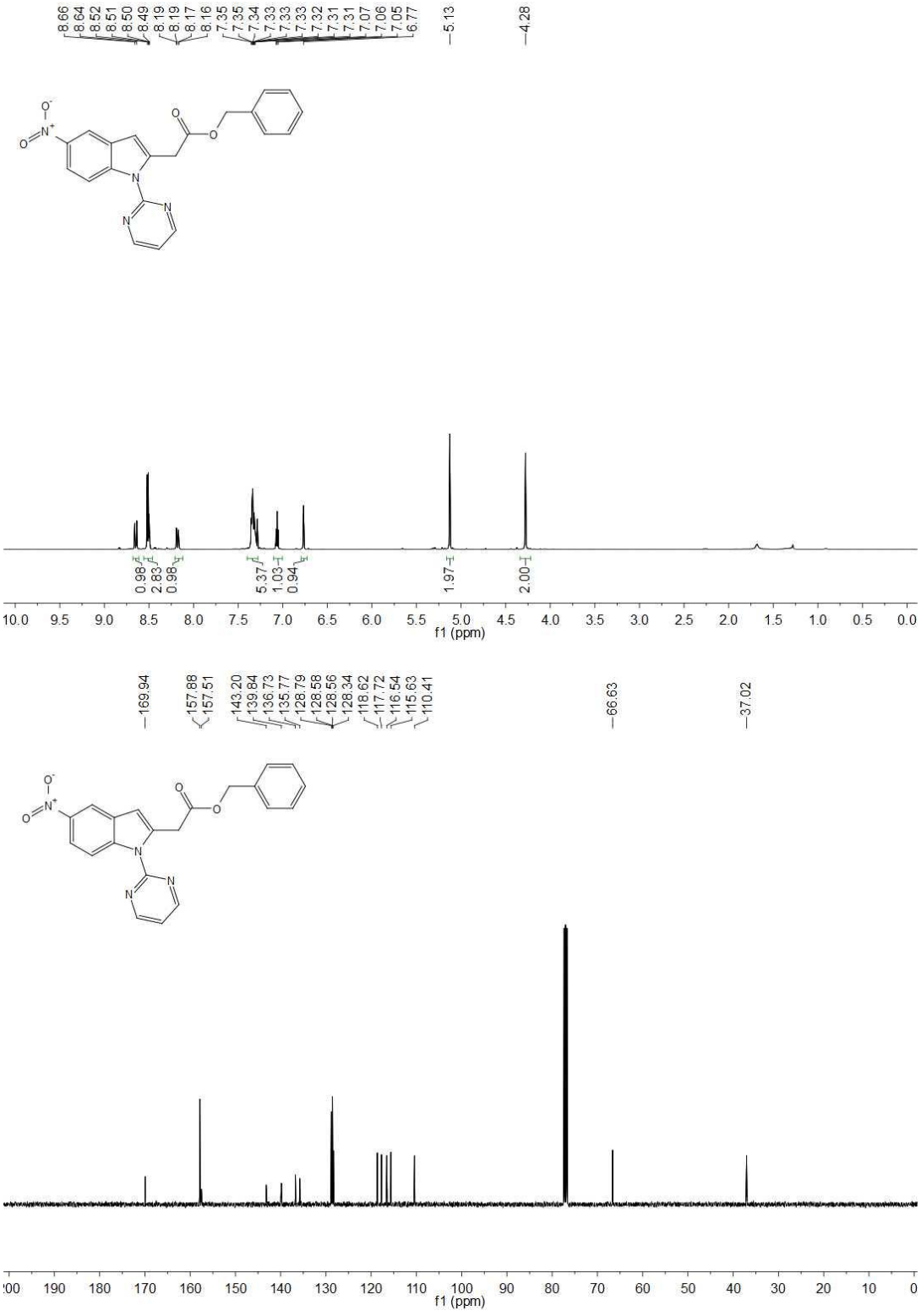
3r


8.716
8.704
8.568
8.547
7.571
7.569
7.552
7.550
7.298
7.291
7.215
7.213
7.212
7.097
7.095
6.963
6.960
4.991
4.976
4.960
4.944
4.929
4.179
1.128
1.112
1.91
1.06
0.98
0.96
1.05
1.05
0.98
0.99
1.98
6.40
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)
169.813
157.885
157.302
136.438
133.205
128.630
122.815
121.606
119.922
116.087
114.875
109.199
67.425
36.965
21.250
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20
f1 (ppm)

