Substituent Effects on the Sensitivity of a Quinoline Photoremovable Protecting Group to One- and Two-Photon Excitation

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Synthetic Procedures

General. All reagents and solvents were purchased and used without further purification. Moisture sensitive reactions were carried out using flame or oven-dried glassware and inert atmospheres were maintained using gas bubblers. Na_2SO_4 was used to dry solvent extracts. Pyridine was distilled over CaH_2. Tetrahydrofuran (THF), benzene, and toluene were dried by passing the solvents through activated alumina under positive nitrogen pressure before use. ^1H NMR and ^{13}C NMR spectra were recorded on a 400 MHz spectrometer using tetramethylsilane (TMS) as an internal standard. HPLC analyses were performed using Microsorb C-18 reverse phase columns, an autosampler, and a diode array detector. Mass spectrometry was performed on a quadrupole mass spectrometer with an electrospray ionization source. Electrospray ionization was used for HRMS. KMOPS buffer consisted of 100 mM KCl and 10 mM MOPS solution titrated with KOH to pH 7.2, with additional DTT (5 mM) for thiol experiments. Thin layer and column chromatography were performed on precoated silica gel 60 F_{254} plates and 230-400 mesh silica gel 60, respectively.

7-(Methoxymethoxy)-8-nitroquinaldine (8a). Triethylamine (174 μL, 1.695 mmol) was added to a solution of **5a** (174 mg, 0.847 mmol) in dry THF (5 mL) under a nitrogen atmosphere. Chloromethyl methyl ether (128 μL, 1.695 mmol) was added to the mixture dropwise and the reaction was stirred for 1 h. The reaction was diluted with chloroform, washed with water followed by brine. The organic layer was dried over Na_2SO_4, and the solvent was evaporated to afford **8a** (200 mg, 0.806 mmol, 95%) as a bright yellow solid: ^1H NMR ($CDCl_3$) δ 8.00 (1H, d, J = 8.4 Hz), 7.81 (1H, d, J = 9.2 Hz), 7.47 (1H, d, J = 8.8 Hz), 7.26 (1H, d, J = 8.4 Hz), 5.35 (2H, s), 3.52 (3H, s), 2.69 (3H, s); ^{13}C NMR ($CDCl_3$) δ 162.5, 148.3, 140.3, 137.7, 135.7, 130.3, 122.2, 122.2, 115.4, 95.3, 57.0, 25.9; FTIR (neat) 2955, 1626, 1525, 1508, 1377, 1247, 1226, 1193, 1153, 1065, 991, 924, 835, 806, 656 cm^{-1}; MS (ESI) m/z calcd for $(C_{12}H_{12}N_2O_4 + H)^+$ 249, found 249; HRMS (ESI) m/z calcd for $(C_{12}H_{12}N_2O_4 + H)^+$ 249.0875, found 249.0871.

7-(Methoxymethoxy)-8-nitroquinolin-2-yl formaldehyde (9a). Under a nitrogen atmosphere, selenium dioxide (11 mg, 0.099 mmol) was added to a solution of **8a** (22.1 mg, 0.089 mmol) in dioxane (2 mL) at 85 °C. The reaction was stirred for 20 h at 85 °C, then cooled, diluted with methanol, and vacuum filtered. The filtrate was collected and concentrated, leaving a yellow solid, which was purified by column chromatography (4:6 EtOAc/hexane) to provide **9a** (13.7 mg, 0.0523 mmol, 59%) as a yellow solid: ^{1}H NMR ($CDCl_3$) δ 10.15 (1H, s), 8.35 (1H, d, J = 8.4 Hz), 8.02 (1H, d, J = 8 Hz), 8.00 (1H, d, J = 9.6 Hz), 7.76 (1H, d, J = 9.2 Hz), 5.43 (2H, s), 3.56 (3H, s); ^{13}C NMR ($CDCl_3$) δ 193.25, 154.14, 149.28, 140.47, 137.83, 137.55, 130.64, 125.26, 119.33, 117.34, 95.45, 57.24; FTIR (neat) 2858, 1715, 1529, 1263, 1197, 1155, 1061, 935, 918, 849, 806, 771, 658 cm^{-1}; MS (ESI) *m*/*z* calcd for $(C_{12}H_{10}N_2O_5 + H)^+$ 263, found 263; HRMS (ESI) *m*/*z* calcd for $(C_{12}H_{10}N_2O_5 + H)^+$ 263.0668, found 263.0662.

7-(Methoxymethoxy)-8-nitroquinolin-2-yl methanol (10a). $NaBH_4$ was added to a solution of **9a** (18.1 mg, 0.0691 mmol) in absolute EtOH (5 mL). The reaction mixture was stirred for 15 min, diluted with chloroform, washed with water followed by brine. The organic layer was dried over Na_2SO_4 and the solvent was evaporated to afford **10a** (8.3 mg, 0.032 mmol, 45%) as a yellow solid: ^{1}H NMR ($CDCl_3$) δ 8.14 (1H, d, J = 8.8 Hz), 7.90 (1H, d, J = 9.2 Hz), 7.58 (1H, d, J = 9.2 Hz), 7.31 (1H, d, J = 8.4 Hz), 5.39 (2H, s), 4.91 (2H, s), 3.54 (3H, s); ^{13}C NMR ($CDCl_3$) δ 162.4, 149.0, 139.1, 136.7, 131.9, 130.6, 123.1, 118.5, 116.3, 95.4, 64.5, 57.1; FTIR (neat) 3583, 2923, 1635, 1516, 1263, 1157, 1084, 1047, 931, 916, 804 cm^{-1}; MS (ESI) *m*/*z* calcd for $(C_{12}H_{12}N_2O_5 + H)^+$ 265, found 265; HRMS (ESI) *m*/*z* calcd for $(C_{12}H_{12}N_2O_5 + H)^+$ 265.0824, found 265.0814.

7-(Methoxymethoxy)-8-nitroquinolin-2-yl methyl acetate (11a). DMAP (10.2 mg, 0.083 mmol) and acetic anhydride (15 μL, 0.16 mmol) were added to a solution of **10a** (8.3 mg, 0.032 mmol) in chloroform (4 mL) and pyridine (1 mL) under a nitrogen atmosphere. The reaction was stirred for 18 h. The solvent was evaporated and the residue was purified by column chromatography (3:7 EtOAc/hexane) to afford **11a** (7.6 mg, 0.025 mmol, 78%) as a yellow solid: ^{1}H NMR ($CDCl_3$) δ 8.16 (1H, d, J = 8.4 Hz), 7.88 (1H, d, J = 9.2 Hz), 7.56 (1H, d, J = 9.2 Hz), 7.44 (1H, d, J = 8.4 Hz), 5.37 (2H, s), 5.36 (2H, s), 3.53 (3H, s), 2.20 (3H, s); ^{13}C NMR ($CDCl_3$) δ 170.8, 159.4, 148.7, 140.0, 137.7, 136.7, 130.4, 123.0, 119.0, 116.6, 95.3, 67.0, 57.1, 21.1; FTIR (neat) 2932, 1747, 1654, 1543, 1386, 1218, 1073, 810 cm^{-1}; MS (ESI) *m*/*z* calcd for $(C_{14}H_{14}N_2O_6 + H)^+$ 307, found 307; HRMS (ESI) *m*/*z* calcd for $(C_{14}H_{14}N_2O_6 + H)^+$ 307.0930, found 307.0930.

7-Hydroxy-8-nitroquinolin-2-yl methyl acetate (NHQ-OAc, 1a). One drop of 12 N HCl was added to a solution of **11a** (7.0 mg, 0.023 mmol) in methanol (5 mL). The reaction was stirred for 10 min at room temperature followed by evaporation of the solvent. The resulting residue was taken up in chloroform, and the resulting clear solution was decanted and concentrated. The resulting residue was purified by column chromatography (1:1 EtOAc/hexane) to afford **NHQ-OAc** (3.0 mg, 0.0115 mmol, 50%) as a dark orange solid: ^{1}H NMR (DMSO-d_6) δ 8.42 (1H, d, J = 8.4 Hz), 8.04 (1H, d, J = 9.2 Hz), 7.48 (1H, d, J = 8.4 Hz), 7.41 (1H, d, J = 8.8 Hz), 5.27 (2H, s), 2.15 (3H, s); ^{13}C NMR (DMSO-d_6) 170.1, 158.5, 149.8, 139.5, 137.1, 133.9, 130.7, 120.7, 118.9, 117.7, 66.0, 20.5; FTIR (neat) 3076, 2922, 1740, 1637, 1527, 1506, 1450, 1375, 1342, 1304, 1213, 1140, 1063, 1028, 895, 844, 794, 656 cm^{-1}; MS (ESI) *m*/*z* calcd for $(C_{12}H_{10}N_2O_5 + H)^+$ 263, found 263; HRMS (ESI) *m*/*z* calcd for $(C_{12}H_{10}N_2O_5 + H)^+$ 263.0668, found 263.0651.

8-Chloro-7-methoxymethylquinoline (8c). Triethylamine (1.879 mL, 13.49 mmol) was added to a solution of **5c** (0.2612 g, 1.349 mmol) in THF (20 mL) under a nitrogen atmosphere. Chloromethyl methyl ether (0.241 mL, 3.17 mmol) was added to the mixture dropwise. After stirring for 2 h, the solution was diluted with EtOAc and washed successively with water (×2) and brine. The organic layer was dried over $MgSO_4$, filtered, and evaporated. The resulting residue was purified by flash chromatography (3:7 EtOAc/hexane) to afford **8c** (0.2298g, 0.9668 mmol, 72%) as a yellow solid (mp 78–79 °C): ^{1}H NMR ($CDCl_3$) δ 8.01 (1H, d, J = 8.8 Hz), 7.67 (1H, d, J = 8.8 Hz), 7.47 (1H, d, J = 9.2 Hz), 7.26 (1H, d, J = 8.8 Hz), 5.40 (2H, s), 3.58 (3H, s), 2.82 (3H, s); ^{13}C NMR ($CDCl_3$) δ 160.9, 153.8, 145.4, 136.6, 126.9, 123.5, 121.4, 116.7, 105.0, 95.7, 56.8, 26.0; FTIR (neat) 2919, 1611, 1508, 1259, 1011, 833, 783 cm^{-1}; MS (ESI) *m/z* calcd for $(C_{12}H_{12}ClNO_2 + H)^+$ 238 (^{35}Cl) and 240 (^{37}Cl), found 238 (^{35}Cl) and 240 (^{37}Cl); HRMS (ESI) *m/z* calcd for $(C_{12}H_{12}ClNO_2 + H)^+$ 238.0635 (^{35}Cl) and 240.0605 (^{37}Cl), found 238.0623 (^{35}Cl) and 240.0593 (^{37}Cl).

8-Chloro-2-formyl-7-methoxymethylquinoline (9c). Under a nitrogen atmosphere, selenium dioxide (0.0604 g, 0.544 mmol) was added to a solution of **8c** (0.1232 g, 0.5184 mmol) in *p*-dioxane (3 mL), and the resulting orange solution was stirred in a sealed flask for 2 h at 85 °C. The black precipitate was removed by vacuum filtration and the filtrand was evaporated, leaving a residue, which was purified by column chromatography (2:8 EtOAc/hexane) to afford **9c** (0.0724 g, 0.288 mmol, 56%) as a pale yellow solid (mp 118–121 °C): ^{1}H NMR ($CDCl_3$) δ 10.30 (1H, s), 8.30 (1H, d, J = 8.0 Hz), 7.99, (1H, d, J = 8.0 Hz), 7.81 (1H, d, J = 9.6 Hz), 7.70 (1H, d, J = 8.8 Hz), 5.45 (2H, s), 3.60 (3H, s); ^{13}C NMR ($CDCl_3$) δ 193.9, 154.7, 153.4, 145.6, 138.0, 127.2, 127.0, 121.3, 120.2, 116.5, 95.7, 57.0; FTIR (neat) 2931, 2835, 1713, 1615, 1303, 1159, 1043, 920, 775 cm^{-1}; MS (ESI) *m/z* calcd for $(C_{12}H_{10}ClNO_3 + H)^+$ 252 (^{35}Cl) and 254 (^{37}Cl), found 252 (^{35}Cl) and 254 (^{37}Cl); HRMS (ESI) *m/z* calcd for $(C_{12}H_{10}ClNO_3 + H)^+$ 252.0427 (^{35}Cl) and 254.0398 (^{37}Cl), found 252.0418 (^{35}Cl) and 254.0390 (^{37}Cl).

8-Chloro-2-hydroxymethyl-7-methoxymethylquinoline (10c). $NaBH_4$ (0.0028 g, 0.074 mmol) was added to a solution of **9c** (0.0397 g, 0.158 mmol) in ethanol (4 mL). The mixture was stirred for 20 min. The solvent was evaporated, and the resulting solid residue was dissolved in chloroform, then washed with water (×2) followed by brine, dried over $MgSO_4$, and concentrated to afford **10c** (0.0396 g, 0.156 mmol, 99%) as a white, crystalline solid (mp 84–87 °C): ^{1}H NMR ($CDCl_3$) δ 8.09 (1H, d, J = 8.4 Hz), 7.71 (1H, d, J = 8.8 Hz), 7.52 (1H, d, J = 9.2 Hz), 7.24 (1H, d, J = 8.4 Hz), 5.41 (2H, s), 4.94 (2H, s) 3.58 (3H, s); ^{13}C NMR ($CDCl_3$) δ 160.3, 154.2, 144.1, 137.2, 127.0, 124.4, 120.0, 117.4, 117.2, 95.7, 64.4, 56.8; FTIR (neat) 3342, 2925, 1615, 1155, 1005, 835, 781 cm^{-1}; MS (ESI) *m/z* calcd for $(C_{12}H_{12}ClNO_3 + H)^+$ 254 (^{35}Cl) and 256 (^{37}Cl), found 254 (^{35}Cl) and 256 (^{37}Cl); HRMS (ESI) *m/z* calcd for $(C_{12}H_{12}ClNO_3 + H)^+$ 254.0584 (^{35}Cl) and 256.0554 (^{37}Cl), found 254.0577 (^{35}Cl) and 256.0546 (^{37}Cl).

