Vilsmeier–Haack reagent-promoted formyloxylation of α-chloro-*N*-arylacetamides by formamide

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All chemicals were reagent grade and used as purchased. All reactions were carried out under argon or nitrogen atmosphere and monitored by TLC. Flash column chromatography was carried out on silica gel (230–400 mesh). Analytical thin-layer chromatography (TLC) was performed on precoated plates (silica gel 60 F-254) purchased from Merck Inc. Mixtures of ethyl acetate and hexanes were used as eluants. Infrared (IR) spectra were measured on a Bomem Michelson Series FT-IR spectrometer. The wavenumbers reported are referenced to the polystyrene absorption at 1601 cm^{-1}. Absorption intensities are recorded by the following abbreviations: s, strong; m, medium; w, weak. Proton NMR spectra were obtained on a Bruker (200 MHz or 500 MHz) spectrometer by use of $CDCl_3$ as solvent. Multiplicities are recorded by the following abbreviations: s, singlet; d, doublet; t, triplet; q, quartet; m, multiplet; *J*, coupling constant (Hz). Carbon-13 NMR spectra were obtained on a

Bruker (50 MHz or 125 MHz) spectrometer by used of $CDCl_3$ as solvent. Carbon-13 chemical shifts are referenced to the center of the $CDCl_3$ triplet (δ 77.0 ppm). High-resolution mass spectra were obtained from a JEOL JMS-HX110 mass spectrometer.

General procedure for the formyloxylation of α-chloro-*N*-arylacetamides 1, 6a–n, 8a, 8b, and 8c with formamide in the presence of PBr_3. α-Chloro-*N*-arylacetamides **1**, **6a**–**n**, **8a**, **8b**, and **8c** (~1.0 mmol, 1.0 equiv) were dissolved in formamide (2.0 mL) and added with PBr_3 (3.0 equiv). The reaction mixture was heated at 80–90 °C for 4.0 h. The solution was added with saturate aqueous $NaHCO_3$ (15 mL) and extracted with CH_2Cl_2 (15 mL × 2). The combined organic layers were washed with saturated aqueous $NaHCO_3$ (15 mL), dried over $MgSO_4$, filtered, and concentrated under reduced pressure. The residue was purified by column chromatography on silica gel to give the corresponding α-formyloxylated products **4**, **7a**–**n**, **9a**, and **9c** in 70–96% yields.

2-Oxo-2-(phenylamino)ethyl formate (4). Yield: 96%; yellow liquid; ^{1}H NMR ($CDCl_3$, 200 MHz) δ 4.72 (s, 2 H, CH_2), 7.11–7.15 (m, 1 H, ArH), 7.25–7.33 (dd, J = 8.2, 7.8 Hz, 2 H, ArH), 7.51 (d, J = 8.2 Hz, 2 H, ArH), 8.02 (br, 1 H, NH), 8.14 (s, 1 H, O=C–H); ^{13}C NMR ($CDCl_3$, 50 MHz) δ 62.36, 120.19, 125.15, 129.16, 137.04, 158.80 (NC=O), 164.11 (HC=O); IR (KBr) 3298 (br, NH), 3061, 1730 (s, C=O), 1680 (s, C=O), 1163, 759 cm^{-1}; EIMS *m*/*z* 179 (M^+, 43), 120 (17), 93 (100), 92 (17), 77 (24), 65 (20), 51 (6); HRMS Calcd for $C_9H_9NO_3$: 179.0582; Found: 179.0583.

2-[(2-Fluorophenyl)amino]-2-oxoethyl formate (7a). Yield: 74%; white solids; mp 43–45 °C; ^{1}H NMR ($CDCl_3$, 200 MHz) δ 4.79 (s, 2 H, CH_2), 7.06–7.14 (m, 4 H, ArH), 8.20 (s, 1 H, O=C–H), 8.29 (br, 1 H, NH); ^{13}C NMR ($CDCl_3$, 50 MHz) δ 62.31, 114.81, 115.18, 121.91, 124.75, 125.20, 125.33, 150.88, 154.97, 158.87 (NC=O), 164.29 (HC=O); IR (KBr) 3275 (br, NH), 1732 (s, C=O), 1685 (s, C=O), 1458, 1161 (C–O), 756 cm^{-1}; EIMS *m*/*z* 197 (M^+, 26), 111 (100), 83 (15), 110 (10), 57 (5);

HRMS Calcd for $C_9H_8FNO_3$: 197.0488; Found: 197.0490.

2-[(3-Fluorophenyl)amino]-2-oxoethyl formate (7b). Yield: 84%; white solids; mp 46–48 °C; ^{1}H NMR ($CDCl_3$, 200 MHz) δ 4.75 (s, 2 H, CH_2), 6.82–6.86 (m, 1 H, ArH), 7.13–7.28 (m, 2 H, ArH), 7.44 (dd, *J* = 10.7, 3.5 Hz, 1 H, ArH), 8.02 (br, 1 H, NH), 8.17 (s, 1 H, O=C–H); ^{13}C NMR ($CDCl_3$, 50 MHz) δ 62.17, 107.44, 107.96, 111.64, 112.06, 115.40, 130.13, 130.31, 137.89, 138.10, 158.94 (NC=O), 160.41, 164.46 (HC=O), 165.29; IR (KBr) 3290 (br, NH), 1732 (s, C=O), 1681 (s, C=O), 1543, 1157 (C–O), 775 cm^{-1}; EIMS *m*/*z* 197 (M^+, 40), 138 (12), 111 (100), 110 (16), 95 (16), 84 (11), 83 (19), 57 (8); HRMS Calcd for $C_9H_8FNO_3$: 197.0488; Found: 197.0485.

2-[(4-Fluorophenyl)amino]-2-oxoethyl formate (7c). Yield: 88%; white solids; mp 49–51 °C; ^{1}H NMR ($CDCl_3$, 200 MHz) δ 4.76 (s, 2 H, CH_2), 6.98–7.06 (m, 2 H, ArH), 7.24–7.81 (m, 2 H, ArH), 7.81 (br, 1 H, NH), 8.19 (s, 1 H, O=C–H); ^{13}C NMR ($CDCl_3$, 125 MHz) δ 62.31, 115.80, 115.98, 122.06, 122.12, 132.51, 158.75, 158.89 (NC=O), 160.58, 164.16 (HC=O); IR (KBr) 3336 (br, NH), 2924, 1735 (s, C=O), 1681 (s, C=O), 1512, 1157 (C–O) cm^{-1}; EIMS *m*/*z* 197 (M^+, 40), 138 (12), 111 (100), 110 (16), 95 (16), 84 (11), 83 (19), 57 (8); HRMS Calcd for $C_9H_8FNO_3$: 197.0488; Found: 197.0492.

2-[(2-Bromophenyl)amino]-2-oxoethyl formate (7d). Yield: 71%; white solids; mp 49–52 °C; ^{1}H NMR ($CDCl_3$, 200 MHz) δ 4.80 (s, 2 H, CH_2), 6.99 (dd, *J* = 7.8, 7.2 Hz, 1 H, ArH), 7.30 (dd, *J* = 7.8, 7.2 Hz, 1 H, ArH), 7.53 (dd, *J* = 7.7, 6.0 Hz, 1 H, ArH), 8.22 (s, 1 H, O=C–H), 8.32 (dd, *J* = 7.7, 6.0 Hz, 1 H, ArH), 8.43 (br, 1 H, NH); ^{13}C NMR ($CDCl_3$, 50 MHz) δ 62.30, 113.60, 121.84, 125.89, 128.49, 132.32, 134.49, 158.76 (NC=O), 164.25 (HC=O); IR (KBr) 3375 (br, NH), 1735 (s, C=O), 1531 (s, C=O), 1438, 1157 (C–O), 582 cm^{-1}; EIMS *m*/*z* 259 (M^+ + 2, 13), 257 (M^+, 13), 173 (57), 171 (59); HRMS Calcd for $C_9H_8BrNO_3$: 256.9688; Found: 256.9686.

2-[(3-Bromophenyl)amino]-2-oxoethyl formate (7e). Yield: 78%; yellow liquid; ^{1}H

NMR ($CDCl_3$, 200 MHz) δ 4.75 (s, 2 H, CH_2), 7.13–7.29 (m, 1 H, ArH), 7.41 (dd, *J* = 9.8, 7.5 Hz, 2 H, ArH), 7.77 (s, 1 H, ArH), 8.17 (s, 1 H, O=C–H); ^{13}C NMR ($CDCl_3$, 50 MHz) δ 62.21, 118.59, 122.67, 123.06, 128.12, 130.41, 137.72, 158.81 (NC=O), 164.33 (HC=O); IR (KBr) 3305 (br, NH), 1732 (s, C=O), 1682 (s, C=O), 1423, 1161 (C–O), 590 cm^{-1}; EIMS *m*/*z* 259 (M^+ + 2, 8), 257 (M^+, 8), 231 (57), 229 (58), 200 (20), 198 (20), 173 (92), 171 (100); HRMS Calcd for $C_9H_8BrNO_3$: 256.9688; Found: 256.9686.

2-[(4-Bromophenyl)amino]-2-oxoethyl formate (7f). Yield: 89%; white solids; mp 47–50 °C; ^1H NMR ($CDCl_3$, 200 MHz) δ 4.73 (s, 2 H, CH_2), 7.37–7.44 (m, 4 H, ArH), 8.03 (br, 1 H, NH) 8.15 (s, 1 H, O=C–H); ^{13}C NMR ($CDCl_3$, 50 MHz) δ 62.14, 117.76, 121.71 (2 × CH), 132.04 (2 × CH), 135.57, 158.95 (NC=O), 164.38 (HC=O); IR (KBr) 3433 (br, NH), 1732 (s, C=O), 1689 (s, C=O), 1261, 1161 (C–O), 574 cm^{-1}; EIMS *m*/*z* 259 (M^+ + 2, 16), 257 (M^+, 16), 191 (100), 178 (25) , 173 (33), 171 (33), 152 (11), 91 (17); HRMS Calcd for $C_9H_8BrNO_3$: 256.9688; Found: 256.9683.

2-Oxo-2-{[2-(trifluoromethyl)phenyl]amino}ethyl formate (7g). Yield: 70%; white solids; mp 47–49 °C; ^1H NMR ($CDCl_3$, 200 MHz) δ 4.80 (s, 2 H, CH_2), 7.23–7.26 (m, 1 H, ArH), 7.57–7.63 (m, 2 H, ArH), 8.19 (s, 1 H, O=C–H), 8.20–8.24 (m, 1 H, ArH), 8.25 (br, 1 H, NH); ^{13}C NMR ($CDCl_3$, 50 MHz) δ 62.19, 119.98, 120.20, 120.58, 120.87, 121.20, 124.08, 125.14, 126.27, 126.63, 133.08, 133.93, 158.62 (NC=O), 164.57 (HC=O); IR (KBr) 3433 (br, NH), 1712 (s, C=O), 1670 (s, C=O), 1319, 1114 (C–O), 767 cm^{-1}; EIMS *m*/*z* 247 (M^+, 32), 168 (41), 161 (100), 141 (32), 114 (11); HRMS Calcd for $C_{10}H_8F_3NO_3$:247.0456; Found: 247.0452.

2-Oxo-2-{[3-(trifluoromethyl)phenyl]amino}ethyl formate (7h). Yield: 78%; yellow liquid; ^1H NMR ($CDCl_3$, 200 MHz) δ 4.79 (s, 2 H, CH_2), 7.38–7.52 (m, 2 H, ArH), 7.78–7.84 (m, 2 H, ArH), 7.98 (br, 1 H, NH); 8.20 (s, 1 H, O=C–H); ^{13}C NMR ($CDCl_3$, 50 MHz) δ 62.20, 116.79, 116.86, 121.63, 121.70, 123.18, 129.73, 130.73,

131.53, 131.82, 132.58, 132.83, 137.04, 158.78 (NC=O), 164.50 (HC=O); IR (KBr) 3425 (br, NH), 1728 (s, C=O), 1689 (s, C=O), 1161 (C–O), 1122, 698 cm^{-1}; EIMS *m*/*z* 247 (M^+, 32), 161 (100), 160 (13), 145 (15), 87 (22), 55 (37), 54 (15); HRMS Calcd for $C_{10}H_8F_3NO_3$: 247.0456; Found: 247.0455.

2-Oxo-2-{[4-(trifluoromethyl)phenyl]amino}ethyl formate (7i). Yield: 91%; white solids; mp 50–52 °C; ^1H NMR ($CDCl_3$, 500 MHz) δ 4.79 (s, 2 H, CH_2), 7.59 (d, *J* = 8.5 Hz, 2 H, ArH), 7.67 (d, *J* = 8.5 Hz, 2 H, ArH), 8.20 (s, 1 H, O=C–H); ^{13}C NMR ($CDCl_3$, 125 MHz) δ 62.32, 119.77 (2 × CH + CH), 121.43, 122.27, 122.63, 123.83, 123.07, 126.43, 126.46, 139.60, 158.67 (NC=O), 164.44 (HC=O); IR (KBr) 3441 (br, NH), 1743 (s, C=O), 1678 (s, C=O), 1539, 1165 (C–O), 740 cm^{-1}; EIMS *m*/*z* 247 (M^+, 34), 161 (100), 145 (21), 142 (12), 111 (7), 87 (13); HRMS Calcd for $C_{10}H_8F_3NO_3$: 247.0456; Found: 247.0461.

