

Supporting Information

Copper(I) Chloride Salt Catalyzed Csp²-N Cross-Coupling of Disulfides with Amines: An Efficient Approach to C2-Functionalized Pyrimidines

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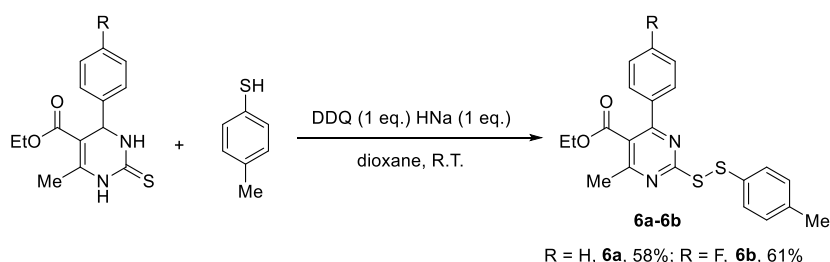
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1. General

¹H NMR and ¹³C NMR data analyses were performed with a Varian Mercury plus-400 instrument and plus-600 instrument unless otherwise specified. Dual-beam infrared spectrophotometer CDCl₃ as solvent and tetramethylsilane (TMS) as the internal standard were employed. Chemical shifts were reported in units (ppm) by assigning TMS resonance in the ¹H NMR spectrum as 0.00 ppm. The data of ¹H NMR was reported as follows: chemical shift, multiplicity (s = singlet, d = doublet, t = triplet, m = multiplet and br = broad), coupling constant (J values) in Hz and integration. Chemical shift for ¹³C NMR spectra were recorded in ppm from TMS using the central peak of CDCl₃ (77.0 ppm) as the internal standard. Flash chromatography was performed using 200-300 mesh silica gel with the indicated solvent system according to standard techniques. Analytical thin-layer chromatography (TLC) was performed on pre-coated, glass-backed silica gel plates. Melting points were measured with an XT-4 apparatus. High-resolution mass spectra (HRMS) (ESI) were obtained with a Bruker Daltonics APEX II 47e and Orbitrap Elite mass spectrometer. Column chromatography was generally performed on silica gel (200–300 mesh) and TLC analyses were conducted on silica gel GF254 plates.

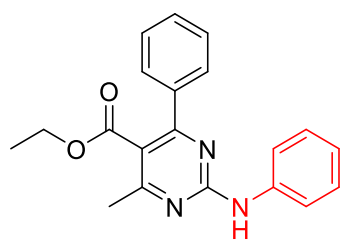
2. Experimental details and characterization data for all products.

2.1 Synthesis of unsymmetrical disulfides 6a and 6b. The mixture of ethyl 6-methyl-4-aryl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (5 mmol), *p*-toluenethiol (5 mmol), 2,3-dichloro-5,6-dicyano-1,4-benzoquinone (5 mmol) and NaH (5 mmol) in dioxane (15.0 mL) in 100 mL round-bottom flask was stirred at rt for 5 min. Then, 2 mL diluted hydrochloric acid was added to the mixture to quench the reaction and extracted with ethyl acetate (3×25 mL). The combined organic layers were washed with aqueous NaHCO₃ and brine, dried over MgSO₄, filtered, and the volatiles were removed in vacuo. The residue was purified by column chromatography on silica gel (ethyl acetate/ petroleum ether 1:10) to give the product.

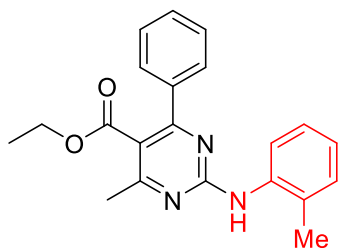


2.2 General procedure for the synthesis of 3a. Under an atmosphere of nitrogen, disulfide¹ **1a** (1 mmol, 0.546g), aniline **2a** (3 mmol, 0.279g), CuCl (1.0 mmol, 0.099g) and K₃PO₄ (3.0 mmol, 0.637g) were added to an oven-dried Schlenk tube. The tube was stoppered and degassed with nitrogen three times. Water-free xylene (3 mL) was added by syringe and the mixture was stirred for 8 h at 140°C and the reaction was monitored by TLC analysis. Then, 2mL diluted hydrochloric acid were added to the mixture to quench the reaction and extracted with ethyl acetate (3×100 mL). The combined organic layers were washed with aqueous NaHCO₃ and brine, dried over MgSO₄, filtered, and the volatiles were removed in vacuo. The residue was purified by column chromatography on silica gel (ethyl acetate/ petroleum ether 1:30) to give the corresponding products.

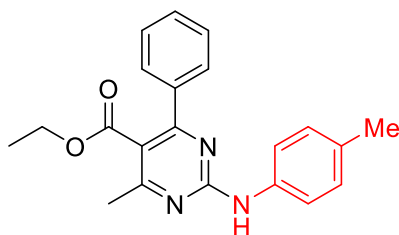
2.3 Characterization Data for the Isolated Products.



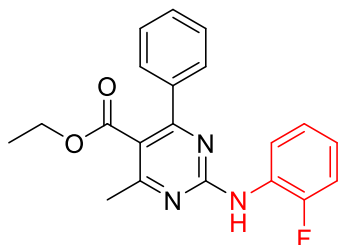
Ethyl 4-methyl-6-phenyl-2-(phenylamino)pyrimidine-5-carboxylate (3a).² Colorless oil. IR (KBr): 3325 (s), 2983 (m), 1716 (s), 1550 (s), 1383 (s), 1160 (m), 1050 (s), 585 (m) cm⁻¹. ¹H NMR (400 MHz, CDCl₃) δ 7.67-7.62 (m, 5H), 7.44 (d, *J* = 4.8 Hz, 3H), 7.32 (t, *J* = 7.6 Hz, 2H), 7.04 (t, *J* = 7.2 Hz, 1H), 4.11 (q, *J* = 7.2 Hz, 2H), 2.57 (s, 3H), 1.00 (t, *J* = 6.8 Hz, 3H); ¹³C NMR (100 MHz, CDCl₃) δ 168.41, 167.17, 165.73, 158.71, 139.01, 138.52, 129.60, 128.71, 128.23, 127.96, 122.57, 119.16, 116.93, 61.19, 22.88, 13.46. HRMS (ESI) *m/z* calcd for C₂₀H₁₉N₃O₂ [M + H]⁺ 334.1550, found 334.1552.



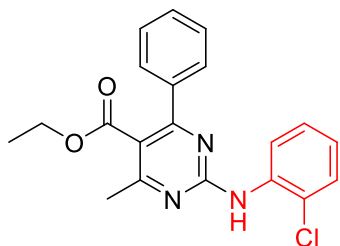
Ethyl 4-methyl-6-phenyl-2-(o-tolylamino)pyrimidine-5-carboxylate (3b).² Brown oil. IR (KBr): 3315 (s), 2970 (m), 1713 (s), 1655 (m), 1456 (s), 1245 (m), 860 (s) cm^{-1} . ^1H NMR (400 MHz, CDCl_3) δ 8.07 (d, $J = 8.1$ Hz, 1H), 7.54-7.51(m, 2H), 7.36-7.35 (m, 3H), 7.17 (t, $J = 3.6$ Hz, 1H), 7.15-7.12 (m, 1H), 7.01 (s, 1H), 6.96 (t, $J = 7.4$ Hz, 1H), 4.02 (q, $J = 7.2$ Hz, 2H), 2.47 (s, 3H), 2.26 (s, 3H), 0.91 (t, $J = 7.2$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 168.50, 167.26, 165.88, 159.09, 138.59, 136.97, 130.39, 129.63, 128.29, 127.99, 126.50, 123.63, 121.50, 117.02, 61.23, 29.66, 22.92, 18.16, 13.53. HRMS (ESI) m/z calcd for $\text{C}_{21}\text{H}_{21}\text{N}_3\text{O}_2$ $[\text{M} + \text{H}]^+$ 348.1707, found 348.1710.



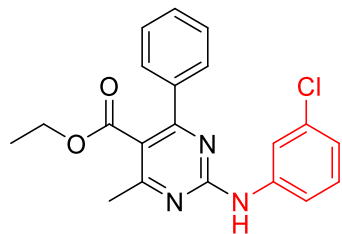
Ethyl 4-methyl-6-phenyl-2-(p-tolylamino)pyrimidine-5-carboxylate (3c).² Brown oil. IR (KBr): 3318 (s), 2982 (m), 1715 (s), 1552 (s), 1433 (m), 1386 (s), 1160 (m), 1055 (s), 885 (m) cm^{-1} . ^1H NMR (400 MHz, CDCl_3) δ 7.53 (d, $J = 4.0$ Hz, 2H), 7.45 (d, $J = 8.0$ Hz, 2H), 7.35 (s, 4H), 7.04 (d, $J = 8.0$ Hz, 2H), 4.01 (q, $J = 7.2$ Hz, 2H), 2.47 (s, 3H), 2.23 (s, 3H), 0.90 (t, $J = 7.2$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ = 168.49, 167.18, 165.80, 158.87, 138.75, 136.50, 132.26, 129.54, 129.29, 128.22, 128.02, 119.49, 116.84, 61.15, 22.90, 20.70, 13.50. HRMS (ESI) m/z calcd for $\text{C}_{21}\text{H}_{21}\text{N}_3\text{O}_2$ $[\text{M} + \text{H}]^+$ 348.1707, found 348.1710.



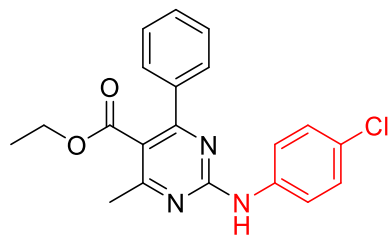
Ethyl 2-(2-fluorophenylamino)-4-methyl-6-phenylpyrimidine-5-carboxylate (3d).² Colourless oil. IR (KBr): 3322 (s), 2875 (m), 1719 (s), 1550 (s), 1385 (s), 1153 (m), 856 (s), 630 (m) cm^{-1} . ^1H NMR (400 MHz, CDCl_3) δ 8.60 (t, $J = 8.2$ Hz, 1H), 7.63-7.61 (m, 2H), 7.55 (s, 1H), 7.45-7.43 (m, 3H), 7.15-7.06 (m, 2H), 6.96 (q, $J = 6.0$ Hz, 1H), 4.11 (q, $J = 7.2$ Hz, 2H), 2.57 (s, 3H), 0.99 (t, $J = 7.2$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 168.28, 167.20, 165.70, 158.47, 153.59, 138.48, 129.67, 128.29, 128.03, 127.68, 124.22, 122.42, 120.61, 117.78, 114.61, 61.26, 22.82, 13.51. HRMS (ESI) m/z calcd for $\text{C}_{20}\text{H}_{18}\text{FN}_3\text{O}_2$ $[\text{M} + \text{H}]^+$ 352.1456, found 352.1454.



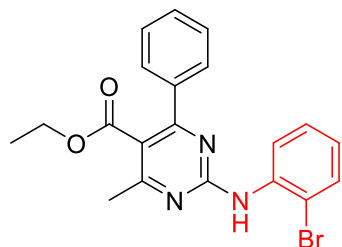
Ethyl 2-(2-chlorophenylamino)-4-methyl-6-phenylpyrimidine-5-carboxylate (3e).² Light yellow oil. IR (KBr): 3328 (s), 2969 (m), 1724 (s), 1455 (s), 1240 (m), 855 (s) cm^{-1} . ^1H NMR (400 MHz, CDCl_3) δ = 8.61 (d, J = 8.4 Hz, 1H), 7.71 (s, 1H), 7.56 (d, J = 4.8 Hz, 2H), 7.40 (s, 3H), 7.32 (d, J = 7.6 Hz, 1H), 7.21 (q, J = 8.4 Hz, 1H), 6.91 (t, J = 7.0 Hz, 1H), 4.05 (q, J = 7.2 Hz, 2H), 2.51 (s, 3H), 0.93 (t, J = 7.0 Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 168.33, 167.24, 165.72, 158.48, 138.49, 135.92, 129.77, 129.10, 128.37, 128.13, 127.39, 122.90, 122.52, 120.49, 118.07, 61.35, 22.87, 13.57. HRMS (ESI) m/z calcd for $\text{C}_{20}\text{H}_{18}\text{ClN}_3\text{O}_2$ [$\text{M} + \text{H}$]⁺ 368.1160, found 368.1163.



Ethyl 2-((3-chlorophenyl)amino)-4-methyl-6-phenylpyrimidine-5-carboxylate (3f). Brown oil. IR (KBr): 3384 (s), 2920 (m), 1720 (s), 1560 (s), 1274 (m), 1084 (s), 670 (m) cm^{-1} . ^1H NMR (600 MHz, CDCl_3) δ 7.87 – 7.85 (m, 1H), 7.80 (s, 1H), 7.65 – 7.63 (m, 2H), 7.44 – 7.40 (m, 4H), 7.19-7.16 (t, J = 7.8 Hz, 1H), 6.99-6.98 (d, J = 7.8 Hz, 1H), 4.16-4.12 (q, J = 7.2 Hz, 2H), 2.58 (s, 3H), 1.03-1.00 (t, J = 6.6 Hz, 3H); ^{13}C NMR (150 MHz, CDCl_3) δ 168.37, 167.39, 165.78, 158.56, 140.41, 138.35, 134.44, 129.89, 129.76, 128.43, 128.10, 122.55, 119.18, 117.16, 61.44, 22.98, 13.60. HRMS (ESI) m/z calcd for $\text{C}_{20}\text{H}_{18}\text{ClN}_3\text{O}_2$ [$\text{M} + \text{H}$]⁺ 368.1160, found 368.1162.

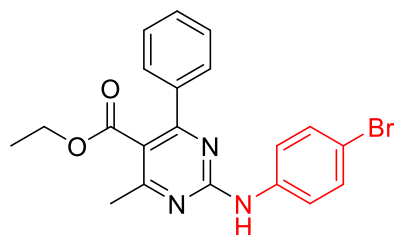


Ethyl 2-(4-chlorophenylamino)-4-methyl-6-phenylpyrimidine-5-carboxylate (3g).² Colorless oil. IR (KBr): 3285 (s), 2980 (m), 1718 (s), 1455 (s), 1248 (m), 860 (s) cm^{-1} . ^1H NMR (400 MHz, CDCl_3) δ 7.97 (s, 1H), 7.62-7.59 (m, 2H), 7.51 (d, J = 8.4 Hz, 2H), 7.41 (d, J = 5.6 Hz, 3H), 7.20 (d, J = 8.8 Hz, 2H), 4.11 (q, J = 7.2 Hz, 2H), 2.55 (s, 3H), 0.98 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 168.28, 167.24, 165.70, 158.53, 138.30, 137.63, 129.75, 128.60, 128.29, 127.95, 127.32, 120.40, 117.25, 61.30, 22.88, 13.52. HRMS (ESI) m/z calcd for $\text{C}_{20}\text{H}_{18}\text{ClN}_3\text{O}_2$ [$\text{M} + \text{H}$]⁺ 368.1160, found 368.1157.

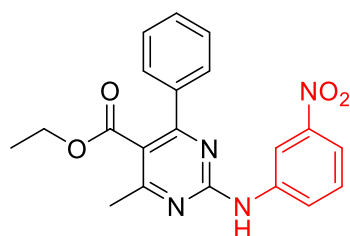


Ethyl 2-(2-bromophenylamino)-4-methyl-6-phenylpyrimidine-5-carboxylate (3h).² Light yellow oil. IR (KBr): 3235 (s), 2956 (m), 1715 (s), 1545 (m), 1365 (m), 1255 (s), 735 (m), 680 (m) cm^{-1} . ^1H NMR (400 MHz, CDCl_3) δ = 8.54 (d, J = 8.0 Hz, 1H), 7.68 (s, 1H), 7.54 (d, J = 4.8 Hz, 2H), 7.45 (d, J = 8.0 Hz, 1H), 7.36 (s, 3H), 7.22 (t, J = 7.8 Hz, 1H), 6.80 (t, J = 7.6 Hz, 1H), 4.02 (q, J = 6.8 Hz, 2H), 2.49 (s, 3H), 0.91 (t, J = 7.0 Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 168.28, 167.18, 165.60, 158.40, 138.36, 136.88, 132.31, 129.73, 128.30, 128.05, 127.96,

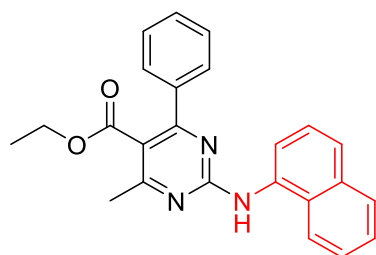
123.42, 120.71, 117.93, 113.21, 61.30, 22.84, 13.52. HRMS (ESI) m/z calcd for $C_{20}H_{18}BrN_3O_2$ $[M + H]^+$ 412.0655, found 412.0657.



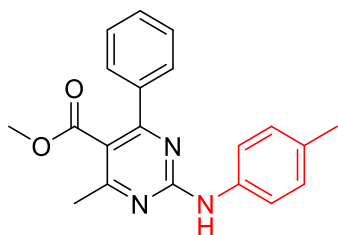
Ethyl 2-(4-bromophenylamino)-4-methyl-6-phenylpyrimidine-5-carboxylate (3i).² Yellow oil. IR (KBr): 3295 (s), 2895 (m), 1721 (s), 1560 (s), 1365 (m), 755 (m), 680 (m) cm^{-1} . 1H NMR (400 MHz, $CDCl_3$) δ 7.59-7.53 (m, 5H), 7.44-7.38 (m, 5H), 4.11 (q, $J = 6.8$ Hz, 2H), 2.56 (s, 3H), 0.99 (t, $J = 6.8$ Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.31, 167.28, 165.76, 158.48, 138.40, 137.64, 131.70, 129.79, 128.36, 128.00, 120.75, 117.54, 114.99, 61.34, 22.91, 13.54. HRMS (ESI) m/z calcd for $C_{20}H_{18}BrN_3O_2$ $[M + H]^+$ 412.0655, found 412.0657.



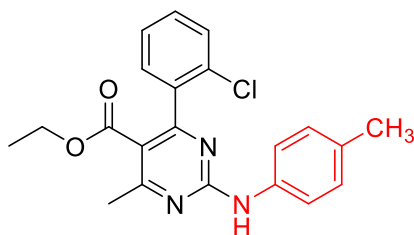
Ethyl 4-methyl-2-((3-nitrophenyl)amino)-6-phenylpyrimidine-5-carboxylate (3j). Yellow oil. IR (KBr): 3325 (s), 2869 (m), 1718 (s), 1560 (s), 1557 (s), 1456 (m), 1355 (s), 788 (s) cm^{-1} . 1H NMR (600 MHz, $CDCl_3$) δ 8.95 (s, 1H), 7.89-7.88 (d, $J = 7.8$ Hz, 1H), 7.81-7.80 (d, $J = 7.8$ Hz, 1H), 7.68-7.67 (d, $J = 4.2$ Hz, 2H), 7.55 (s, 1H), 7.48-7.45 (m, 4H), 4.16-4.13 (q, $J = 7.2$ Hz, 2H), 2.60 (s, 3H), 1.03 (t, $J = 7.1$ Hz, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 168.17, 167.52, 165.72, 158.19, 148.79, 140.39, 138.05, 130.11, 129.49, 128.51, 128.13, 124.30, 117.11, 113.77, 113.18, 61.55, 22.93, 13.58. HRMS (ESI) m/z calcd for $C_{20}H_{19}N_4O_4$ $[M + H]^+$ 379.1401, found 379.1403.



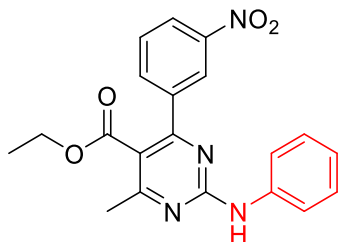
Ethyl 4-methyl-2-(naphthalen-2-ylamino)-6-phenylpyrimidine-5-carboxylate (3k).² Brown oil. IR (KBr): 3316 (s), 2975 (m), 1716 (s), 1554 (s), 1382 (s), 1048 (m), 885 (s) cm^{-1} . 1H NMR (400 MHz, $CDCl_3$) δ 8.18 (d, $J = 7.6$ Hz, 1H), 8.01 (d, $J = 4.4$ Hz, 1H), 7.86 (s, 1H), 7.79 (s, 1H), 7.65 (d, $J = 8.0$ Hz, 1H), 7.58 (d, $J = 5.2$ Hz, 2H), 7.49 (s, 3H), 7.40 (s, 3H), 4.10 (q, $J = 7.2$ Hz, 2H), 2.53 (s, 3H), 0.99 (t, $J = 7.0$ Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.49, 167.35, 165.88, 159.80, 138.58, 134.19, 133.80, 129.56, 128.58, 128.21, 128.03, 127.22, 125.89, 125.79, 125.67, 124.43, 121.05, 119.17, 117.22, 61.20, 22.88, 13.53. HRMS (ESI) m/z calcd for $C_{24}H_{21}N_3O_2$ $[M + H]^+$ 384.1707, found 384.1710.



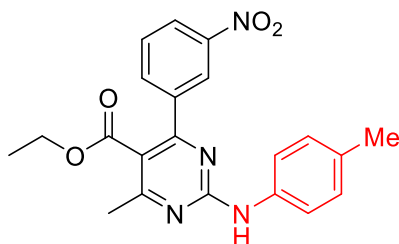
Methyl 4-methyl-6-phenyl-2-(p-tolylamino)pyrimidine-5-carboxylate (3l). Yellow oil. IR (KBr): 3323 (s), 2980 (m), 1715 (s), 1552 (s), 1380 (s), 1165 (m), 1045 (s), 580 (m) cm^{-1} . ^1H NMR (600 MHz, CDCl_3) δ 7.62-7.61 (m, 2H), 7.56 (d, $J = 7.8$ Hz, 2H), 7.47-7.42 (m, 3H), 7.25 (s, 1H), 7.14 (d, $J = 7.8$ Hz, 2H), 3.62 (s, 3H), 2.54 (s, 3H), 2.32 (s, 3H); ^{13}C NMR (150 MHz, CDCl_3) δ 169.13, 167.29, 165.69, 158.88, 138.59, 136.46, 132.44, 129.77, 129.41, 128.39, 127.97, 119.48, 52.10, 22.99, 20.78. HRMS (ESI) m/z calcd for $\text{C}_{20}\text{H}_{20}\text{N}_3\text{O}_2$ [$\text{M} + \text{H}$] $^+$ 334.1550, found 334.1553.



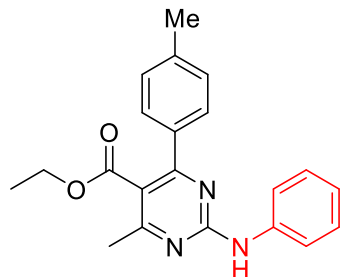
Ethyl 4-(2-chlorophenyl)-6-methyl-2-(p-tolylamino)pyrimidine-5-carboxylate (3m). Yellow oil. IR (KBr): 3323 (s), 2973 (m), 1715 (s), 1655 (s), 1450 (s), 1250 (m), 850 (s) cm^{-1} . ^1H NMR (600 MHz, CDCl_3) δ 7.54 (d, $J = 7.2$ Hz, 2H), 7.43 (d, $J = 7.8$ Hz, 1H), 7.34-7.32 (m, 4H), 7.13 (d, $J = 8.4$ Hz, 2H), 4.01 (q, $J = 7.2$ Hz, 2H), 2.66 (s, 3H), 2.32 (s, 3H), 0.88 (t, $J = 7.2$ Hz, 3H); ^{13}C NMR (150 MHz, CDCl_3) δ 169.04, 166.61, 165.85, 158.66, 138.71, 136.18, 132.69, 131.89, 129.69, 129.56, 129.42, 129.37, 128.04, 126.57, 119.57, 119.47, 116.93, 77.22, 77.00, 76.79, 60.86, 24.08, 20.79, 13.38, 1.01, -0.02. HRMS (ESI) m/z calcd for $\text{C}_{21}\text{H}_{21}\text{ClN}_3\text{O}_2$ [$\text{M} + \text{H}$] $^+$ 382.1317, found 382.1315.



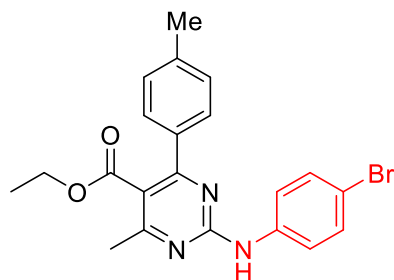
Ethyl 4-methyl-6-(3-nitrophenyl)-2-(phenylamino)pyrimidine-5-carboxylate (3n).² Light yellow oil IR (KBr): 3120 (s), 2868 (m), 1714 (s), 1565 (s), 1552 (s), 1456 (s), 1360 (s), 780 (s) cm^{-1} . ^1H NMR (400 MHz, CDCl_3) δ 8.45 (s, 1H), 8.24 (d, $J = 7.6$ Hz, 1H), 7.86 (d, $J = 7.6$ Hz, 1H), 7.57 (m, 3H), 7.34 (s, 1H), 7.28 (t, $J = 7.6$ Hz, 2H), 7.01 (t, $J = 7.2$ Hz, 1H), 4.10 (q, $J = 6.8$ Hz, 2H), 2.52 (s, 3H), 1.02 (t, $J = 7.0$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 168.19, 167.68, 163.26, 158.82, 148.19, 140.25, 138.69, 134.06, 129.31, 128.97, 124.27, 123.37, 123.25, 119.50, 117.00, 61.59, 23.24, 13.72. HRMS (ESI) m/z calcd for $\text{C}_{20}\text{H}_{18}\text{N}_4\text{O}_4$ [$\text{M} + \text{H}$] $^+$ 379.1401, found 379.1403.



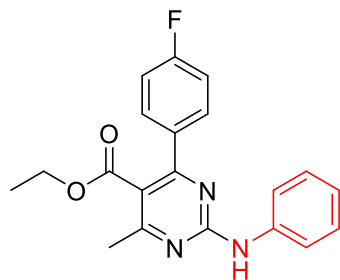
Ethyl 4-methyl-6-(3-nitrophenyl)-2-(p-tolylamino)pyrimidine-5-carboxylate (3o).² Yellow solid, m.p. = 126-128 °C. IR (KBr):3315 (s), 2970 (m), 1720 (s), 1565 (s), 1558 (s), 1459 (m), 1345 (s), 780 (s) cm⁻¹. ¹H NMR (400 MHz, CDCl₃) δ 8.41 (s, 1H), 8.19 (d, *J* = 7.2 Hz, 1H), 7.83 (d, *J* = 7.2 Hz, 1H), 7.51 (d, *J* = 8.0 Hz, 1H), 7.47 (d, *J* = 7.2 Hz, 1H), 7.41 (d, *J* = 8.0 Hz, 2H), 7.04 (d, *J* = 8.0 Hz, 2H), 4.08 (q, *J* = 7.2 Hz, 2H), 2.49 (s, 3H), 2.23 (s, 3H), 0.99 (t, *J* = 7.0 Hz, 3H); ¹³C NMR (100 MHz, CDCl₃) δ 168.12, 167.68, 163.22, 158.88, 148.07, 140.24, 135.97, 134.00, 132.85, 129.36, 129.18, 124.13, 123.30, 119.75, 116.53, 61.46, 23.19, 20.70, 13.65. HRMS (ESI) *m/z* calcd for C₂₁H₂₀N₄O₄ [M + H]⁺ 393.1557, found 393.1559.



Ethyl 4-methyl-2-(phenylamino)-6-(p-tolyl)pyrimidine-5-carboxylate (3p).² Colourless oil. IR (KBr):3325 (s), 2973 (m), 1710 (s), 1652 (s), 1456 (s), 1253 (m), 880 (s) cm⁻¹. ¹H NMR (400 MHz, CDCl₃) δ 7.68 (d, *J* = 9.6 Hz, 1H), 7.63 (d, *J* = 8.0 Hz, 2H), 7.55-7.53 (m, 2H), 7.31-7.27 (m, 2H), 7.22 (d, *J* = 7.2 Hz, 2H), 7.02 (d, *J* = 6.8 Hz, 1H), 4.17-4.11 (m, 2H), 2.54 (s, 3H), 2.37 (s, 3H), 1.04 (t, *J* = 7.0 Hz, 3H); ¹³C NMR (100 MHz, CDCl₃) δ 168.66, 166.89, 165.53, 158.73, 139.86, 139.14, 135.61, 128.96, 128.72, 128.01, 122.52, 119.16, 116.94, 61.21, 22.85, 21.28, 13.58. HRMS (ESI) *m/z* calcd for C₂₁H₂₁N₃O₂ [M + H]⁺ 348.1707, found 348.1710.

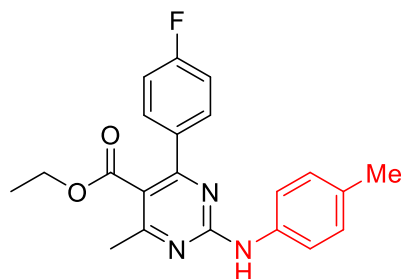


Ethyl 2-(4-bromophenylamino)-4-methyl-6-p-tolylpyrimidine-5-carboxylate (3q).² White solid, m.p. = 115-117 °C. IR (KBr):3335 (s), 2960 (m), 1716 (s), 1558 (s), 1368 (m), 1255 (s), 746 (m), 695 (m) cm⁻¹. ¹H NMR (400 MHz, CDCl₃) δ 7.80 (s, 1H), 7.49 (t, *J* = 9.8 Hz, 4H), 7.36 (d, *J* = 8.8 Hz, 2H), 7.21 (d, *J* = 6.8 Hz, 2H), 4.15 (q, *J* = 7.2 Hz, 2H), 2.53 (s, 3H), 2.38 (s, 3H), 1.05 (t, *J* = 7.0 Hz, 3H); ¹³C NMR (100 MHz, CDCl₃) δ 168.52, 166.98, 165.52, 158.50, 140.08, 138.26, 135.38, 131.57, 129.03, 127.99, 120.75, 117.32, 114.82, 61.33, 22.85, 21.31, 13.61. HRMS (ESI) *m/z* calcd for C₂₁H₂₀BrN₃O₂ [M + H]⁺ 426.0812, found 426.0815.