(8-Chloro-7-(methoxymethoxy)quinolin-2-yl)methyl acetate (11c). Under a nitrogen atmosphere, DMAP (0.0079 g), pyridine (1.0 mL), and acetic anhydride (0.121 mL, 1.28 mmol) were added to a solution of **10c** (0.0630 g, 0.2483 mmol) in chloroform (4 mL). After stirring for 2 h, the solvents were evaporated and the remaining residue was purified by column chromatography (1:3 EtOAc/hexane) to afford **21c** (0.0640g, 0.216 mmol, 87%) as a white solid (mp 114–117 °C): ^{1}H NMR ($CDCl_3$) δ 8.14 (1H, d, J = 8.8 Hz), 7.71 (1H, d, J = 9.2 Hz), 7.54 (1H, d, J = 8.8 Hz), 7.42 (1H, d, J = 8.0), 5.47 (2H, s), 5.41 (2H, s), 3.58 (3H, s), 2.23 (3H, s);

^{13}C NMR ($CDCl_3$) δ 170.9, 157.8, 154.2, 145.2, 137.3, 127.0, 124.5, 120.4, 118.4, 117.8, 95.8, 67.6, 56.9, 21.2; FTIR (neat) 2937, 1745, 1619, 1514, 1379, 1245, 1058, 839, 783 cm^{-1}; MS (ESI) *m*/*z* calcd for $(C_{12}H_{12}ClNO_3 + H)^+$ 254 (^{35}Cl) and 256 (^{37}Cl), found 254 (^{35}Cl) and 256 (^{37}Cl); HRMS (ESI) *m*/*z* calcd for $(C_{12}H_{12}ClNO_3 + H)^+$ 254.0584 (^{35}Cl) and 256.0554 (^{37}Cl), found 254.0577 (^{35}Cl) and 256.0546 (^{37}Cl).

(8-Chloro-7-hydroxyquinolin-2-yl)methyl acetate (CHQ-OAc, 1c). 12N HCl (1 drop) was added to a solution of **11c** (0.0140 g, 0.0473 mmol) in methanol (3 mL), and the mixture stirred for 10 min. The solvent was evaporated, and the residue was purified by column chromatography (3:7 EtOAc/hexane) to afford **CHQ-OAc** (0.0042 g, 0.017 mmol, 35%) as a white solid (mp 126–127 °C dec): ^{1}H NMR ($CDCl_3$) δ 8.13 (1H, d, *J* = 8.5 Hz), 7.68 (1H, d, *J* = 8.5 Hz) 7.40 (1H, d, *J* = 8.5 Hz) 7.34 (1H, d, *J* = 9.0 Hz) 5.46 (2H, s), 2.23 (3H, s); ^{13}C NMR ($CDCl_3$) δ 171.0, 157.7, 153.2, 144.7, 137.4 127.6 123.8, 118.2, 117.8, 115.1, 67.5, 21.2; FTIR (neat) 2928, 1737, 1629, 1511, 1343, 1251, 850, 777 cm^{-1}; MS (ESI) *m*/*z* calcd for $(C_{12}H_{10}ClNO_3 + H)^+$ 252 (^{35}Cl) and 254 (^{37}Cl), found 252 (^{35}Cl) and 254 (^{37}Cl); HRMS (ESI) *m*/*z* calcd for $(C_{12}H_{10}ClNO_3 + H)^+$ 252.0427 (^{35}Cl) and 254.0398 (^{37}Cl), found 252.0420 (^{35}Cl) and 254.0390 (^{37}Cl).

4-Chloro-7-(dimethylamino)quinoline-2-carbaldehyde (14b). 4-Chloro-*N*,*N*,2-trimethyl-quinolin-7-amine[1] (**13b**, 100 mg, 0.453 mmol) was dissolved in *m*-xylene (5 mL). Selenium dioxide (75 mg, 0.68 mmol) was added and the mixture was heated to 90 °C under nitrogen overnight. The hot reaction mixture was filtered through cotton and the filtrate was evaporated. The residue was dissolved in chloroform, adsorbed onto silica gel, and purified by column chromatography (chloroform) to provide **14b** (83.1 mg, 0.35 mmol, 78%) as a yellow-orange solid: ^{1}H NMR ($CDCl_3$) δ 10.11 (1H, s), 8.12 (1H, d, *J* = 9.6 Hz), 7.77 (1H, s), 7.37 (1H, dd, *J* = 8.8, 2.4 Hz), 7.23 (1H, d, *J* = 2.8 Hz), 3.17 (6H, s); ^{13}C NMR ($CDCl_3$) δ 193.5, 153.0, 152.4, 151.1, 143.9, 125.3, 120.5, 119.6, 114.0, 107.2, 40.7, 30.0; FTIR (neat) 2926, 2856, 1697, 1616, 1514, 1363, 1296, 1124, 846, 775 cm^{-1}; MS (ESI) *m*/*z* calcd for $(C_{12}H_{11}ClN_2O + H)^+$ 235, found 235; HRMS (ESI) *m*/*z* calcd for $(C_{12}H_{11}ClN_2O + H)^+$ 235.0638, found 235.0637.

(4-Chloro-7-(dimethylamino)quinolin-2-yl)methanol (15b). Compound **14b** (50 mg, 0.213 mmol) was dissolved in absolute ethanol (2 mL). $NaBH_4$ (8 mg, 0.213 mmol) was added to the solution and the mixture was stirred for 30 min. The solvent was evaporated and the residue dissolved in methanol and filtered. The filtrate was adsorbed onto silica gel and purified by column chromatography (7:3 EtOAc/hexane) to obtain **15b** (30 mg, 0.126 mmol, 60%). ^{1}H NMR ($CDCl_3$) δ 8.02 (1H, d, *J* = 8.8 Hz), 7.21 (1H, dd, *J* = 9.2, 2.8 Hz), 7.11 (1H, d, *J* = 2.8 Hz), 7.07 (1H, s), 4.81 (2H, s), 3.14, (6H, s); ^{13}C NMR ($CDCl_3$) δ 159.4, 152.1, 149.6, 143.1, 125.1, 117.9, 116.5, 114.3, 106.3, 64.2, 40.6; FTIR (neat) 2918, 1622, 1535, 1508, 1394, 1284, 1207, 1174, 1134; MS (ESI) *m*/*z* calcd for $(C_{12}H_{13}ClN_2O + H)^+$ 237, found 237; HRMS (ESI) *m*/*z* calcd for $(C_{12}H_{13}ClN_2O + H)^+$ 237.0838, found 237.0832.

(4-Chloro-7-(dimethylamino)quinolin-2-yl)methyl acetate (DMAQ-Cl-OAc, 2b). Pyridine (0.6 mL) was added to **15b** (30 mg, 0.126 mmol) and the solution was stirred under nitrogen for a few minutes before acetic anhydride (70 μL) was added dropwise. The solution was stirred under nitrogen for 17 h before the solvent was evaporated. The resulting residue was purified by column chromatography (3:7 EtOAc/hexane) to give **DMAQ-Cl-OAc** (20.0 mg, 71 μmol, 57%):

^{1}H NMR ($CDCl_3$) δ 8.03 (1H, d, J = 9.2 Hz), 7.23 (1H, d, J = 9.2Hz), 7.11 (1H, s), 7.14 (1H, s), 5.30 (2H, s), 3.14 (6H, s), 2.23 (3H, s); ^{13}C NMR ($CDCl_3$) δ 170.6, 156.3, 151.9, 150.4, 143.0, 124.7, 117.9, 116.9, 115.4, 106.4, 67.1, 40.4, 21.0; FTIR (neat) 2992, 1744, 1616, 1514, 1425, 1373, 1225, 1132, 1053, 862, 845, 810, 756, 677 cm^{-1}; MS (ESI) *m/z* calcd for $(C_{12}H_{15}ClN_2O + H)^+$ 279, found 279; HRMS (ESI) *m/z* calcd for $(C_{12}H_{15}ClN_2O + H)^+$ 279.0900, found, 279.0934.

Detailed Procedures for Photochemical Experiments

Determination of the uncaging quantum efficiency (Q_u). These experiments were carried out using a previously described method.[2-5] KMOPS-buffered solutions (3 mL) of **1a–c**, **2**, and **3** (100 μM) in quartz cuvettes were irradiated with 365-nm light from a mercury lamp (Spectroline SB-100P; Spectronics, Westbury, NY) with a set of light filters. The spectral output of the lamp after the glass filters (CS0-52 and CS7-60, Ace Glass, Vineland, NJ) is 365 ± 15 nm. Aliquots (20 μL) of the reaction solution were removed for analysis by HPLC at periodic intervals. An external standard method was used to determine the concentration of the caged compound. The analytes were eluted isocratically (flow rate of 1 mL/min) with acetonitrile and water containing 0.1% TFA.

Compound	t_R (min)	λ_{obs} (nm)*	Mobile Phase
NHQ-OAc (1a)	7.9	320	65:35 acetonitrile/water (0.1% TFA)
CyHQ-OAc (1b)	6.4	320	35:65 acetonitrile/water (0.1% TFA)
CHQ-OAc (1c)	5.9	310	40:60 acetonitrile/water (0.1% TFA)
DMAQ-OAc (2a)	6.8	438	40:60 acetonitrile/water (0.1% TFA)
DMAQ-Cl-OAc (2b)	6.2	445	50:50 acetonitrile/water (0.1% TFA)
TQ-OAc (3)	5.8	330	35:65 acetonitrile/water (0.1% TFA)

*Detector observation wavelength

The uncaging quantum efficiency (Q_u) of each chromophore was calculated using equation (1),[6,7] where I is the radiant power in einstein·cm^{-2}·s^{-1}, σ is the decadic extinction coefficient (10^3 times ε, molar extinction coefficient) in cm^2·mol^{-1}, and $t_{90\%}$ is the irradiation time in s for 90% conversion to product. The UV intensity of the lamp I was measured by potassium ferrioxalate actinometry[8] in the same setup.

$$Q_u = \left(I\sigma t_{90\%}\right)^{-1} \quad (1)$$

Determination of the dark hydrolysis rate (τ_{dark}). Substrates were dissolved in KMOPS and stored in the dark at room temperature. HPLC analysis was carried out periodically to determine the extent of decay as described for determining the uncaging quantum efficiency.

Determination of the 2-photon uncaging action cross-section (δ_u). These experiments were carried out using a previously described method.[2-5] Measurements were performed in microcuvettes (10×1×1 mm illuminated dimensions) using light from a fs-pulsed and mode-locked Ti:sapphire laser focused on the center of the cuvette chamber with a 25-mm focal length

lens optimized for IR lasers (06LXP003/076, Melles-Griot, Irvine, CA). The laser beam was attenuated by passing the beam through an electro-optical modulator or a ½-waveplate and polarizing beamsplitter cube so that the average power exiting the apparatus was 300–350 mW. Successive aliquots (25 μL) of each caged compound in KMOPS were placed into the cuvette and irradiated for 0, 5, 10, 20, and 40 min. Each aliquot was analyzed by HPLC to determine the concentration of the remaining caged compound as described for determining the uncaging quantum efficiency. For compounds **1c**, **2a**, **2b**, and **3** (τ_{dark} < 50 h), a correction was made for background dark hydrolysis that occurred while the irradiated samples were waiting for HPLC analysis. The fraction of the decay from hydrolysis in the dark was calculated using the measured dark hydrolysis rate and the waiting time from the end of the experiment until the HPLC injection. This value was subtracted from the total decay (hydrolysis + photolysis) measured by HPLC. For compounds with τ_{dark} > 50 h, dark hydrolysis did not measurably impact the concentration determination.

The two-photon uncaging action cross-section, δ_u, was estimated by referencing to fluorescein, a compound with a known fluorescence quantum yield (Q_f = 0.9) and absorbance cross-section (δ_a = 30 GM at 740 nm),[9,10] using equation (2):[2]

$$\delta_u = \frac{N_p \phi Q_f \delta_a C_F}{< F(t) > C_S} \qquad (2)$$

N_p is the number of molecules photolyzed per unit time (molecules/s, determined by HPLC analysis of the reaction); ϕ is the collection efficiency of the detector (SED033 on an IL-1700, International Light, Newburyport, MA) used to measure the fluorescence of fluorescein emitted at a right angle to the beam and passed though a 535/45 nm bandpass filter; C_F is the concentration of the fluorescein standard (mol/L); <F(t)> is the time averaged fluorescent photon flux (photons/s) of the fluorescein standard collected by the detector; and C_S is the initial concentration of the caged compound (mol/L).

