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Supplementary Information

Copper-promoted dehydrosulfurative carbon–nitrogen cross-coupling with concomitant aromatization for synthesis of 2-aminopyrimidines

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1. General Information

Common solvents were purified before use. Toluene (PhMe) was purified by distillation from sodium-benzophenone ketyl. N,N-Dimethylforamide (DMF, AcroSeal), 1,4-dioxane (AcroSeal) and 2-propanol (AcroSeal) were used as received. All reagents were reagent grade and purified where necessary. Reactions were monitored by thin layer chromatography (TLC) using Whatman pre-coated silica gel plates. Flash column chromatography was performed over ultra-pure silica gel (230-400 mesh) from Merck. Melting points (mp) were determined in opened capillary tubes and are uncorrected. ^{1}H NMR and ^{13}C NMR spectra were recorded on a Bruker AVANCE 300 (300 MHz) or 600 (600 MHz) spectrometer using residual solvent peaks as an internal standard ($CHCl_3$: δ 7.26 ppm for proton and δ 77.0 ppm for carbon; $CHDCl_2$: δ 5.32 ppm for proton and δ 53.5 ppm for carbon). Multiplicities for ^{1}H NMR are designated as: s = singlet, d = doublet, t = triplet, q = quartet, quint = quintet, sext =sextet, sept = septet, dd = doublet of doublets, m = multiplet and br = broad. Infrared spectra (IR) were recorded on JASCO FT/IR-4100 spectrometer and are reported in reciprocal centimeter (cm^{-1}). High resolution mass spectra (HRMS) were obtained on BrukermicroTOF-Q.

2. General procedure for the synthesis of 2-arylaminopyrimidine

To an oven-dried test tube with a magnetic stirring bar were added DHPM or pyrimidine-2-thiol (0.25 mmol), aryl amine (0.38 mmol) and $Cu(OAc)_2$ (90.5 mg, 0.50 mmol) in DMF (1.5 mL). The mixture was degassed with Ar. To the mixture was added slowly LiHMDS (1.0 M in THF, 0.38 mL, 0.38 mmol) at 0 °C in an ice bath and the resulting mixture was allowed to stir at 100 °C in an oil bath under Ar atmosphere until the DHPM or pyrimidine-2-thiol completely disappeared (18-24 h). The mixture was diluted with EtOAc (30 mL) and filtered through a Celite pad. The filtrate was washed with water (5 mL) and brine (5 mL), dried over $MgSO_4$, filtered, and concentrated in vacuo. The crude product was purified by flash column chromatography (silica gel; eluent: *n*-hexane/EtOAc, 10/1 to 4/1) to give the corresponding 2-arylaminopyrimidine.

3. General procedure for synthesis of 2-alkylaminopyrimidine

To an oven-dried test tube with a magnetic stirring bar were added DHPM (0.25 mmol), $Cu(OAc)_2$ (90.5 mg, 0.50 mmol) and K_3PO_4 (106 mg, 0.50 mmol) and 4 Å molecular sieves (100 mg). The reaction vessel was flushed with Ar three times. To the mixture were added 2-propanol (1.5 mL), ethylene glycol (0.028 mL, 0.50 mmol) and aliphatic amine (0.38 mmol), and the resulting mixture was allowed to stir at 100 °C in an oil bath under Ar atmosphere until the DHPM completely disappeared (18-24 h). The resulting mixture was diluted with EtOAc (30 mL) and filtered through a Celite pad. The filtrate was washed with water (5 mL) and brine (5 mL), dried over $MgSO_4$, filtered, and concentrated in vacuo. The crude product was purified by flash column chromatography (silica gel; eluent: *n*-hexane/EtOAc, 10/1 to 4/1) to give the corresponding 2-alkylaminopyrimidine.

4. Characterization data for 2-aminopyrimidines

Ethyl 4-methyl-6-phenyl-2-(phenylamino)pyrimidine-5-carboxylate (**3a**).[1] Eluent in chromatography: *n*-hexane/EtOAc 10:1. Yield: 73.3 mg, 88%; colorless oil. ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.70 (d, *J* = 7.8 Hz, 2H), 7.62 (m, 2H), 7.46–7.42 (m, 4H), 7.34 (t, *J* = 7.7 Hz, 2H), 7.06 (t, *J* = 7.4 Hz, 1H), 4.11 (q, *J* = 7.1 Hz, 2H), 2.57 (s, 3H), 1.00 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (151 MHz, $CDCl_3$) δ 168.4, 167.2, 165.9, 158.6, 139.1, 138.6, 129.7, 128.9, 128.4, 128.1, 122.8, 119.3, 117.2, 61.3, 22.9, 13.6. For the scale-up synthesis, to an oven-dried round-bottom flask with a magnetic stirring bar were added DHPM **1a** (1.00 g, 3.60 mmol), $Cu(OAc)_2$ (1.30 g, 7.20 mmol). The reaction vessel was sealed by septum and flushed with Ar three times. To the mixture were added DMF (15 mL) and aniline (0.660 mL, 7.20 mmol), and the mixture was cooled to 0 °C in an ice bath. To the mixture was added slowly LiHMDS (1.0 M in THF, 7.20 mL, 7.20 mmol) and the resulting mixture was allowed to stir at 100 °C in an oil bath for 18 h under Ar atmosphere. The mixture was filtered through a Celite pad and rinsed with EtOAc (120 mL). The filtrate was washed with water (20 mL) and brine (20 mL), dried over $MgSO_4$, filtered, and concentrated in vacuo. The crude product was purified by flash column chromatography (*n*-hexane/EtOAc, 10/1) to give **3a** (948 mg, 79%).

Ethyl 4-methyl-6-phenyl-2-(p-tolylamino)pyrimidine-5-carboxylate (**3b**).[2] Eluent in chromatography: *n*-hexane/EtOAc 10:1. Yield: 80.7 mg, 93%; colorless viscous oil. ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.62 (m, 2H), 7.56 (d, *J* = 8.4 Hz, 2H), 7.45 (m, 4H), 7.14 (d, *J* = 8.3 Hz, 2H), 4.10 (q, *J* = 7.1 Hz, 2H), 2.56 (s, 3H), 2.33 (s, 3H), 1.00 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (151 MHz, $CDCl_3$) δ 168.4, 167.1, 166.0, 158.7, 138.7, 136.4, 132.4, 129.7, 129.4, 128.3, 128.1, 119.5, 116.9, 61.2, 22.9, 20.8, 13.5.

Ethyl 2-((4-methoxyphenyl)amino)-4-methyl-6-phenylpyrimidine-5-carboxylate (**3c**).[1] Eluent in chromatography: *n*-hexane/EtOAc 10:1. Yield: 78.0 mg, 86%; colorless viscous oil. ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.60 (m, 2H), 7.57 (m, 2H), 7.49 (s, 1H), 7.46-7.41 (m, 3H), 6.89 (m, 2H), 4.09 (q, *J* = 7.1 Hz, 2H), 3.80 (s, 3H), 2.55 (s, 3H), 0.99 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (151 MHz, $CDCl_3$) δ 168.4, 167.1, 166.1, 158.7, 155.7, 138.7, 132.1, 129.7, 128.3, 128.0, 121.3, 116.7, 114.1, 61.2, 55.5, 22.8, 13.5.

Ethyl 2-((4-fluorophenyl)amino)-4-methyl-6-phenylpyrimidine-5-carboxylate (**3d**).[3] Eluent in chromatography: *n*-hexane/EtOAc 10:1. Yield: 78.1 mg, 89%; brown solid. ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.62–7.59 (m, 4H), 7.48 (s, 1H), 7.47-7.42 (m, 3H), 7.02 (m, 2H), 4.11 (q, *J* = 7.1 Hz, 2H), 2.56 (s, 3H), 1.00 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (151 MHz, $CDCl_3$) δ 168.4, 167.3, 166.0, 159.4 (C-F, $^{1}J_{C\text{-}F}$ = 242 Hz), 158.62, 157.8 (C-F, $^{1}J_{C\text{-}F}$ = 242 Hz), 138.5, 135.10 (C-F, $^{4}J_{C\text{-}F}$ = 2.6 Hz), 135.08 (C-F, $^{4}J_{C\text{-}F}$ = 2.6 Hz), 129.8, 128.4, 128.0, 121.1 (C-F, $^{3}J_{C\text{-}F}$ = 7.7 Hz), 121.0 (C-F, $^{3}J_{C\text{-}F}$ = 7.7 Hz), 117.3, 115.5 (C-F, $^{2}J_{C\text{-}F}$ = 22 Hz), 115.4 (C-F, $^{2}J_{C\text{-}F}$ = 22 Hz), 61.3, 22.9, 13.5.

Ethyl 2-((4-iodophenyl)amino)-4-methyl-6-phenylpyrimidine-5-carboxylate (**3e**).[3] Eluent in chromatography: *n*-hexane/EtOAc 10:1. Yield: 73.4 mg, 64%; white solid. ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.60 (m, 5H), 7.49–7.42 (m, 5H), 4.12 (q, *J* = 7.1 Hz, 2H), 2.56 (s, 3H), 1.00 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (151 MHz, $CDCl_3$) δ 168.3, 167.2, 165.8, 158.4, 139.0, 138.4, 137.7, 129.8, 128.4, 128.0, 121.2, 117.6, 85.3, 61.4, 22.8, 13.6.

Ethyl 4-methyl-2-((4-nitrophenyl)amino)-6-phenylpyrimidine-5-carboxylate (**3f**).[3] Eluent in chromatography: *n*-hexane/EtOAc 10:1, Yield: 56.7 mg, 60%; pale yellow solid. ^{1}H NMR (600 MHz, $CDCl_3$): δ 8.21 (d, *J* = 9.2 Hz, 2H), 7.90 (s, 1H), 7.85 (d, *J* = 9.2 Hz, 2H), 7.63 (m, 2H), 7.50–7.45 (m, 3H), 4.15 (q, *J* = 7.1 Hz, 2H), 2.61 (s, 3H), 1.03 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (151 MHz, $CDCl_3$) δ 167.9, 167.4, 165.8, 157.8, 145.2, 142.1, 137.9, 130.2, 128.6, 128.1, 125.2, 119.0, 118.0, 61.7, 22.8, 13.6.

Ethyl 2-((4-cyanophenyl)amino)-4-methyl-6-phenylpyrimidine-5-carboxylate (**3g**).[3] Eluent in chromatography: *n*-hexane/EtOAc 10:1. Yield: 51.9 mg, 58%; pale yellow viscous oil. ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.85 (s, 1H), 7.79 (d, *J* = 8.7 Hz, 2H), 7.61 (m, 2H), 7.58 (d, *J* = 8.7 Hz, 2H), 7.49–7.43 (m, 3H), 4.14 (q, *J* = 7.1 Hz, 2H), 2.59 (s, 3H), 1.02 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (151 MHz, $CDCl_3$) δ 168.0, 167.3, 165.8, 157.9, 143.2, 138.0, 133.2, 130.1, 128.5, 128.0, 119.3, 118.6, 105.0, 61.6, 22.8, 13.5.

Ethyl 4-methyl-2-(naphthalen-1-ylamino)-6-phenylpyrimidine-5-carboxylate (**3h**).[4] Eluent in chromatography: *n*-hexane/EtOAc 10:1. Yield: 54.6 mg, 57%; pale yellow viscous oil. ^{1}H NMR (600 MHz, $CDCl_3$): δ 8.20 (d, *J* = 7.5 Hz, 1H), 8.05 (m, 1H), 7.87 (m, 1H), 7.82 (s, 1H), 7.67 (d, *J* = 8.2 Hz, 1H), 7.60 (m, 2H), 7.51 (m, 3H), 7.42 (m, 3H), 4.12 (q, *J* = 7.1 Hz, 2H), 2.55 (s, 3H), 1.01 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (151 MHz, $CDCl_3$) δ 168.5, 167.3, 166.0, 159.7, 138.6, 134.2, 133.8, 129.7, 128.6, 128.3, 128.1, 127.2, 126.0, 125.9, 125.7, 124.5, 121.1, 119.1, 117.3, 61.3, 22.9, 13.6.

Ethyl 4-methyl-6-phenyl-2-(o-tolylamino)pyrimidine-5-carboxylate (**3i**).[4] Eluent in chromatography: *n*-hexane/EtOAc 10:1. Yield: 53.7 mg, 65%; pale yellow viscous oil. ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.13 (d, *J* = 8.0 Hz, 1H), 7.60 (m, 2H), 7.50–7.37 (m, 3H), 7.24 (t, *J* = 8.1 Hz, 1H), 7.21 (d, *J* = 7.4 Hz, 1H), 7.04 (t, *J* = 7.4 Hz, 1H), 4.10 (q, *J* = 7.1 Hz, 2H), 2.55 (s, 3H), 2.35 (s, 3H), 1.00 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 168.6, 167.3, 166.2, 159.1, 138.7, 137.1, 130.6, 129.9, 128.6, 128.5, 128.2, 126.7, 124.0, 121.9, 117.2, 61.5, 23.0, 18.4, 13.7.

Ethyl 4-methyl-6-phenyl-2-(propylamino)pyrimidine-5-carboxylate (**3j**). Eluent in chromatography: *n*-hexane/EtOAc 10:1. Yield: 42.6 mg, 57%; pale yellow viscous oil. ^{1}H NMR (300 MHz, $CDCl_3$): δ 7.54 (s, 2H), 7.41 (m, 3H), 5.51 (brs, 1H), 4.04 (q, *J* = 7.1 Hz, 2H), 3.44 (q, *J* = 6.6 Hz, 2H), 2.48 (s, 3H), 1.62 (sext, J = 7.2 Hz, 2H), 0.95, (m, 6H); ^{13}C{^{1}H} NMR (75 MHz, $CDCl_3$) δ 168.8, 166.2, 161.2, 139.2, 129.4, 128.2, 127.9, 114.9, 61.0, 43.1, 22.9, 22.8, 13.5, 11.4; IR (film) cm^{-1}: 2965, 1711, 1553, 1447, 1259, 1173, 1082, 700; HRMS (ESI) (*m/z*): calcd for $C_{17}H_{22}N_3O_2$ $[M+H]^+$ 300.1712, found 300.1699.

Ethyl 4-methyl-2-morpholino-6-phenylpyrimidine-5-carboxylate (**3k**).[3] Eluent in chromatography: *n*-hexane/EtOAc 10:1. Yield: 52.3 mg, 64%; yellow solid. ^{1}H NMR (600 MHz, $CDCl_3$): 7.57 (dd, *J* = 7.8, 1.6 Hz, 2H), 7.45 – 7.38 (m, 3H), 4.06 (q, *J* = 7.1 Hz, 2H), 3.93 (t, *J* = 4.7 Hz, 4H), 3.76 (*J* = 4.7 Hz, 4H), 2.50 (s, 3H), 0.95 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (151 MHz, $CDCl_3$) δ 168.9, 167.0, 165.7, 160.2, 139.3, 129.5, 128.2, 128.1, 114.6, 66.9, 61.0, 44.2, 23.1, 13.5.

Ethyl 4-methyl-6-phenyl-2-(pyrrolidin-1-yl)pyrimidine-5-carboxylate (**3l**).[1] Eluent in chromatography: *n*-hexane/EtOAc 10:1. Yield: 50.3 mg, 65%; yellow oil. ^{1}H NMR (600 MHz, CD_2Cl_2) δ 7.45 (dt, *J* = 10.3, 4.9 Hz, 2H), 7.37 – 7.27 (m, 3H), 3.98 – 3.90 (m, 2H), 3.53 (t, *J* = 6.7 H z, 4H), 2.38 (s, 3H), 1.90 (q, *J* = 6.6 Hz, 4H), 0.91 – 0.83 (m, 3H); ^{13}C{^{1}H} NMR (151 MHz, CD_2Cl_2) δ 169.1, 166.7, 165.6, 159.3, 140.0, 129.2, 128.1, 113.5, 60.8, 46.7, 25.5, 23.0, 13.5.

N,4-diphenylpyrimidin-2-amine (**4a**).[6] Eluent in chromatography: *n*-hexane/EtOAc 10:1. Yield: 22.2 mg, 36%; white solid. ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.49 (d, *J* = 5.3 Hz, 1H), 8.13-8.06 (m, 2H), 7.74-7.72 (m, 2H), 7.54 (brs, 1H) 7.53-7.47 (m, 3H), 7.38 (t, *J* = 7.8 Hz, 2H), 7.17 (d, *J* = 5.2 Hz, 1H), 7.07 (t, *J* = 7.4 Hz, 1H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 165.2, 160.4, 158.5, 139.8, 137.2, 130.9, 129.0, 128.97, 127.3, 122.6, 119.4, 108.5.

tert-Butyl 4-methyl-6-phenyl-2-(phenylamino)pyrimidine-5-carboxylate (**4b**).[3] Eluent in chromatography: *n*-hexane/EtOAc 10:1. Yield: 29.8 mg, 33%; pale yellow viscous oil. ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.68 (d, *J* = 7.7 Hz, 2H), 7.64 (m, 2H), 7.61 (brs, 1H), 7.47–7.43 (m, 3H), 7.33 (t, *J* = 7.5 Hz, 2H), 7.05 (t, *J* = 7.4 Hz, 1H), 2.57 (s, 3H), 1.33 (s, 9H); ^{13}C{^{1}H} NMR (151 MHz, $CDCl_3$) δ 167.2, 166.6, 165.6, 158.2, 139.1, 138.6, 129.7, 128.9, 128.31, 128.29, 122.7, 119.2, 118.8, 82.2, 27.6, 22.7.

Ethyl 4-methyl-6-(p-tolyl)-2-(p-tolylamino)pyrimidine-5-carboxylate (**4c**). Eluent in chromatography: *n*-hexane/EtOAc 10:1. Yield: 81.2 mg, 90%; yellow oil. ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.54 (t, *J* = 8.5 Hz, 4H), 7.49 (s, 1H), 7.24 (d, *J* = 7.9 Hz, 2H), 7.13 (d, *J* = 8.3 Hz, 2H), 4.14 (q, *J* = 7.1 Hz, 2H), 2.55 (s, 3H), 2.41 (s, 3H), 2.32 (s, 3H), 1.06 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (151 MHz, $CDCl_3$) δ 168.7, 166.9, 165.7, 158.7, 139.9, 136.5, 135.7, 132.3, 129.3, 129.0, 128.1, 119.5, 116.8, 61.2, 22.8, 21.3, 20.7, 13.6; IR (film) cm^{-1}: 3301, 2984, 1711, 1510, 1433, 1254, 1086, 806, 505; HRMS (ESI) (*m/z*): calcd for $C_{22}H_{24}N_3O_2$ $[M+H]^+$ 362.1869, found 362.1847.

Ethyl 4-(4-fluorophenyl)-6-methyl-2-(phenylamino)pyrimidine-5-carboxylate (**4d**).[4] Eluent in chromatography: *n*-hexane/EtOAc 10:1. Yield: 77.2 mg, 88%; white solid. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.67 (d, *J* = 7.8 Hz, 2H), 7.63 (m, 2H), 7.60 (brs, 1H), 7.34 (t, *J* = 7.9 Hz, 2H), 7.14 (t, *J* = 8.6 Hz, 2H), 7.07 (t, *J* = 7.4 Hz, 1H), 4.15 (q, *J* = 7.1 Hz, 2H), 2.57 (s, 3H), 1.07 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (151 MHz, $CDCl_3$) δ 168.2, 167.2, 164.73, 164.66 (C-F, $^1J_{C\text{-}F}$ = 251 Hz), 163.0 (C-F, $^1J_{C\text{-}F}$ = 251 Hz), 158.4, 138.9, 134.6 (C-F, $^4J_{C\text{-}F}$ = 3.2 Hz), 134.5 (C-F, $^4J_{C\text{-}F}$ = 3.2 Hz), 130.22 (C-F, $^3J_{C\text{-}F}$ = 8.6 Hz), 130.17 (C-F, $^3J_{C\text{-}F}$ = 8.6 Hz), 128.9, 123.0, 119.4, 117.0, 115.5 (C-F, $^2J_{C\text{-}F}$ = 21.8 Hz), 115.4 (C-F, $^2J_{C\text{-}F}$ = 21.8 Hz), 61.4, 22.8, 13.7.

Ethyl 4-(4-bromophenyl)-6-methyl-2-(phenylamino)pyrimidine-5-carboxylate (**4e**).[4] Eluent in chromatography: *n*-hexane/EtOAc 10:1. Yield: 71.1 mg, 69%; yellow solid. ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.67 (m, 2H), 7.58 (m, 2H), 7.50 (m, 3H), 7.34 (t, *J* = 8.0 Hz, 2H), 7.07 (t, *J* = 7.4 Hz, 1H), 4.14 (q, *J* = 7.1 Hz, 2H), 2.57 (s, 3H), 1.07 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (151 MHz, $CDCl_3$) δ 168.1, 167.4, 164.7, 158.5, 138.9, 137.5, 131.6, 129.8, 128.9, 124.4, 123.0, 119.4, 117.0, 61.5, 22.9, 13.7.

Ethyl 2-((4-fluorophenyl)amino)-4-methylpyrimidine-5-carboxylate (**4f**). Eluent in chromatography: *n*-hexane/EtOAc 10:1. Yield: 37.1 mg, 54%; pale yellow solid, mp 123-125 °C. ^{1}H NMR (600 MHz, $CDCl_3$): δ 8.92 (s, 1H), 7.61 (m, 3H), 7.05 (m, 2H), 4.35 (q, *J* = 7.1 Hz, 2H), 2.74 (s, 3H), 1.39 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (151 MHz, $CDCl_3$) δ 170.8, 164.9, 161.1, 159.91 (C-F, $^{1}J_{C\text{-}F}$ = 243 Hz), 159.89, 158.3 (C-F, $^{1}J_{C\text{-}F}$ = 243 Hz), 134.41 (C-F, $^{4}J_{C\text{-}F}$ = 2.7 Hz), 134.39 (C-F, $^{4}J_{C\text{-}F}$ = 2.7 Hz), 121.90 (C-F, $^{3}J_{C\text{-}F}$ = 7.7 Hz), 121.85 (C-F, $^{3}J_{C\text{-}F}$ = 7.7 Hz), 115.7 (C-F, $^{2}J_{C\text{-}F}$ = 22.7 Hz), 115.6 (C-F, $^{2}J_{C\text{-}F}$ = 22.7 Hz), 114.7, 60.8, 24.7, 14.3; IR (film) cm^{-1}: 3321, 1674, 1594, 1502, 1442, 1363, 1271, 1194, 829, 711, 587, 507; HRMS (ESI) (*m/z*): calcd for $C_{14}H_{15}FN_3O_2$ $[M+H]^+$ 276.1148; found 276.1132.

