SUPPORTING INFORMATION

LiCl-Promoted Pd(II)-Catalyzed *ortho* Carbonylation of *N*,*N*-Dimethylbenzylamines

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Contents

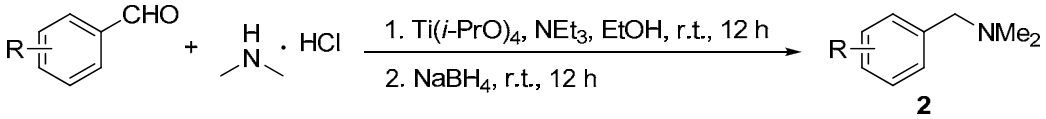
General Methods and Physical Methods

All the reactions were carried out in a stoppered Schlenk flask. All the solvents were freshly distilled before use except TEFol. TFEol, anhydrous $Cu(OAc)_2$ and Pd/C (5 wt% Pd) were purchased from Acros. $PdCl_2$ was purchased from Zealand Co. Ltd., lithium chloride monohydrate and *N*,*N*-dimethylbenzylamine were purchased from Sinopharm Chemical Reagent Co., Ltd. *N*,*N*-Dimethylbenzylamine was distilled under reduced pressure and stored under N_2 atmosphere. LiCl and dimethylamine hydrochloride were dried in vacuo before used. Other commercially available chemicals were directly used without further purification.

^{1}H NMR (300 MHz or 200 MHz) and ^{13}C NMR (75 MHz or 50 MHz) were registered on Varian 300 M or 200 M spectrometers with $CDCl_3$ as solvent and tetramethylsilane (TMS) as an internal standard. Chemical shifts were reported in units (ppm) by assigning the TMS resonance in the ^{1}H spectrum as 0.00 ppm and the $CDCl_3$ resonance in the ^{13}C spectrum as 77.0 ppm. All coupling constants (*J* values) are reported in hertz (Hz). Column chromatography was performed on silica gel 200-300 mesh. IR, GC, and MS were performed by the State-authorized Analytical Center in Peking University.

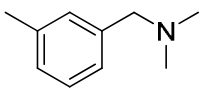
General Experimental Procedures and Characterization Data

General Procedure for Preparation of Functionalized *N*,*N*-Dimethylbenzylamines 2.



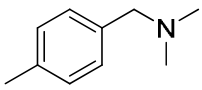
2

Functionalized *N*,*N*-dimethylbenzylamines **2** were prepared by reductive amination according to the reported procedure. To a solution of NEt_3 (4.2 mL, 30 mmol) in absolute EtOH (23 mL) was added dimethylamine hydrochloride (2.48 g, 30 mmol), Ti(*i*-PrO)$_4$ (9.0 mL, 30 mmol), and the corresponding aldehyde (15 mmol). The mixture was stirred at 25 °C for 12 h, $NaBH_4$ (0.86 g, 22.5 mmol) was added, and the resulting mixture was further stirred for 12 h at 25 °C. The reaction was quenched by pouring the mixture into aqueous ammonia (25 mL, 2 N) and filtered through a Celite pad, and the resulting inorganic solid was washed with CH_2Cl_2 (100 mL). The filtrate was washed with CH_2Cl_2 (3 × 50 mL), concentrated to about 30 mL, and washed with HCl (2 N, 3 × 10 mL). The solution was neutralized to pH = 9 with 10% aqueous NaOH and extracted with CH_2Cl_2 (3 × 50 mL). Additional NaOH was added to keep the inorganic phase basic. The organic phases were combined and dried over $MgSO_4$ and then evaporated to give the corresponding *N*,*N*-dimethylbenzylamine **2** as a colorless to light yellow oil without further purification.



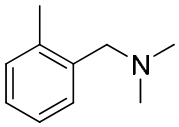
2b

***N*,*N*,3-trimethylbenzylamine (2b):** 2.2 g, 63% yield. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.08 (m, 4H), 3.33 (s, 2H), 2.28 (s, 3H), 2.18 (s, 6H) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) 138.7, 137.7, 129.7, 128.0, 127.7, 126.0, 64.3, 45.3, 21.2 ppm; IR *v* 2941, 2814, 2769, 1456, 1032, 844, 779, 696 cm^{-1} MS: (m/z) (%): 149 (2) [M$^+$], 58 (100).



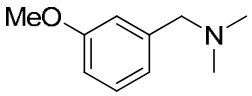
2c

***N,N,*4-trimethylbenzylamine (2c):** 1.2 g, 52% yield. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.19 (d, 2H, *J*=7.2), 7.12 (d, 2H, *J*=7.5), 3.37 (s, 2H), 2.32 (s, 3H), 2.22 (s, 6H) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) 136.5, 135.6, 129.0, 128.9, 64.0, 45.2, 21.0 ppm; IR *v* 2943, 2858, 2766, 1456, 1031, 855, 800 cm^{-1} MS: (m/z) (%): 149 (5) [M^+], 42 (100).



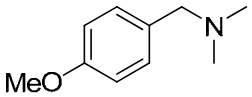
2d

***N,N*-dimethyl(*o*-tolyl)methanamine (2d):** 1.4 g, 65% yield. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.26 (m, 1H), 7.22 (m, 3H), 3.39 (s, 2H), 2.39 (s, 3H), 2.26 (s, 6H) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) 137.2, 137.0, 130.2, 129.8, 126.9, 125.5, 62.0, 45.5, 19.0 ppm; IR *v* 2942, 2855, 2762, 1459, 1021, 741 cm^{-1} MS: (m/z) (%): 149 (6) [M^+], 42 (100).



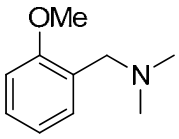
2e

***N,N*-dimethyl-3-methoxylbenzylamine (2e):** 1.1 g, 44% yield. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.18 (t, 1H, *J*=7.8), 6.87-6.85 (m, 2H), 6.78-6.75 (m, 1H), 3.74 (s, 3H), 3.36 (s, 2H), 2.21 (s, 6H) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) 159.4, 140.2, 128.8, 121.0, 113.9, 112.4, 64.0, 54.7, 45.0 ppm; IR *v* 2941, 2815, 2776, 1601, 1586, 1489, 1456, 1361, 1267, 1150, 1043, 866, 840, 783, 745 cm^{-1} MS: (m/z) (%): 166 (100) [$(M+H)^+$].



2f

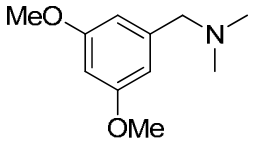
***N,N*-dimethyl-4-methoxylbenzylamine (2f):** 0.9 g, 35% yield. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.18 (d, 2H, *J*=9), 6.82 (d, 2H, *J*=9), 3.76 (s, 3H), 3.32 (s, 2H), 2.18 (s, 6H) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) 158.6, 130.8, 130.2, 113.5, 63.6, 55.1, 45.1 ppm; IR *v* 2942, 2813, 2768, 1511, 1243, 1028, 811 cm^{-1} MS: (m/z) (%): 165 (2) [M^+], 58 (100).



2g

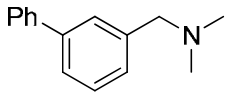
***N,N*-dimethyl-2-methoxylbenzylamine (2g):** 1.3 g, 53% yield. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.22 (m, 2H), 6.87 (m, 2H), 3.80 (s, 3H), 3.43(s, 2H), 2.24 (s, 6H) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) 157.8, 130.7, 128.1,

126.7, 120.0, 110.3, 57.8, 55.3, 45.4 ppm; IR *v* 2960, 2858, 1713, 1255, 1177, 1020, 788 cm^{-1} MS: (m/z) (%): 165 (9) [M+], 58 (100).



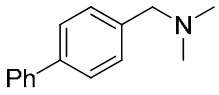
2h

***N*,*N*-dimethyl-3,5-dimethoxylbenzylamine (2h):** 2.6 g, 89% yield. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 6.48 (d, 2H, *J*=2.1), 6.36 (t, 1H, *J*=2.1), 3.79 (s, 6H), 3.36 (s, 2H), 2.24 (s, 6H) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) 160.6, 141.4, 106.6, 99.1, 64.6, 55.3, 45.4 ppm; IR *v* 2941, 2815, 2772, 1597, 1456, 1205, 1153, 1031 cm^{-1} MS: (m/z) (%): 195 (5) [M^+], 152 (100).



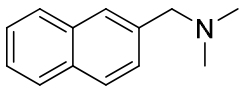
2i

***N*,*N*-dimethyl-3-phenylbenzylamine (2i):** 2.5 g, 78% yield. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.60-7.53 (m, 3H), 7.48-7.45 (m, 1H), 7.41-7.32 (m, 3H), 7.31-7.25 (m, 2H), 3.45 (s, 2H), 2.24 (s, 6H) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) 141.1, 140.9, 139.0, 128.4, 127.8, 127.6, 126.9, 125.6, 64.2, 45.1 ppm; IR *v* 3030, 2944, 2815, 2766, 1599, 1480, 1455, 1360, 1251, 1174, 1146, 1096, 1032, 898, 841, 795, 755, 730, 699 cm^{-1} HRMS: Anal. Calcd. for $C_{15}H_{18}N$ 212.14338, Found: 212.14301.



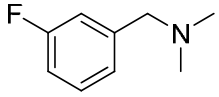
2j

***N*,*N*-dimethyl-4-phenylbenzylamine (2j):** 2.2 g, 69% yield. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.59-7.53 (m, 4H), 7.44-7.31 (m, 5H), 3.45 (s, 2H), 2.26 (s, 6H) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) 140.7, 139.7, 137.6, 129.3, 128.5, 126.9, 126.8, 126.7, 63.8, 45.2 ppm; IR *v* 3028, 2940, 2814, 2768, 1599, 1487, 1456, 1363, 1253, 1174, 1146, 1097, 1032, 859, 813, 759, 736, 697 cm^{-1} HRMS: Anal. Calcd. for $C_{15}H_{18}N$ 212.14338, Found: 212.14308.



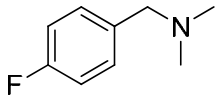
2k

***N*,*N*-dimethyl-2-naphthalenemethanamine (2k):** 0.8 g, 30% yield. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.81-7.78 (m, 3H), 7.71 (s, 1H), 7.48-7.41 (m, 3H), 3.55 (s, 2H), 2.26 (s, 6H) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) 138.3, 128.9, 128.2, 126.9, 61.8, 42.2 ppm; IR *v* 3055, 2941, 2854, 2768, 1455, 1366, 1261, 1031, 894, 814, 752 cm^{-1} MS: (m/z) (%): 185 (60) [M^+], 141 (100).



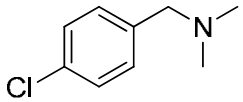
2l

***N,N*-dimethyl-3-fluorobenzylamine (2l):** 1.4 g, 61% yield . ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.24 (m, 1H), 7.03 (m, 2H), 6.88 (m, 1H), 3.38 (s, 2H), 2.21 (s, 6H) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) 164.5, 161.2, 141.6, 141.5, 129.6, 129.5, 124.5, 124.4, 115.8, 115.5, 114.0, 113.7, 63.8, 63.7, 45.3 ppm; IR *v* 2945, 2819, 2775, 1590, 1487, 1455, 1256, 783, 687 cm^{-1} MS: (m/z) (%): 153 (6) [M^{+}], 58 (100).



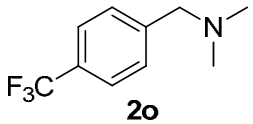
2m

***N,N*-dimethyl-4-fluorobenzylamine (2m):** 1.5 g, 60% yield. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.22 (m, 2H), 6.95 (m, 2H), 3.33 (s, 2H), 2.19 (s, 6H) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) 163.5, 160.3, 134.6, 134.5, 130.5, 130.4, 130.0, 115.0, 114.8, 112.4, 63.5, 45.1 ppm; IR *v* 2925, 2854, 1614, 1525, 1361, 1168, 803.6 cm^{-1} MS: (m/z) (%): 153 (51) [M^{+}], 58 (100).



2n

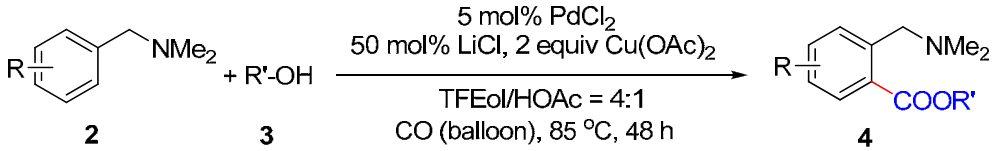
***N,N*-dimethyl-4-chlorobenzylamine (2n):** 1.8 g, 71% yield. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.26 (m, 4H), 3.37 (s, 2H), 2.21(s, 6H) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) 137.4, 132.7, 130.3, 128.3, 63.5, 45.2 ppm; IR *v* 2944, 2817, 2769, 1490, 1086, 1015, 857, 801 cm^{-1} MS: (m/z) (%): 169 (1) [M^{+}], 58 (100).



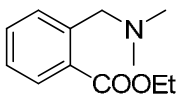
2o

***N,N*-dimethyl-4-(trifluoromethyl)benzylamine (2o):** 1.8 g, 58% yield. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.55 (d, 2H, *J*=8.1), 7.40 (d, 2H, *J*=7.8), 3.44 (s, 2H), 2.21(s, 6H) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) 142.9, 129.4, 125.14, 125.09, 125.04, 124.99, 63.7, 45.3 ppm; IR *v* 1329, 1171, 1129, 1069, 1020, 870, 817 cm^{-1} MS: (m/z) (%): 203 (3) [M^{+}], 58 (100).

***ortho* Carbonylation of Functionalized *N,N*-Dimethylbenzylamines 2 with Alcohol Nucleophiles 3.**



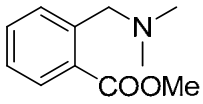
2 **3** **4**



4aa

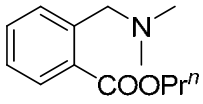
ethyl 2-((dimethylamino)methyl)benzoate (4aa): 66.4 mg, 64% yield. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.76 (d, 1H, *J*=7.5), 7.42 (m, 2H), 7.32 (m, 1H), 4.33 (q, 2H, *J*=7.2), 3.72 (s, 2H), 2.22 (s, 6H), 1.38 (t, 3H, *J*=7.2) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) 168.3, 140.0, 131.2, 131.1, 130.0, 129.7, 126.7, 61.5, 60.8, 45.4, 14.2 ppm; IR *v*

2978, 2943, 2817, 2769, 1719, 1602, 1456, 1366, 1246, 1174, 1126, 1080, 1027, 846, 743 cm^{-1} MS: (m/z) (%): 207 (30) [M^+], 178 (100).



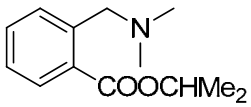
4ab

methyl 2-((dimethylamino)methyl)benzoate (4ab): 45.8 mg, 47% yield. ^1H NMR ($CDCl_3$, 300 MHz) δ 7.80-7.77 (m, 1H), 7.48-7.41 (m, 2H), 7.34-7.29 (m, 1H), 3.90 (s, 3H), 3.72 (s, 2H), 2.23 (s, 6H) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) 168.8, 140.3, 131.2, 130.1, 129.9, 126.8, 61.7, 51.9, 45.5 ppm; IR *v* 2951, 2777, 1719, 1613, 1454, 1372, 1272, 1126, 1084, 956, 806, 752 cm^{-1} HRMS: Anal. Calcd. for $C_{11}H_{16}NO_2$ 194.11756, Found: 194.11761.



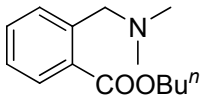
4ac

propyl 2-((dimethylamino)methyl)benzoate (4ac): 55.7 mg, 50% yield. ^1H NMR ($CDCl_3$, 300 MHz) δ 7.78-7.76 (m, 1H), 7.49-7.41 (m, 2H), 7.32-7.27 (m, 1H), 4.25 (t, 2H, *J*=6.6), 3.73 (s, 2H), 2.23 (s, 6H), 1.85-1.73 (m, 2H), 1.03 (t, 3H, *J*=7.4) ppm; ^{13}C NMR ($CDCl_3$, 50 MHz) 168.3, 140.1, 131.4, 131.0, 130.0, 129.7, 126.7, 66.4, 61.5, 45.4, 22.0, 10.5 ppm; IR *v* 2969, 2771, 1716, 1600, 1458, 1376, 1261, 1126, 1081, 939, 753 cm^{-1} HRMS: Anal. Calcd. for $C_{13}H_{20}NO_2$ 222.14886, Found: 222.14858.



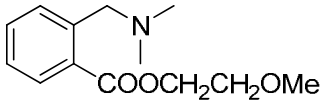
4ad

isopropyl 2-((dimethylamino)methyl)benzoate (4ad): 47.0 mg, 42% yield. ^1H NMR ($CDCl_3$, 300 MHz) δ 7.74-7.71 (m, 1H), 7.48-7.39 (m, 2H), 7.31-7.26 (m, 1H), 5.29-5.17 (m, 1H), 3.73 (s, 2H), 2.22 (s, 6H), 1.37 (d, 6H, *J*=6.0) ppm; ^{13}C NMR ($CDCl_3$, 50 MHz) 167.8, 139.9, 131.9, 130.9, 130.0, 129.5, 126.6, 68.2, 61.4, 45.4, 21.8 ppm; IR *v* 2979, 2773, 1711, 1601, 1466, 1374, 1267, 1107, 1080, 919, 846, 748 cm^{-1} HRMS: Anal. Calcd. for $C_{13}H_{20}NO_2$ 222.14886, Found: 222.14822.



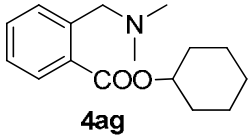
4ae

butyl 2-((dimethylamino)methyl)benzoate (4ae): 75.9 mg, 65% yield. ^1H NMR ($CDCl_3$, 300 MHz) δ 7.78-7.76 (m, 1H), 7.48-7.41 (m, 2H), 7.33-7.27 (m, 1H), 4.30 (t, 2H, *J*=6.6), 3.73 (s, 2H), 2.23 (s, 6H), 1.79-1.70 (m, 2H), 1.54-1.41 (m, 2H), 0.97 (t, 3H, *J*=7.4) ppm; ^{13}C NMR ($CDCl_3$, 50 MHz) 168.3, 140.1, 131.3, 131.0, 130.0, 129.7, 126.7, 64.7, 61.5, 45.4, 30.7, 19.2, 13.7 ppm; IR *v* 2959, 2872, 2817, 2770, 1719, 1602, 1457, 1364, 1274, 1246, 1126, 1080, 1029, 961, 844, 741 cm^{-1} HRMS: Anal. Calcd. for $C_{14}H_{22}NO_2$ 236.16451, Found: 236.16459.



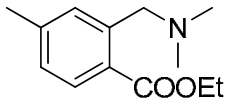
4af

2-methoxyethyl 2-((dimethylamino)methyl)benzoate (4af): 55.1 mg, 46% yield. ^{1}H NMR ($CDCl_3$, 300 MHz) *δ* 7.81-7.78 (m, 1H), 7.48-7.41 (m, 2H), 7.32-7.28 (m, 1H), 4.46-4.42 (m, 2H), 3.74-3.70 (m, 4H), 3.42 (s, 3H), 2.23 (s, 6H) ppm; ^{13}C NMR ($CDCl_3$, 50 MHz) 168.2, 140.2, 131.2, 130.9, 130.0, 129.9, 126.7, 70.4, 63.8, 61.5, 58.9, 45.4 ppm; IR *v* 2944, 2777, 1718, 1600, 1452, 1368, 1262, 1200, 1122, 1081, 1027, 866, 752 cm^{-1} HRMS: Anal. Calcd. for $C_{13}H_{20}NO_3$ 238.14377, Found: 238.14315.



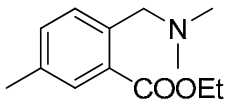
4ag

cyclohexyl 2-((dimethylamino)methyl)benzoate (4ag): 48.8 mg, 37% yield. ^{1}H NMR ($CDCl_3$, 300 MHz) *δ* 7.77-7.74 (m, 1H), 7.50-7.40 (m, 2H), 7.31-7.27 (m, 1H), 5.04-4.96 (m, 1H), 3.75 (s, 2H), 2.23 (s, 6H), 2.01-1.95 (m, 2H), 1.81-1.77 (m, 2H), 1.63-1.29 (m, 6H) ppm; ^{13}C NMR ($CDCl_3$, 50 MHz) 167.6, 139.9, 130.9, 129.9, 129.6, 126.6, 73.1, 61.3, 45.5, 31.6, 25.4, 23.7 ppm; IR *v* 2937, 2856, 2816, 2769, 1714, 1601, 1449, 1364, 1247, 1121, 1080, 1015, 942, 891, 842, 742 cm^{-1} HRMS: Anal. Calcd. for $C_{16}H_{24}NO_2$ 262.18016, Found: 262.17957.



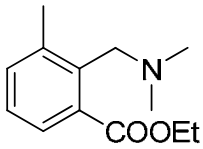
4ba

ethyl 2-((dimethylamino)methyl)-4-methylbenzoate (4ba): 75.3 mg, 68% yield. ^{1}H NMR ($CDCl_3$, 300 MHz) *δ* 7.71 (d, 1H, *J*=7.8), 7.30 (s, 1H), 7.09 (d, 1H, *J*=7.8), 4.33 (q, 2H, *J*=7.2), 3.72 (s, 2H), 2.37 (s, 3H), 2.24 (s, 6H), 1.38 (t, 3H, *J*=7.2) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) 168.1, 141.7, 140.3, 130.7, 130.1, 128.0, 127.3, 61.4, 60.6, 45.5, 21.4, 14.2 ppm; IR *v* 2977, 2941, 2817, 2769, 1719, 1612, 1455, 1365, 1275, 1249, 1133, 1081, 1031, 836, 773 cm^{-1} HRMS: Anal. Calcd. for $C_{13}H_{20}NO_2$ 222.14886, Found: 222.14861.