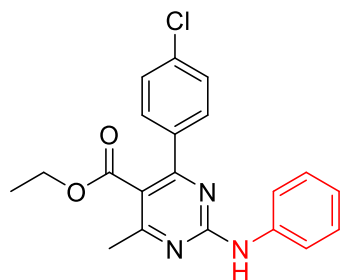


Ethyl 4-(4-fluorophenyl)-6-methyl-2-(phenylamino)pyrimidine-5-carboxylate (3r).² White solid, m.p. = 127-129 °C. IR (KBr):3320 (s), 2985 (m), 1718 (s), 1556 (s), 1385 (s), 1153 (m), 850 (s), 620 (m) cm⁻¹. ¹H NMR (400 MHz, CDCl₃) δ 7.54 (d, *J* = 7.2 Hz, 5H), 7.22 (t, *J* = 7.6 Hz, 2H), 7.02 (t, *J* = 8.4 Hz, 2H), 6.95 (t, *J* = 7.2 Hz, 1H), 4.05

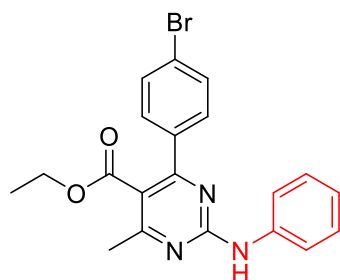
(q, $J = 7.2$ Hz, 2H), 2.46 (s, 3H), 0.96 (t, $J = 7.0$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3): δ 168.34, 167.30, 164.70, 162.43, 158.72, 138.98, 134.64, 130.10, 128.79, 122.78, 119.29, 116.93, 115.32, 61.30, 22.90, 13.61. HRMS (ESI) m/z calcd for $\text{C}_{20}\text{H}_{18}\text{FN}_3\text{O}_2$ $[\text{M} + \text{H}]^+$ 352.1456, found 352.1459.



Ethyl 4-(4-fluorophenyl)-6-methyl-2-(p-tolylamino)pyrimidine-5-carboxylate (3s).² Brown oil. IR (KBr): 3320 (s), 2875 (m), 1715 (s), 1558 (s), 1457 (s), 1150 (m), 859 (s), 633 (m) cm^{-1} . ^1H NMR (400 MHz, CDCl_3) δ 7.53 (t, $J = 6.8$ Hz, 2H), 7.43 (d, $J = 8.4$ Hz, 2H), 7.38 (s, 1H), 7.03 (t, $J = 8.2$ Hz, 4H), 4.05 (q, $J = 7.2$ Hz, 2H), 2.45 (s, 3H), 2.23 (s, 3H), 0.97 (t, $J = 7.0$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 168.42, 167.30, 164.72, 162.43, 158.82, 136.37, 134.77, 132.45, 130.10, 129.32, 119.56, 116.69, 115.30, 61.25, 22.93, 20.71, 13.63. HRMS (ESI) m/z calcd for $\text{C}_{21}\text{H}_{21}\text{FN}_3\text{O}_2$ $[\text{M} + \text{H}]^+$ 366.1612, found 366.1614.

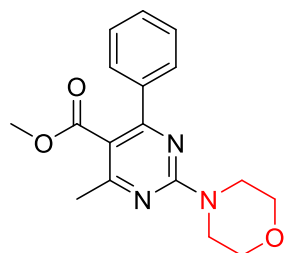


Ethyl 4-(4-chlorophenyl)-6-methyl-2-(phenylamino)pyrimidine-5-carboxylate (3t).² White solid, m.p. = 129-131 $^\circ\text{C}$. IR (KBr): 3210 (s), 2976 (m), 1714 (s), 1545 (m), 1376 (s), 1243 (s), 750 (m), 520 (m) cm^{-1} . ^1H NMR (400 MHz, CDCl_3) δ 7.59 (d, $J = 7.6$ Hz, 2H), 7.49 (d, $J = 8.0$ Hz, 2H), 7.35-7.32 (m, 3H), 7.26 (t, $J = 7.6$ Hz, 2H), 6.98 (t, $J = 7.2$ Hz, 1H), 4.07 (q, $J = 6.8$ Hz, 2H), 2.48 (s, 3H), 0.99 (t, $J = 7.2$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3): δ 168.24, 167.48, 164.51, 158.74, 138.98, 137.08, 135.94, 129.49, 128.90, 128.57, 122.91, 119.30, 117.03, 61.41, 22.99, 13.68. HRMS (ESI) m/z calcd for $\text{C}_{20}\text{H}_{18}\text{ClN}_3\text{O}_2$ $[\text{M} + \text{H}]^+$ 368.1160, found 368.1158.

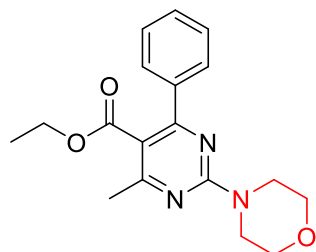


Ethyl 4-(4-bromophenyl)-6-methyl-2-(phenylamino)pyrimidine-5-carboxylate (3u).² White solid, m.p. = 123-125 $^\circ\text{C}$. IR (KBr): 3230 (s), 2965 (m), 1720 (s), 1550 (m), 1368 (m), 1250 (s), 740 (m), 690 (m) cm^{-1} . ^1H NMR (400 MHz, CDCl_3) δ 7.67 (s, 1H), 7.50 (d, $J = 7.6$ Hz, 2H), 7.44 (d, $J = 8.4$ Hz, 2H), 7.38 (d, $J = 8.4$ Hz, 2H), 7.19 (t, $J = 7.6$ Hz, 2H), 6.93 (t, $J = 6.8$ Hz, 1H), 4.03 (q, $J = 7.2$ Hz, 2H), 2.44 (s, 3H), 0.95 (t, $J = 7.0$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 168.13, 167.43, 164.49, 158.74, 138.90, 137.45, 131.41, 129.67, 128.75, 124.16,

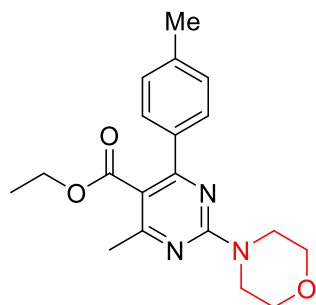
122.81, 119.32, 116.80, 61.32, 22.92, 13.59. HRMS (ESI) m/z calcd for $C_{20}H_{18}BrN_3O_2$ $[M + H]^+$ 412.0655, found 412.0657.



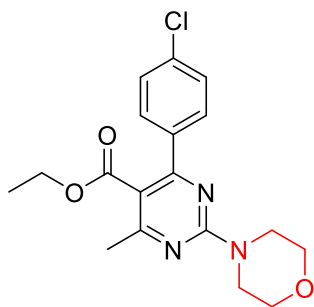
Methyl 4-methyl-2-morpholino-6-phenylpyrimidine-5-carboxylate (5a).³ Colorless oil. IR (KBr): 2952 (w), 1718 (vs), 1638 (s), 1560 (s), 1490 (s), 1458 (s), 1068 (s), 1024 (m), 766 (vw) cm^{-1} . 1H NMR (400 MHz, $CDCl_3$) δ 7.59–7.58 (m, 2H), 7.41 (d, $J = 4.8$ Hz, 3H), 3.93–3.91 (m, 4H), 3.76–3.74 (m, 4), 3.58 (s, 3H), 2.49 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 169.51, 167.05, 165.41, 160.29, 139.17, 129.54, 128.19, 128.00, 114.19, 66.84, 51.86, 44.13, 23.16. HRMS (ESI) m/z calcd for $C_{17}H_{19}N_3O_3$ $[M + H]^+$ 314.1499, found 314.1497.



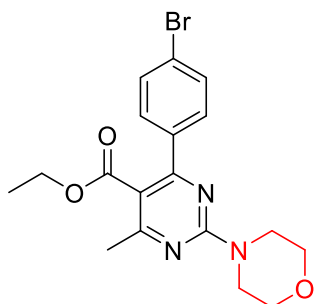
Ethyl 4-methyl-2-morpholino-6-phenylpyrimidine-5-carboxylate (5b).³ White solid, m.p. = 118–119 °C. IR (KBr): 2964 (w), 1718 (vs), 1560 (s), 1512 (s), 1492 (s), 1444 (s), 1232 (s), 690 (vw), 576 (vw) cm^{-1} . 1H NMR (400 MHz, $CDCl_3$) δ 7.58–7.40 (m, 5 H), 4.08–4.03 (m, 2 H), 3.94–3.92 (m, 4 H), 3.76 (t, $J = 4.80$ Hz, 4 H), 2.50 (s, 3 H), 0.95 (t, $J = 7.60$ Hz, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.96, 167.03, 165.66, 160.20, 139.30, 129.46, 128.16, 128.06, 114.48, 66.87, 60.99, 44.10, 23.14, 13.54. HRMS (ESI) m/z calcd for $C_{18}H_{21}N_3O_3$ $[M + H]^+$ 328.1656, found 326.1658.



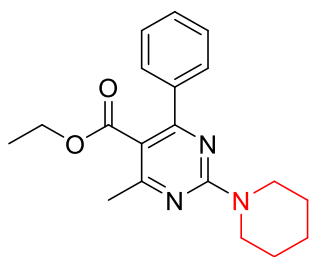
Ethyl 4-Methyl-2-morpholino-6-(p-tolyl)pyrimidine-5-carboxylate (5c).³ White solid, mp 68–70 °C. IR (KBr): 2964 (s), 1716 (vs), 1584 (s), 1560 (vs), 1510 (s), 1448 (m), 1234 (s), 1016 (s), 796 (s), 594 (m) cm^{-1} . 1H NMR (400 MHz, $CDCl_3$) δ 7.49 (d, $J = 8.00$ Hz, 2H), 7.22 (d, $J = 8.00$ Hz, 2H), 4.12–4.07 (m, 2H), 3.92 (t, $J = 4.40$ Hz, 4H), 3.75 (t, $J = 4.40$ Hz, 4H), 2.48 (s, 3H), 2.38 (s, 3H), 1.01 (t, $J = 6.80$ Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.16, 166.74, 165.43, 160.22, 139.64, 136.36, 128.86, 128.03, 114.45, 66.86, 60.98, 44.12, 23.04, 21.29, 13.61. HRMS (ESI) m/z calcd for $C_{19}H_{23}N_3O_3$ $[M + H]^+$ 342.1812, found 342.1815.



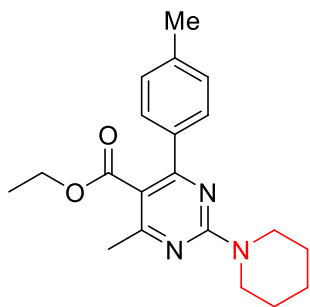
Ethyl 4-(4-Chlorophenyl)-6-methyl-2-morpholinopyrimidine-5-carboxylate (5d).³ White solid, mp 80–83 °C. IR (KBr): 2950 (w), 1715 (vs), 1605 (s), 1580 (s), 1490 (s), 1454 (s), 1050 (s), 1025 (m), 830 (s), 650 (s), 540 (s) cm⁻¹. ¹H NMR (400 MHz, CDCl₃) δ 7.52–7.37 (m, 4H), 4.12–4.07 (m, 2H), 3.92 (t, J = 5.6 Hz, 4H), 3.76 (t, J = 5.20 Hz, 4H), 2.50 (s, 3H), 1.02 (t, J = 7.60 Hz, 3 H); ¹³C NMR (100 MHz, CDCl₃) δ 168.68, 167.23, 164.45, 160.04, 137.70, 135.65, 129.47, 128.40, 114.27, 66.82, 61.14, 44.10, 23.17, 13.65. HRMS (ESI) m/z calcd for C₁₈H₂₀ClN₃O₃ [M + H]⁺ 362.1266, found 362.1268.



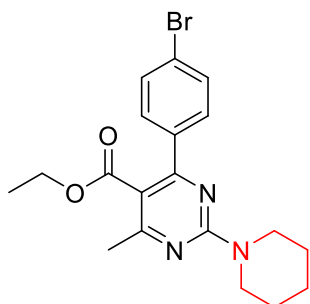
Ethyl 4-(4-Bromophenyl)-6-methyl-2-morpholinopyrimidine-5-carboxylate (5e).³ white solid, mp 92–93 °C. IR (KBr): 2950 (w), 1718 (vs), 1596 (s), 1575 (s), 1482 (s), 1456 (s), 1034 (m), 650 (s), 585 (s) cm⁻¹. ¹H NMR (400 MHz, CDCl₃) δ 7.55–7.43 (m, 4H), 4.12–4.06 (m, 2H), 3.91 (t, J = 4.4 Hz, 4H), 3.75 (t, J = 4.8 Hz, 4H), 2.49 (s, 3H), 1.02 (t, J = 6.8 Hz, 3H); ¹³C NMR (100 MHz, CDCl₃) δ 168.65, 167.30, 164.53, 160.11, 138.25, 131.35, 129.75, 123.95, 114.28, 66.83, 61.12, 44.15, 23.17, 13.66. HRMS (ESI) m/z calcd for C₁₈H₂₀BrN₃O₃ [M + H]⁺ 406.0761, found 406.0759.



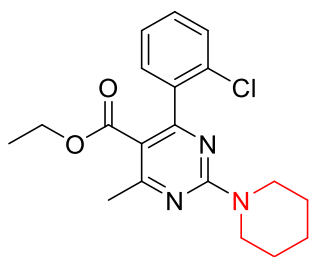
Ethyl 4-Methyl-6-phenyl-2-(piperidin-1-yl)pyrimidine-5-carboxylate (5f).³ White solid, mp 69–70 °C. IR (KBr): 2950 (w), 1715 (vs), 1565 (s), 1550 (s), 1495 (s), 1450 (s), 1270 (s), 1164 (m) cm⁻¹. ¹H NMR (400 MHz, CDCl₃) δ 7.58–7.56 (m, 2H), 7.42–7.38 (m, 3H), 4.06–4.01 (m, 2H), 3.89 (t, J = 5.60 Hz, 4H), 2.49 (s, 3H), 1.68–1.60 (m, 6H), 0.93 (t, J = 7.2 Hz, 3H); ¹³C NMR (100 MHz, CDCl₃) δ 169.20, 166.91, 165.73, 160.15, 139.75, 129.20, 128.06, 113.18, 60.77, 44.64, 25.84, 24.83, 23.20, 13.51. HRMS (ESI) m/z calcd for C₁₉H₂₃N₃O₂ [M + H]⁺ 326.1863, found 326.1865.



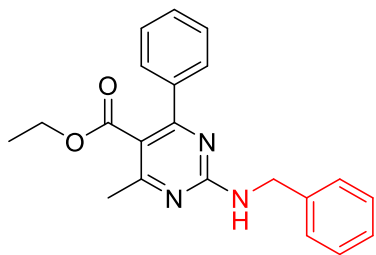
Ethyl 4-Methyl-2-(piperidin-1-yl)-6-(p-tolyl)pyrimidine-5-carboxylate (5g).³ White solid, mp 68–69 °C. IR (KBr): 2925 (w), 1718 (vs), 1598 (s), 1568 (s), 1540 (s), 1230 (s), 1063 (s) cm^{-1} . ^1H NMR (400 MHz, CDCl_3) δ 7.47 (d, $J = 8.0$ Hz, 2H), 7.19 (d, $J = 8.0$ Hz, 2H), 4.10–4.04 (m, 2H), 3.88 (t, $J = 5.2$ Hz, 4H), 2.47 (s, 3H), 2.38 (s, 3H), 1.67–1.59 (m, 6H), 0.99 (t, $J = 7.2$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) $\delta = 169.42, 166.61, 165.52, 139.35, 136.83, 128.77, 128.08, 60.79, 44.67, 25.85, 24.87, 23.19, 21.32, 13.63$. HRMS (ESI) m/z calcd for $\text{C}_{20}\text{H}_{25}\text{N}_3\text{O}_2$ $[\text{M} + \text{H}]^+$ 340.2020, found 340.2023.



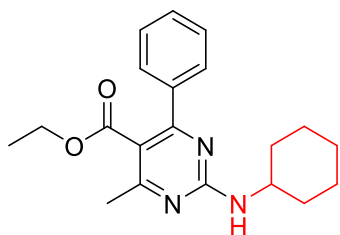
Ethyl 4-(4-Bromophenyl)-6-methyl-2-(piperidin-1-yl)pyrimidine-5-carboxylate (5h).³ White solid, mp 61–62 °C. IR (KBr): 2928 (w), 1714 (vs), 1578 (s), 1558 (s), 1510 (s), 1458 (s), 1064 (s), 645 (m), 573 (s) cm^{-1} . ^1H NMR (400 MHz, CDCl_3) δ 7.52 (d, $J = 8.4$ Hz, 2 H), 7.43 (d, $J = 8.0$ Hz, 2 H), 4.09–4.04 (m, 2 H), 3.88 (t, $J = 5.2$ Hz, 4 H), 2.49 (s, 3 H), 1.68–1.60 (m, 6 H), 1.00 (t, $J = 7.2$ Hz, 3 H); ^{13}C NMR (100 MHz, CDCl_3) δ 168.89, 167.21, 164.59, 160.04, 138.70, 131.21, 129.76, 123.67, 60.89, 44.67, 25.85, 24.82, 23.29, 13.66. HRMS (ESI) m/z calcd for $\text{C}_{19}\text{H}_{22}\text{N}_3\text{O}_2$ $[\text{M} + \text{H}]^+$ 404.0968, found 404.0966.



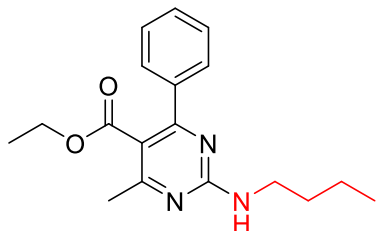
Ethyl 4-(2-Chlorophenyl)-6-methyl-2-(piperidin-1-yl)pyrimidine-5-carboxylate (5i).³ colorless oil. IR (KBr): 2932 (s), 1716 (vs), 1560 (s), 1542 (s), 1510 (s), 1458 (s), 1092 (s), 1066 (s), 806 (s), 760 (s), 574 (s) cm^{-1} . ^1H NMR (600 MHz, CDCl_3): δ 7.38–7.37 (m, 1H), 7.28 (d, $J = 2.4$ Hz, 3H), 3.94 (q, $J = 4.8$ Hz, 2H), 3.85 (t, $J = 3.6$ Hz, 4H), 2.58 (s, 3H), 1.68–1.56 (m, 6H), 0.83 (t, $J = 4.8$ Hz, 3H); ^{13}C NMR (150 MHz, CDCl_3) δ 168.54, 167.20, 165.69, 159.97, 139.89, 131.94, 129.72, 129.17, 129.15, 126.34, 113.07, 60.34, 44.70, 25.82, 24.80, 24.40, 13.38. HRMS (ESI) m/z calcd for $\text{C}_{19}\text{H}_{22}\text{ClN}_3\text{O}_2$ $[\text{M} + \text{H}]^+$ 360.1473, found 360.1475.



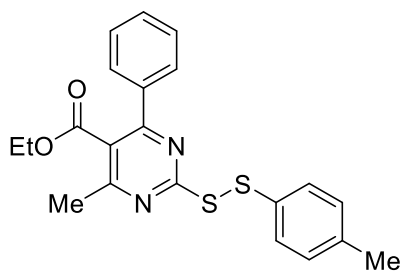
Ethyl 2-(Benzylamino)-4-methyl-6-phenylpyrimidine-5-carboxylate (5j).³ Colorless oil. IR (KBr): 3252 (vs), 1716 (vs), 1598 (s), 1560 (s), 1532 (s), 1448 (s), 1256 (vs), 1166 (w), 1080 (vs), 1026 (s), 770 (s) cm^{-1} . ^1H NMR (600 MHz, CDCl_3) δ 7.54 (d, $J = 4.4$ Hz, 2H), 7.41–7.39 (m, 3H), 7.32–7.30 (m, 4H), 7.26–7.25 (m, 1H), 6.12 (s, 1H), 4.66 (d, $J = 4.0$ Hz, 2H), 4.06 (q, $J = 4.8$ Hz, 2H), 2.48 (s, 3H), 0.95 (t, $J = 4.4$ Hz, 3H); ^{13}C NMR (150 MHz, CDCl_3) δ 168.80, 161.12, 139.10, 129.43, 128.49, 128.31, 128.19, 128.05, 128.00, 127.80, 127.52, 127.16, 115.51, 61.03, 45.25, 22.69, 13.55. HRMS (ESI) m/z calcd for $\text{C}_{21}\text{H}_{21}\text{N}_3\text{O}_2$ [$\text{M} + \text{H}$]⁺ 348.1707, found 348.1710.



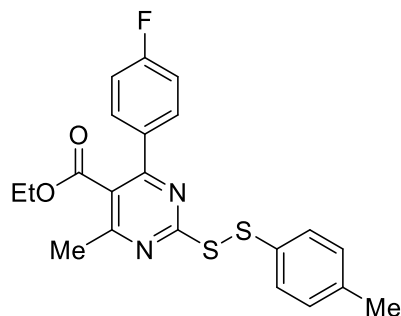
Ethyl 2-(cyclohexylamino)-4-methyl-6-phenylpyrimidine-5-carboxylate (5k). Brown oil. IR (KBr): 3372 (s), 2924 (m), 1718 (s), 1560 (s), 1448 (m), 1378 (s), 830 (s) cm^{-1} . ^1H NMR (600 MHz, CDCl_3) δ 7.54 (s, 2H), 7.41 (s, 3H), 5.23 (s, 1H), 4.04 (q, $J = 7.2$ Hz, 2H), 3.98–3.94 (m, 1H), 2.47 (s, 3H), 2.04 (d, $J = 9.0$ Hz, 3H), 1.74 (d, $J = 13.8$ Hz, 3H), 1.62 (d, $J = 12.0$ Hz, 2H), 1.41 (q, $J = 11.4$ Hz, 2H), 0.94 (t, $J = 7.2$ Hz, 3H); ^{13}C NMR (150 MHz, CDCl_3) δ 160.56, 139.35, 129.29, 128.16, 127.91, 60.91, 49.48, 33.05, 25.69, 24.70. HRMS (ESI) m/z calcd for $\text{C}_{20}\text{H}_{25}\text{N}_3\text{O}_2$ [$\text{M} + \text{H}$]⁺ 330.2020, found 340.2023.



Ethyl 2-(Butylamino)-4-methyl-6-phenylpyrimidine-5-carboxylate (5l).³ White solid, mp 76–78 $^{\circ}\text{C}$. IR (KBr): 3242 (vs), 1715 (vs), 1598 (s), 1570 (s), 1512 (s), 1446 (s), 1250 (s), 1085 (vs), 1028 (s), 775 (s) cm^{-1} . ^1H NMR (400 MHz, CDCl_3) δ 7.55 (s, 2H), 7.42 (s, 3H), 5.53 (s, 1H), 4.04 (q, $J = 7.2$ Hz, 2H), 3.47 (q, $J = 6.4$ Hz, 2H), 2.49 (s, 3H), 1.61–1.54 (m, 2H), 1.44–1.35 (m, 2H), 0.94 (t, $J = 7.2$ Hz, 6H); ^{13}C NMR (100 MHz, CDCl_3) δ 168.80, 166.11, 161.19, 139.28, 139.25, 129.27, 128.11, 127.90, 114.94, 60.88, 40.98, 31.68, 19.97, 13.78, 13.74, 13.49. HRMS (ESI) m/z calcd for $\text{C}_{18}\text{H}_{23}\text{N}_3\text{O}_2$ [$\text{M} + \text{H}$]⁺ 314.1863, found 314.1865.



Ethyl 4-methyl-6-phenyl-2-(p-tolyldisulfanyl)pyrimidine-5-carboxylate (6a). Colorless oil. IR (KBr): 2964 (w), 1718 (s), 1560 (s), 1512 (s), 1492 (s), 1444 (s), 1260 (s), 1232 (s), 690 (w), 576 (w) cm^{-1} . ^1H NMR (400 MHz, CDCl_3) δ 7.54 (d, $J = 6.0$ Hz, 2H), 7.48 – 7.33 (m, 5H), 7.01 (d, $J = 8.0$ Hz, 2H), 4.09 (q, $J = 7.2$ Hz, 2H), 2.51 (s, 3H), 2.23 (s, 3H), 0.97 (t, $J = 7.2$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 170.67, 167.85, 166.36, 164.19, 138.34, 137.23, 130.66, 130.37, 129.72, 128.50, 122.59, 61.93, 22.68, 21.17, 13.66. HRMS (ESI) m/z calcd for $\text{C}_{21}\text{H}_{20}\text{N}_2\text{O}_2\text{S}_2$ $[\text{M} + \text{H}]^+$ 397.1039, found 397.1041.



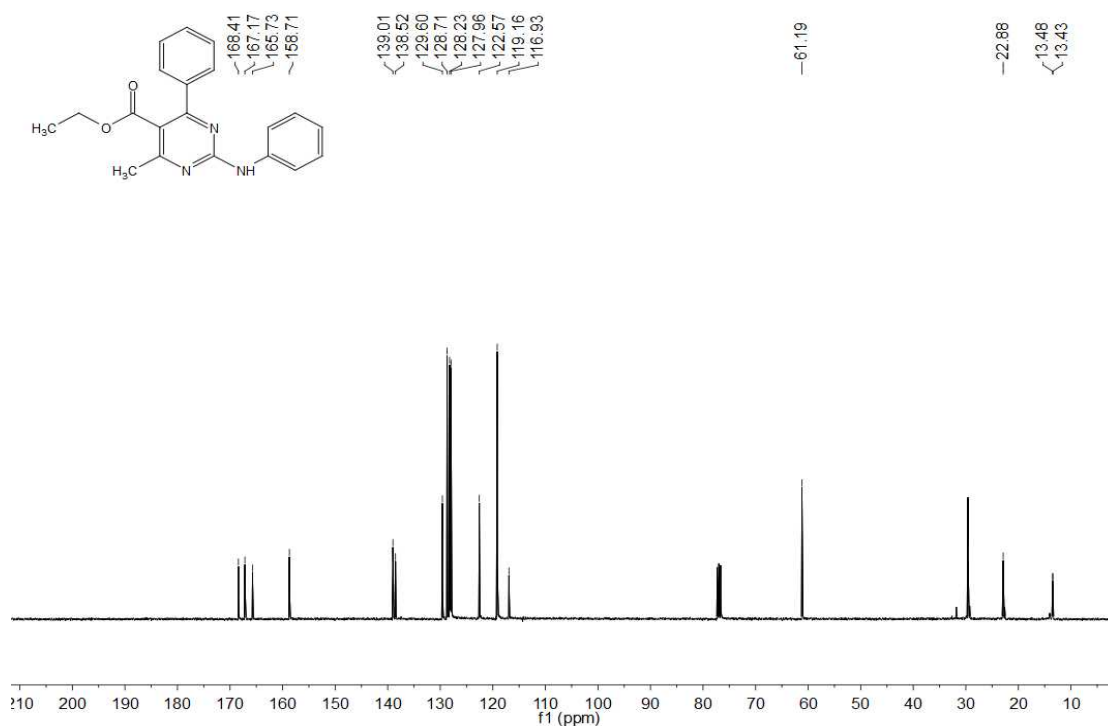
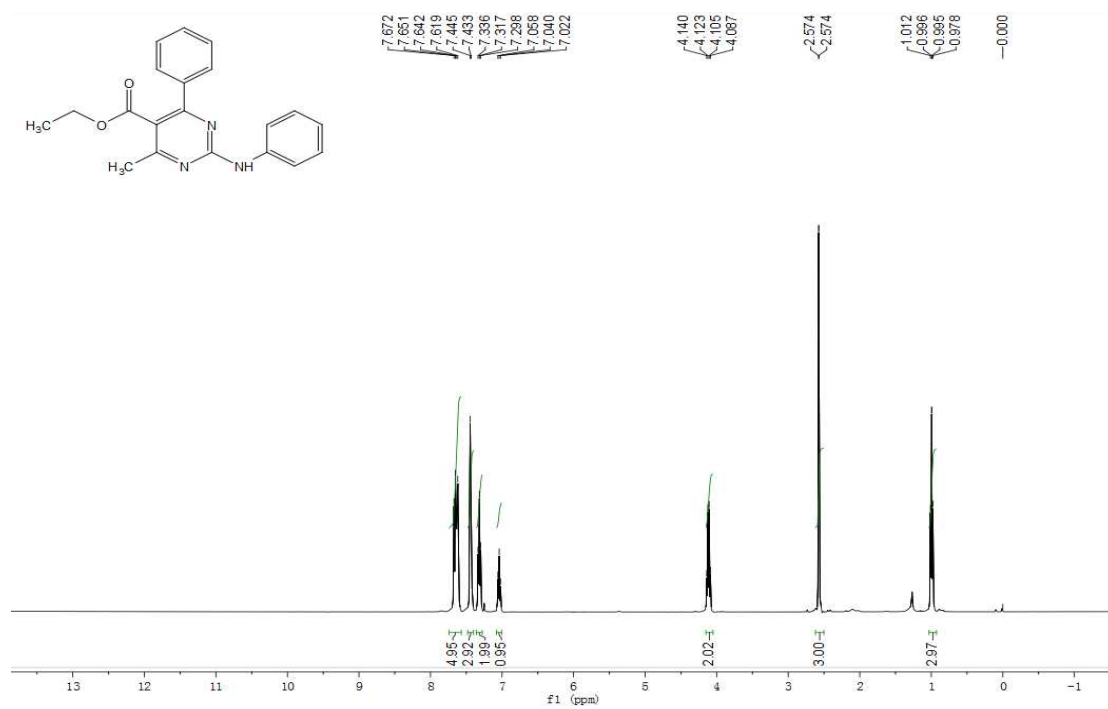
Ethyl 4-(4-fluorophenyl)-6-methyl-2-(p-tolyldisulfanyl)pyrimidine-5-carboxylate (6b). Colorless oil. IR (KBr): 2950 (w), 1710 (s), 1560 (s), 1480 (s), 1440 (s), 1300 (s), 1270 (s), 1220 (s), 730 (w), 680 (w), 570 (w) cm^{-1} . ^1H NMR (400 MHz, CDCl_3) δ 7.57 (d, $J = 8.8$ Hz, 2H), 7.46 (d, $J = 8.0$ Hz, 2H), 7.09 – 6.95 (m, 4H), 4.14 (q, $J = 7.2$ Hz, 2H), 2.52 (s, 3H), 2.25 (s, 3H), 1.05 (t, $J = 7.2$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 170.72, 167.80, 166.44, 162.84, 138.35, 133.09, 132.10, 130.50, 129.73, 122.36, 115.78, 62.02, 22.66, 21.15, 13.74. HRMS (ESI) m/z calcd for $\text{C}_{21}\text{H}_{19}\text{FN}_2\text{O}_2\text{S}_2$ $[\text{M} + \text{H}]^+$ 415.0945, found 415.0948.