Ethyl 2-((4-fluorophenyl)amino)-4-phenyl-6-propylpyrimidine-5-carboxylate (**4g**). Eluent in chromatography: *n*-hexane/EtOAc 10:1. Yield: 71.1 mg, 75%; pale yellow viscous oil. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.65 (m, 2H), 7.61 (m, 2H), 7.47-7.43 (m, 3H), 7.03 (m, 2H), 4.10 (q, *J* = 7.1 Hz, 2H), 2.80 (m, 2H), 1.82 (sext, J = 7.4 Hz, 2H), 1.03 (t, *J* = 7.4 Hz, 3H), 1.00 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 170.4, 168.4, 165.9, 160.1 (C-F, $^{1}J_{C\text{-}F}$ = 242 Hz), 158.6, 156.9 (C-F, $^{1}J_{C\text{-}F}$ = 242 Hz), 138.5, 135.2, 129.8, 128.4, 128.0, 120.9 (C-F, $^{3}J_{C\text{-}F}$ = 7.7 Hz), 120.8 (C-F, $^{3}J_{C\text{-}F}$ = 7.7 Hz), 117.4, 115.6 (C-F, $^{3}J_{C\text{-}F}$ = 22.6 Hz), 115.3 (C-F, $^{3}J_{C\text{-}F}$ = 22.6 Hz), 61.4, 37.5, 22.0, 14.0, 13.6; IR (film) cm^{-1}: 3013, 2927, 1723, 1263, 731; HRMS (ESI) (*m/z*): calcd for $C_{22}H_{23}FN_3O_2$ $[M+H]^+$ 380.1774, found 380.1748.

Ethyl 2-((4-fluorophenyl)amino)-4-isopropyl-6-phenylpyrimidine-5-carboxylate (**4h**). Eluent in chromatography: *n*-hexane/EtOAc 10:1. Yield: 77.7 mg, 82%; pale yellow viscous oil. ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.66-7.61 (m, 4H), 7.52 (brs, 1H), 7.42-7.47 (m, 3H), 7.03 (m, 2H), 4.10 (q, *J* = 7.1 Hz, 2H), 3.28 (sept, *J* = 6.7 Hz, 1H), 1.33 (d, *J* = 6.7 Hz, 6H), 1.00 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (151 MHz, $CDCl_3$) δ 174.9, 168.5, 165.6, 159.3 (C-F, $^{1}J_{C\text{-}F}$ = 242 Hz), 158.8, 157.7 (C-F, $^{1}J_{C\text{-}F}$ = 242 Hz), 138.5, 135.30 (C-F, $^{4}J_{C\text{-}F}$ = 2.6 Hz), 135.28 (C-F, $^{4}J_{C\text{-}F}$ = 2.6 Hz), 129.8, 128.4, 128.0, 120.8 (C-F, $^{3}J_{C\text{-}F}$ = 7.7 Hz), 120.7 (C-F, $^{3}J_{C\text{-}F}$ = 7.7 Hz), 116.8, 115.5 (C-F, $^{2}J_{C\text{-}F}$ = 22.4 Hz), 115.3 (C-F, $^{2}J_{C\text{-}F}$ = 22.4 Hz), 61.4, 32.9, 21.7, 13.6; IR (film) cm^{-1}: 3015, 2925, 1720, 1559, 1264, 732; HRMS (ESI) (*m/z*): calcd for $C_{22}H_{23}FN_3O_2$ $[M+H]^+$ 380.1774, found 380.1796.

Ethyl 2-(butylamino)-4,6-diphenylpyrimidine-5-carboxylate (**4i**).[7] Eluent in chromatography: *n*-hexane/EtOAc 10:1. Yield: 60.0 mg, 64%; pale yellow solid. ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.62 (brs, 4H), 7.46-7.41 (m, 6H), 5.65 (brs, 1H), 3.95 (q, *J* = 7.1 Hz, 2H), 3.54 (q, *J* = 6.9 Hz, 2H), 1.62 (quint, *J* = 7.3 Hz, 2H), 1.43 (sext, *J* = 7.4 Hz, 2H), 0.95 (t, *J* = 7.4 Hz, 3H), 0.88 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (151 MHz, $CDCl_3$) δ 168.8, 166.1, 161.1, 138.4, 129.6, 128.3, 128.1, 115.3, 61.2, 41.2, 31.7, 20.0, 13.8, 13.4.

Ethyl 2-(butylamino)-4-(4-nitrophenyl)-6-phenylpyrimidine-5-carboxylate (**4j**). Eluent in chromatography: *n*-hexane/EtOAc 10:1. Yield: 70.4 mg, 67%; yellow solid, mp 133-135 °C. ^{1}H NMR (600 MHz, $CDCl_3$): δ 8.29 (d, *J* = 8.7 Hz, 2H), 7.78 (brs, 2H), 7.61 (m, 2H), 7.48–7.42 (m, 3H), 5.75 – 5.61 (m, 1H), 3.94 (q, *J* = 7.1 Hz, 2H), 3.52 (m, 2H), 1.61 (quint, *J* = 7.3 Hz, 2H), 1.43 (sext, *J* = 7.5 Hz, 2H), 0.96 (t, *J* = 7.4 Hz, 3H), 0.88 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (151 MHz, $CDCl_3$) δ 168.2, 166.9, 164.2, 161.2, 148.4, 144.7, 138.1, 129.9, 129.3, 128.4, 127.9, 123.4, 115.2, 61.5, 41.2, 31.6, 20.0, 13.8, 13.4; IR (film) cm^{-1}: 3257, 2967, 1710, 1581, 1518, 1341, 1275, 1164, 1080, 858, 763, 694; HRMS (ESI) (*m/z*): calcd for $C_{23}H_{25}N_4O_4$ $[M+H]^+$ 421.1876, found 421.1853.

Ethyl 2-morpholino-4-phenyl-6-(p-tolyl)pyrimidine-5-carboxylate (**4k**). Eluent in chromatography: n-hexane/EtOAc 10:1. Yield: 67.5 mg, 57%; yellow oil. ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.63 (m, 2H), 7.55 (d, *J* = 8.1 Hz, 2H), 7.46–7.40 (m, 3H), 7.23 (d, *J* = 8.0 Hz, 2H), 3.97 (m, 6H), 3.77 (t, *J* = 4.8 Hz, 4H), 2.40 (s, 3H), 0.91 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (151 MHz, $CDCl_3$) δ 169.2, 165.75, 165.73, 160.4, 139.8, 138.8, 135.8, 129.5, 128.9, 128.17, 128.16, 114.9, 66.9, 61.2, 44.3, 21.4, 13.4; IR (film) cm^{-1}: 3027, 2961, 1714, 1577, 1263, 731; HRMS (ESI) (*m/z*): calcd for $C_{24}H_{26}N_3O_3$ $[M+H]^+$ 404.1974, found 404.1955.

Ethyl 2-(3a,7a-dihydro-1H-indol-1-yl)-4-methyl-6-phenylpyrimidine-5-carboxylate (**4l**).[8] To an oven-dried test tube with a magnetic stirring bar were added DHPM **1a** (69.1 mg, 0.25 mmol), CuTC (143 mg, 0.75 mmol), Cs_2CO_3 (245 mg, 0.75 mmol) and indole (44.5 mg, 0.38 mmol) in 1,4-Dioxane (1.5 mL), and the reaction mixture was allowed to stir at 120 °C in an oil bath for 16 h under air. The resulting mixture was diluted with EtOAc (30 mL) and filtered through a Celite pad. The filtrate was washed with water (5 mL) and brine (5 mL), dried over $MgSO_4$, filtered, and concentrated in vacuo. The crude product was purified by flash column chromatography (silica gel; eluent: *n*-hexane/EtOAc, 20/1) to give **4l** (43.1 mg, 48%) as colorless solid; ^{1}H NMR (600 MHz, $CDCl_3$): δ 8.78 (d, *J* = 8.3 Hz, 1H), 8.28 (d, *J* = 3.7 Hz, 1H), 7.66 (m, 2H), 7.53 (d, *J* = 7.7 Hz, 1H), 7.42 (m, 3H), 7.25 (m, 1H), 7.15 (m, 1H), 6.61 (d, *J* = 3.6 Hz, 1H), 4.10 (q, *J* = 7.1 Hz, 2H), 2.61 (s, 3H), 0.98 (t, *J* = 7.2 Hz, 3H); ^{13}C{^{1}H} NMR (151 MHz, $CDCl_3$) δ 168.1, 167.3, 165.4, 156.4, 138.0, 135.5, 131.5, 130.1, 128.5, 128.3, 126.0, 123.7, 122.3, 120.8, 120.6, 116.6, 107.2, 61.7, 22.9, 13.6.

N,4,6-Triphenyl-2-pyrimidinamine (**4m**).[9] Eluent in chromatography: *n*-hexane/EtOAc 20:1. Yield: 61.4 mg, 76%; yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.20-8.12 (m, 4H), 7.86-7.77 (m, 2H), 7.78–7.71 (m, 1H), 7.61 (s, 1H), 7.57-7.51 (m, 6H), 7.43-7.37 (m, 2H), 7.07 (t, *J* = 7.3 Hz, 3H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 165.9, 160.5, 140.1, 137.7, 130.8, 129.0, 128.98, 127.3, 122.3, 119.2, 104.9.

Ethyl 4-methyl-2-(phenylamino)pyrimidine-5-carboxylate (**5a**).[10] Eluent in chromatography: *n*-hexane/EtOAc 10:1. Yield: 37.2 mg, 58%; white solid. ^{1}H NMR (600 MHz, $CDCl_3$): δ 9.00 (brs, 1H), 7.71 (brs, 1H), 7.66 (d, *J* = 8.0 Hz, 2H), 7.36 (t, *J* = 7.9 Hz, 2H), 7.11 (t, *J* = 7.4 Hz, 1H), 4.35 (q, *J* = 7.1 Hz, 2H), 2.75 (s, 3H), 1.39 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (151 MHz, $CDCl_3$) δ 170.6, 164.9, 161.0, 159.7, 138.3, 129.0, 123.7, 120.1, 114.7, 60.8, 24.6, 14.3.

N-phenylpyrimidin-2-amine (**5b**).[11] Eluent in chromatography: *n*-hexane/EtOAc 10:1. Yield: 17.5 mg, 41%; brown solid. ^{1}H NMR (600 MHz, CD_2Cl_2) δ 8.44 (d, *J* = 4.8 Hz, 2H), 8.08 (s, 1H), 7.66 (d, *J* = 7.6 Hz, 2H), 7.35 (m, 2H), 7.05 (t, *J* = 7.4 Hz, 1H), 6.74 (t, *J* = 4.8 Hz, 1H); ^{13}C{^{1}H} NMR (151 MHz, CD_2Cl_2) δ 160.9, 158.5, 140.3, 129.3, 123.0, 120.1, 113.1.

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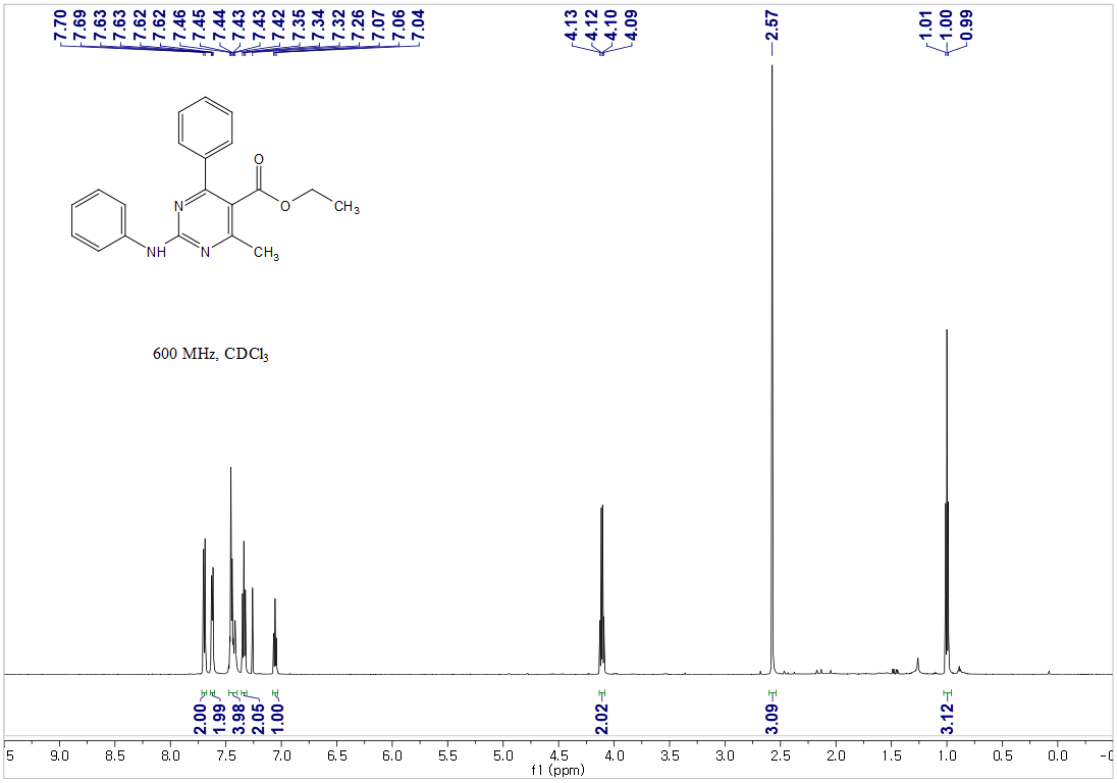
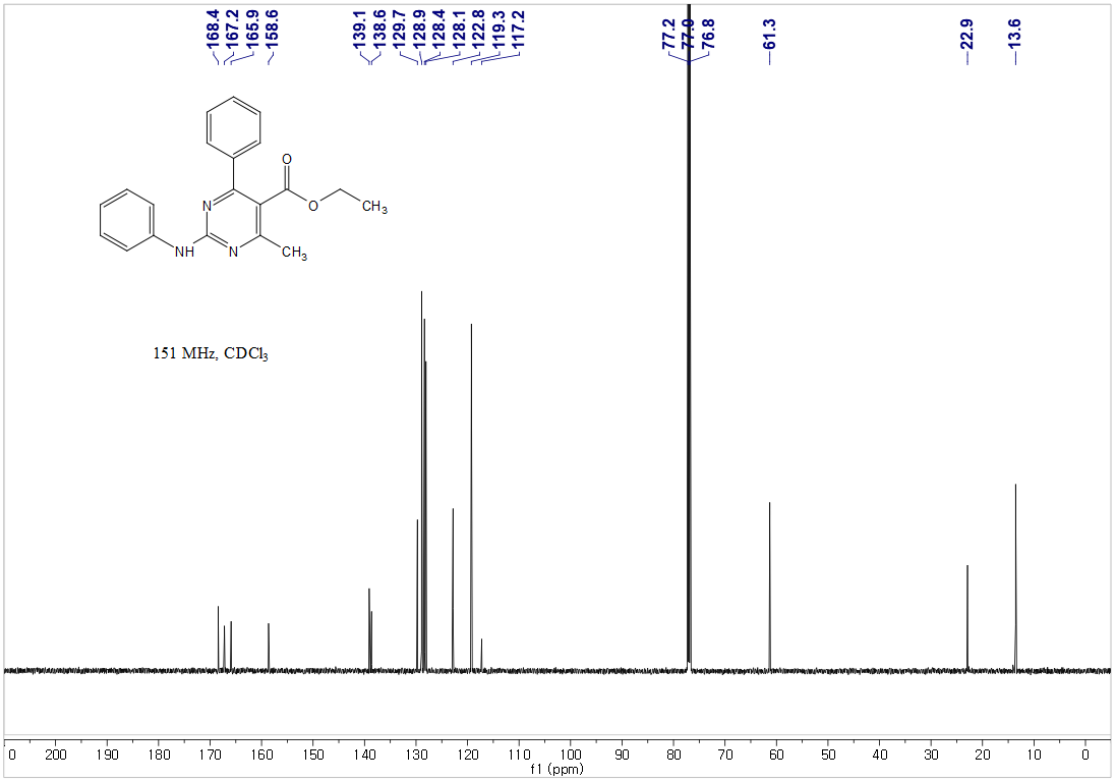
3. ^{1}H and ^{13}C NMR spectra of 2-aryl(alkyl)aminopyrimidines

Ethyl 4-methyl-6-phenyl-2-(phenylamino)pyrimidine-5-carboxylate (3a)





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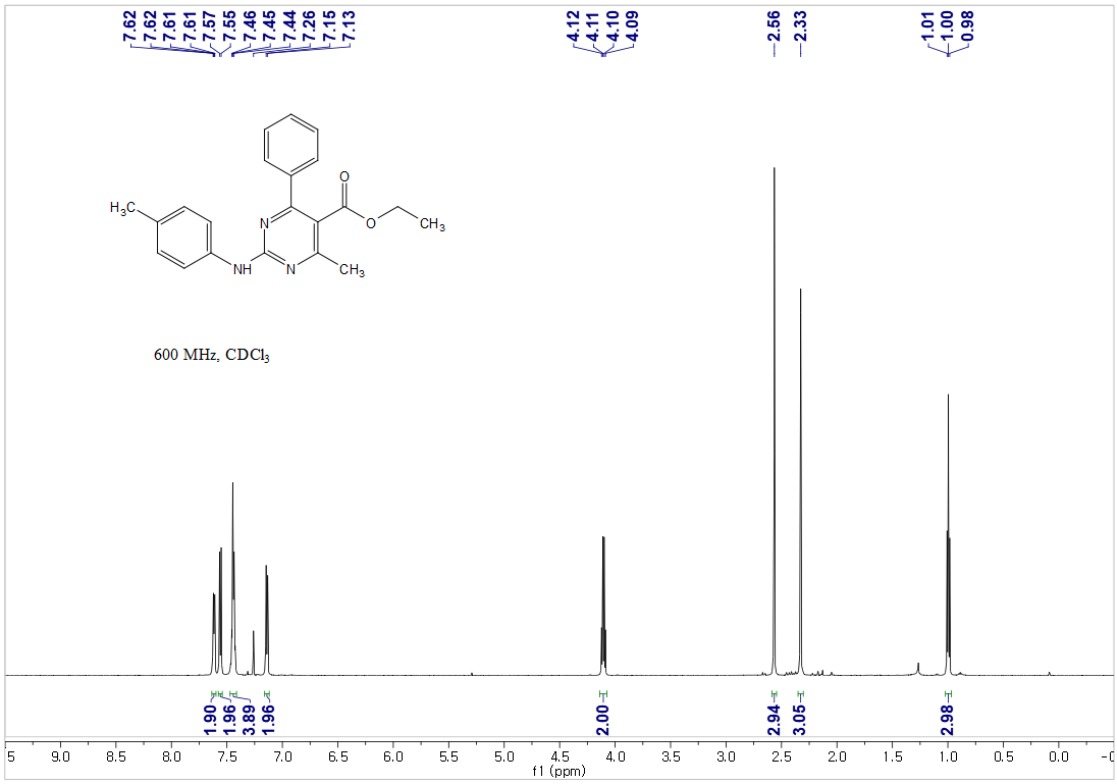

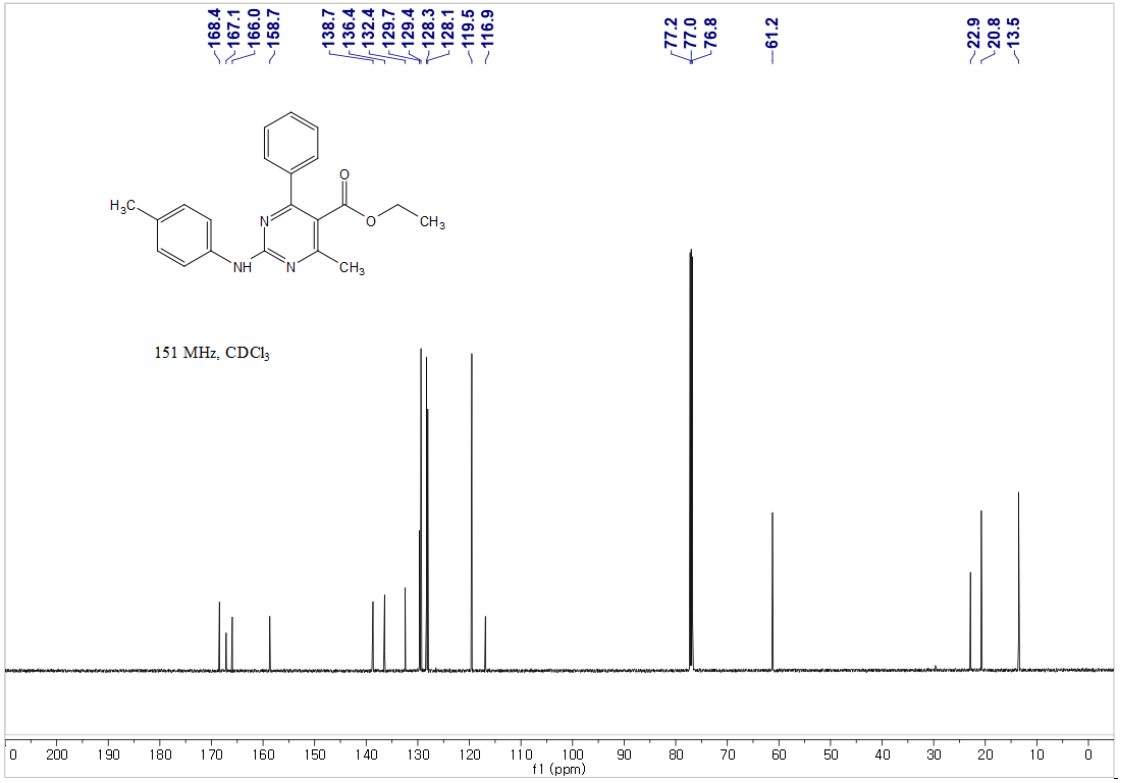

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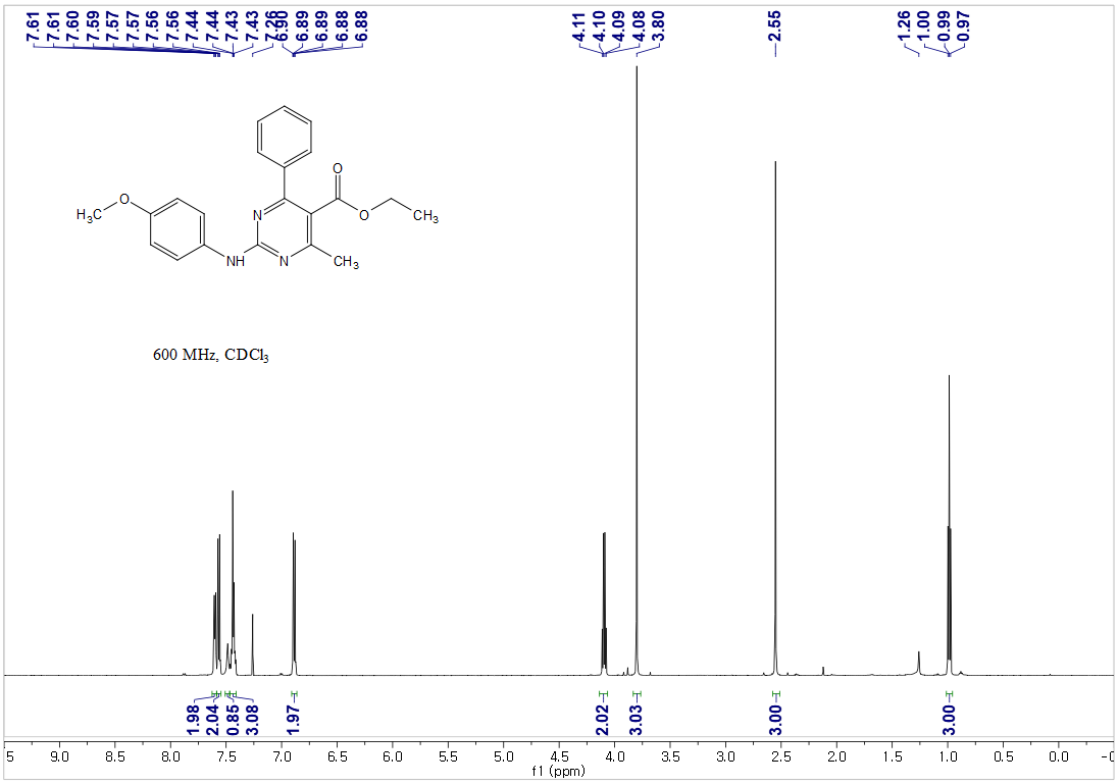