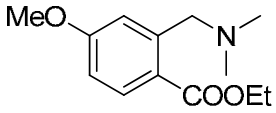
4ca

ethyl 2-((dimethylamino)methyl)-5-methylbenzoate (4ca): 80.1 mg, 72% yield. ^{1}H NMR ($CDCl_3$, 300 MHz) *δ* 7.58 (s, 1H), 7.32 (d, 1H, *J*=8.4), 7.23 (d, 1H, *J*=8.4), 4.35 (q, 2H, *J*=7.2), 3.67 (s, 2H), 2.36 (s, 3H), 2.21 (s, 6H), 1.39 (t, 3H, *J*=7.2) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) 168.5, 136.9, 136.4, 131.8, 131.1, 130.3, 130.2, 61.2, 60.6, 45.2, 20.8, 14.2 ppm; IR *v* 2942, 2814, 2768, 1718, 1591, 1457, 1366, 1286, 1196, 1080, 1026, 951, 854, 832, 811 cm^{-1} HRMS: Anal. Calcd. for $C_{13}H_{20}NO_2$ 222.14886, Found: 222.14835.



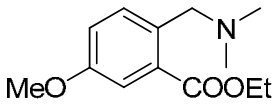
4da

ethyl 2-((dimethylamino)methyl)-3-methylbenzoate (4da): 57.3 mg, 52% yield. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.40 (d, 1H, *J*=5.7), 7.18 (m, 2H), 4.33 (q, 2H, *J*=7.5), 3.63 (s, 2H), 2.39 (s, 3H), 2.16 (s, 6H), 1.39 (t, 3H, *J*=7.2) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) 169.9, 137.7, 136.8, 133.8, 132.3, 126.5, 126.4, 60.7, 56.5, 45.0, 20.0, 14.2 ppm; IR *v* 2968, 1719, 1610, 1577, 1458, 1365, 1281, 1129, 1034, 957, 851, 765 cm^{-1} HRMS: Anal. Calcd. for $C_{13}H_{20}NO_2$ 222.14834, Found: 222.14886.



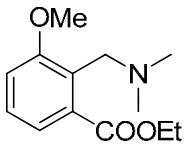
4ea

ethyl 2-((dimethylamino)methyl)-4-methoxybenzoate (4ea): 90.6 mg, 76% yield. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.86 (d, 1H, *J*=8.7), 7.12 (s, 1H), 6.78 (d, 1H, *J*=5.4), 4.32 (q, 2H, *J*=6.9), 3.85 (s, 3H), 3.78 (s, 2H), 2.26 (s, 6H), 1.37 (t, 3H, *J*=7.2) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) 167.2, 162.0, 143.4, 132.4, 122.5, 115.0, 111.6, 61.5, 60.3, 55.2, 45.6, 14.2 ppm; IR *v* 2941, 2771, 1708, 1603, 1572, 1465, 1365, 1252, 1148, 1127, 1086, 1039, 876, 843, 777 cm^{-1} HRMS: Anal. Calcd. for $C_{13}H_{20}NO_3$ 238.14377, Found: 238.14391.



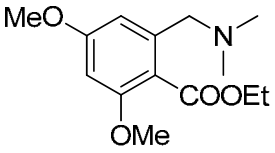
4fa

ethyl 2-((dimethylamino)methyl)-5-methoxybenzoate (4fa): 64.8 mg, 55% yield. ^{1}H NMR ($CDCl_3$, 200 MHz) δ 7.34-7.28 (m, 2H), 6.98-6.92 (m, 1H), 4.34 (q, 2H, *J*=7.1), 3.81 (s, 3H), 3.63 (s, 2H), 2.19 (s, 6H), 1.37 (t, 3H, *J*=6.9) ppm; ^{13}C NMR ($CDCl_3$, 50 MHz) 168.1, 158.2, 132.3, 131.9, 131.4, 116.7, 114.8, 60.9, 60.8, 55.3, 45.2, 14.1 ppm; IR *v* 2941, 2816, 2767, 1719, 1611, 1513, 1458, 1366, 1281, 1244, 1225, 1181, 1074, 1027, 855, 815 cm^{-1} HRMS: Anal. Calcd. for $C_{13}H_{20}NO_3$ 238.14377, Found: 238.14331.



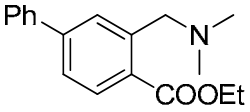
4ga

ethyl 2-((dimethylamino)methyl)-3-methoxybenzoate (4ga): 58.1 mg, 49% yield. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.29-7.23 (m, 2H), 6.99-6.96 (m, 1H), 4.33 (q, 2H, *J*=7.2), 3.83 (s, 3H), 3.72 (s, 2H), 2.18 (s, 6H), 1.37 (t, 3H, *J*=7.1) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) 168.0, 158.1, 132.2, 131.9, 130.1, 116.6, 114.7, 60.9, 58.7, 55.2, 45.2, 14.1 ppm; IR *v* 2939, 1715, 1587, 1466, 1366, 1279, 1159, 1129, 1059, 951, 863, 759, 733 cm^{-1} HRMS: Anal. Calcd. for $C_{13}H_{20}NO_3$ 238.14377, Found: 238.14361.



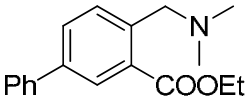
4ha

ethyl 2-((dimethylamino)methyl)-4,6-dimethoxybenzoate (4ha): 66.8 mg, 50% yield. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 6.50 (d, 1H, *J*=2.4), 6.37 (d, 1H, *J*=2.1), 4.33 (q, 2H, *J*=7.1), 3.81 (s, 3H), 3.80 (s, 3H), 3.40 (s, 2H), 2.18 (s, 6H), 1.35 (t, 3H, *J*=6.9) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) 168.0, 161.2, 158.0, 140.0, 116.5, 105.3, 97.4, 61.9, 60.7, 55.8, 55.4, 45.2, 14.1 ppm; IR *v* 2942, 2817, 2772, 1725, 1605, 1257, 1157, 1098, 861 cm^{-1} HRMS: Anal. Calcd. for $C_{13}H_{20}NO_3$ 268.15433, Found: 268.15386.



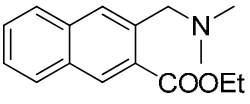
4ia

ethyl 3-((dimethylamino)methyl)biphenyl-4-carboxylate (4ia): 110.1 mg, 78% yield. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.87 (d, 1H, *J*=7.8), 7.71 (m, 1H), 7.64-7.60 (m, 2H), 7.53-7.50 (m, 1H), 7.47-7.42 (m, 2H), 7.39-7.36 (m, 1H), 4.36 (q, 2H, *J*=7.1), 3.80 (s, 2H), 2.26 (s, 6H), 1.39 (t, 3H, *J*=7.2) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) 168.0, 143.9, 140.8, 140.1, 130.6, 130.4, 129.8, 128.8, 127.8, 127.2, 125.3, 61.7, 60.8, 45.5, 14.2 ppm; IR *v* 2975, 2937, 2818, 2769, 1718, 1608, 1456, 1365, 1249, 1136, 1086, 1031, 847, 757 cm^{-1} HRMS: Anal. Calcd. for $C_{18}H_{22}NO_2$ 284.16451, Found: 284.16507.



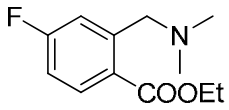
4ja

ethyl 4-((dimethylamino)methyl)biphenyl-3-carboxylate (4ja): 66.9 mg, 47% yield. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 8.02 (d, 1H, *J*=2.1), 7.70-7.66 (m, 1H), 7.65-7.61 (m, 2H), 7.57-7.54 (m, 1H), 7.49-7.44 (m, 2H), 7.41-7.38 (m, 1H), 4.40 (q, 2H, *J*=7.2), 3.78 (s, 2H), 2.27 (s, 6H), 1.42 (t, 3H, *J*=7.1) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) 168.3, 140.0, 139.8, 139.0, 131.7, 130.6, 129.6, 128.8, 128.5, 127.5, 127.0, 61.3, 61.0, 45.5, 14.3 ppm; IR *v* 2925, 2853, 2817, 2767, 1719, 1600, 1457, 1366, 1305, 1237, 1081, 1027, 860, 760 cm^{-1} HRMS: Anal. Calcd. for $C_{18}H_{22}NO_2$ 284.16451, Found: 284.16497.



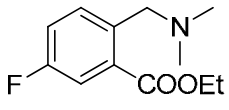
4ka

ethyl 3-((dimethylamino)methyl)-2-naphthoate (4ka): 88.7 mg, 69 % yield. ^{1}H NMR ($CDCl_3$, 200 MHz) δ 8.29 (s, 1H), 7.84 (m, 3H), 7.49 (m, 2H), 4.40 (q, 2H, *J*=7.0), 3.84 (s, 2H), 2.24 (s, 6H), 1.42 (t, 3H, *J*=7.0) ppm; ^{13}C NMR ($CDCl_3$, 50 MHz) 168.4, 136.0, 134.2, 131.6, 130.6, 128.6, 128.4, 127.7, 127.4, 127.3, 126.1, 62.1, 60.9, 45.4, 14.2 ppm; IR *v* 2975, 2941, 2854, 2816, 2769, 1718, 1465, 1366, 1279, 1263, 1201, 1131, 1061, 897, 852, 781, 754 cm^{-1} HRMS: Anal. Calcd. for $C_{16}H_{20}NO_2$ 258.14825, Found: 258.14886.



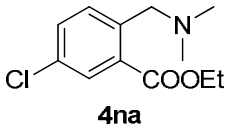
4la

ethyl 2-((dimethylamino)methyl)-4-fluorobenzoate (4la): 45.1 mg, 40% yield. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.86-7.81 (m, 1H), 7.31-7.24 (m, 1H), 6.98-6.91 (m, 1H), 4.32 (q, 2H, *J*=7.1), 3.73 (s, 2H), 2.23 (s, 6H), 1.36 (t, 3H, *J*=7.2) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) 167.0, 166.3, 162.9, 155.5, 144.4, 132.6, 132.5, 130.5, 116.7, 116.4, 113.6, 113.3, 61.2, 60.9, 45.6, 14.2 ppm; IR *v* 2929, 2858, 2819, 2772, 1723, 1612, 1589, 1456, 1366, 1253, 1173, 1111, 1079, 1031, 962, 837, 775 cm^{-1} HRMS: Anal. Calcd. for $C_{12}H_{17}FNO_2$ 226.12378, Found: 226.12345.



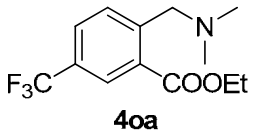
4ma

ethyl 2-((dimethylamino)methyl)-5-fluorobenzoate (4ma): 33.8 mg, 30% yield. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.47-7.39 (m, 2H), 7.14-7.07 (m, 1H), 4.33 (q, 2H, *J*=7.2), 3.65 (s, 2H), 2.18 (s, 6H), 1.36 (t, 3H, *J*=7.1) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) 167.0, 162.8, 159.5, 136.0, 135.9, 132.8, 132.7, 131.8, 131.7, 118.0, 117.7, 116.9, 116.6, 61.1, 60.8, 45.3, 14.1 ppm; IR *v* 2926, 2855, 1722, 1601, 1578, 1469, 1419, 1373, 1301, 1273, 1231, 1126, 1070, 935, 789 cm^{-1} HRMS: Anal. Calcd. for $C_{12}H_{17}FNO_2$ 226.12378, Found: 226.12334.



4na

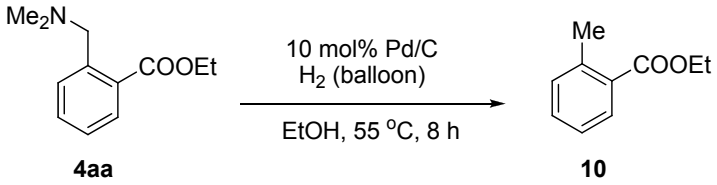
ethyl 2-((dimethylamino)methyl)-5-chlorobenzoate (4na): 43.5 mg, 36% yield. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.75 (m, 1H), 7.41-7.40 (m, 2H), 4.35 (q, 2H, *J*=7.1), 3.68 (s, 2H), 2.21 (s, 6H), 1.38 (t, 3H, *J*=7.2) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) 166.9, 138.8, 132.6, 131.3, 131.0, 130.3, 128.3, 63.5, 60.9, 45.4, 14.1 ppm; IR *v* 2928, 2854, 2818, 2771, 1725, 1594, 1563, 1457, 1366, 1286, 1240, 1137, 1107, 1077, 1027, 896, 853, 782 cm^{-1} HRMS: Anal. Calcd. for $C_{12}H_{17}{}^{35}ClNO_2$ 242.09423, Found: 242.09398.



4oa

ethyl 2-((dimethylamino)methyl)-5-trifluoromethylbenzoate (4oa): 30.3 mg, 22% yield. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 8.03 (s, 1H), 7.72-7.65 (m, 2H), 4.39 (q, 2H, *J*=7.2), 3.78 (s, 2H), 2.24 (s, 6H), 1.41 (t, 3H, *J*=7.1) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) 167.0, 144.5, 131.9, 130.3, 129.1, 127.6, 126.7, 125.1, 63.8, 61.3, 45.5, 14.2 ppm; IR *v* 2927, 2857, 1720, 1628, 1601, 1463, 1377, 1326, 1259, 1171, 1127, 1097, 1020, 952, 833, 811, 747 cm^{-1} HRMS: Anal. Calcd. for $C_{13}H_{17}F_3NO_2$ 276.12059, Found: 276.12028.

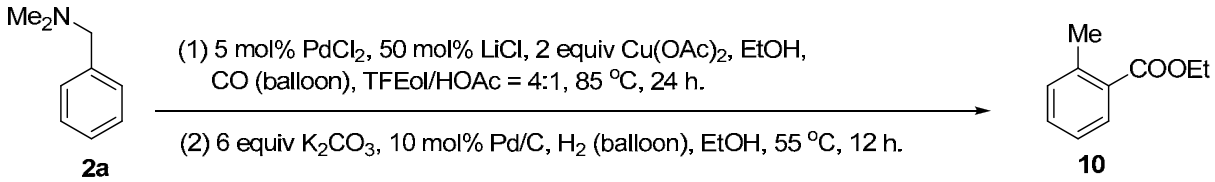
Procedures for the Hydrogenation of Functionalized *N*,*N*-Dimethylbenzylamine to Ethyl 2-Methylbenzoate (10).



4aa **10**

A mixture of ethyl 2-((dimethylamino)methyl)benzoate **4aa** (103.6 mg, 0.5 mmol) and Pd/C catalyst (5 wt% Pd, 106.4 mg, 0.05 mmol) in EtOH (6 mL) was stirred under H_2 at balloon pressure at 55 °C for 8 h. After the catalyst was filtered, the filtrate was evaporated to get the desired product **10** (73.6 mg, 90% yield) as a colorless oil without further purification.

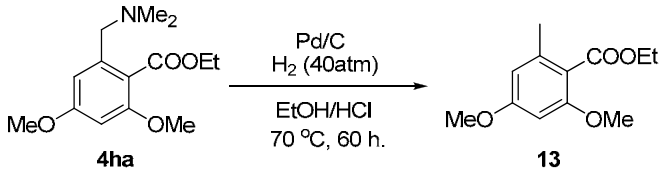
Procedures for the Transformation from *N*,*N*-Dimethylbenzylamine to Ethyl 2-Methylbenzoate (10) in One Pot.



2a **10**

$PdCl_2$ (4.4 mg, 0.025 mmol), LiCl (10.6 mg, 0.25 mmol), $Cu(OAc)_2$ (181.6 mg, 1.0 mmol), and TFEol (2 mL) were added into a Schlenk tube. Then *N*,*N*-dimethylbenzylamine **2a** (67.6 mg, 0.5 mmol) was added, followed by ethanol (1 mL) and HOAc (0.5 mL, 8.0 mmol). The tube was stoppered and heated at 85 °C in an oil bath for 24 h. After that, the reaction mixture was cooled to room temperature and K_2CO_3 (414.6 mg, 3.0 mmol), Pd/C (5 wt% Pd, 106.4 mg, 0.05 mmol), and additional EtOH (2 mL) were added. The mixture was stirred at 55 °C under H_2 at balloon pressure for 12 h. The mixture was neutralized and the solid (Pd/C and Cu) was filtered. The inorganic phase was extracted by CH_2Cl_2 three times. The organic layers were combined, dried over Na_2SO_4, evaporated, and purified by flash chromatography with petroleum ether/EtOAc (10:1) to give the product **10** (33.3 mg, 41% yield) as a colorless oil. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.92-7.89 (m, 1H), 7.39-7.33 (m, 1H), 7.24-7.19 (m, 2H), 4.34 (q, 2H, *J*=7.2), 2.59 (s, 3H), 1.37 (t, 3H, *J*=7.2) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) 167.5, 139.8, 131.7, 131.5, 130.3, 129.8, 125.5, 60.5, 21.6, 14.2 ppm; MS: (m/z) (%): 165 (100) [$(M+H)^+$].

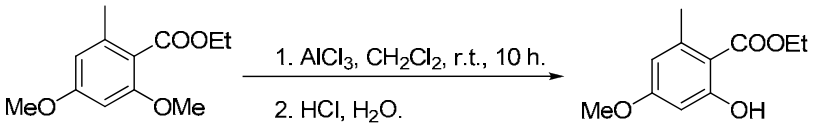
Procedures for the Synthesis of Two Molecular Segments 11 and 12 of Variolaric Acid.



4ha **13**

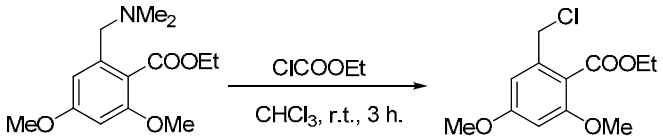
ethyl 2,4-dimethoxy-6-methylbenzoate (13): 4ha (179.6 mg, 0.67 mmol) and Pd/C catalyst (5 wt% Pd, 284.0 mg, 0.13 mmol) were added to the mixture of EtOH/HCl (6 mL, 1000:1). The mixture was stirred under H_2 at 40 atm at 70 °C for 60 h. After the catalyst was filtered, the filtrate was evaporated to get the crude product. Further purification by flash chromatography on silica gel with petroleum ether/EtOAc (10:1) afforded the corresponding product **13** (105.2 mg, 70% yield) as a white solid. ^{1}H NMR ($CDCl_3$, 300

MHz) δ 6.31 (s, 2H), 4.36 (q, 2H, *J*=6.9), 3.79 (s, 6H), 2.29 (s, 3H), 1.36 (t, 3H, *J*=7.2) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) 168.2, 161.2, 158.1, 138.0, 116.7, 106.6, 96.2, 60.9, 55.8, 55.3, 19.8, 14.2 ppm; IR *v* 2942, 2842, 1724, 1605, 1265, 1159, 1097, 830 cm^{-1} MS: (m/z) (%): 224 (36) [M$^+$], 179 (100).



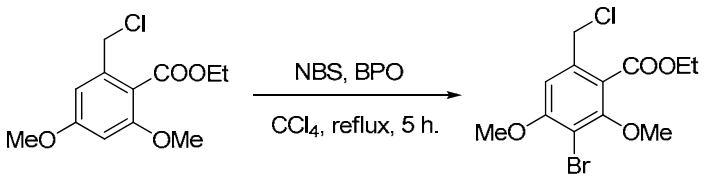
13 **11**

ethyl 2-hydroxy-4-methoxy-6-methylbenzoate (11): Under the protection of N_2, $AlCl_3$ (549 mg, 4.13 mmol) and CH_2Cl_2 (3 mL) were added to a Schlenk tube. After stirred at room temperature for 20 minutes, the mixture of **13** (309.4 mg, 1.38 mmol) and CH_2Cl_2 (12 mL) was added, then the resulting mixture was stirred at room temperature for another 10 h. The reaction was quenched by pouring the mixture into cooled HCl solution (56 mL, 1:1), followed by adding CH_2Cl_2 (55 mL). The organic phase was extracted with CH_2Cl_2 twice, dried over Na_2SO_4 and then evaporated in vacuo. Further purification by flash chromatography on silica gel with petroleum ether/EtOAc (15:1) afforded the corresponding product **11** (223.4 mg, 77% yield) as a white solid. m.p. 75-77 □. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 11.86 (s, 1H), 6.33 (d, 1H, *J*=2.4), 6.28 (m, 1H), 4.39 (q, 2H, *J*=7.1), 3.79 (s, 3H), 2.51 (s, 3H), 1.41 (t, 3H, *J*=7.1) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) 171.7, 165.6, 163.8, 143.1, 111.1, 105.3, 98.7, 61.2, 55.2, 24.4, 14.2 ppm; IR *v* 2925, 2855, 1652, 1261, 1163, 844 cm^{-1} MS: (m/z) (%): 211 (5) [M$^+$], 164 (100).



4ha **14**

ethyl 2-chloromethyl-4,6-dimethoxybenzoate (14): To a solution of **4ha** (328.4 mg, 1.23 mmol) and chloroform (2 mL), ethyl chloroformate (235.0 mg, 2.17 mmol) was added dropwisely at 0 ℃. The resulting mixture was stirred for 15 minutes and then warm to room temperature for another 3 h, after that water (2 mL) was added to quench the reaction. The organic phase was extracted with CH_2Cl_2 three times, dried over K_2CO_3 and then evaporated in vacuo. Further purification by flash chromatography on silica gel with petroleum ether/EtOAc (20:1) afforded the corresponding product **14** (200.5 mg, 63% yield) as a colorless oil. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 6.55 (d, 1H, *J*=2.4), 6.44 (d, 1H, *J*=2.4), 4.61 (s, 2H), 4.40 (q, 2H, *J*=7.2), 3.83 (s, 3H), 3.82 (s, 3H), 1.39 (t, 3H, *J*=7.2) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) 166.8, 161.6, 158.6, 137.6, 115.9, 106.1, 98.8, 85.2, 61.2, 56.0, 55.4, 43.7, 14.1 ppm; IR *v* 2976, 2843, 1722, 1605, 1465, 1058 cm^{-1} MS: (m/z) (%): 258 (52) [M$^+$], 213 (100); HRMS: Anal. Calcd. for $C_{12}H_{15}O_4{}^{35}Cl$ 258.06523, Found: 258.06589.