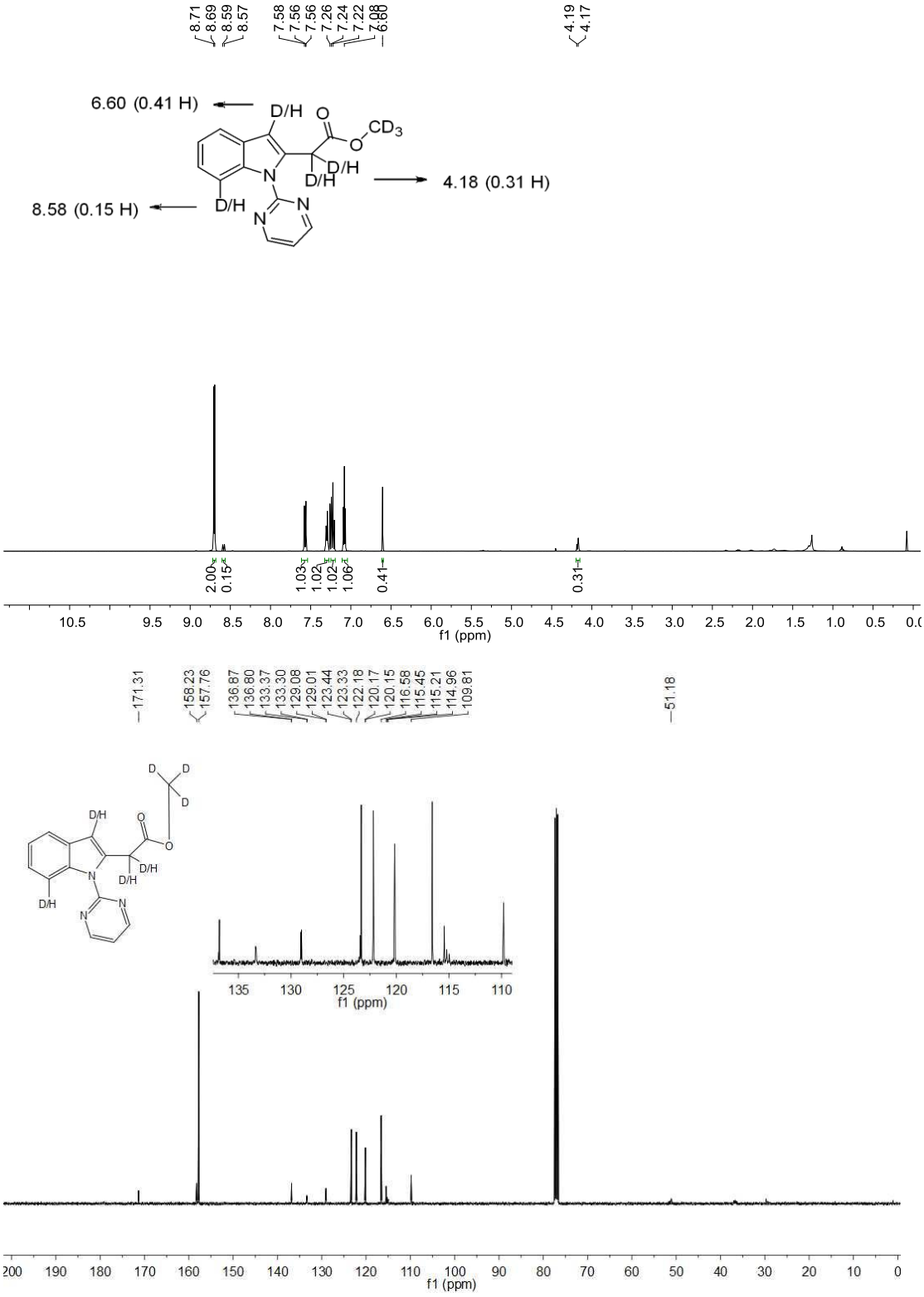
3s


8.735
8.723
8.538
8.517
7.558
7.556
7.539
7.537
7.271
7.260
7.254
7.217
7.198
7.105
7.093
6.984
6.981
4.136
1.337
O
O
N
N
N
1.93
1.00
0.98
1.98
1.04
1.12
0.97
2.05
9.58
f1 (ppm)
169.951
158.418
157.826
136.901
134.679
129.126
123.179
122.069
120.951
118.598
115.223
109.440
80.501
38.161
27.985
f1 (ppm)