3. Reference

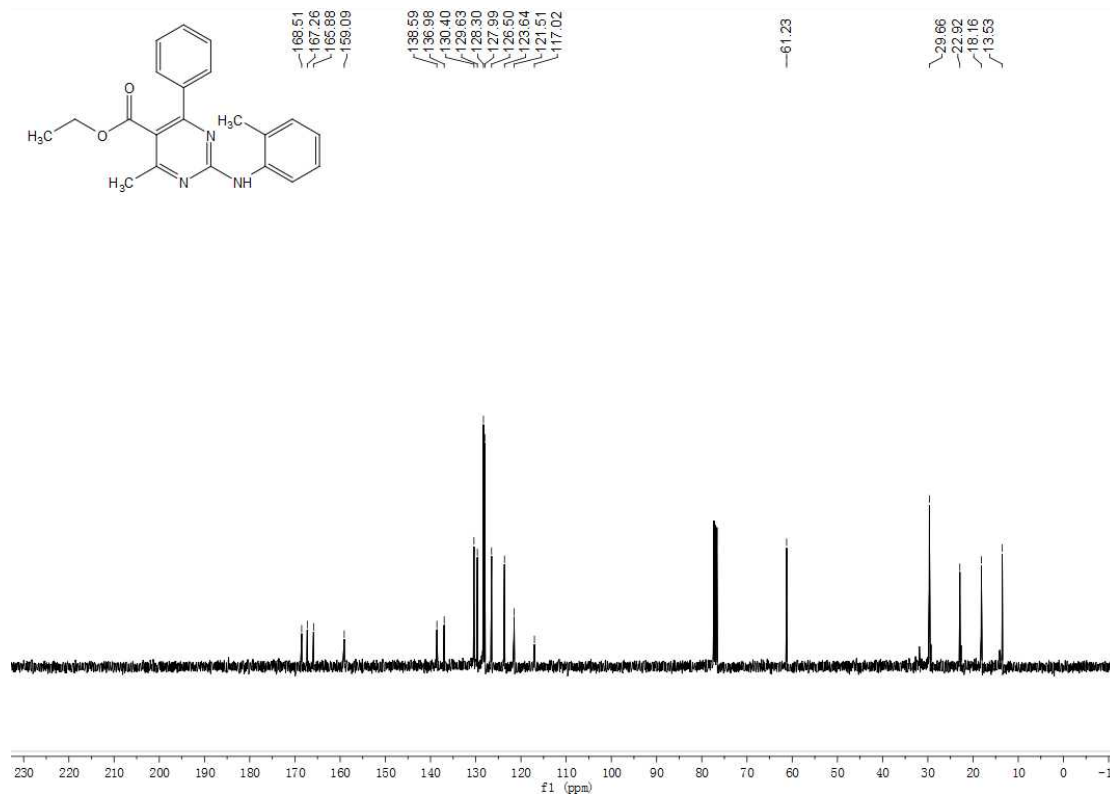
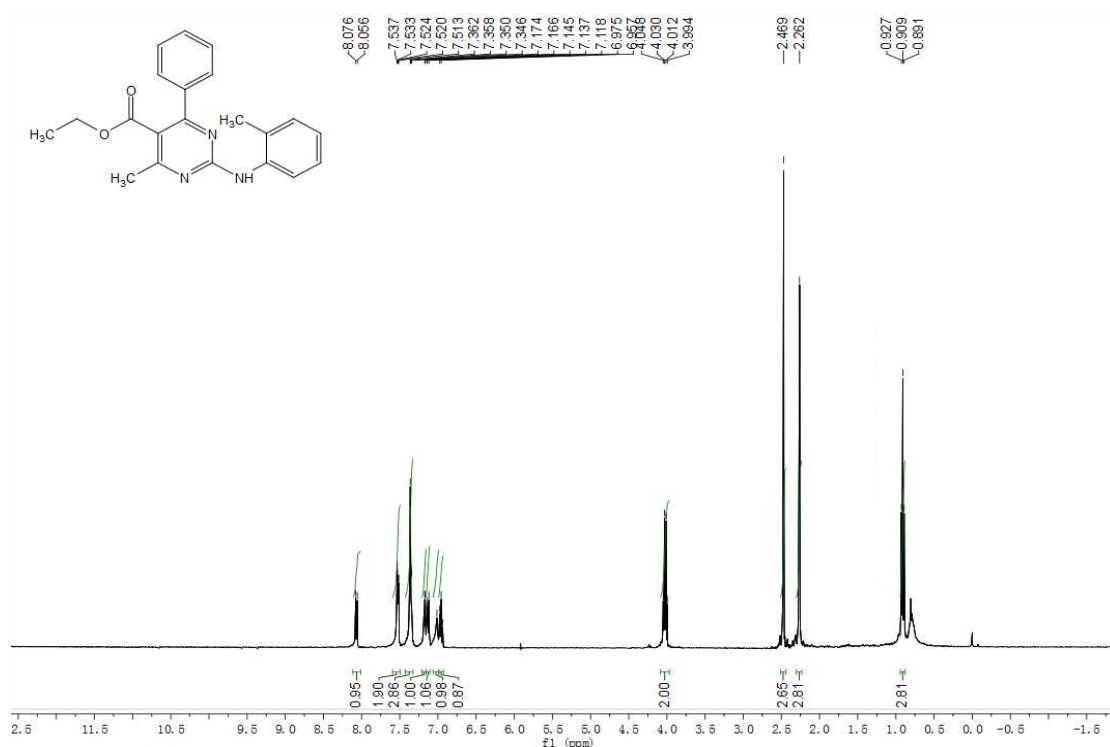
1. Z.-J. Quan, Y. Lv, F.-Q. Jing, X.-D. Jia, C.-D. Huo and X.-C. Wang, *Adv. Synth. Catal.*, 2014, **356**, 325.
2. Y. Zhang, Z.J. Quan, H.-P. Gong, Y. X. Da, Z. Zhang and X.C. Wang, *Tetrahedron*, 2015, **71**, 2113.
3. T. Xing, K.J. Wei Z.J. Quan and X.C. Wang, *Synthesis*, 2015, 2015, **47**, 3925.

4. Copies of the NMR Spectra for All Products.

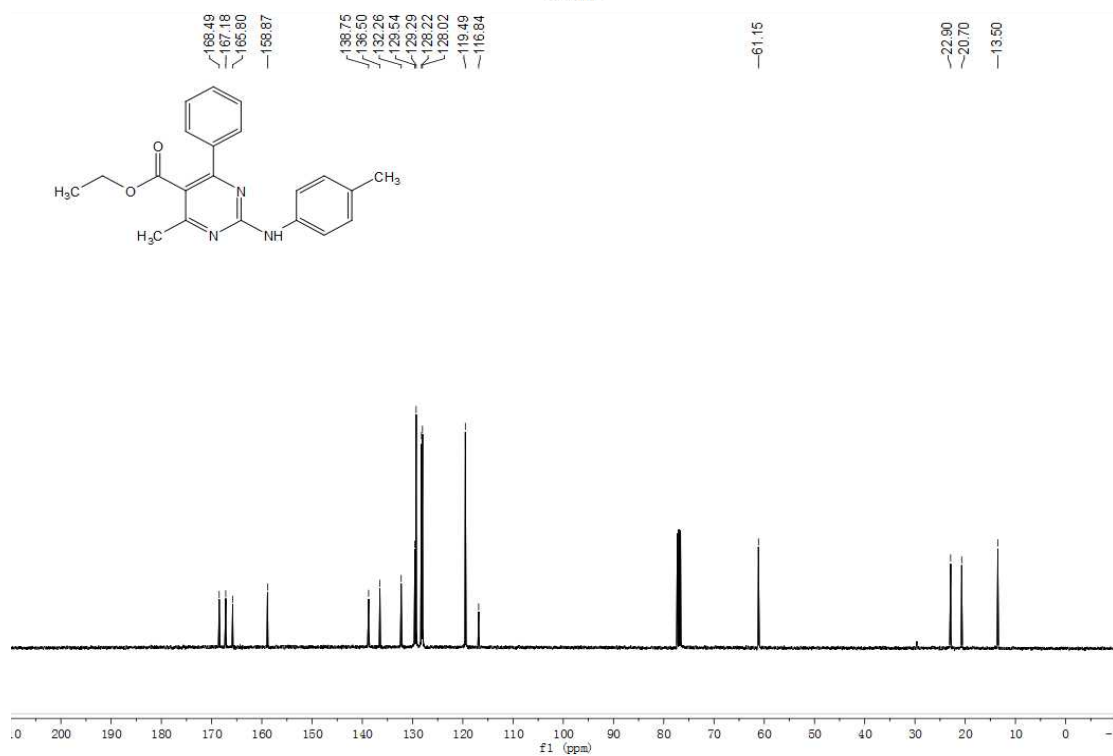
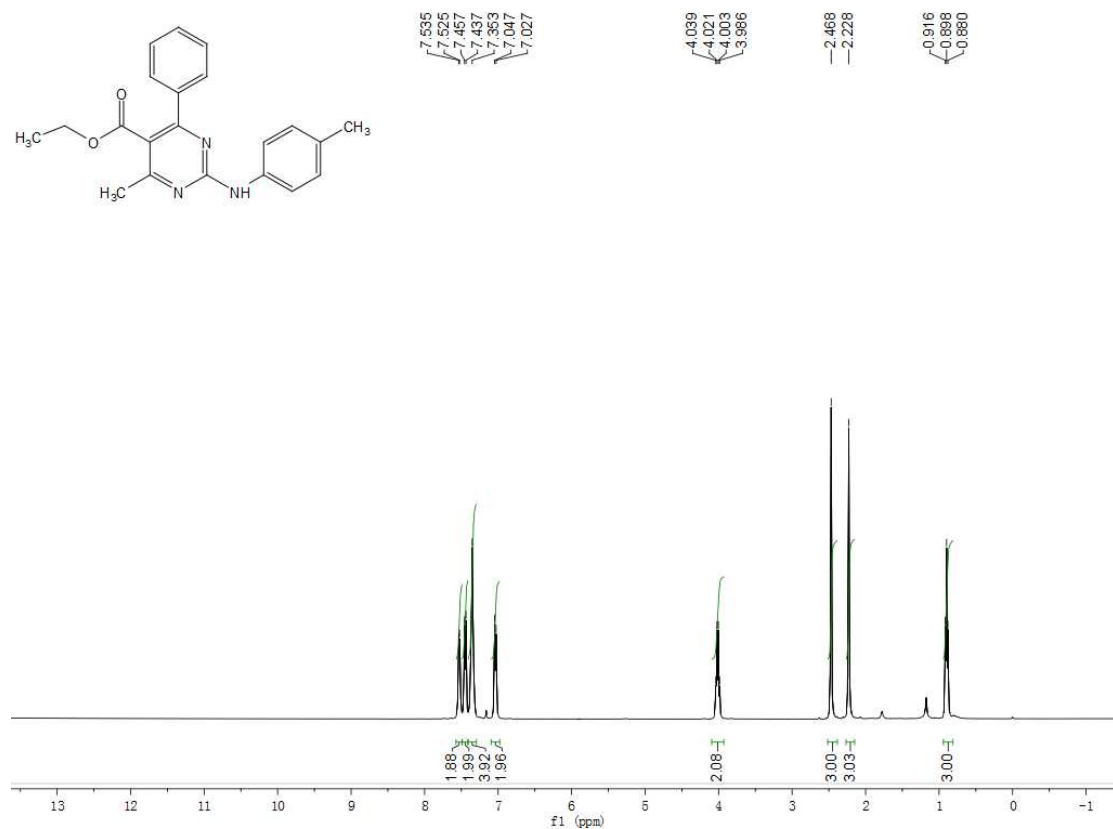
^1H and ^{13}C Spectra of compound 3a (CDCl₃, 400 MHz)



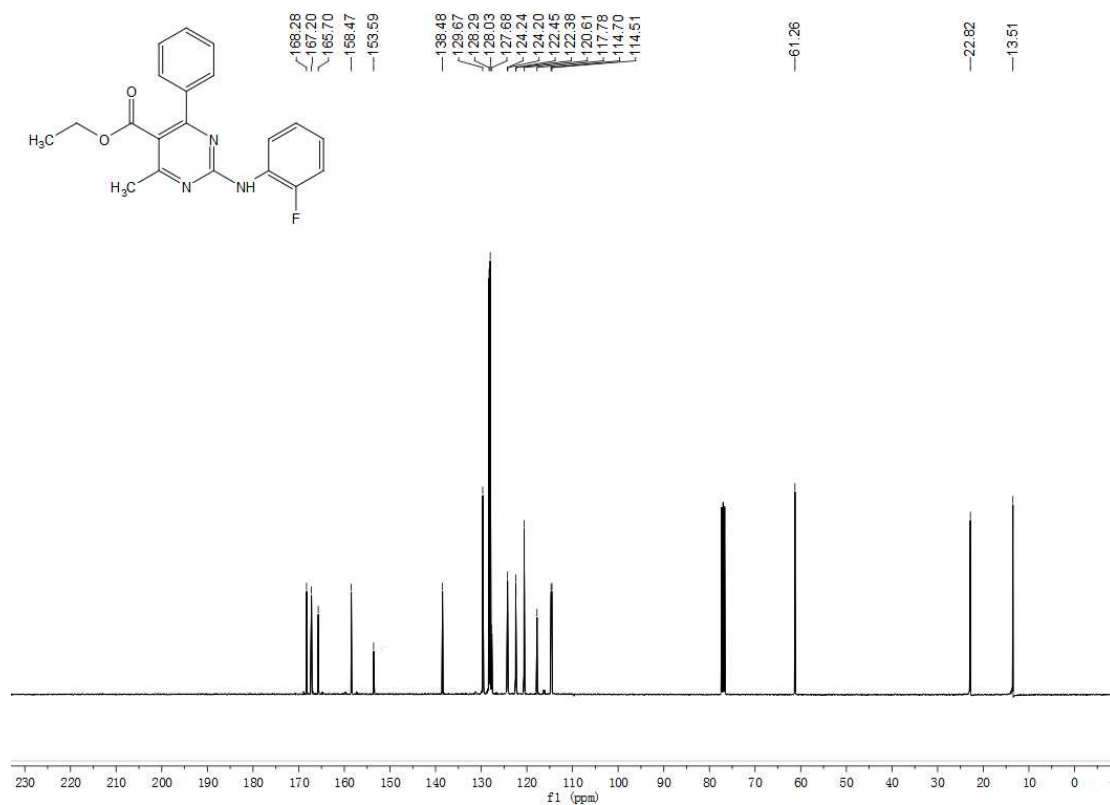
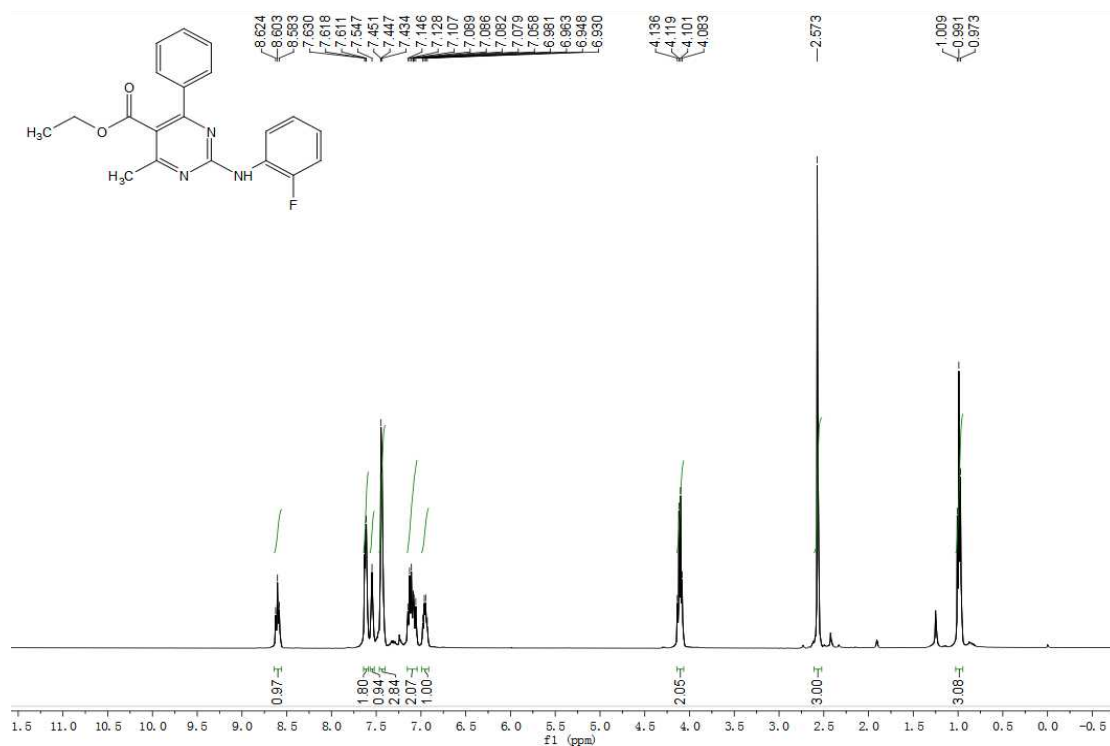
¹H and ¹³C Spectra of compound 3b (CDCl₃, 400 MHz)



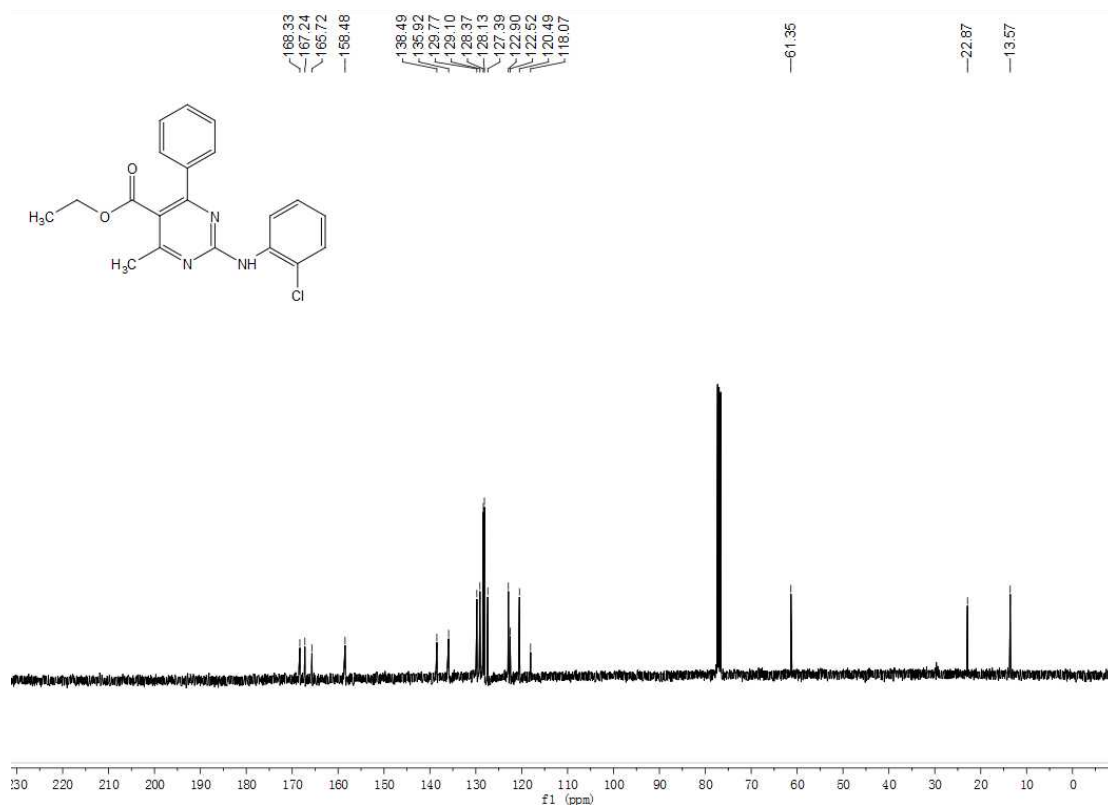
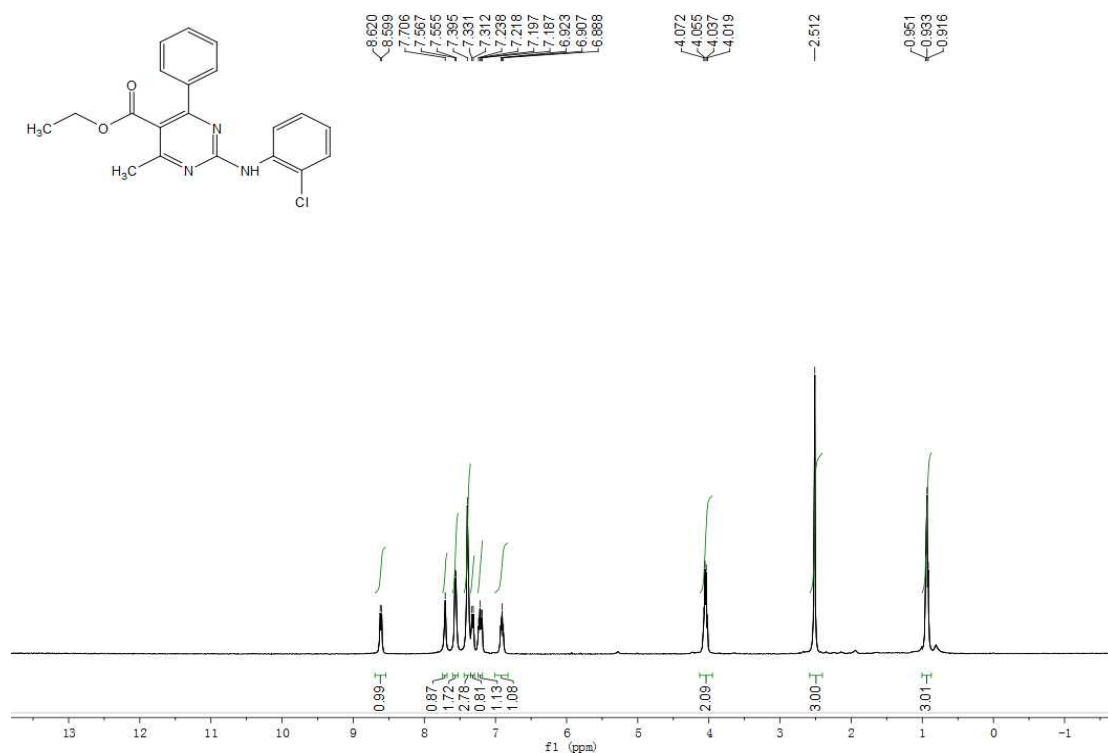
¹H and ¹³C Spectra of compound 3c (CDCl₃, 400 MHz)



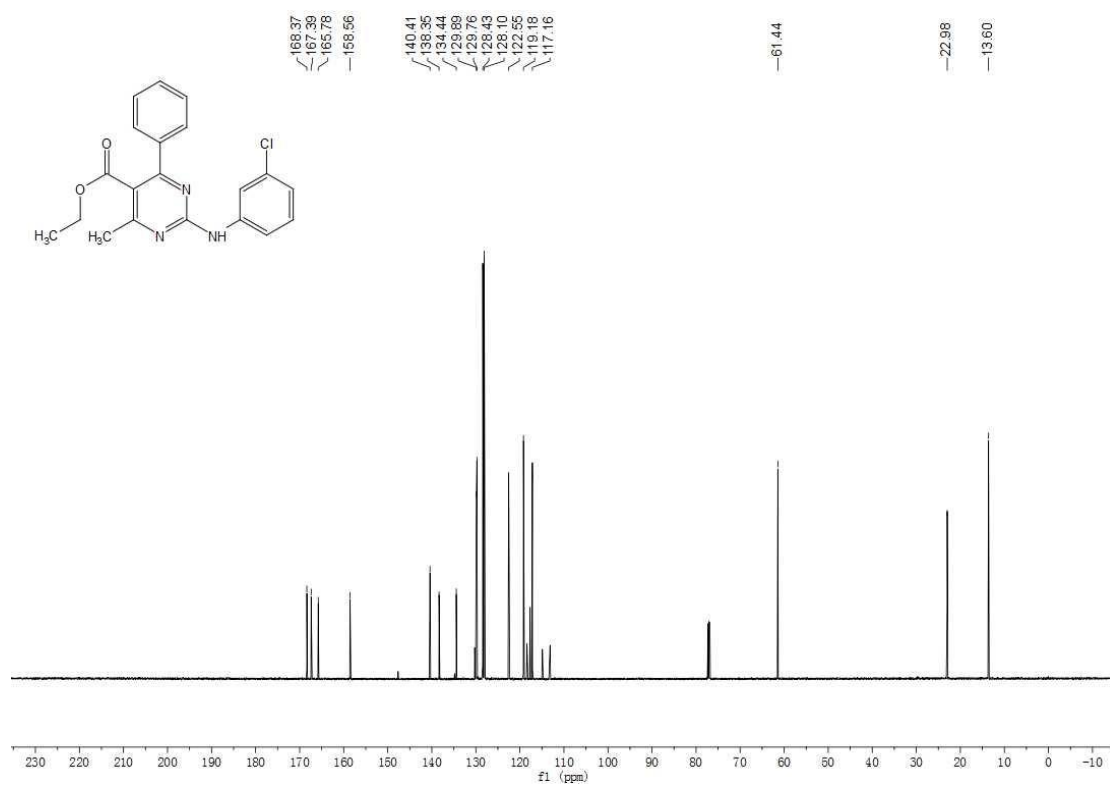
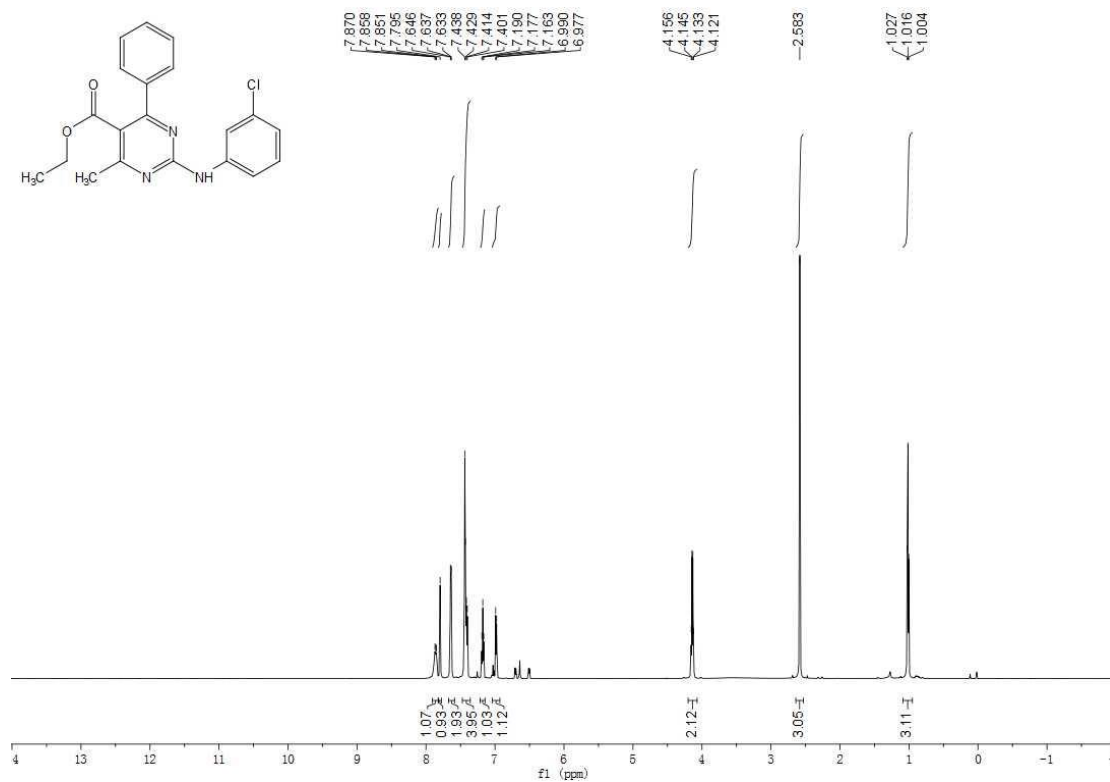
^1H and ^{13}C Spectra of compound 3d (CDCl_3 , 400 MHz)