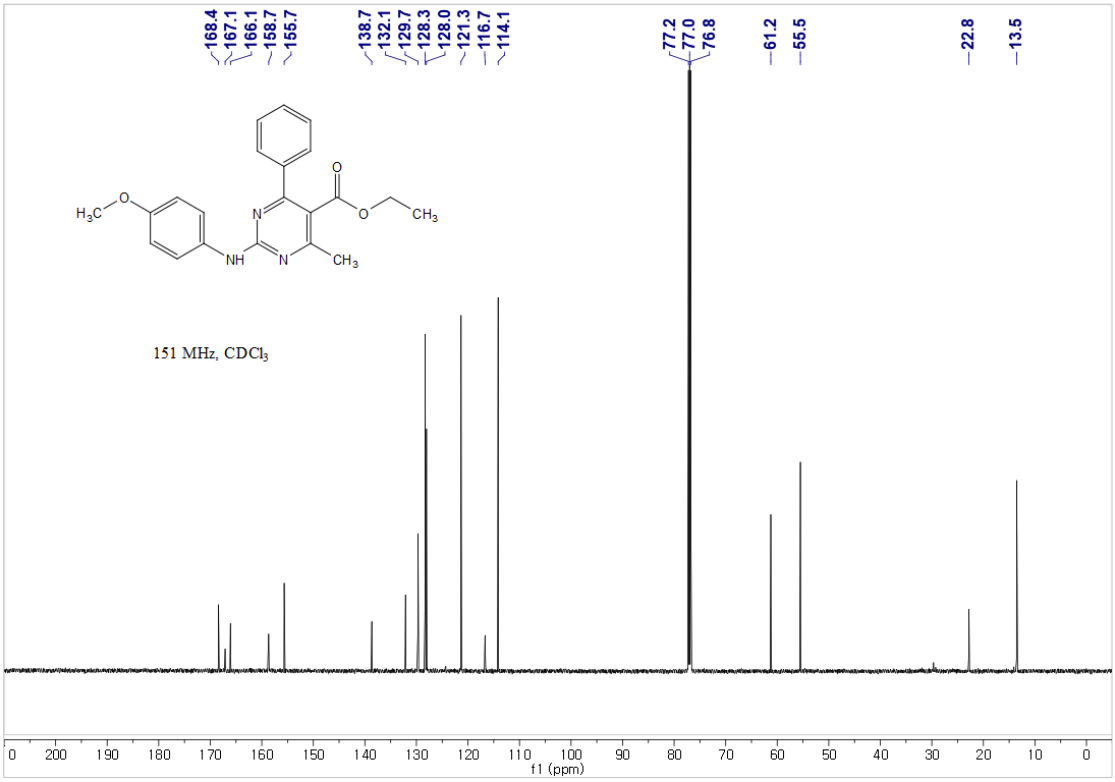

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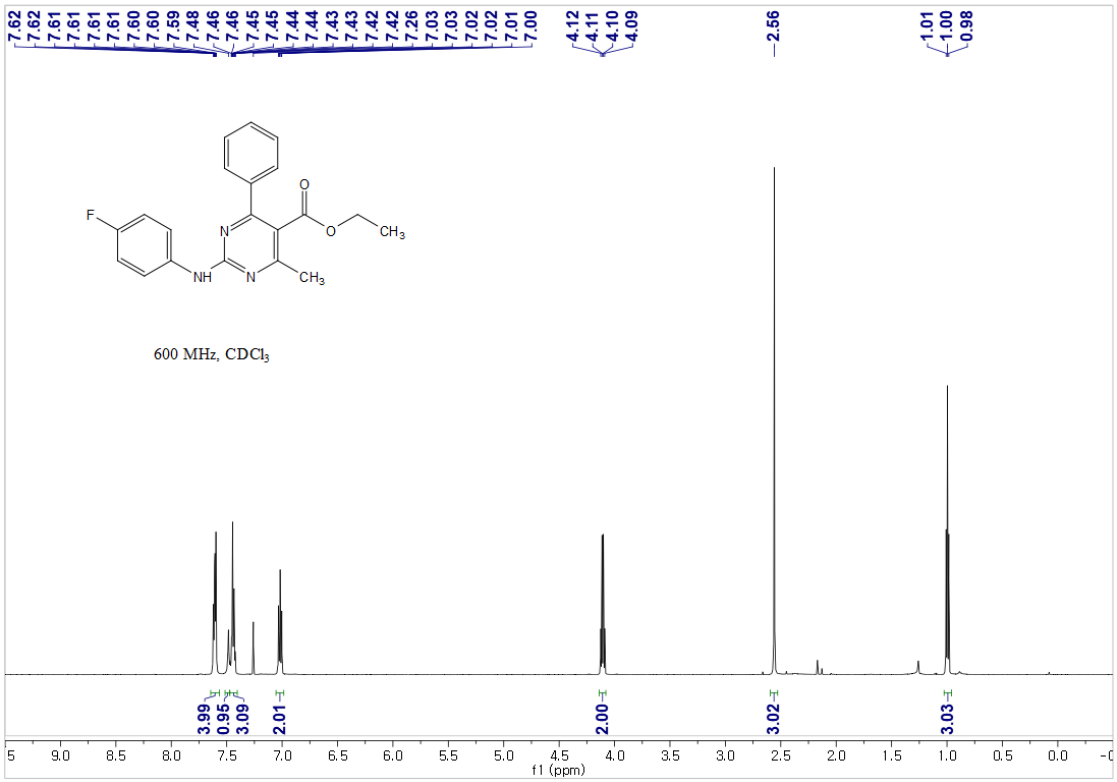
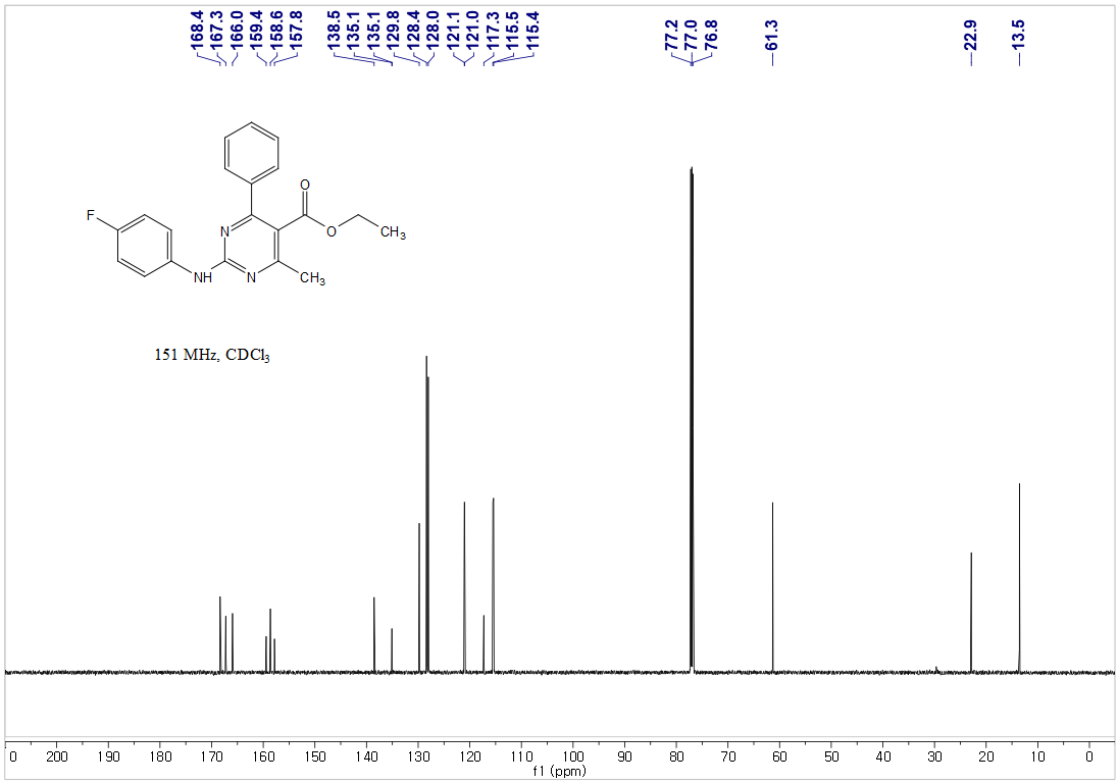
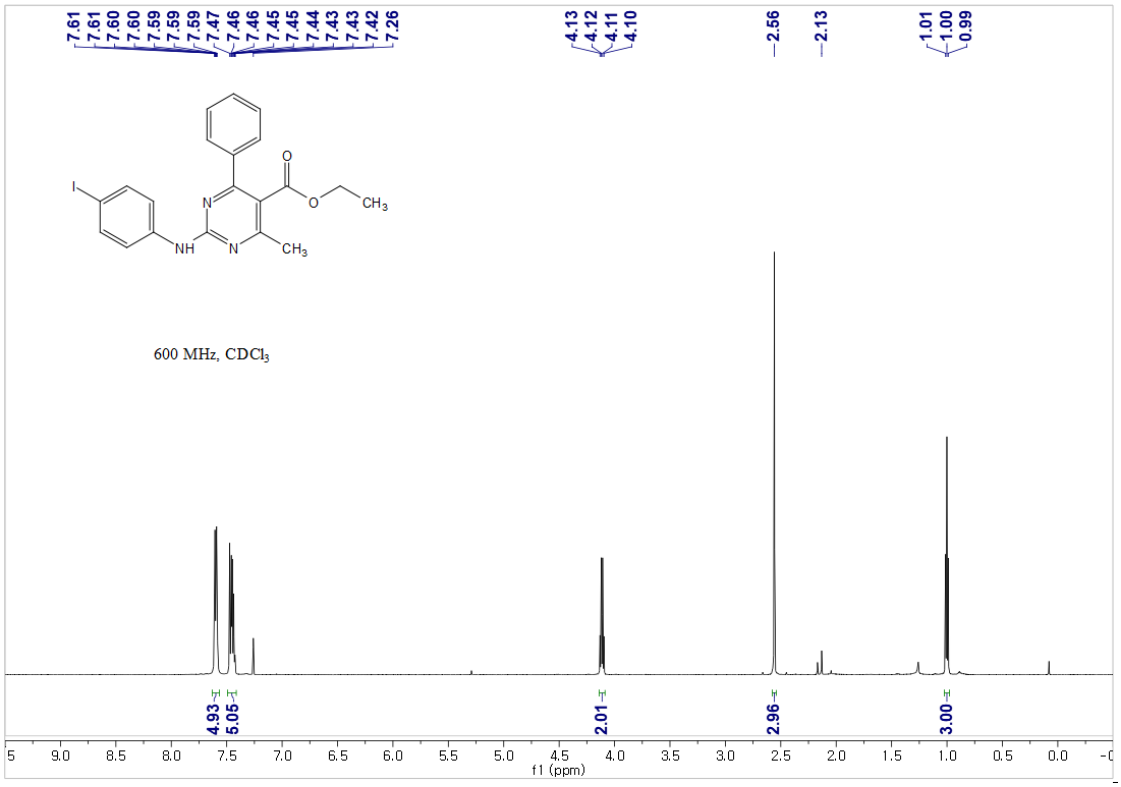
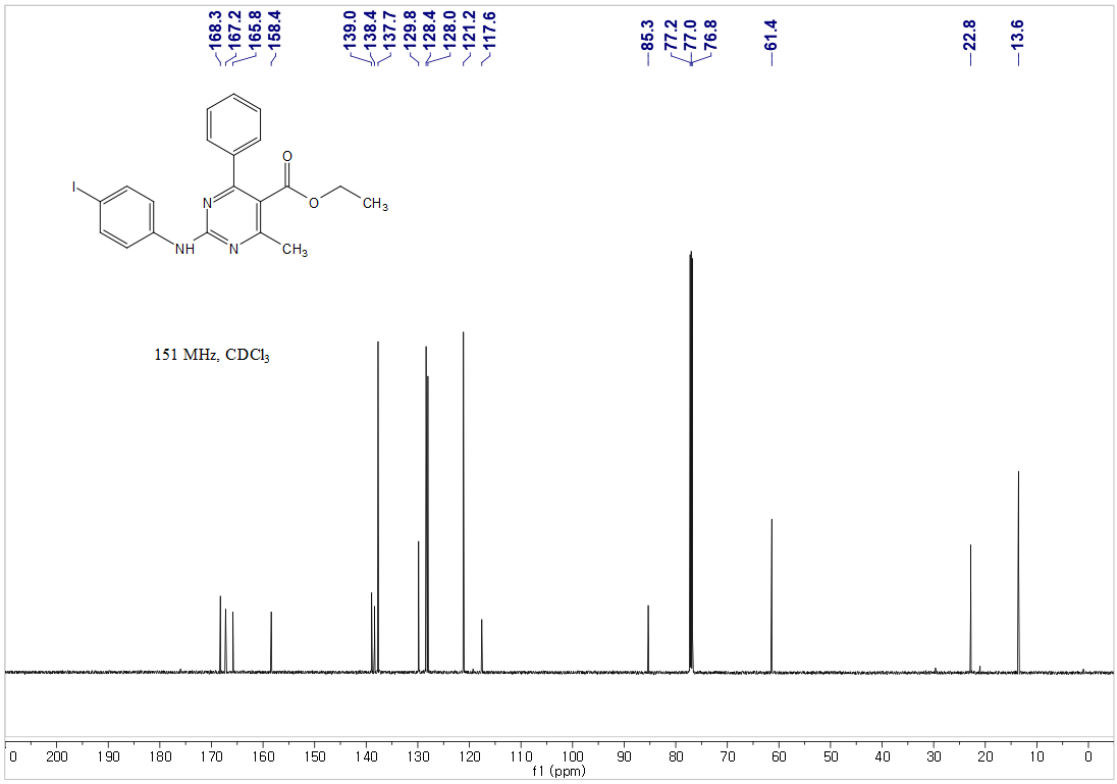




Ethyl 2-((4-iodophenyl)amino)-4-methyl-6-phenylpyrimidine-5-carboxylate (3e)





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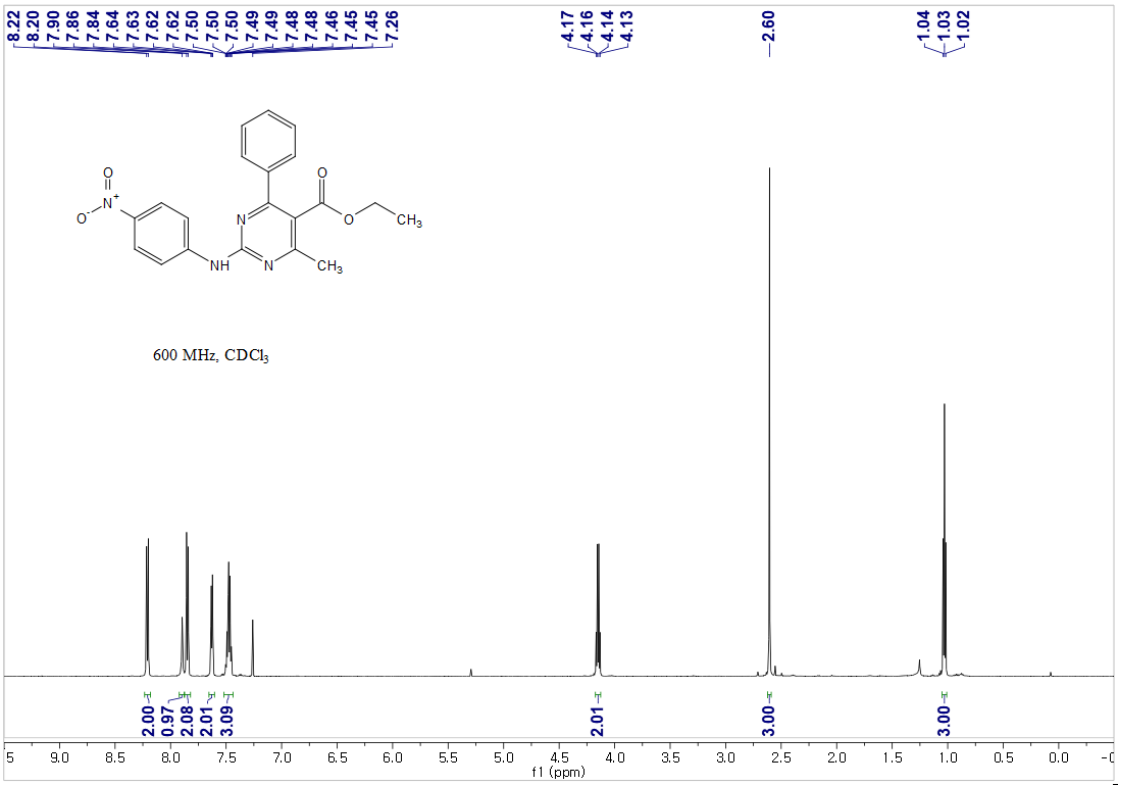
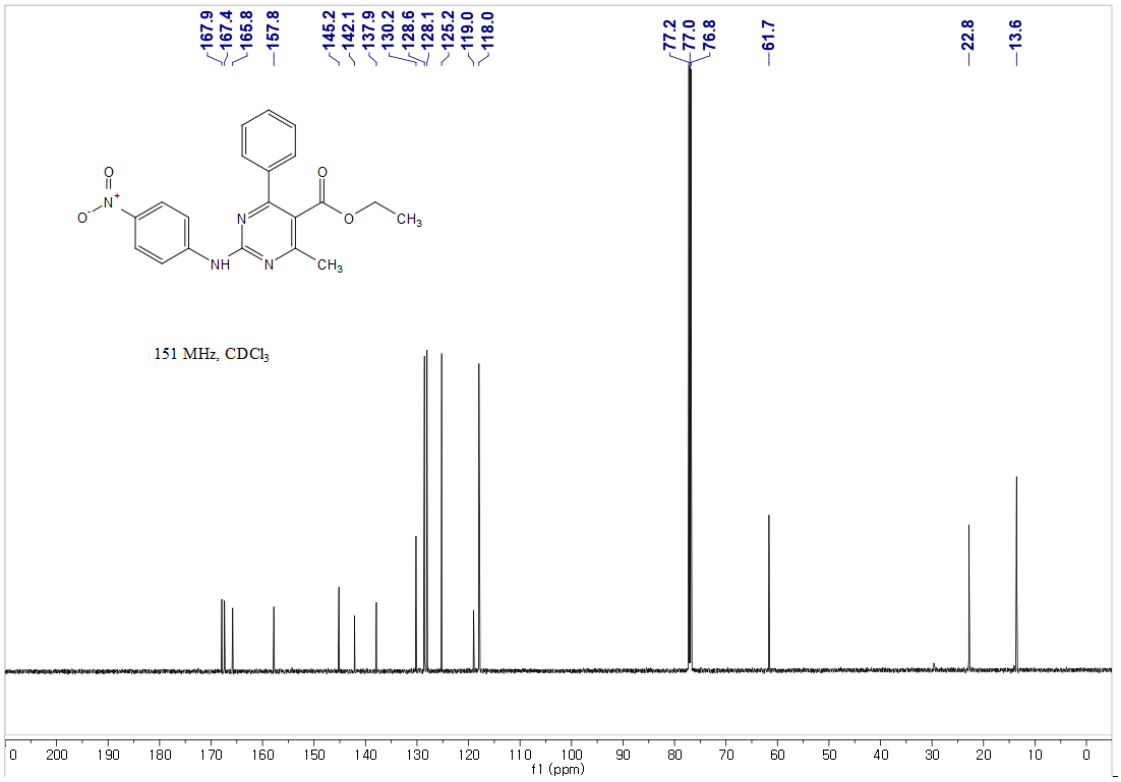
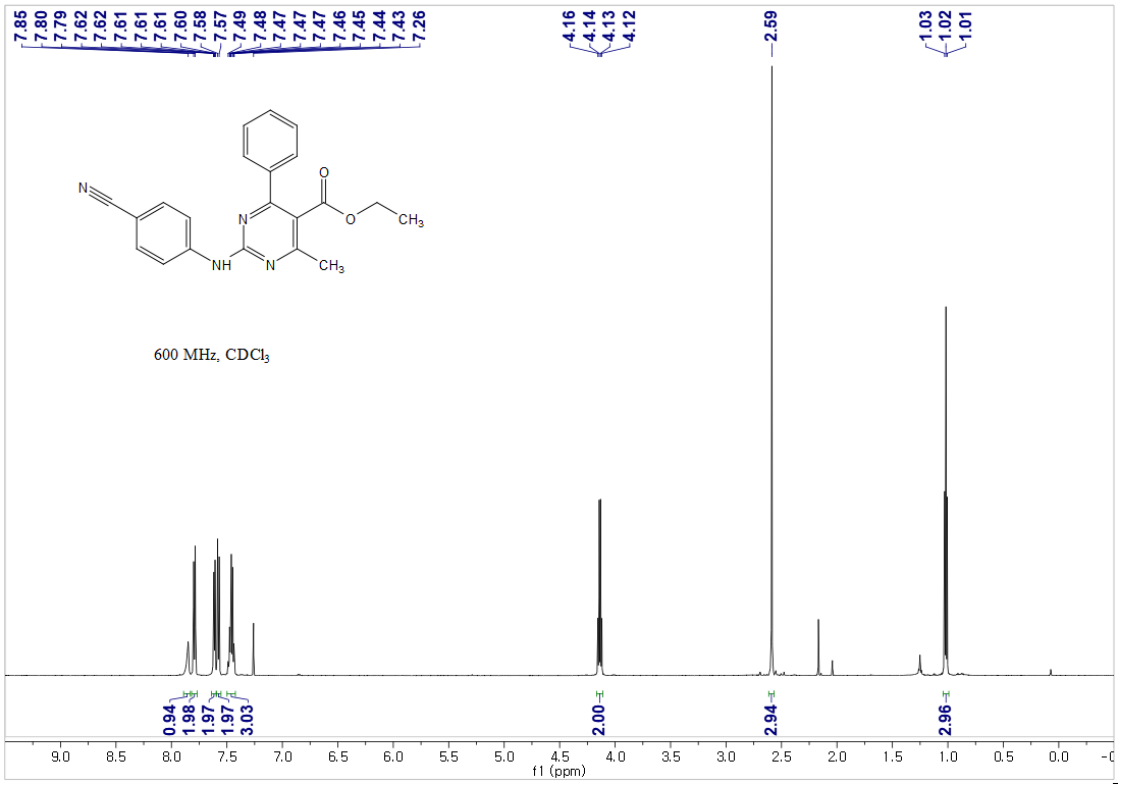
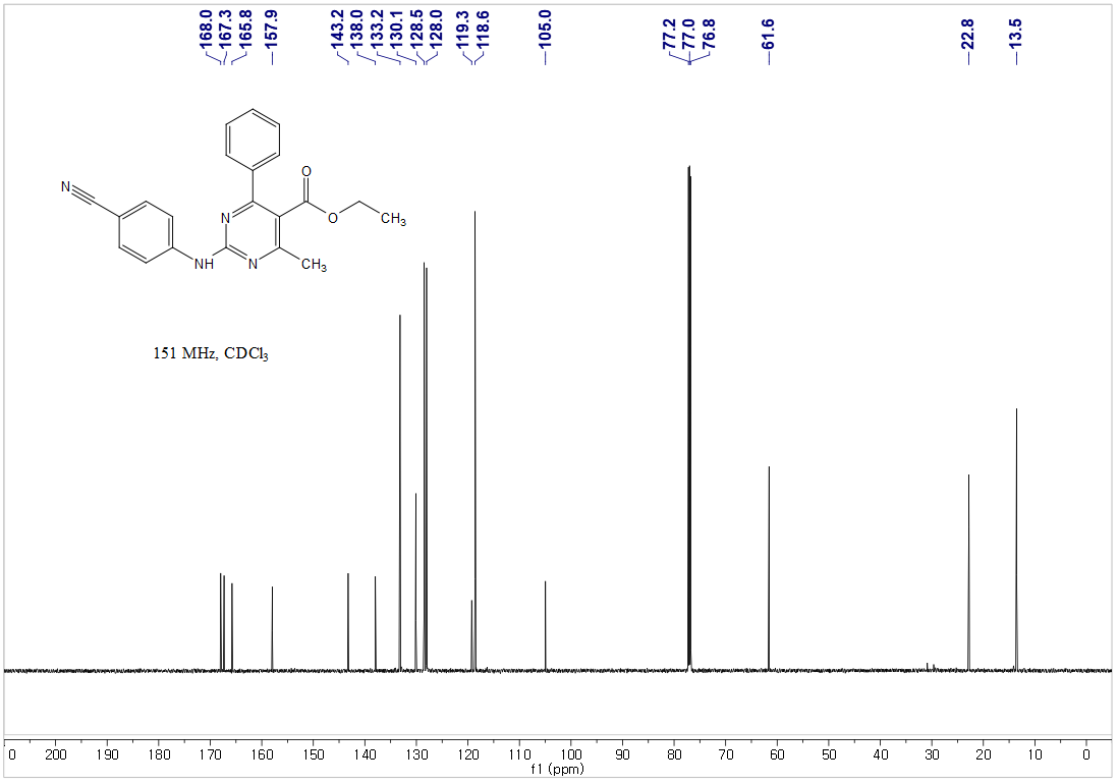