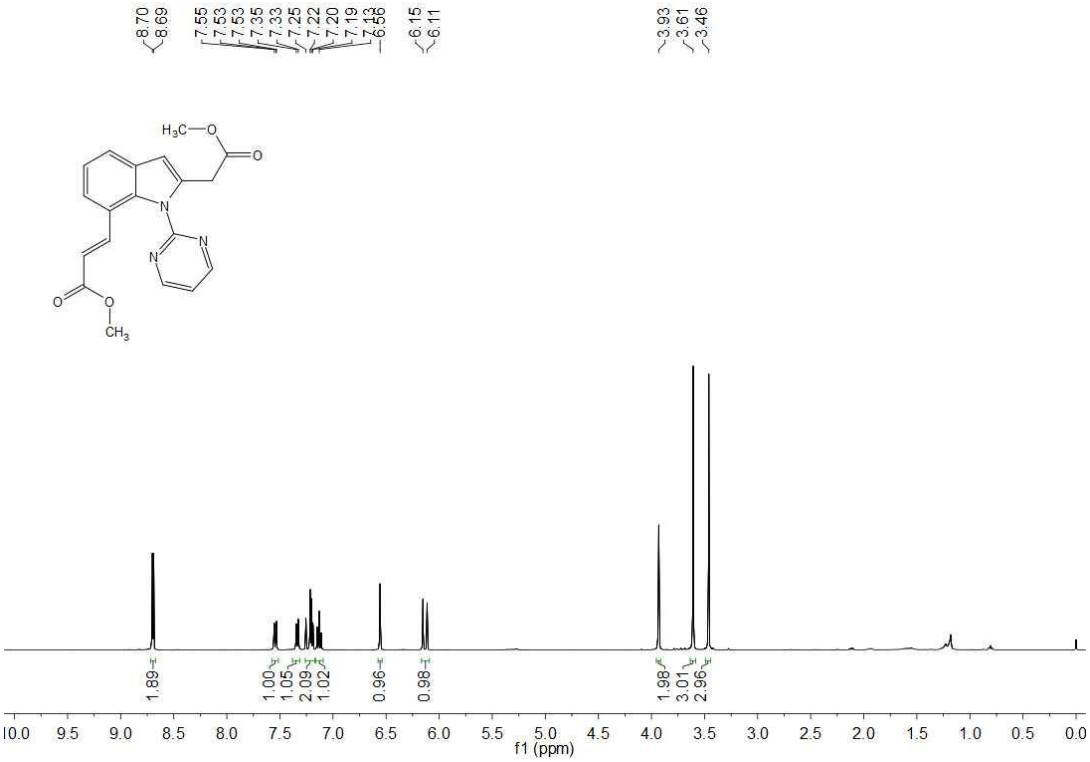
3t

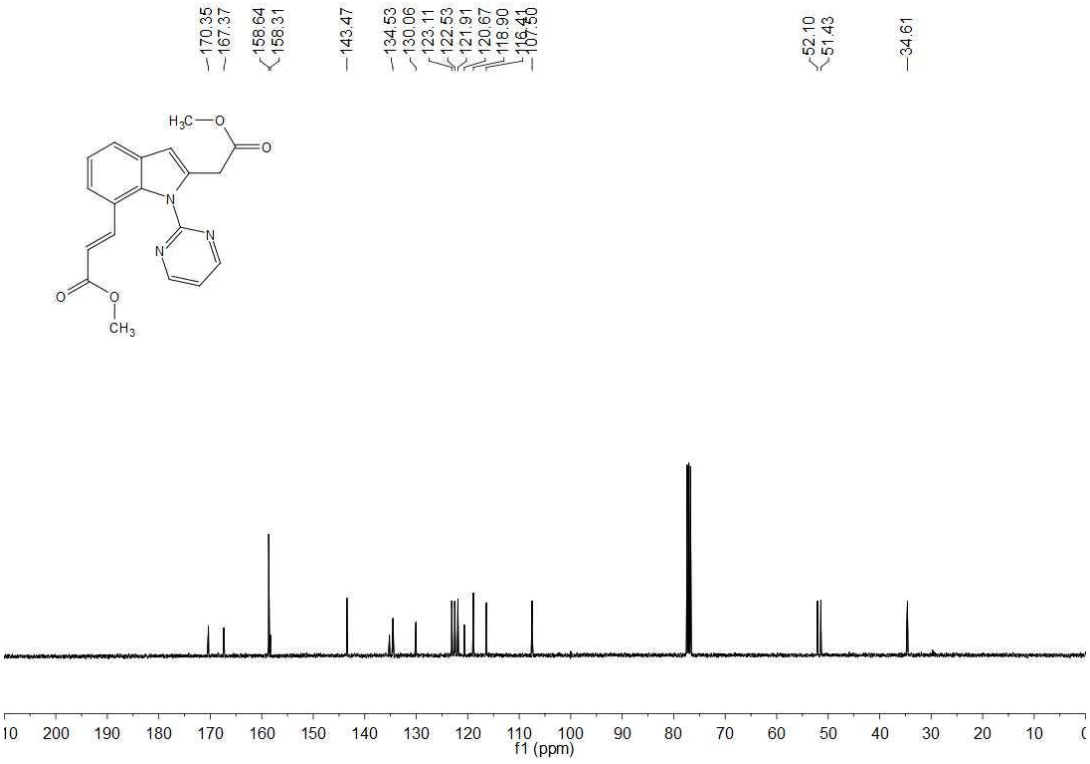

8.66
8.64
8.52
8.51
8.50
8.49
8.19
8.19
8.17
8.16
7.35
7.35
7.34
7.33
7.33
7.33
7.32
7.31
7.31
7.07
7.06
7.05
6.77
5.13
4.28
0.98
2.83
0.98
5.37
1.03
0.94
1.97
2.00
f1 (ppm)
169.94
157.88
157.51
143.20
139.84
136.73
135.77
128.79
128.58
128.56
128.34
118.62
117.72
116.54
115.63
110.41
66.63
37.02
f1 (ppm)