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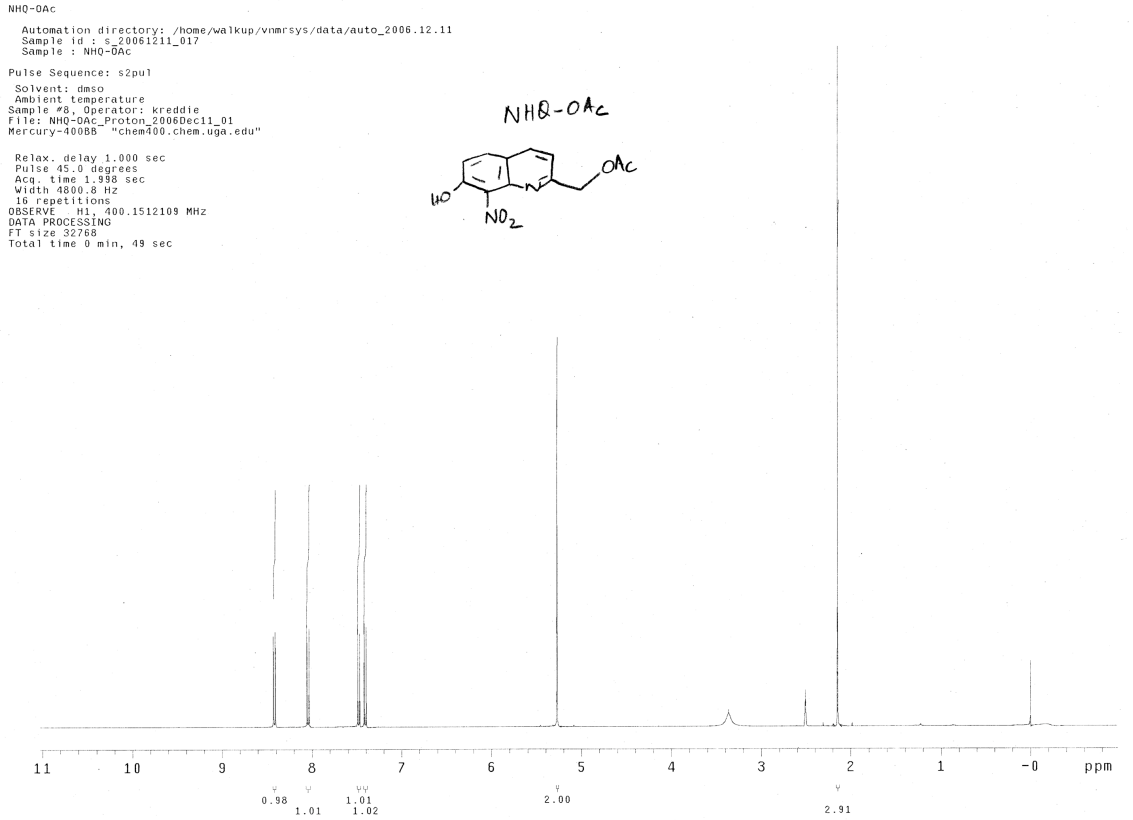
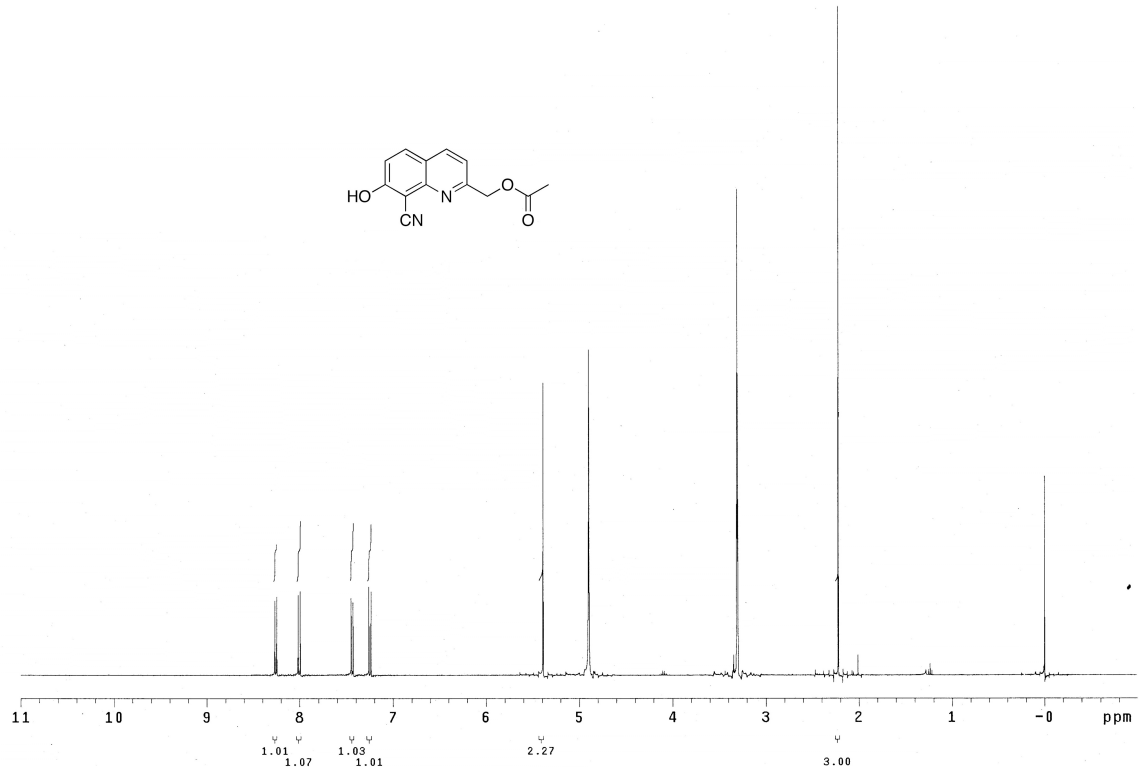
Additional Characterization Data for New Compounds

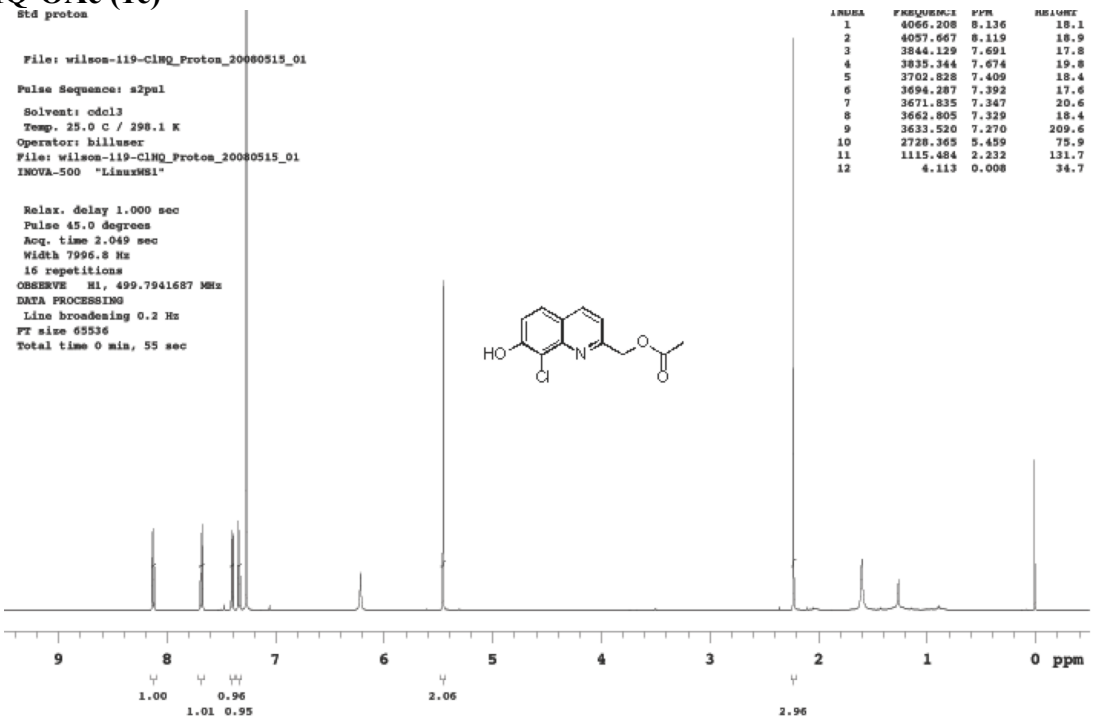
NHQ-OAc (1a)



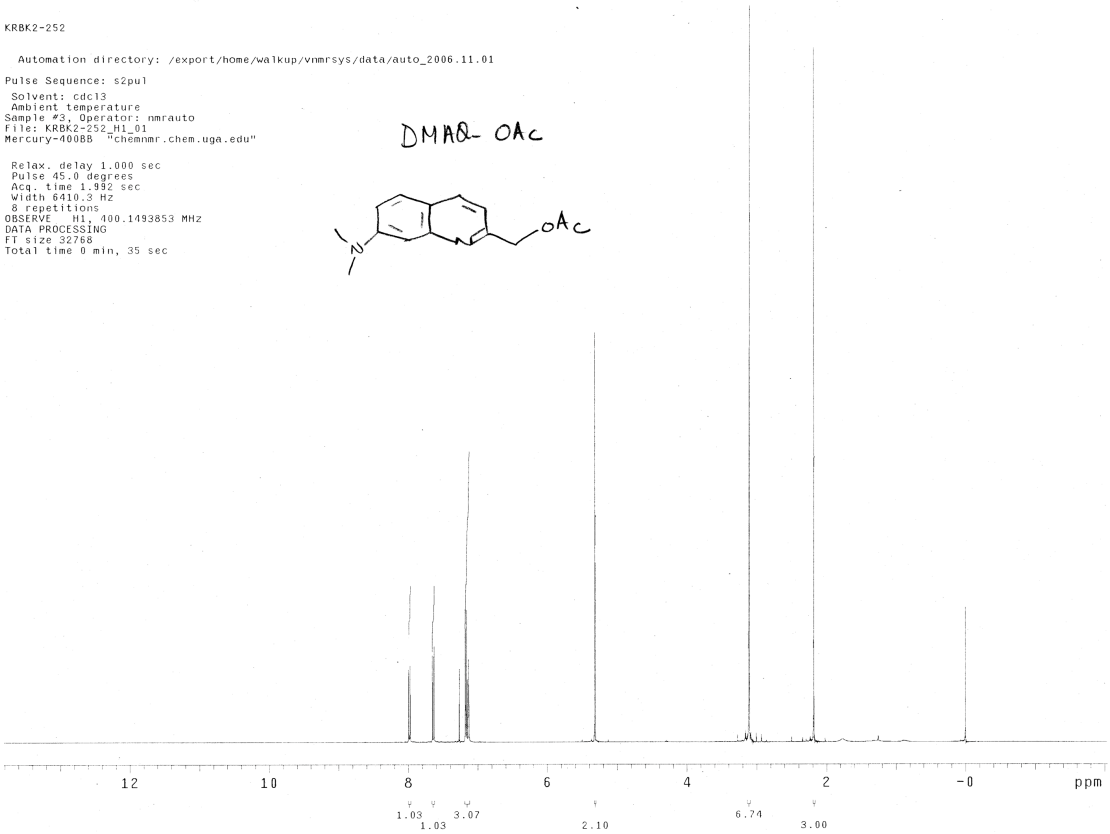
CyHQ-OAc (1b)



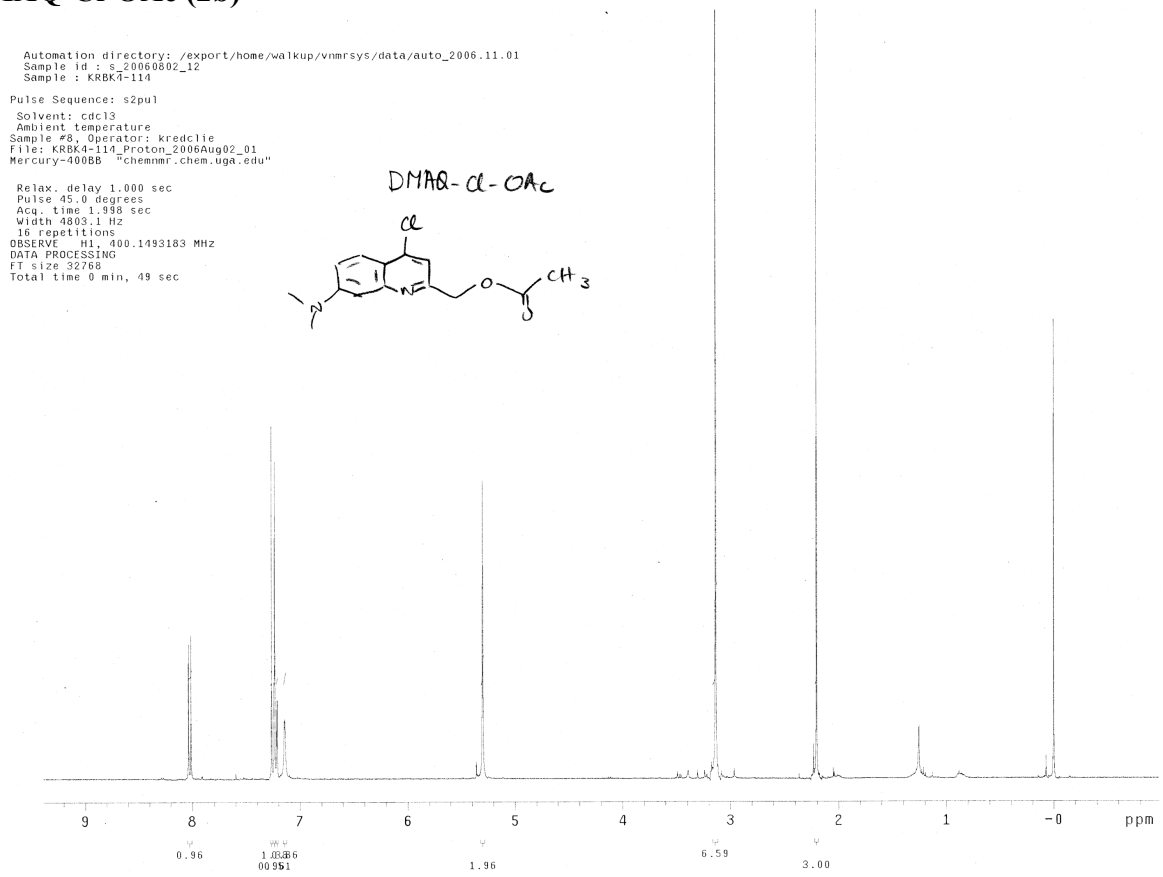
CHQ-OAc (1c)