Ethyl 2-((4-cyanophenyl)amino)-4-methyl-6-phenylpyrimidine-5-carboxylate (3g)





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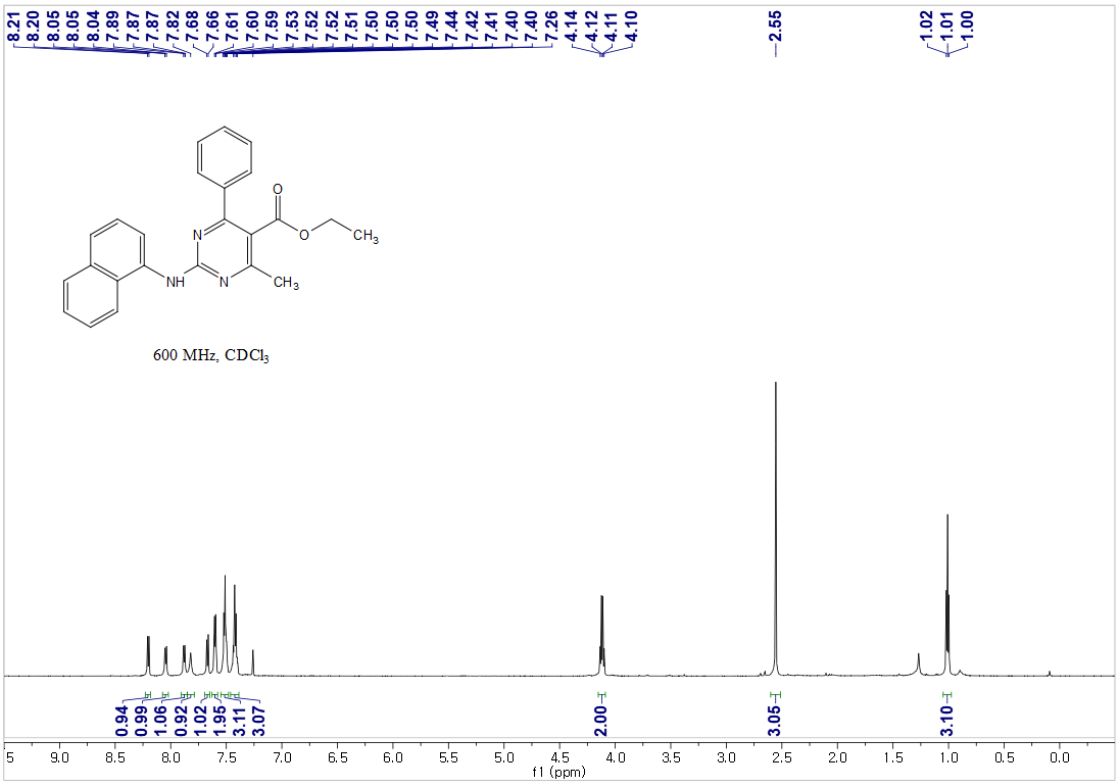

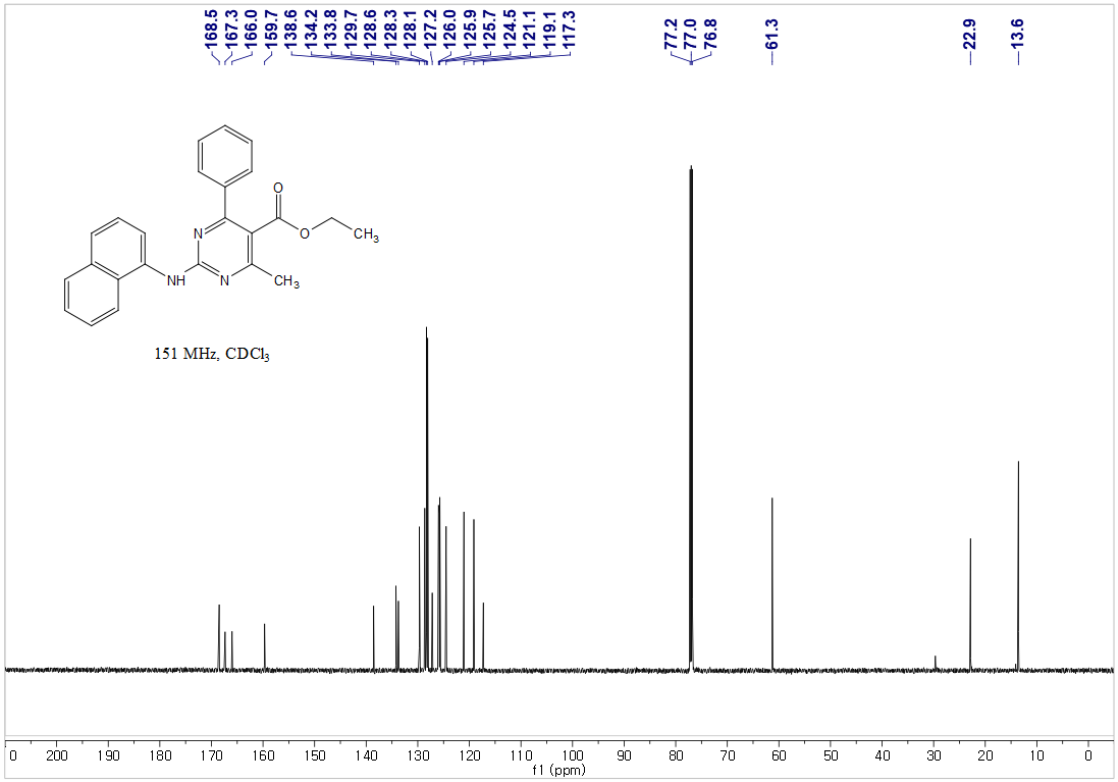

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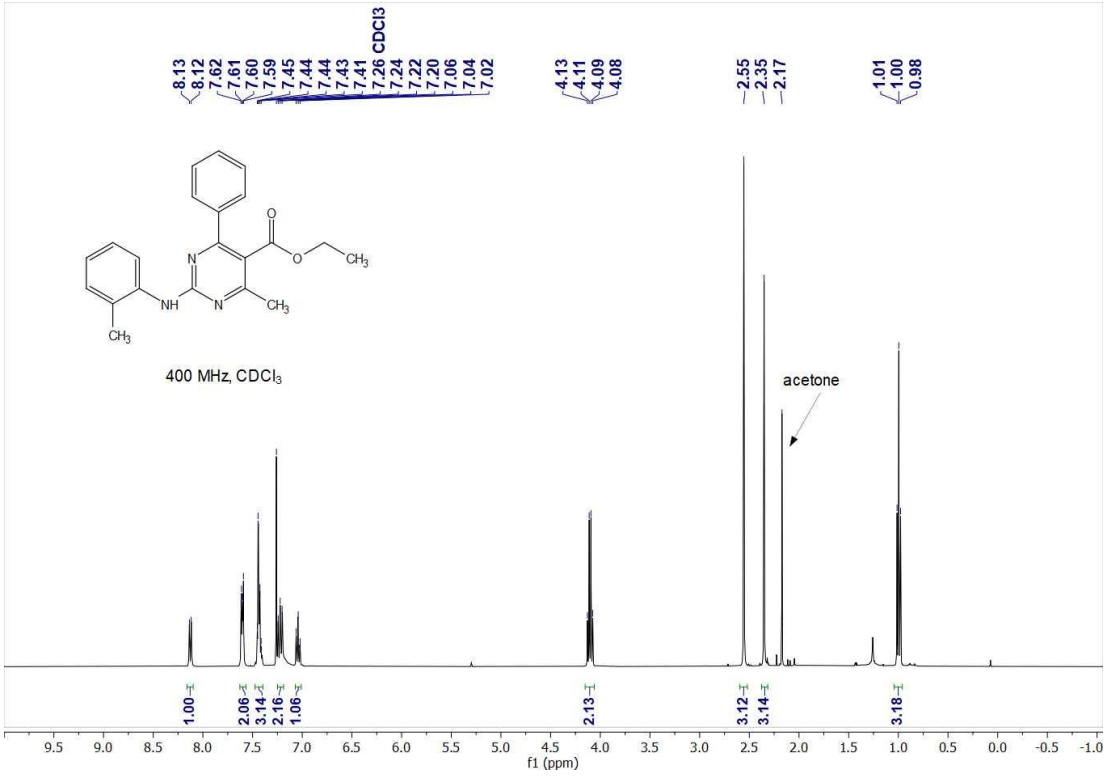

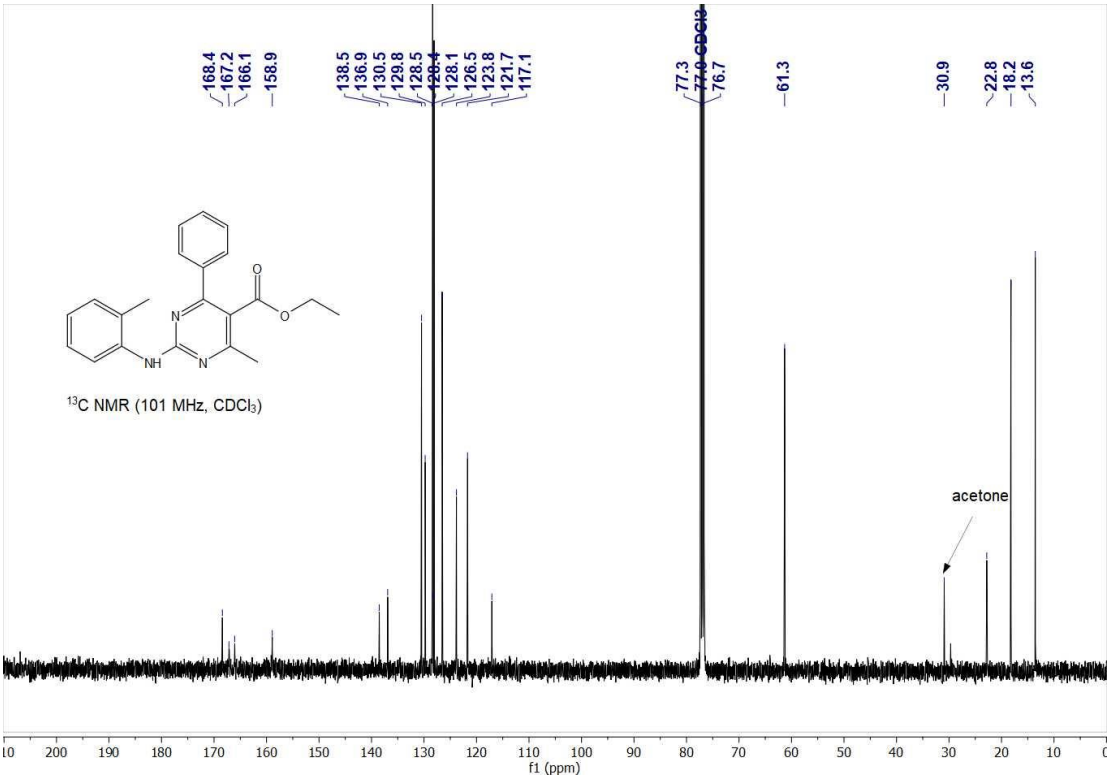

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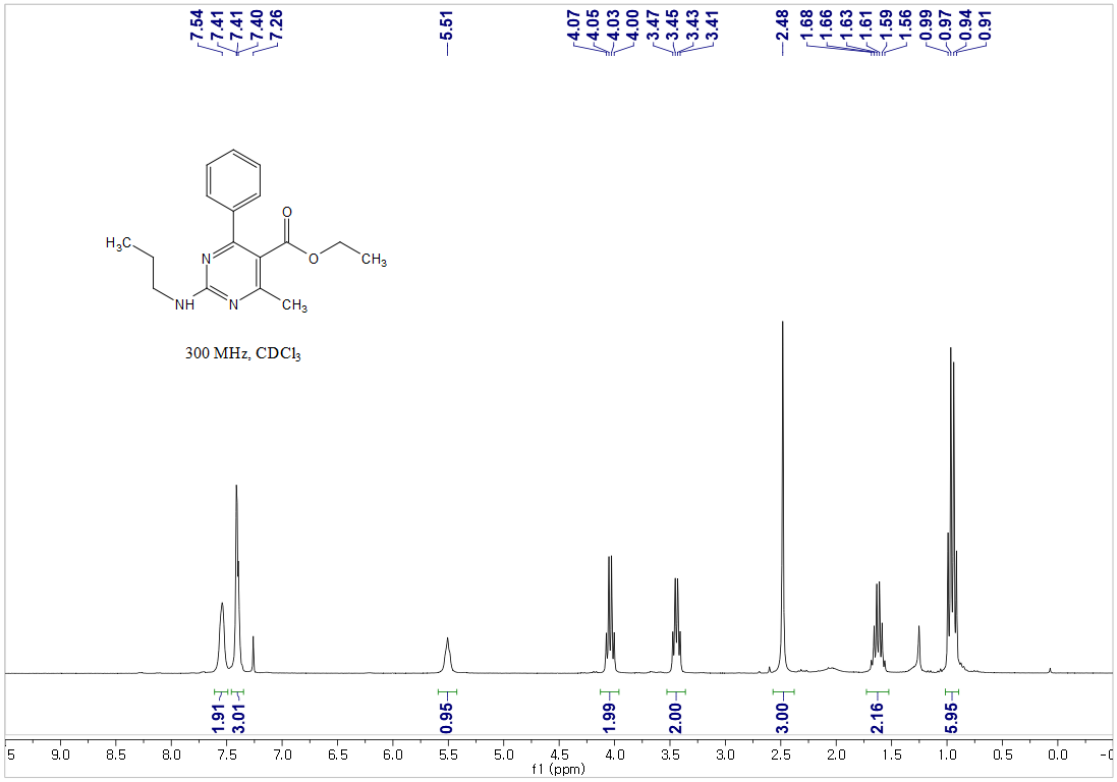
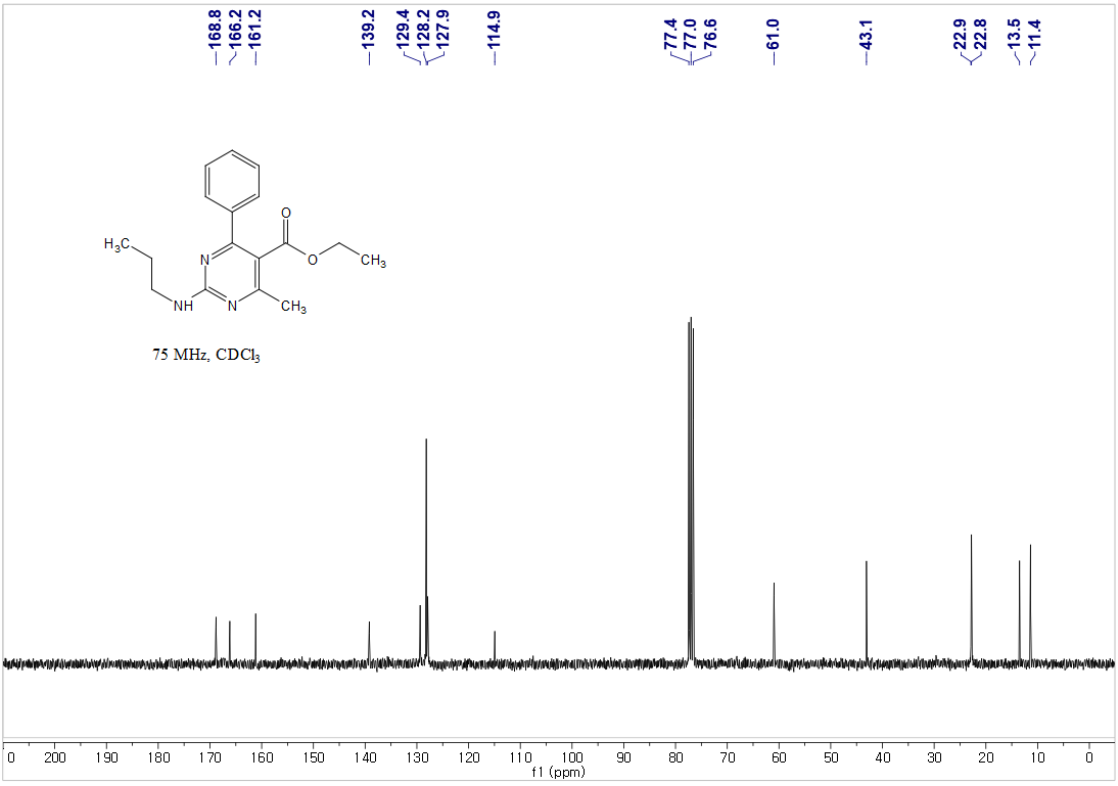
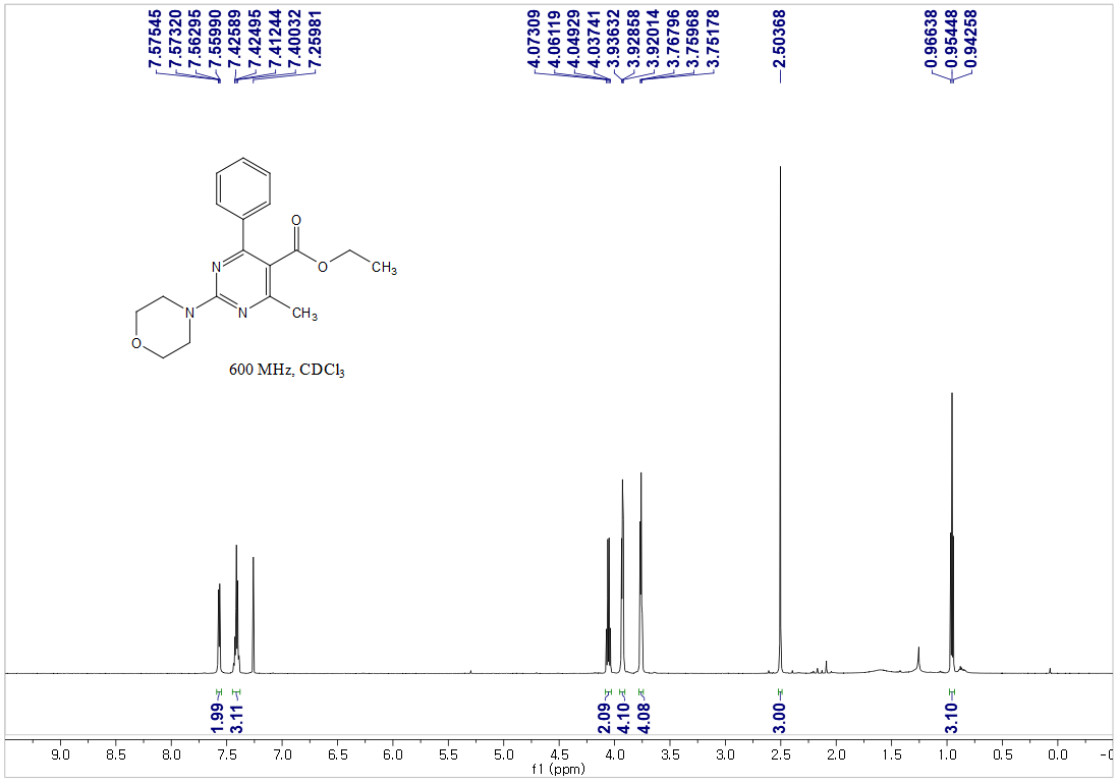
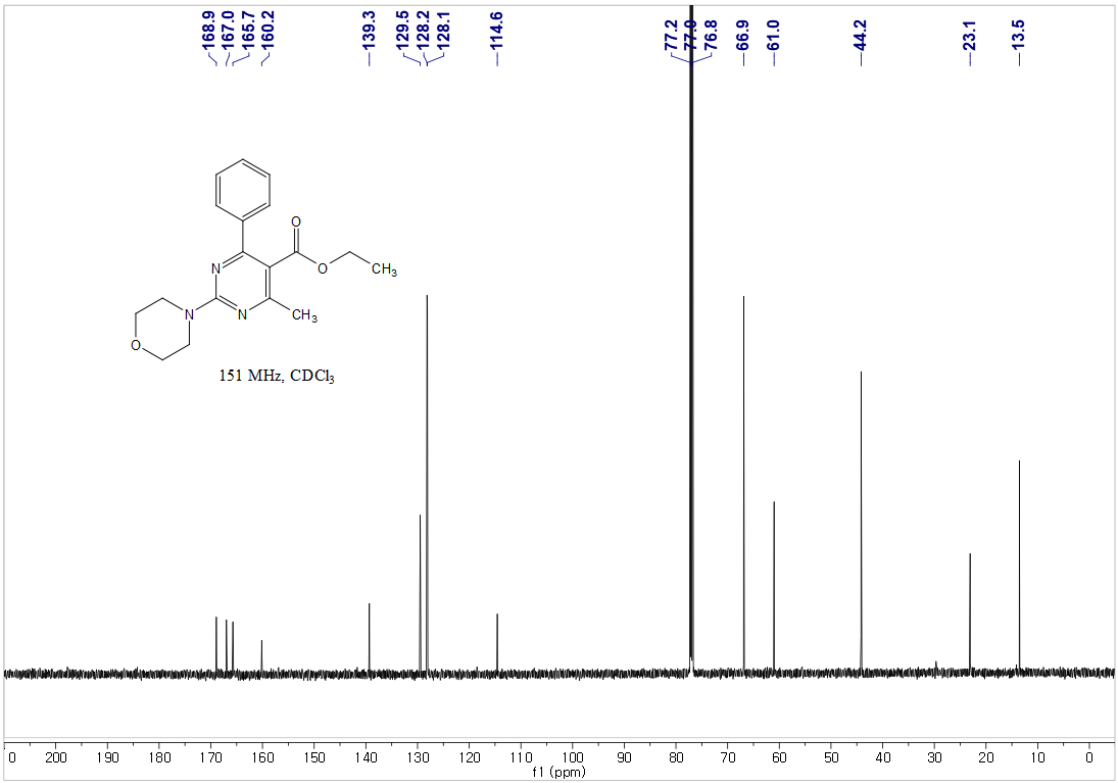