2-Oxo-2-(*p*-tolylamino)ethyl formate (7j). Yield: 89%; white solids; mp 39–41 °C; ^1H NMR ($CDCl_3$, 200 MHz) δ 2.30 (s, 3 H, CH_3), 4.75 (s, 2 H, CH_2), 7.13 (d, *J* = 8.3 Hz, 2 H, ArH), 7.40 (d, *J* = 8.3 Hz, 2 H, ArH), 7.77 (br, 1 H, NH), 8.18 (s, 1 H, O=C–H); ^{13}C NMR ($CDCl_3$, 50 MHz) δ 20.88, 62.30, 119.87, 120.30 (2 × CH), 129.62 (2 × CH), 134.92, 158.89 (NC=O), 164.14 (HC=O); IR (KBr) 3429 (br, NH), 1732 (s, C=O), 1678 (s, C=O), 1265, 1165 (C–O) cm^{-1}; EIMS *m*/*z* 193 (M^+, 26), 165 (18), 134 (12), 107 (100), 106 (76), 91 (23), 77 (39), 65 (18); HRMS Calcd for $C_{10}H_{11}NO_3$: 193.0739; Found: 193.0735.

2-[(4-Hydroxyphenyl)amino]-2-oxoethyl formate (7k). Yield: 87%; yellow liquid; ^1H NMR ($CDCl_3$, 200 MHz) δ 4.77 (s, 2 H, CH_2), 7.09 (d, *J* = 8.8 Hz, 2 H, ArH), 7.55 (d, *J* = 8.8 Hz, 2 H, ArH), 7.84 (br, 1 H, NH), 8.19 (s, 1 H, O=C–H), 8.27 (s, 1 H, OH); ^{13}C NMR ($CDCl_3$, 50 MHz) δ 62.29, 121.33 (2 × CH), 121.85 (2 × CH), 134.64, 158.77 (NC=O), 159.12, 164.22 (HC=O); IR (KBr) 3348.42 (br, NH + OH), 2920, 1728 (s, C=O), 1689 (s, C=O), 1192, 1165 (C–O) cm^{-1}; EIMS *m*/*z* 195 (M^+, 40), 109

(100), 108 (33), 81 (11); HRMS Calcd for $C_9H_9NO_4$: 195.0532; Found: 195.0531.

2-[(4-Methoxyphenyl)amino]-2-oxoethyl formate (7l). Yield: 91%; brown solids; mp 47–48 °C; ^{1}H NMR ($CDCl_3$, 200 MHz) δ 3.77 (s, 3 H, CH_3), 4.75 (s, 2 H, CH_2), 6.86 (d, *J* = 9.0 Hz, 2 H, ArH), 7.42 (d, *J* = 9.0 Hz, 2 H, ArH), 7.78 (br, 1 H, NH), 8.18 (s, 1 H, O=C–H); ^{13}C NMR ($CDCl_3$, 125 MHz) δ 55.47, 62.33, 114.28 (2 × CH), 122.11 (2 × CH), 129.50, 157.00, 158.85 (NC=O), 164.04 (HC=O); IR (KBr) 3309 (br, NH), 1734 (s, C=O), 1668 (s, C=O), 1247, 1149 (C–O), 835 cm^{-1}; EIMS *m*/*z* 209 (M^+, 64), 123 (49), 122 (35), 113 (24), 108 (29), 91 (100), 77 (20); HRMS Calcd for $C_{10}H_{11}NO_4$:209.0688; Found: 209.0687.

2-[(4-Cyanophenyl)amino]-2-oxoethyl formate (7m). Yield: 87%; white solids; mp 50–52 °C; ^{1}H NMR ($CDCl_3$, 200MHz) δ 4.79 (s, 2 H, CH_2), 7.62 (d, *J* = 9.0 Hz, 2 H, ArH), 7.70 (d, *J* = 9.0 Hz, 2 H, ArH), 8.04 (br, 1 H, NH), 8.20 (s, 1 H, O=C–H); ^{13}C NMR ($CDCl_3$, 50 MHz) δ 62.26, 108.15, 118.52, 119.93 (2 × CH), 133.40 (2 × CH), 140.55, 158.67 (NC=O), 164.57 (HC=O); IR (KBr) 3294 (br, NH), 2225 (s, CN) 1732 (s, C=O), 1701 (s, C=O), 1315, 1161 (C–O) cm^{-1}; EIMS *m*/*z* 204 (M^+, 28), 119 (12), 118 (100), 117 (14), 91 (16), 90 (17); HRMS Calcd for $C_{10}H_8N_2O_3$: 204.0535; Found: 204.0537.

2-[(2,5-Dimethoxyphenyl)amino]-2-oxoethyl formate (7n). Yield: 76%; white liquid; ^{1}H NMR ($CDCl_3$, 400 MHz) δ 3.72 (s, 3 H, CH_3), 3.80 (s, 3 H, CH_3), 4.73 (s, 2 H, CH_2), 6.56 (dd, *J* = 11.6, 8.8 Hz, 1 H, ArH), 6.76 (d, *J* = 9.2 Hz, 1 H), 8.02 (d, *J* = 2.8 Hz, 1 H, ArH), 8.17 (s, 1 H, O=C–H), 8.43 (br, 1 H, NH); ^{13}C NMR ($CDCl_3$, 100 MHz) δ 55.62 (OCH_3), 56.13 (OCH_3), 62.27, 106.26 (CH), 109.02 (CH), 110.68 (CH), 126.95 (C), 142.18 (C), 153.65 (C), 158.99 (NC=O), 163.90 (HC=O); IR (KBr) 3745 (br, NH), 3251, 1770 (s, C=O), 1666 (s, C=O), 1535, 1219 (C–O) cm^{-1}; EIMS *m*/*z* 239 (M^+, 70), 224 (16), 165 (11), 138 (100); HRMS Calcd for $C_{11}H_{13}NO_5$: 239.0794; Found: 239.0785.

2-(Naphthalen-1-ylamino)-2-oxoethyl formate (9a). Yield: 86%; white solids; mp 47–49 °C; ^{1}H NMR ($CDCl_3$, 200 MHz) δ 4.90 (s, 2 H, CH_2), 7.43–7.55 (m, 3 H, ArH), 7.71–7.90 (m, 4 H, ArH), 8.27 (s, 1 H, O=C–H); ^{13}C NMR ($CDCl_3$, 50 MHz) δ 62.75, 120.32, 121.19, 125.69, 126.23, 126.61, 126.68, 128.87, 128.89, 130.87, 134.14, 159.02 (NC=O), 164.89 (HC=O); IR (KBr) 3248 (br, NH), 1726 (s, C=O), 1666 (s, C=O), 1217, 1163 (C–O), 767 cm^{-1}; EIMS *m*/*z* 229 (M^+, 55), 179 (22), 143 (100), 115 (57), 93 (52), 77 (20); HRMS Calcd for $C_{13}H_{11}NO_3$: 229.0739; Found: 229.0734.

2-Oxo-2-(quinolin-8-ylamino)ethyl formate (9b). Yield: 87%; white solids; mp 46–48 °C; ^{1}H NMR ($CDCl_3$, 200 MHz) δ 4.90 (s, 2 H, CH_2), 7.47–7.56 (m, 3 H, ArH), 8.14 (d, *J* = 8.3 Hz, 1 H, ArH), 8.32 (s, 1 H, O=C–H), 8.68–8.82 (m, 2 H, ArH), 9.76 (br, 1 H, NH); ^{13}C NMR ($CDCl_3$, 50 MHz) δ 62.61, 117.01, 121.78, 122.46, 127.29, 127.99, 136.41, 138.55, 148.56, 148.58, 159.30 (NC=O), 164.59 (HC=O); IR (KBr) 3331 (NH), 1734 (s, C=O), 1683 (s, C=O), 1153 (C–O), 788 cm^{-1}; EIMS *m*/*z* 230 (M^+, 10), 172 (17) , 171 (100), 144 (46), 135 (23), 91 (12); HRMS calcd for $C_{12}H_{10}N_2O_3$: 230.0691; Found: 230.0695.

2-Oxo-2-(Thiazolylamino)ethyl formate (9c). Yield: 71%; yellow liquid; ^{1}H NMR ($CDCl_3$, 400 MHz) δ 4.90 (s, 2 H, CH_2), 7.03 (d, *J* = 3.6 Hz, 1 H), 7.47 (d, *J* = 3.6 Hz, 1 H), 8.17 (s, 1 H, O=C–H); ^{13}C NMR ($CDCl_3$, 100 MHz) δ 61.50, 114.39 (CH), 130.88 (C), 136.95 (CH), 159.07 (NC=O), 164.02 (HC=O); IR (KBr) 3745 (br, NH), 1728 (s, C=O), 1678 (s, C=O), 1276, 1161 (C–O) cm^{-1}; EIMS *m*/*z* 186 (M^+, 20), 127 (10), 100 (100), 91 (17), 73 (9), 58 (22), 55 (13); HRMS Calcd for $C_6H_6N_2O_3S$: 186.0099; Found: 186.0096.