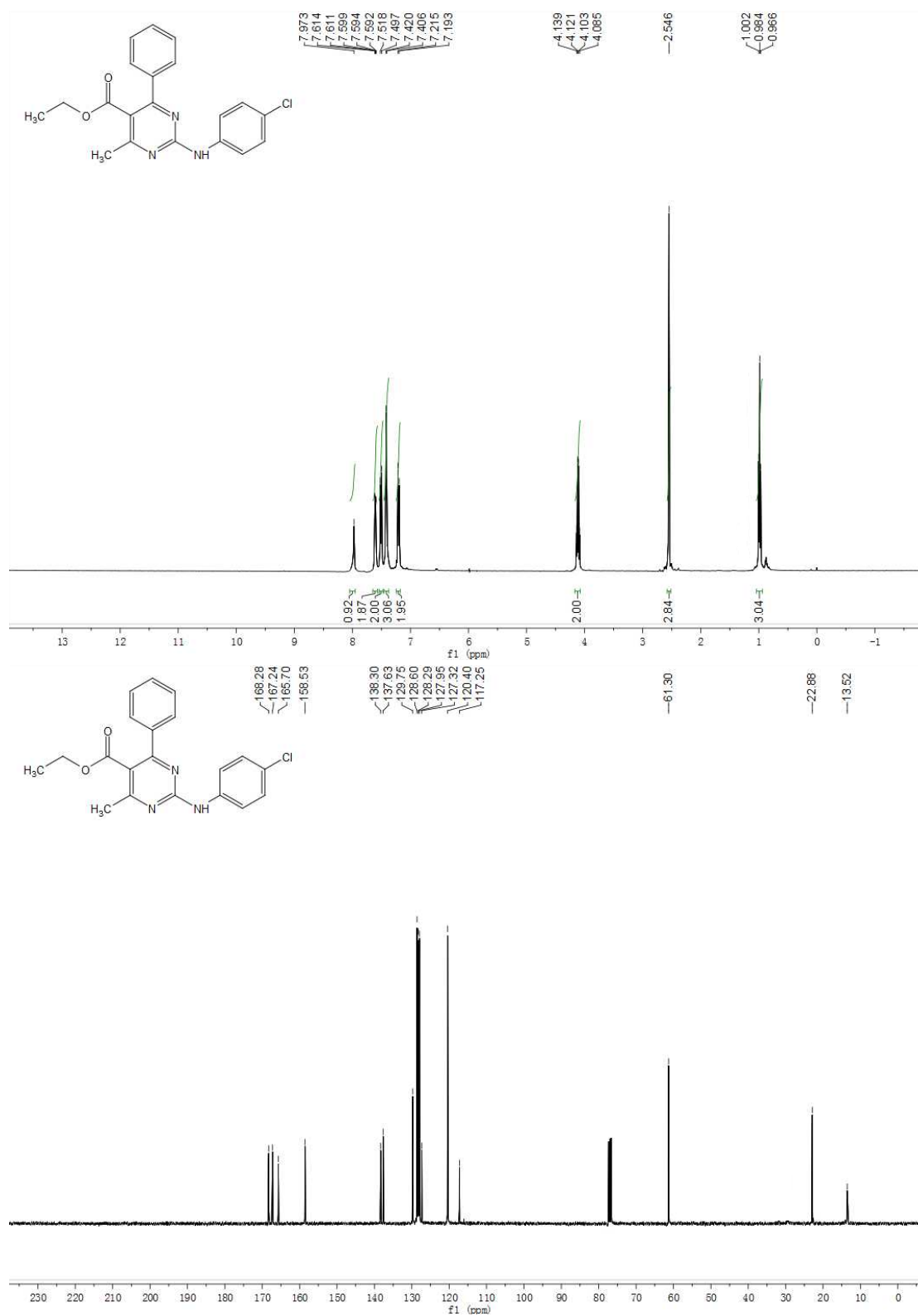
^1H and ^{13}C Spectra of compound 3e (CDCl_3 , 400 MHz)



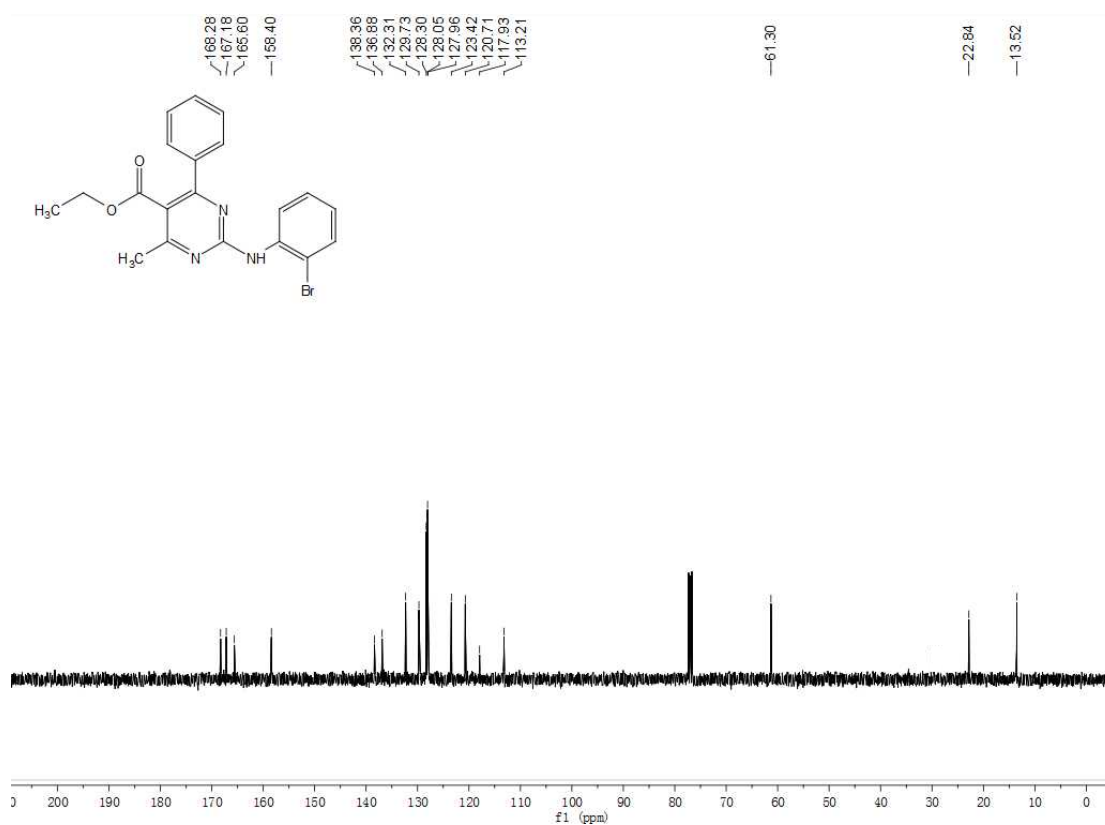
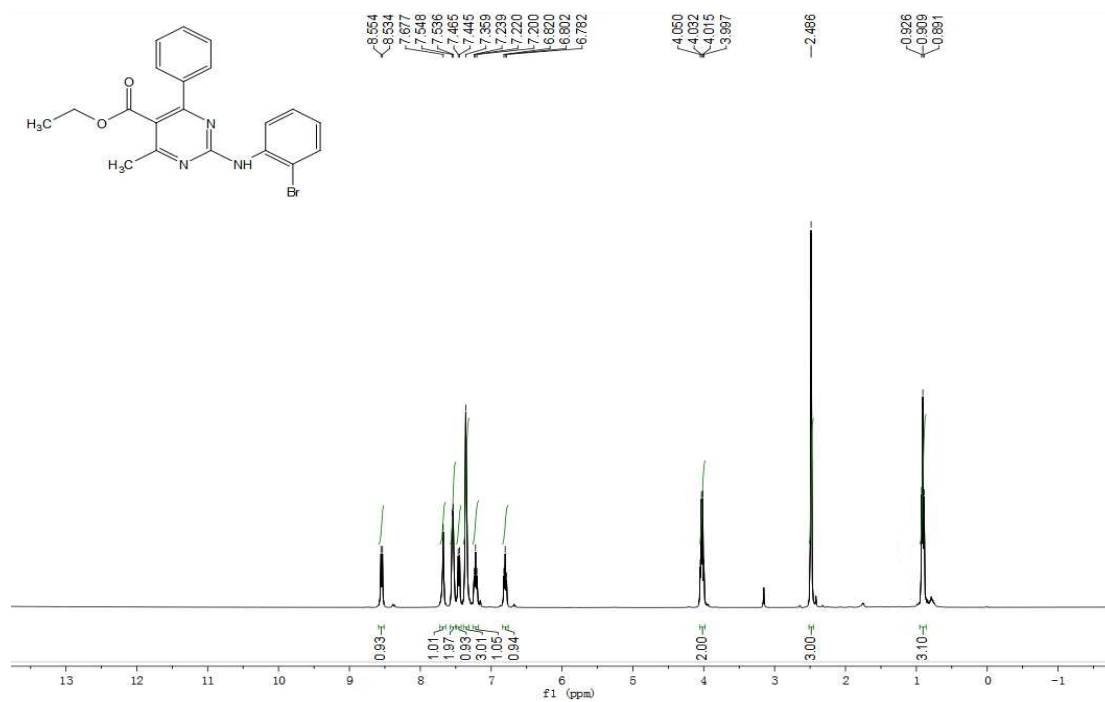
^1H and ^{13}C Spectra of compound 3f (CDCl_3 , 400 MHz)



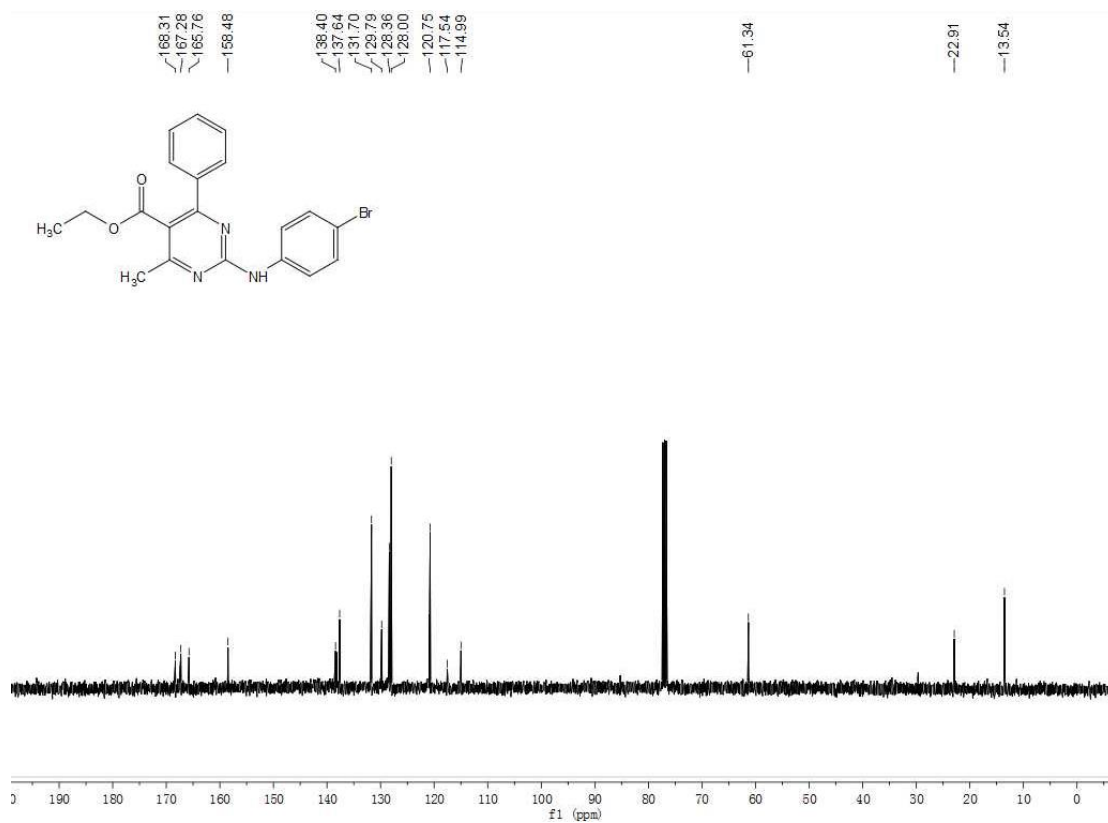
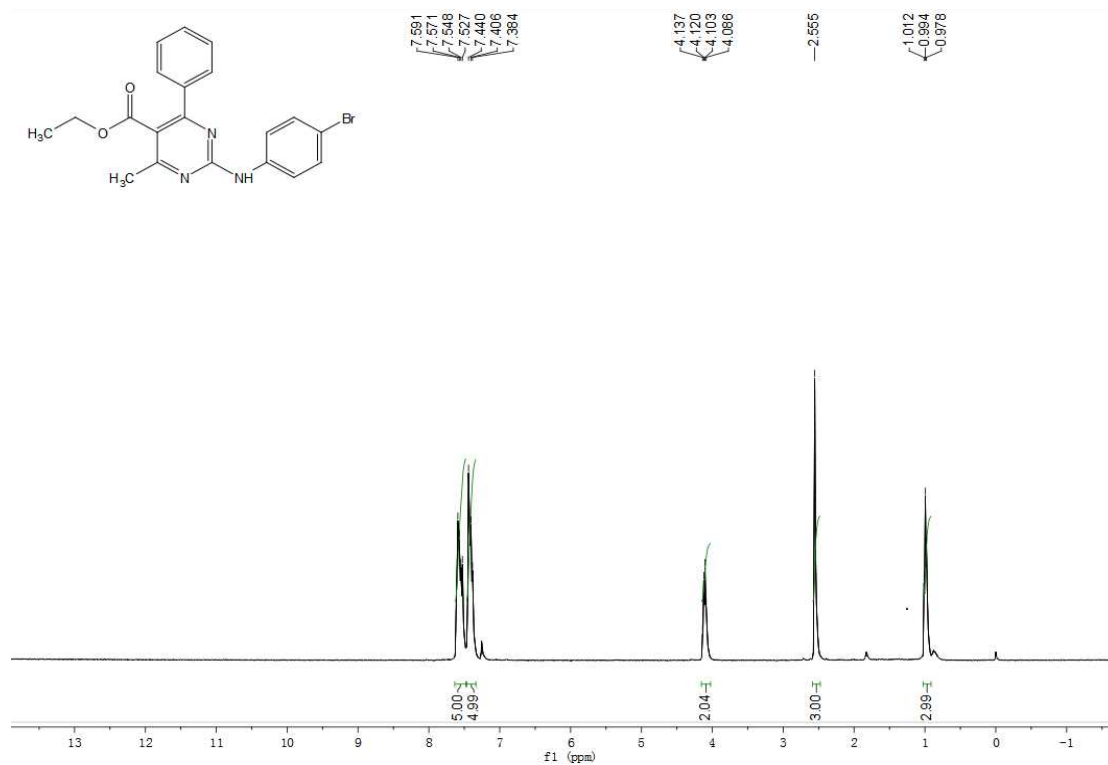
^1H and ^{13}C Spectra of compound 3g (CDCl_3 , 400 MHz)



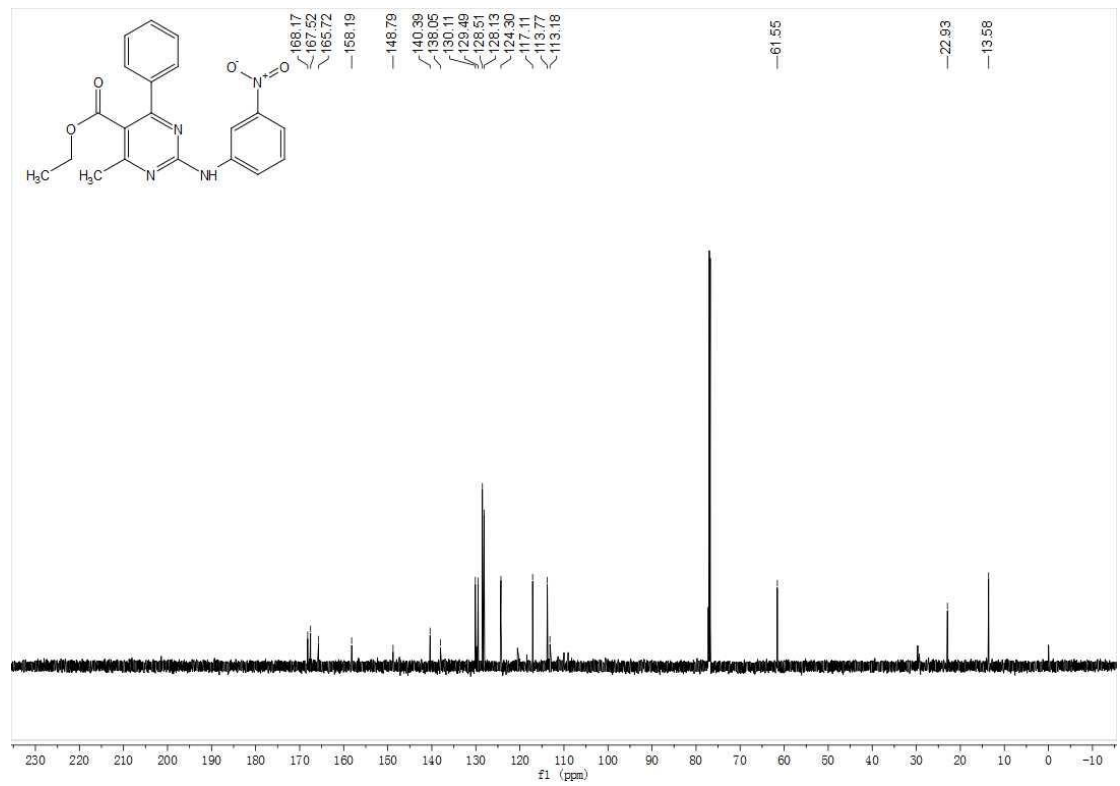
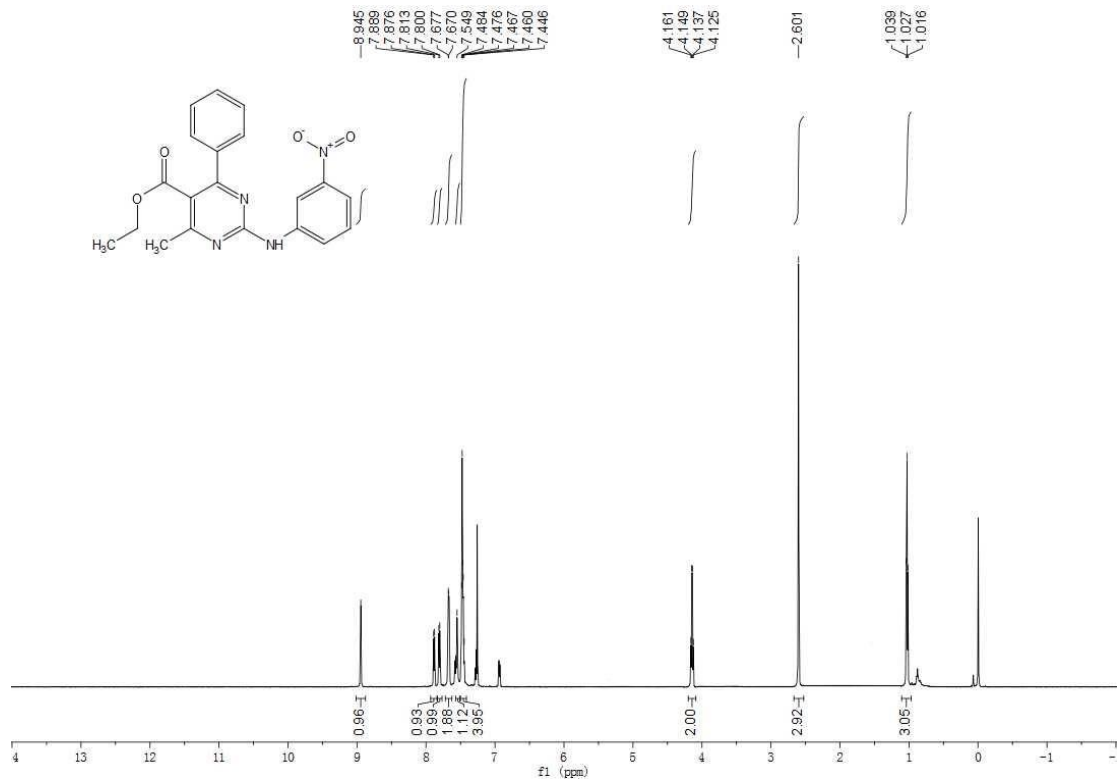
^1H and ^{13}C Spectra of compound 3h (CDCl₃, 400 MHz)



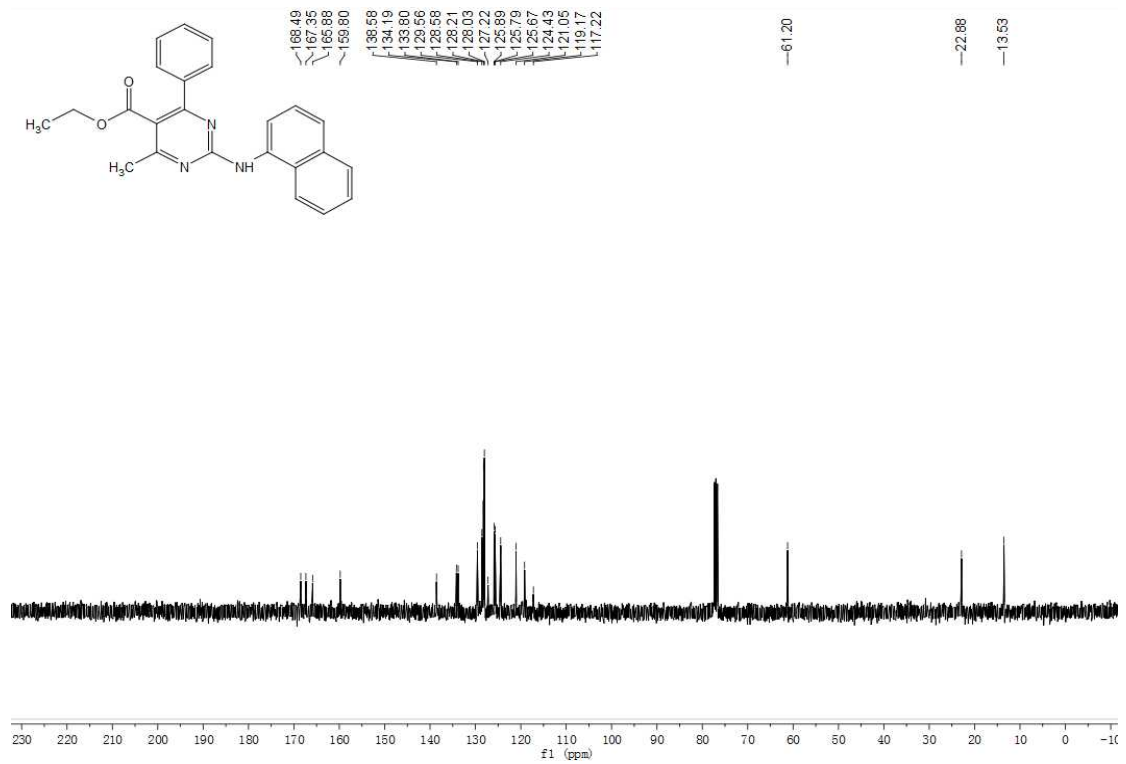
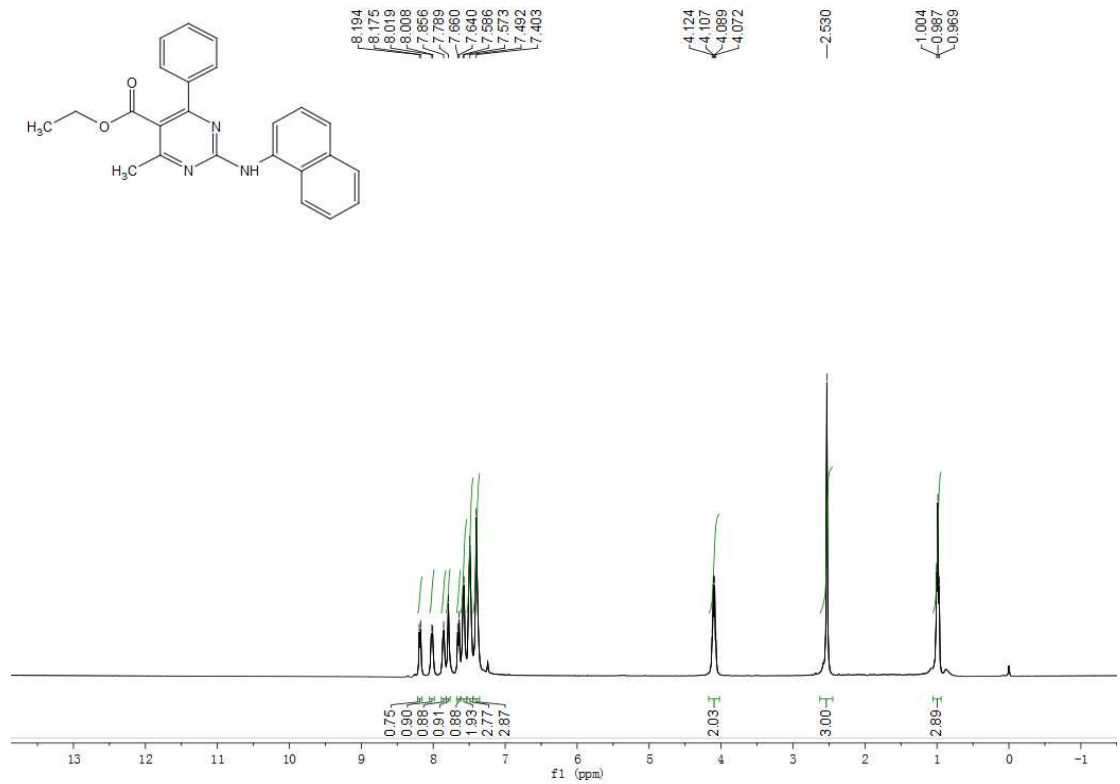
¹H and ¹³C Spectra of compound 3i (CDCl₃, 400 MHz)



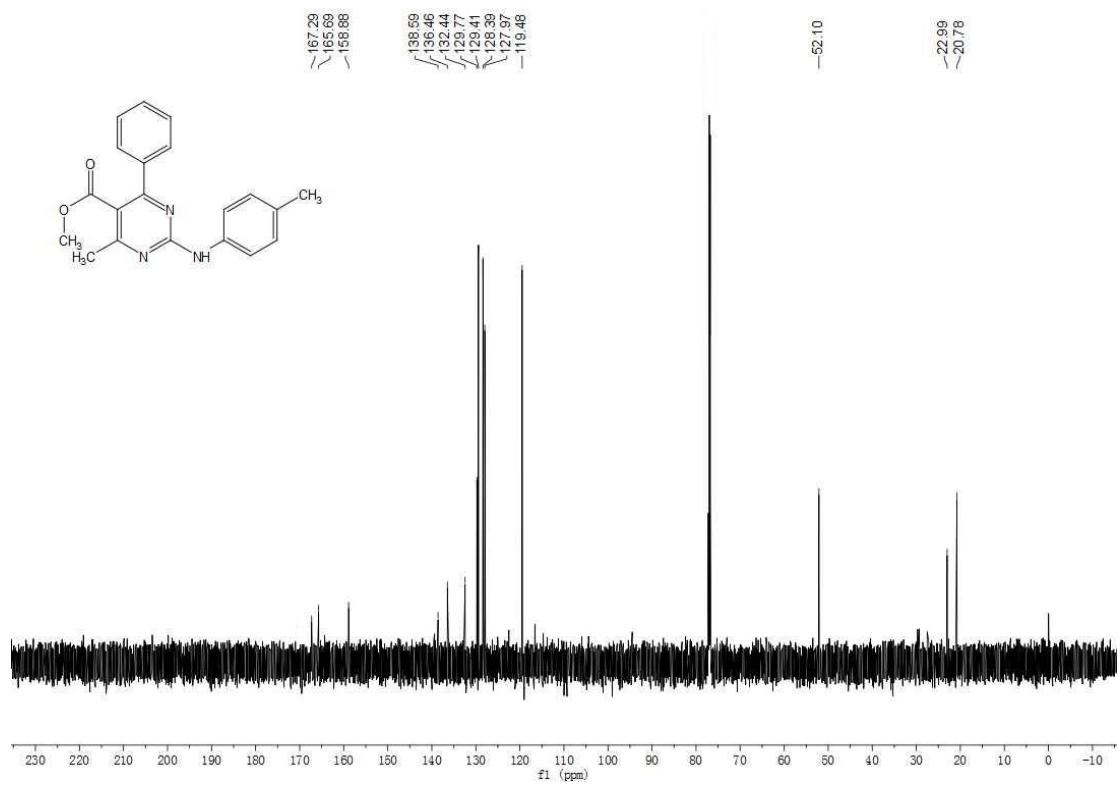
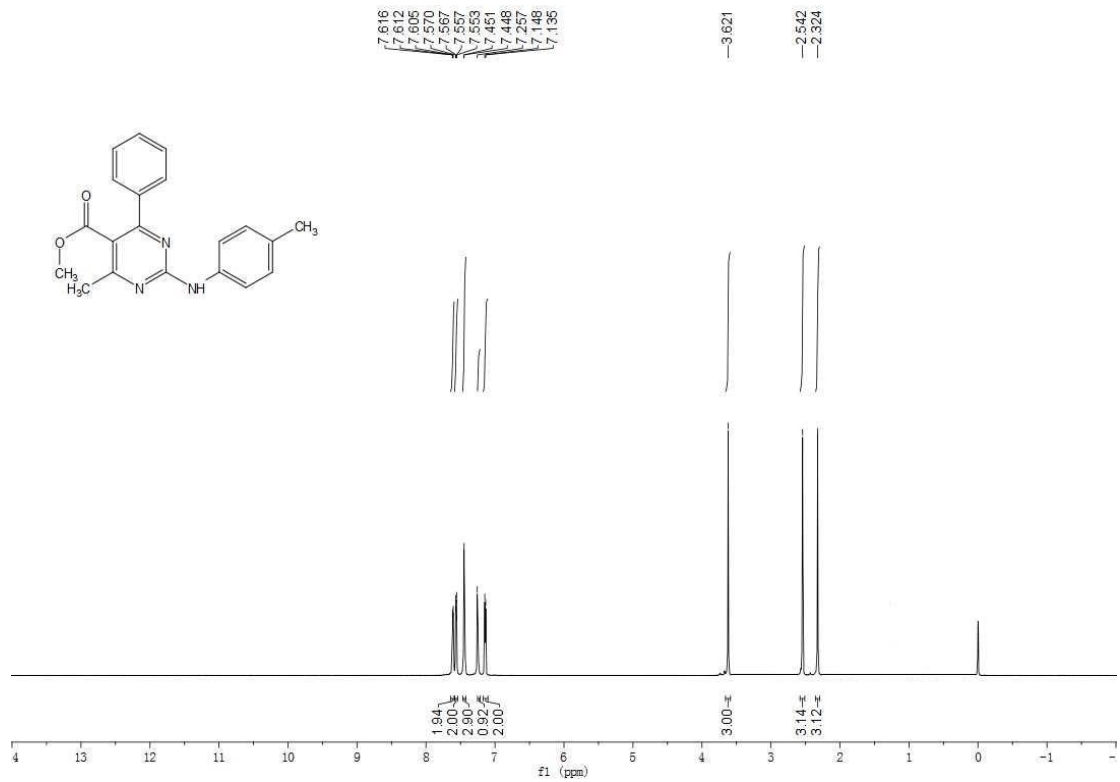
¹H and ¹³C Spectra of compound 3j (CDCl₃, 400 MHz)