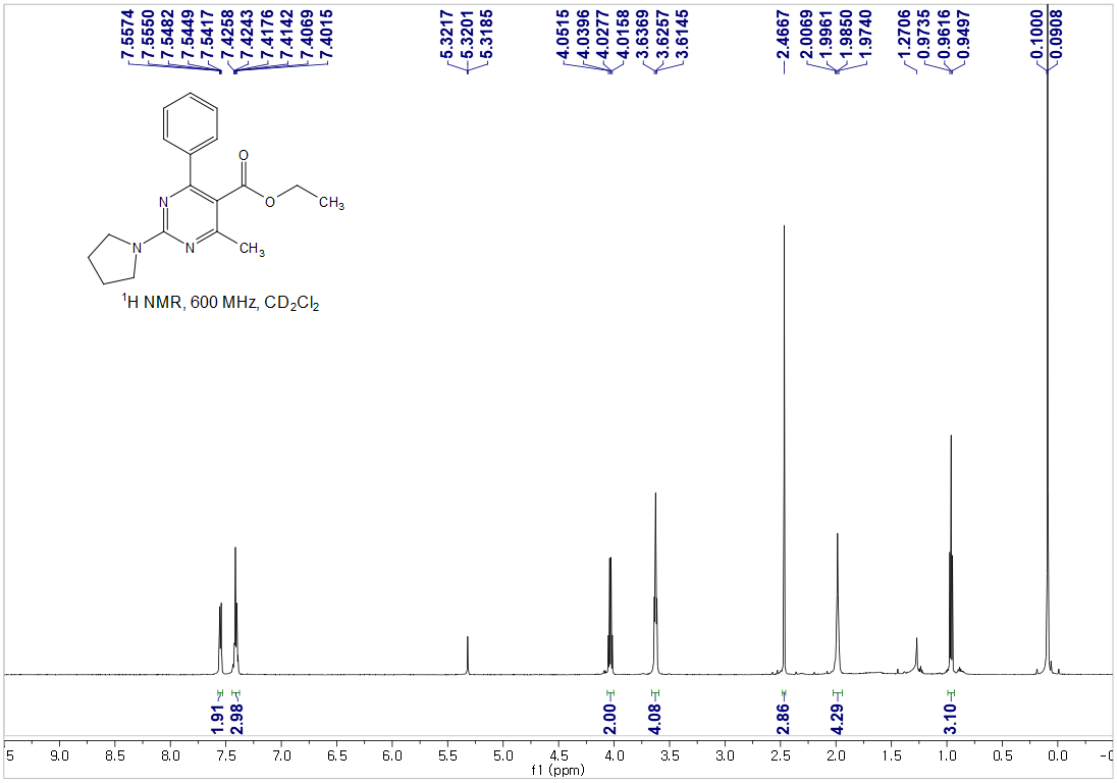


Ethyl 4-methyl-2-morpholino-6-phenylpyrimidine-5-carboxylate (3k)

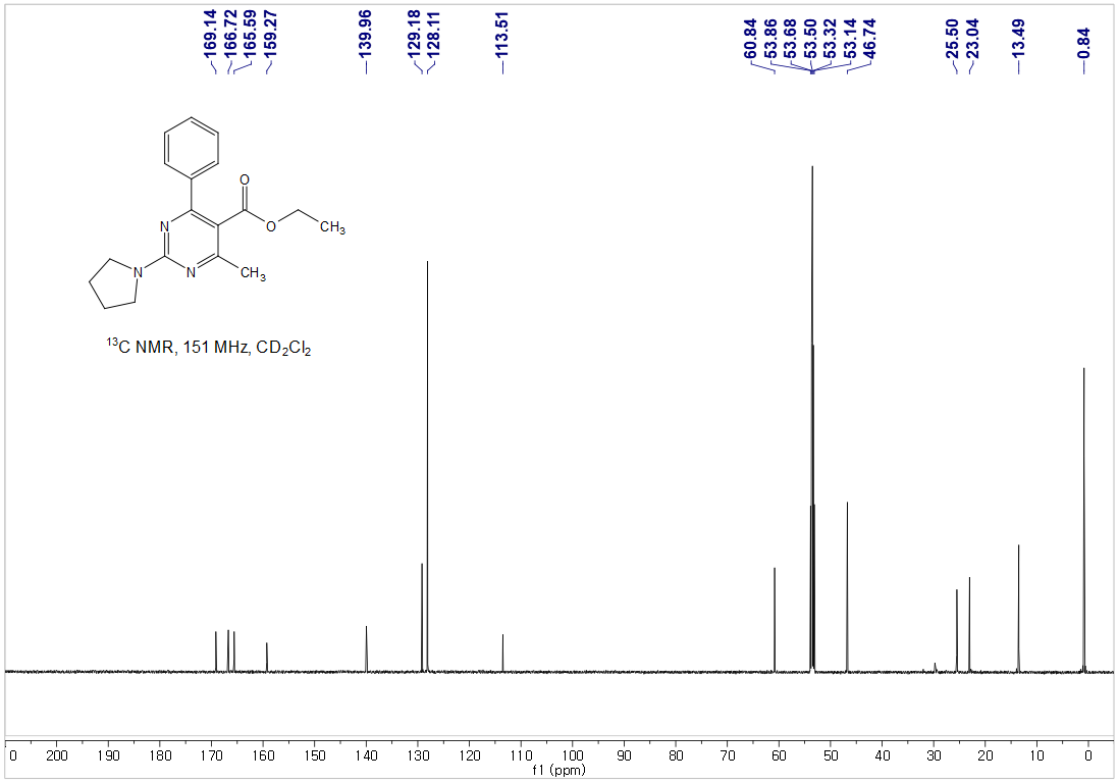




Ethyl 4-methyl-6-phenyl-2-(pyrrolidin-1-yl)pyrimidine-5-carboxylate (3l)

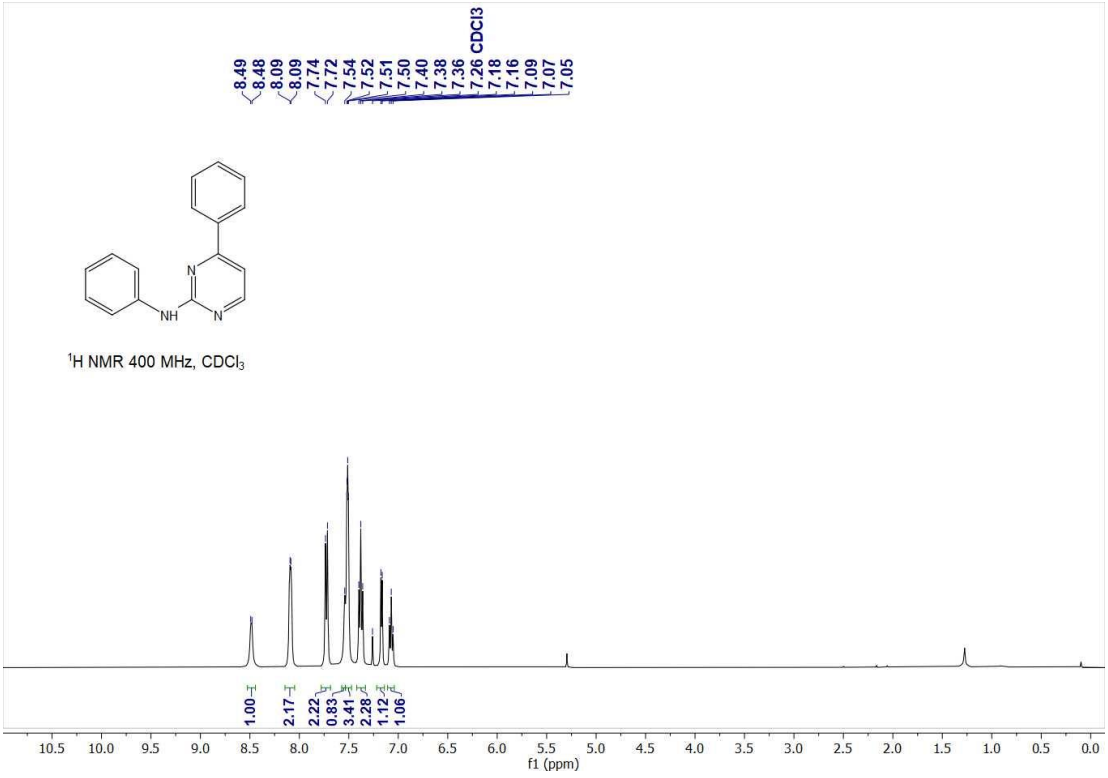


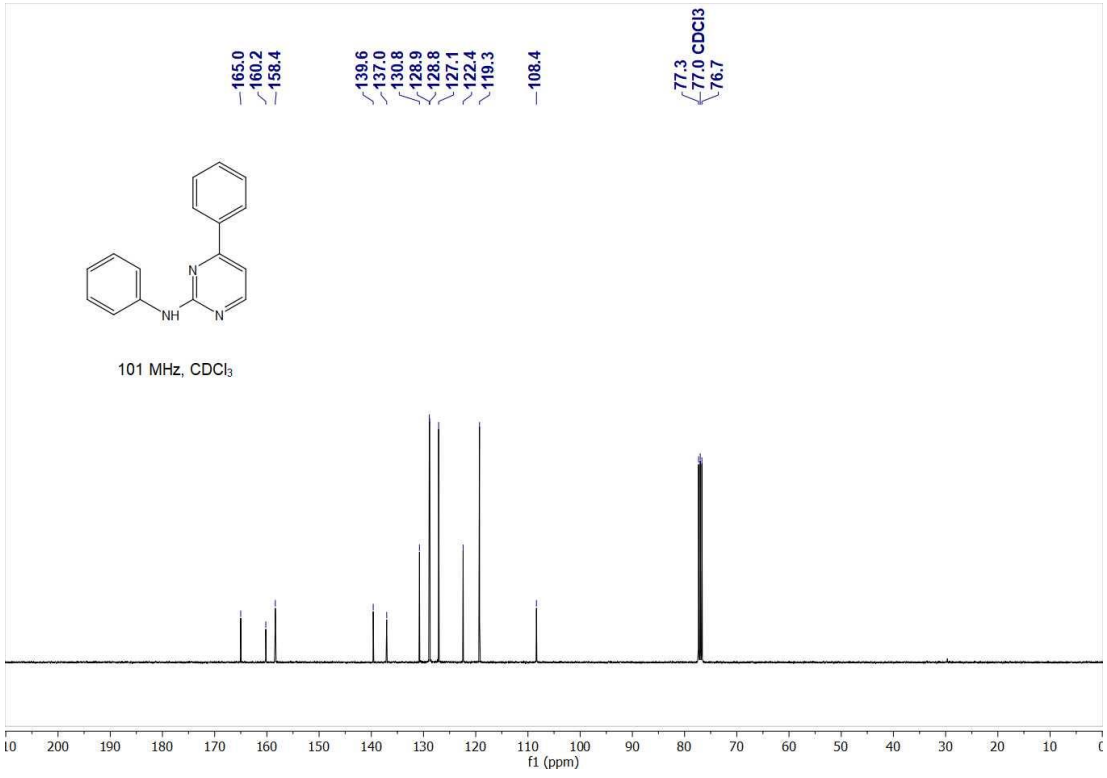
^{1}H NMR, 600 MHz, CD_2Cl_2



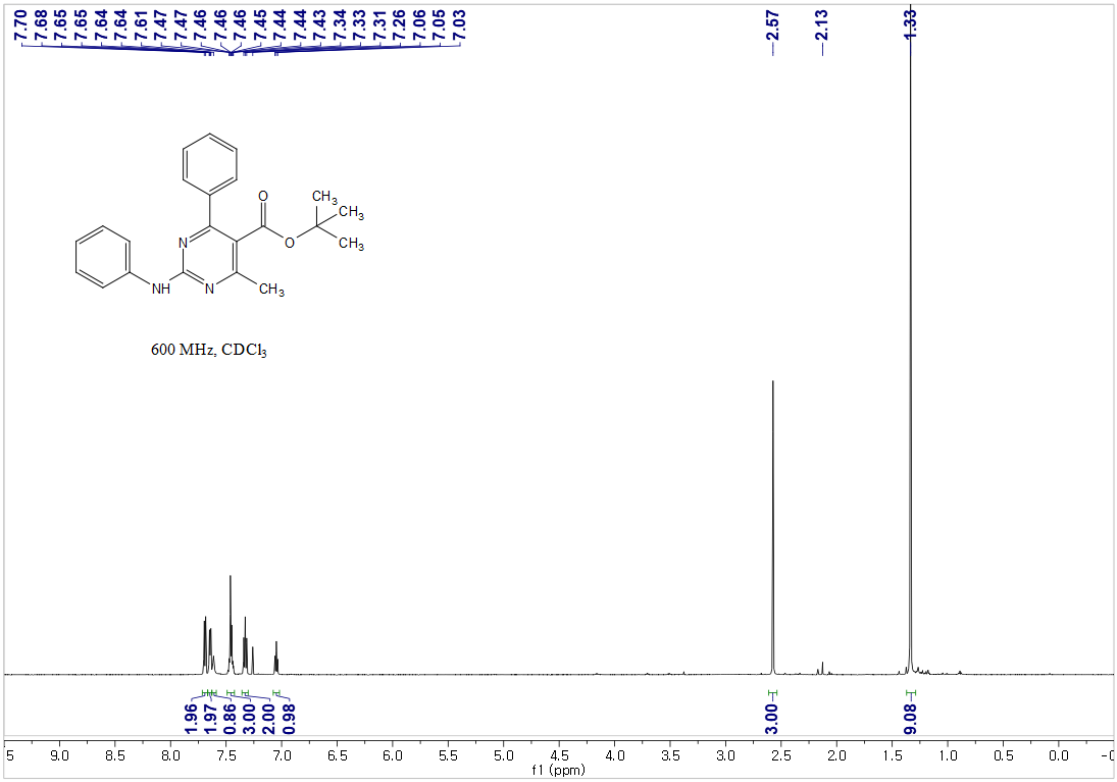
^{13}C NMR, 151 MHz, CD_2Cl_2

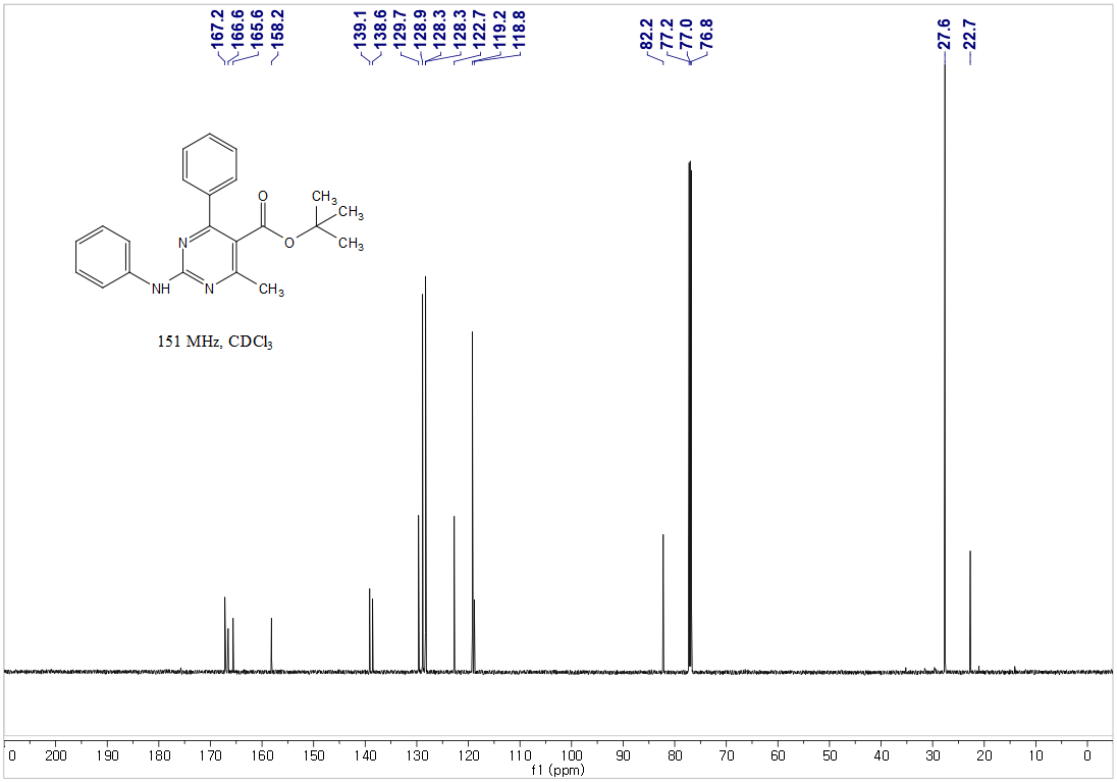
N,4-diphenylpyrimidin-2-amine (4a)