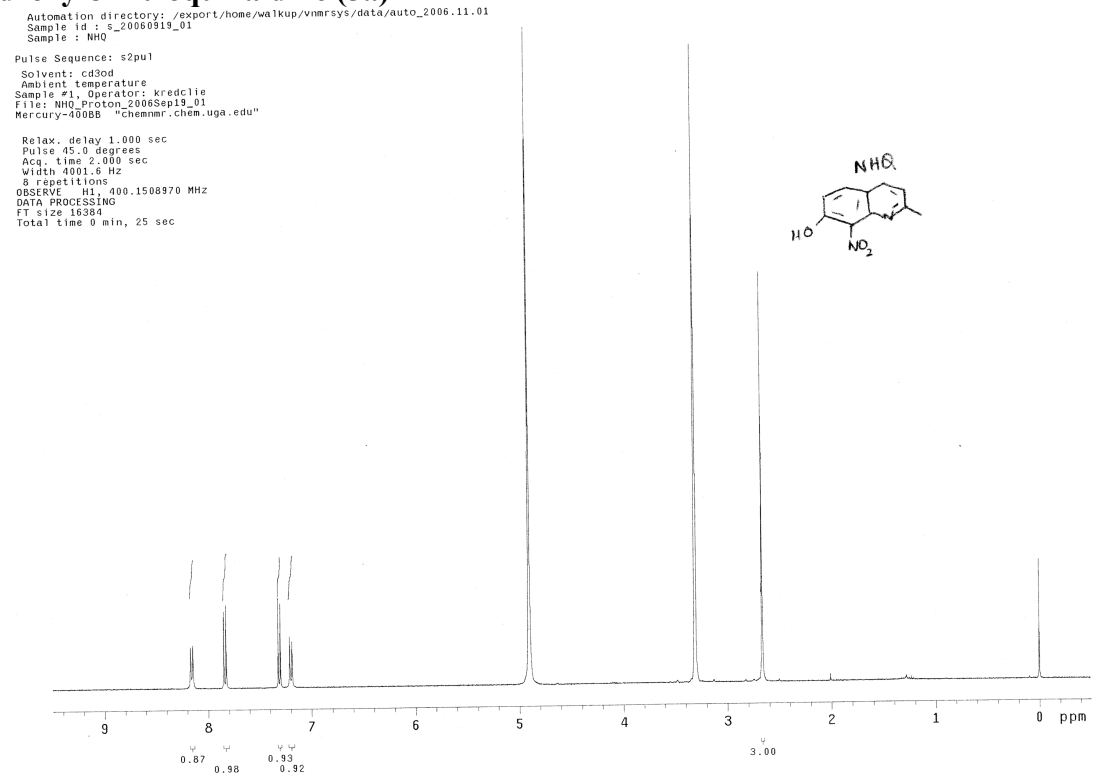
DMAQ-OAc (2a)



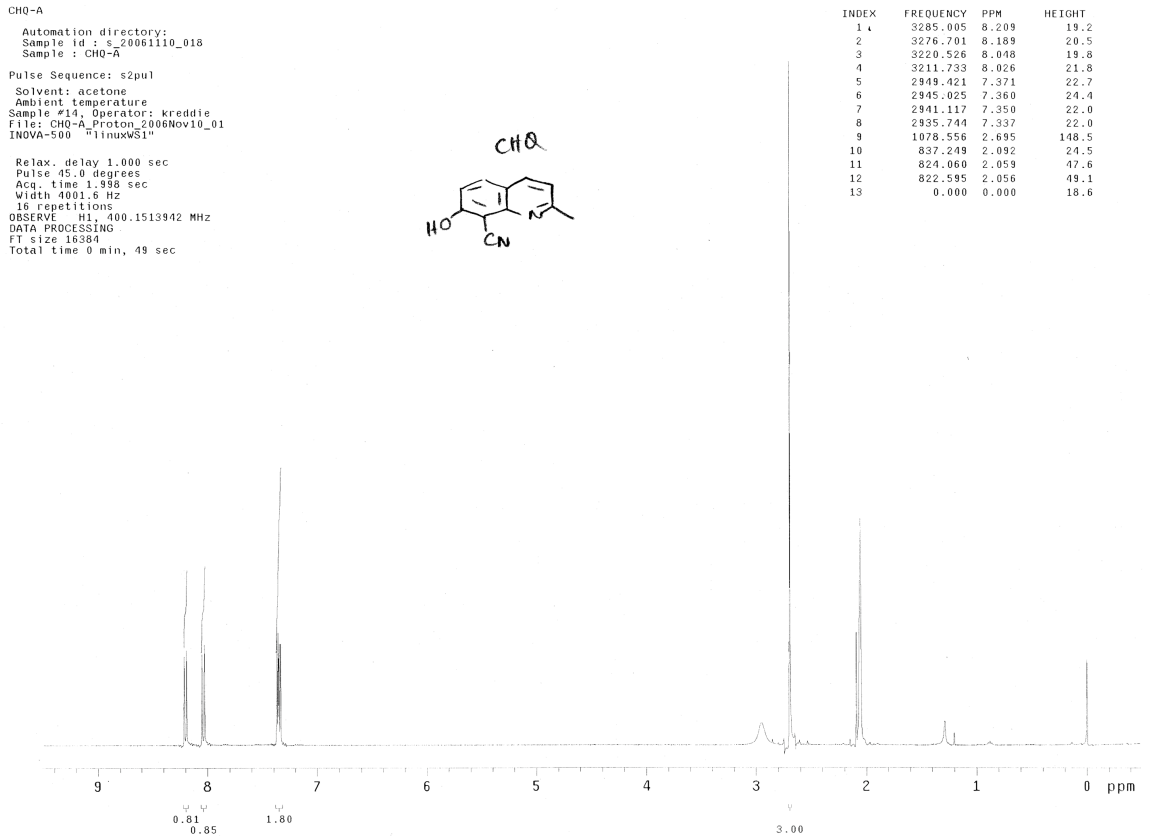
DMAQ-Cl-OAc (2b)



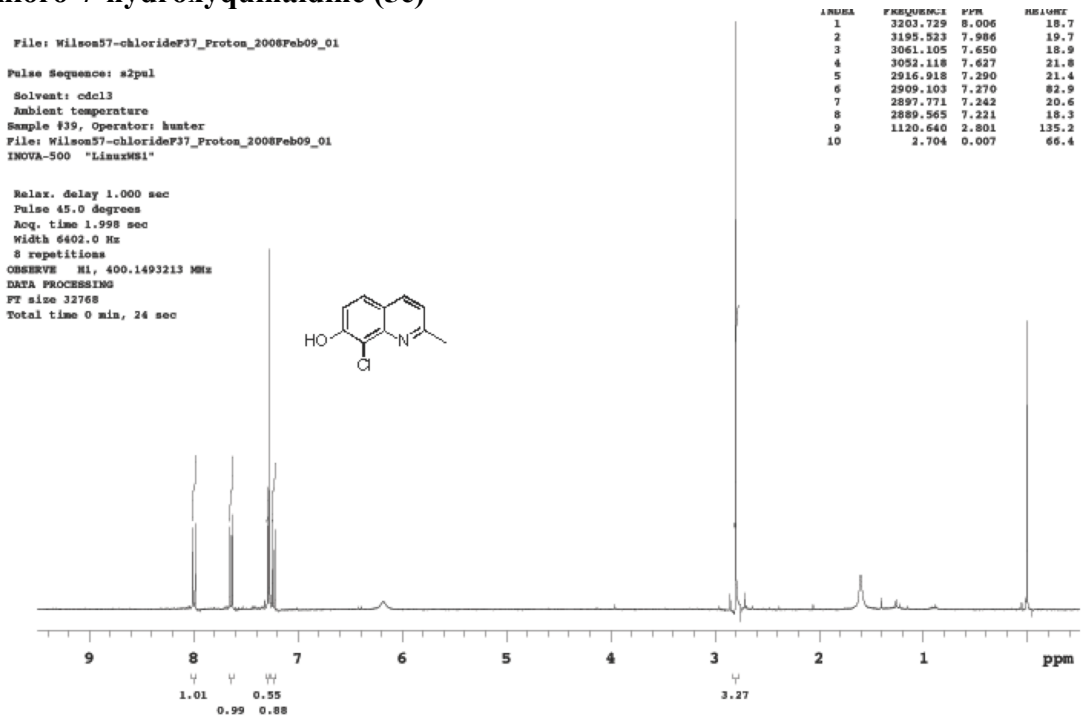
7-Hydroxy-8-nitroquinaldine (5a)



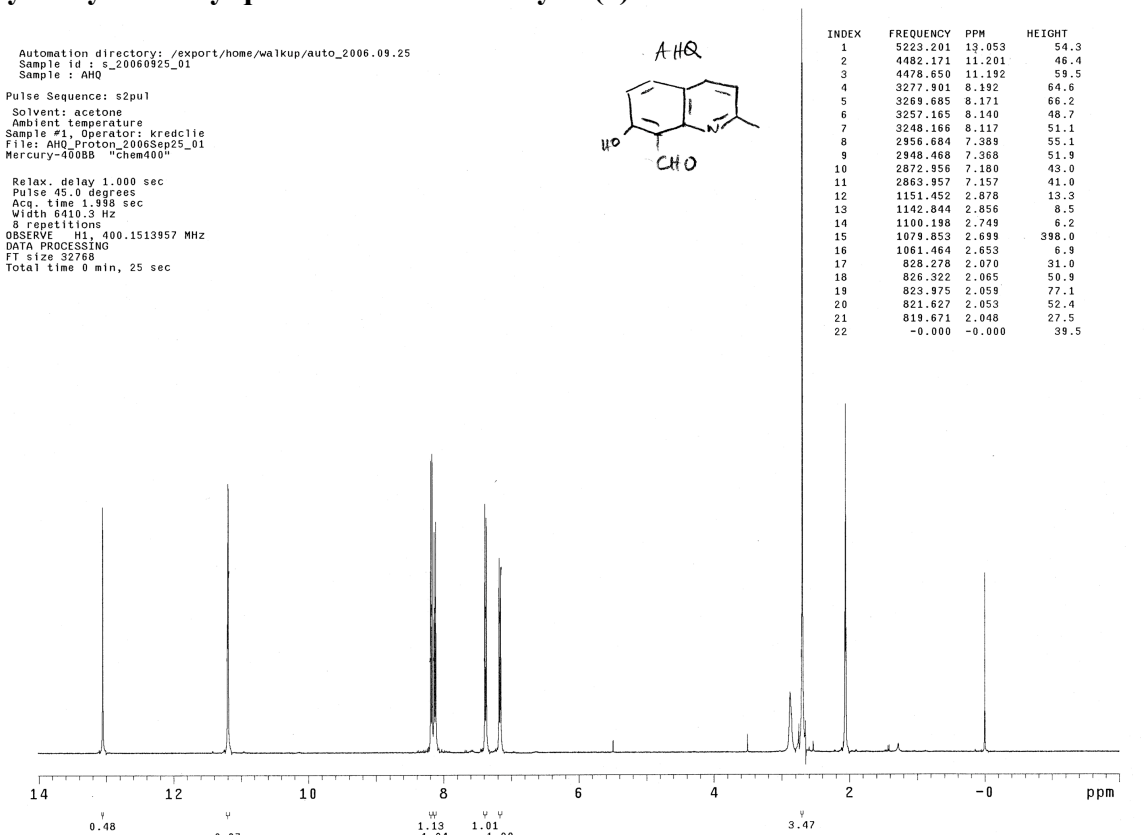
7-Hydroxy-2-methylquinoline-8-carbonitrile (5b)



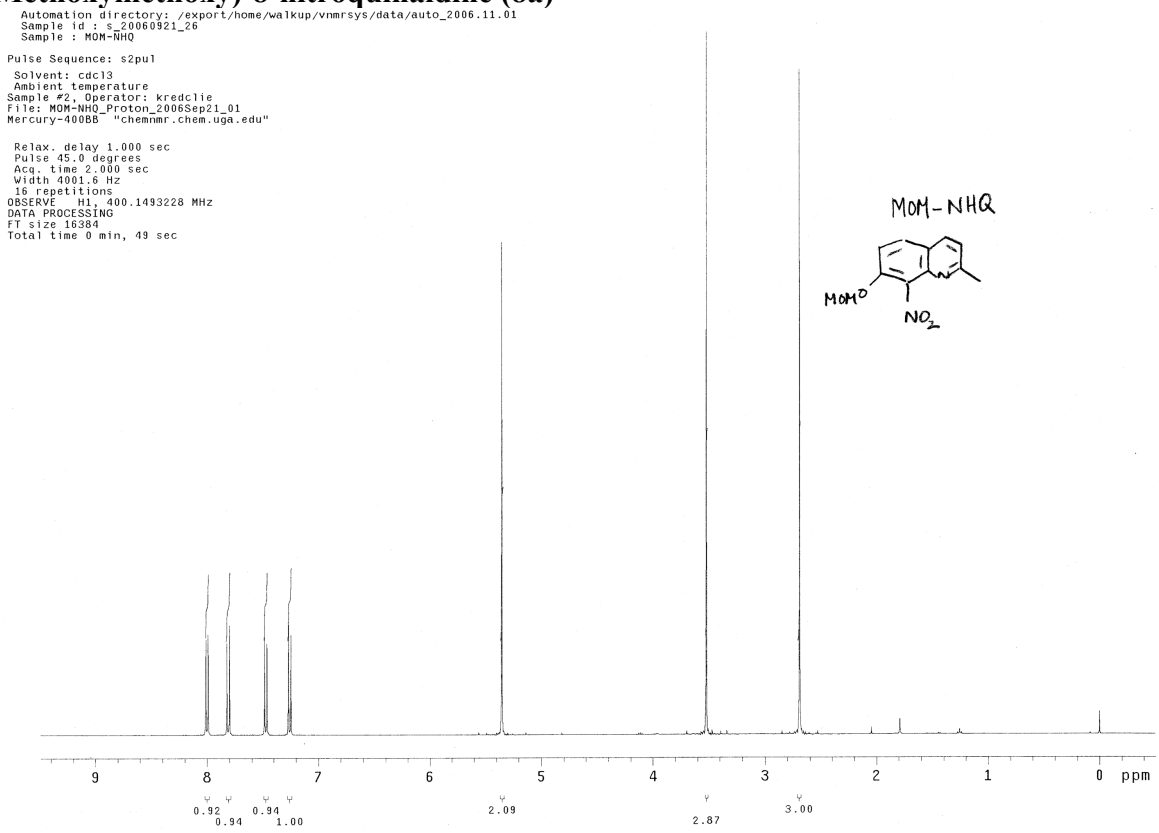
8-Chloro-7-hydroxyquinaldine (5c)