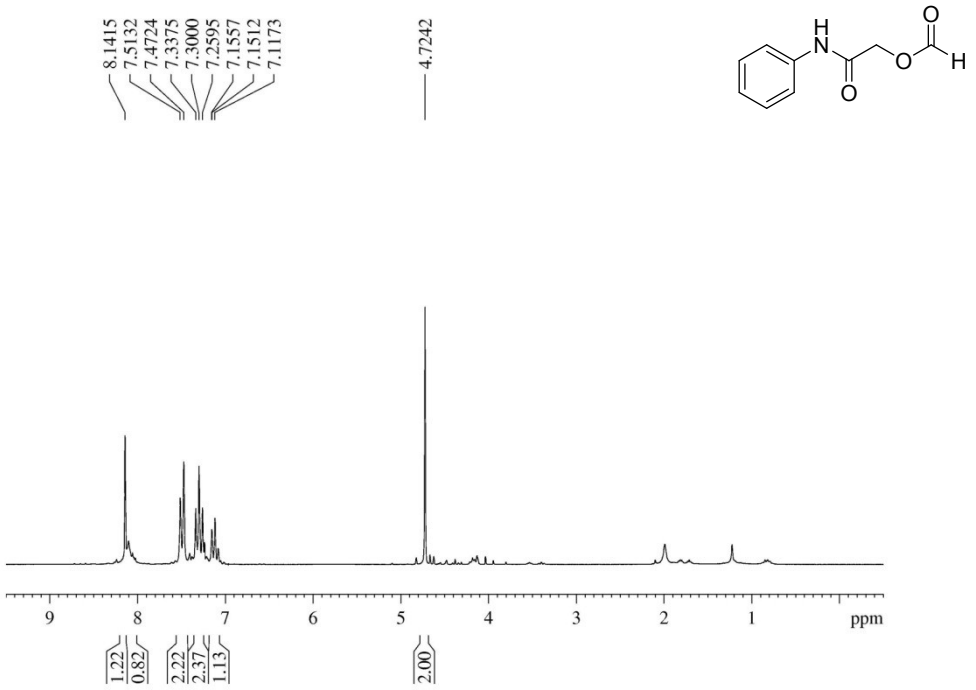

Figure ^{1}H NMR (CDCl3, 200 MHz) spectrum of compound **4**

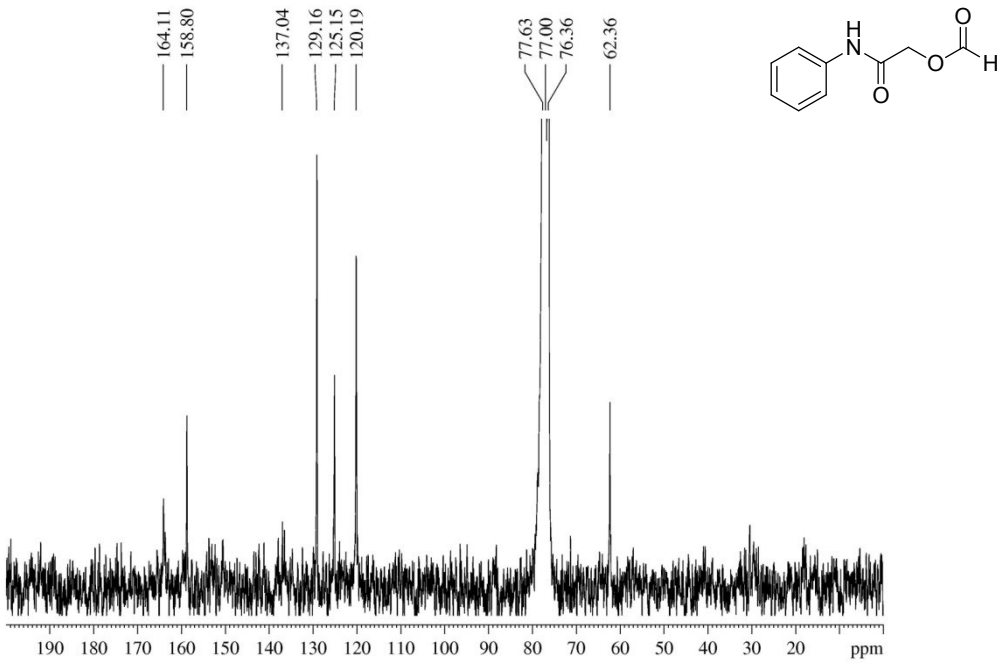

Figure ^{13}C NMR (50 MHz, CDCl3) spectrum of compound **4**

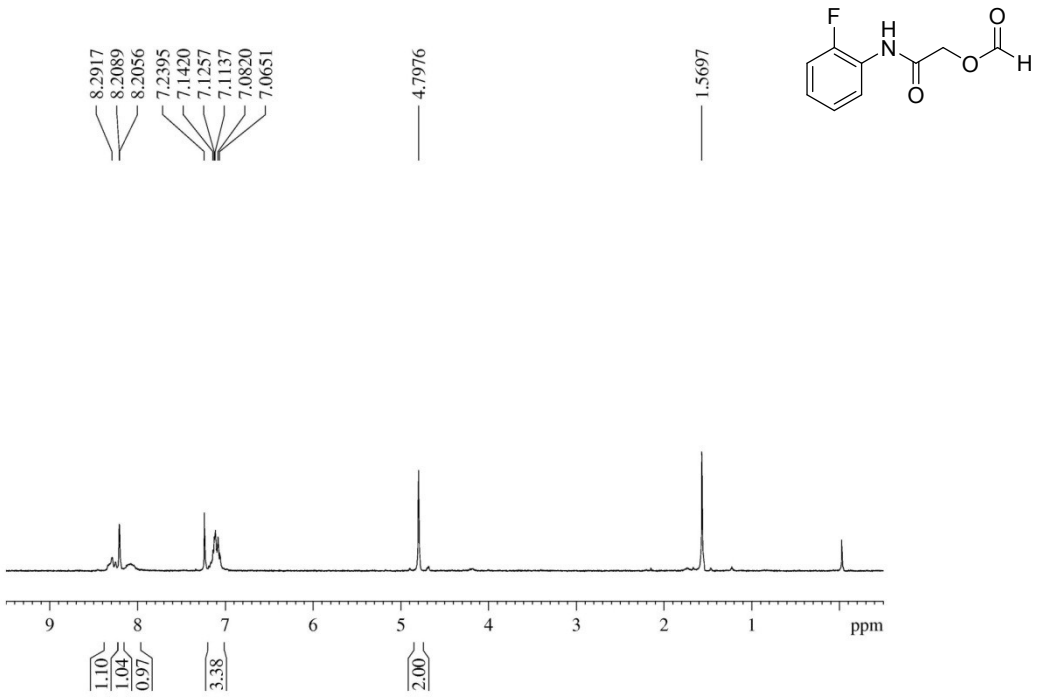

Figure [1]H NMR (CDCl3, 200 MHz) spectrum of compound **7a**

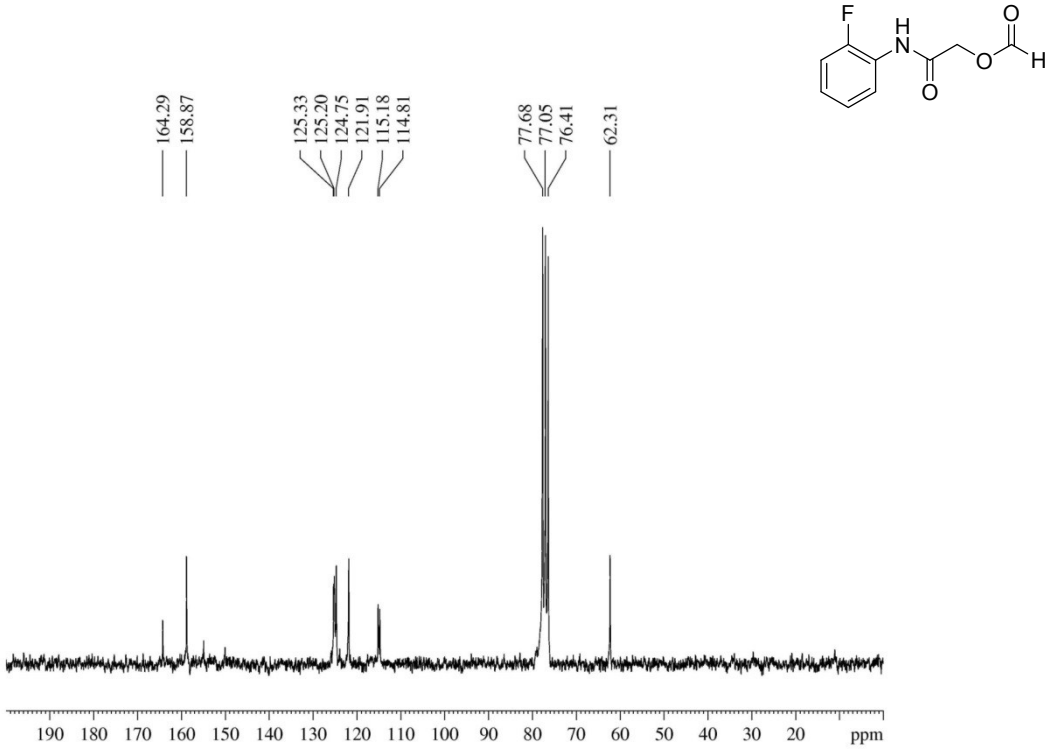

Figure [13]C NMR (50 MHz, CDCl3) spectrum of compound **7a**

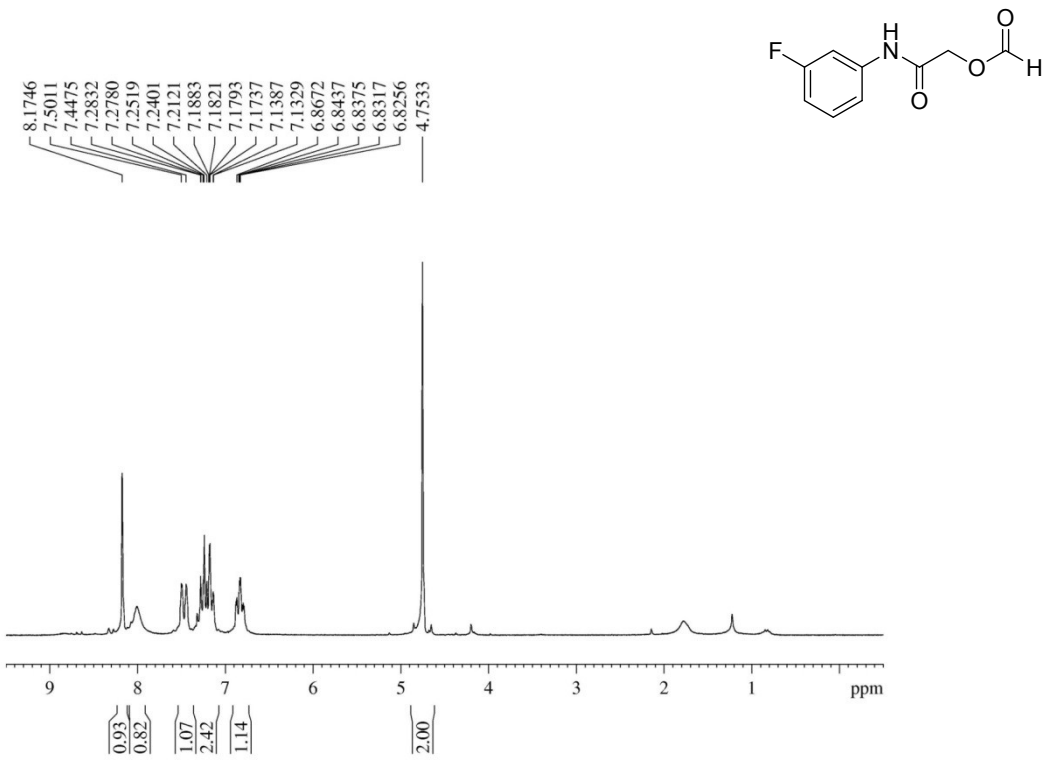

Figure [1]H NMR (CDCl3, 200 MHz) spectrum of compound **7b**

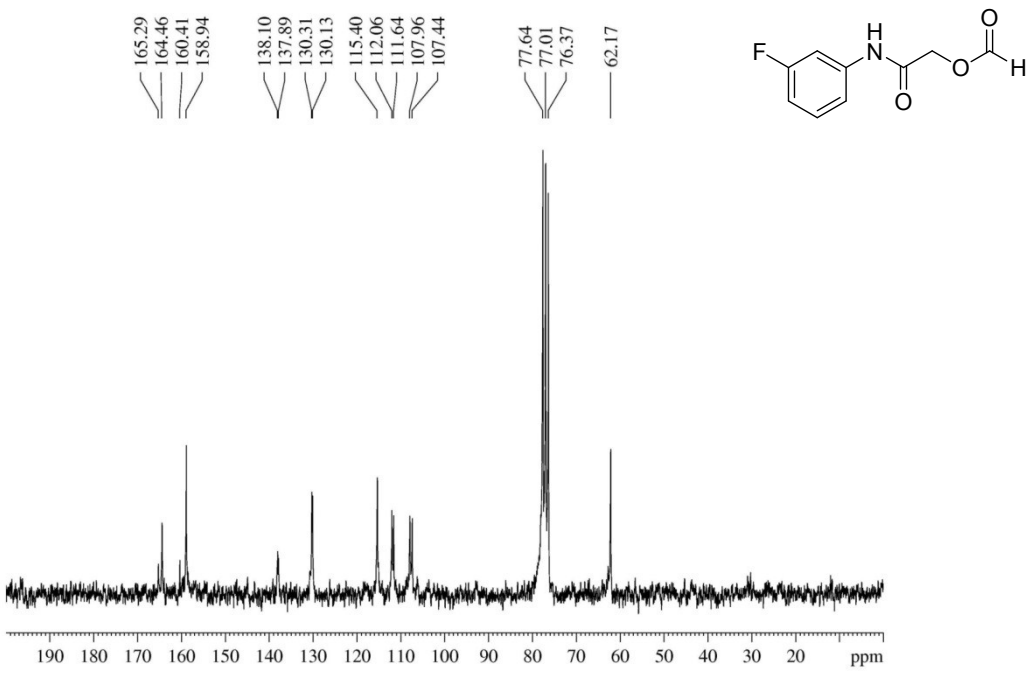

Figure [13]C NMR (50 MHz, CDCl3) spectrum of compound **7b**