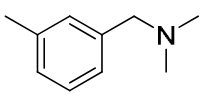
14 **12**

ethyl 3-bromo-6-chloromethyl-2,4-dimethoxybenzoate (12): To a Schlenk tube, **14** (42.1 mg, 0.16 mmol), carbon tetrachloride (1.6 mL), *N*-bromosuccinimide (NBS, 42.7 mg, 0.24 mmol) and benzoyl peroxide (BPO, 3.9 mg, 0.016 mmol) were added. The resulting mixture was heated to reflux at 91 ℃ for 5 h, and then cooled to room temperature. The suspension was filtered, and the solid was washed with carbon tetrachloride three times. The combinition of filtrate was evaporated in vacuo. Further purification by flash chromatography on silica gel with petroleum ether/EtOAc (10:1) afforded the corresponding product **12** (42.7 mg, 79% yield) as a white solid. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 6.48 (s, 1H), 4.77 (s, 2H), 4.42 (q, 2H, *J*=7.1), 3.92 (s, 3H), 3.87 (s, 3H), 1.40 (t, 3H, *J*=7.2) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) 166.4, 157.9, 157.2, 135.8, 118.1, 105.8, 96.6, 61.7, 56.5, 56.3, 42.9, 14.1 ppm; IR *v* 2976, 2936, 2839, 1724, 1589, 1333, 1254, 1211, 1076 cm^{-1} MS: (m/z) (%) 338 (100) [M^+]; HRMS: Anal. Calcd. for $C_{12}H_{14}O_4{}^{35}Cl^{79}Br$ 335.97640, Found: 335.97537.

References

1. Cope, A. C.; Friedrich, E. C. *J. Am. Chem. Soc*. **1968**, *90*, 909.
2. Jones, F. N.; Zinn, M. F.; Hauser, C. R. *J. Org. Chem*. **1963**, *28*, 663.
3. Cai, G.; Fu, Y.; Li, Y.; Wan, X.; Shi, Z. *J. Am. Chem. Soc.* **2007**, *129*, 7666.

NMR Spectra of Products



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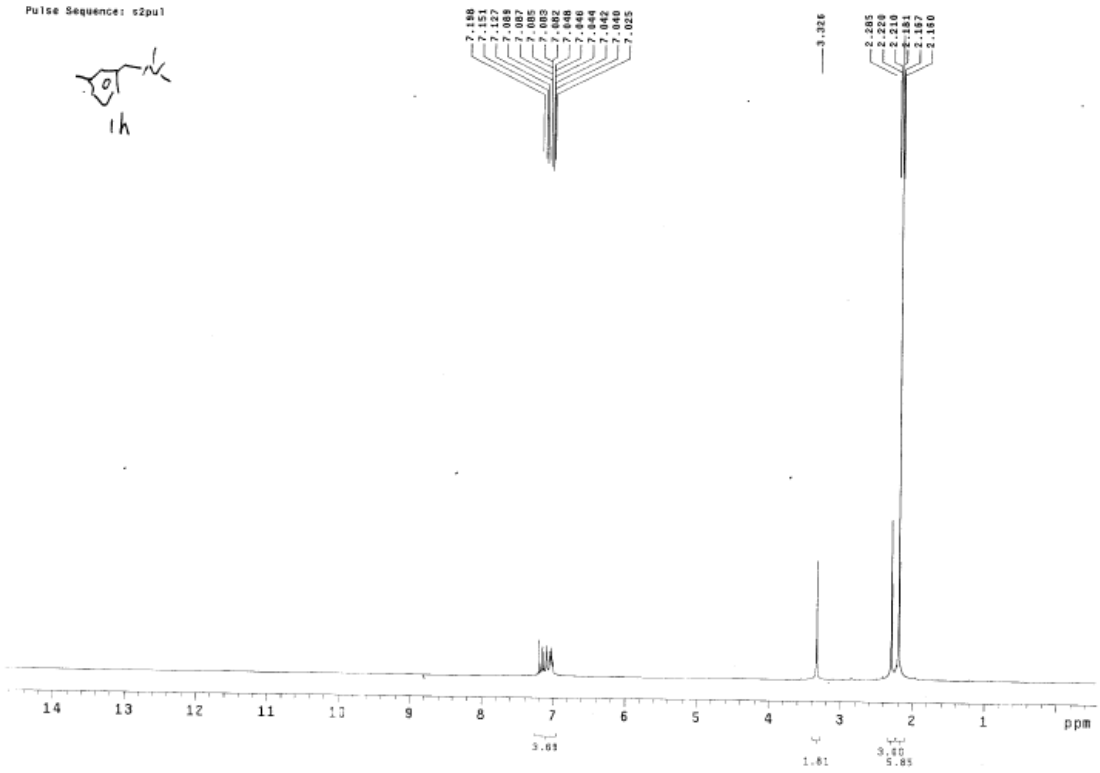

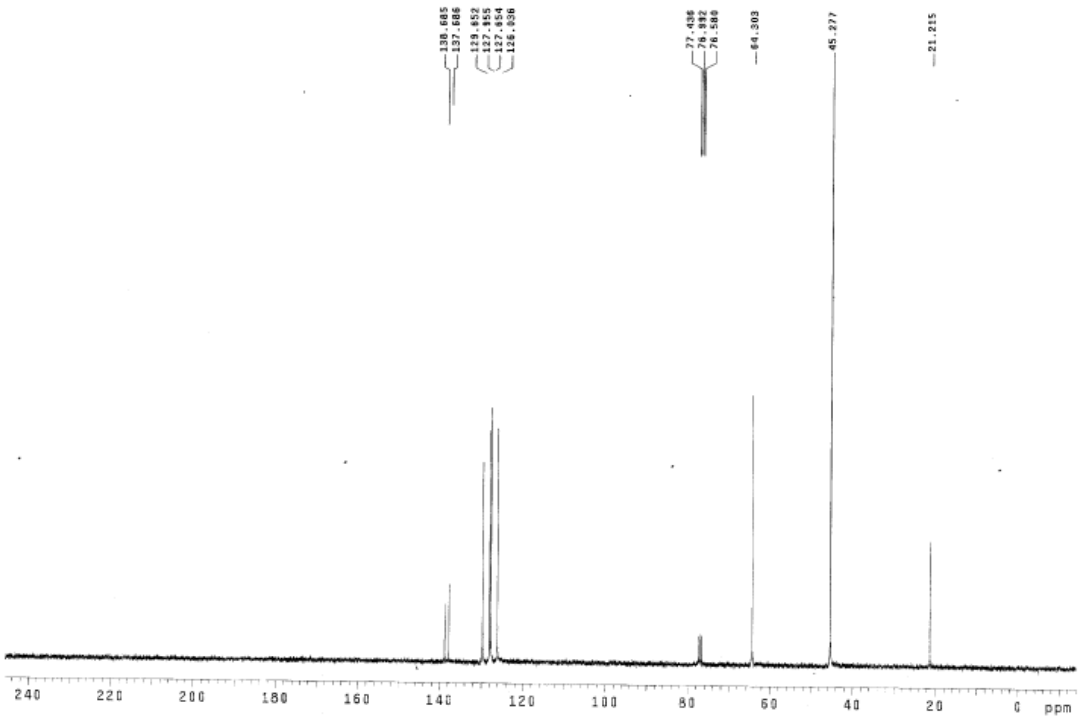

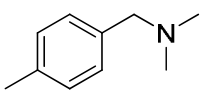

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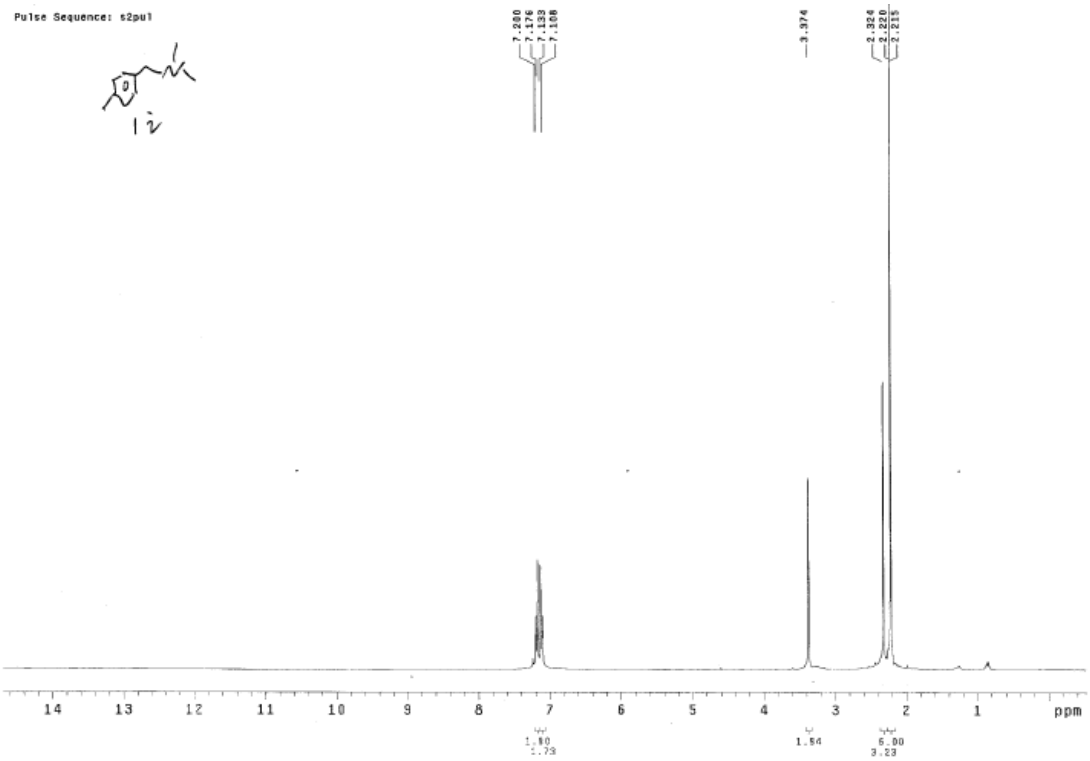
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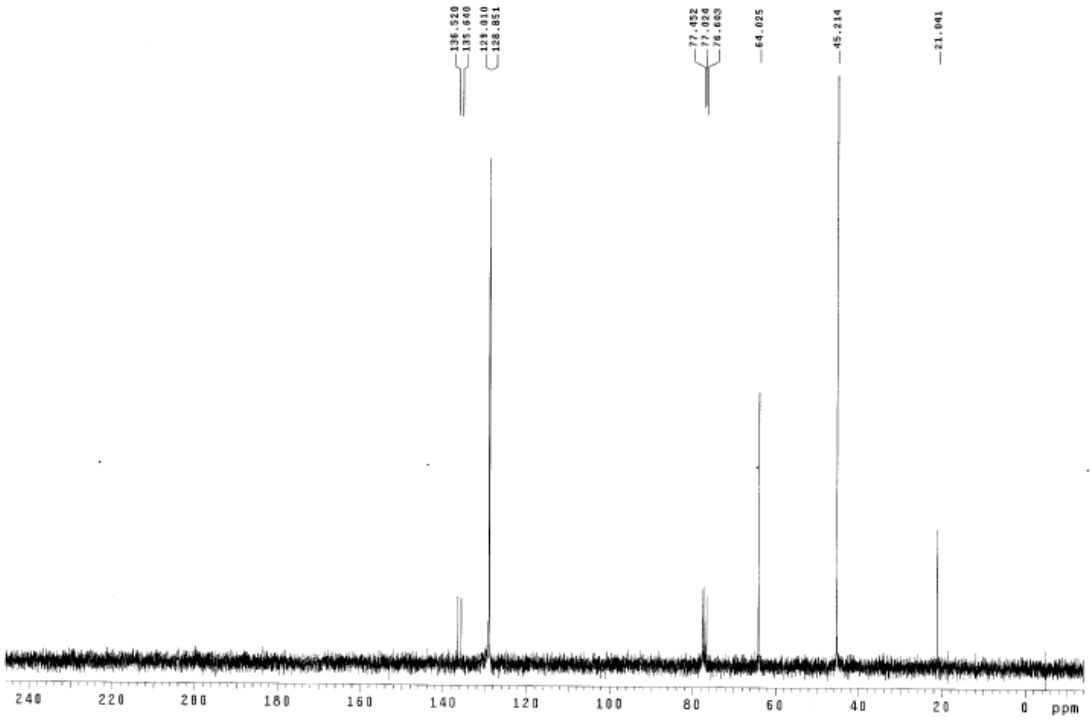
3.23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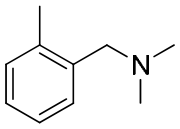

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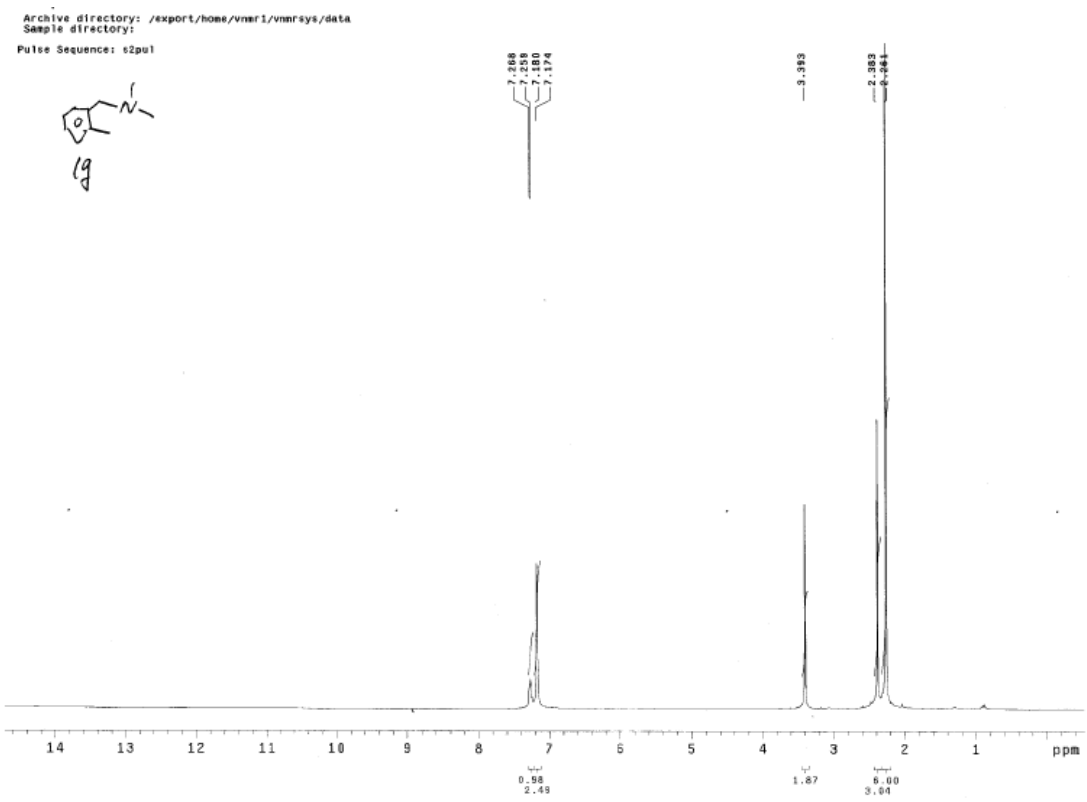
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5
4
3
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1
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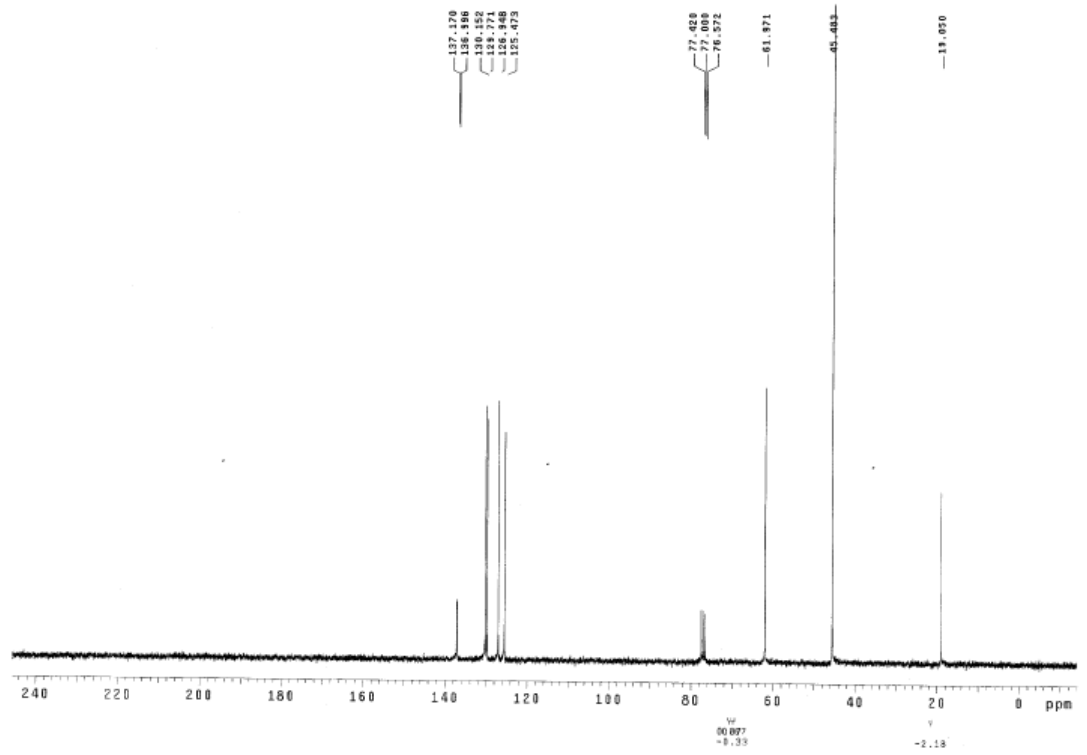
6.00
3.04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140
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20
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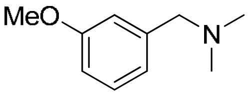

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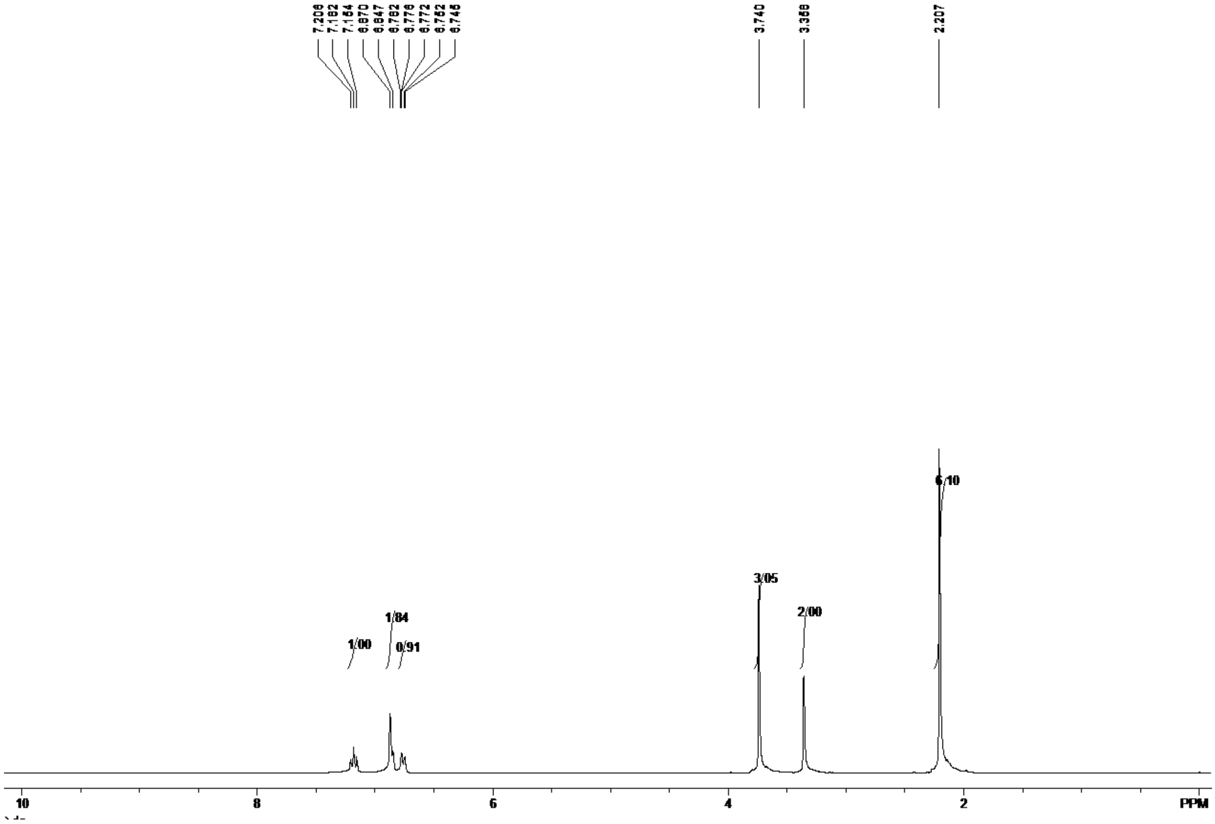