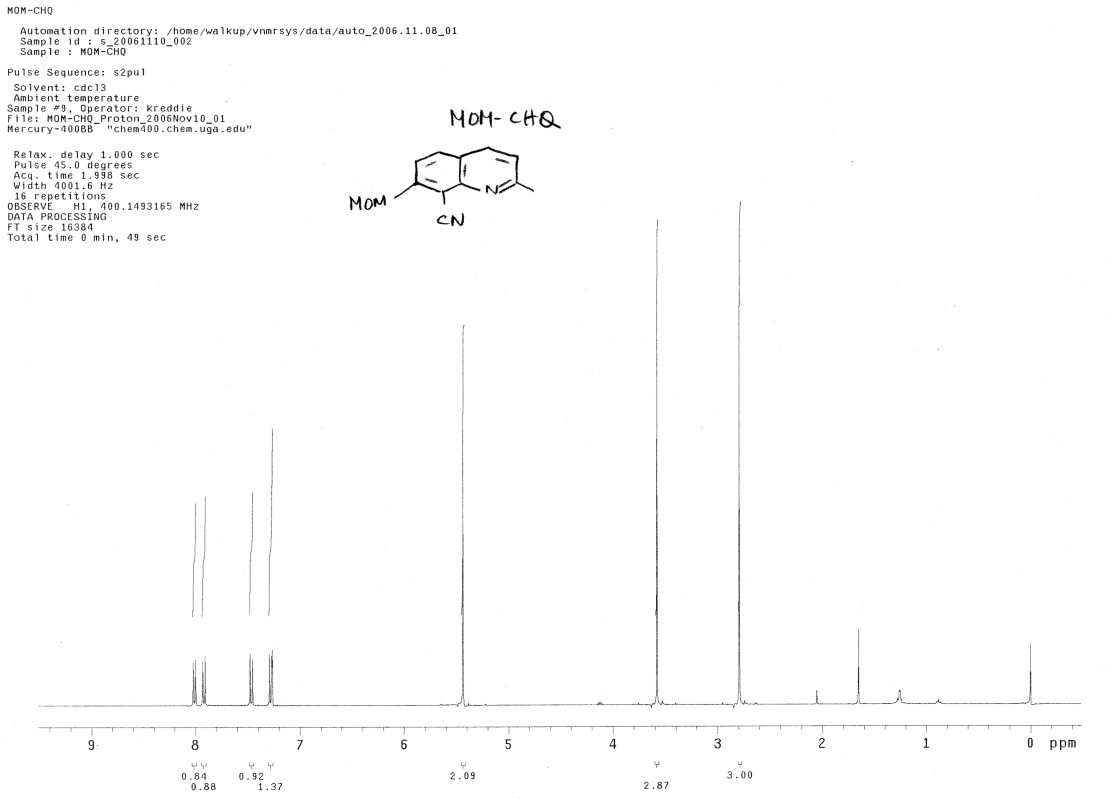
7-Hydroxy-2-methylquinoline-8-carbaldehyde (6)



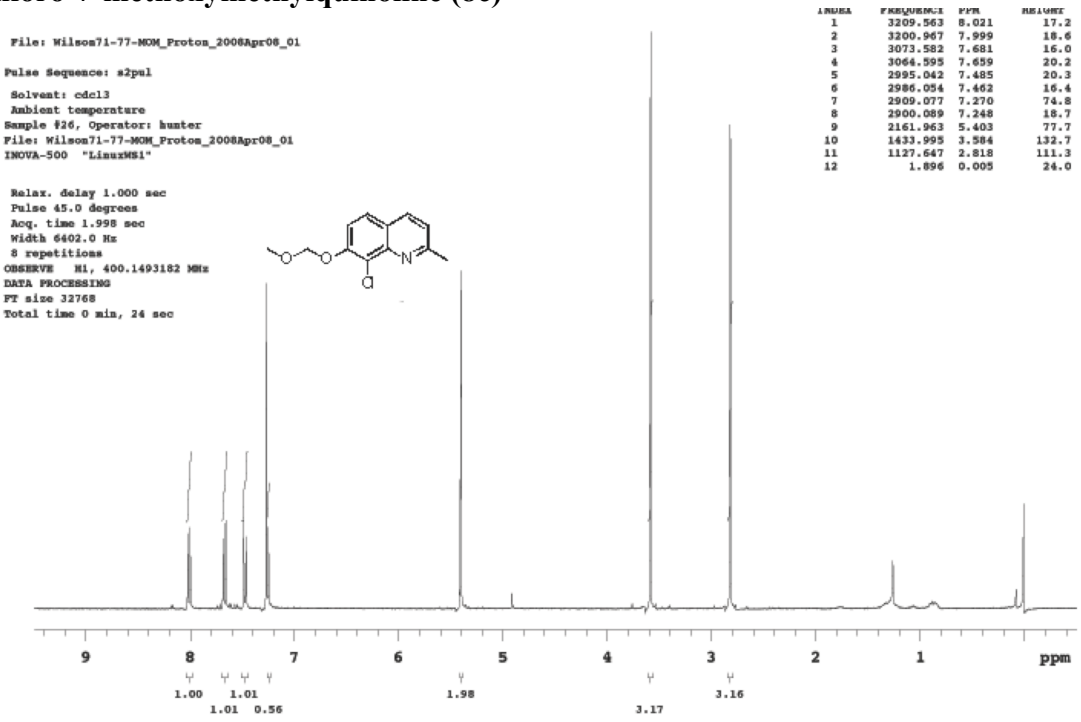
7-(Methoxymethoxy)-8-nitroquinaldine (8a)



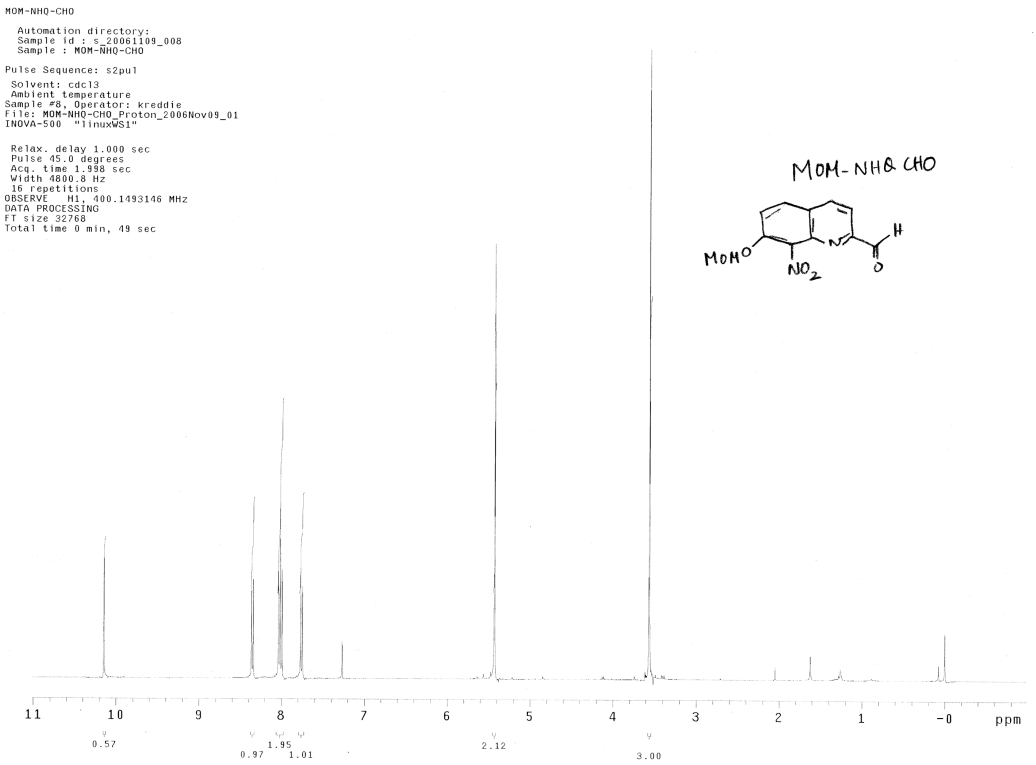
7-(Methoxymethoxy)-2-methylquinoline-8-carbonitrile (8b)



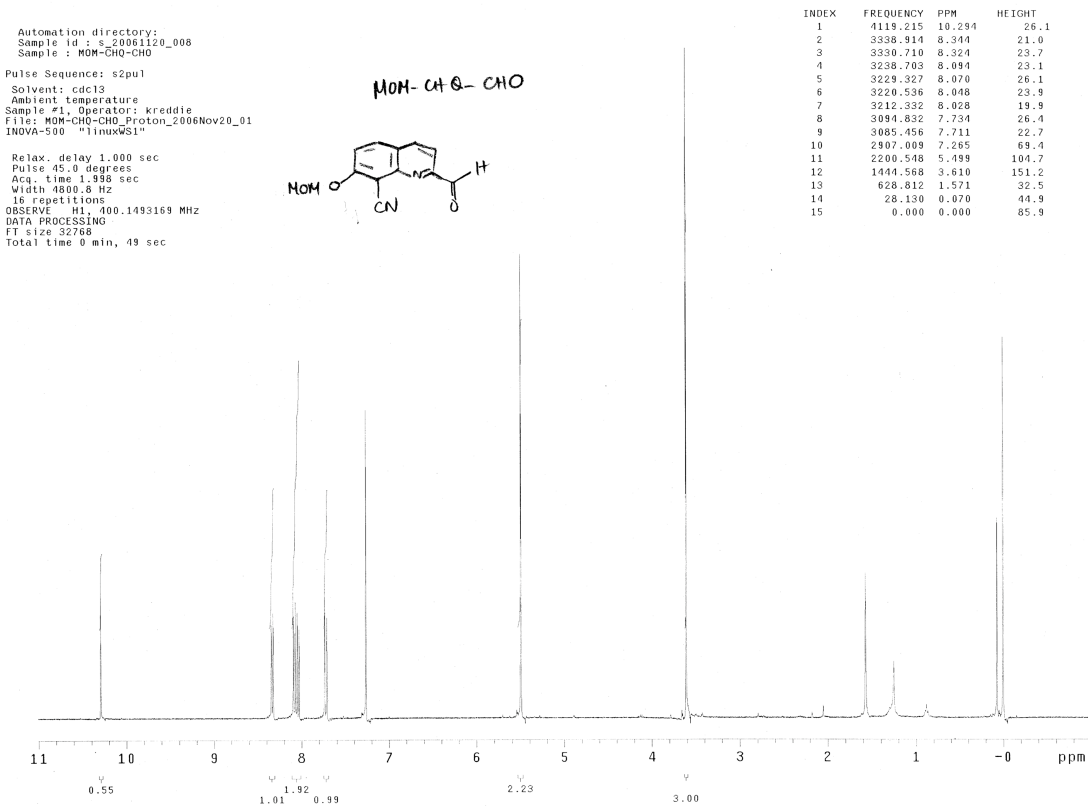
8-Chloro-7-methoxymethylquinoline (8c)



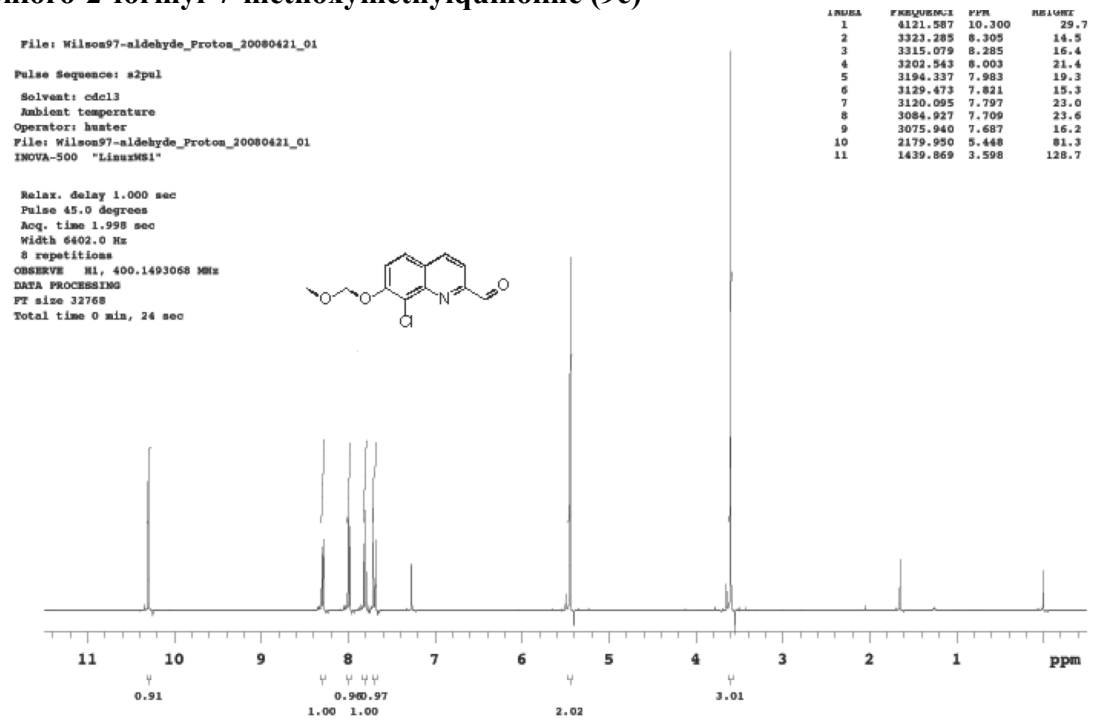
7-(Methoxymethoxy)-8-nitroquinolin-2-yl formaldehyde (9a)