3u

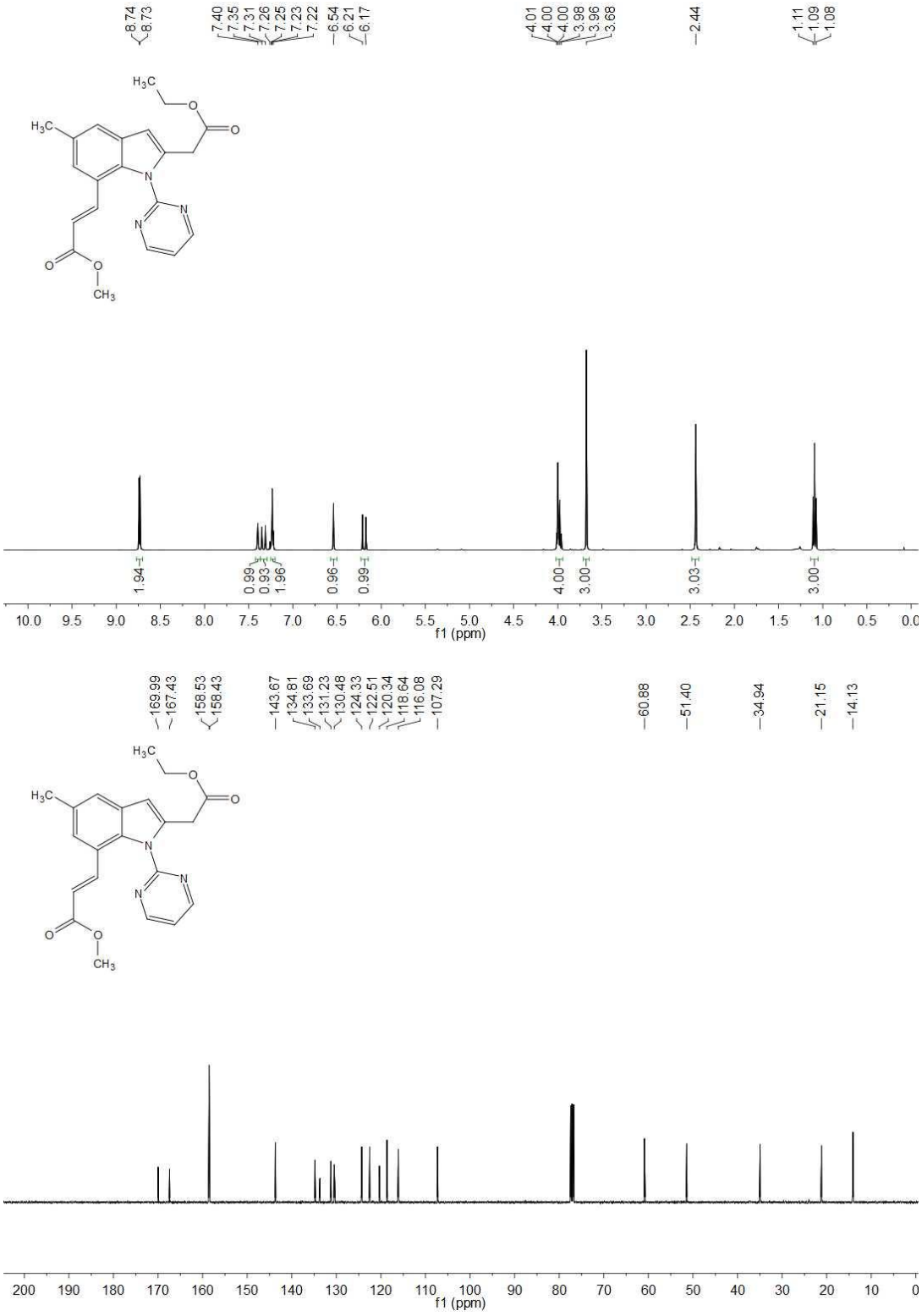

8.71
8.69
8.59
8.57
7.58
7.56
7.56
7.26
7.24
7.22
7.08
6.88
4.19
4.17
6.60 (0.41 H)
D/H
O
CD3
O
D/H
D/H
4.18 (0.31 H)
8.58 (0.15 H)
D/H
N
N
N
2.00
0.15
1.03
1.02
1.02
1.06
0.41
0.31
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)
171.31
158.23
157.76
136.87
136.80
133.37
133.30
129.08
129.01
123.44
123.33
122.18
120.17
120.15
116.58
115.45
115.21
114.96
109.81
51.18
D
D
D
D/H
O
O
D/H
D/H
N
D/H
N
N
135
130
125
120
115
110
f1 (ppm)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