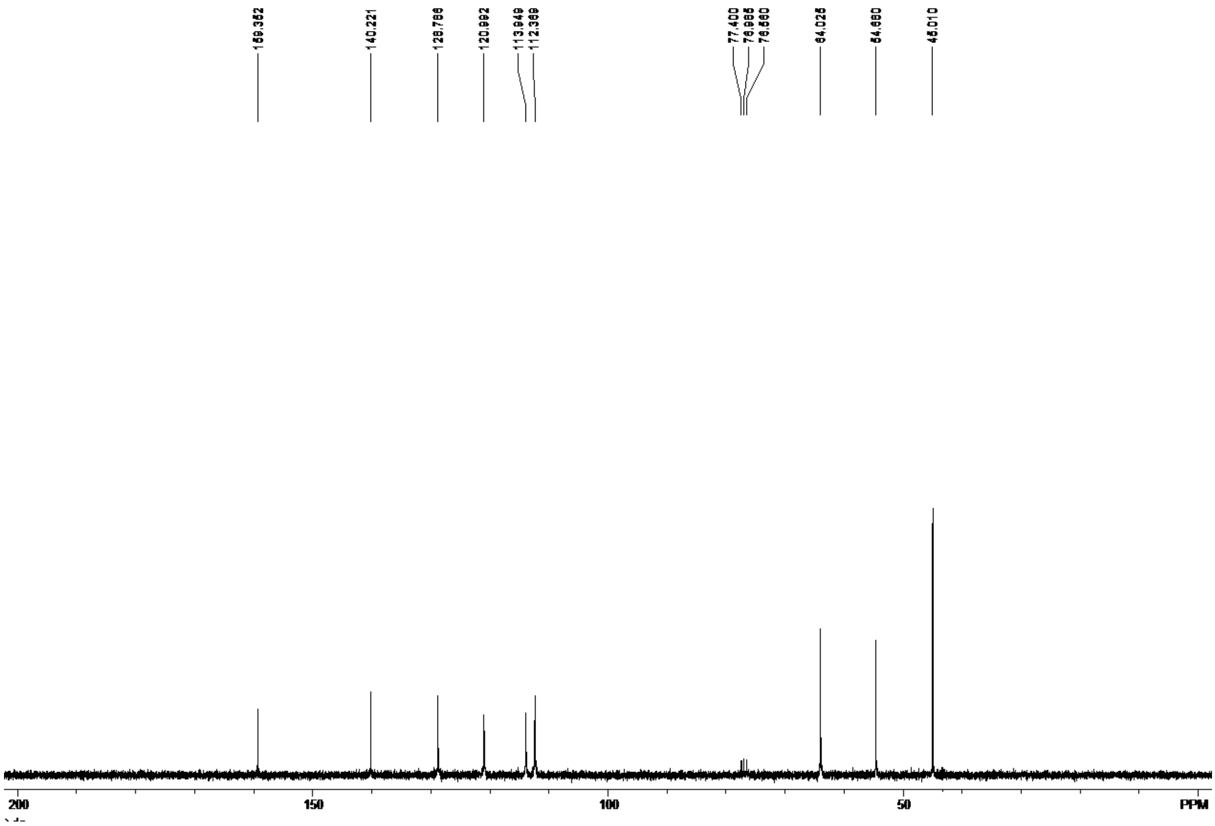

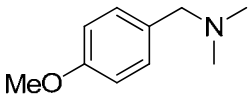
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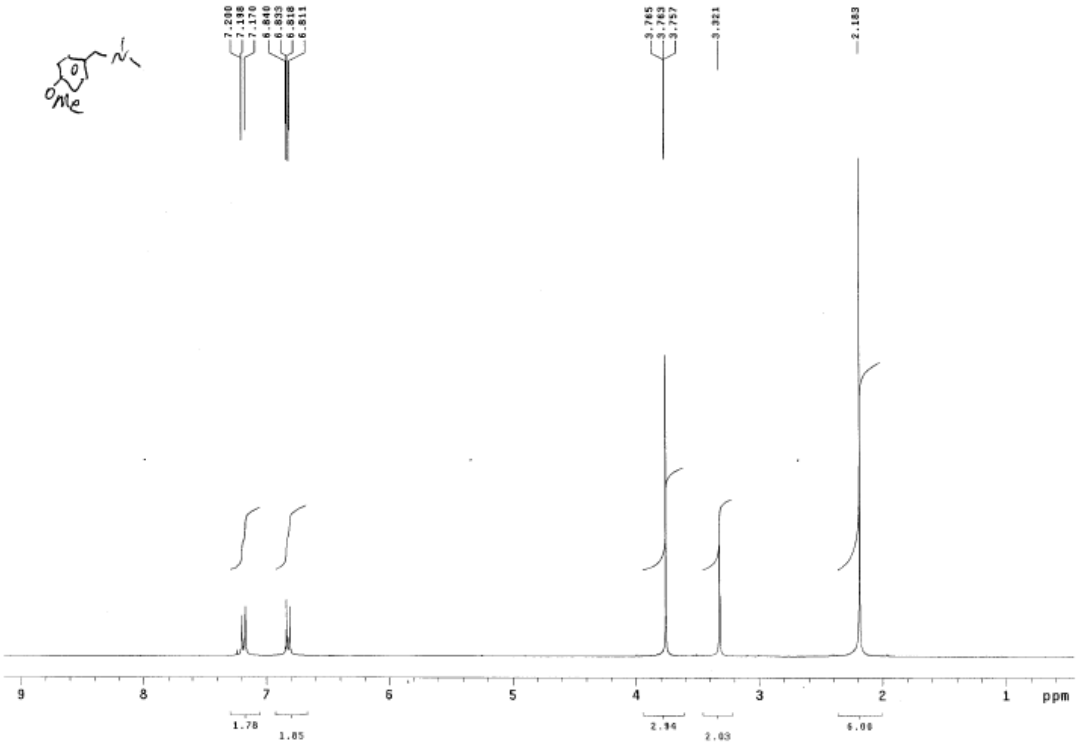
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7
6
5
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3
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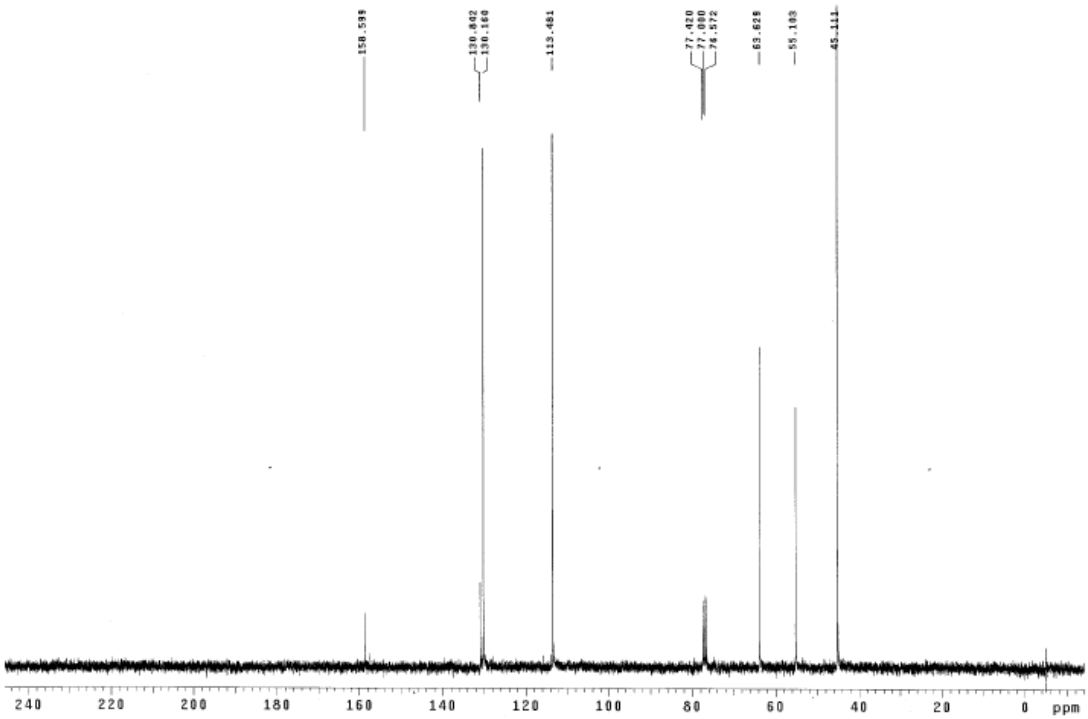
2.03
6.00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40
20
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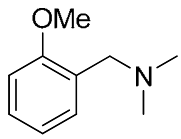
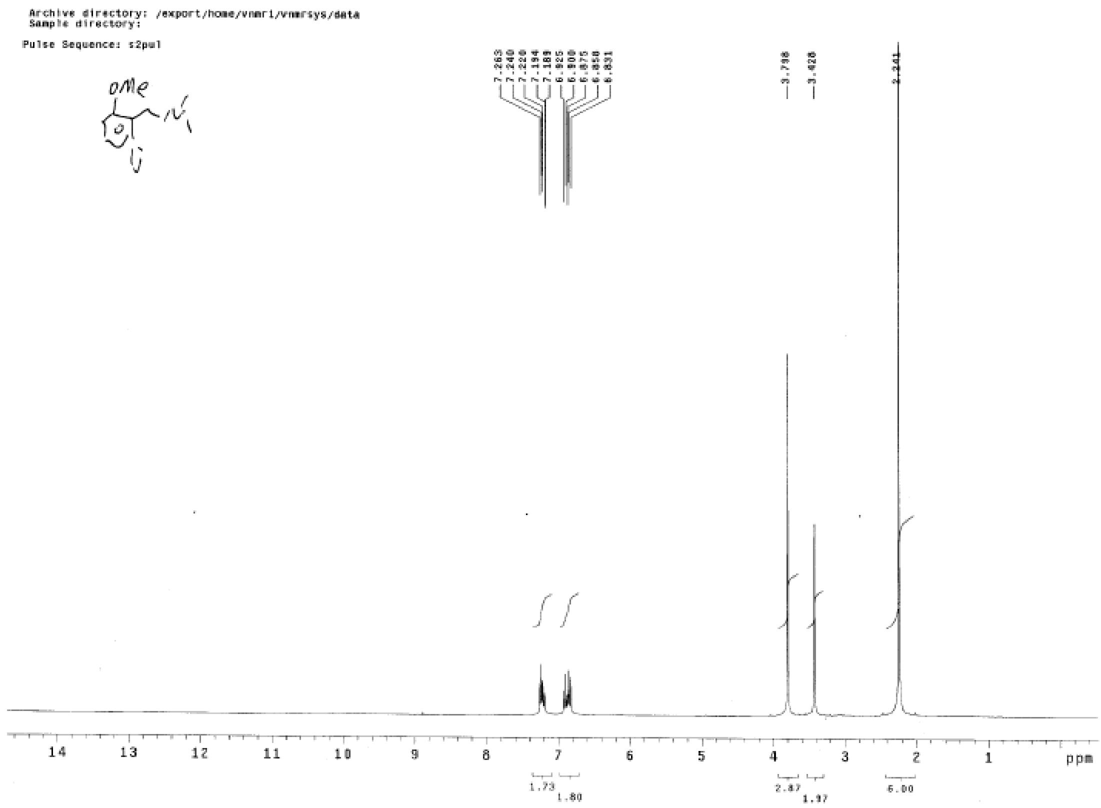
ppm


OMe
N

2g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3.428
2.241
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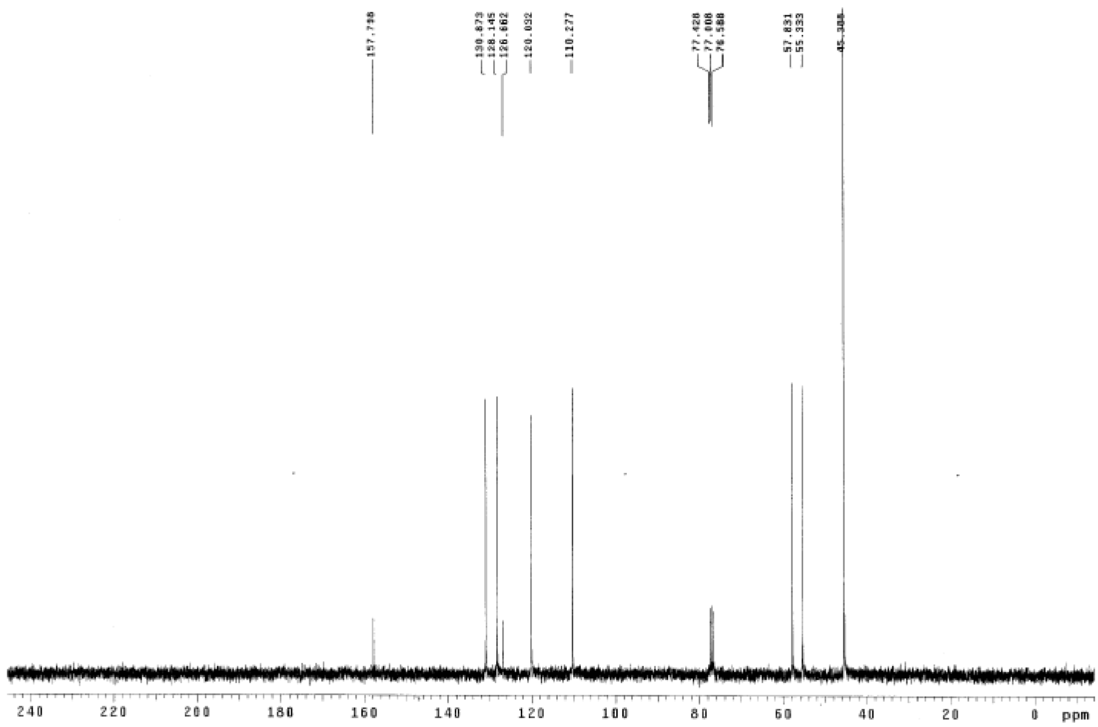
1.73 1.80 2.87 1.97 6.00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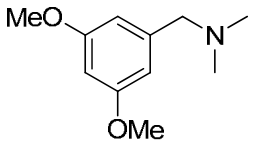
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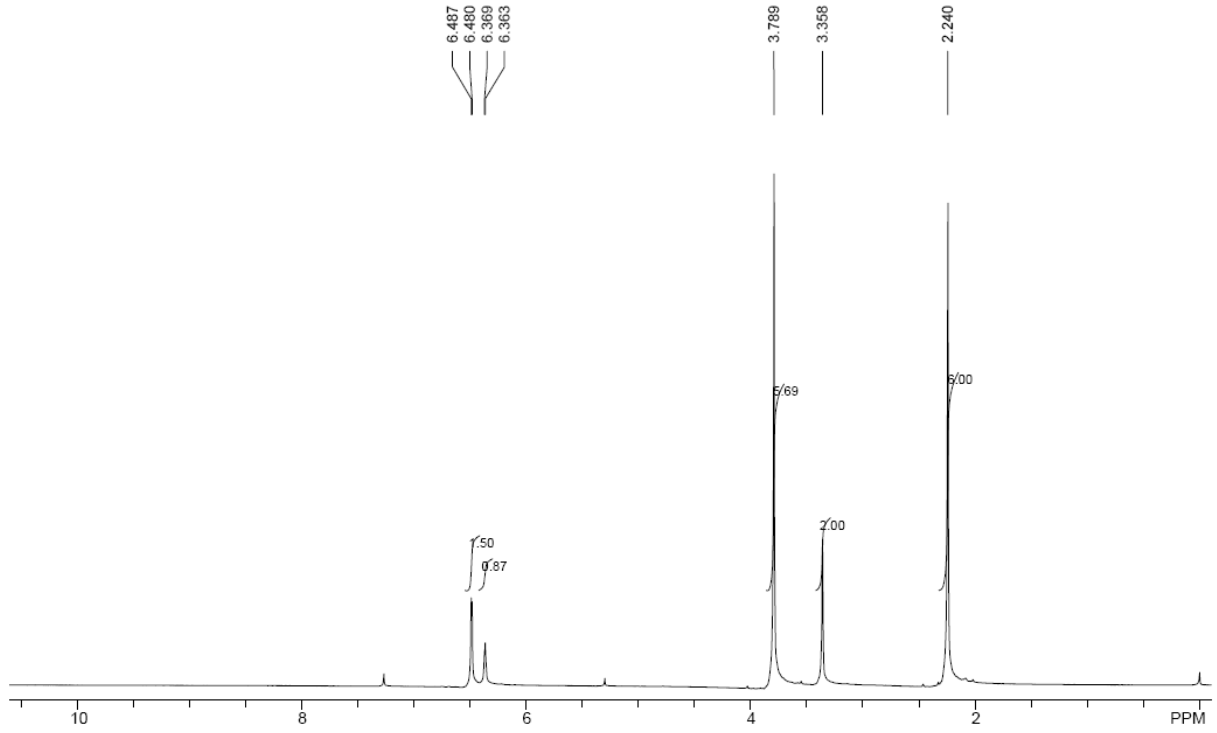
N
OMe

2h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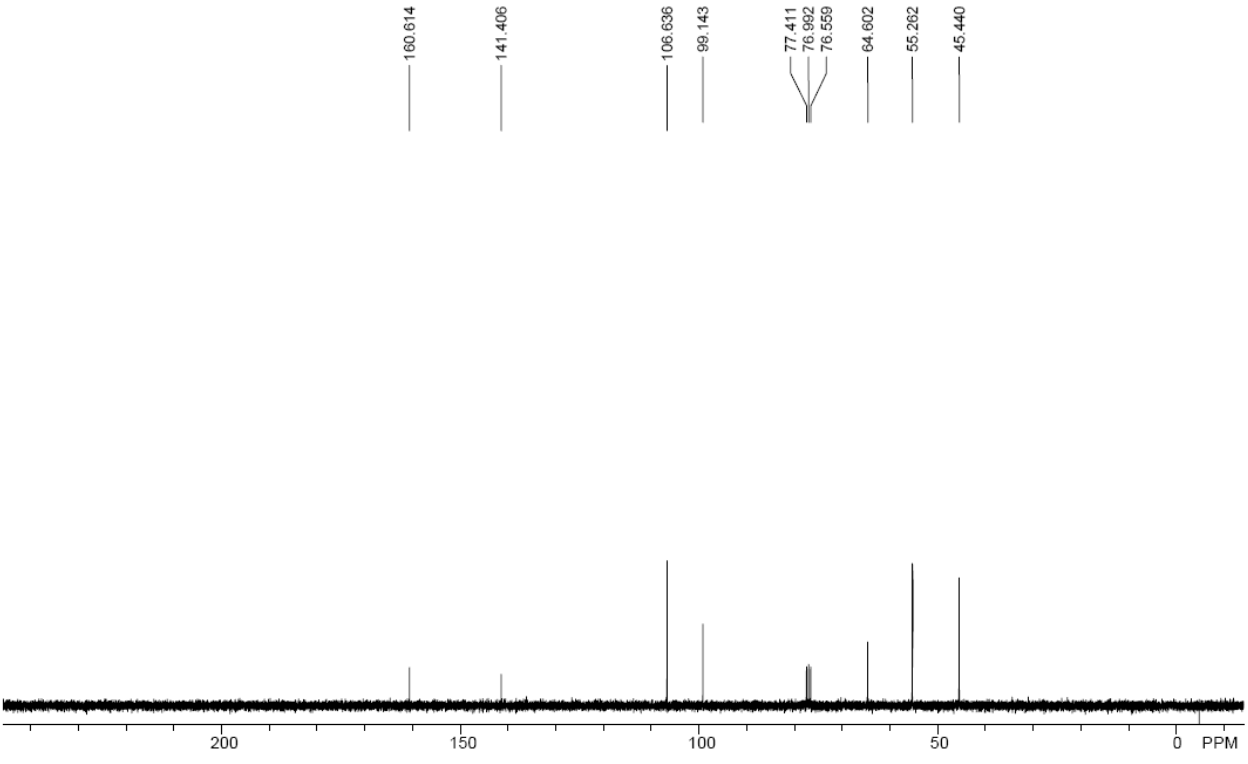
8
6
4
2
PPM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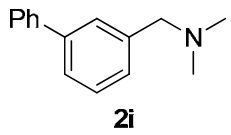
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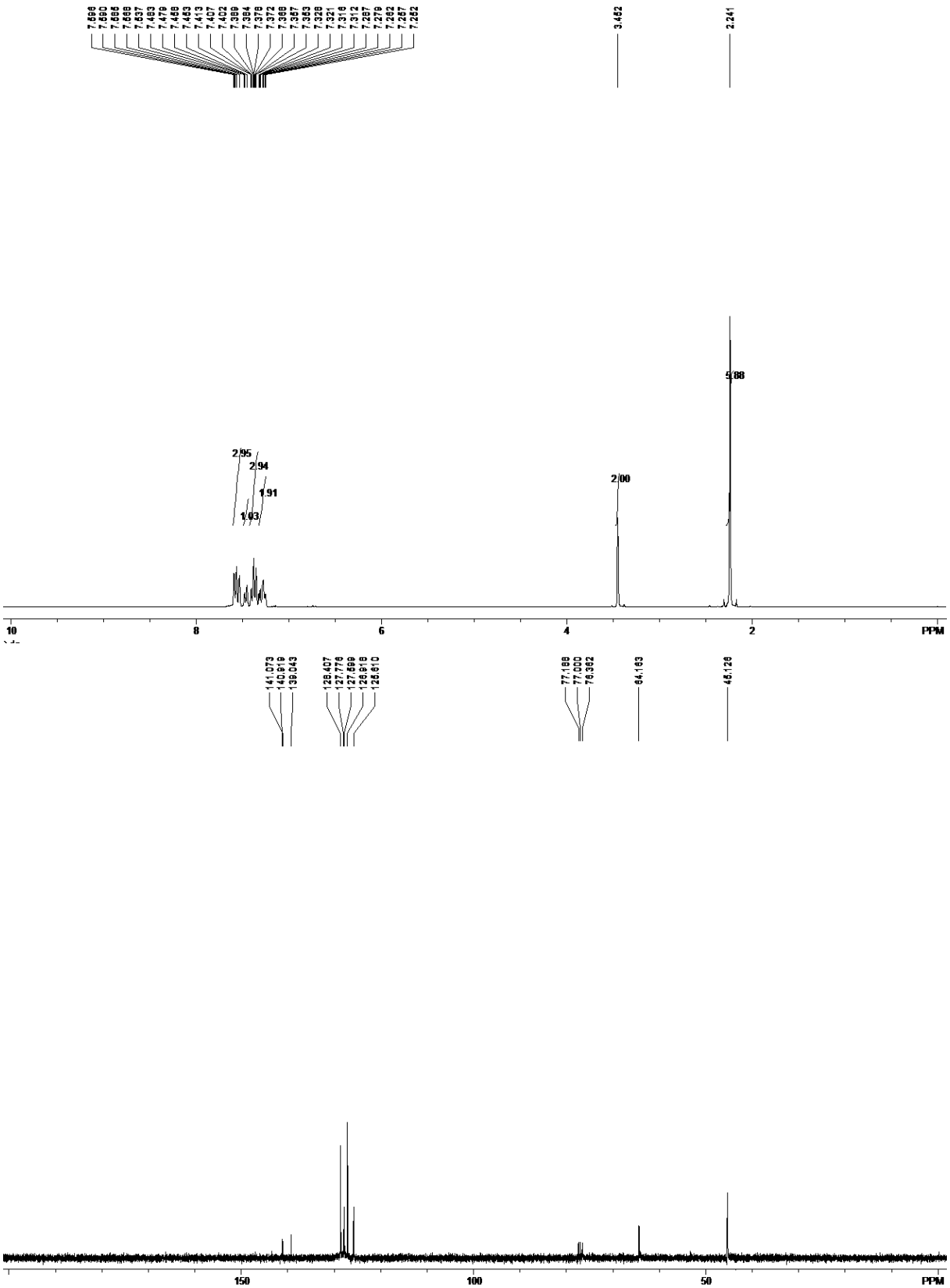
N