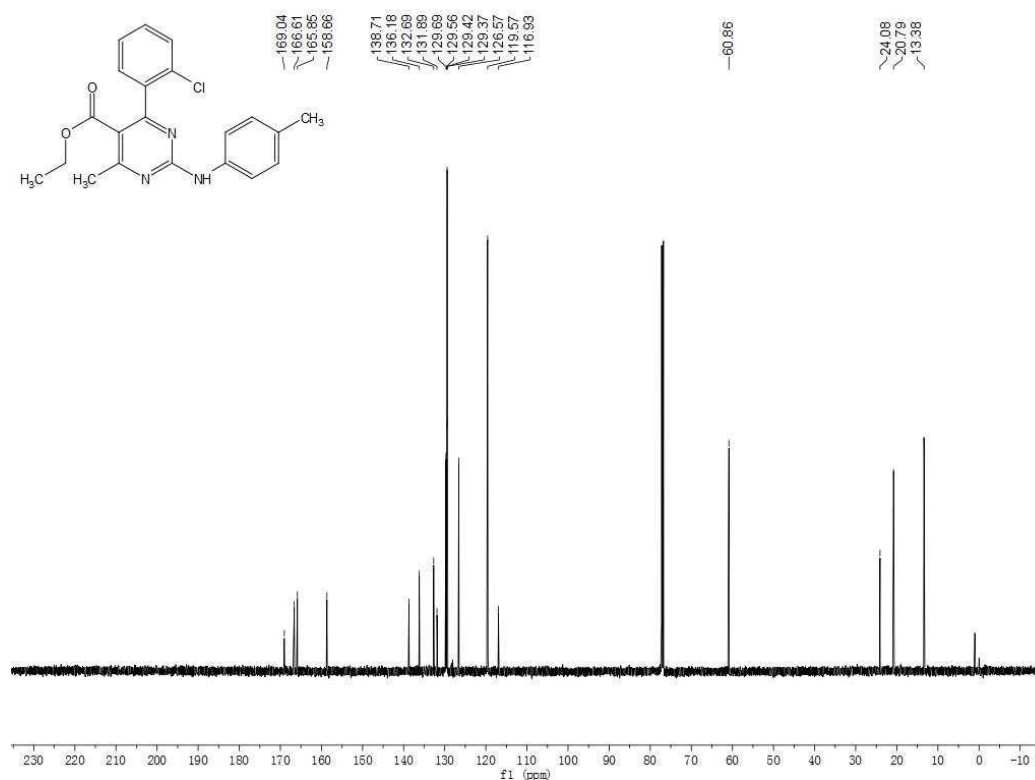
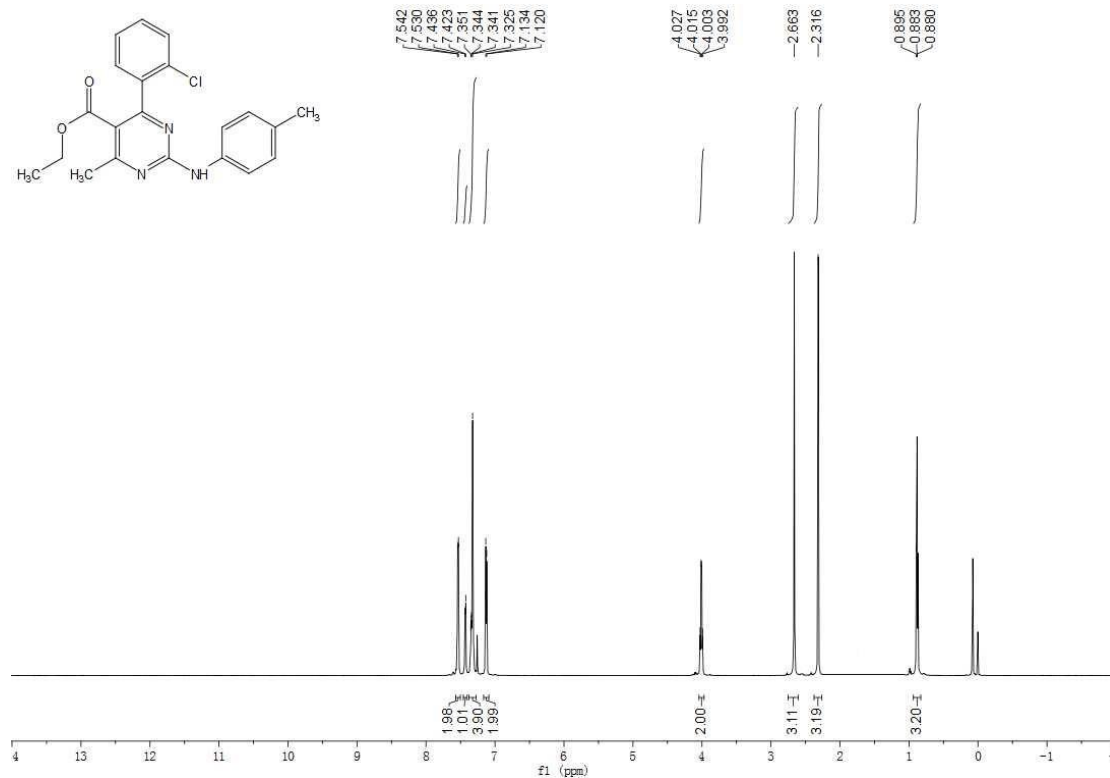
^1H and ^{13}C Spectra of compound 3k (CDCl_3 , 400 MHz)



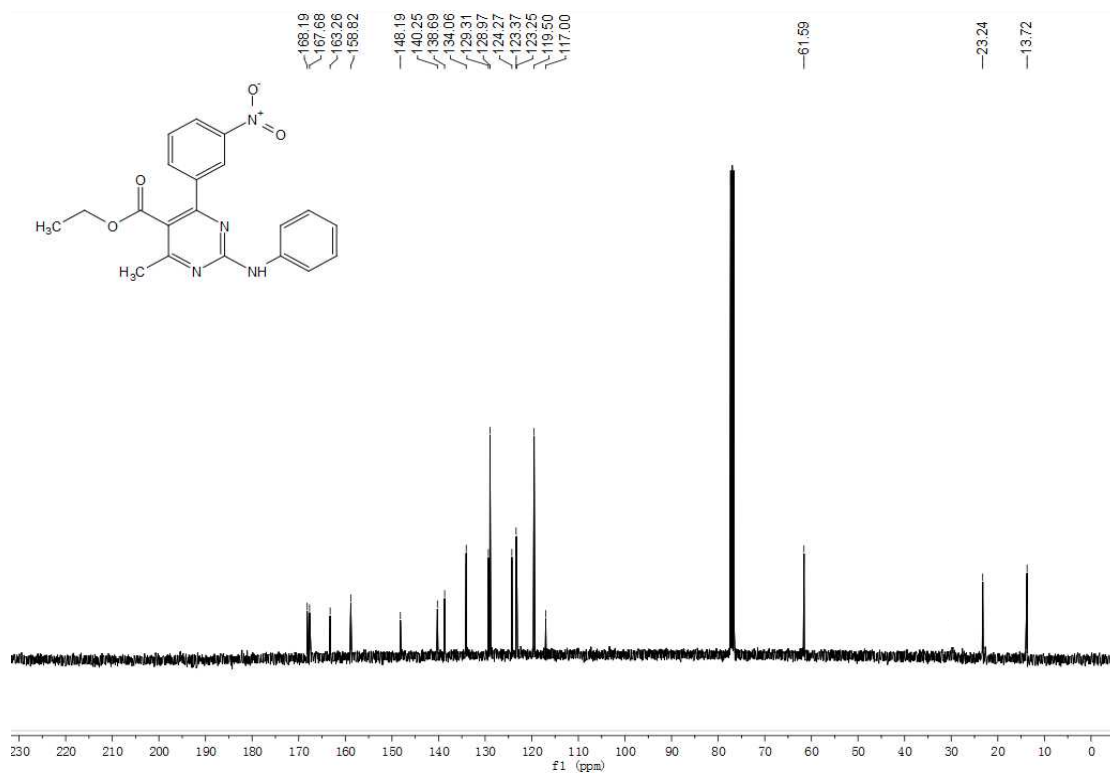
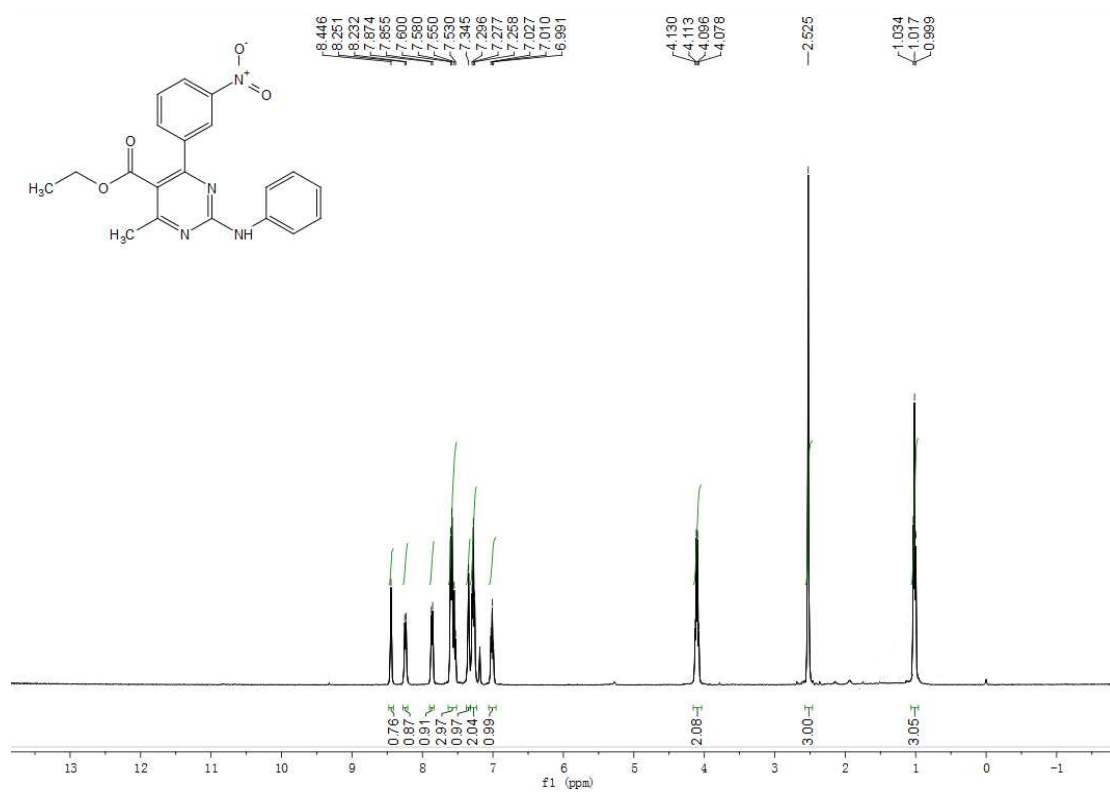
¹H and ¹³C Spectra of compound 31 (CDCl₃, 400 MHz)



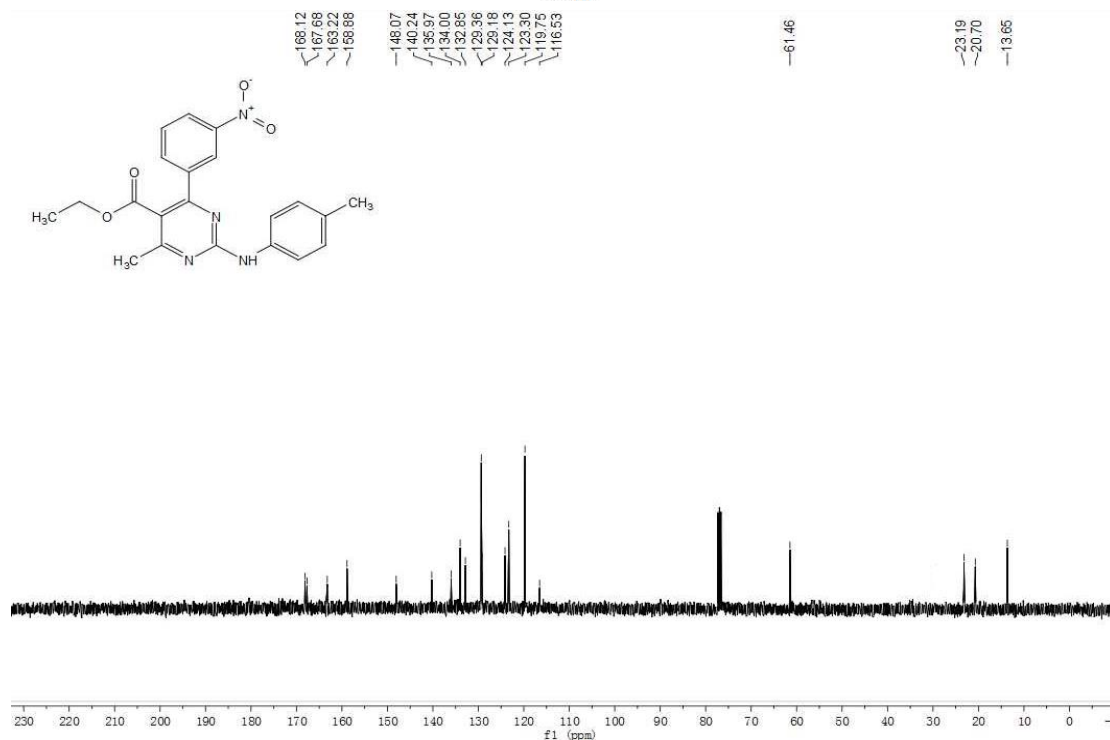
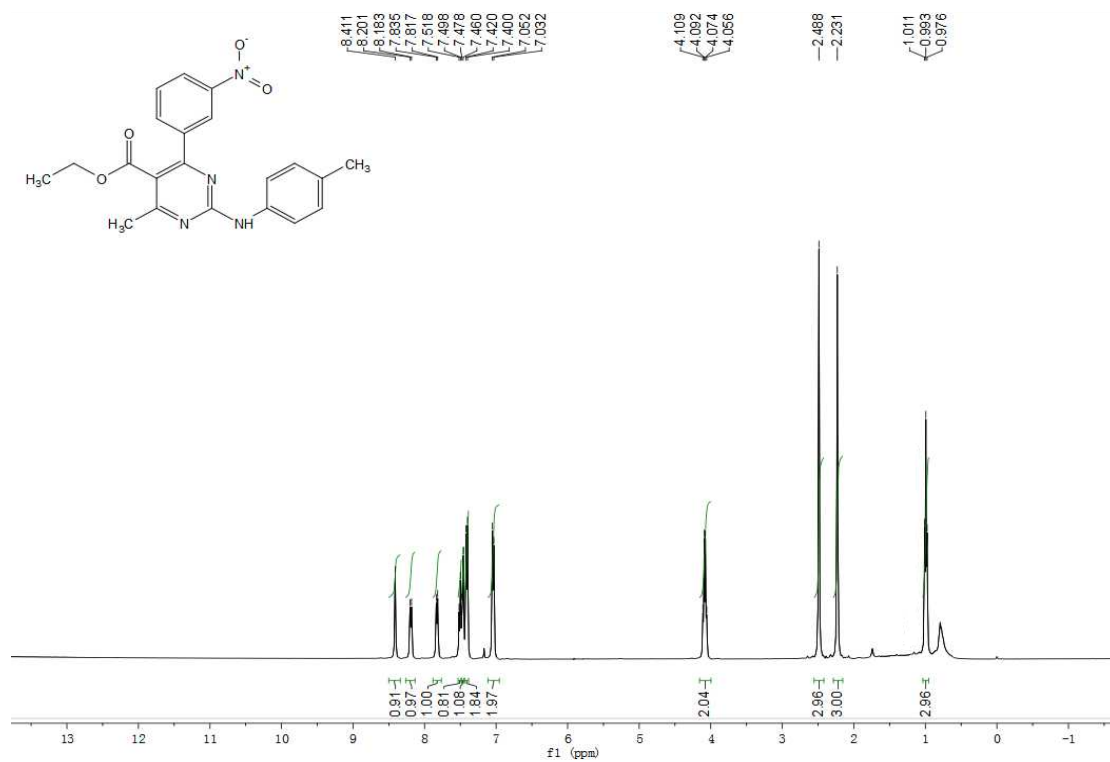
^1H and ^{13}C Spectra of compound 3m (CDCl_3 , 600 MHz)



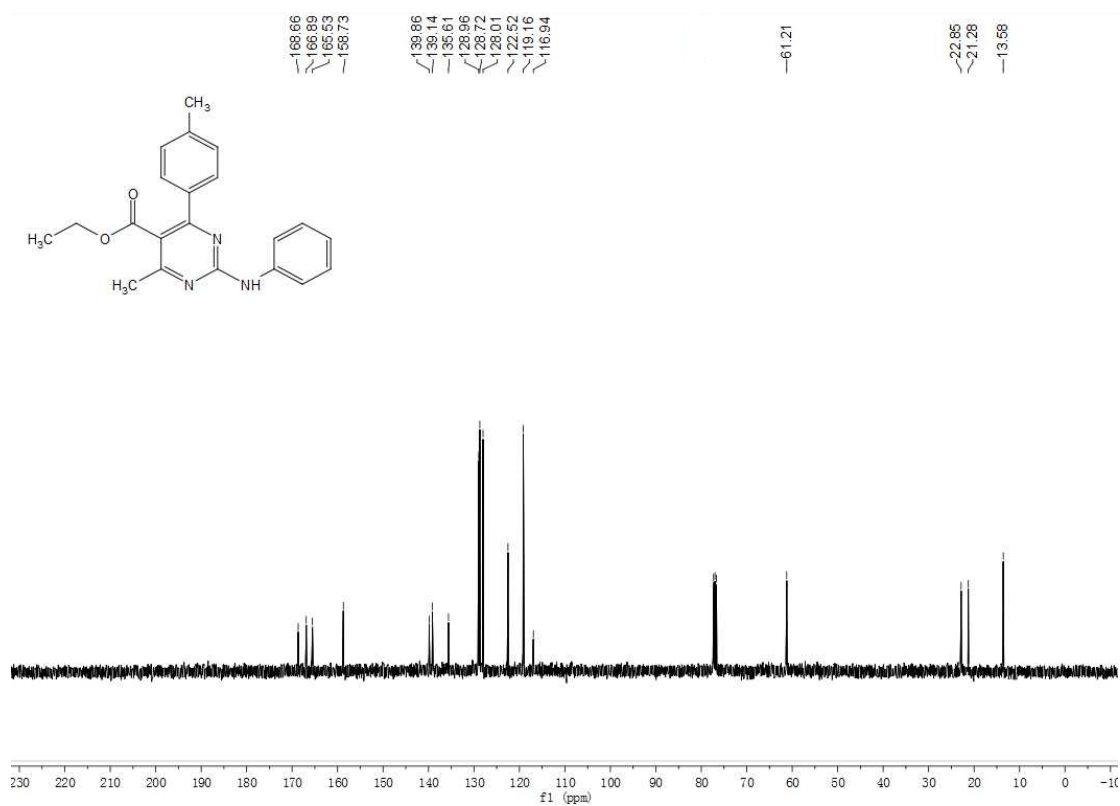
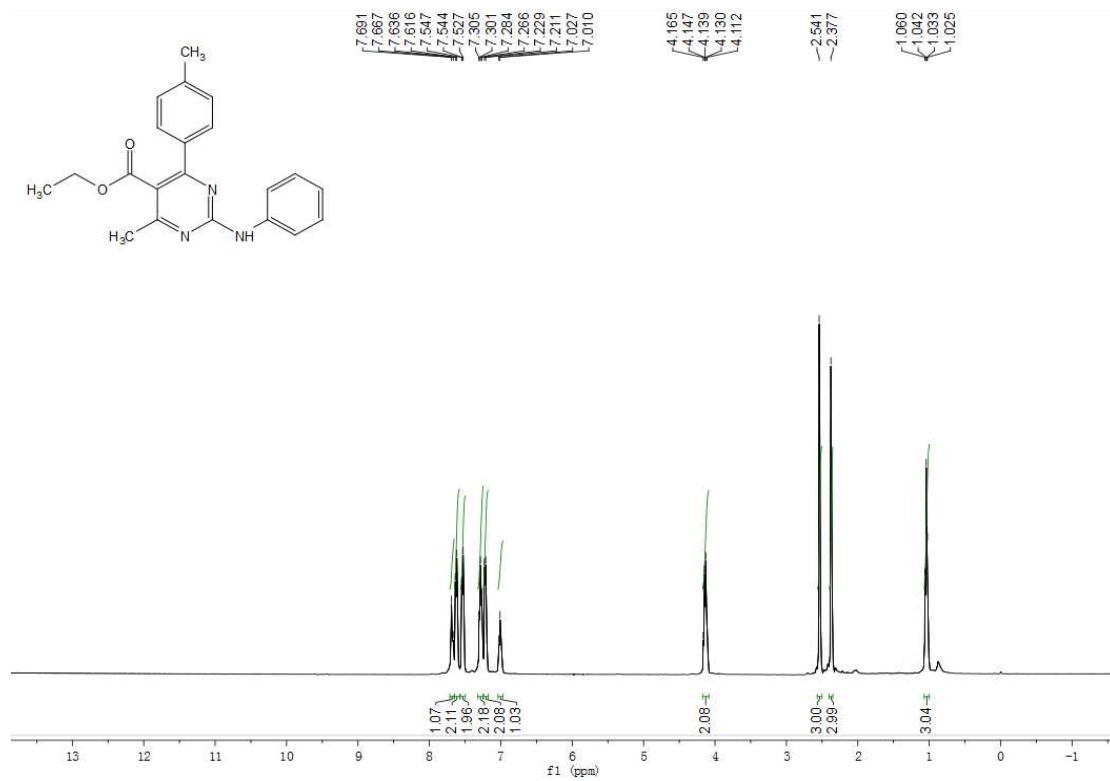
^1H and ^{13}C Spectra of compound 3n (CDCl_3 , 400 MHz)



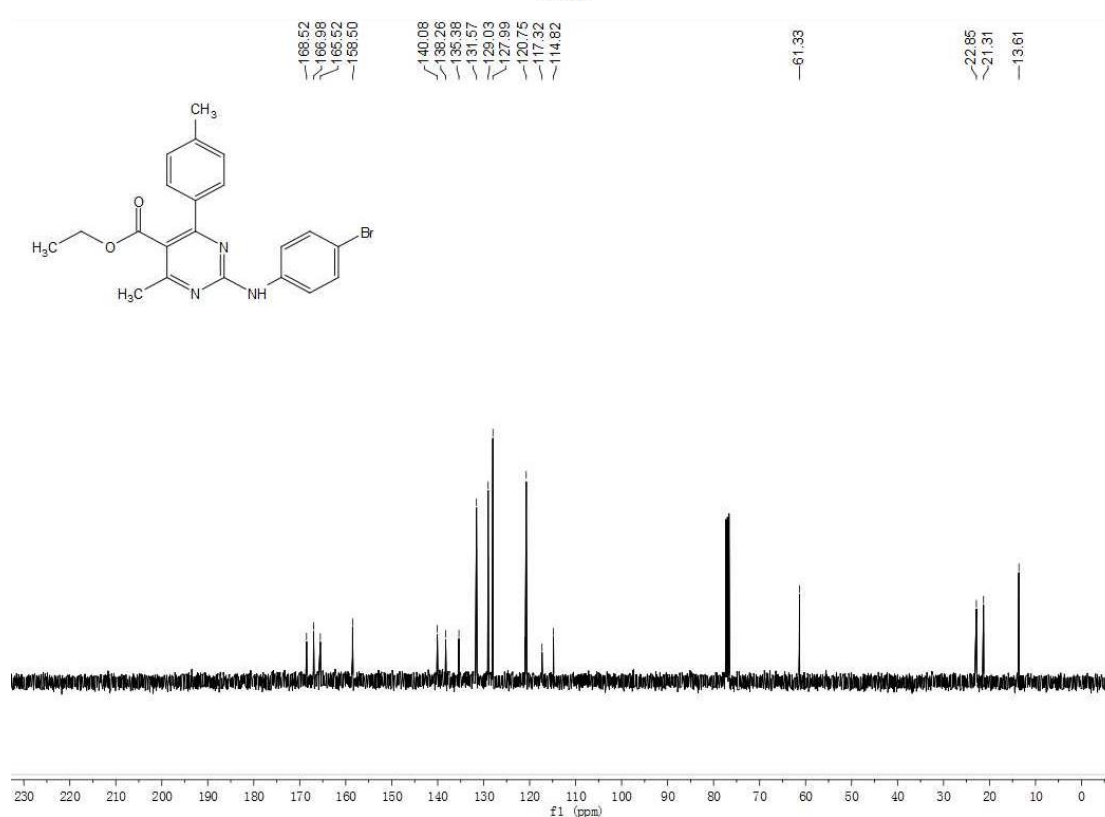
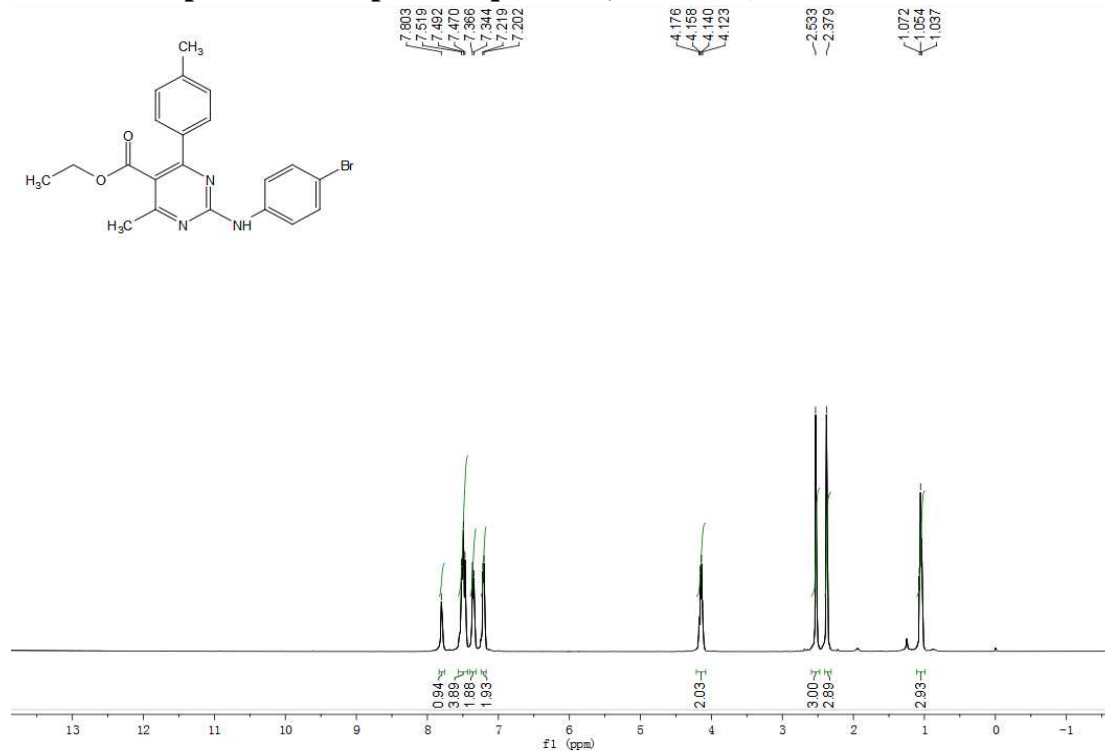
¹H and ¹³C Spectra of compound 3o (CDCl₃, 400 MHz)