4

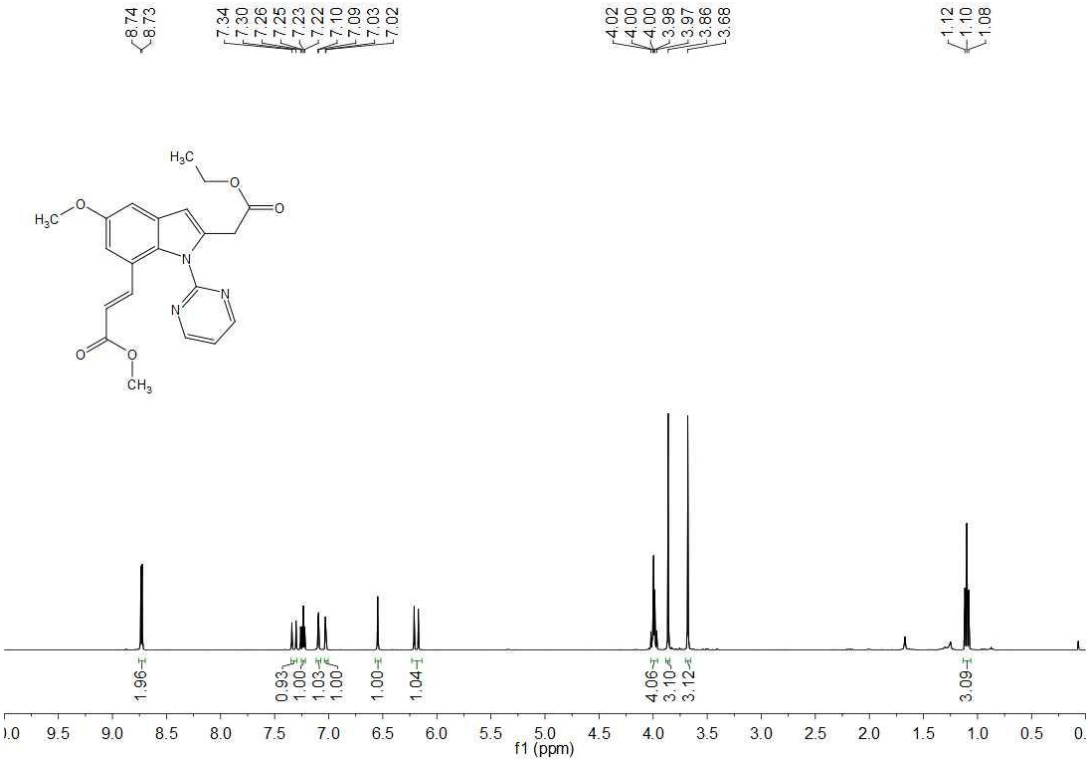

8.70
8.69
7.55
7.53
7.53
7.35
7.33
7.25
7.22
7.20
7.19
6.56
6.15
6.11
3.93
3.61
3.46
1.89
1.00
1.05
2.09
1.02
0.96
0.98
1.98
3.01
2.96
f1 (ppm)