2i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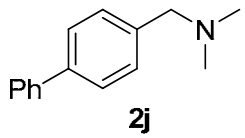
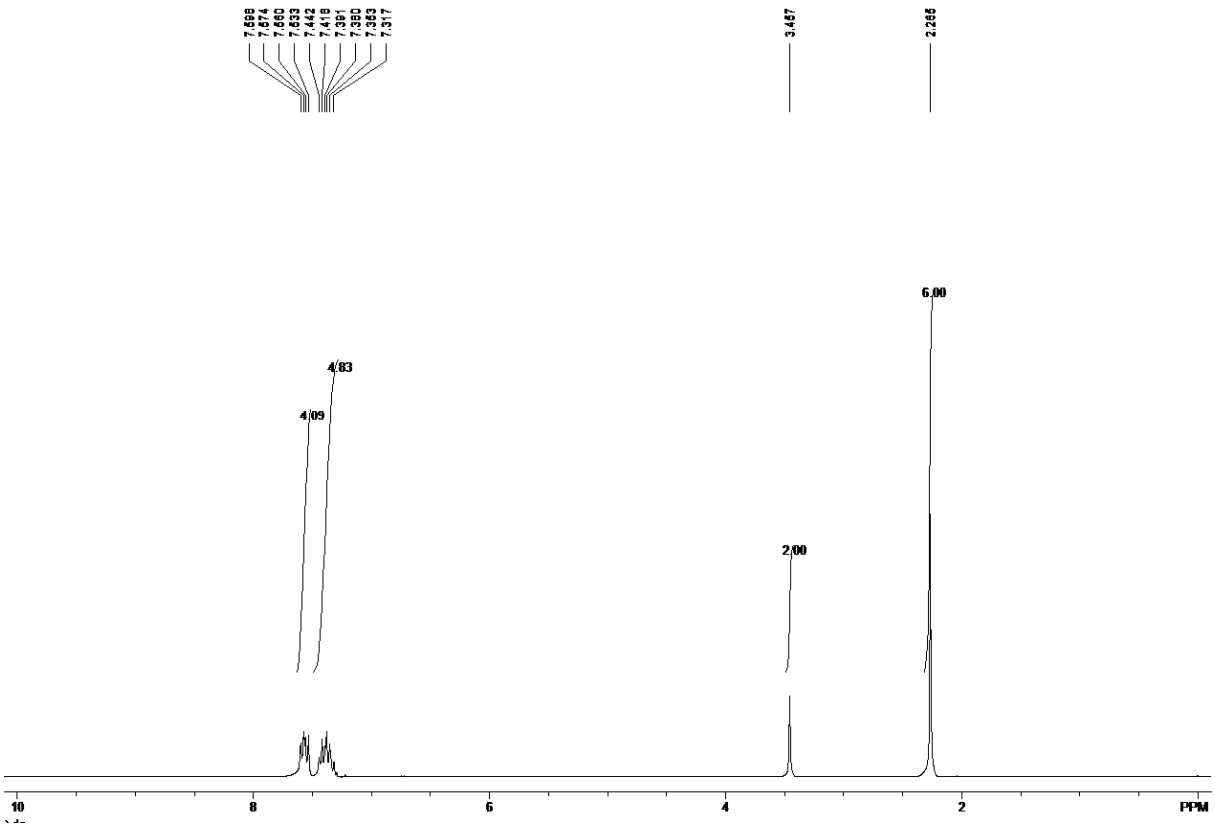

N
Ph

2j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6
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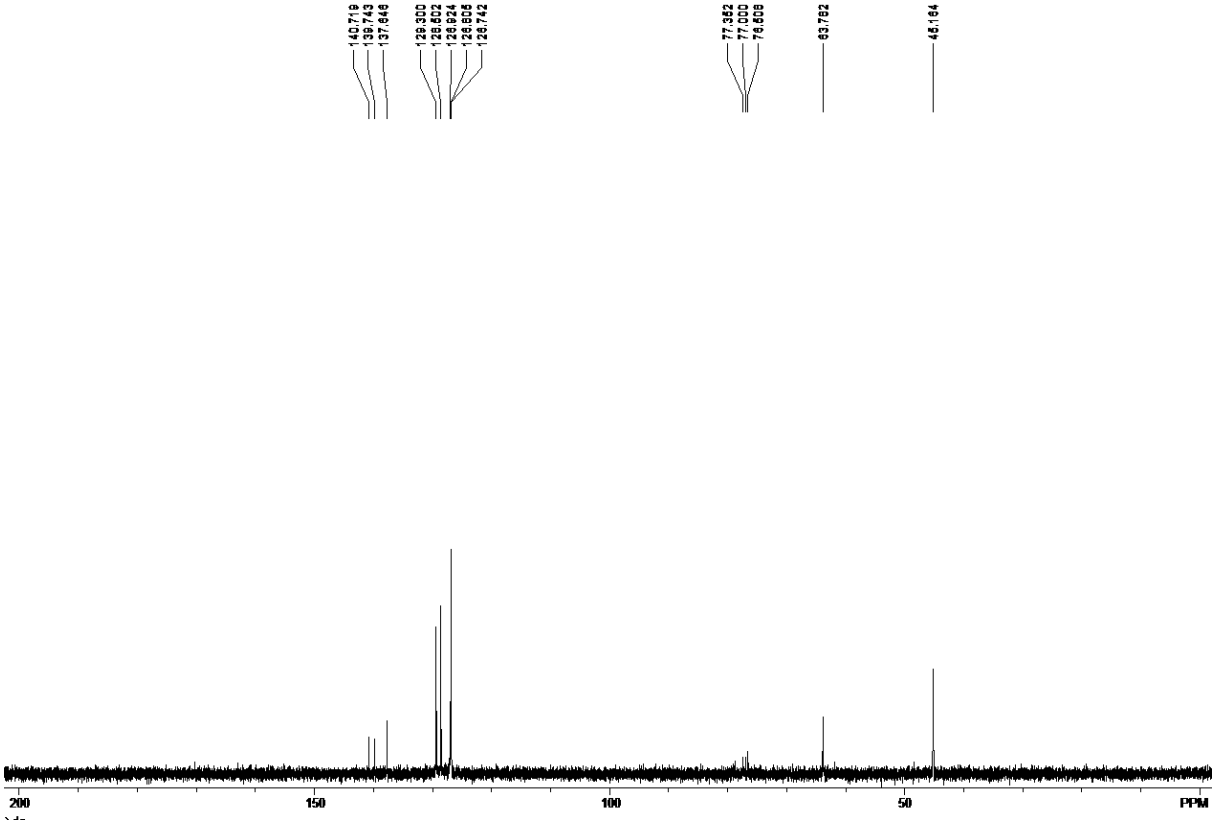
2
PPM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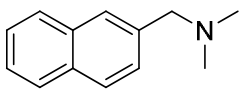

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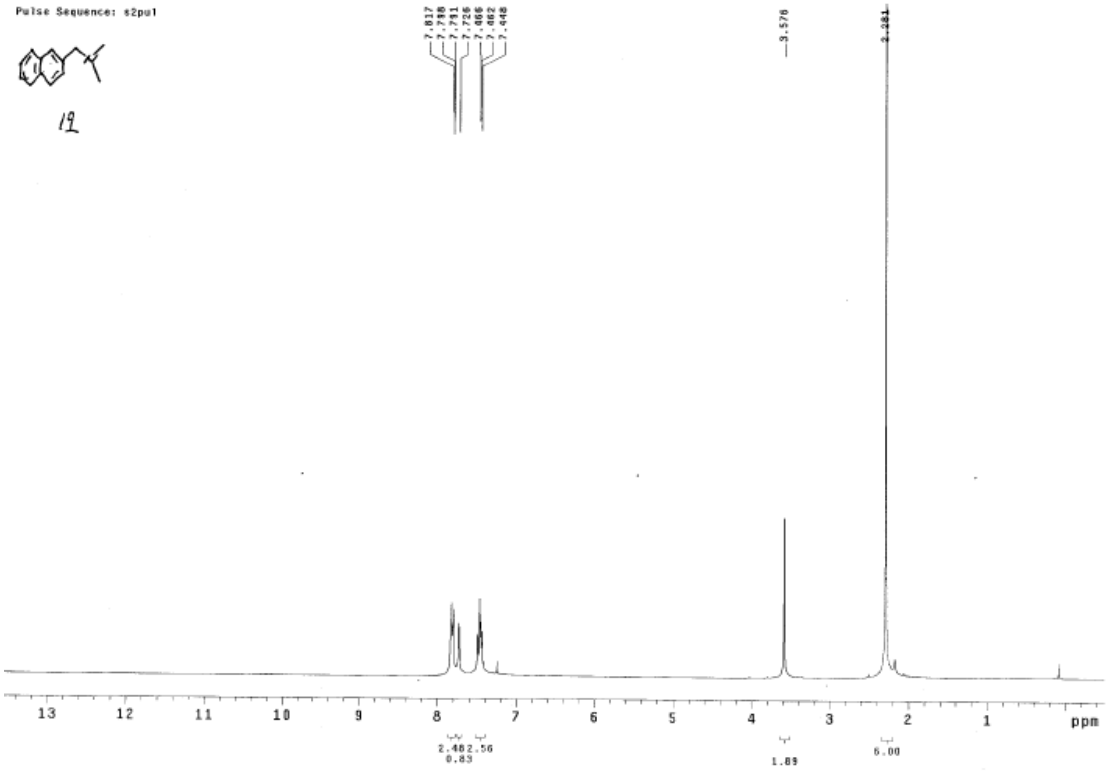
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3
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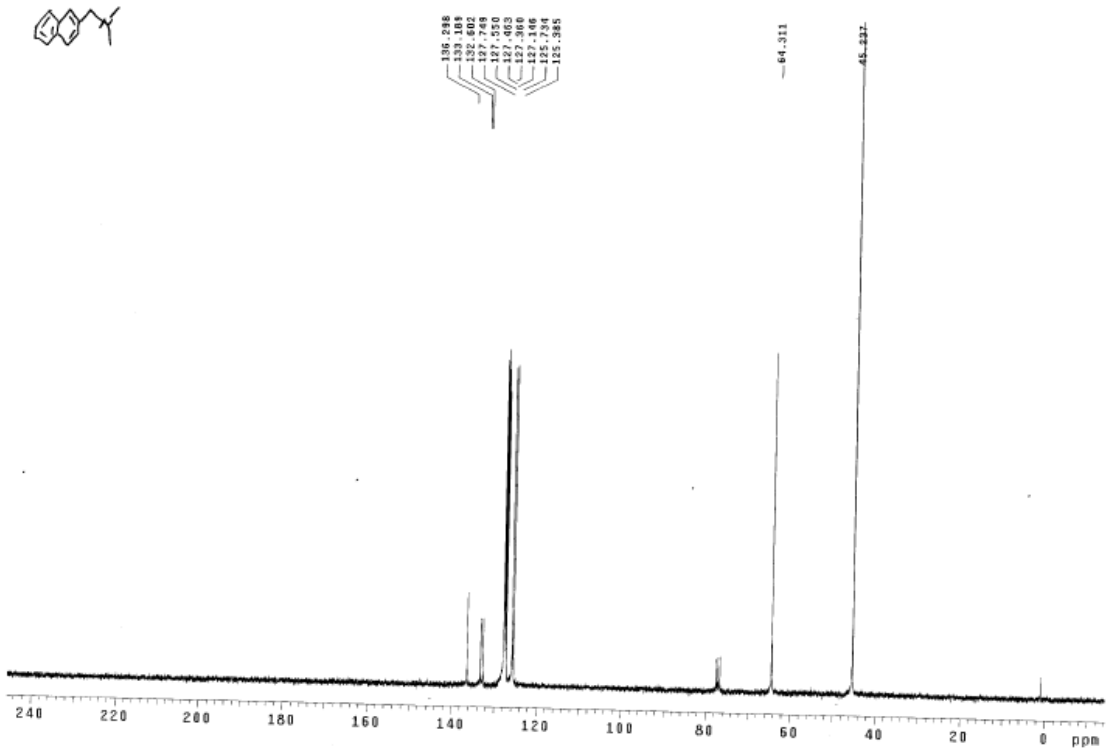
6.00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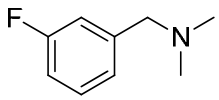

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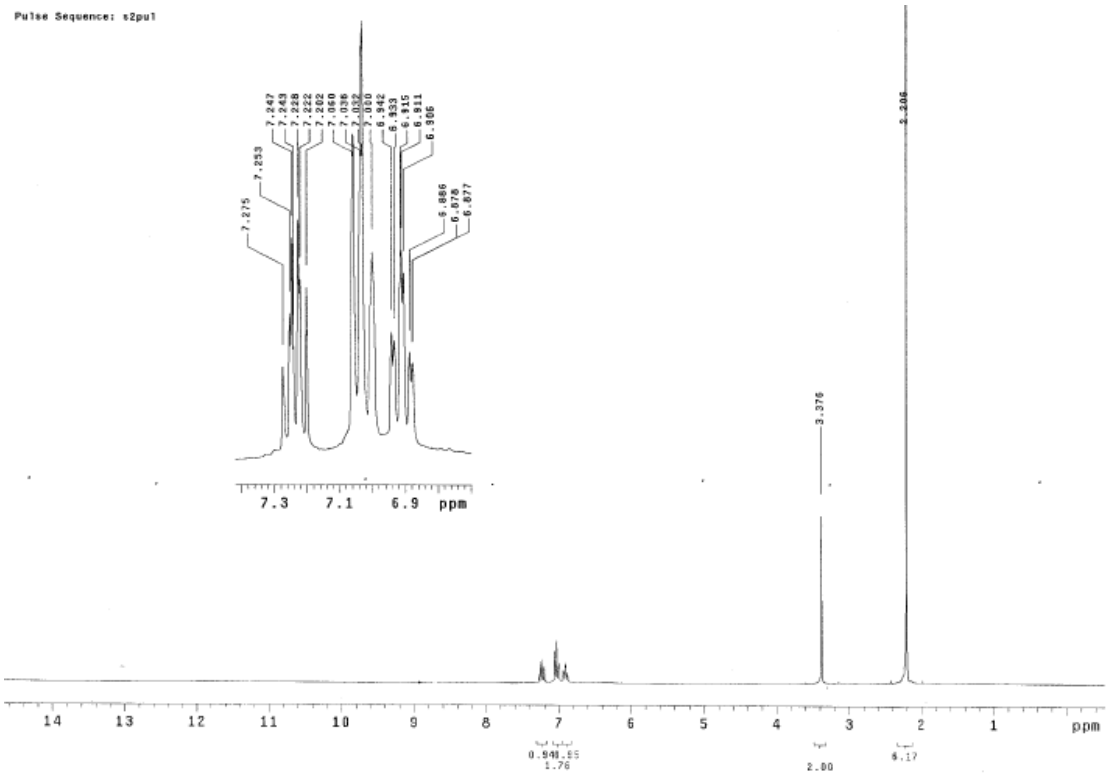
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12
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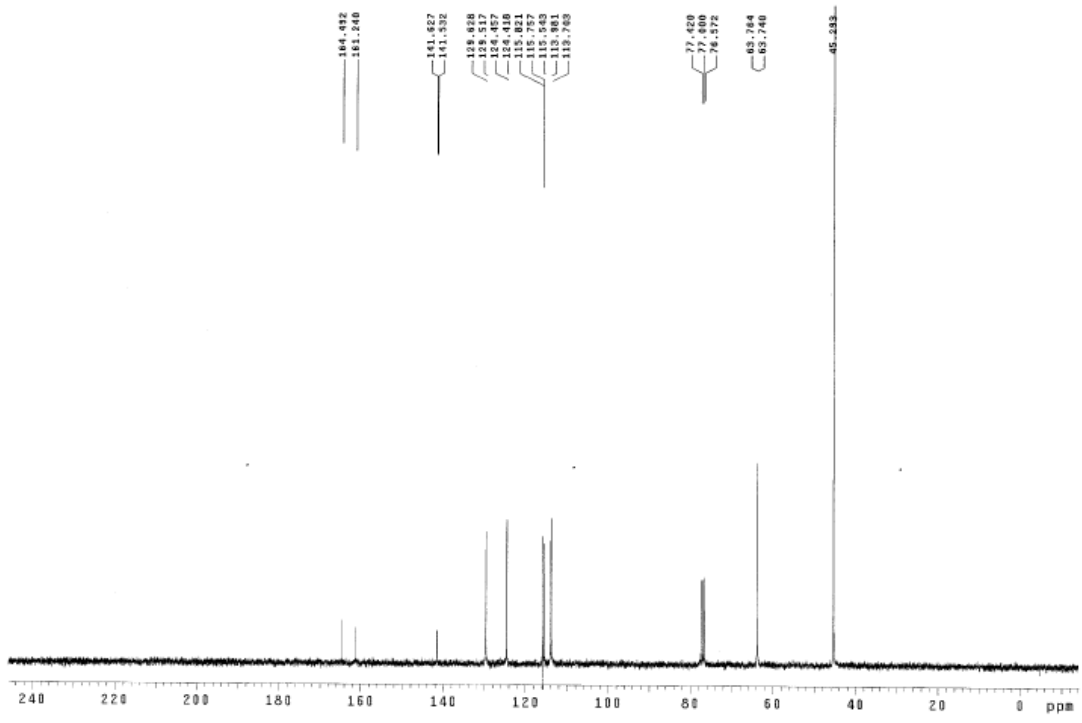
6.17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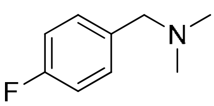
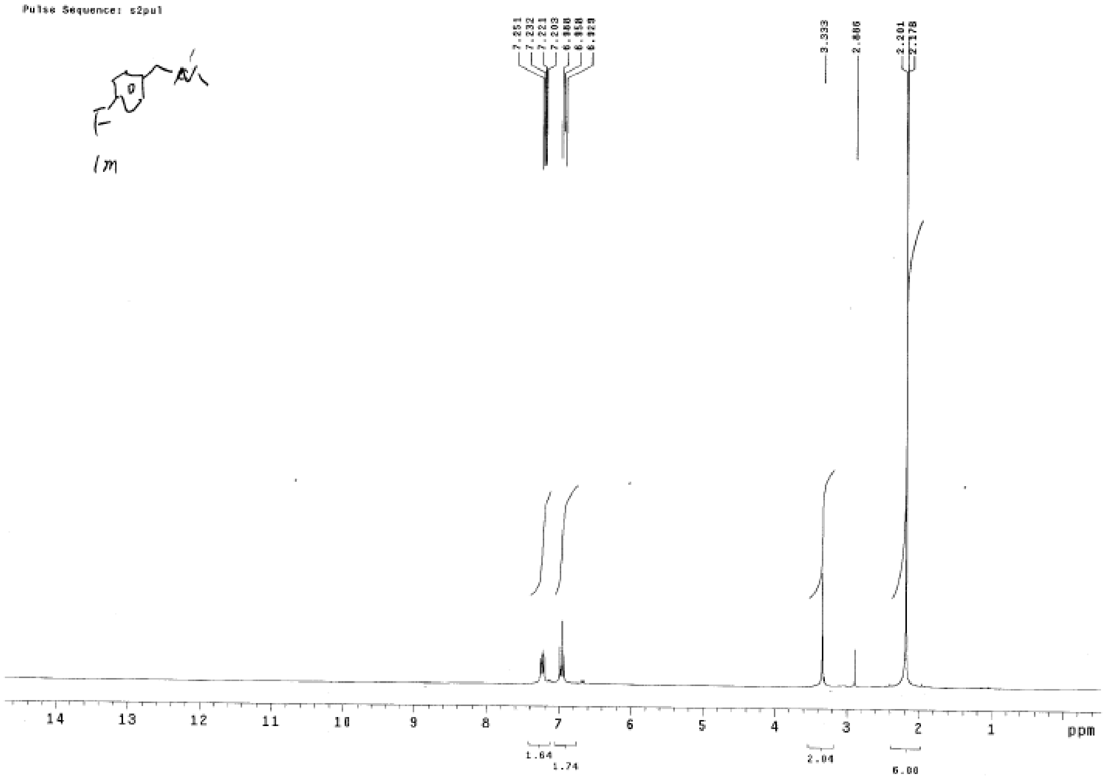
161.240
141.627
141.532
129.628
129.517
124.457
124.418
115.821
115.757
115.543
113.961
113.783
77.420
77.000
76.572
63.764
63.748
45.233
240
220
200
180
160
140
120
100
80
60
40
20
0
ppm