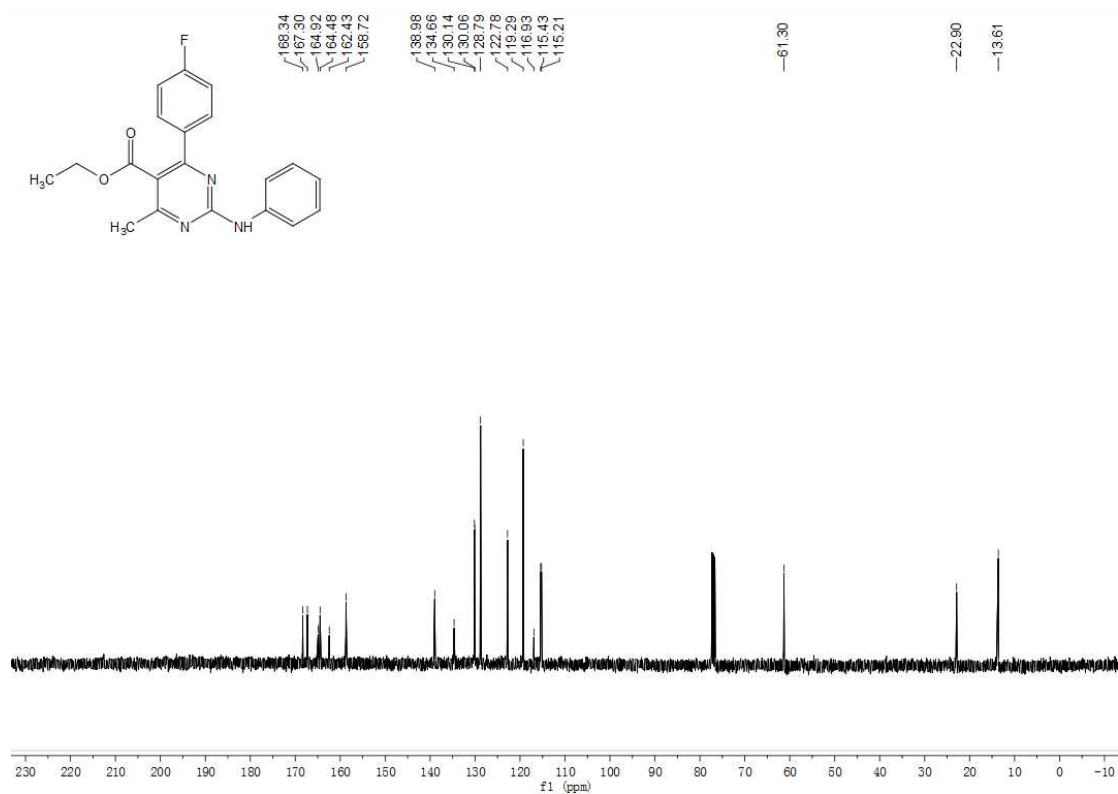
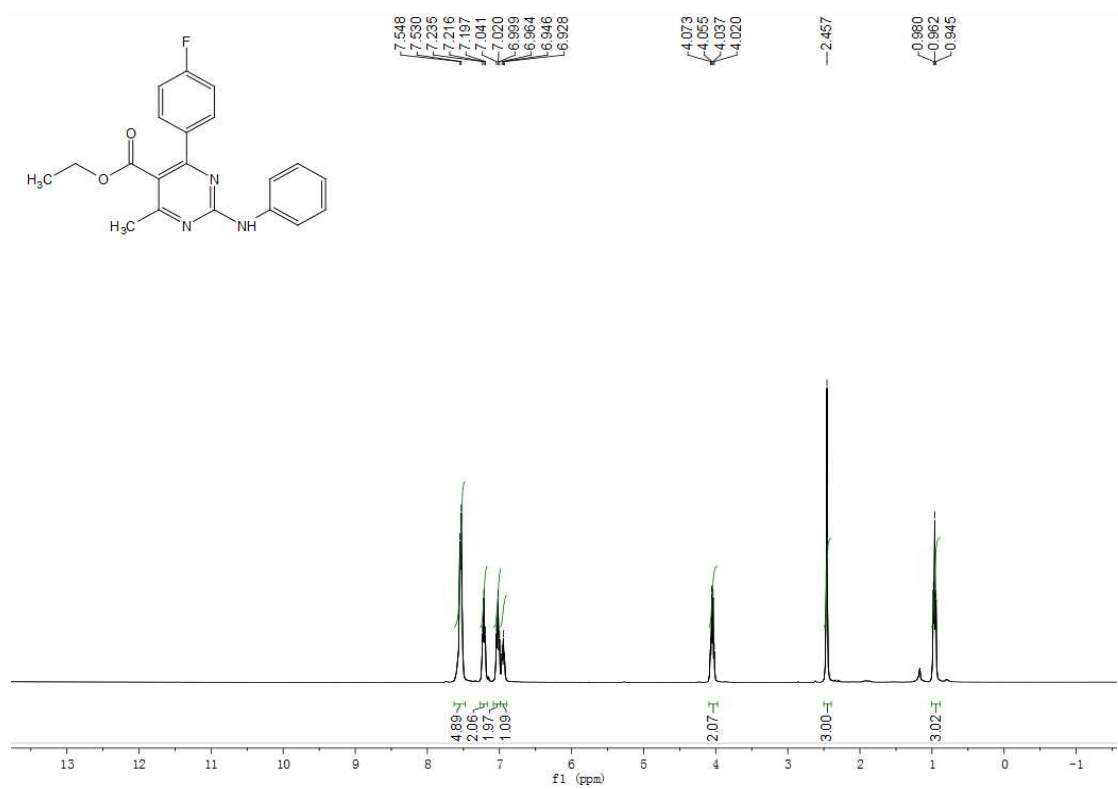
¹H and ¹³C Spectra of compound 3p (CDCl₃, 400 MHz)



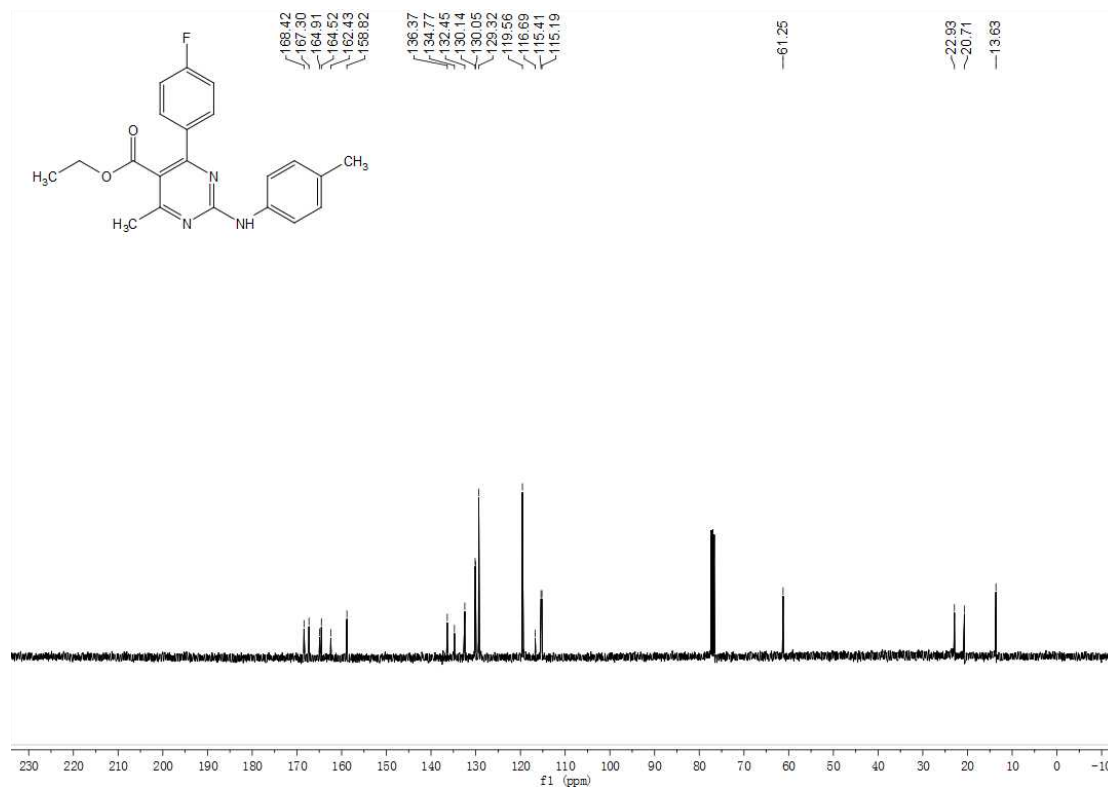
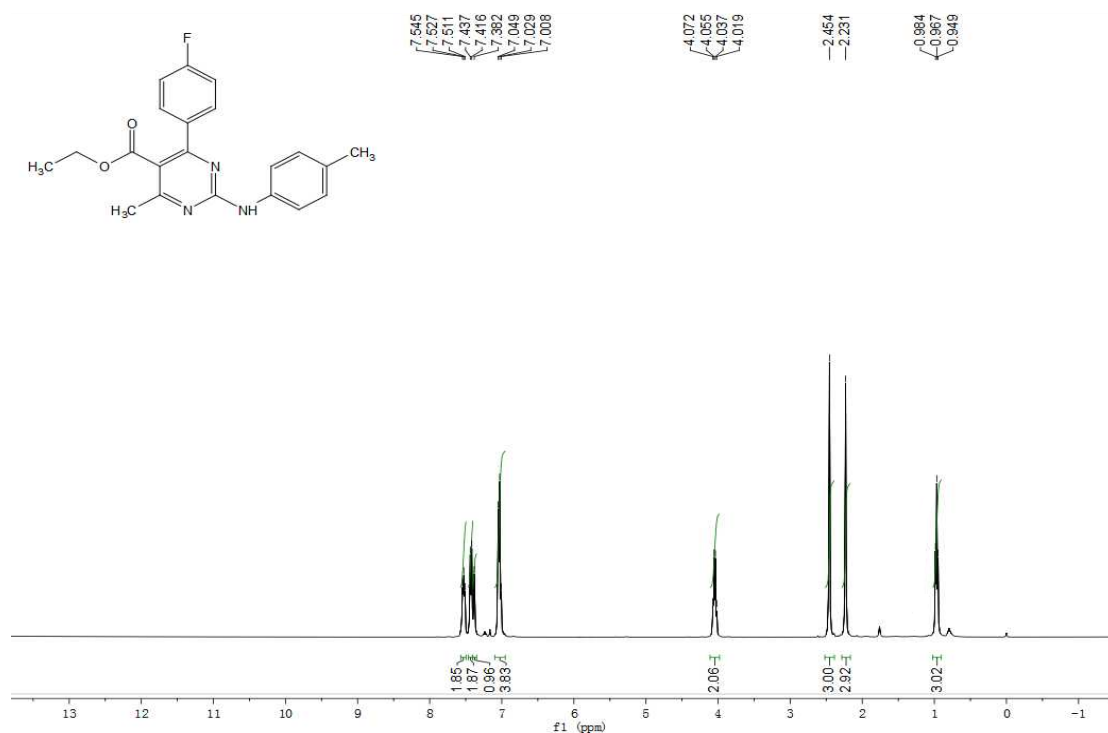
¹H and ¹³C Spectra of compound 3q (CDCl₃, 400 MHz)



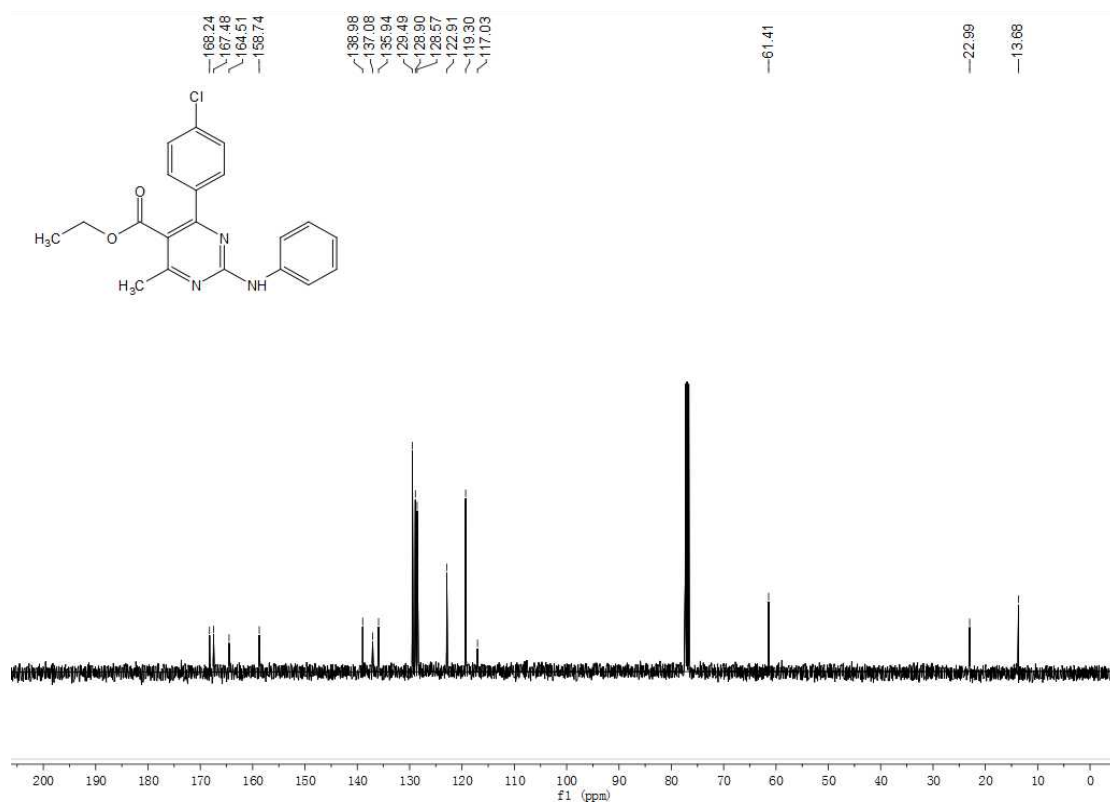
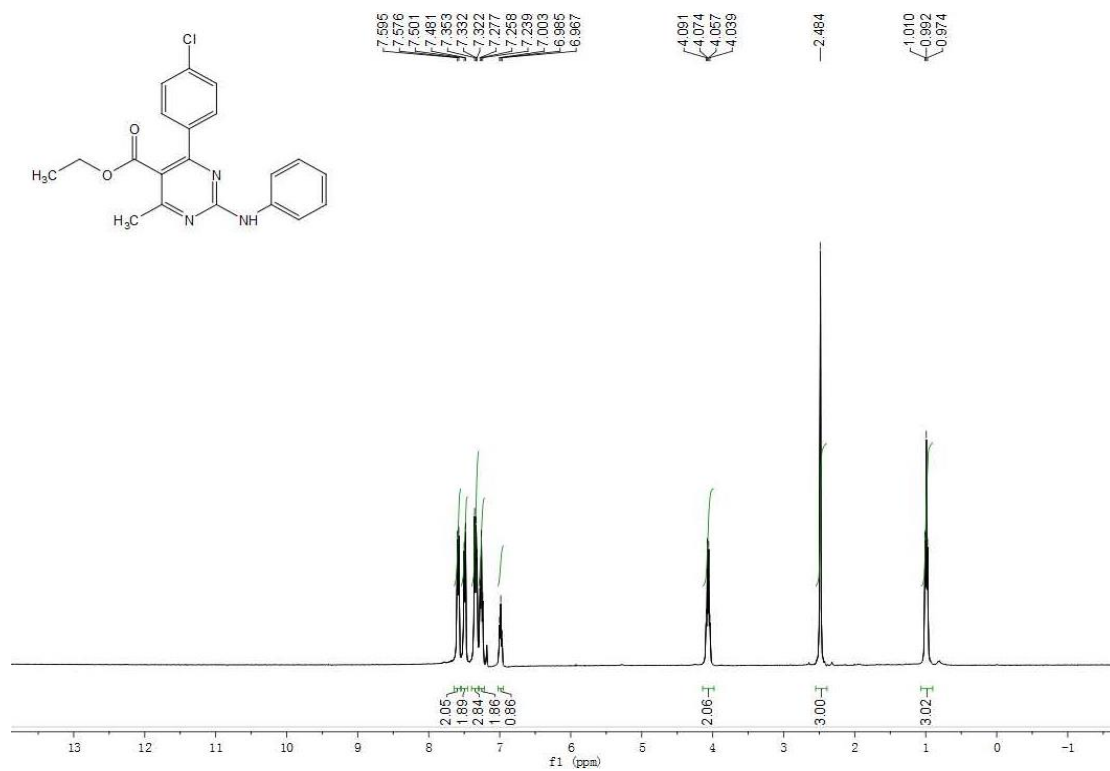
^1H and ^{13}C Spectra of compound 3r (CDCl₃, 400 MHz)



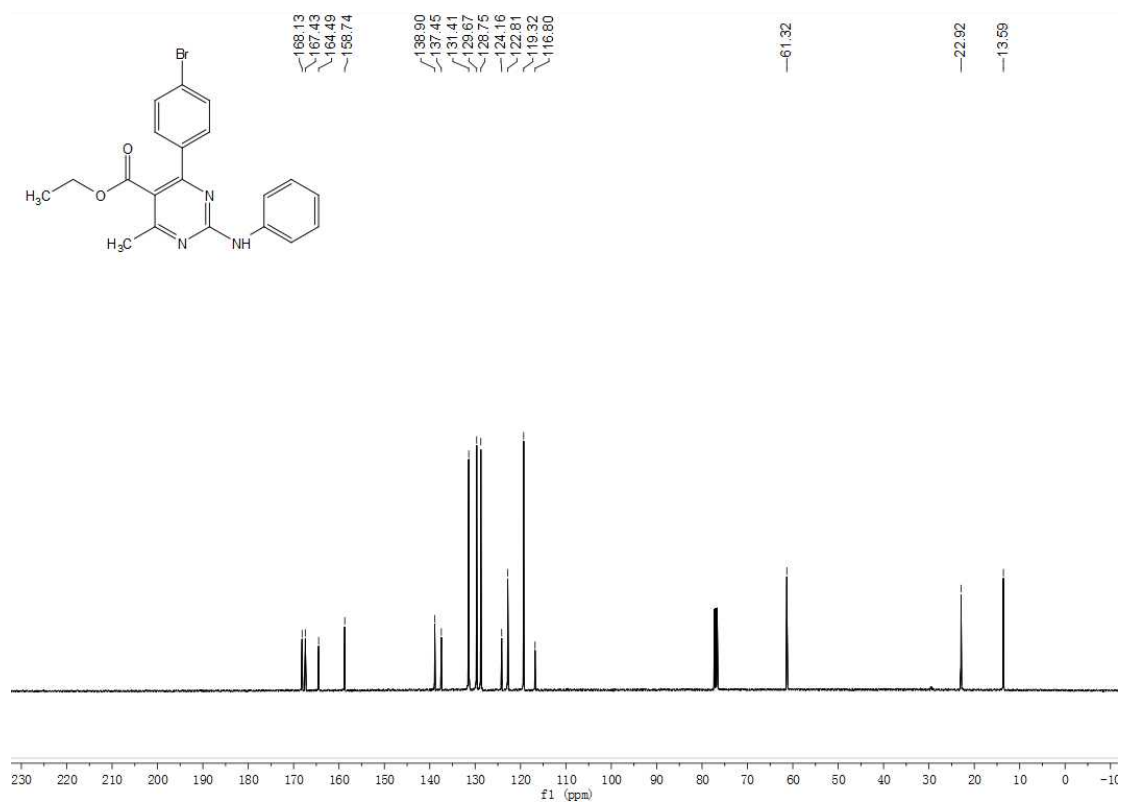
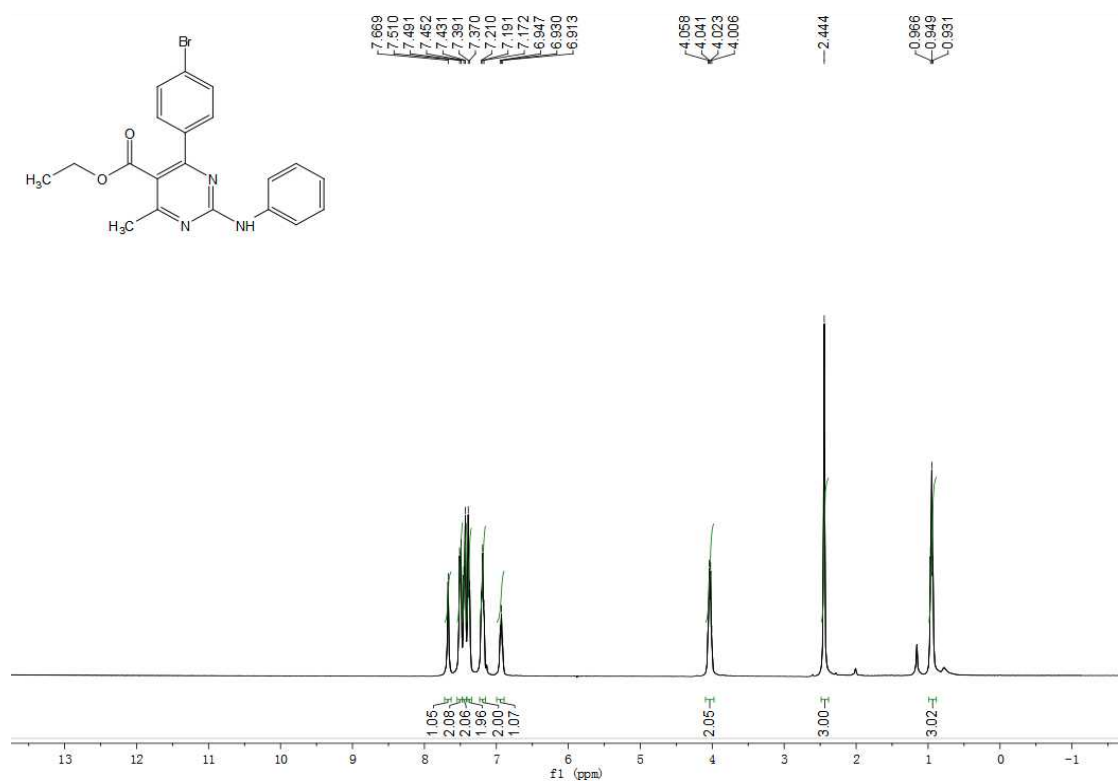
^1H and ^{13}C Spectra of compound 3s (CDCl_3 , 400 MHz)



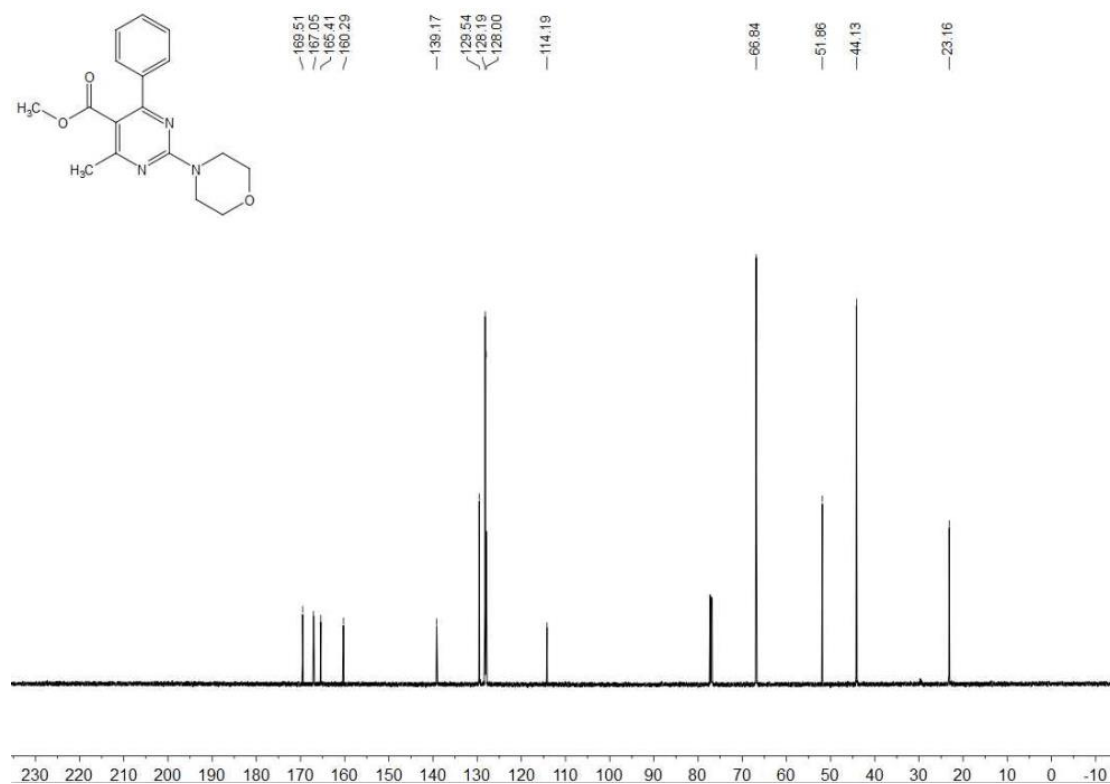
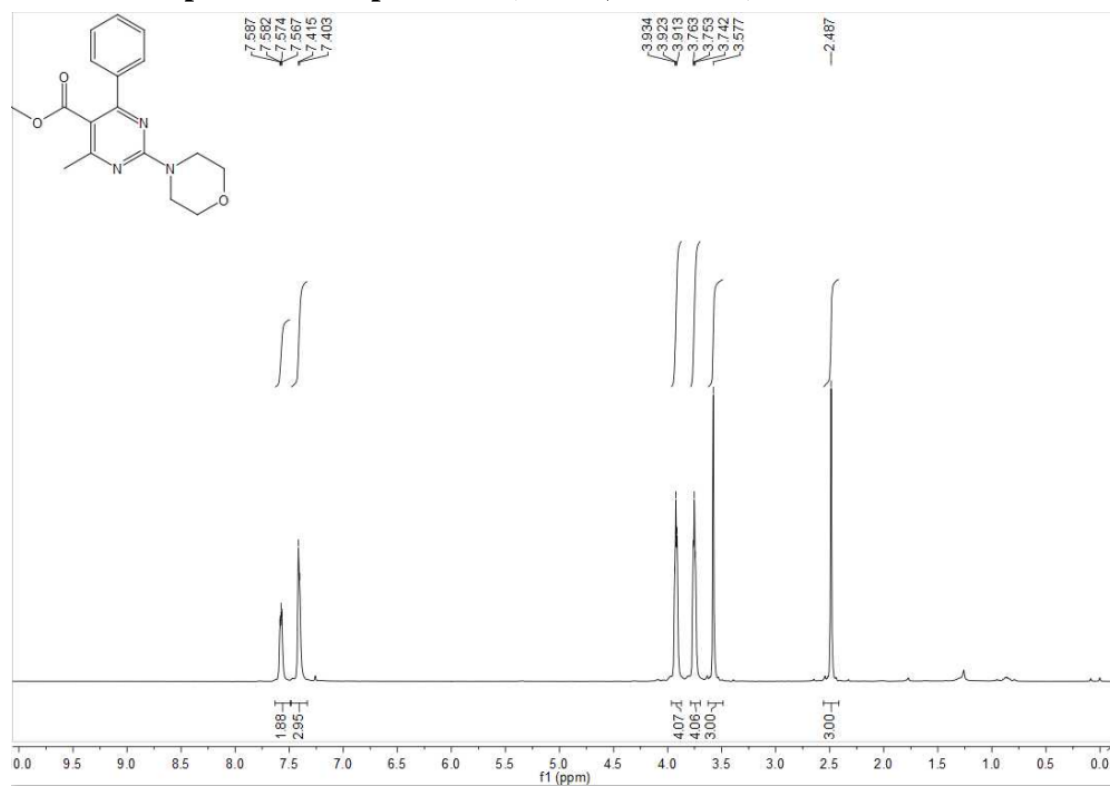
^1H and ^{13}C Spectra of compound 3t (CDCl_3 , 400 MHz)