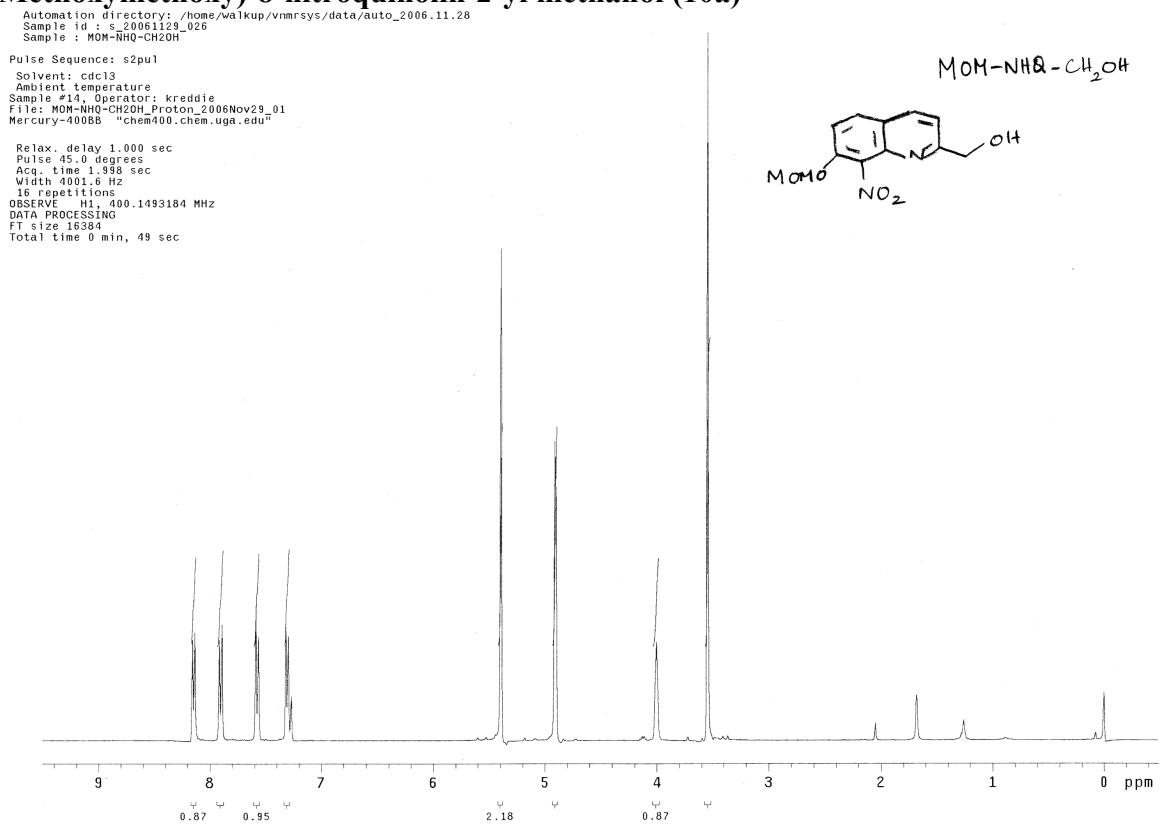
2-Formyl-7-(methoxymethoxy)quinoline-8-carbonitrile (9b)



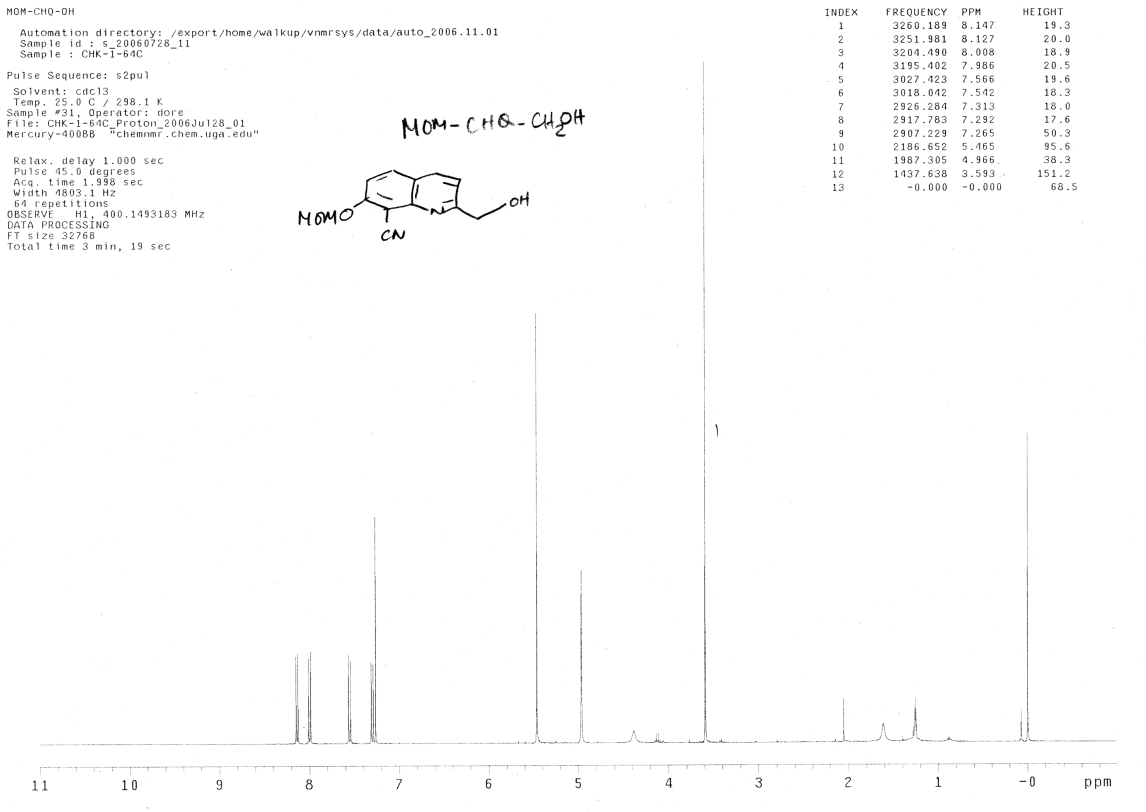
8-Chloro-2-formyl-7-methoxymethylquinoline (9c)



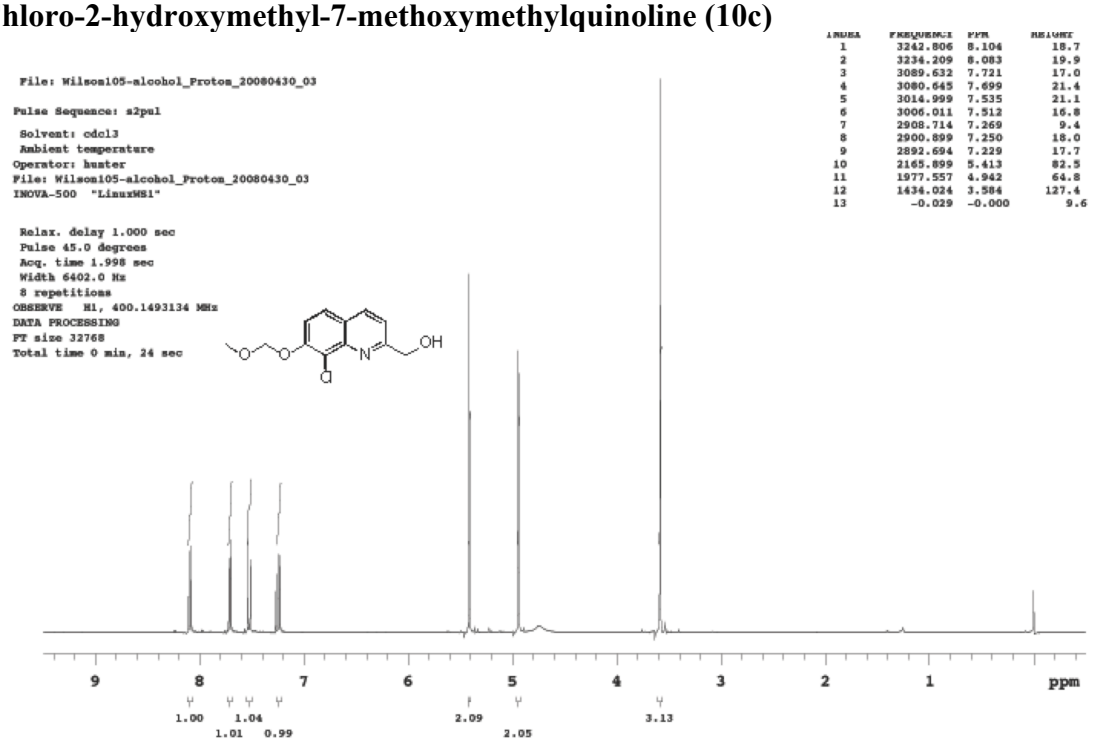
7-(Methoxymethoxy)-8-nitroquinolin-2-yl methanol (10a)



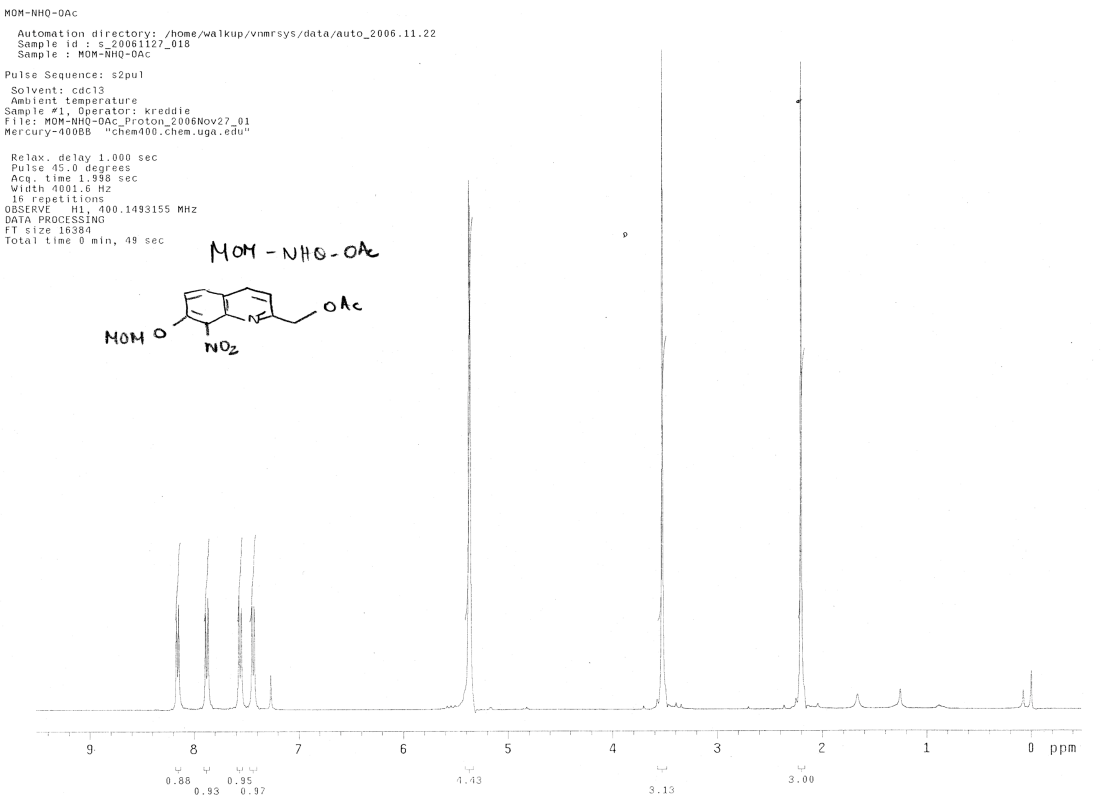
2-(Hydroxymethyl)-7-(methoxymethoxy)quinoline-8-carbonitrile (10b)



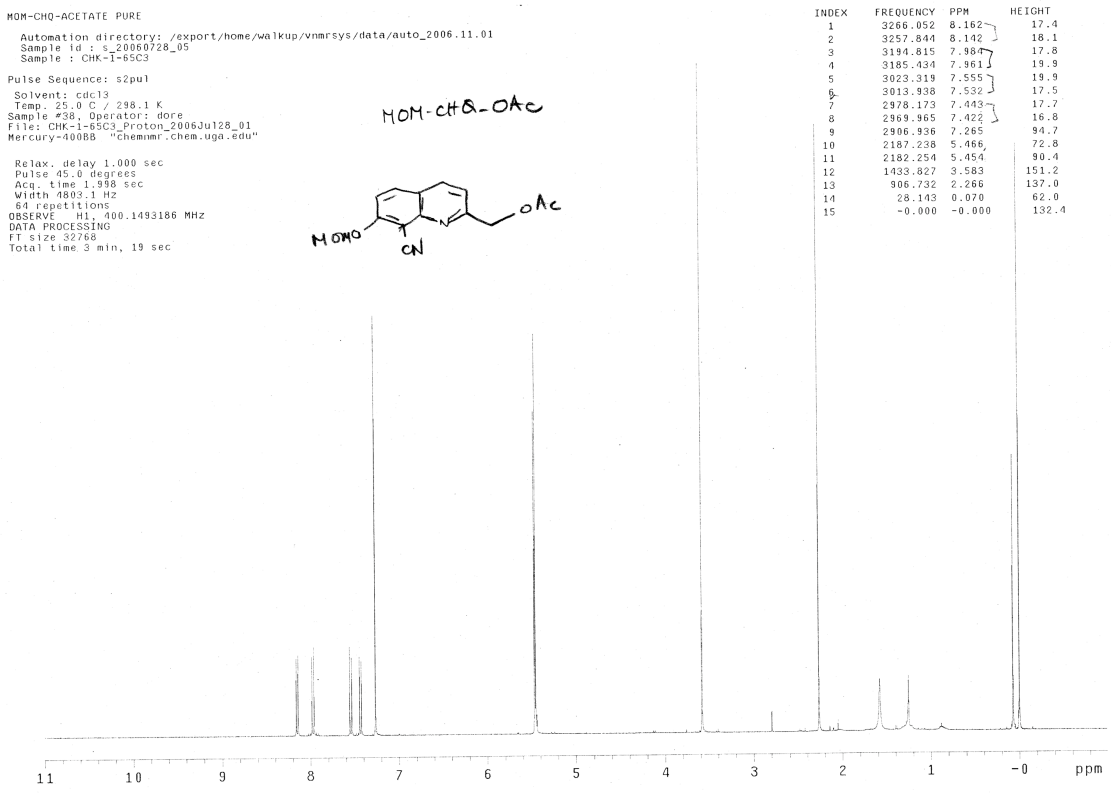
8-Chloro-2-hydroxymethyl-7-methoxymethylquinoline (10c)