F
N

2m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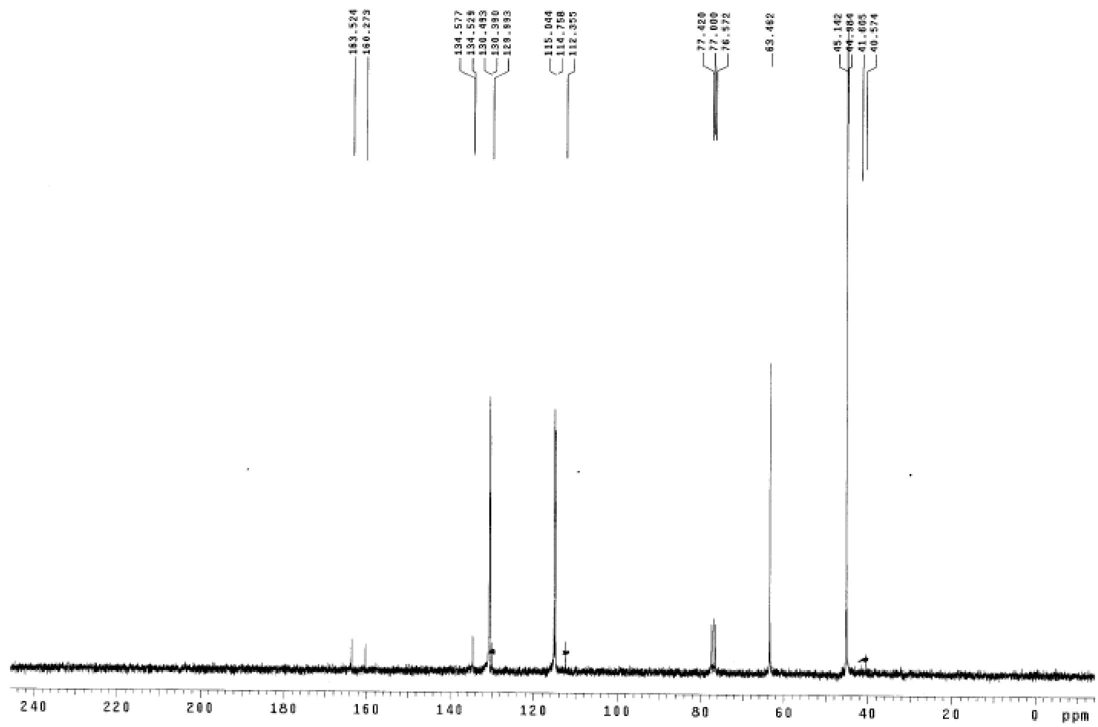
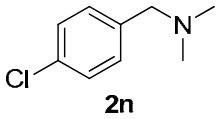
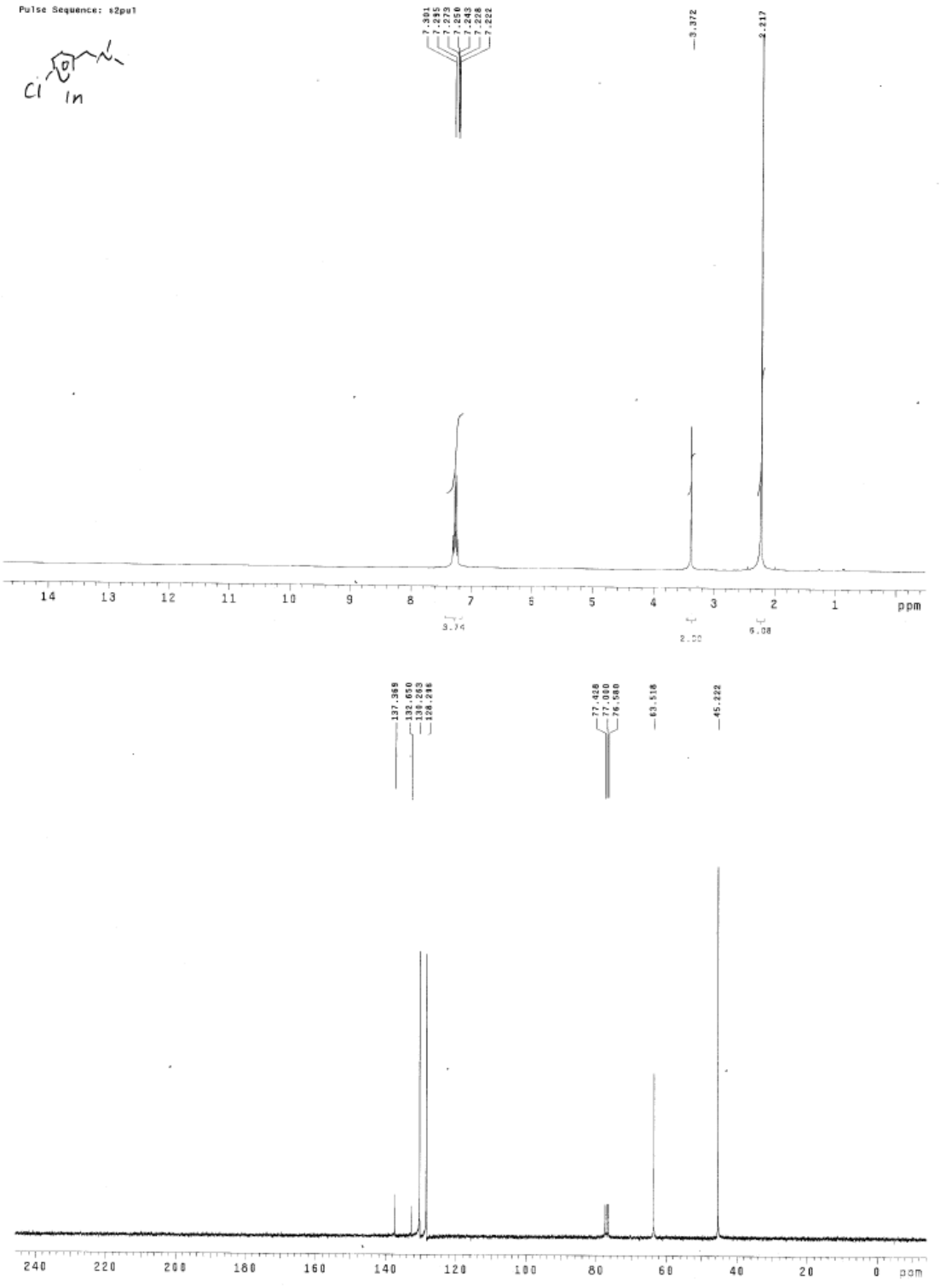
1m
3.333
2.886
2.201
2.178
14
13
12
11
10
9
8
7
6
5
4
3
2
1
ppm
1.64
1.74
2.04
6.00


63.462
240
220
200
180
160
140
120
100
80
60
40
20
0
ppm


Cl
N

2n


Pulse Sequence: s2pul
Cl
1n
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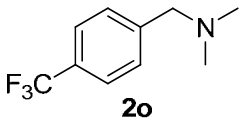
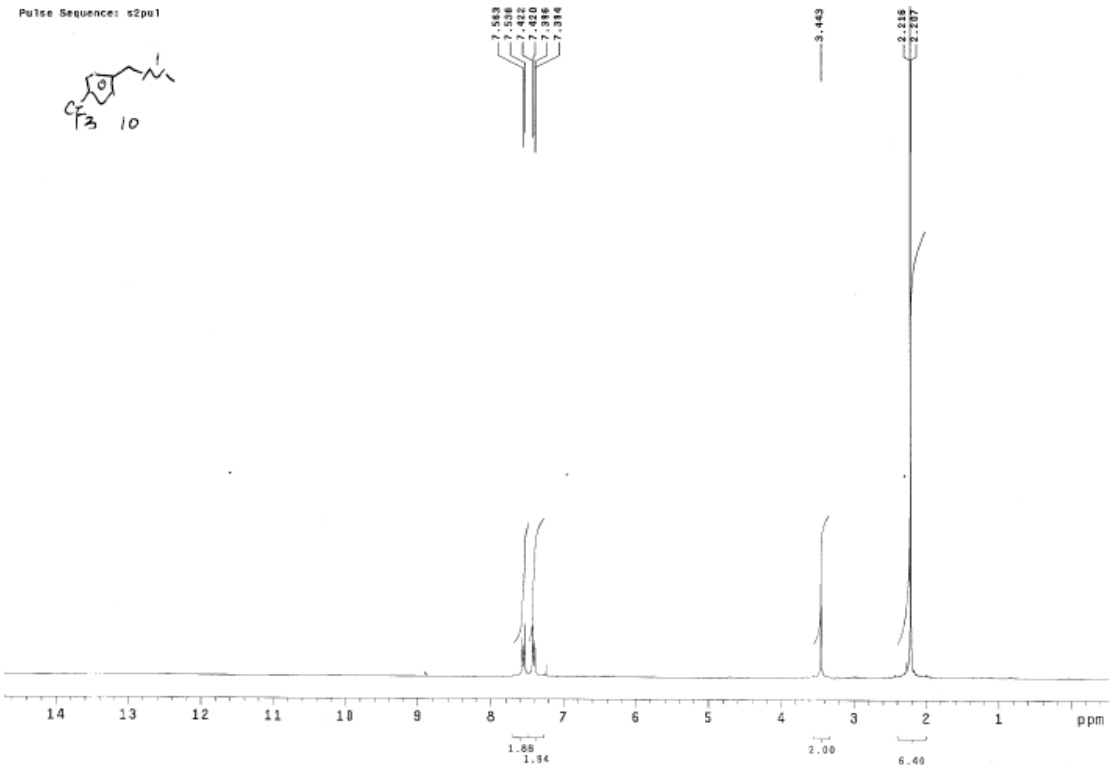
7.295
7.273
7.250
7.243
7.208
7.222
3.372
2.317
14
13
12
11
10
9
8
7
6
5
4
3
2
1
ppm
3.74
2.00
6.08
137.369
132.650
130.255
128.296
77.438
77.000
76.580
63.516
45.222
240
220
200
180
160
140
120
100
80
60
40
20
0
ppm


N
F3C

2o


Pulse Sequence: s2pul
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7.536
7.422
7.420
7.396
7.394
3.443
2.216
2.207
14
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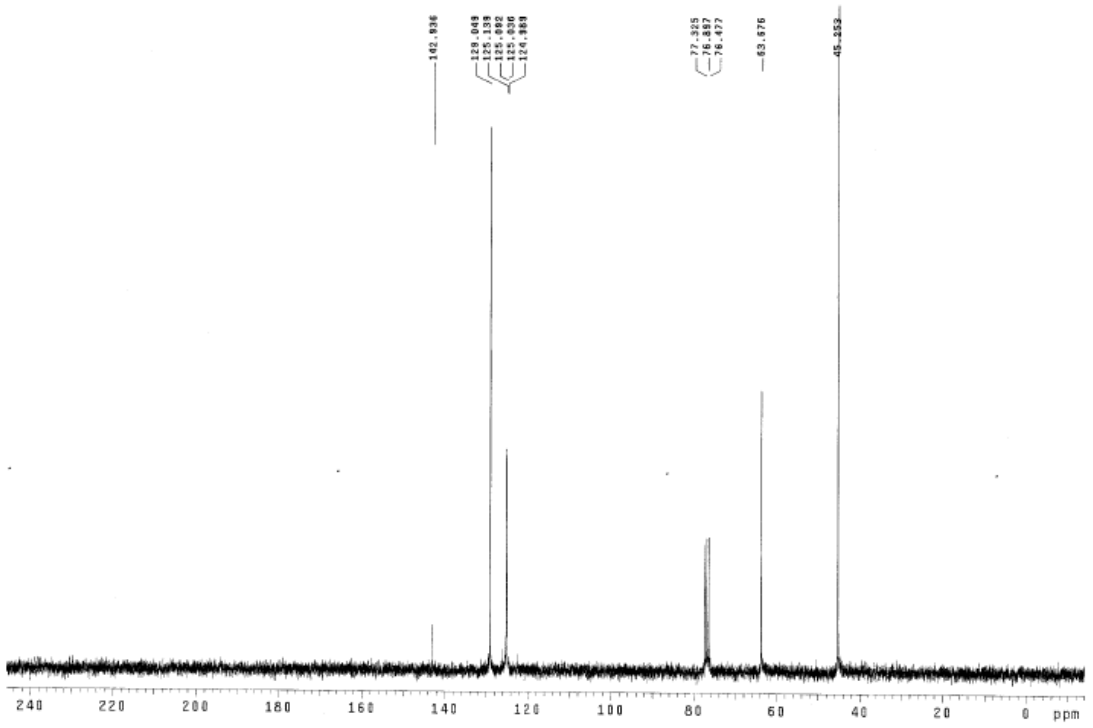
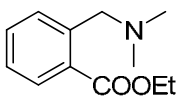
2
1
ppm
1.88
1.94
2.00
6.40


142.836
129.049
125.139
125.092
125.036
124.989
77.325
76.897
76.477
63.676
45.252
240
220
200
180
160
140
120
100
80
60
40
20
0
ppm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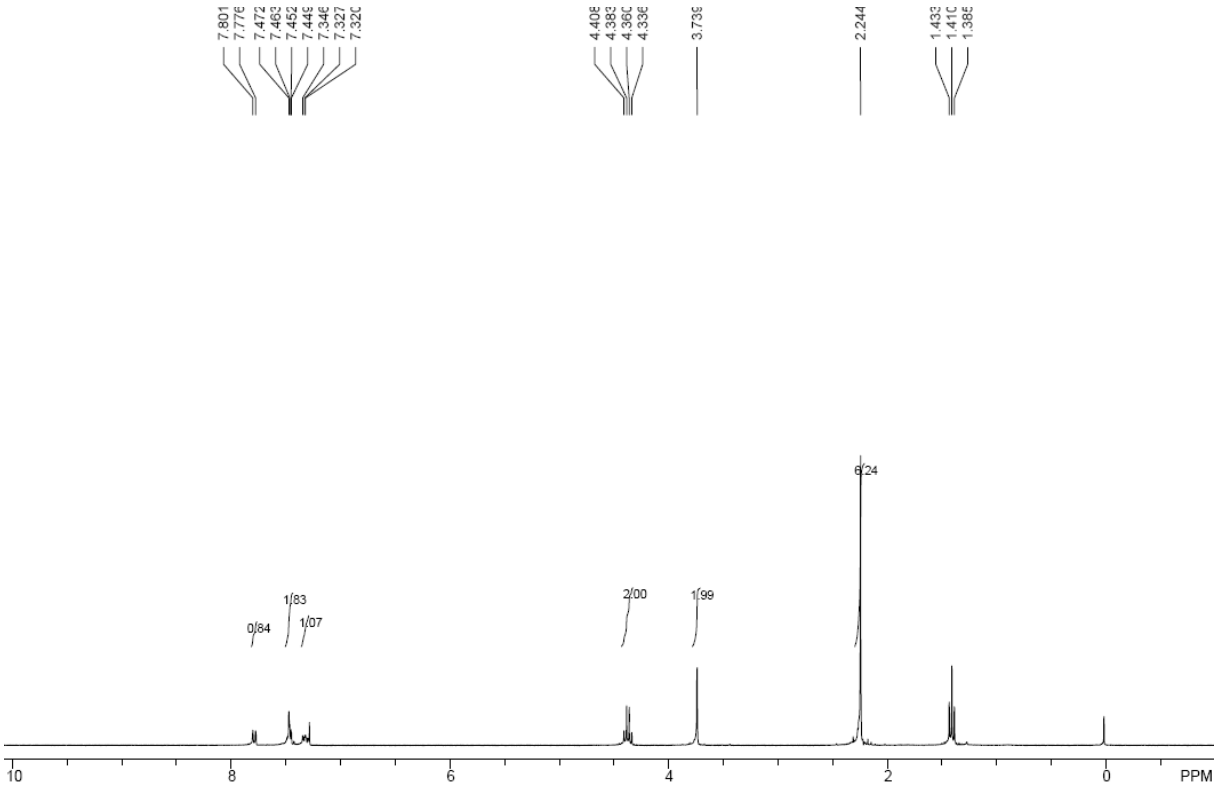
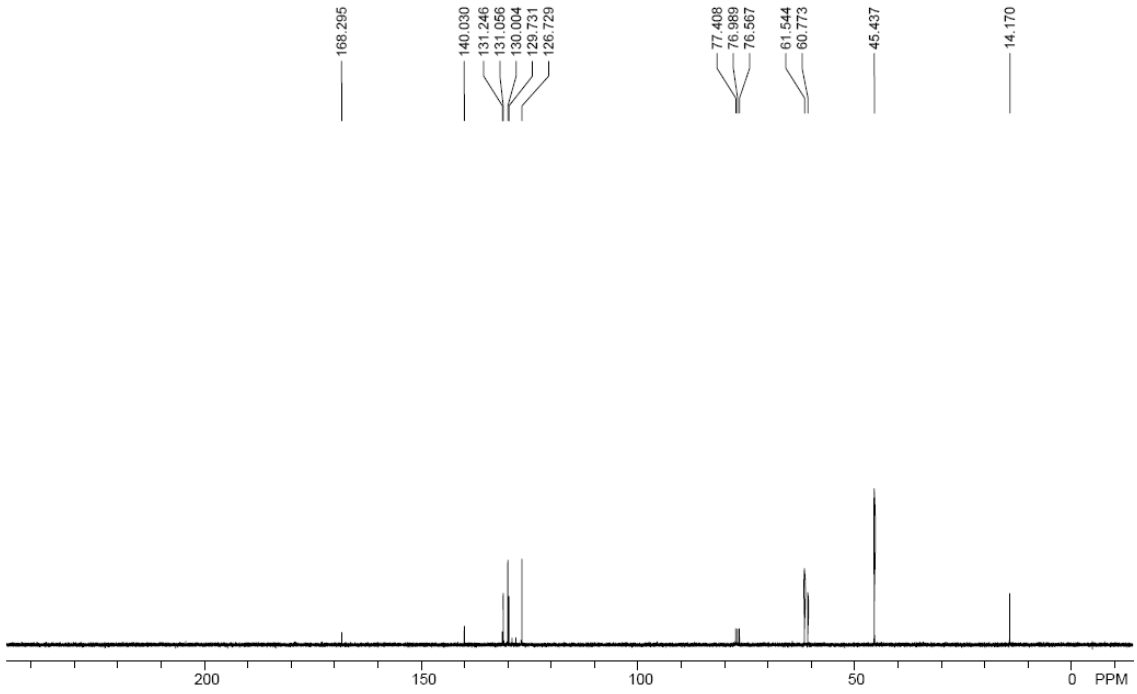
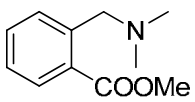
COOEt

4aa


7.801
7.772
7.472
7.463
7.452
7.445
7.346
7.327
7.320
4.408
4.383
4.360
4.338
3.735
2.244
1.433
1.410
1.388
0.84
1.83
1.07
2.00
1.99
6.24
10
8
6
4
2
0
PPM


168.295
140.030
131.246
131.056
130.004
129.731
126.729
77.408
76.989
76.567
61.544
60.773
45.437
14.170
200
150
100
50
0
PPM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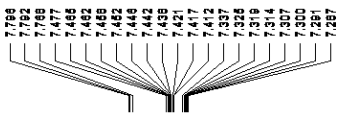
COOMe

4ab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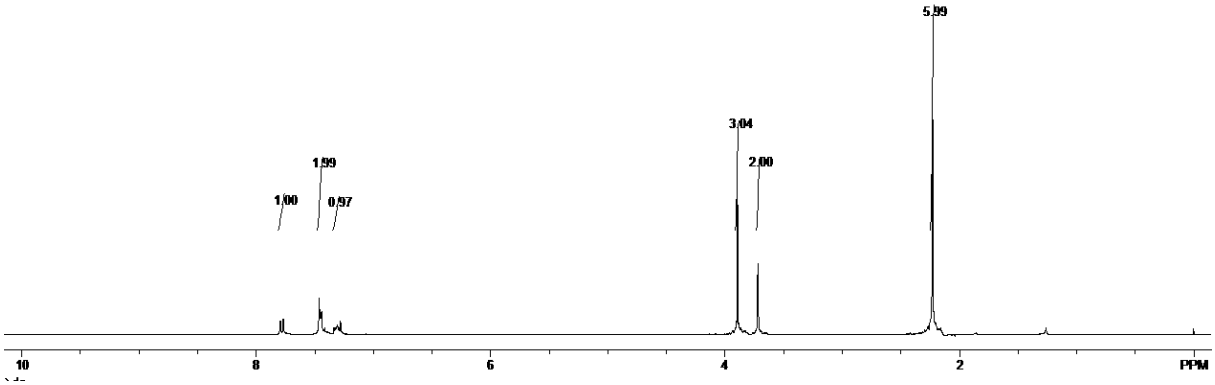
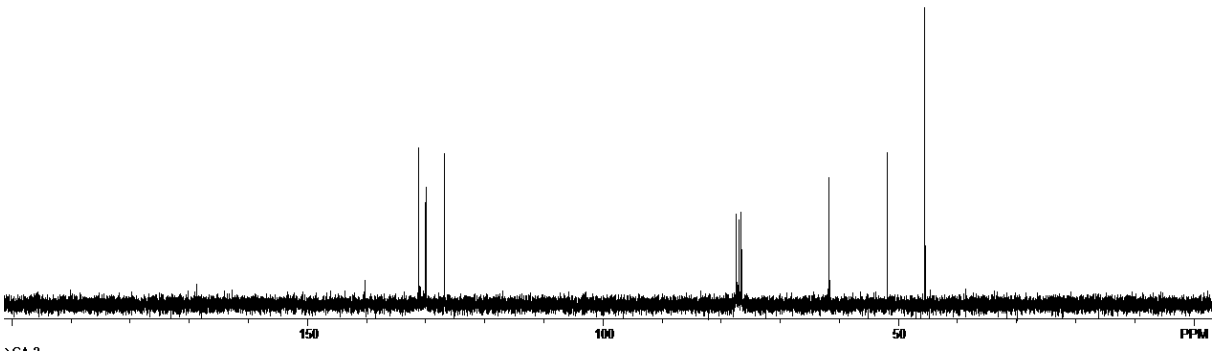
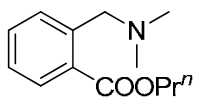
7.792
7.788
7.477
7.466
7.462
7.458
7.452
7.446
7.442
7.438
7.421
7.417
7.412
7.337
7.328
7.319
7.314
7.307
7.300
7.291
7.287


3.695
3.720
2.232


5.99
3.04
2.00
1.99
1.00
0.97
10
8
6
4
2
PPM


168.760
140.282
131.218
130.071
129.892
128.795
77.409
76.988
76.852
61.869
51.915
46.479