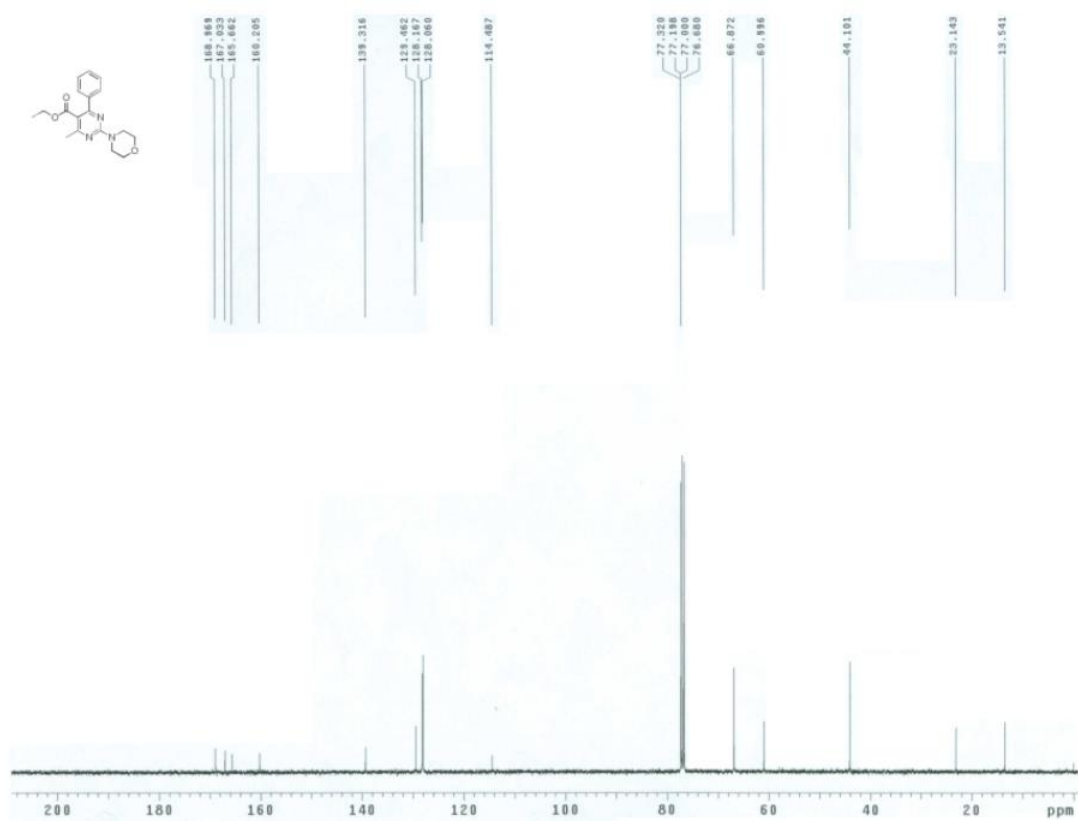
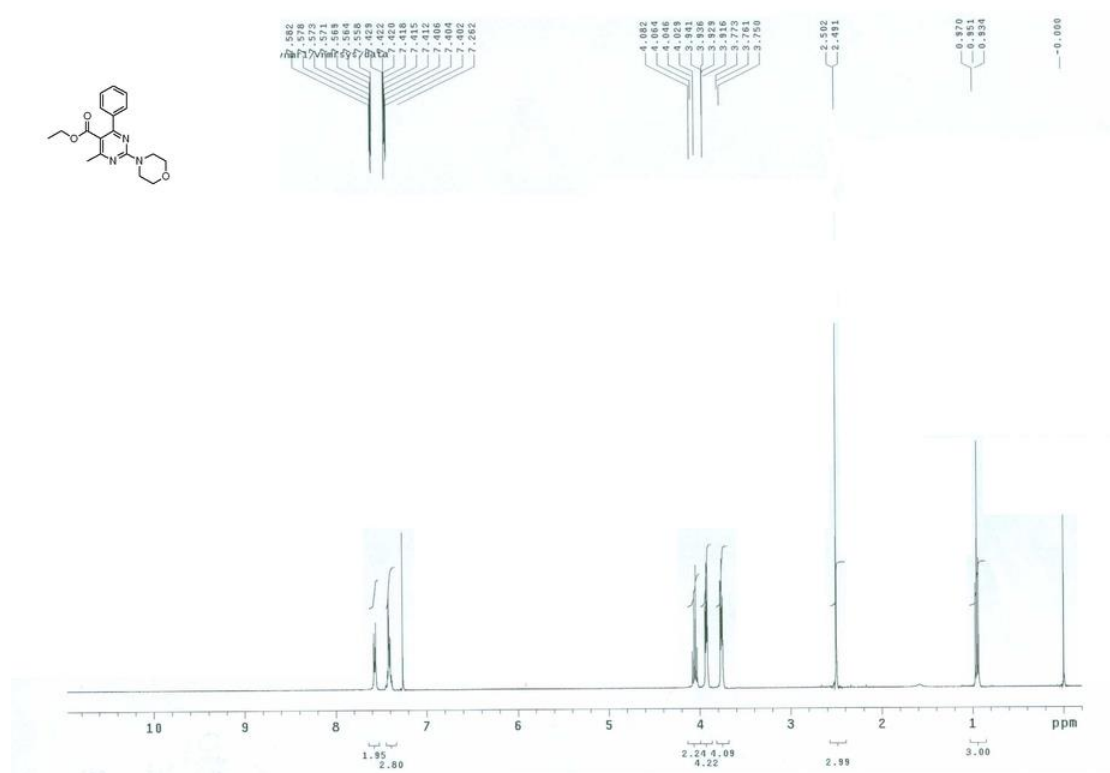
¹H and ¹³C Spectra of compound 3u (CDCl₃, 400 MHz)



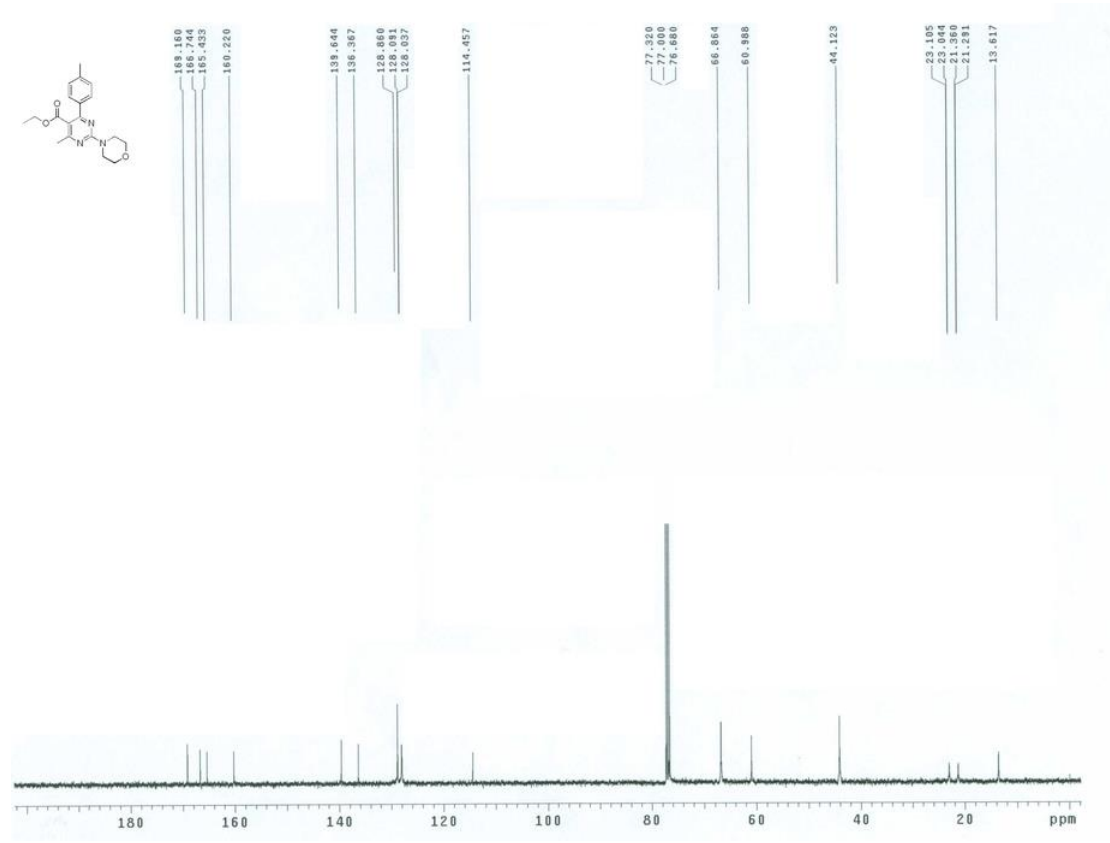
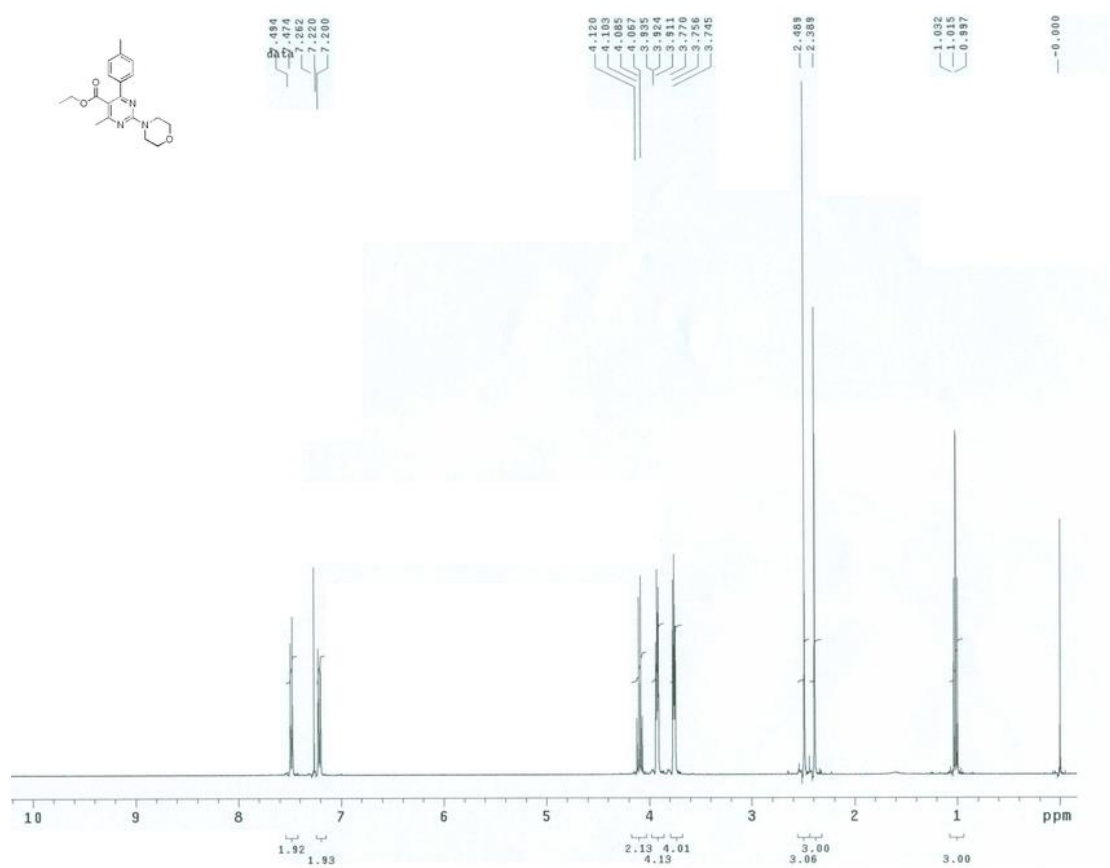
¹H and ¹³C Spectra of compound 5a (CDCl₃, 400 MHz)



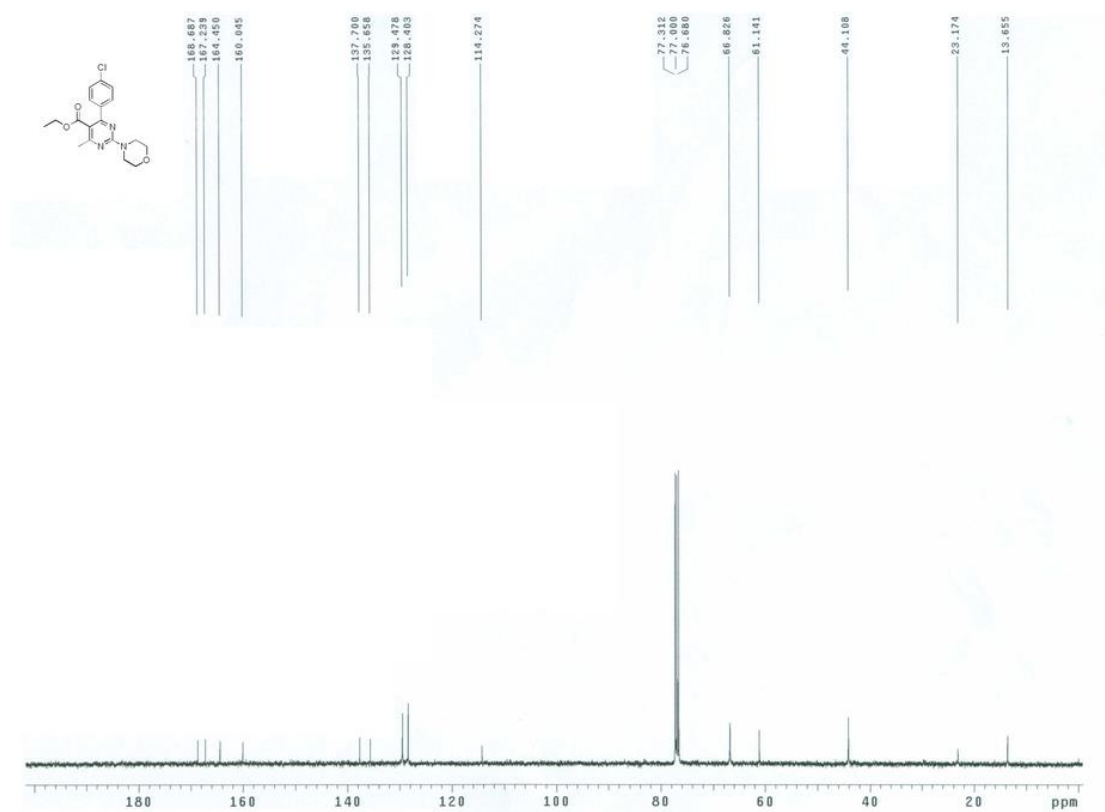
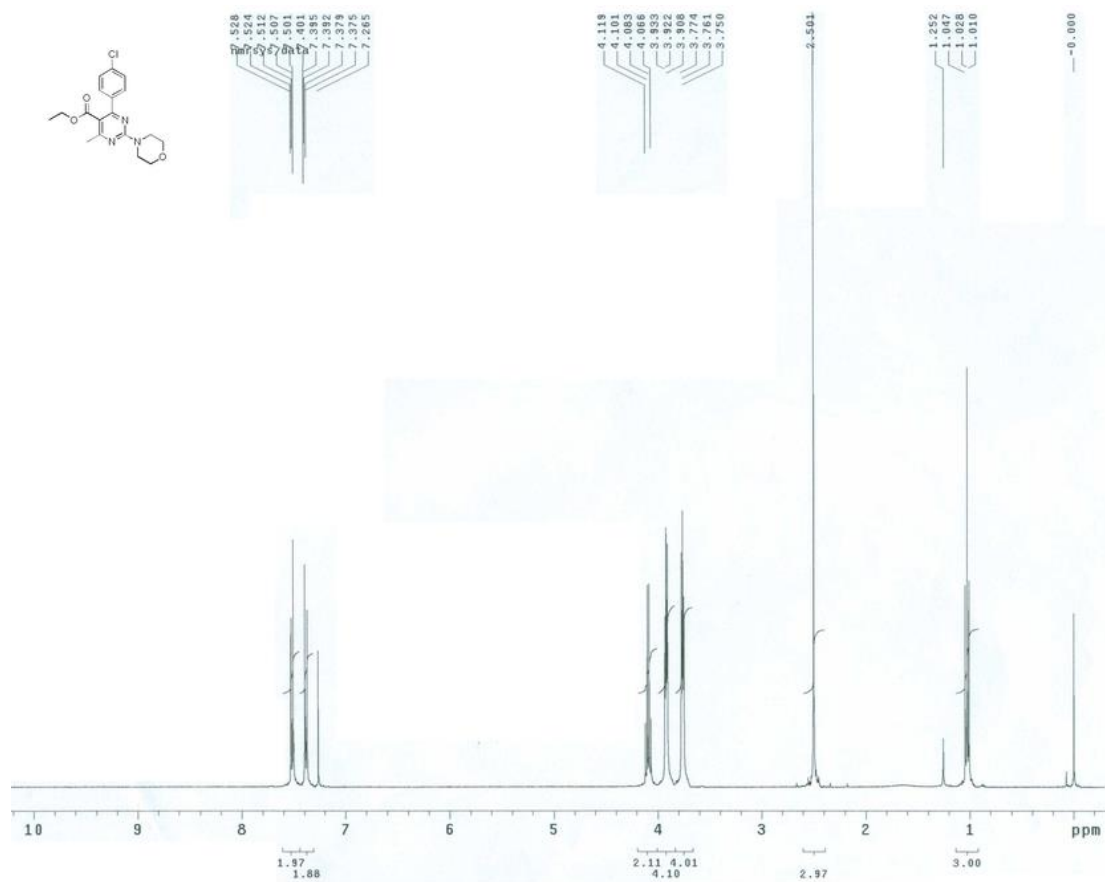
¹H and ¹³C Spectra of compound 5b (CDCl₃, 400 MHz)



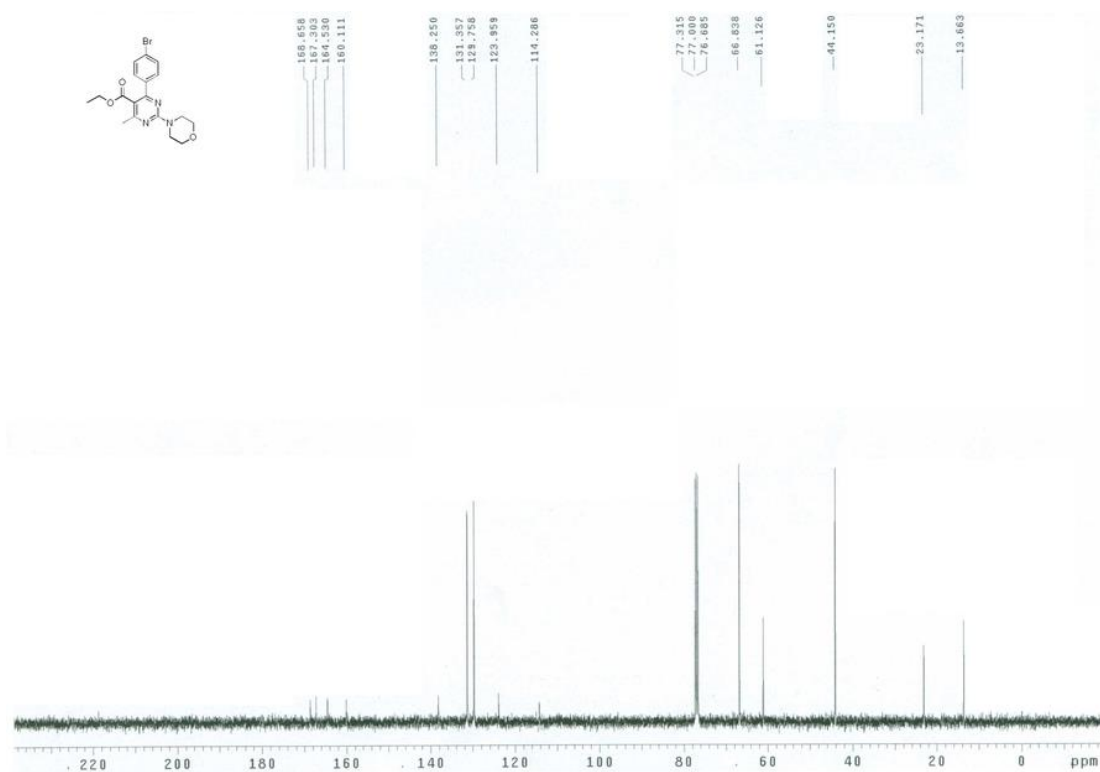
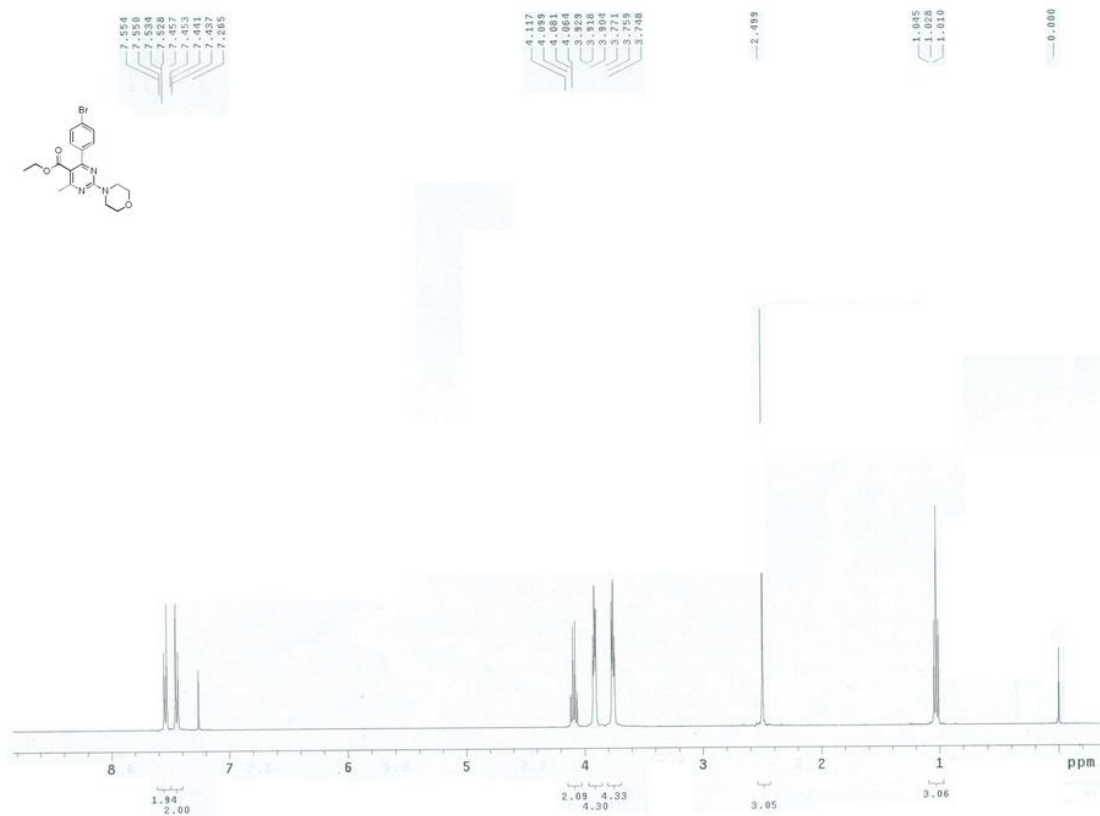
¹H and ¹³C Spectra of compound 5c (CDCl₃, 400 MHz)



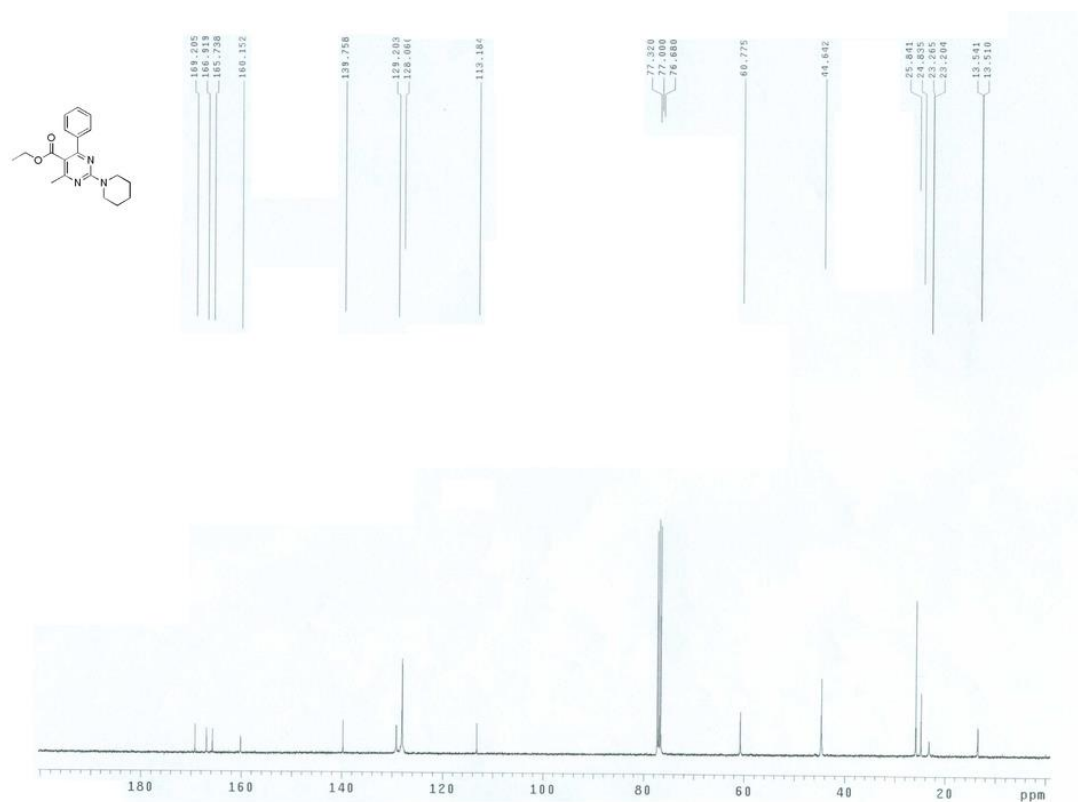
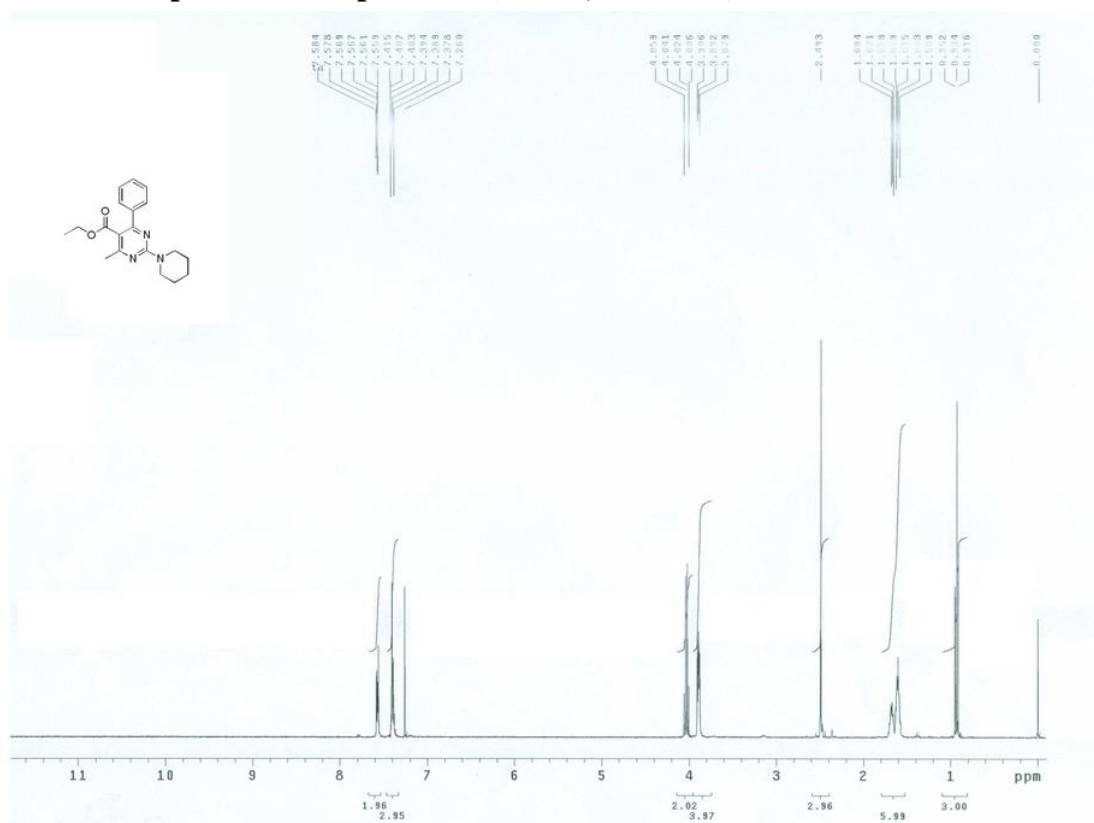
¹H and ¹³C Spectra of compound 5d (CDCl₃, 400 MHz)



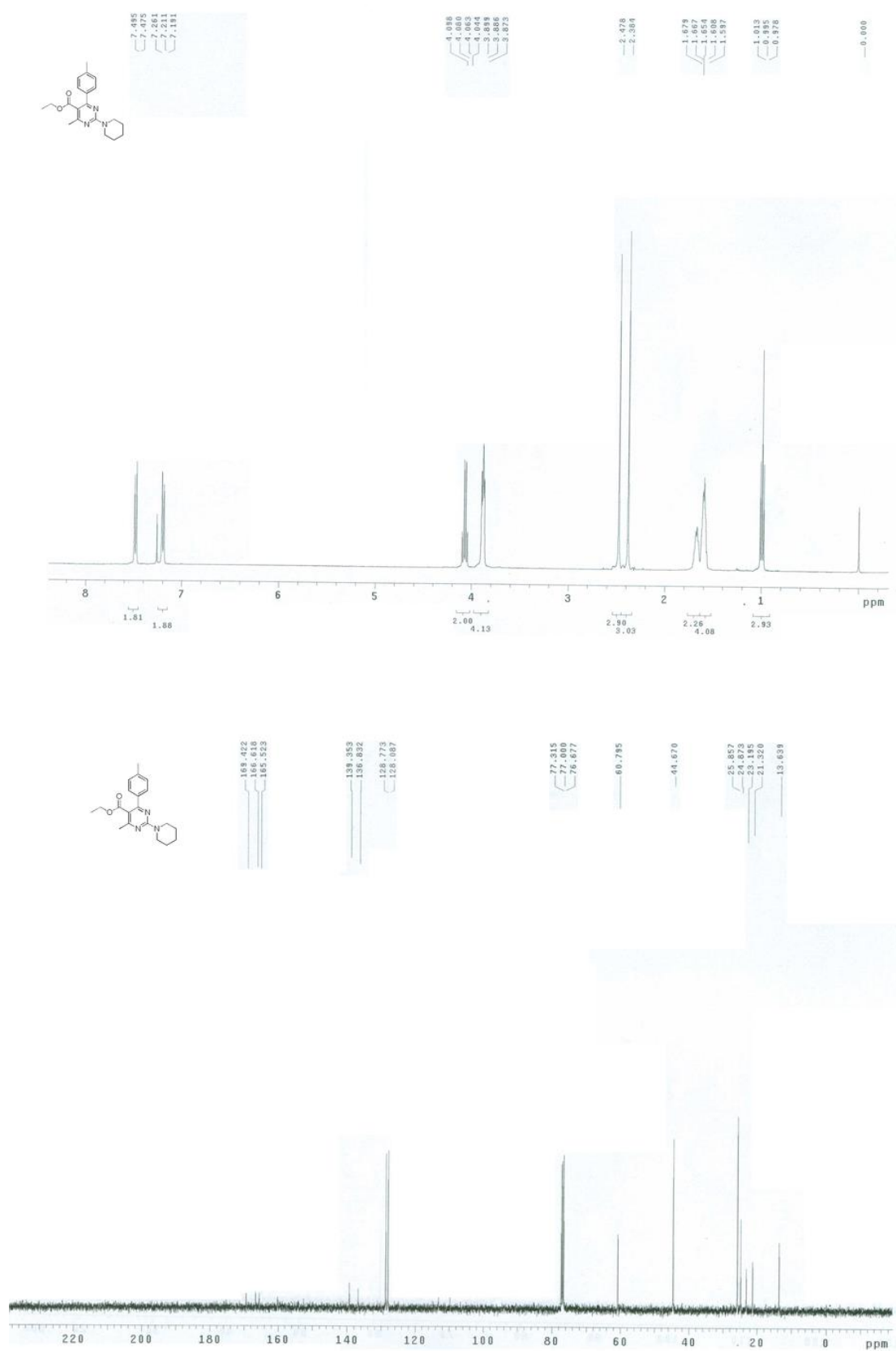
¹H and ¹³C Spectra of compound 5e (CDCl₃, 400 MHz)