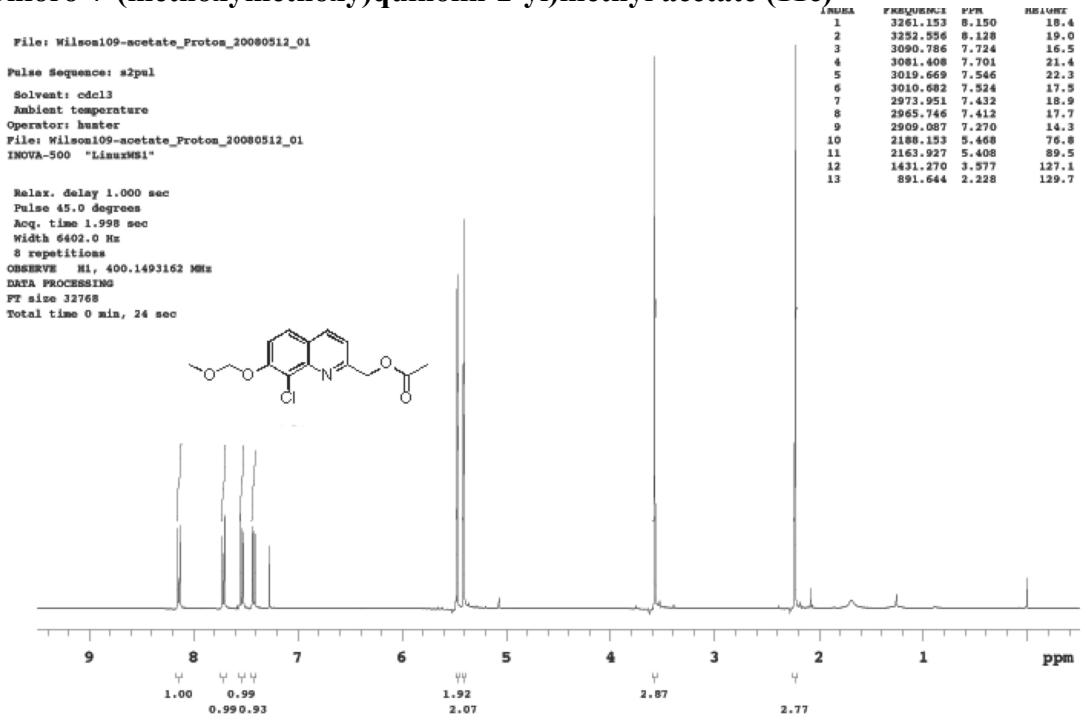
7-(Methoxymethoxy)-8-nitroquinolin-2-yl methyl acetate (11a)



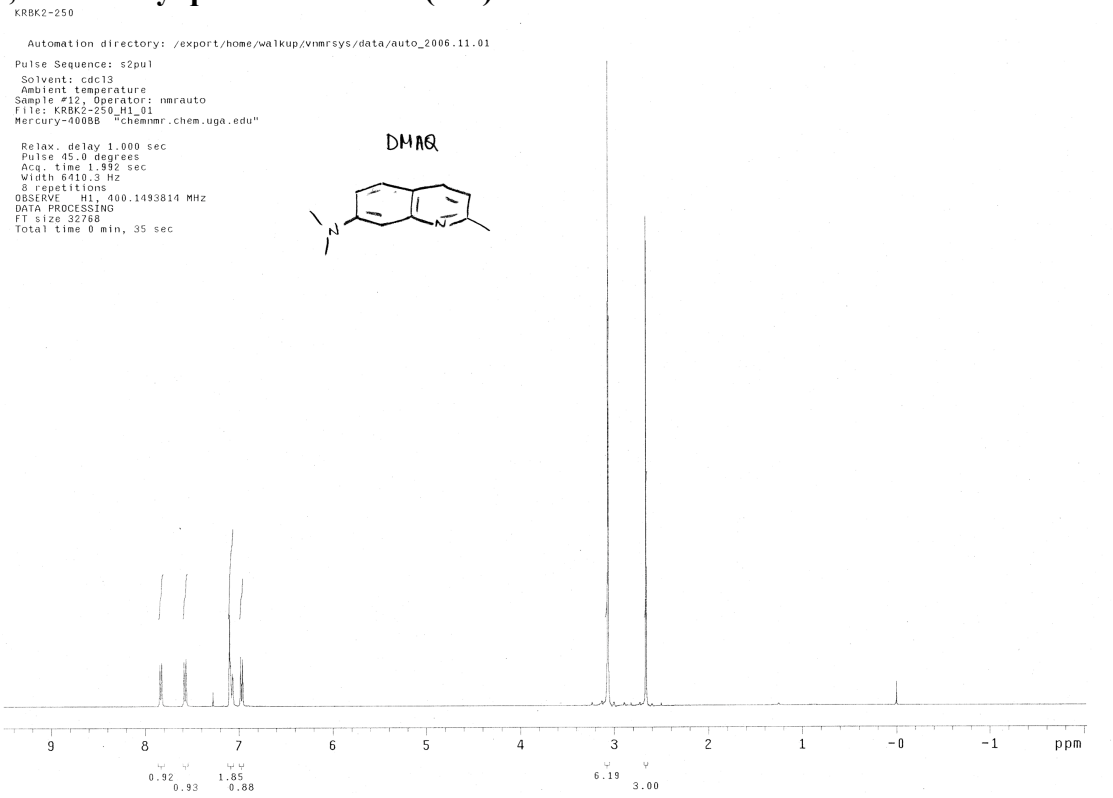
(8-Cyano-7-(methoxymethoxy)quinolin-2-yl)methyl acetate (11b)



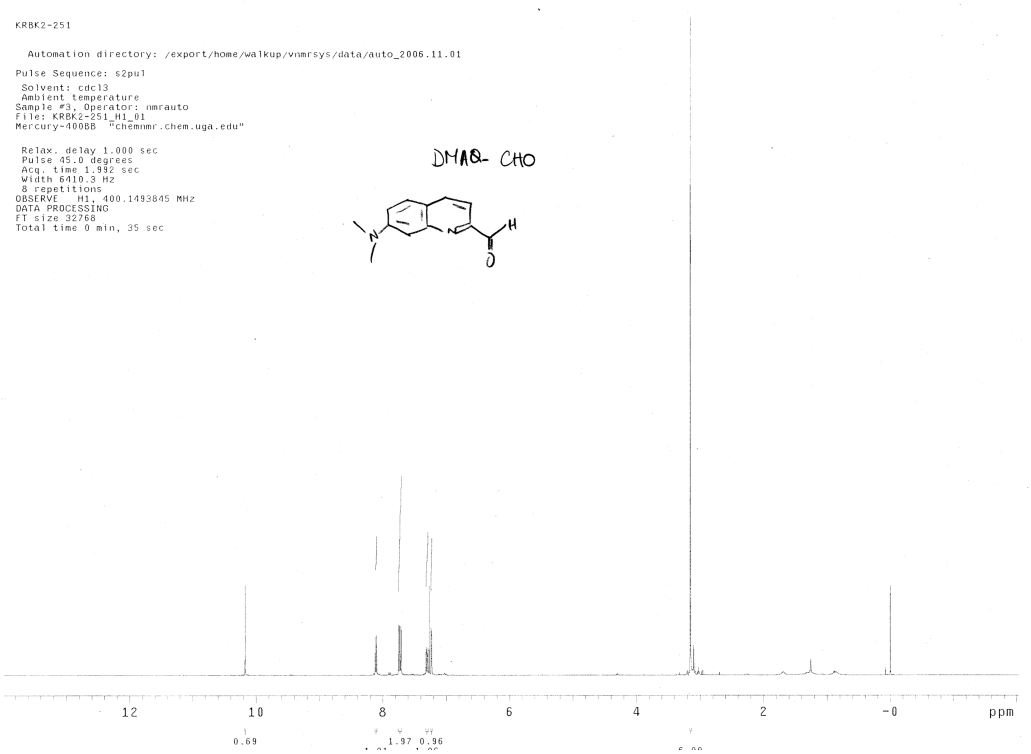
(8-Chloro-7-(methoxymethoxy)quinolin-2-yl)methyl acetate (11c)



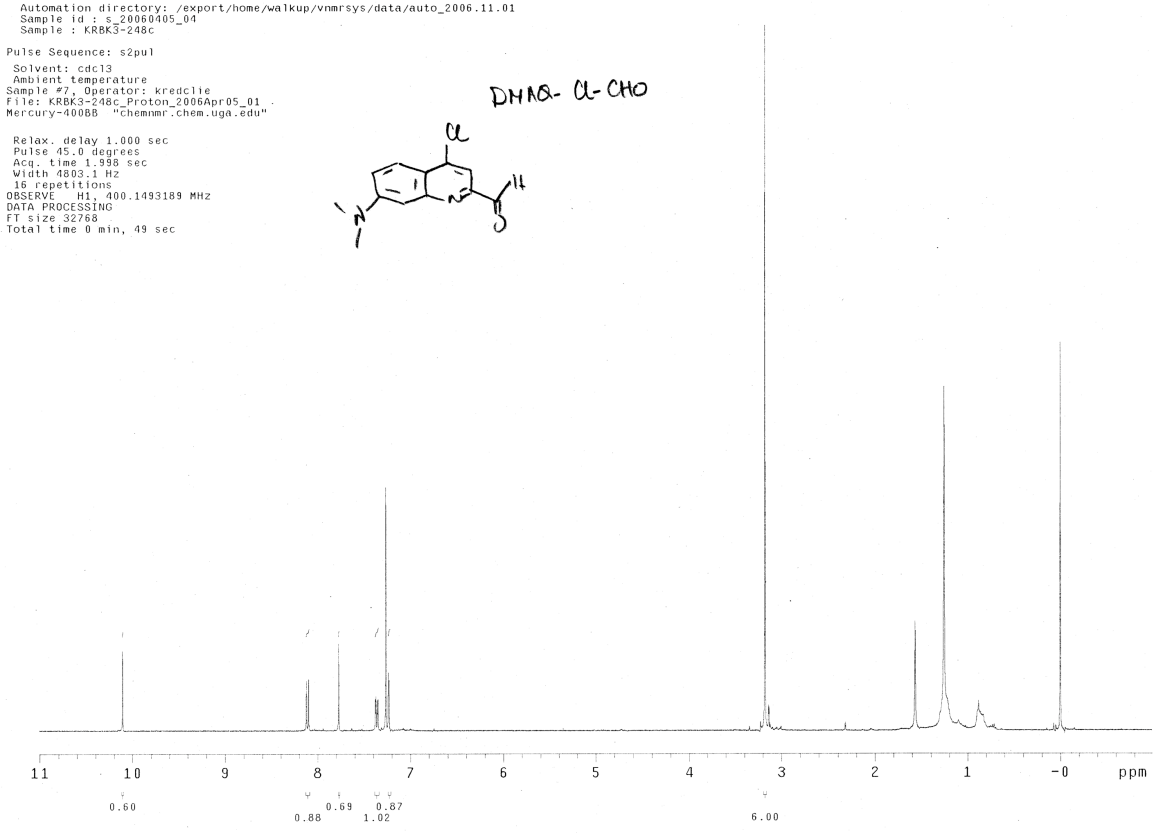
N,*N*,2-Trimethylquinolin-7-amine (13a)



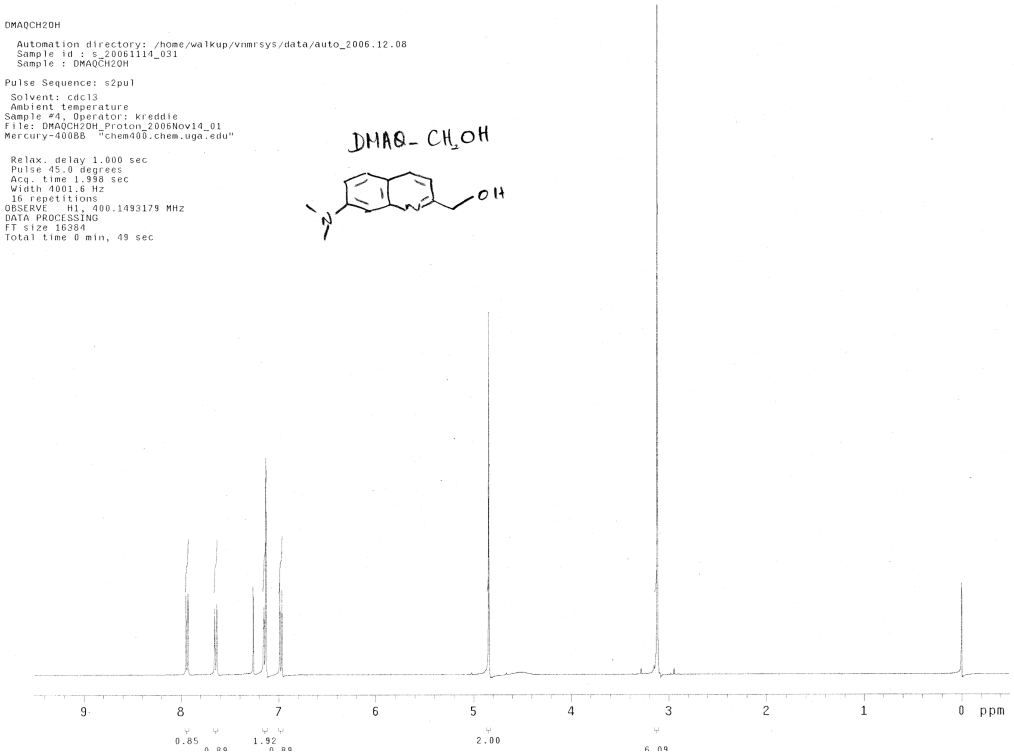
7-(Dimethylamino)quinoline-2-carbaldehyde (14a)