150
100
50
PPM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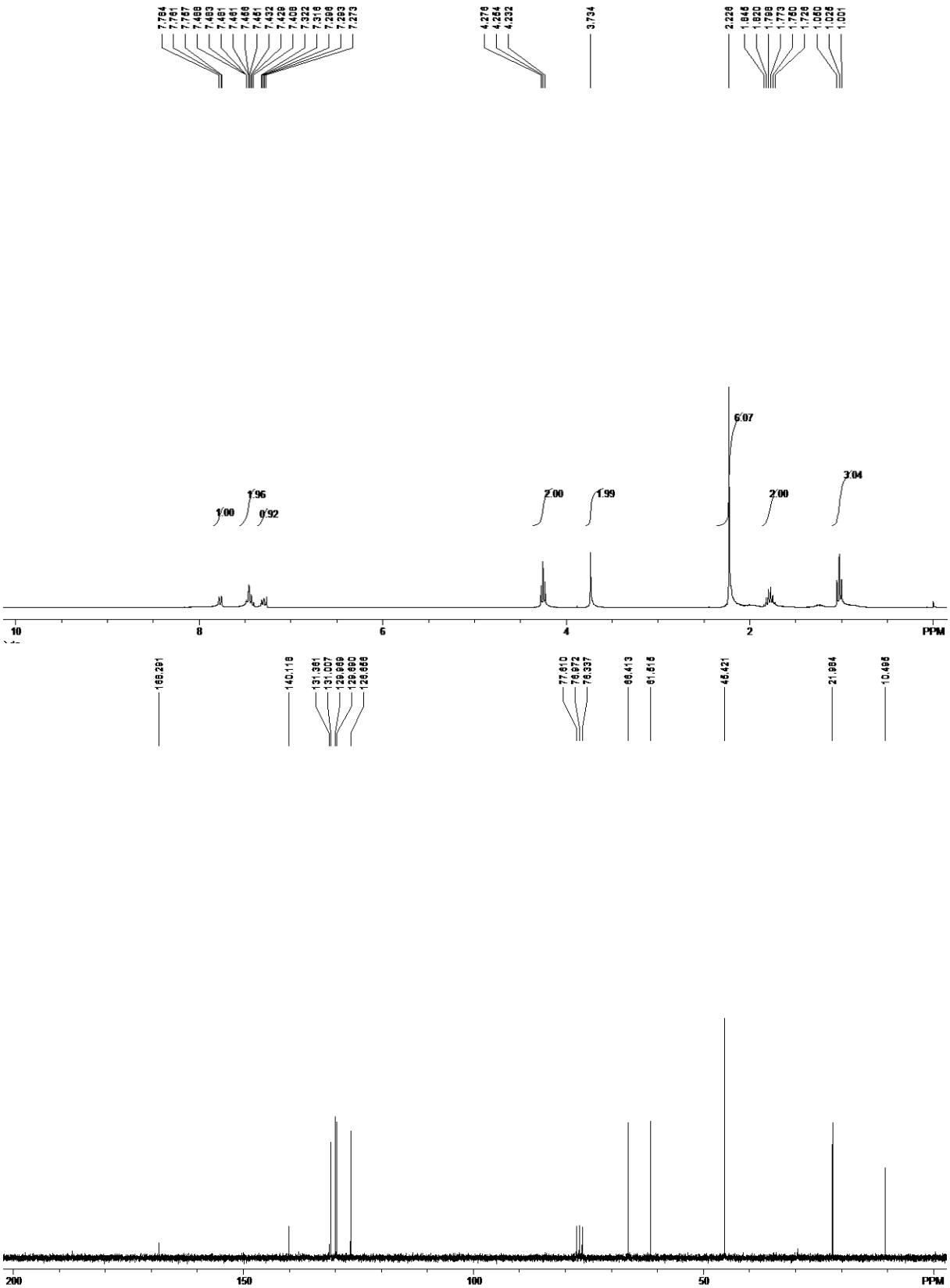
COOPr^n

4ac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7.767
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7.463
7.461
7.451
7.450
7.432
7.429
7.409
7.322
7.316
7.296
7.293
7.273
4.276
4.254
4.232
3.734
2.226
1.846
1.820
1.799
1.773
1.750
1.726
1.060
1.026
1.001
1.00
1.96
0.92
2.00
1.99
6.07
2.00
3.04
10
8
6
4
2
PPM
168.291
140.118
131.361
131.007
129.869
129.690
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76.337
68.413
61.616
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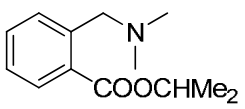
10.498
200
150
100
50
PPM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COOCHMe2

4ad


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7.484
7.479
7.458
7.453
7.444
7.439
7.420
7.416
7.394
7.390
7.311
7.305
7.286
7.281
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6.272
6.253
6.231
6.210
6.190
6.169
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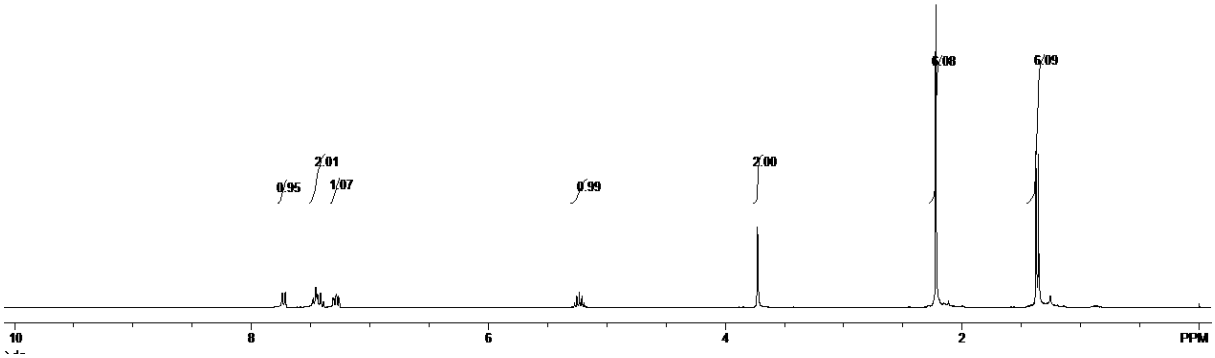
2.222
1.375
1.366


6.08
6.09
2.01
0.95
1.07
0.99
2.00
10
8
6
4
2
PPM


167.767
139.887
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130.078
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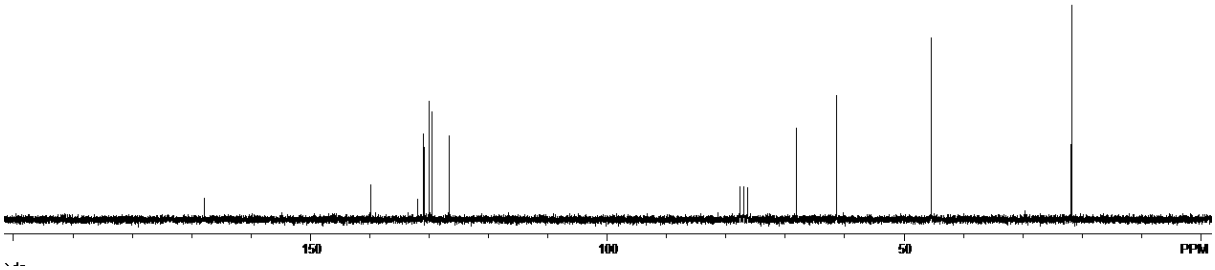
129.808
128.839
77.612
76.974
76.339
68.169
61.360
45.426
21.817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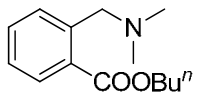
100
50
PPM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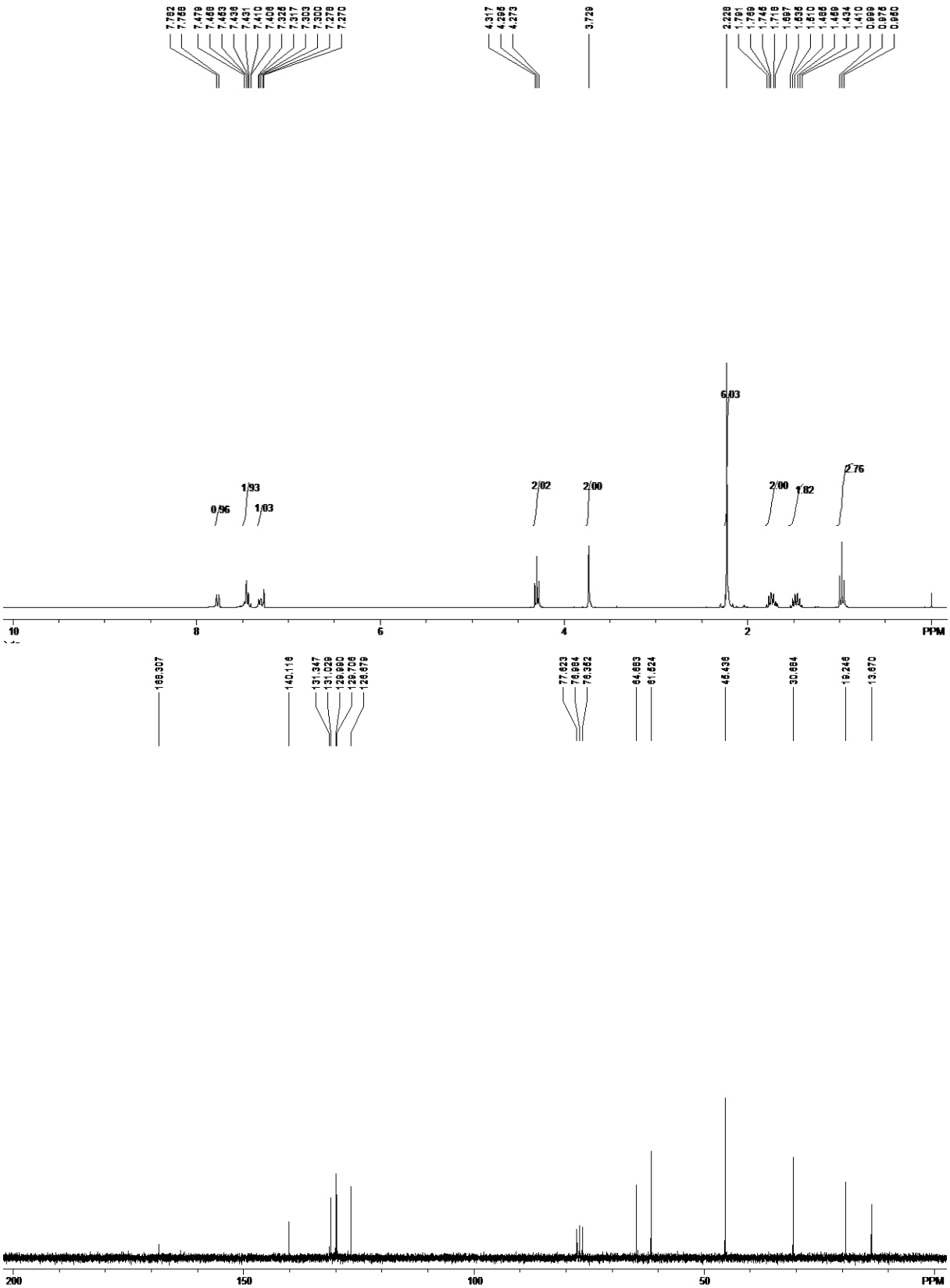
COOBu^n

4ae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7.453
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7.410
7.408
7.326
7.317
7.303
7.300
7.278
7.270
4.317
4.295
4.273
3.729
2.228
1.791
1.759
1.744
1.719
1.697
1.635
1.610
1.488
1.459
1.434
1.410
0.999
0.975
0.960
0.96
1.93
1.03
2.02
2.00
6.03
2.00
1.82
2.76
10
8
6
4
2
PPM
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131.029
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129.706
128.879
77.623
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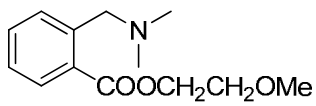
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COOCH2CH2OMe

4af


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7.449
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7.432
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7.406
7.321
7.312
7.300
7.286
7.282
7.267
7.278
4.456
4.447
4.444
4.440
4.436
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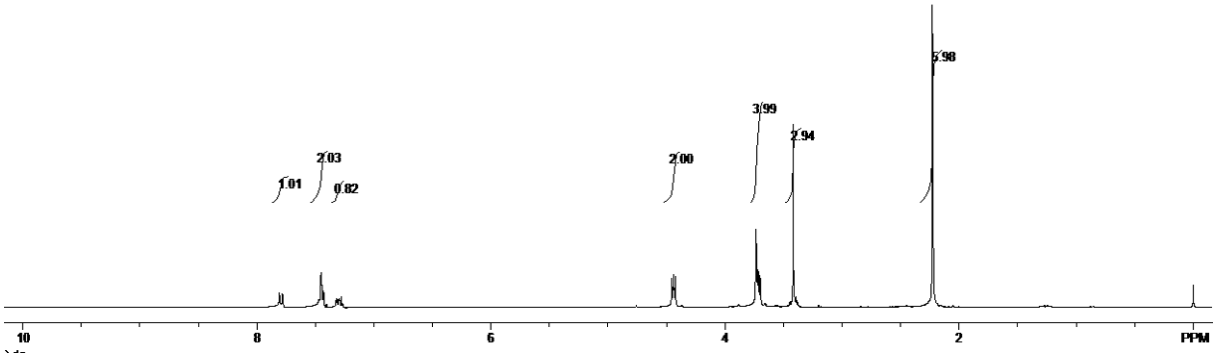
3.417
2.227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8
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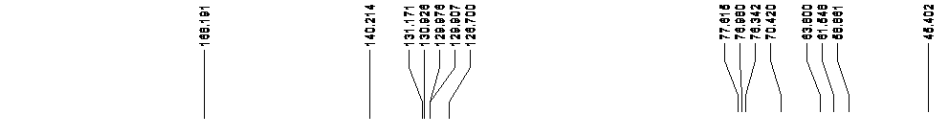
2
PPM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61.848
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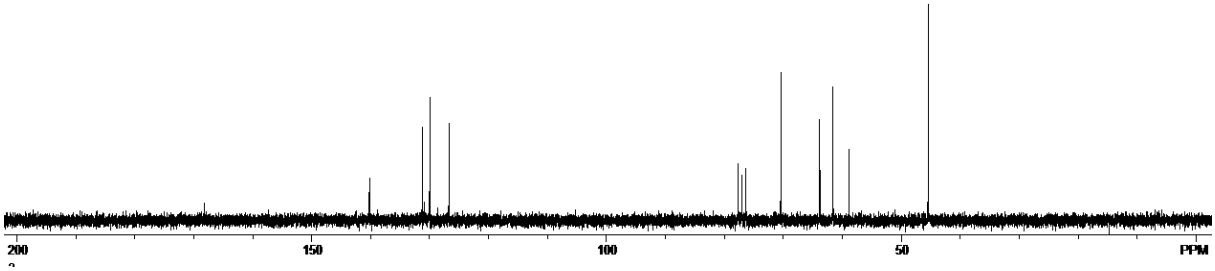
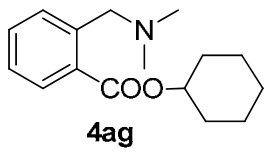
45.402


200
150
100
50
PPM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COO

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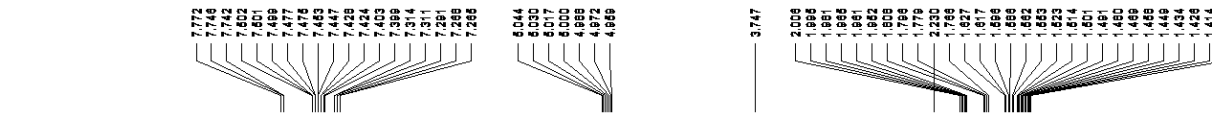

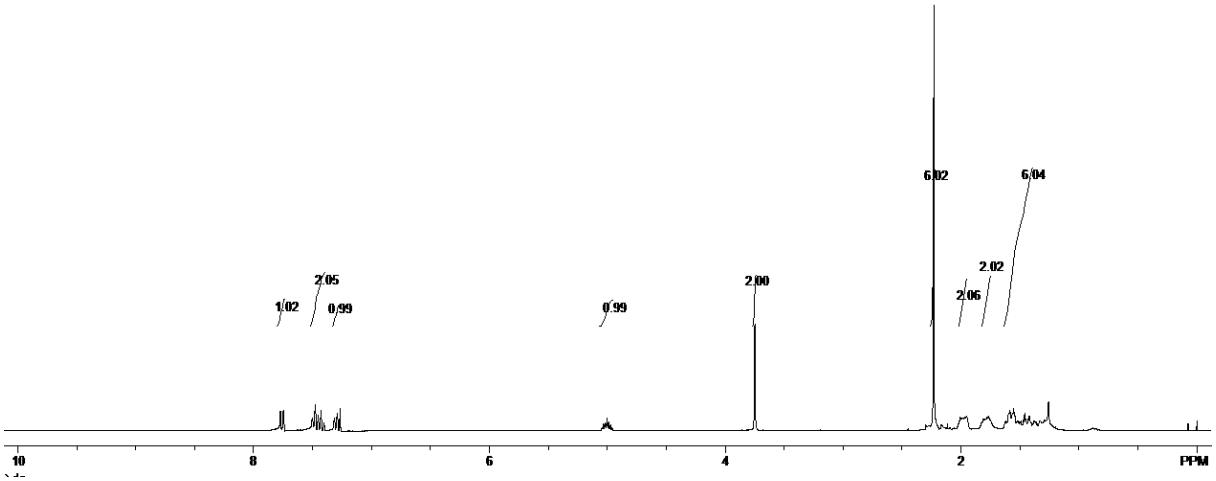
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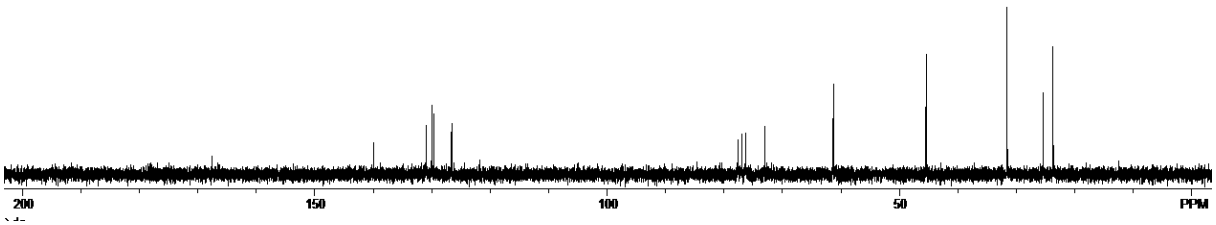
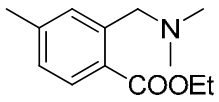
2.00
6.02
6.04
2.06
2.02
10
8
6
4
2
PPM


200
150
100
50
PPM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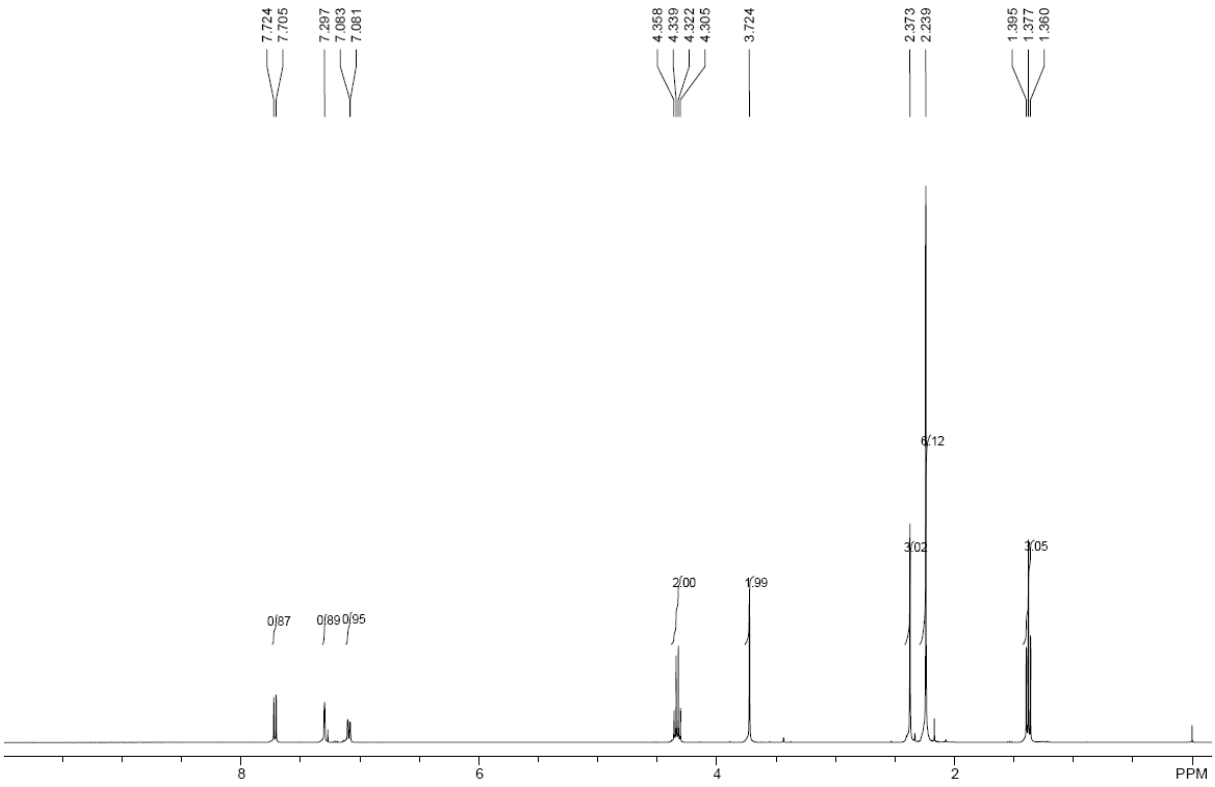
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1.395
1.377
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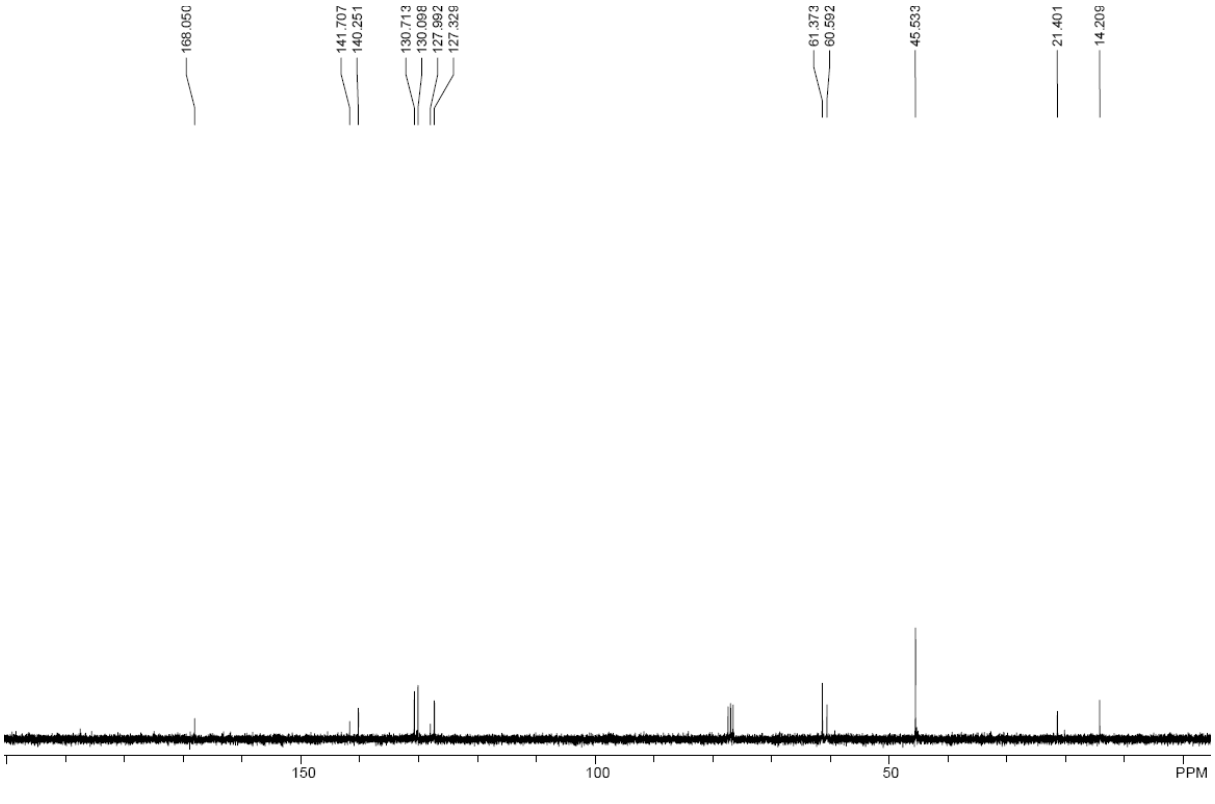
PPM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127.329
61.373
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21.401
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50
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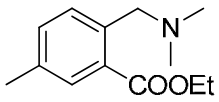
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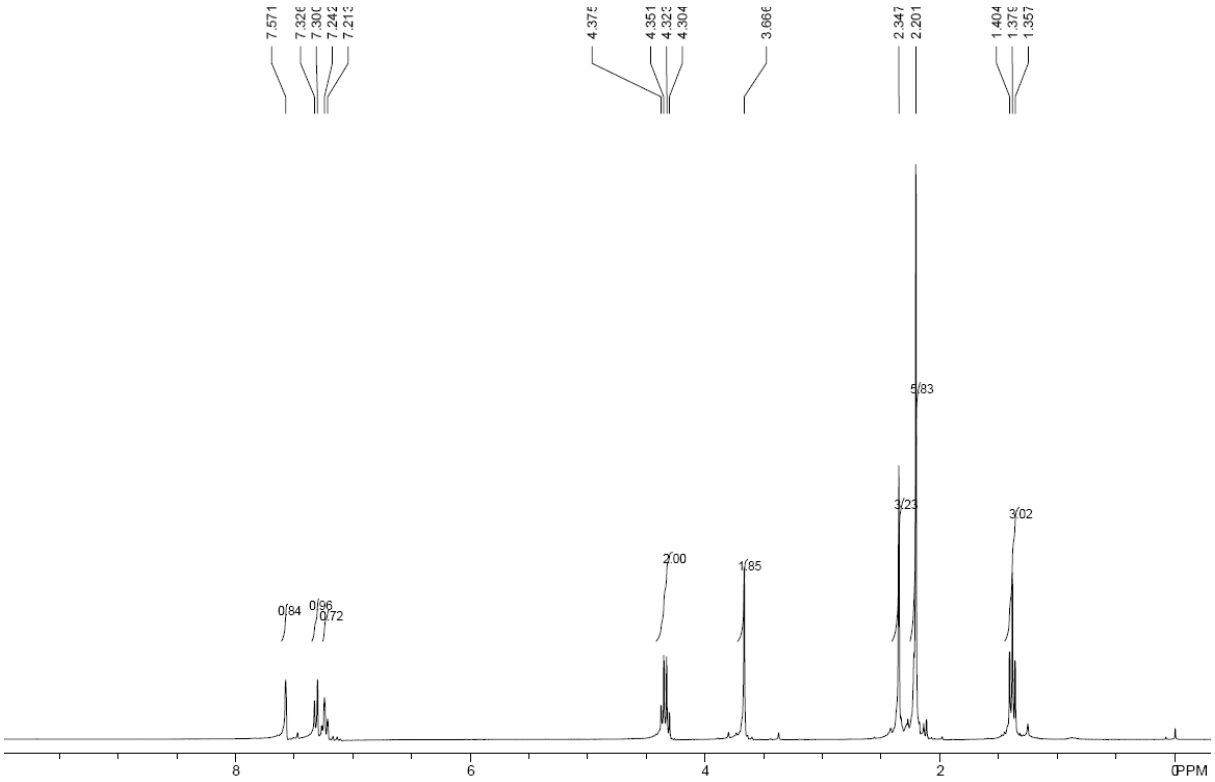
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4.304
3.666
2.347
2.201
1.404
1.378
1.357
5.83
3.23
3.02
2.00
1.85
0.84
0.96
0.72
8
6
4
2
0
PPM