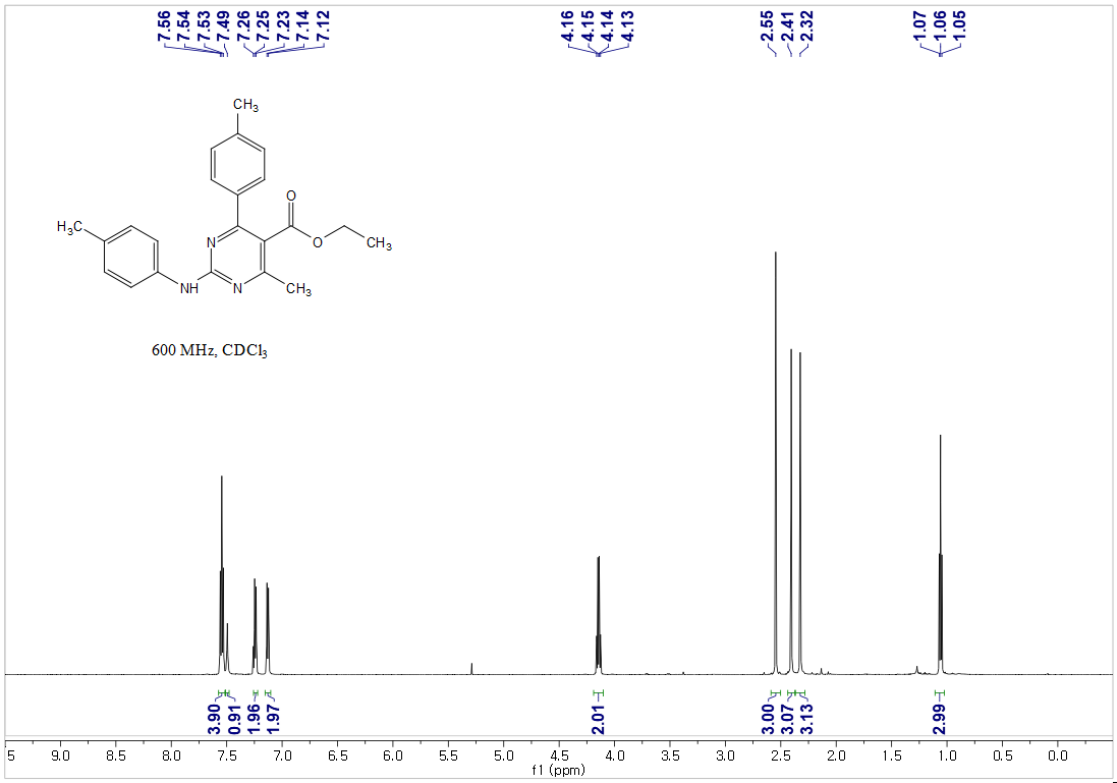


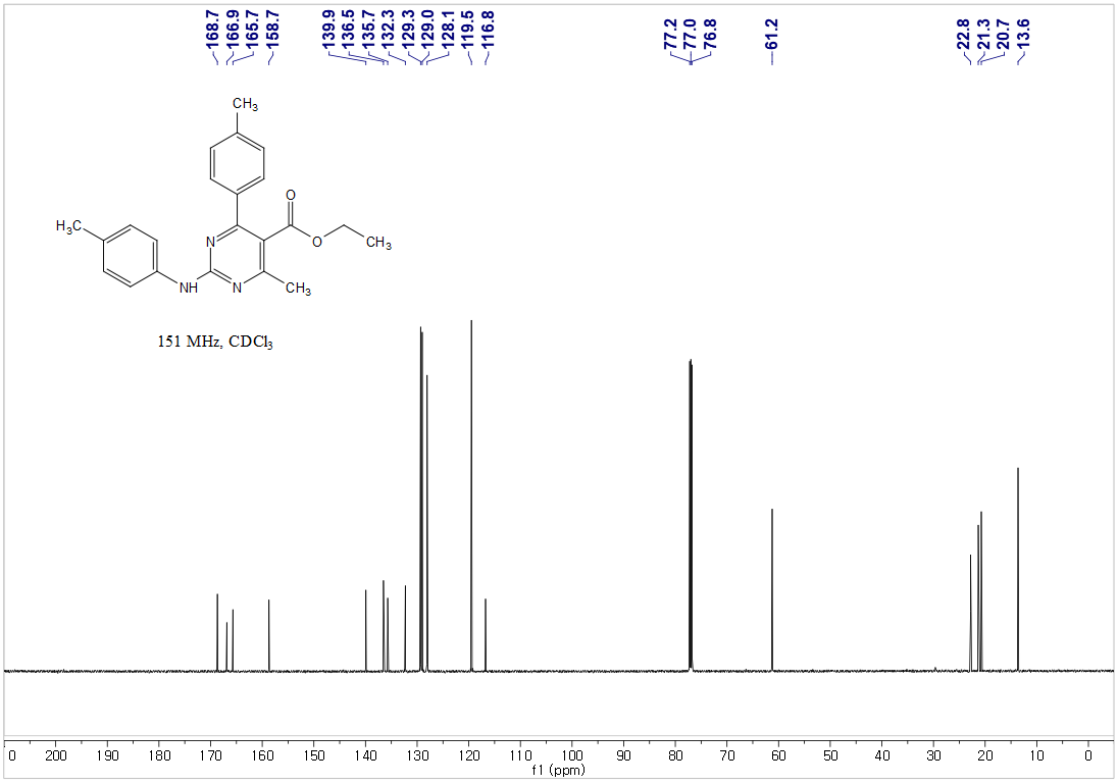
tert-Butyl 4-methyl-6-phenyl-2-(phenylamino)pyrimidine-5-carboxylate (4b)



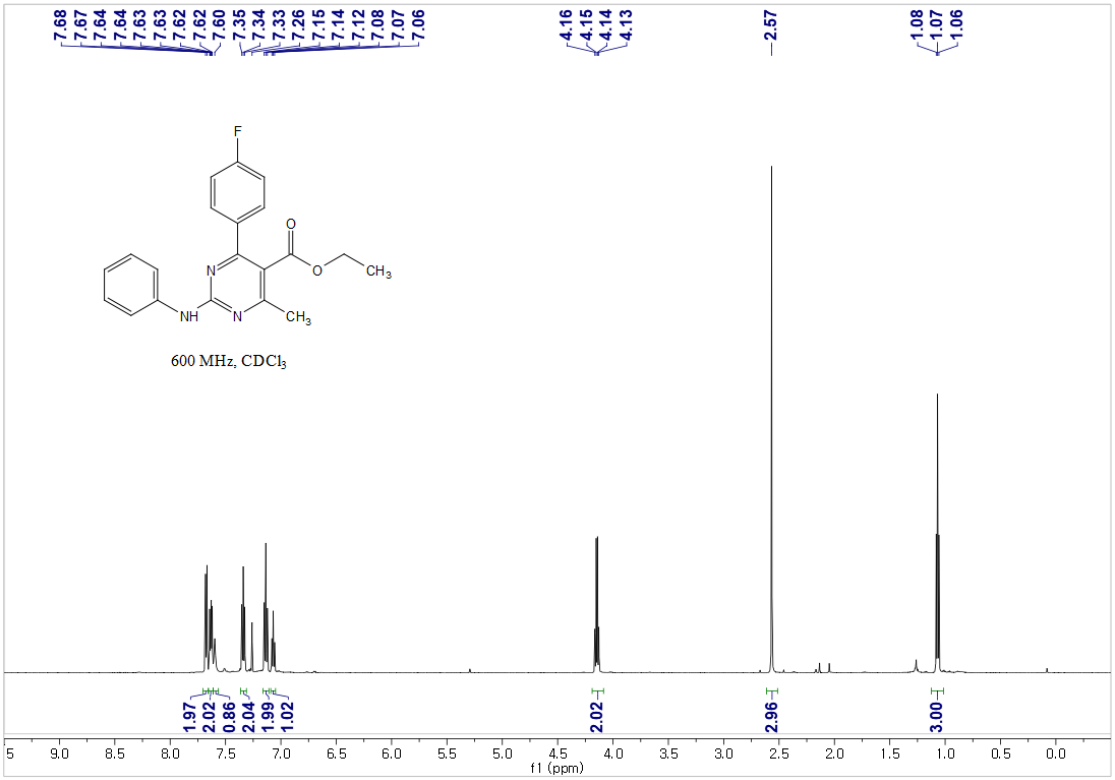


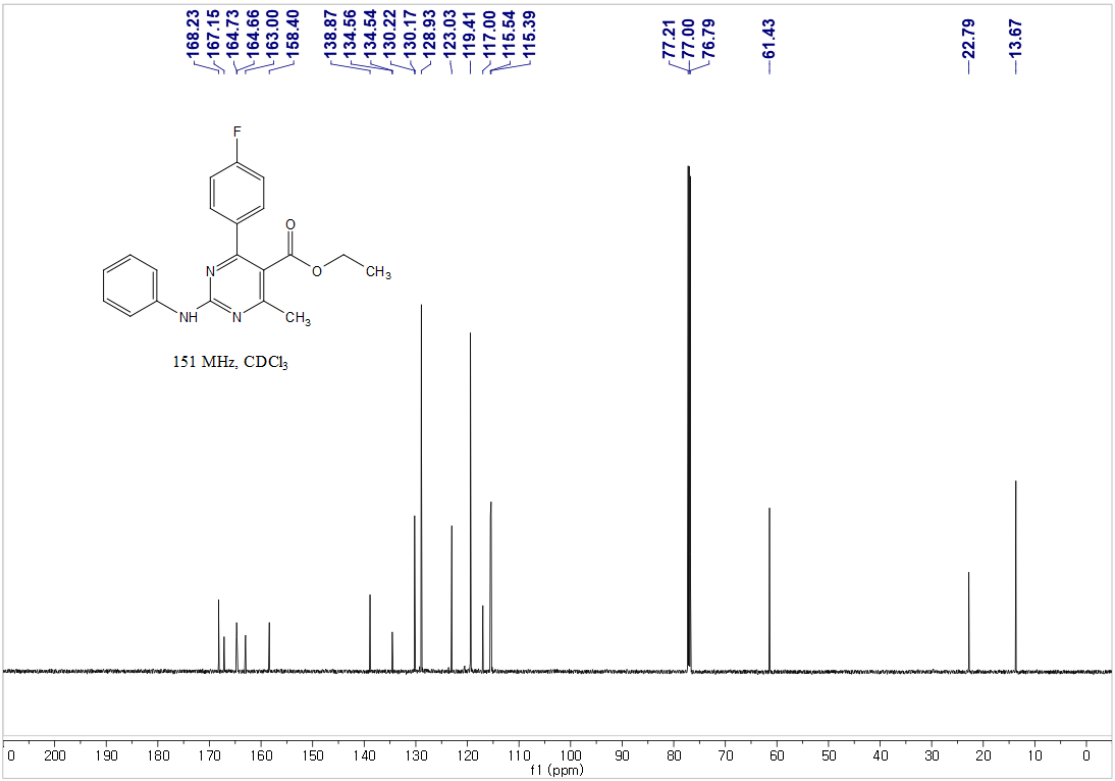
Ethyl 4-methyl-6-(*p*-tolyl)-2-(*p*-tolylamino)pyrimidine-5-carboxylate (4c)



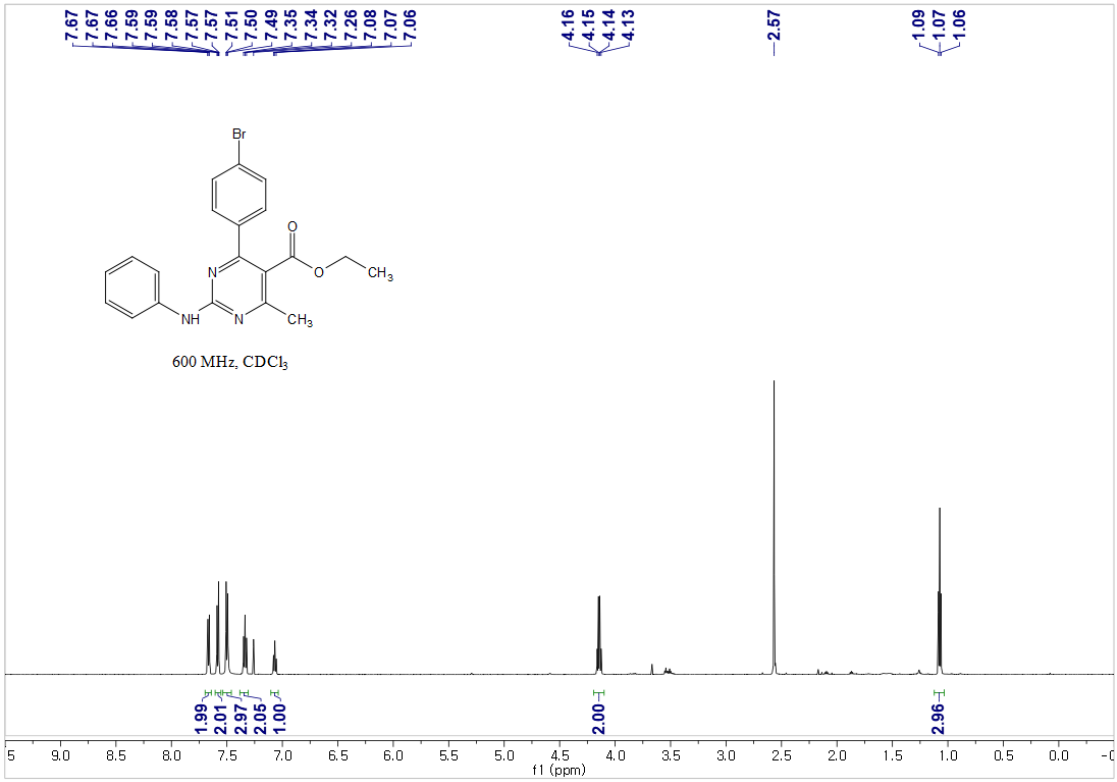


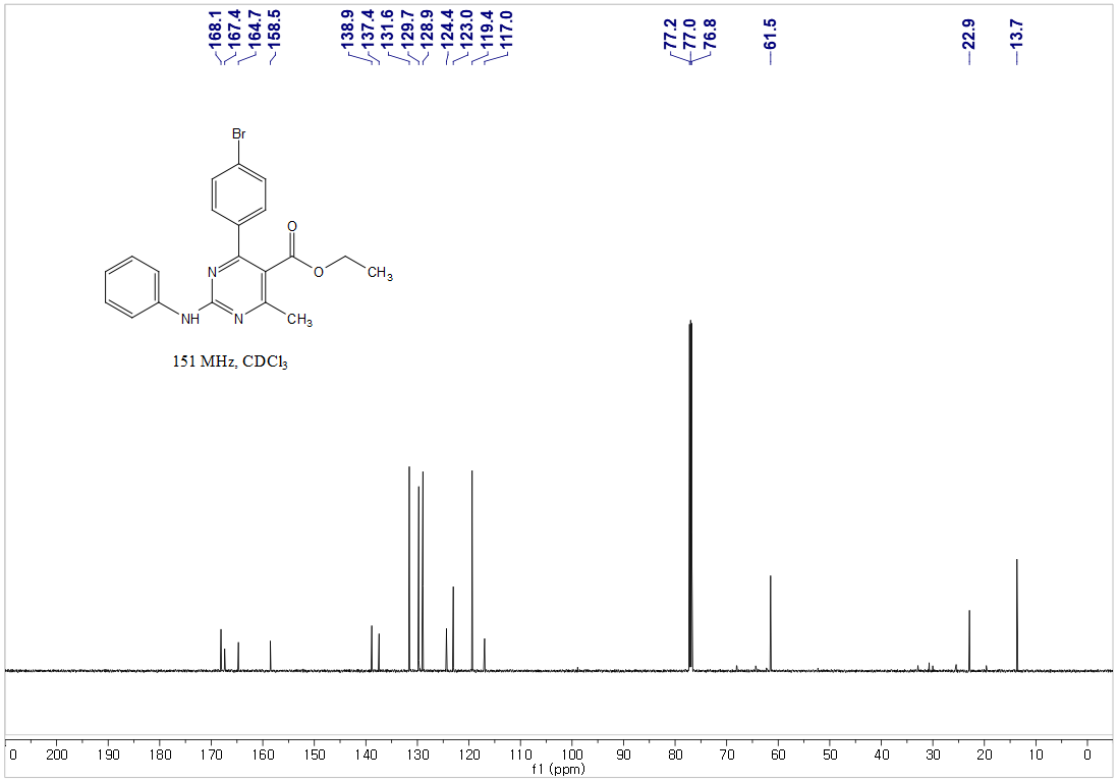
Ethyl 4-(4-fluorophenyl)-6-methyl-2-(phenylamino)pyrimidine-5-carboxylate (4d)



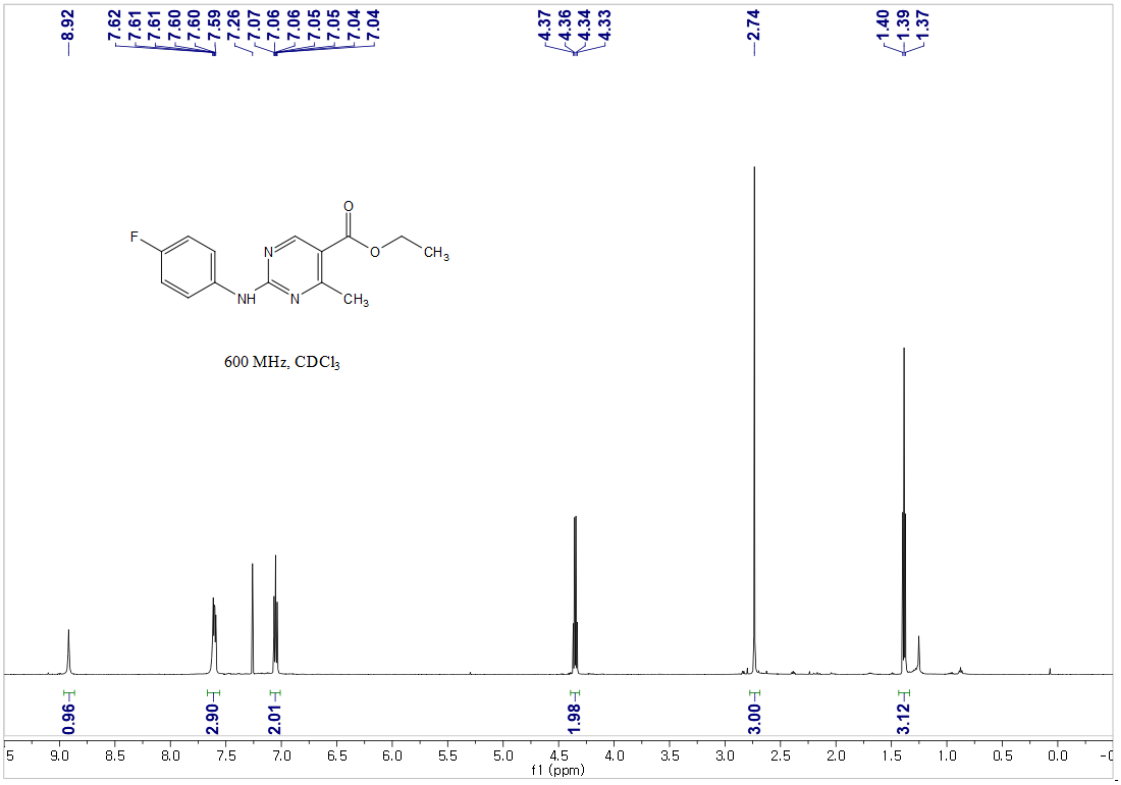


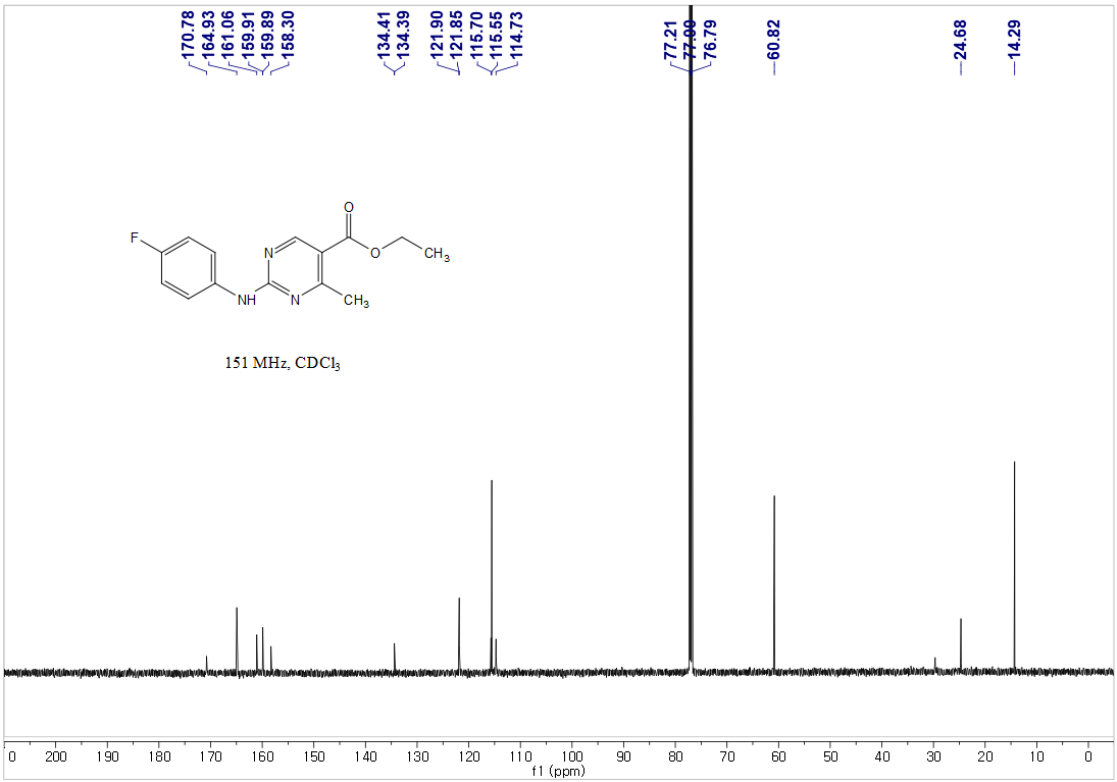
Ethyl 4-(4-bromophenyl)-6-methyl-2-(phenylamino)pyrimidine-5-carboxylate (4e)