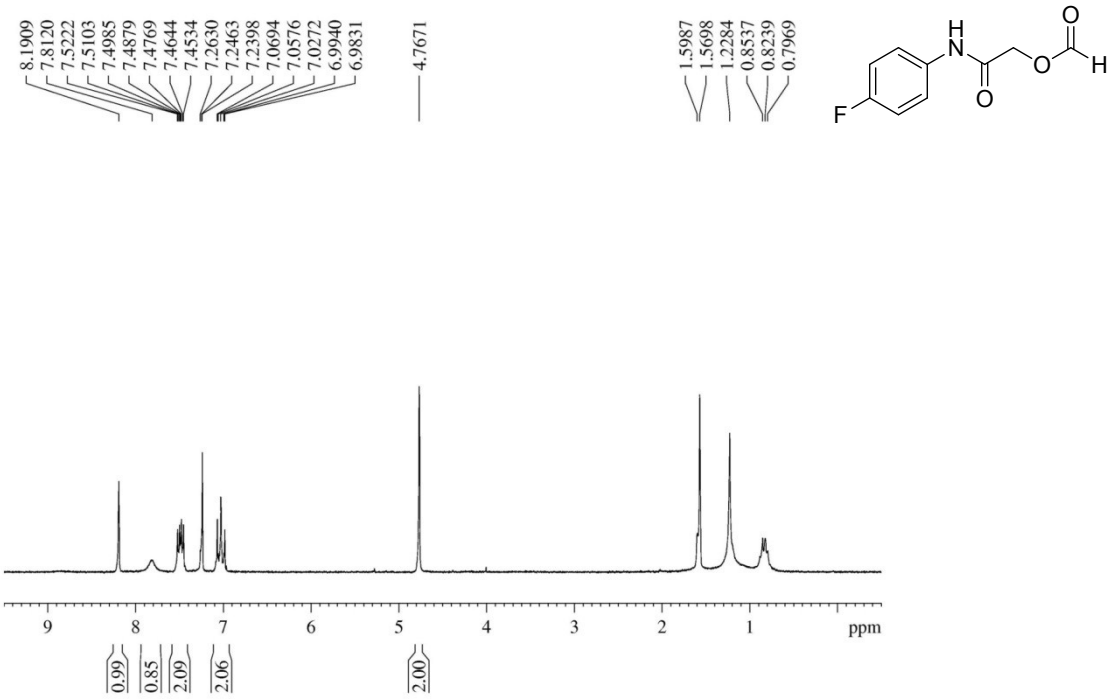

Figure ^{1}H NMR (CDCl3, 200 MHz) spectrum of compound **7c**

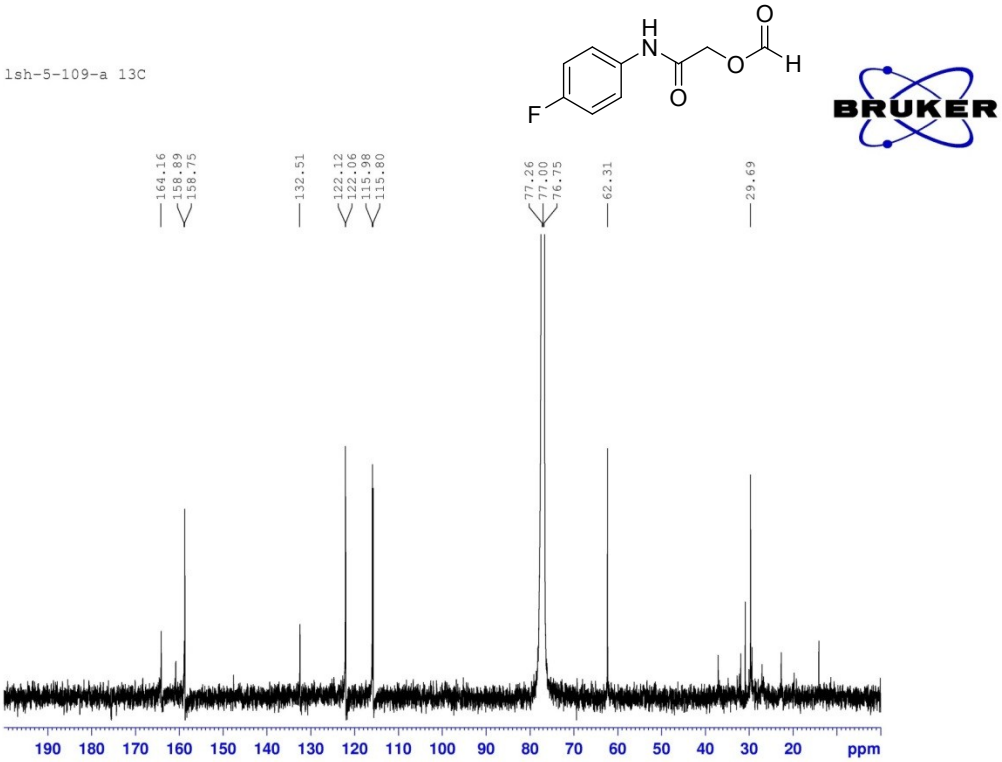

Figure ^{13}C NMR (125 MHz, CDCl3) spectrum of compound **7c**

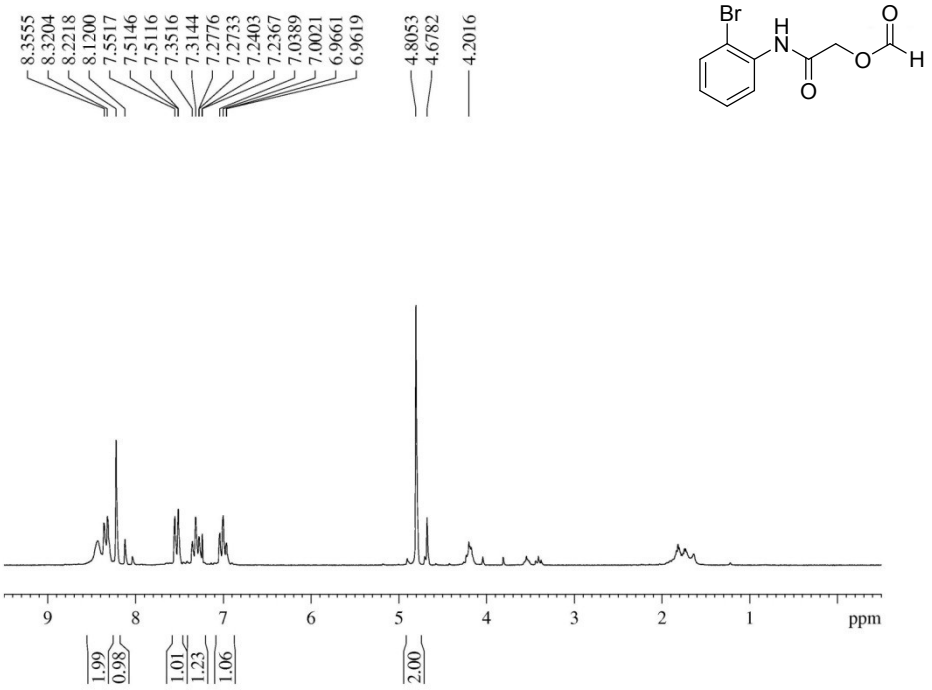

Figure ^{1}H NMR (50 MHz, CDCl3) spectrum of compound **7d**

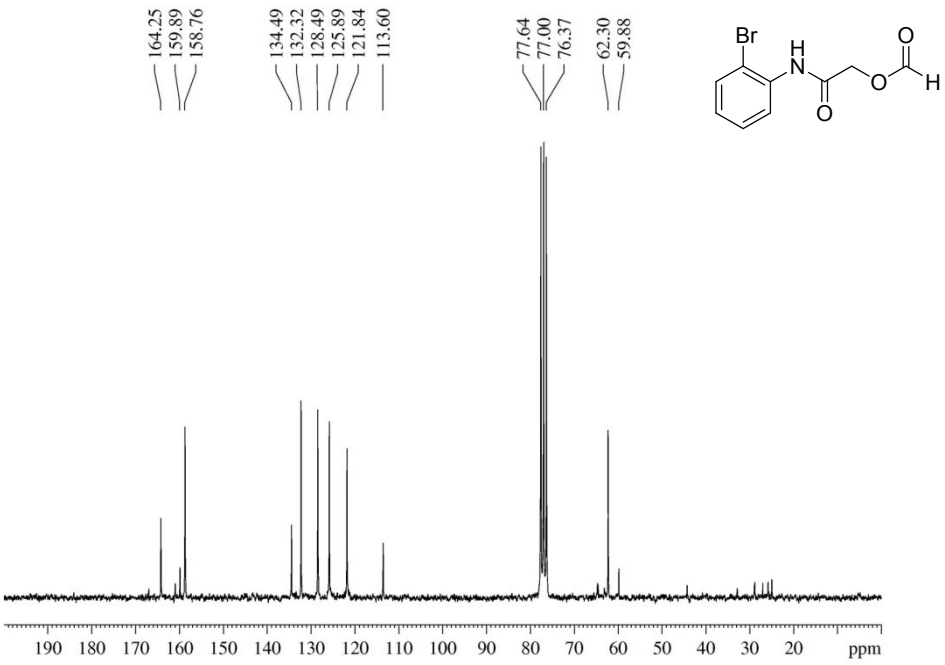

Figure ^{13}C NMR (50 MHz, CDCl3) spectrum of compound **7d**

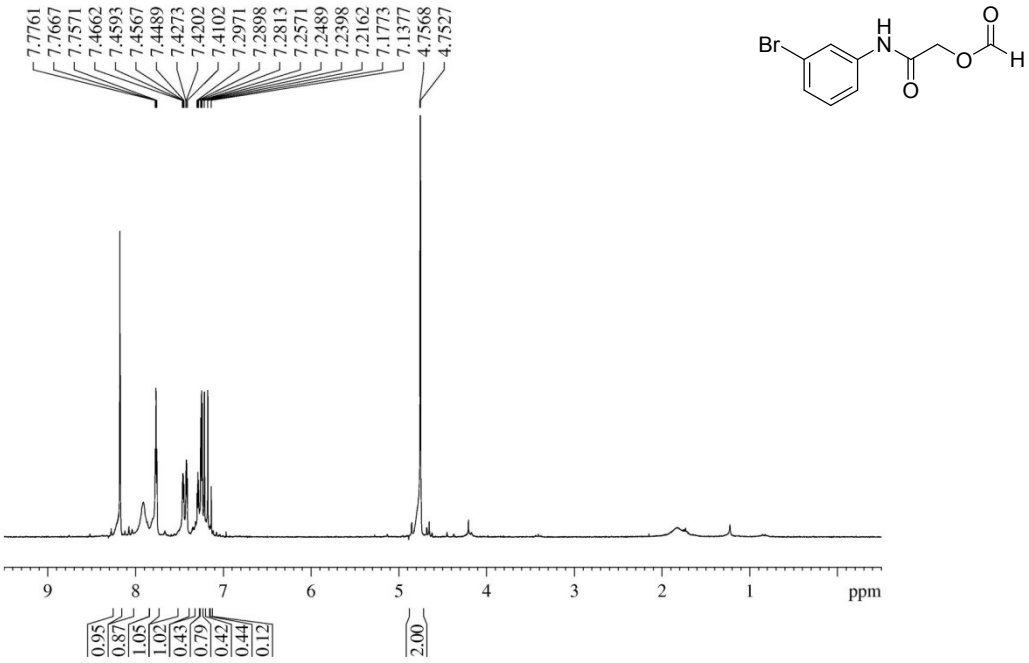

Figure [1]H NMR (CDCl3, 200 MHz) spectrum of compound **7e**

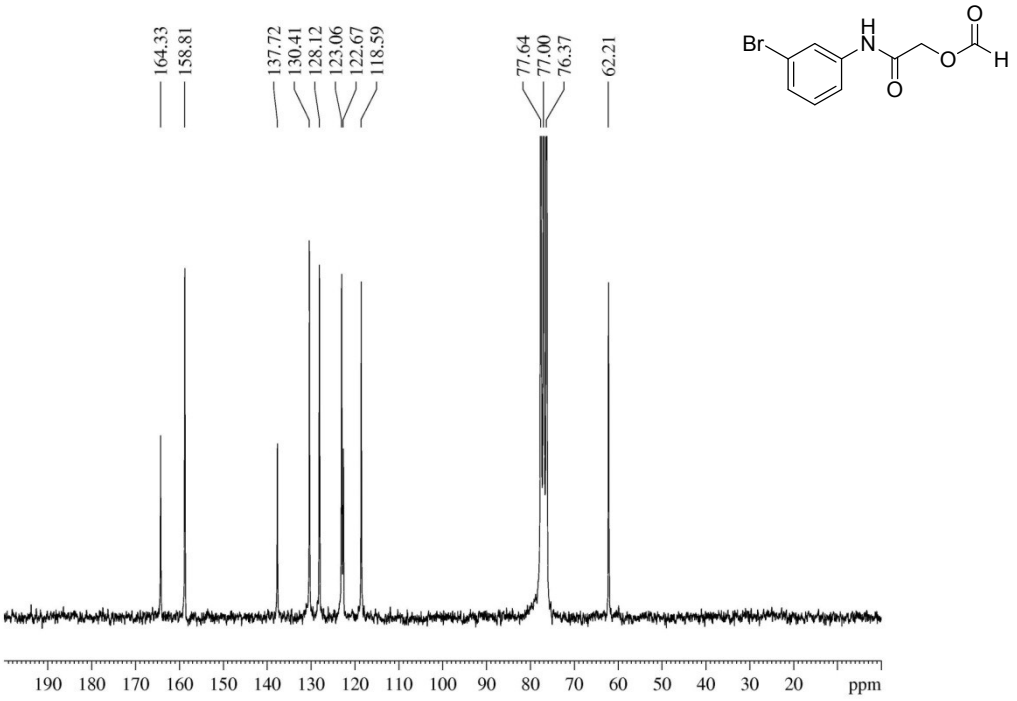

Figure [13]C NMR (50 MHz, CDCl3) spectrum of compound **7e**