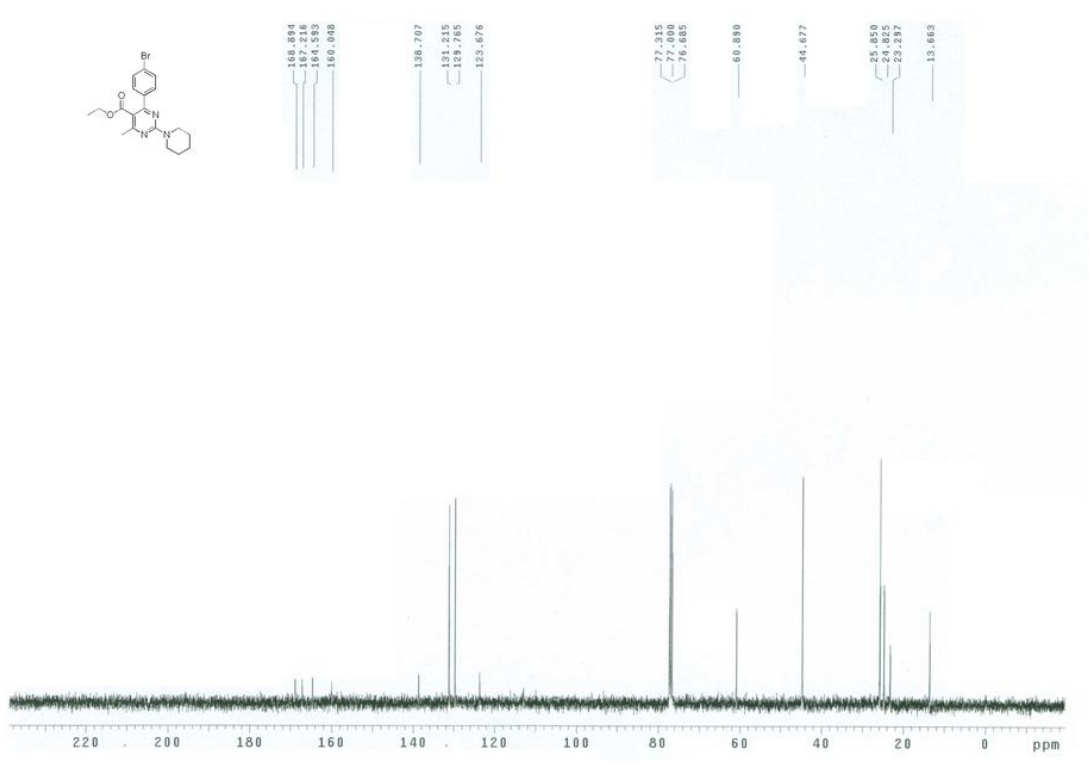
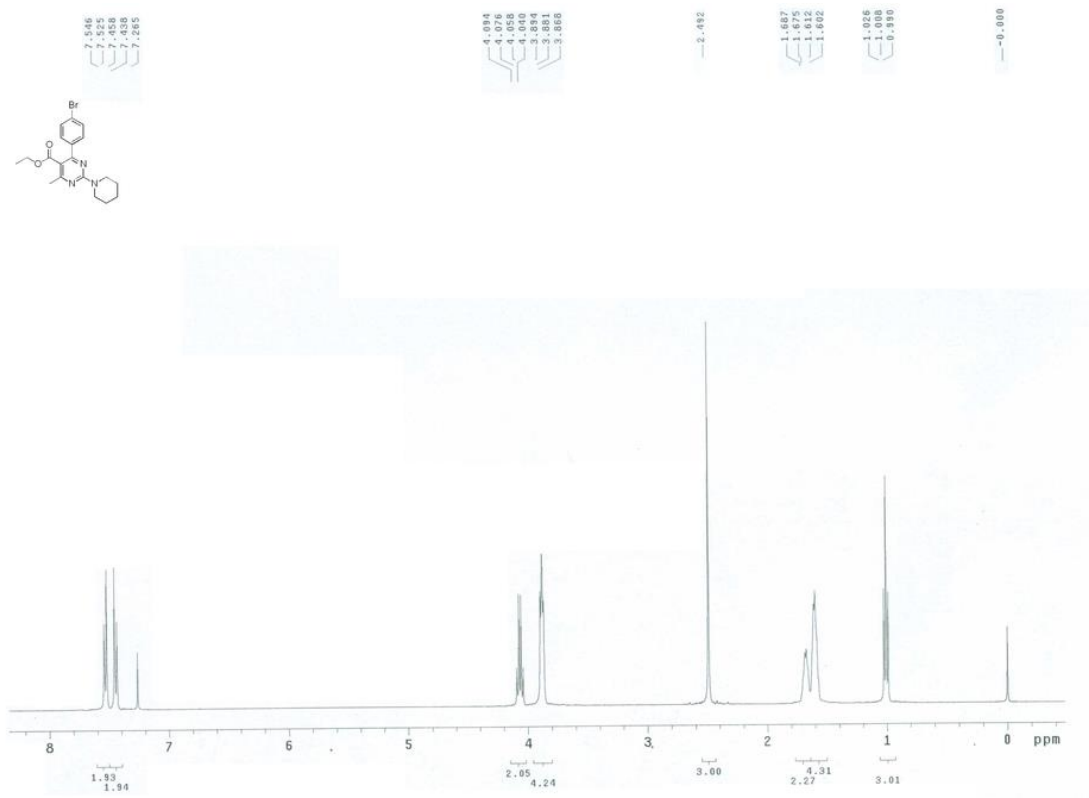
¹H and ¹³C Spectra of compound 5f (CDCl₃, 400 MHz)



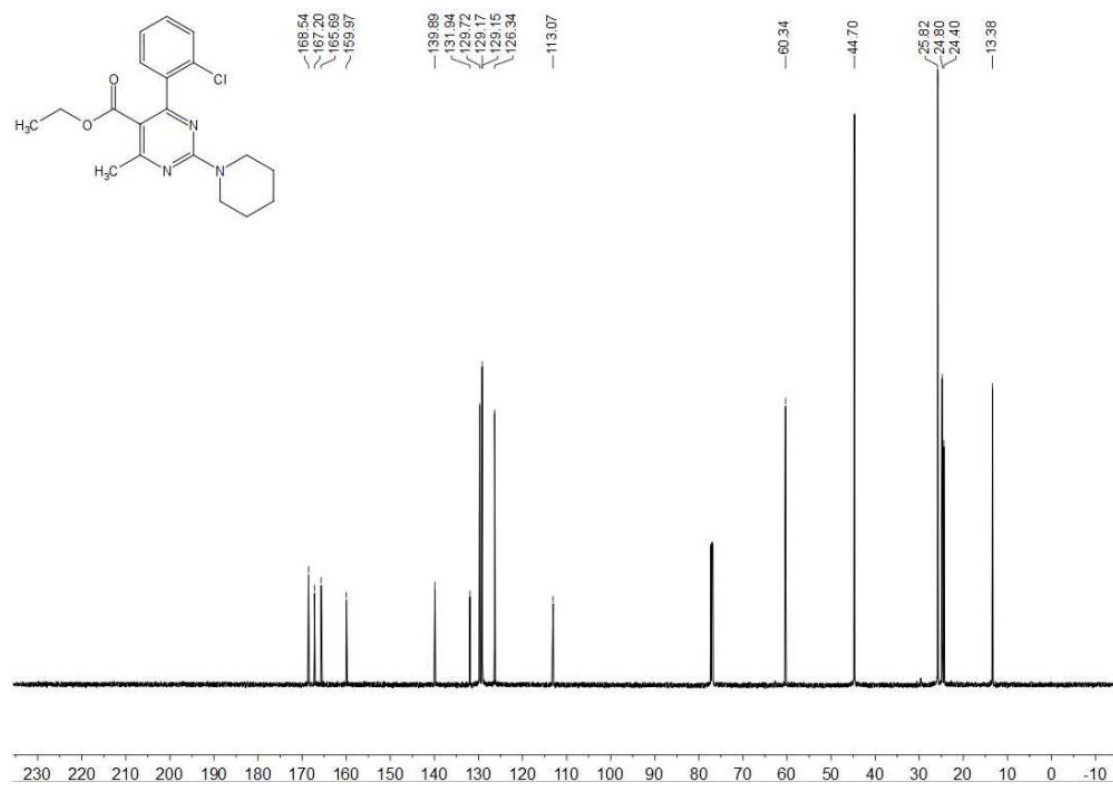
^1H and ^{13}C Spectra of compound 5g (CDCl_3 , 400 MHz)



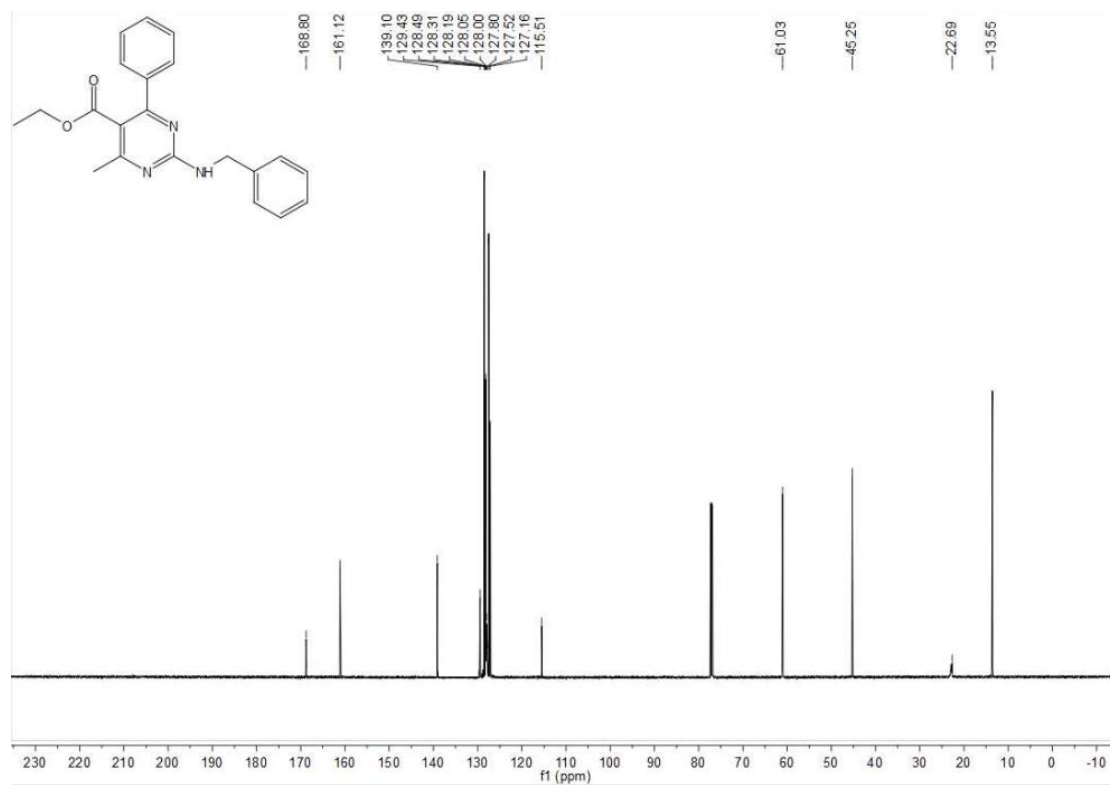
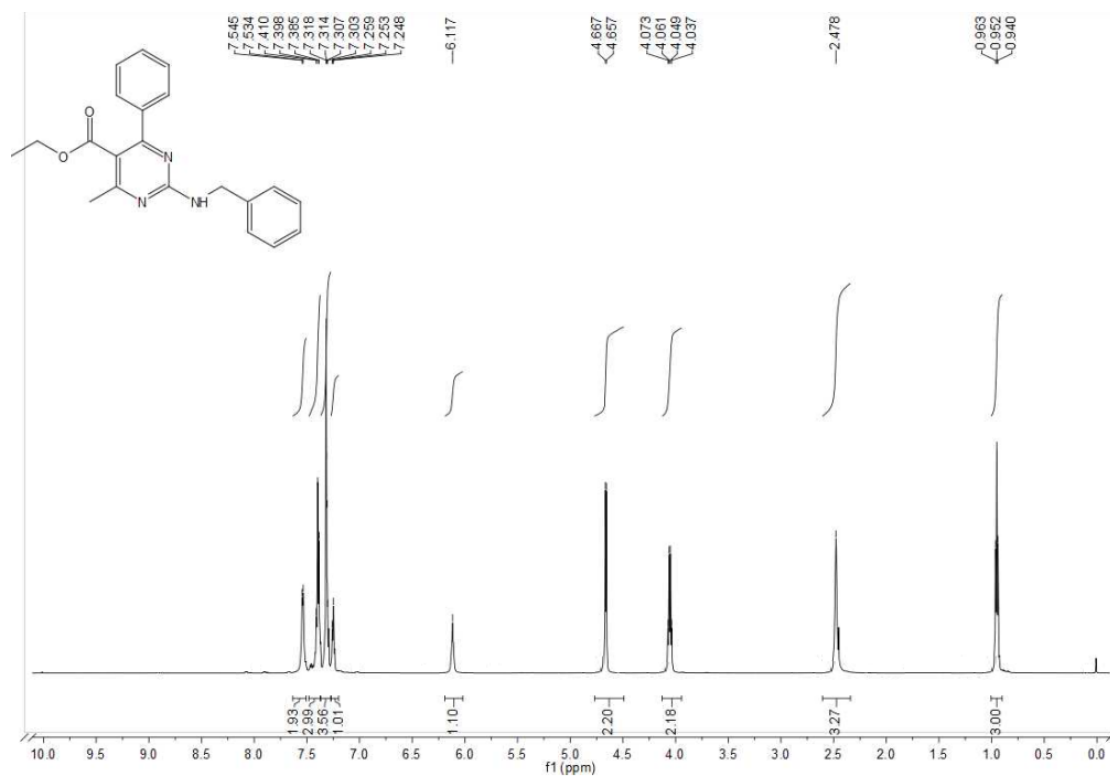
^1H and ^{13}C Spectra of compound 5h (CDCl_3 , 400 MHz)



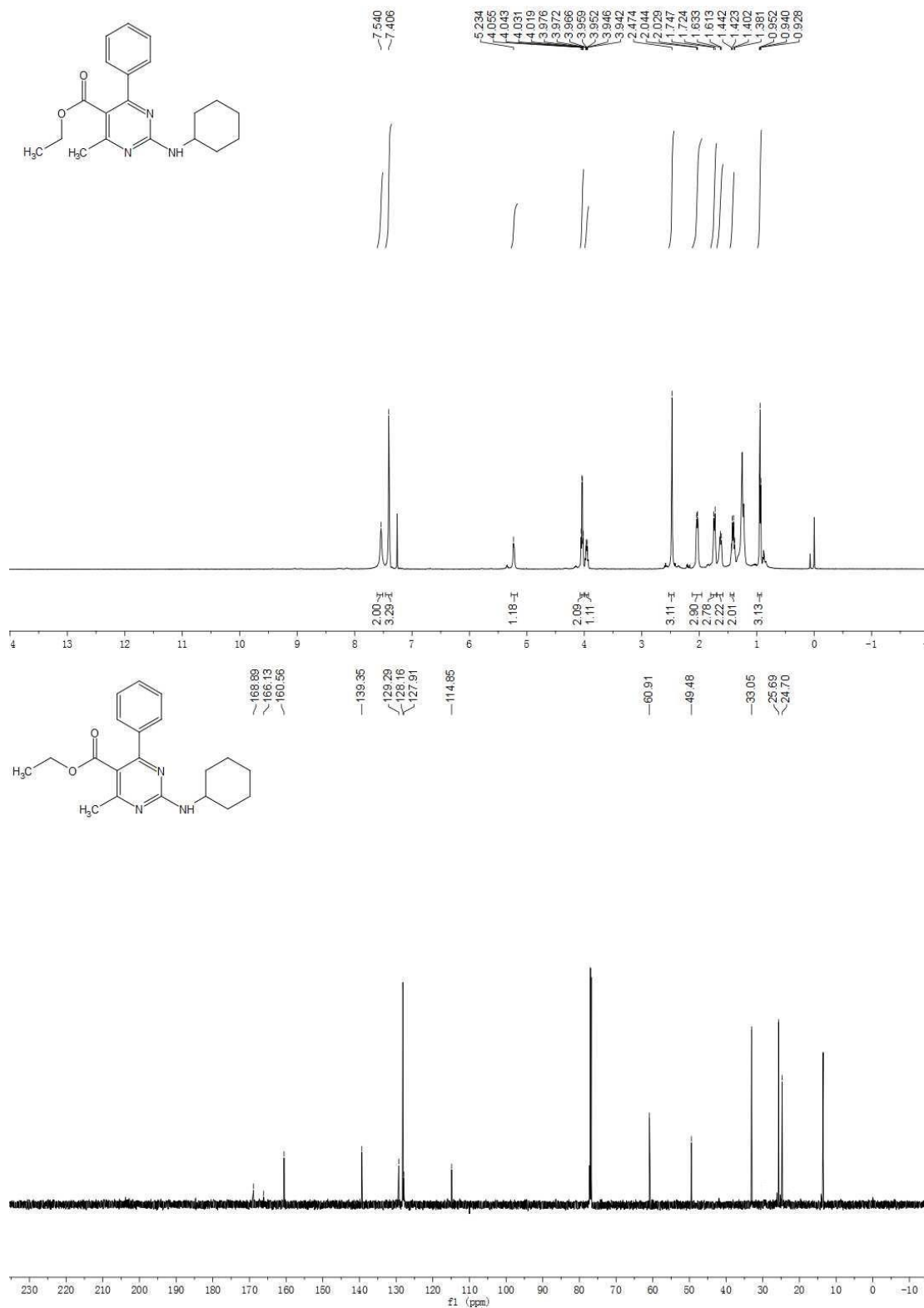
¹H and ¹³C Spectra of compound 5i (CDCl₃, 400 MHz)



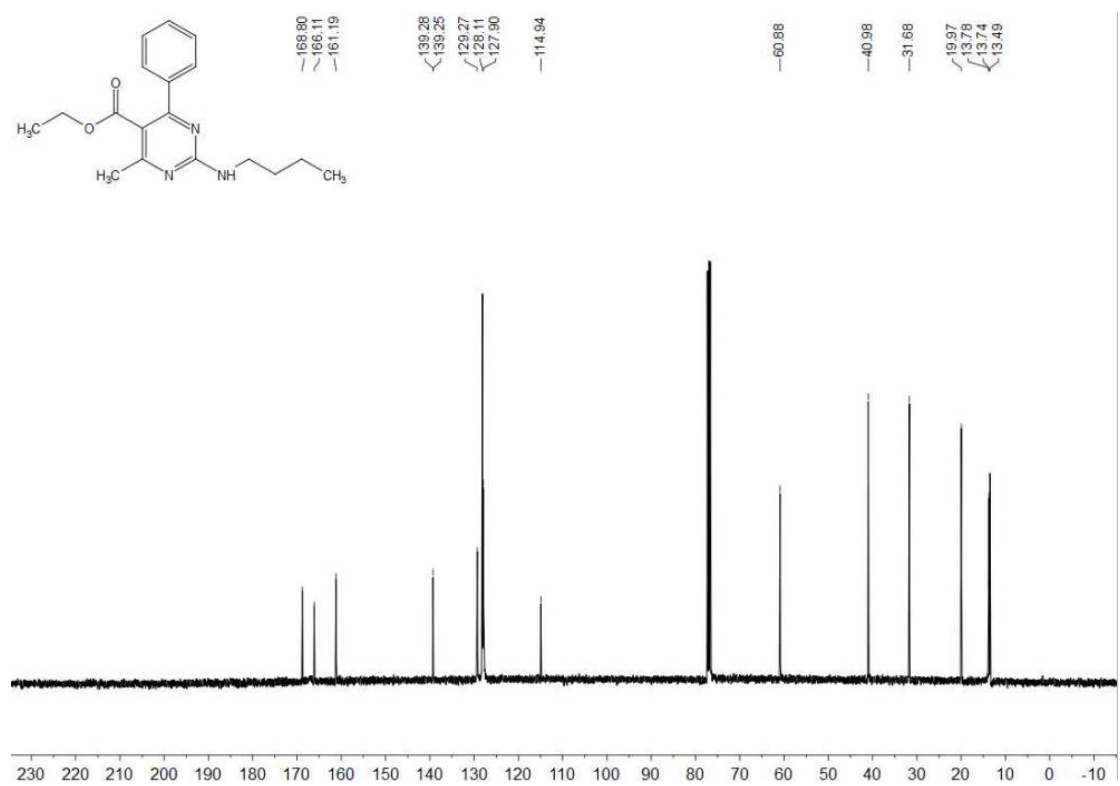
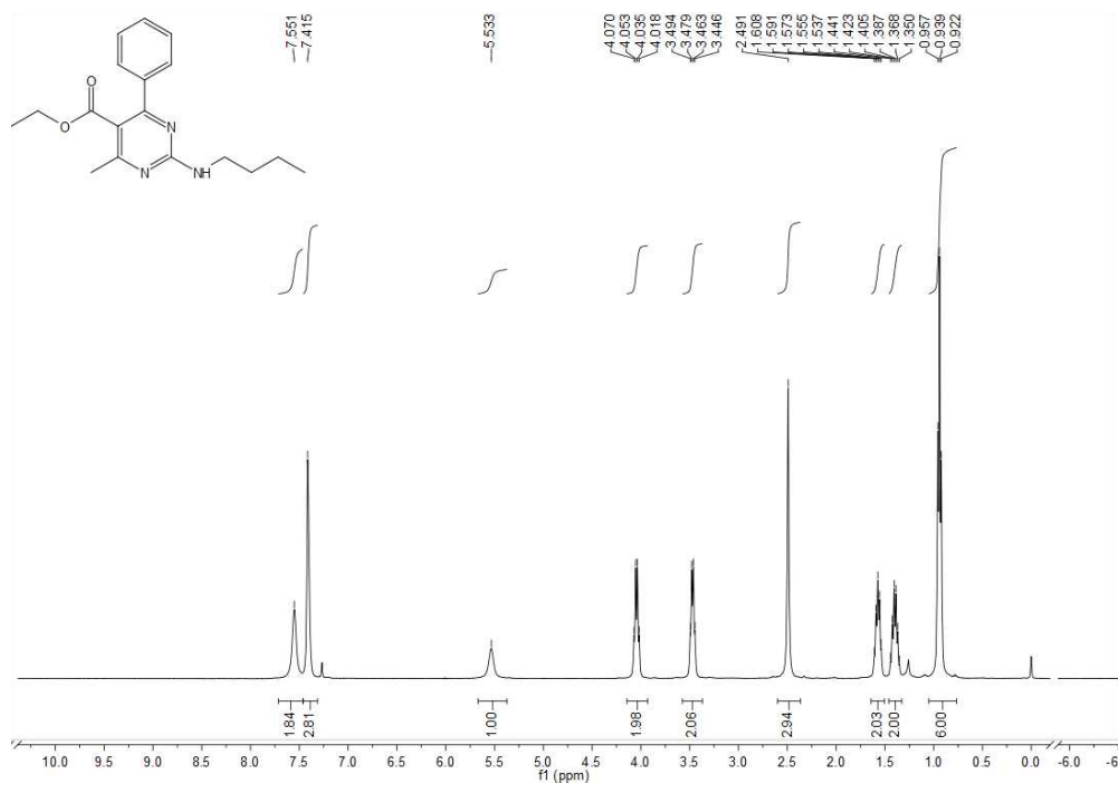
¹H and ¹³C Spectra of compound 5j (CDCl₃, 400 MHz)



¹H and ¹³C Spectra of compound 5k (CDCl₃, 600 MHz)

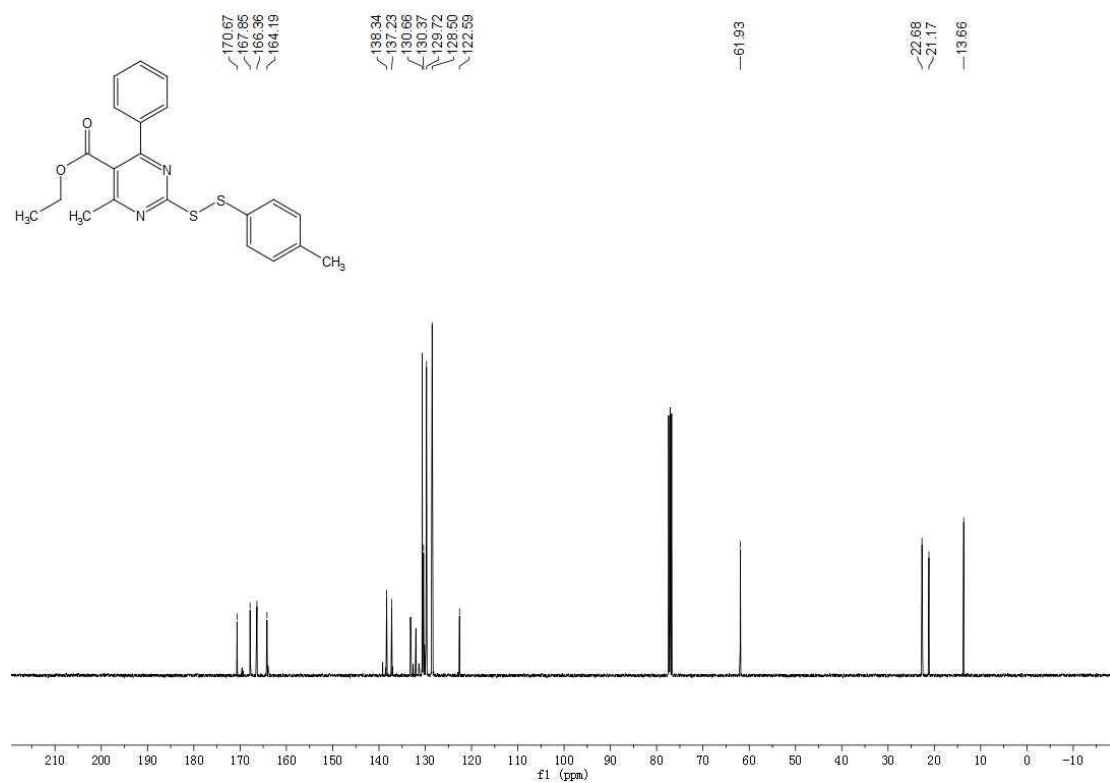
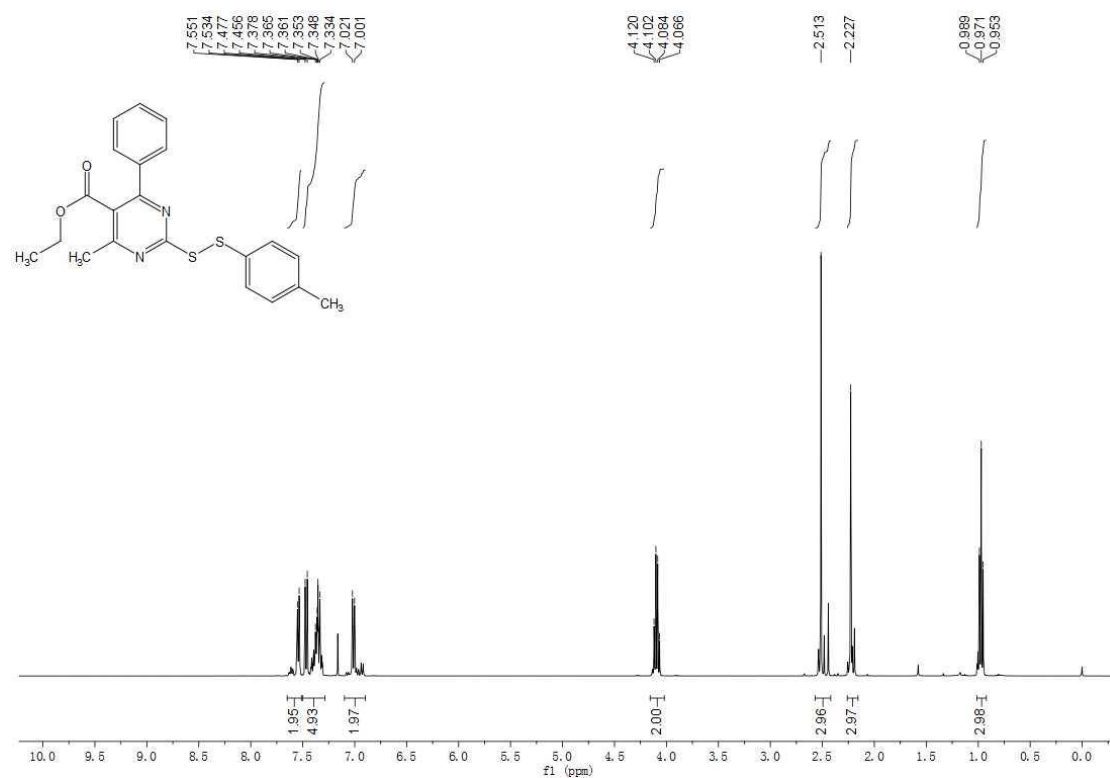


¹H and ¹³C Spectra of compound 5l (CDCl₃, 400 MHz)



¹H and ¹³C Spectra of compound 6a (CDCl₃, 400 MHz)

c



^1H and ^{13}C Spectra of compound 6b (CDCl₃, 400 MHz)