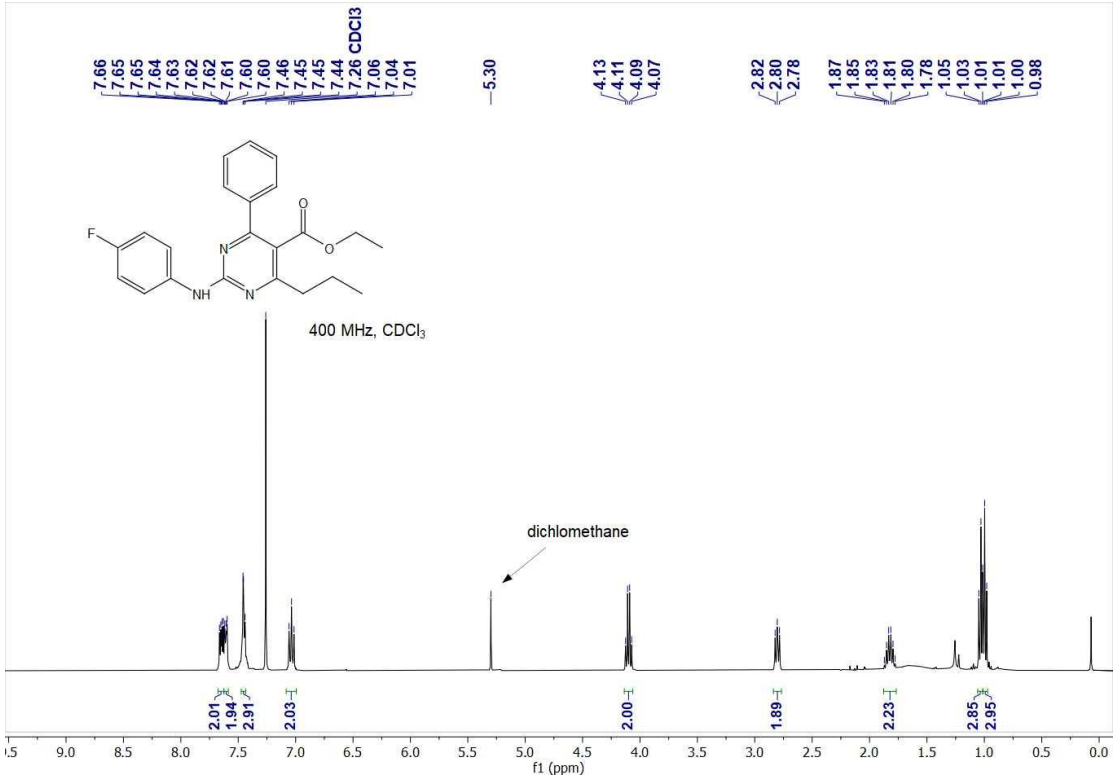


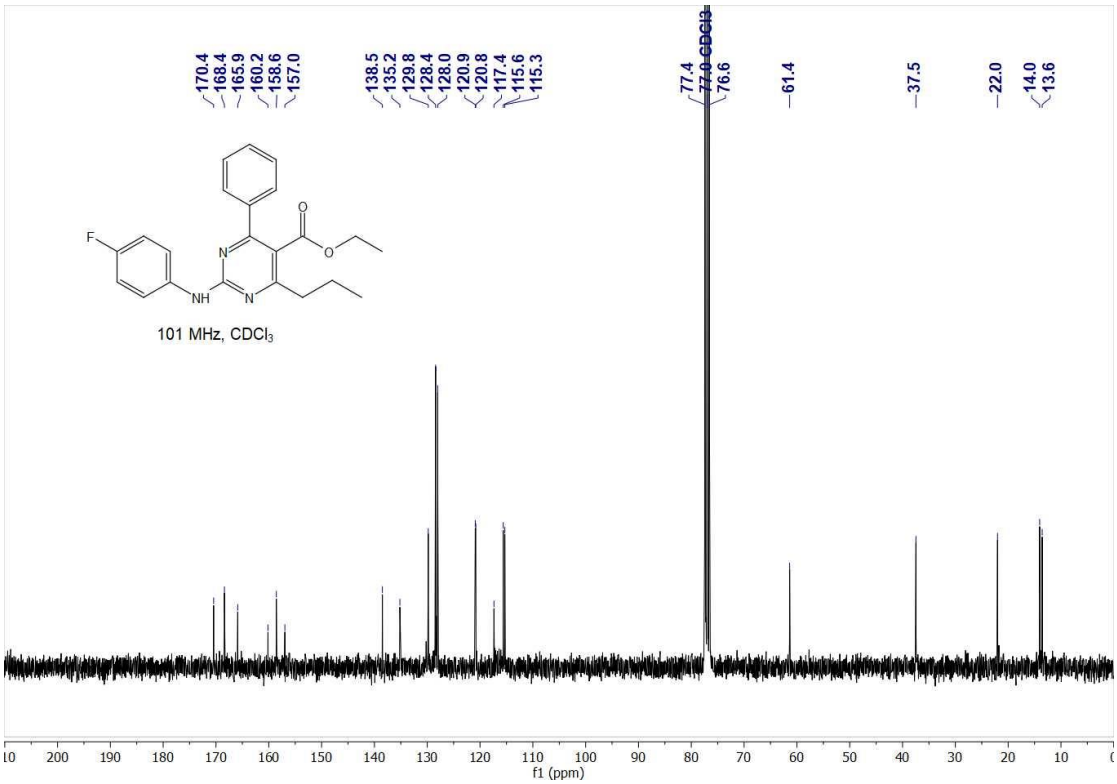
Ethyl 2-((4-fluorophenyl)amino)-4-methylpyrimidine-5-carboxylate (4f)



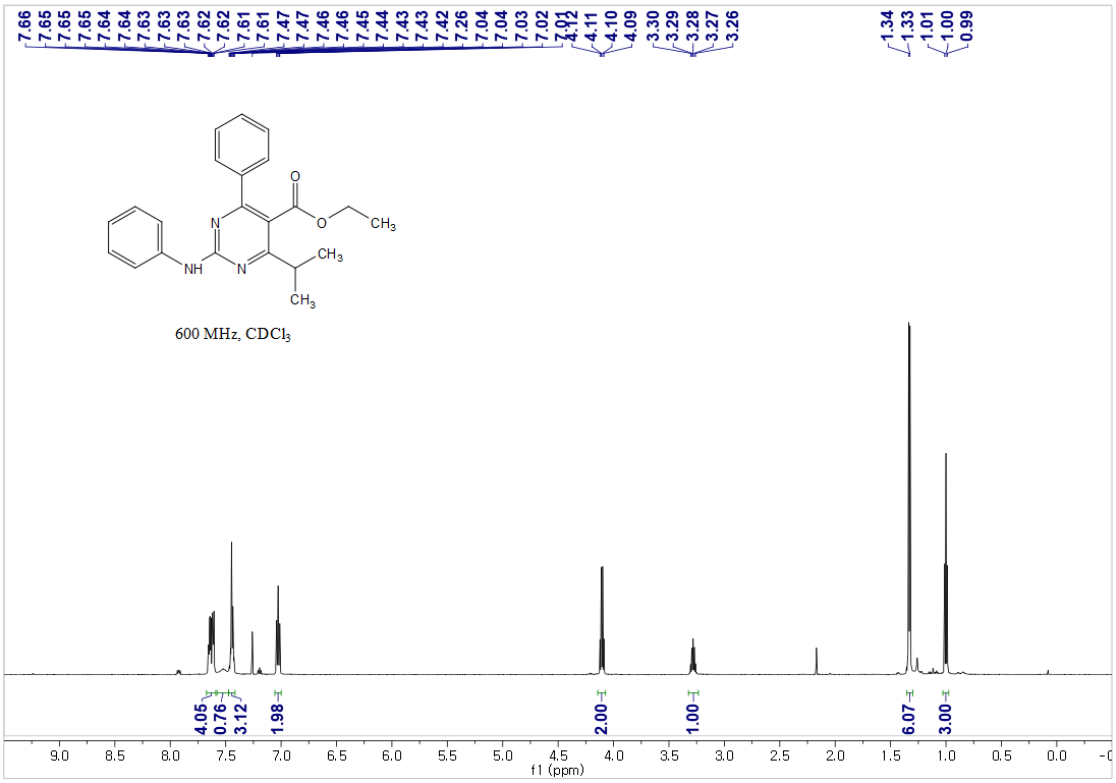


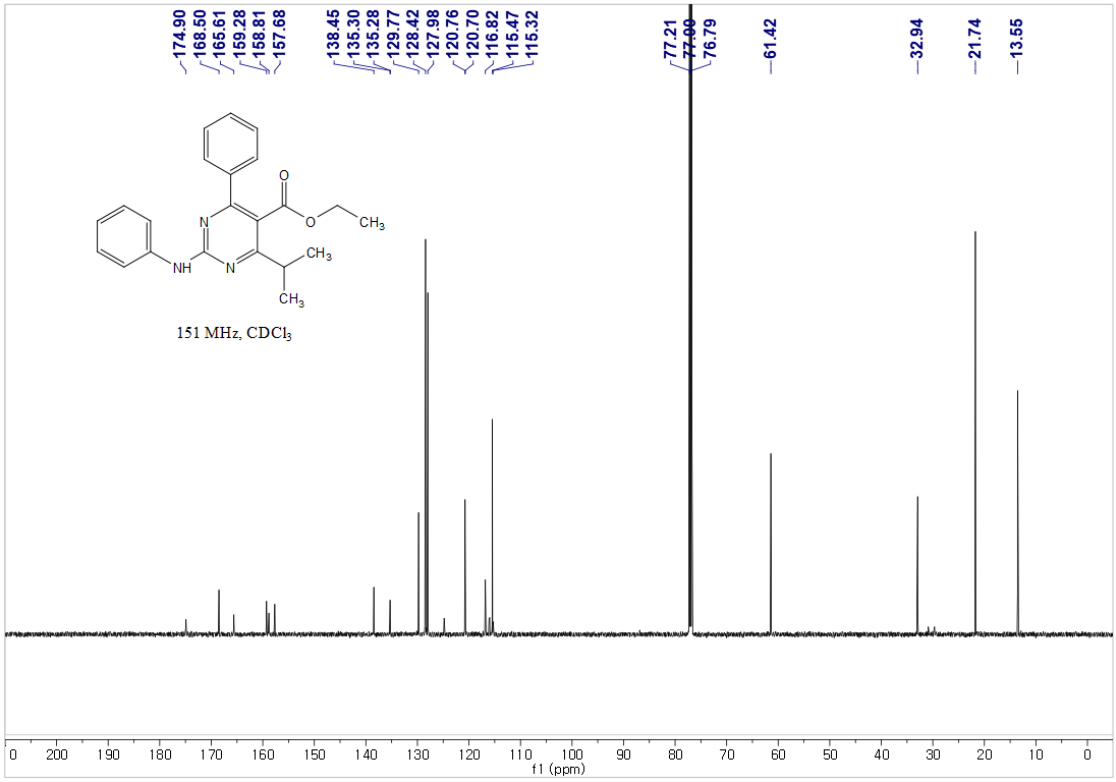
Ethyl 2-((4-fluorophenyl)amino)-4-phenyl-6-propylpyrimidine-5-carboxylate (4g)



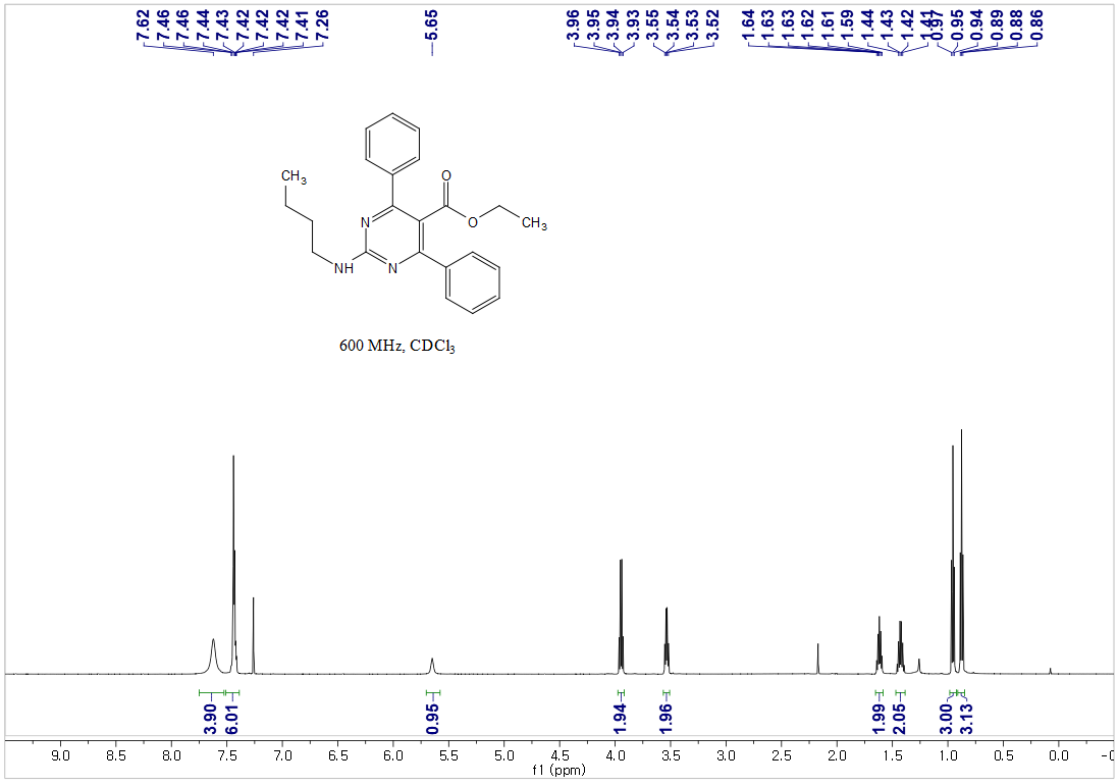


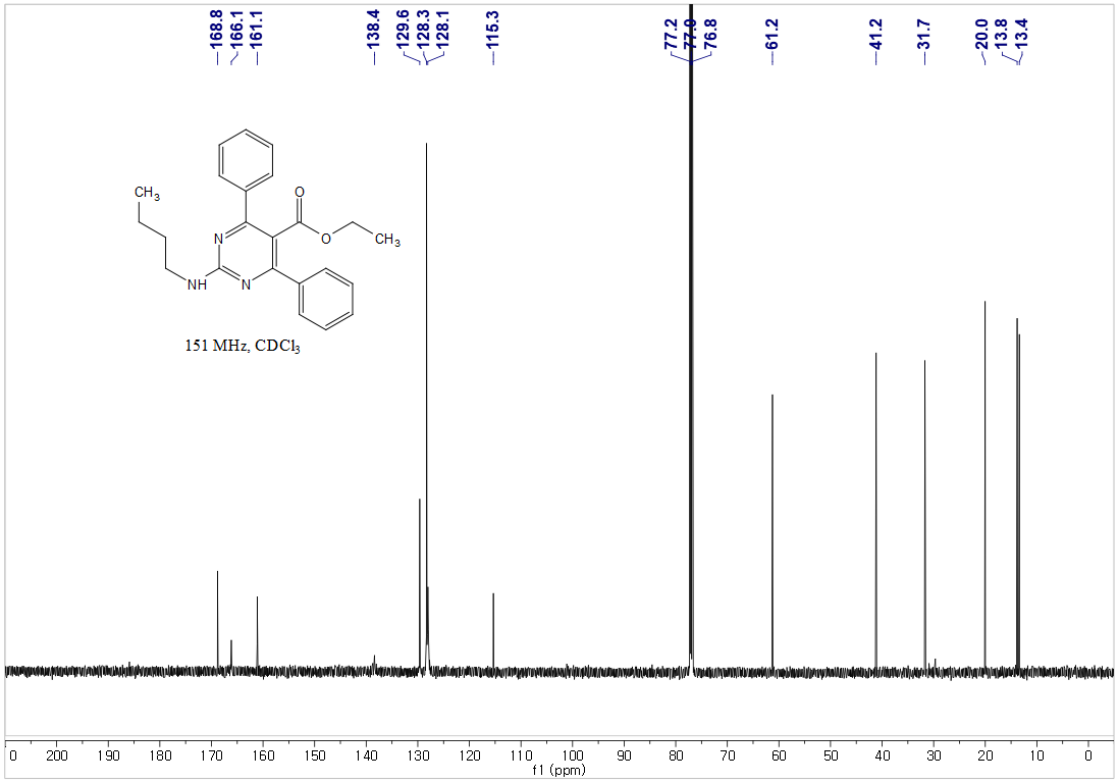
Ethyl 2-((4-fluorophenyl)amino)-4-isopropyl-6-phenylpyrimidine-5-carboxylate (4h)



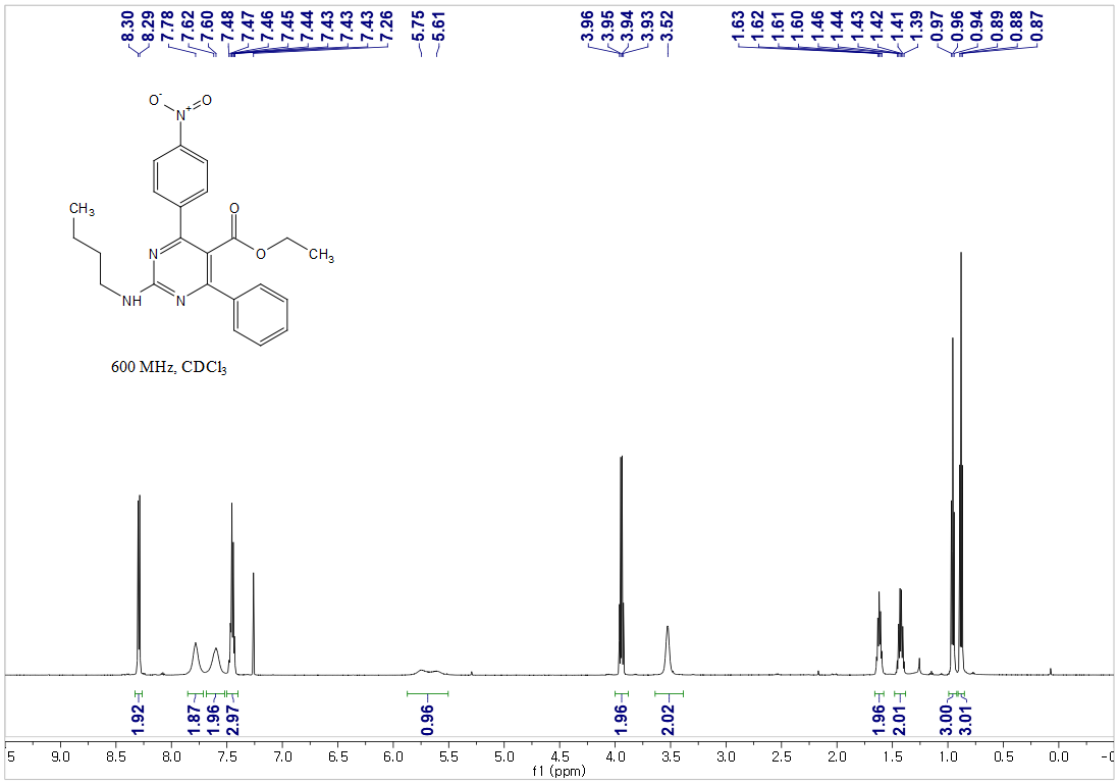


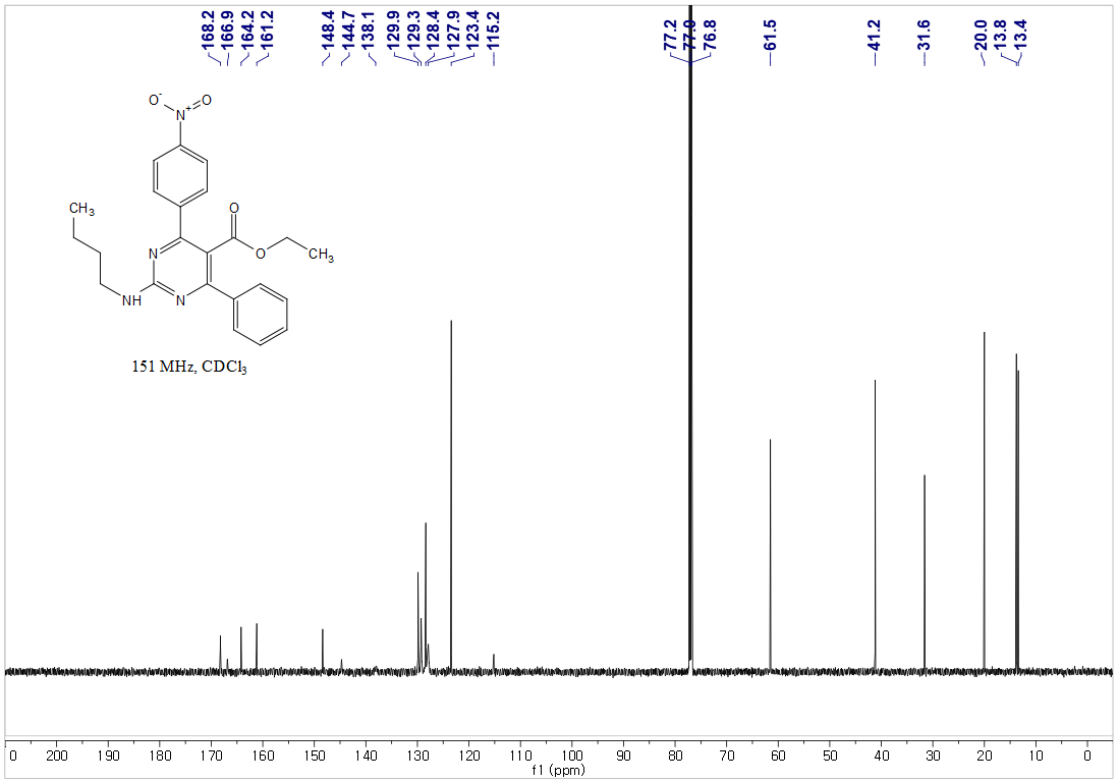
Ethyl 2-(butylamino)-4,6-diphenylpyrimidine-5-carboxylate (4i)