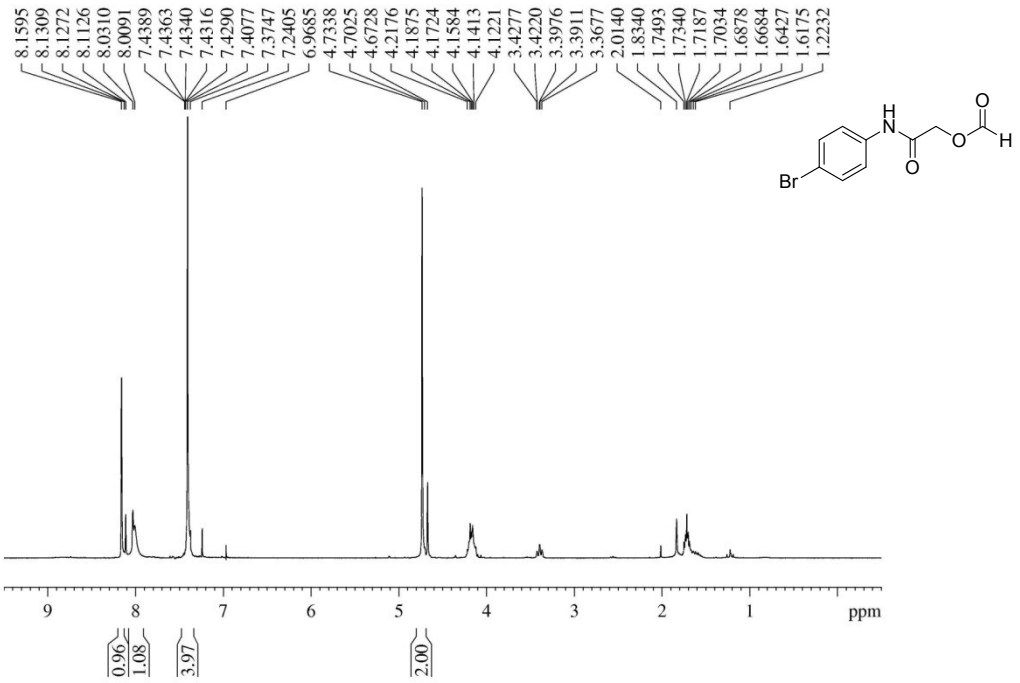

Figure ^{1}H NMR (CDCl3, 200 MHz) spectrum of compound **7f**

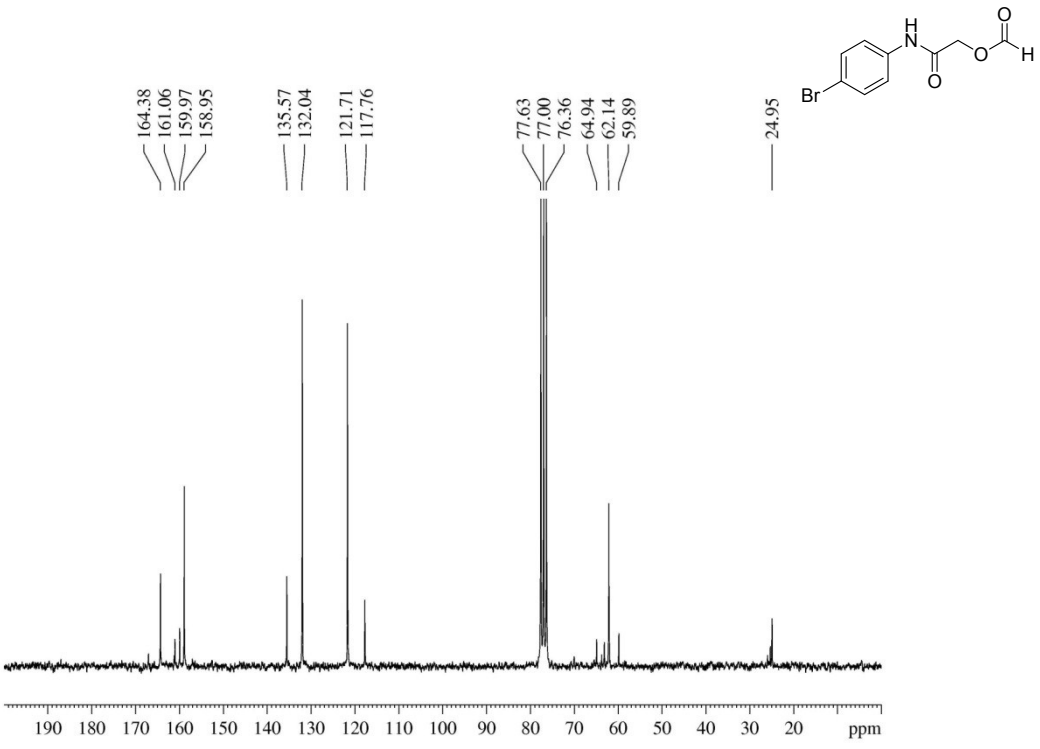

Figure ^{13}C NMR (50 MHz, CDCl3) spectrum of compound **7f**

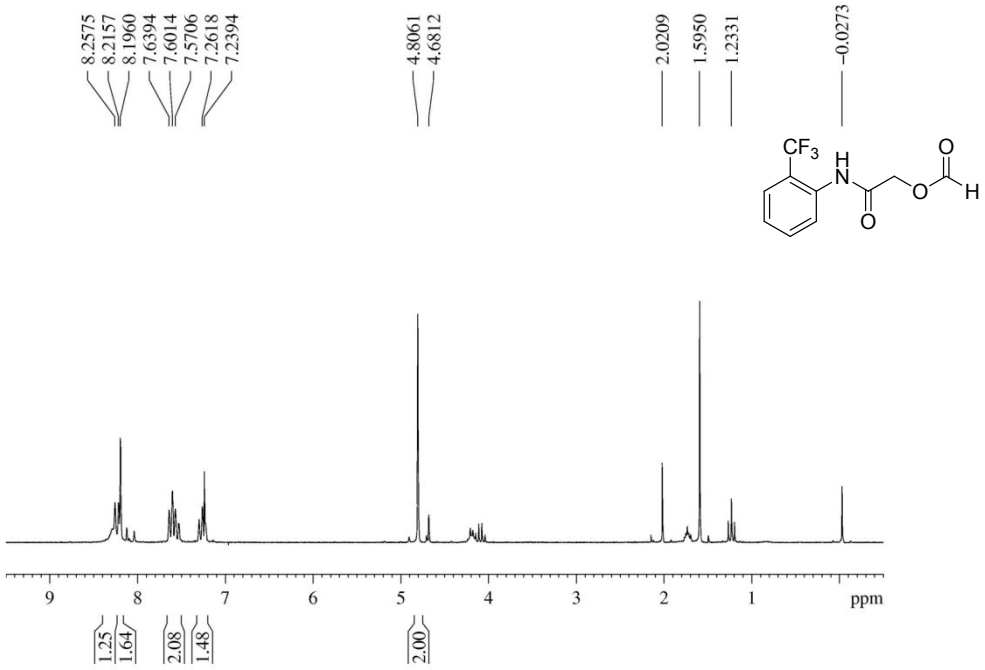

Figure [1]H NMR (CDCl3, 200 MHz) spectrum of compound **7g**

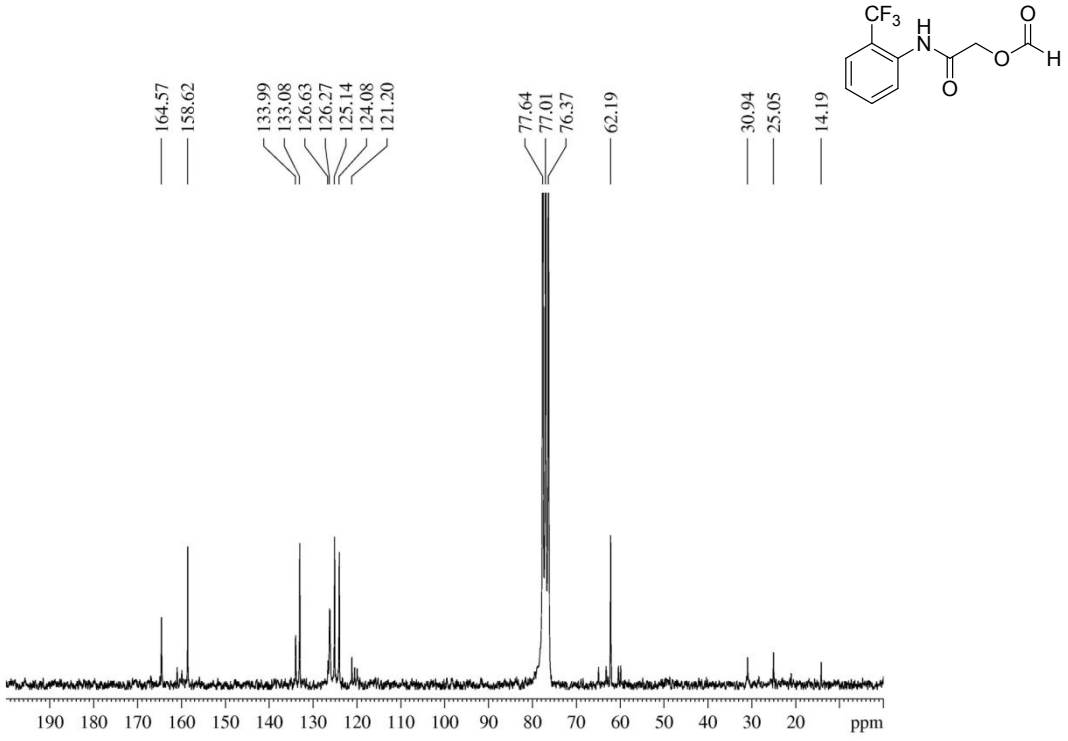

Figure [13]C NMR (50 MHz, CDCl3) spectrum of compound **7g**

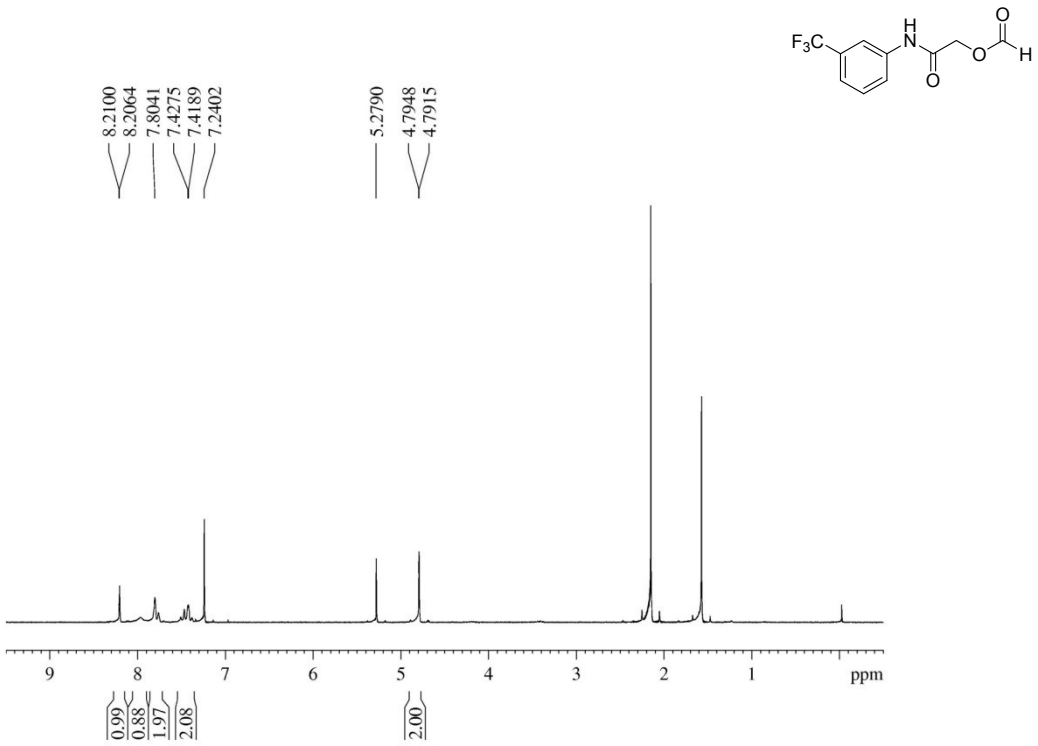

Figure [1]H NMR (CDCl3, 200 MHz) spectrum of compound **7h**

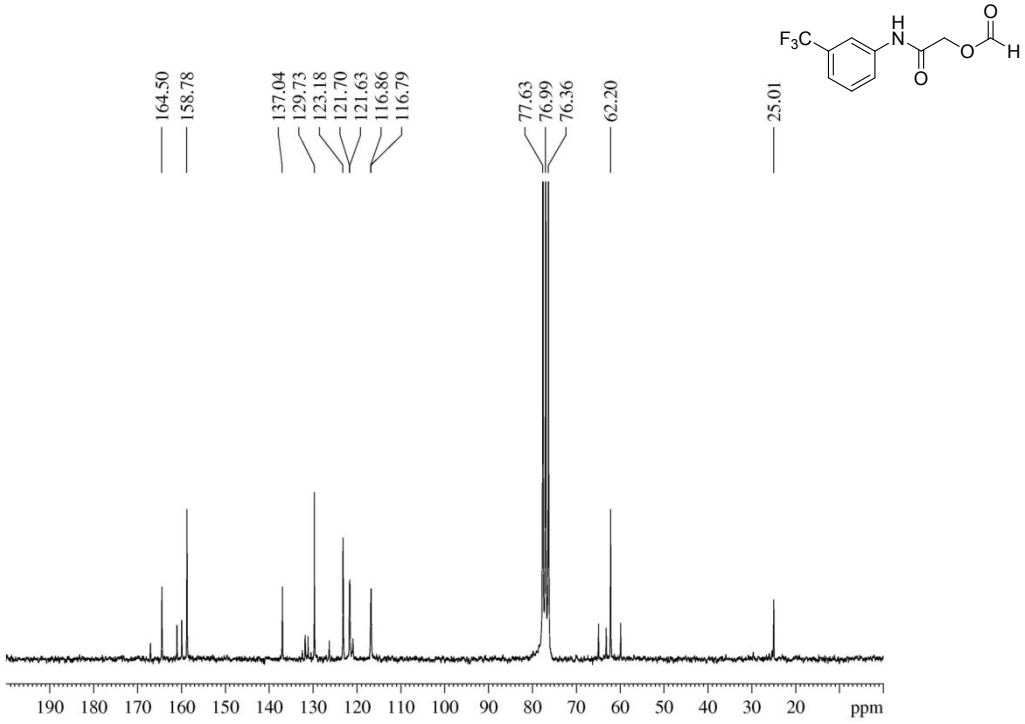

Figure [13]C NMR (50 MHz, CDCl3) spectrum of compound **7h**