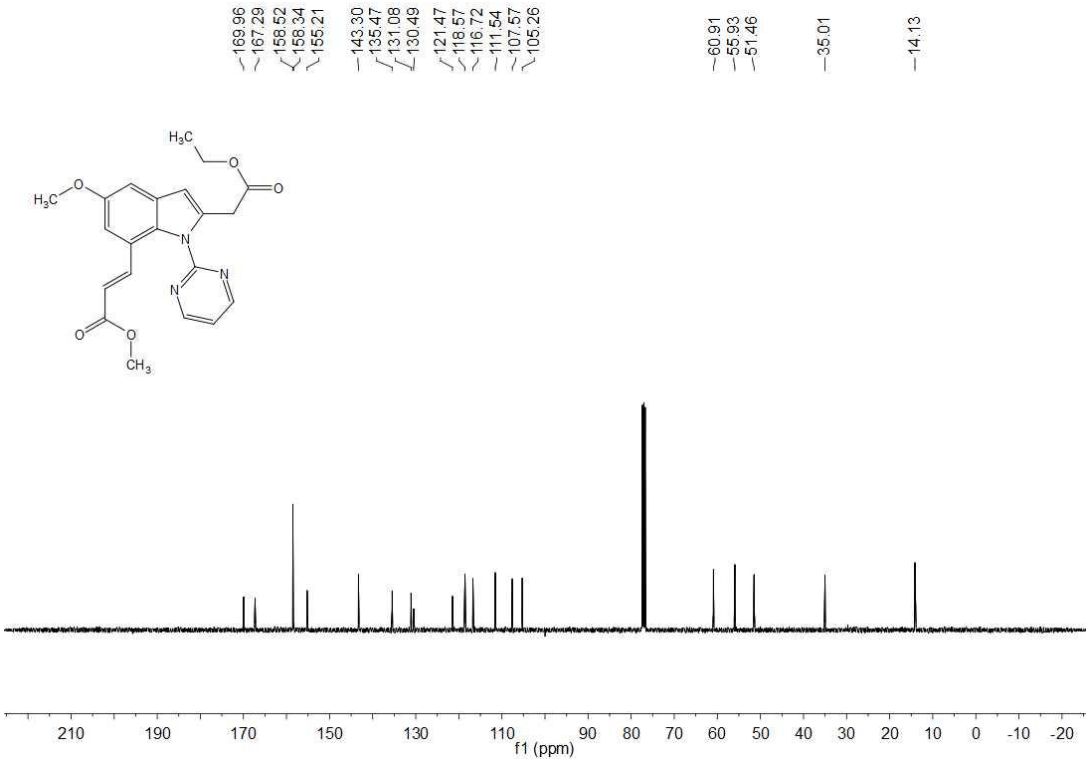

170.35
167.37
158.64
158.31
143.47
134.53
130.06
123.11
122.53
121.91
120.67
118.90
116.41
107.50
52.10
51.43
34.61
f1 (ppm)

5

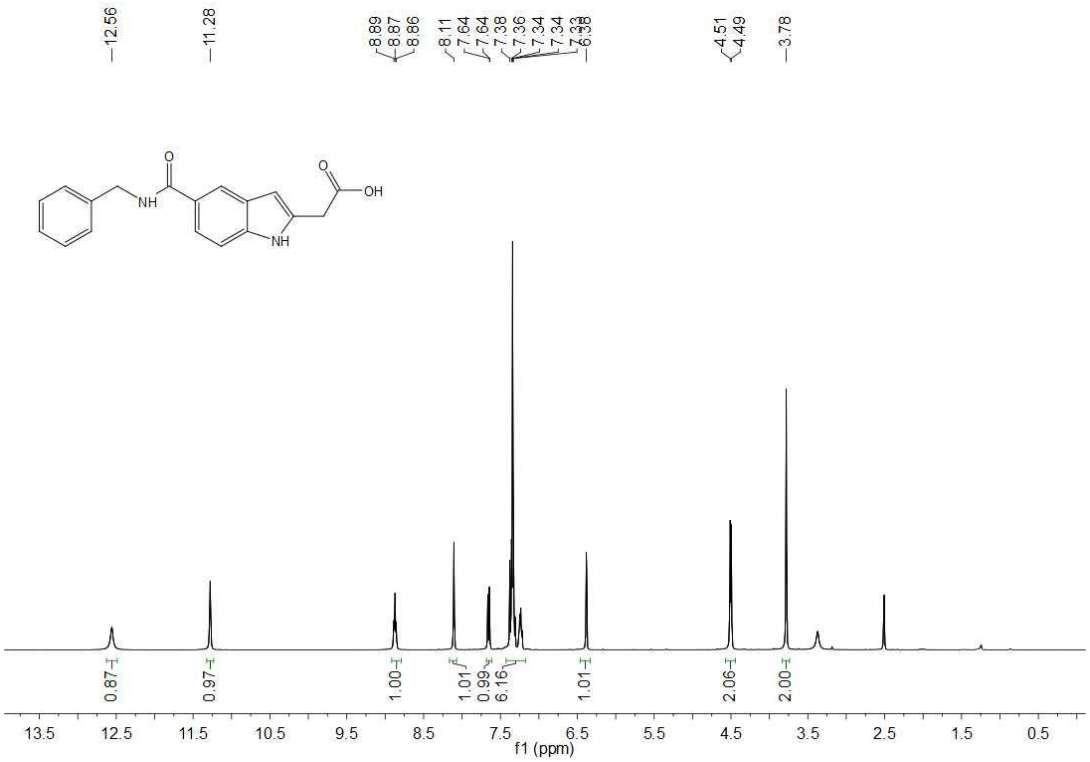

8.74
8.73
7.40
7.35
7.31
7.26
7.25
7.23
7.22
6.54
6.21
6.17
4.01
4.00
4.00
3.98
3.96
3.68
2.44
1.11
1.09
1.08
1.94
0.99
0.93
1.96
0.96
0.99
4.00
3.00
3.03
3.00
f1 (ppm)
169.99
167.43
158.53
158.43
143.67
134.81
133.69
131.23
130.48
124.33
122.51
120.34
118.64
116.08
107.29
60.88
51.40
34.94
21.15
14.13
f1 (ppm)