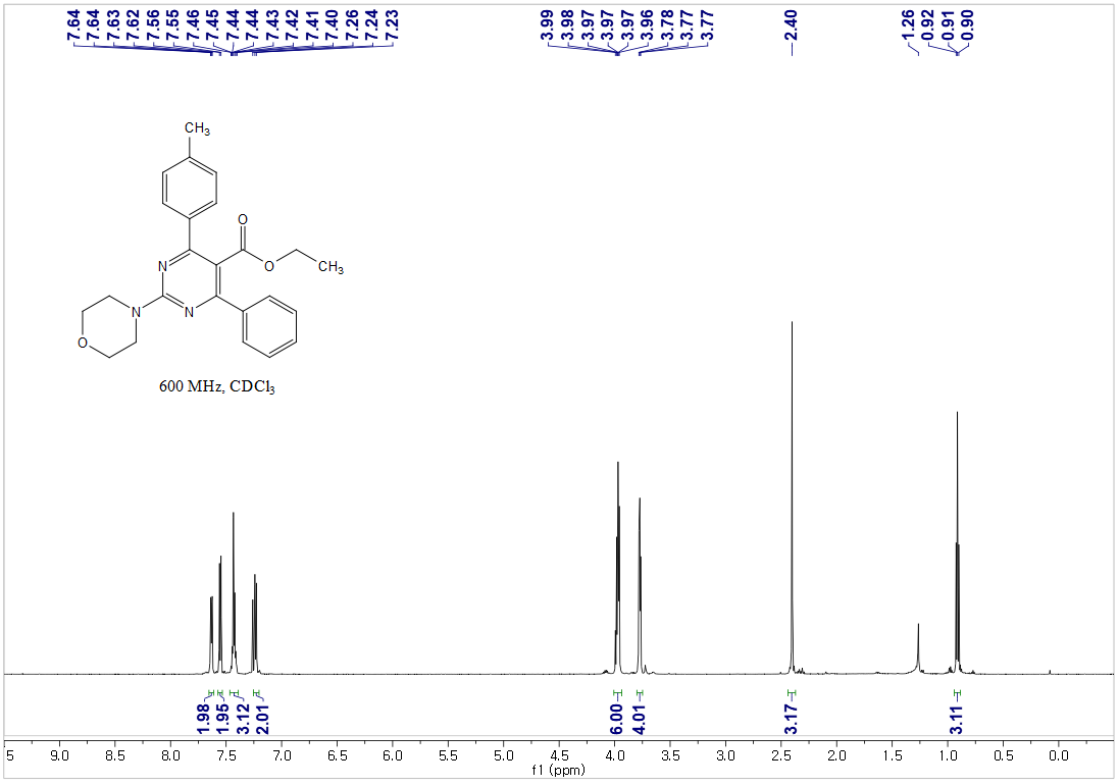


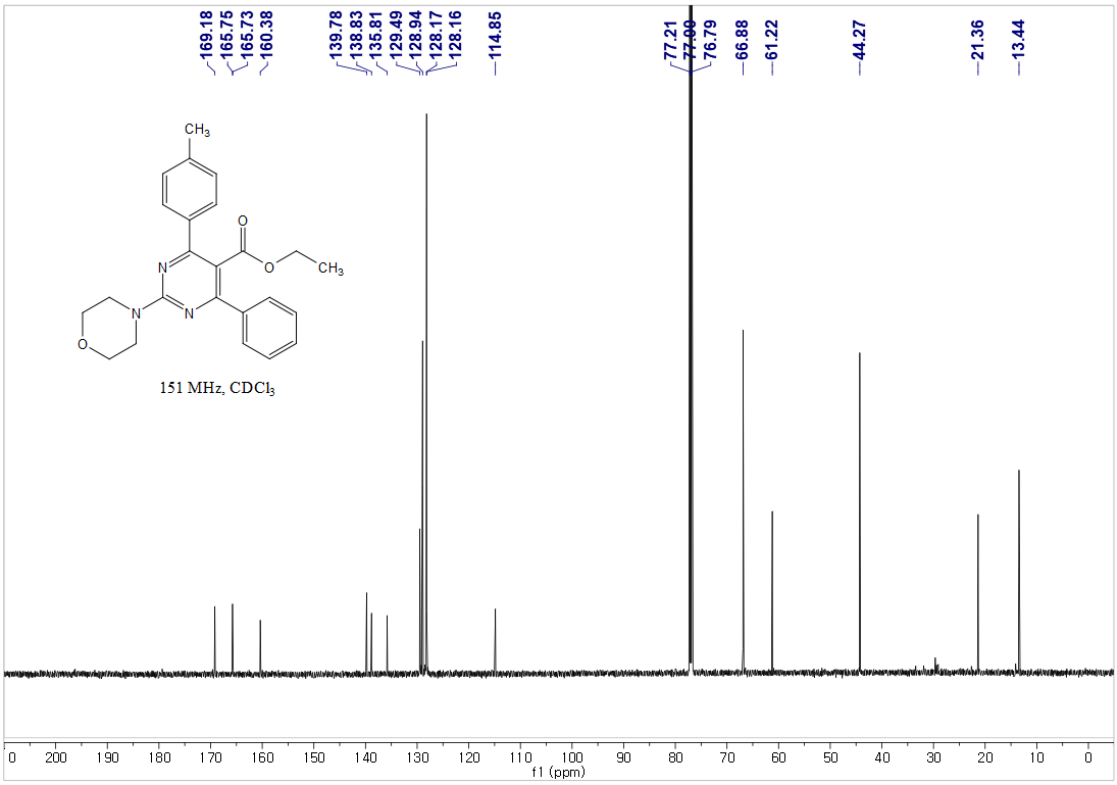
Ethyl 2-(butylamino)-4-(4-nitrophenyl)-6-phenylpyrimidine-5-carboxylate (4j)



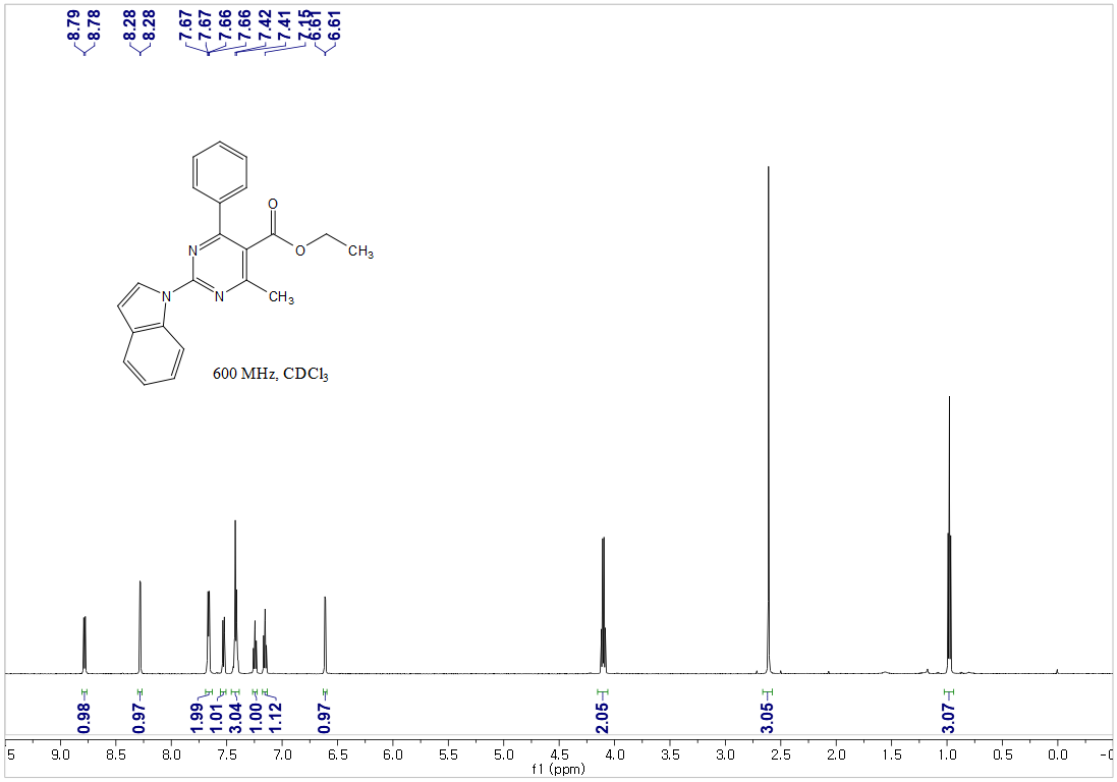


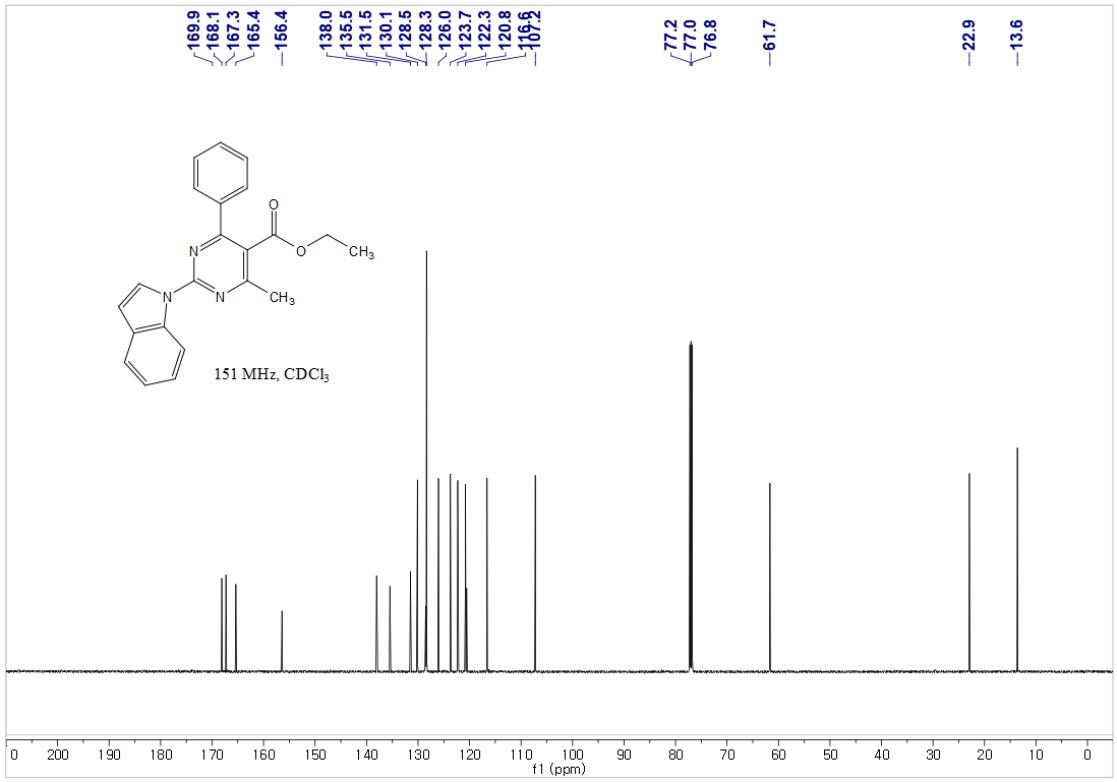
Ethyl 2-morpholino-4-phenyl-6-(*p*-tolyl)pyrimidine-5-carboxylate (4k)



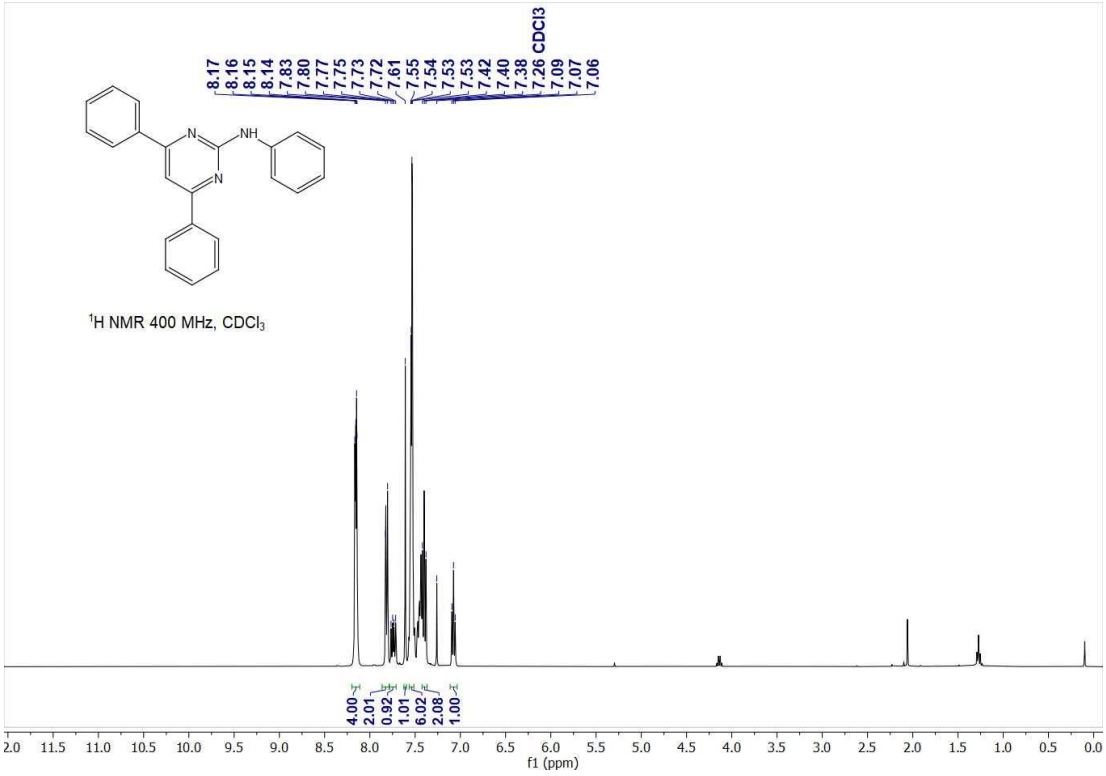


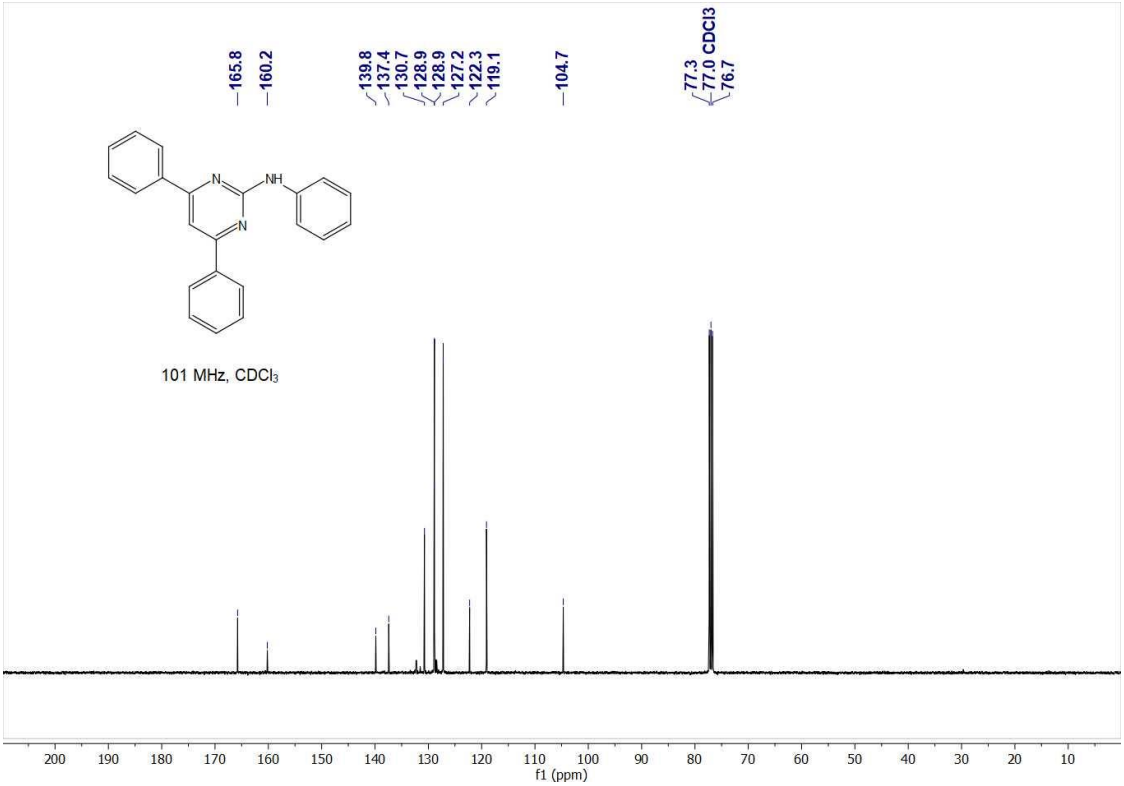
Ethyl 2-(3a,7a-dihydro-1H-indol-1-yl)-4-methyl-6-phenylpyrimidine-5-carboxylate (4l)



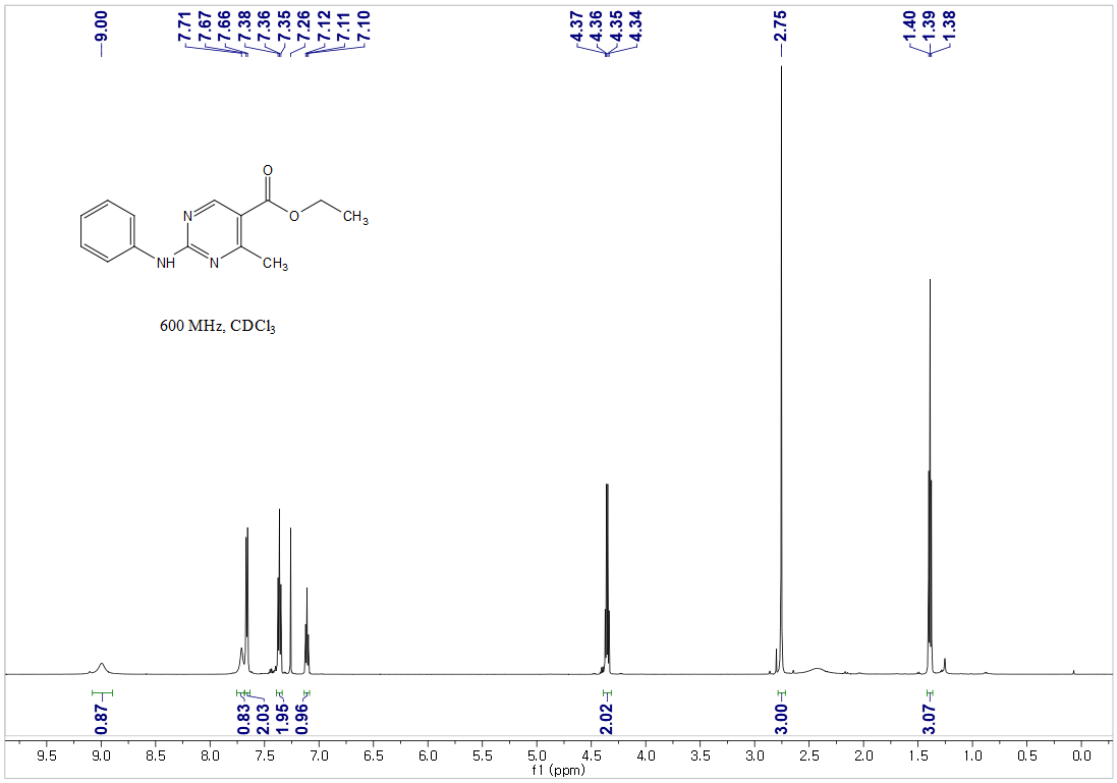


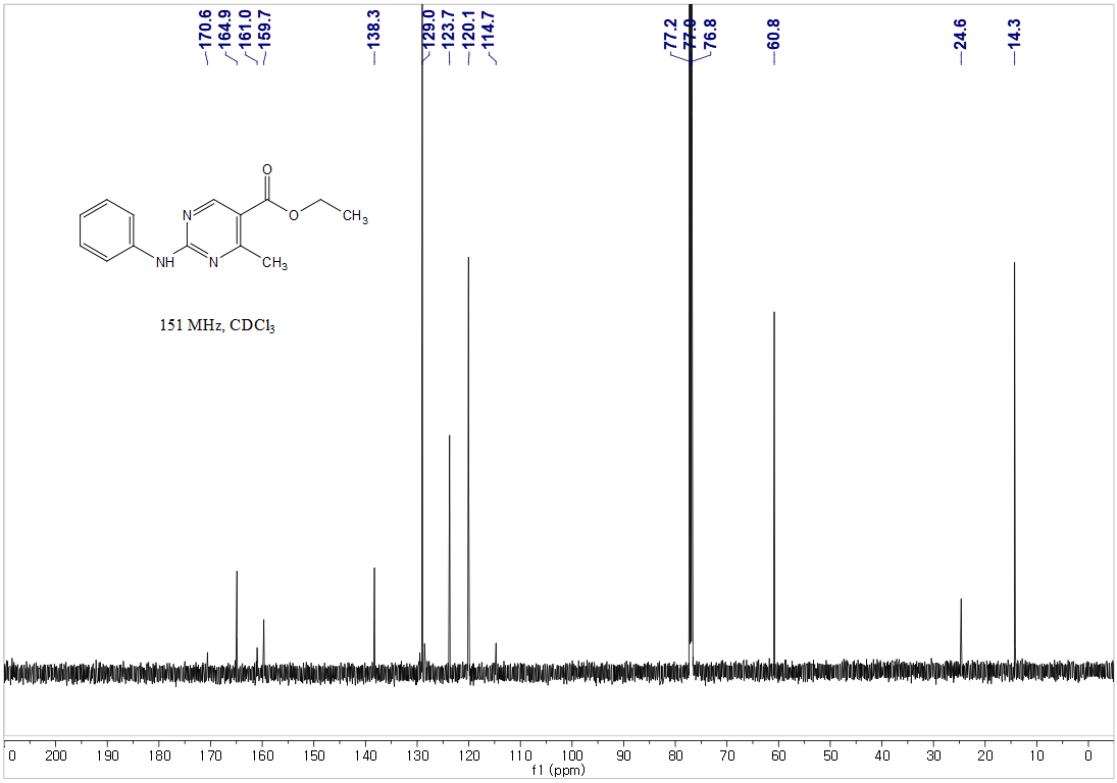
N,4,6-Triphenyl-2-pyrimidinamine (4m)





Ethyl 4-methyl-2-(phenylamino)pyrimidine-5-carboxylate (5a).





N-phenylpyrimidin-2-amine (**5b**)