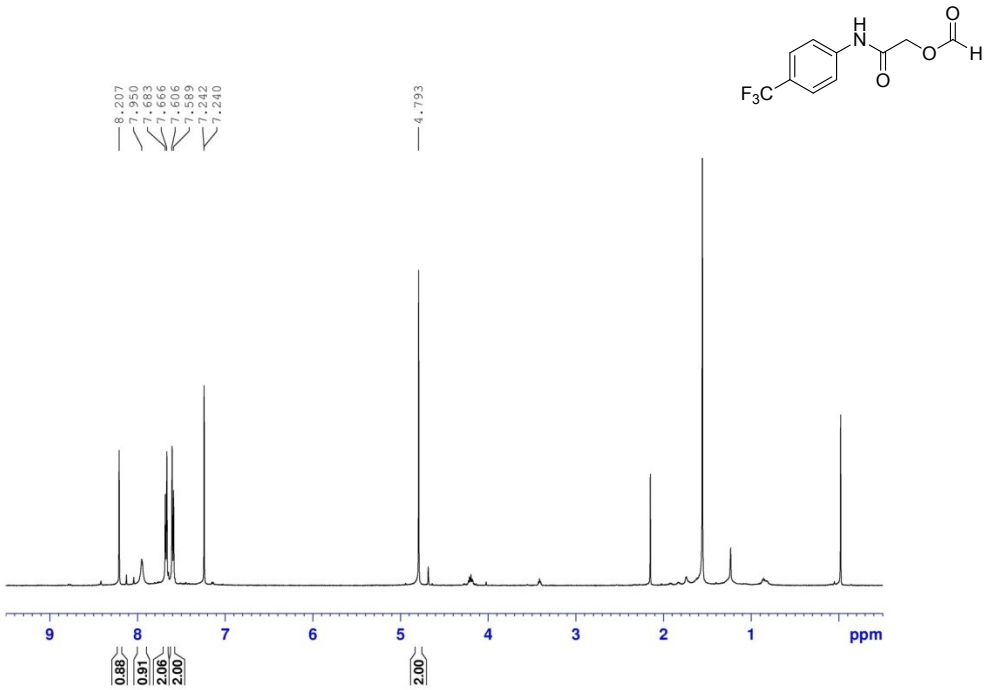

Figure [1]H NMR (CDCl3, 500 MHz) spectrum of compound **7i**

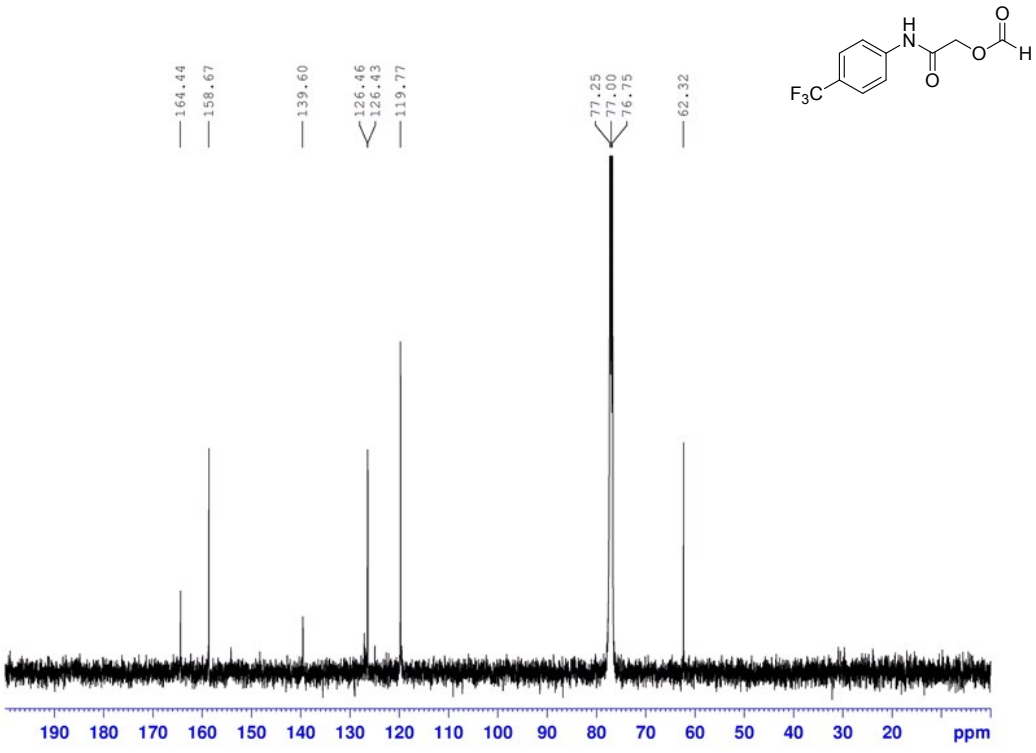

Figure [13]C NMR (125 MHz, CDCl3) spectrum of compound **7i**

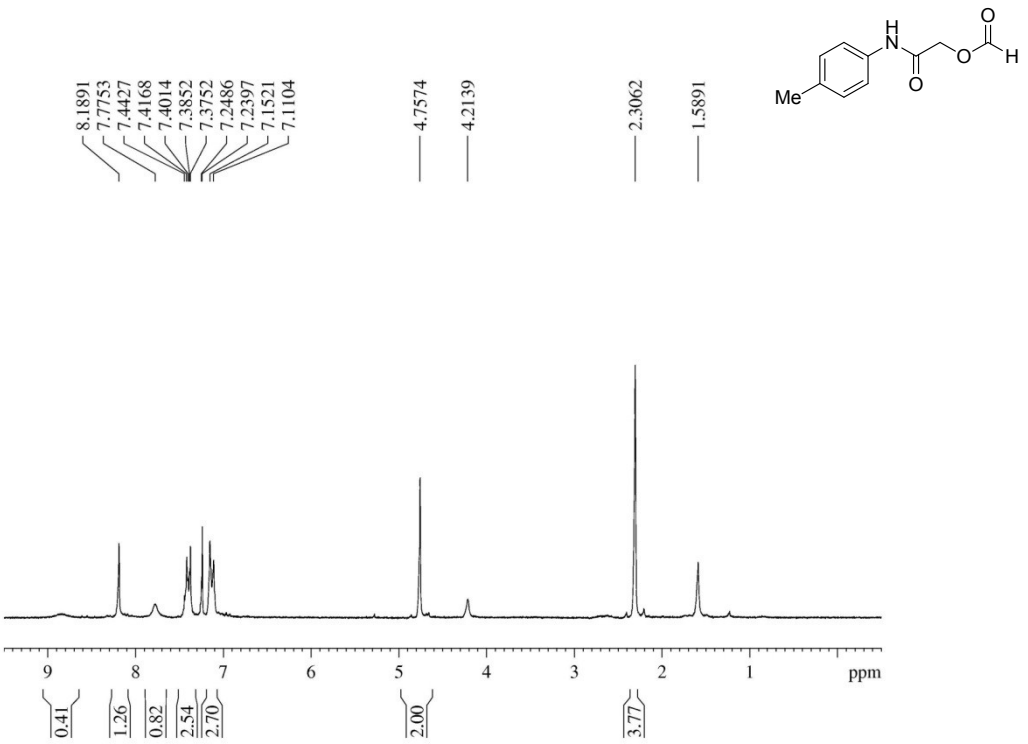

Figure ^{1}H NMR (CDCl3, 200 MHz) spectrum of compound **7j**

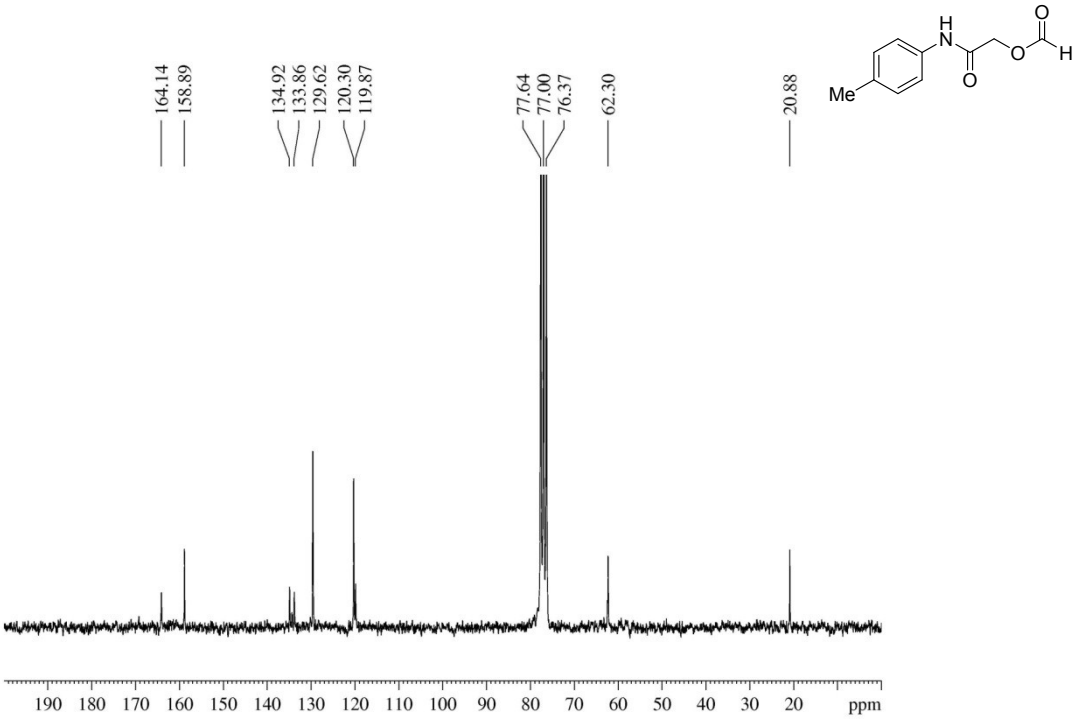

Figure ^{13}C NMR (50 MHz, CDCl3) spectrum of compound **7j**

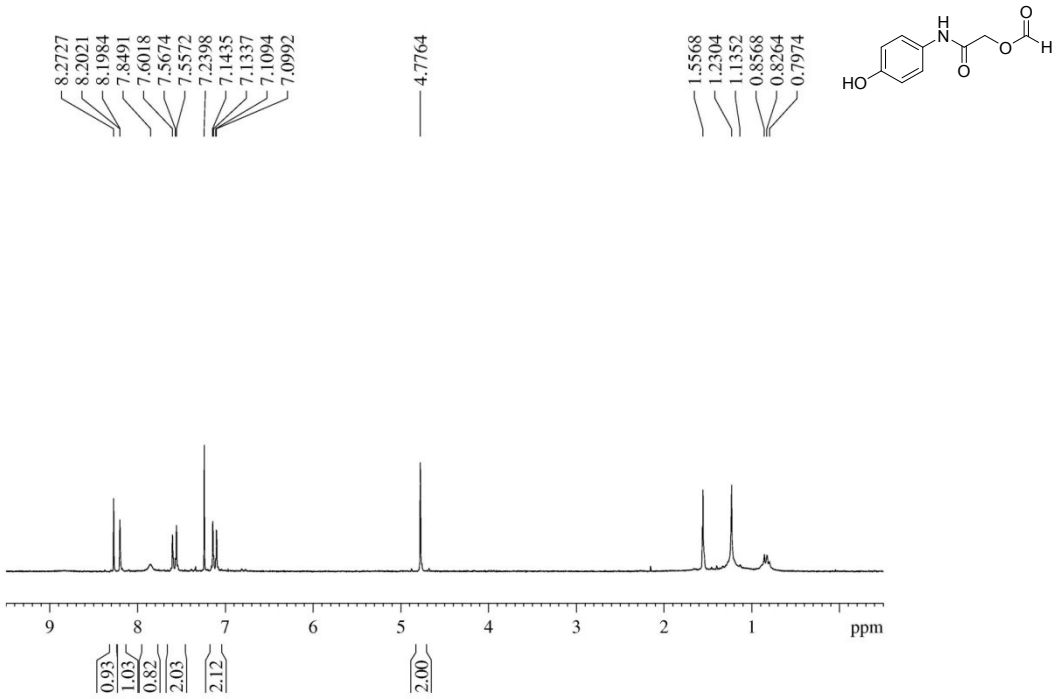

Figure ^{1}H NMR (CDCl3, 200 MHz) spectrum of compound **7k**

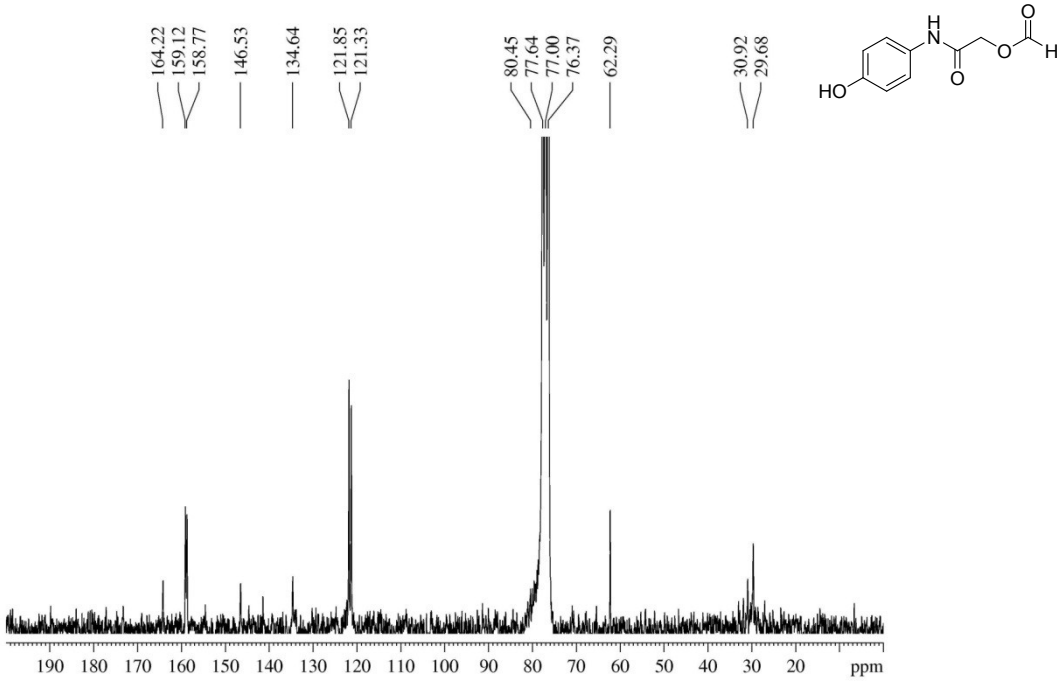

Figure ^{13}C NMR (50 MHz, CDCl3) spectrum of compound **7k**