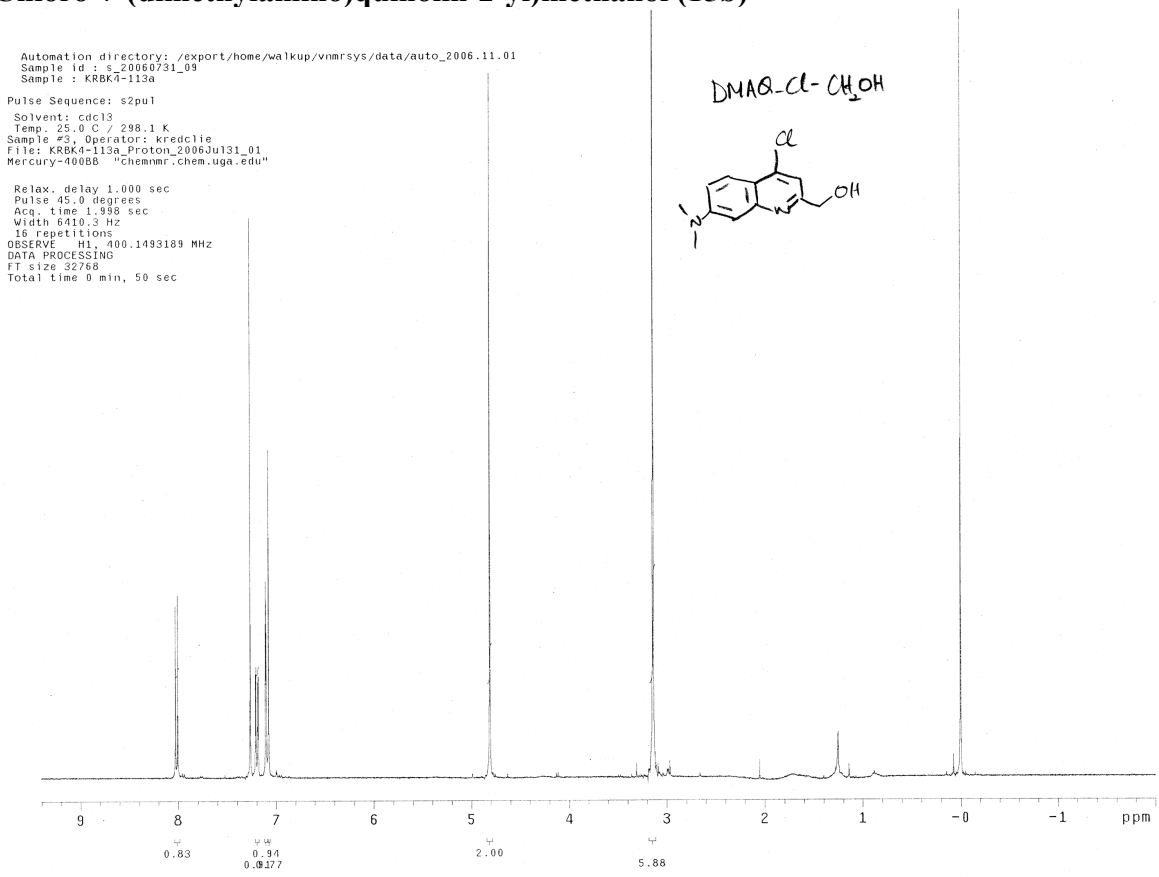
4-Chloro-7-(dimethylamino)quinoline-2-carbaldehyde (14b)



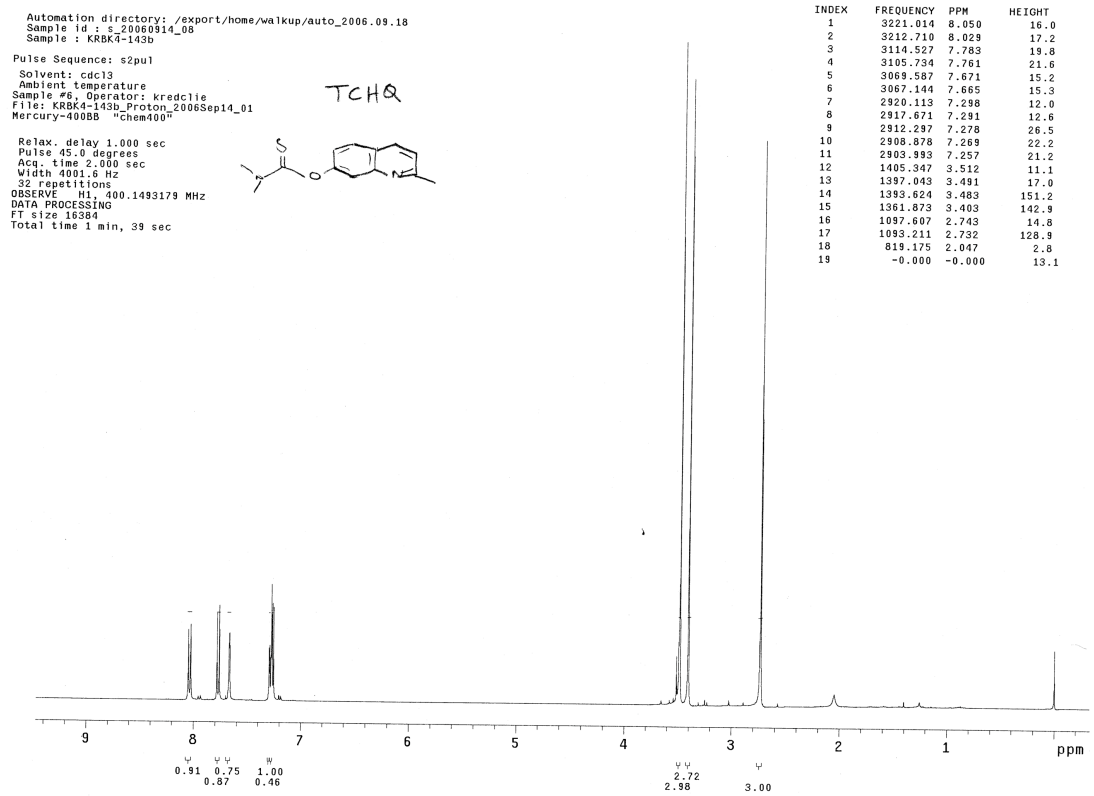
7-(Dimethylamino)quinolin-2-yl)methanol (15a)



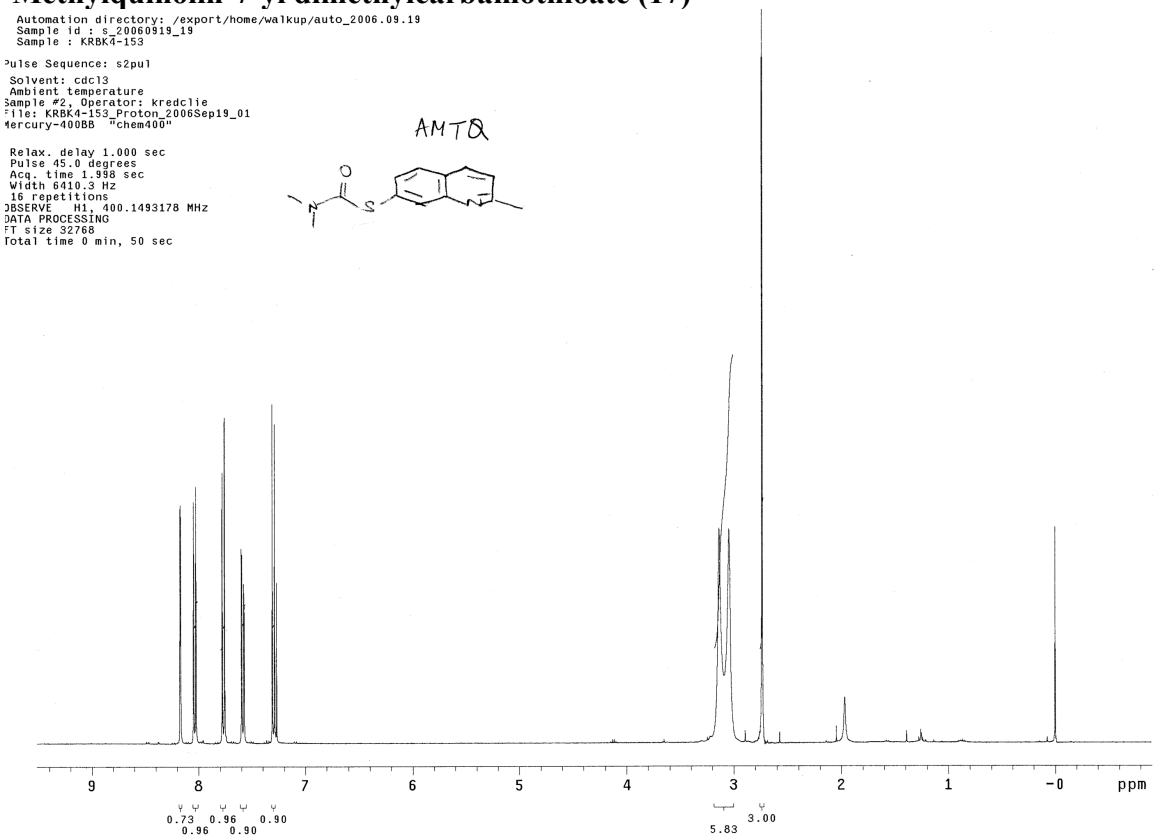
(4-Chloro-7-(dimethylamino)quinolin-2-yl)methanol (15b)



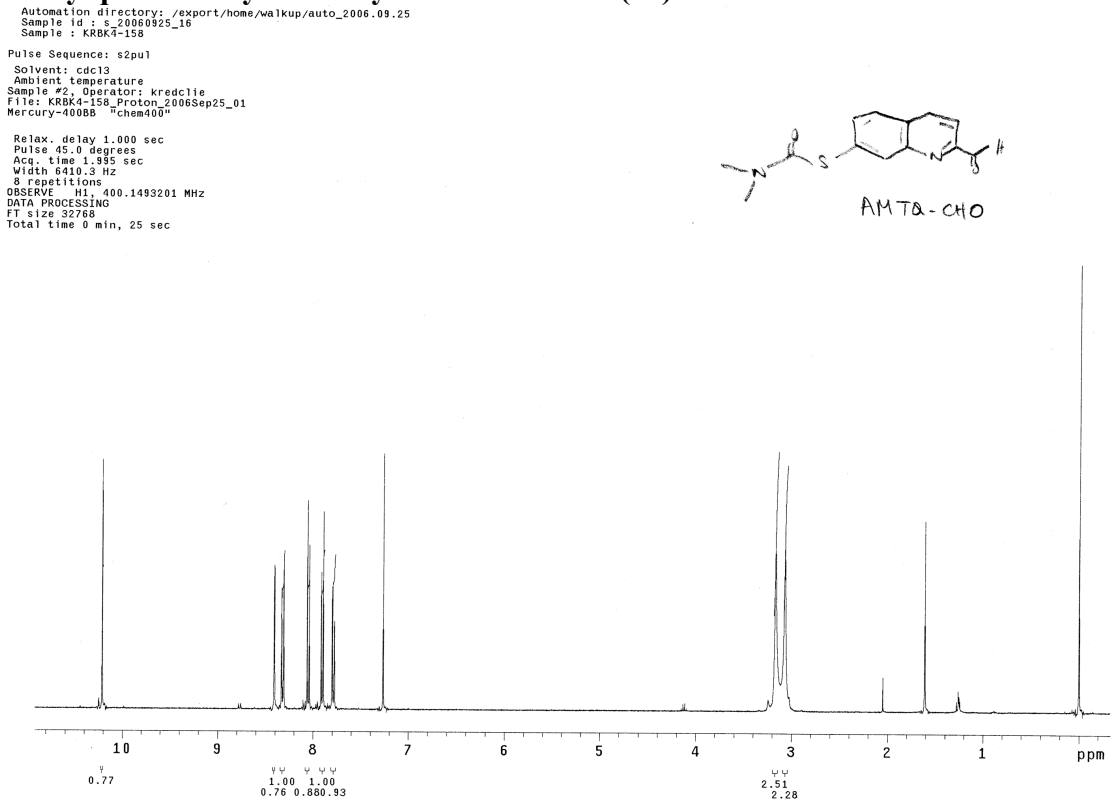
O-2-Methylquinolin-7-yl dimethylcarbamothioate (16)



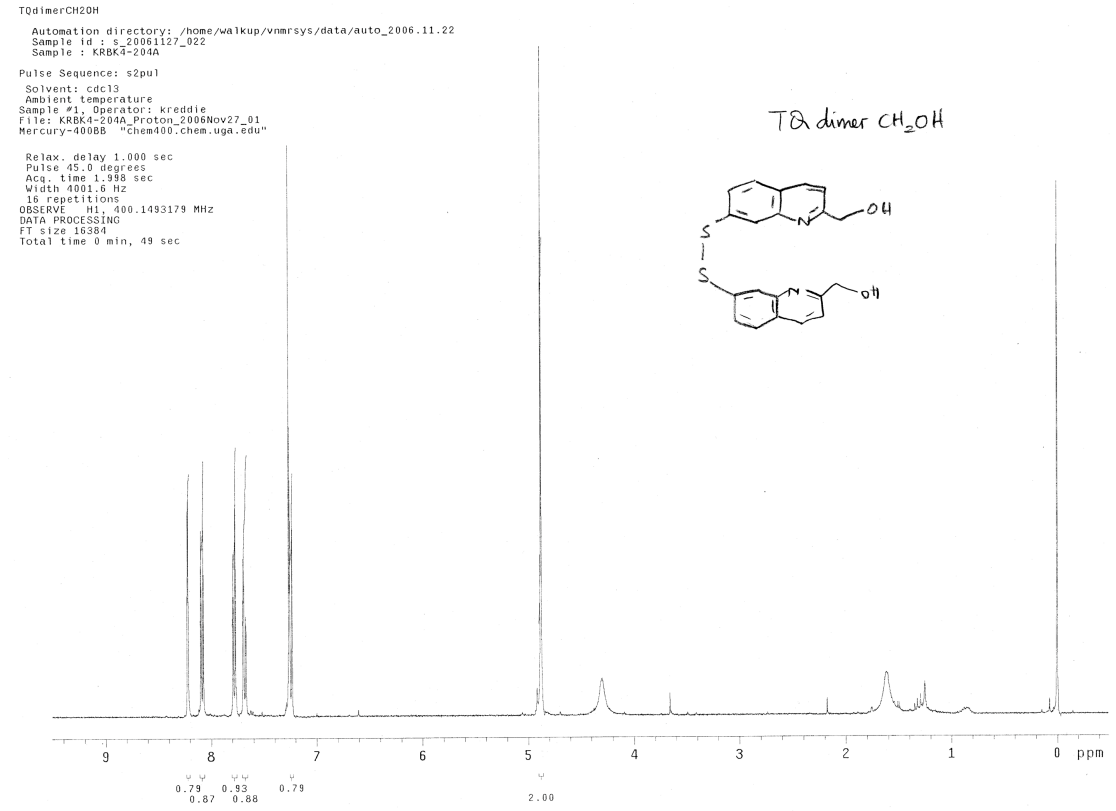
S-2-Methylquinolin-7-yl dimethylcarbamothioate (17)



S-2-Formylquinolin-7-yl dimethylcarbamothioate (18)



(7,7′-Disulfanediylbis(quinoline-7, 2-diyl))dimethanol (20)



(7,7′-Disulfanediylbis(quinoline-7,2-diyl))bis(methylene) diacetate (21)