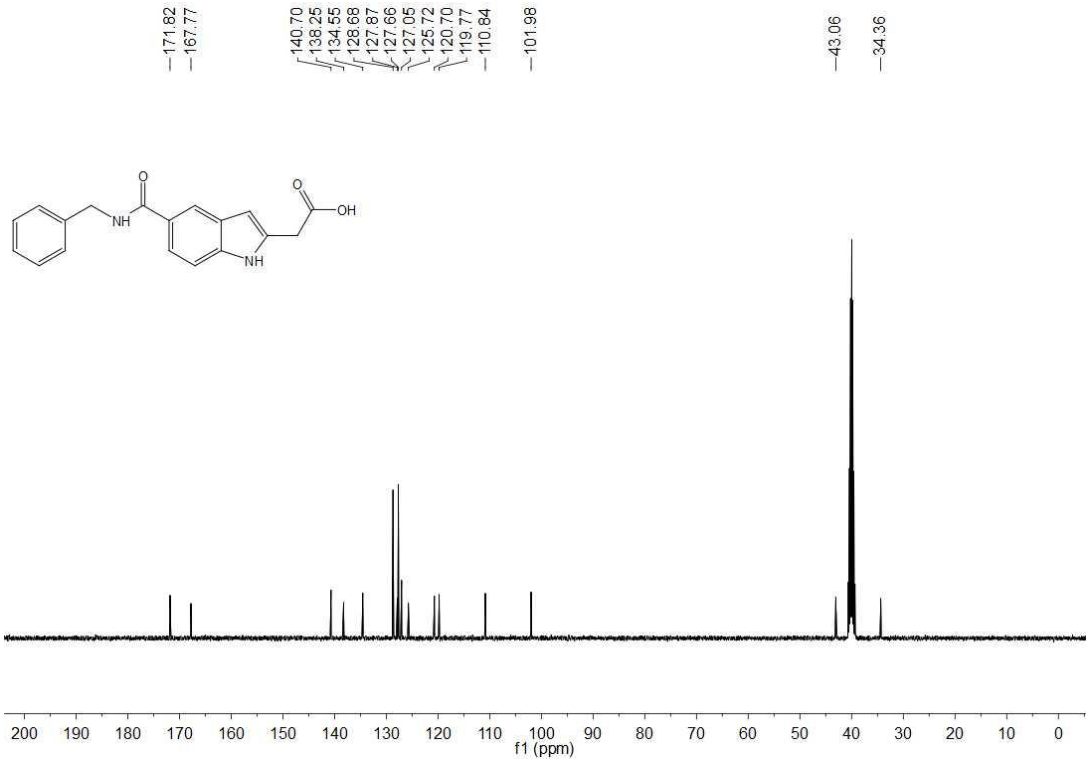
6


8.74
8.73
7.34
7.30
7.26
7.25
7.23
7.22
7.10
7.09
7.03
7.02
4.02
4.00
4.00
3.98
3.97
3.86
3.68
1.12
1.10
1.08
1.96
0.93
1.00
1.03
1.00
1.00
1.04
4.06
3.10
3.12
3.09
f1 (ppm)


169.96
167.29
158.52
158.34
155.21
143.30
135.47
131.08
130.49
121.47
118.57
116.72
111.54
107.57
105.26
60.91
55.93
51.46
35.01
14.13
f1 (ppm)

7


12.56
11.28
8.89
8.87
8.86
8.11
7.64
7.64
7.38
7.36
7.34
7.34
7.33
6.38
4.51
4.49
3.78
NH
O
OH
NH
0.87
0.97
1.00
1.01
0.99
6.16
1.01
2.06
2.00
f1 (ppm)


171.82
167.77
140.70
138.25
134.55
128.68
127.87
127.66
127.05
125.72
120.70
119.77
110.84
101.98
43.06
34.36
NH
O
OH
NH
f1 (ppm)