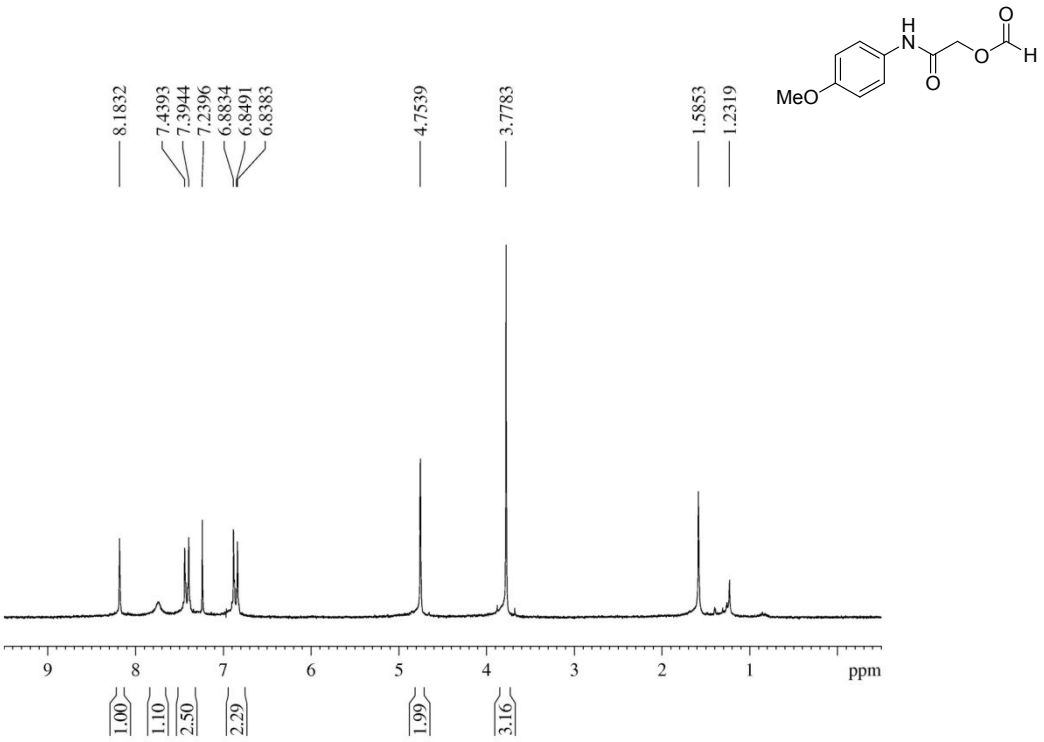

Figure ^{1}H NMR (CDCl3, 200 MHz) spectrum of compound **7l**

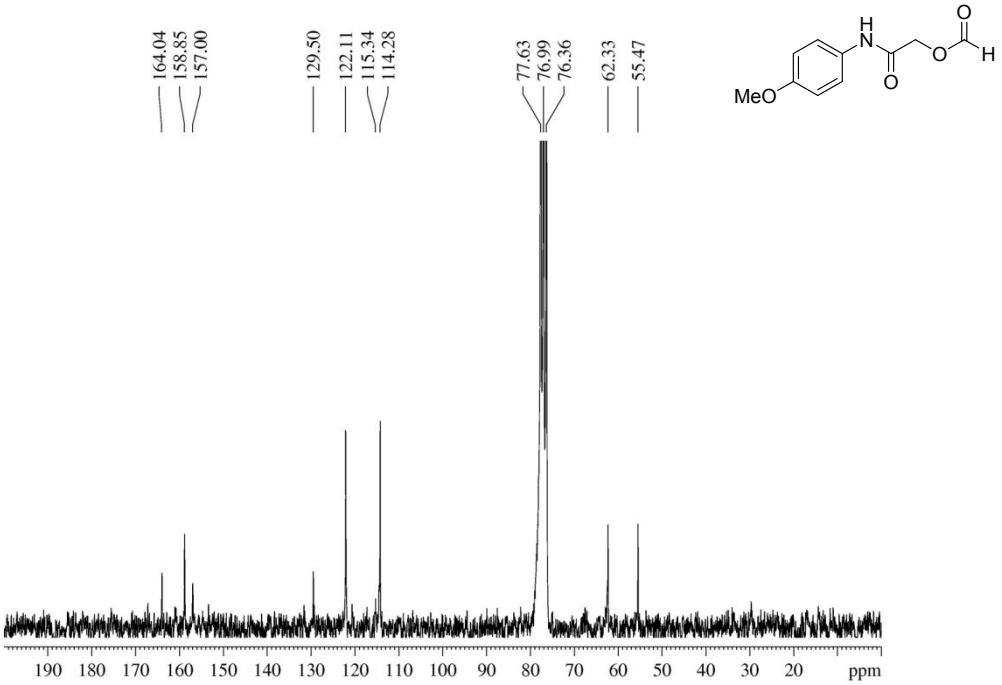

Figure ^{13}C NMR (50 MHz, CDCl3) spectrum of compound **7l**

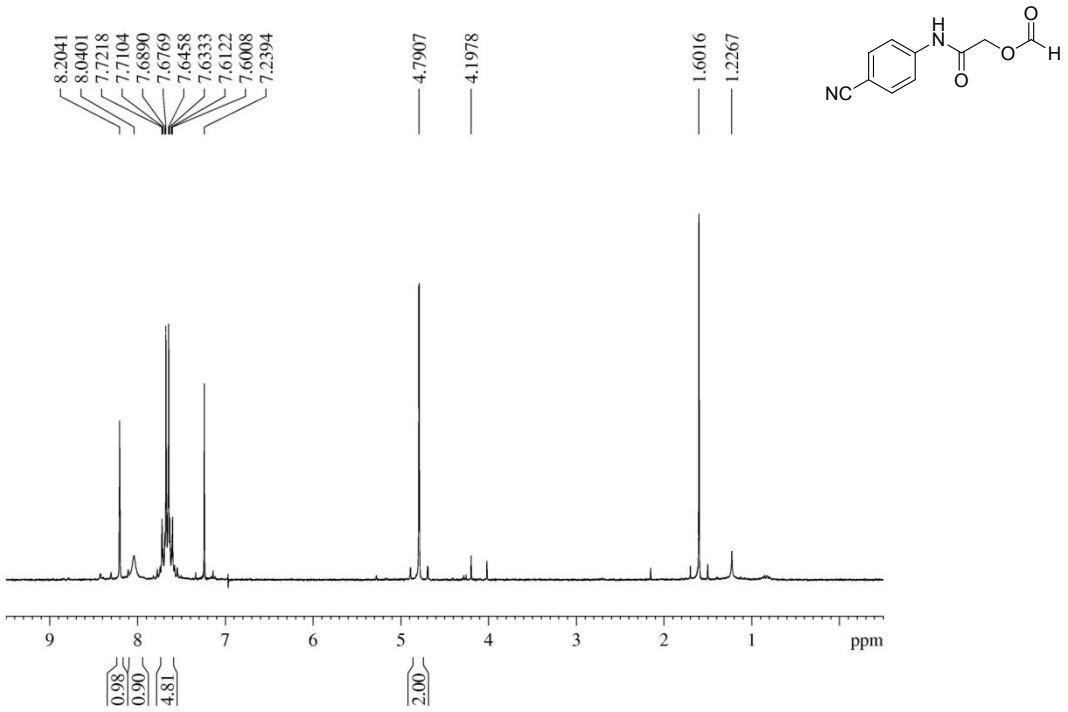

Figure [1]H NMR (CDCl3, 200 MHz) spectrum of compound **7m**

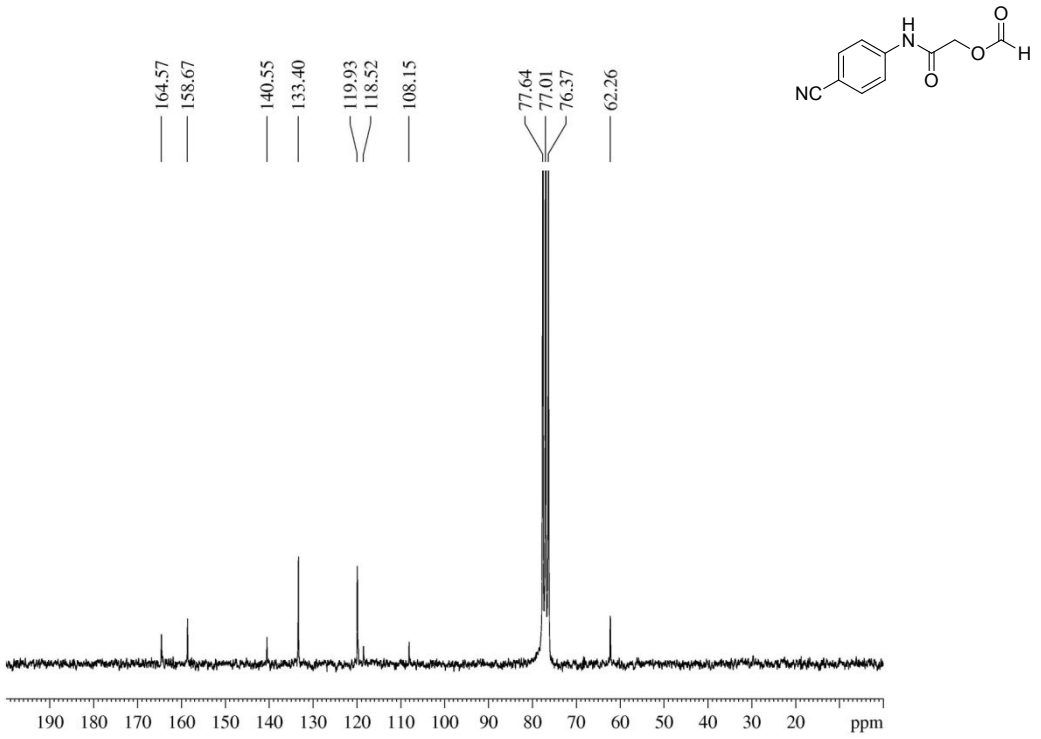

Figure [13]C NMR (50 MHz, CDCl3) spectrum of compound **7m**

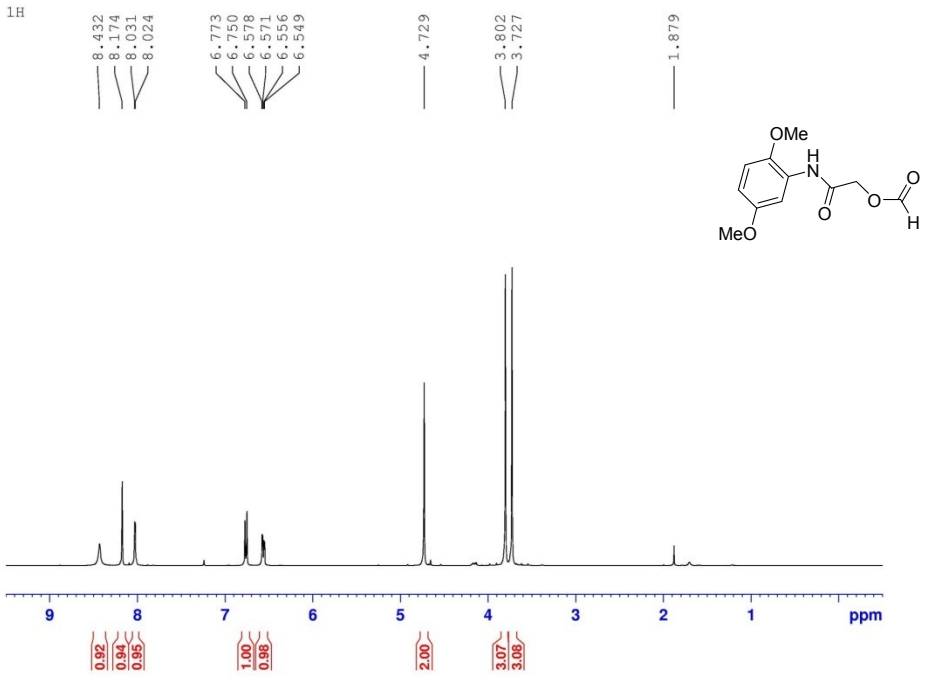

Figure [1]H NMR (CDCl3, 400 MHz) spectrum of compound **7n**

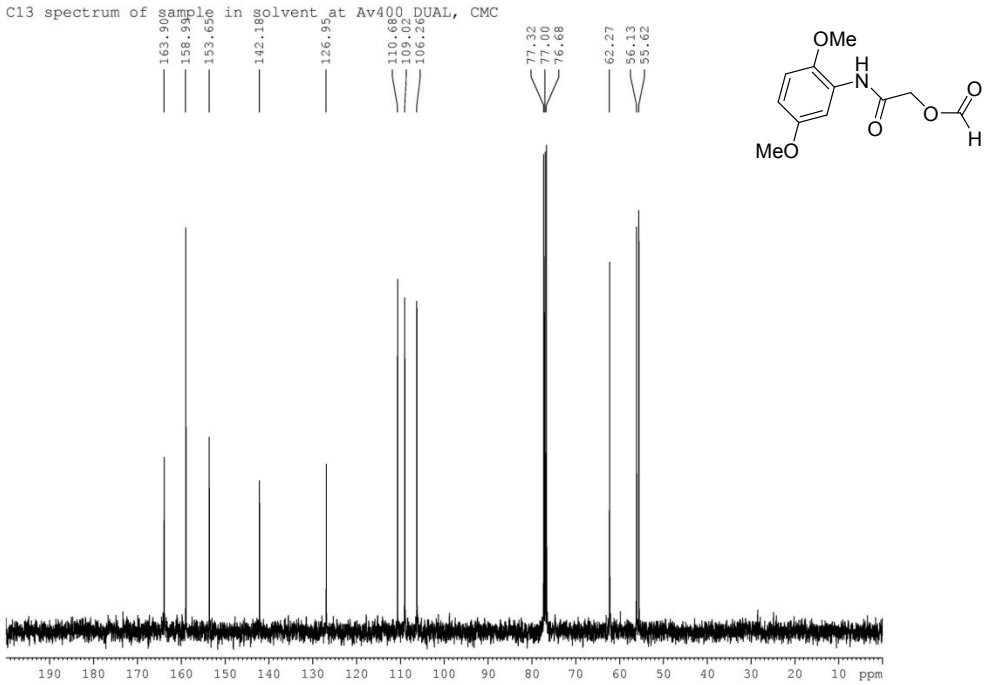

Figure [13]C NMR (50 MHz, CDCl3) spectrum of compound **7n**

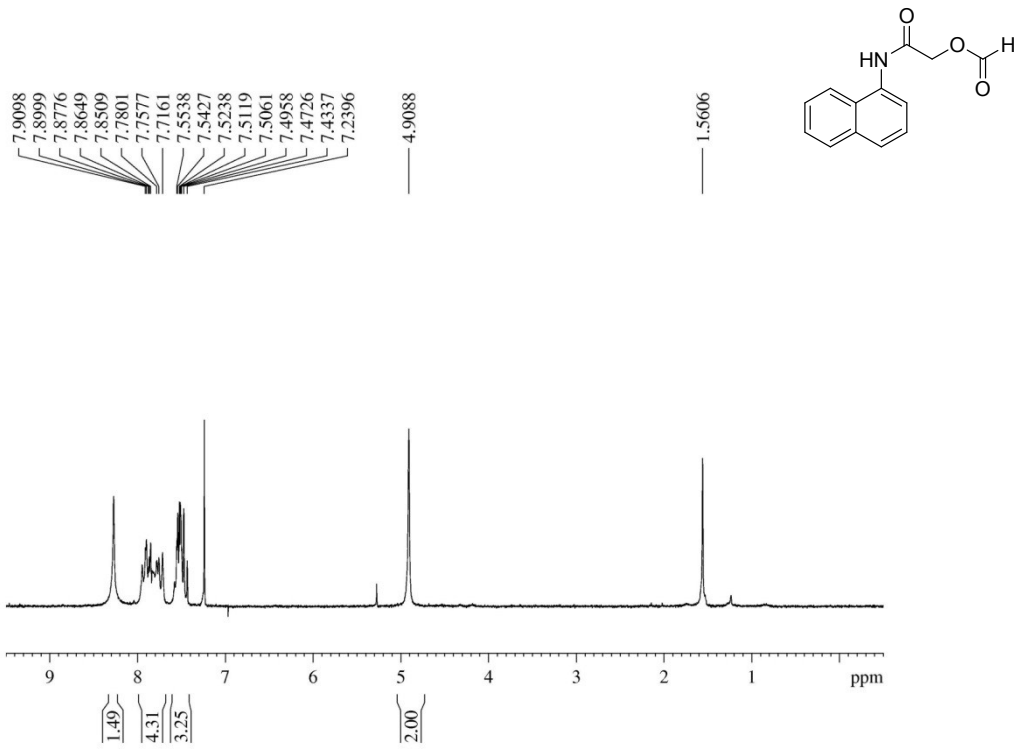

Figure [1]H NMR (CDCl3, 200 MHz) spectrum of compound **9a**

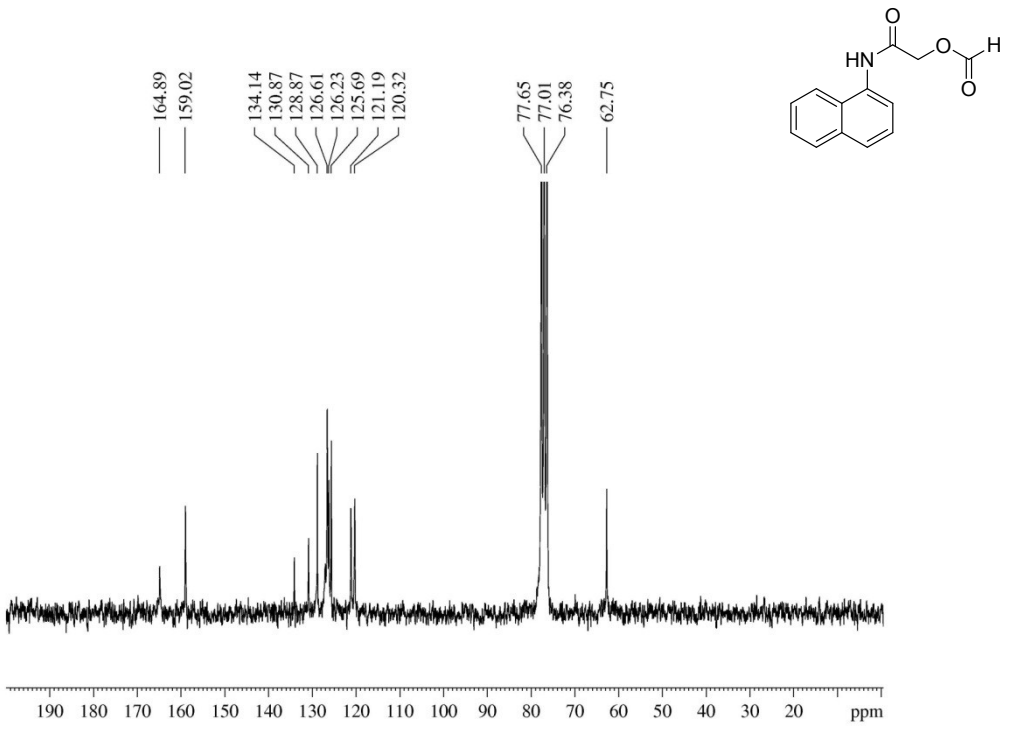

Figure [13]C NMR (50 MHz, CDCl3) spectrum of compound **9a**

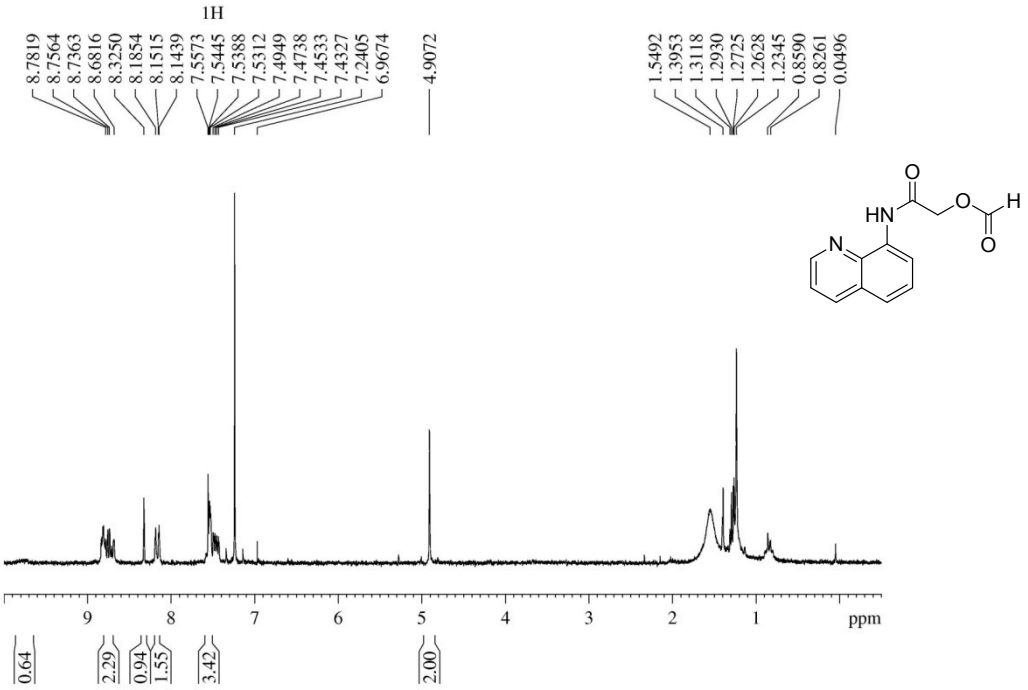

Figure [1]H NMR (CDCl3, 200 MHz) spectrum of compound **9b**

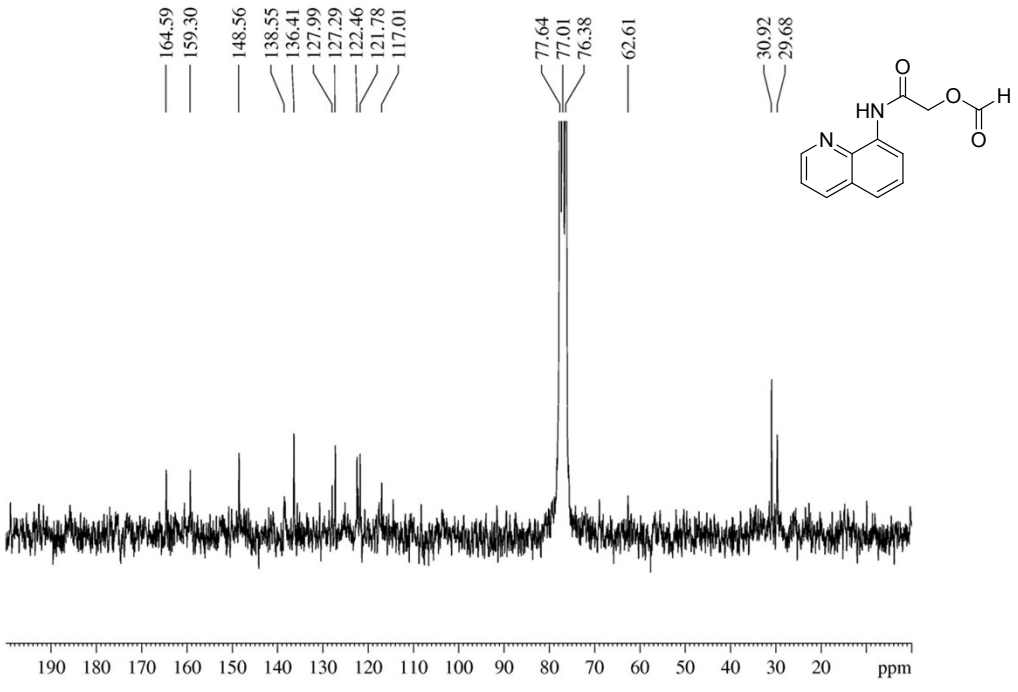

Figure [13]C NMR (50 MHz, CDCl3) spectrum of compound **9b**

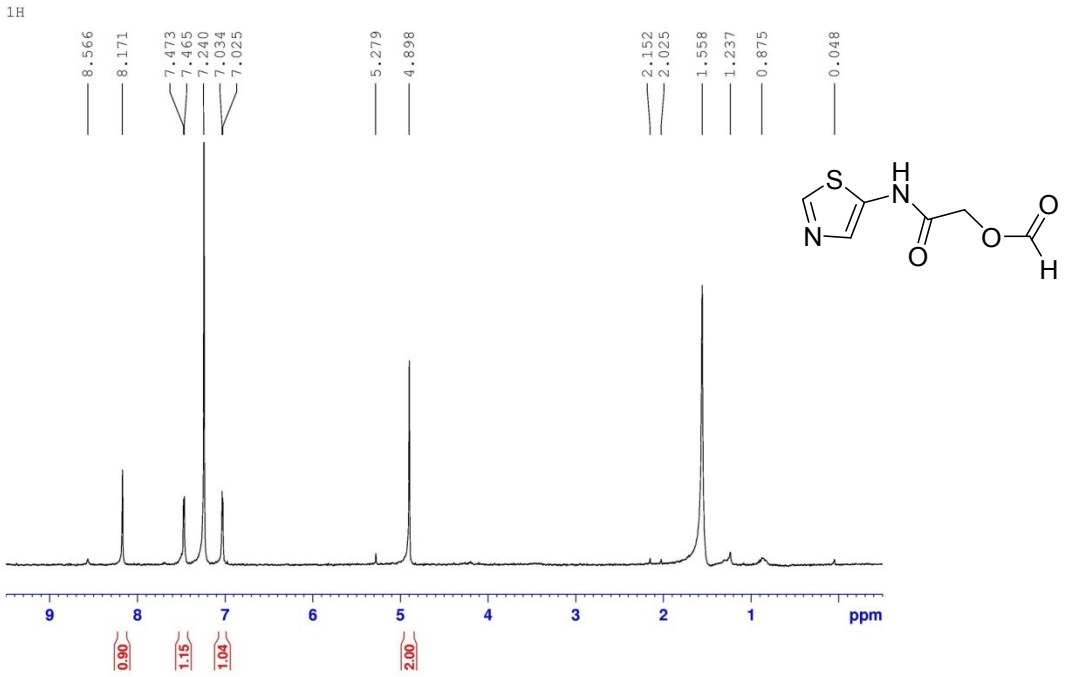

Figure ^{1}H NMR (CDCl3, 400 MHz) spectrum of compound **9c**

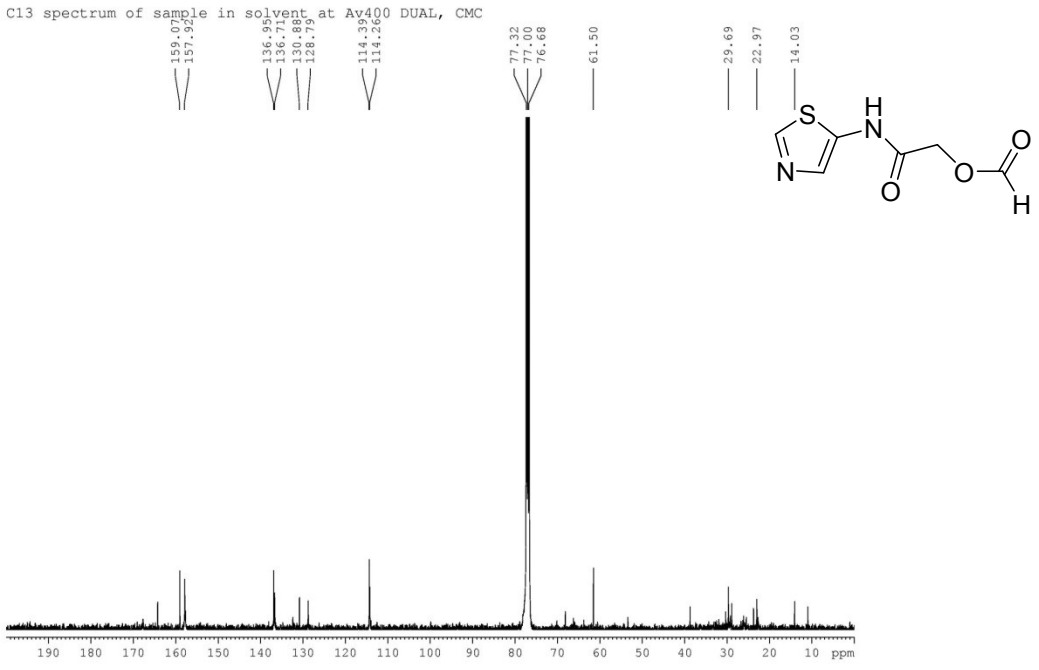

Figure ^{13}C NMR (100 MHz, CDCl3) spectrum of compound **9c**