168.479
136.905
136.436
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130.229
77.411
76.988
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61.232
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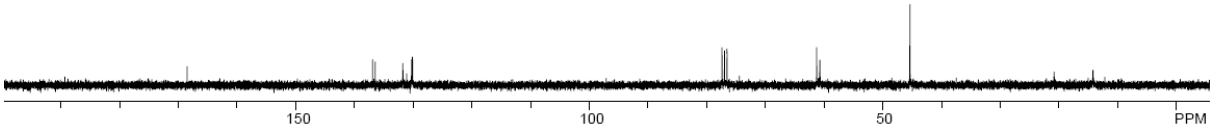
14.174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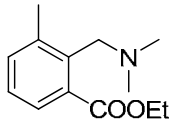
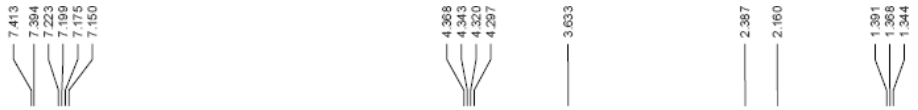
100
50
PPM


N
COOEt

4da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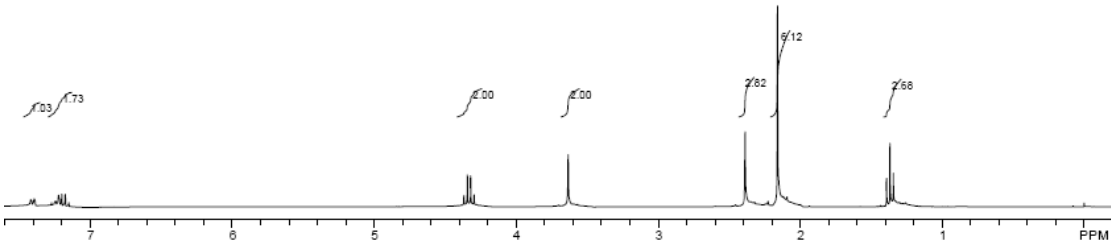
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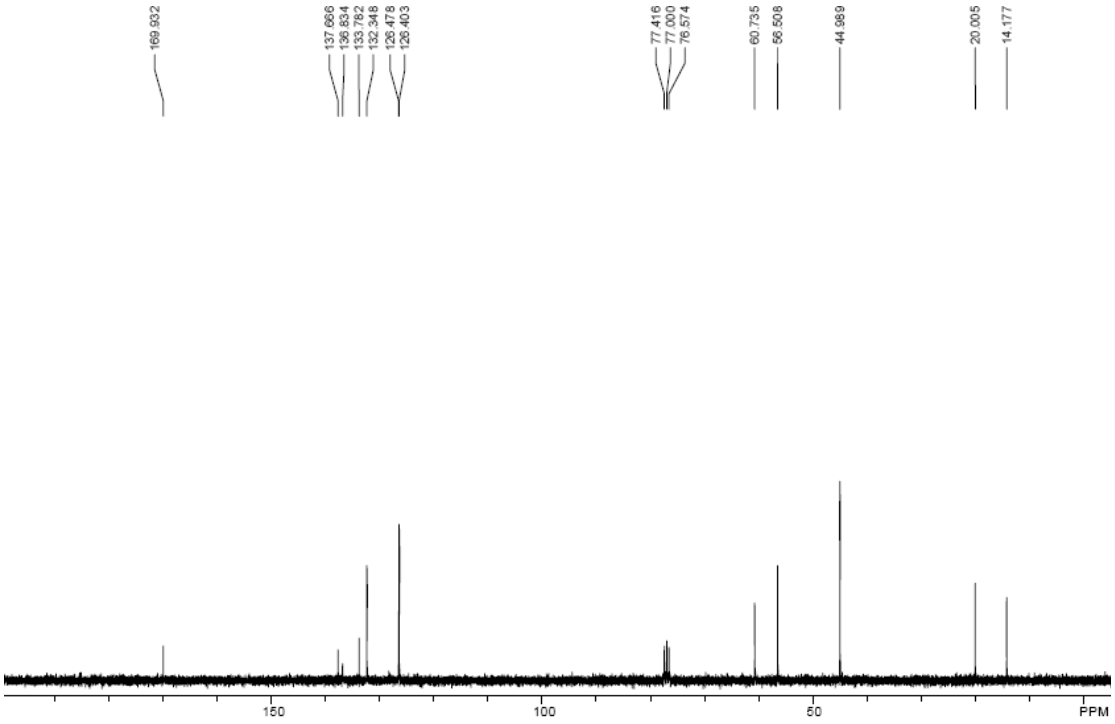
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20.005
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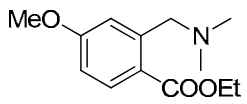
PPM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COOEt

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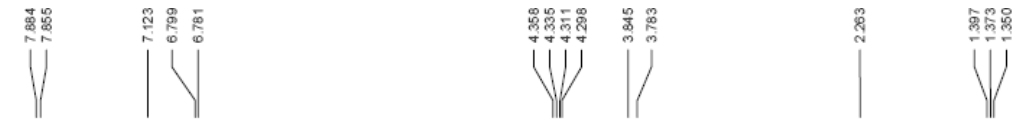
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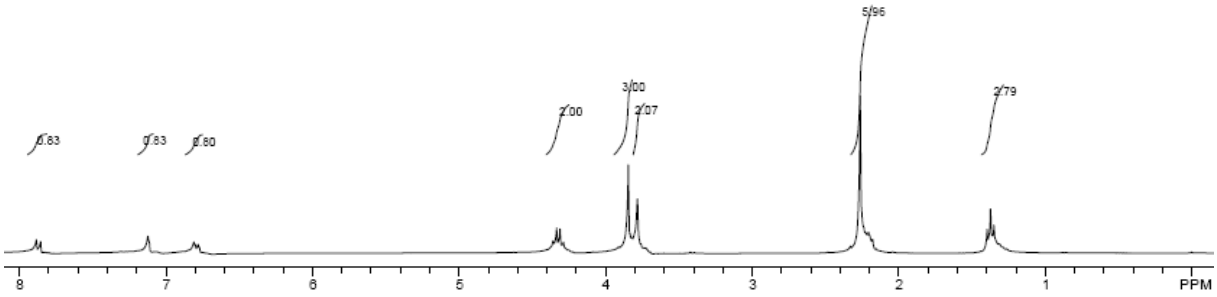
1.350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0.80
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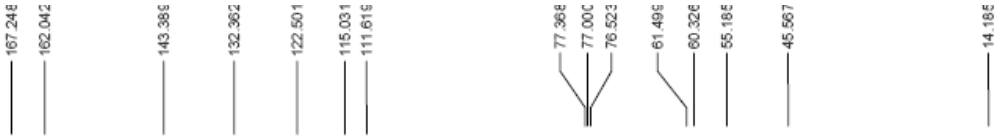
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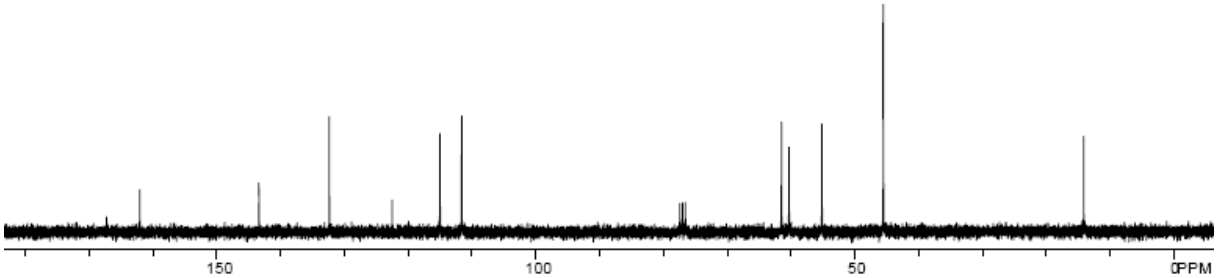
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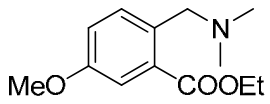
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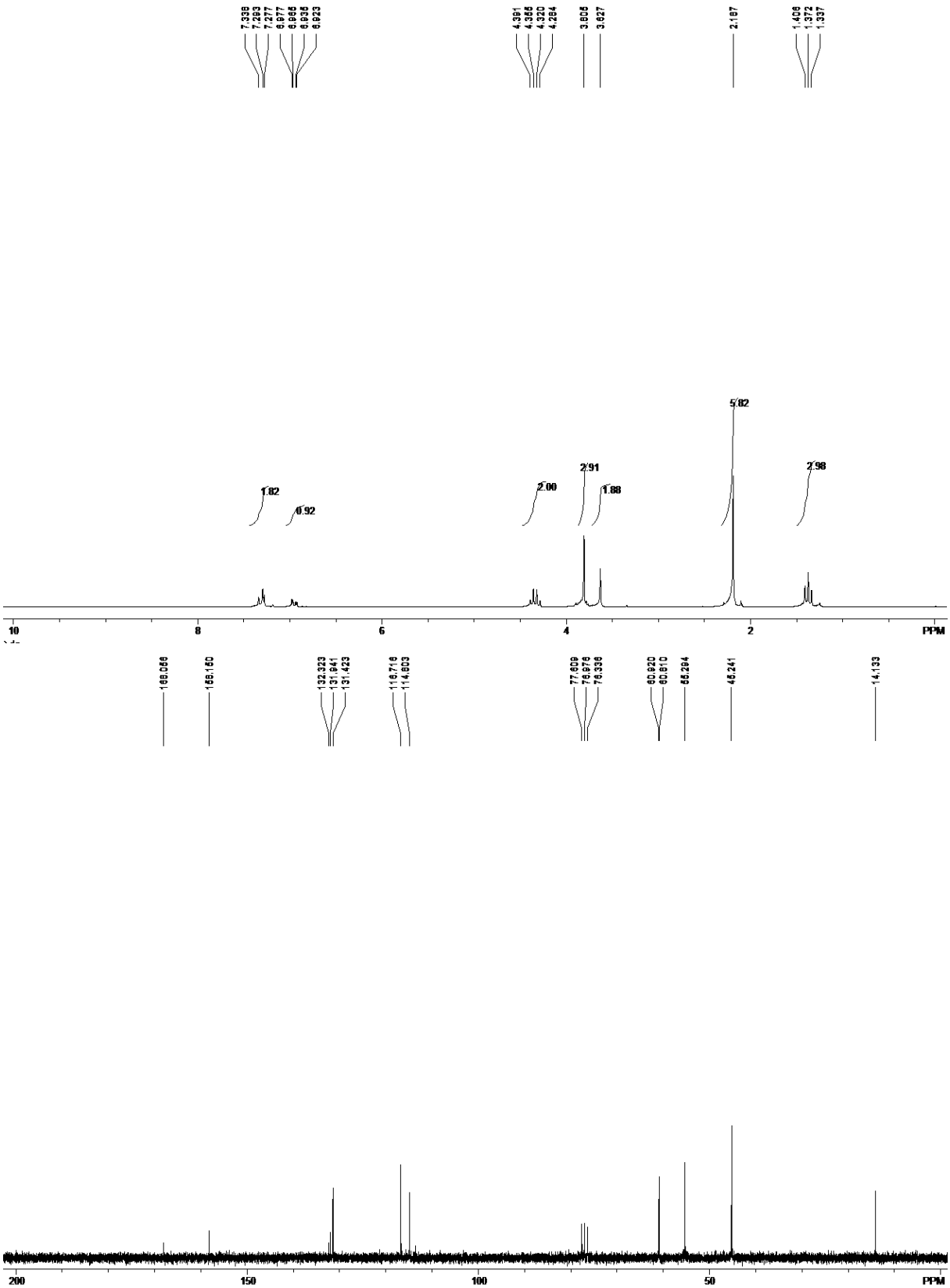
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1.337
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1.88
5.82
2.98
10
8
6
4
2
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131.841
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116.716
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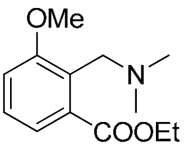
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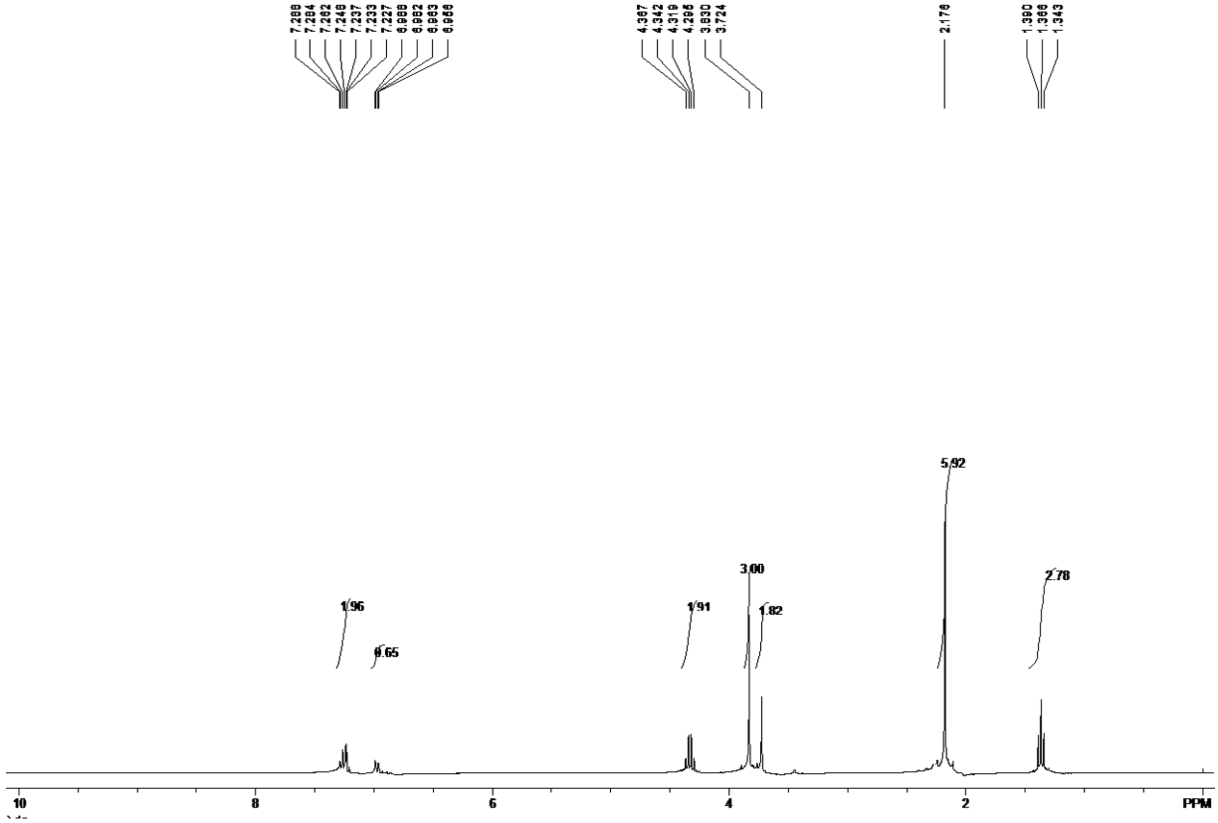
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4.342
4.319
4.295
3.830
3.724
2.176
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1.366
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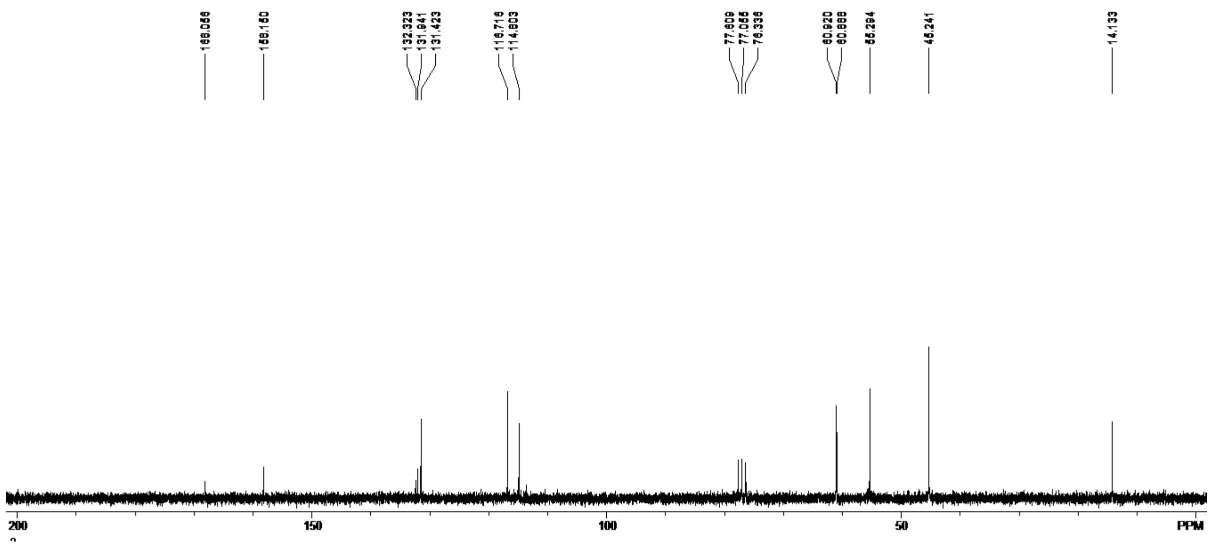
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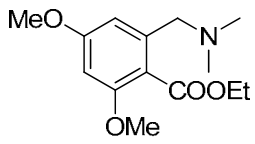
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COOEt
OMe

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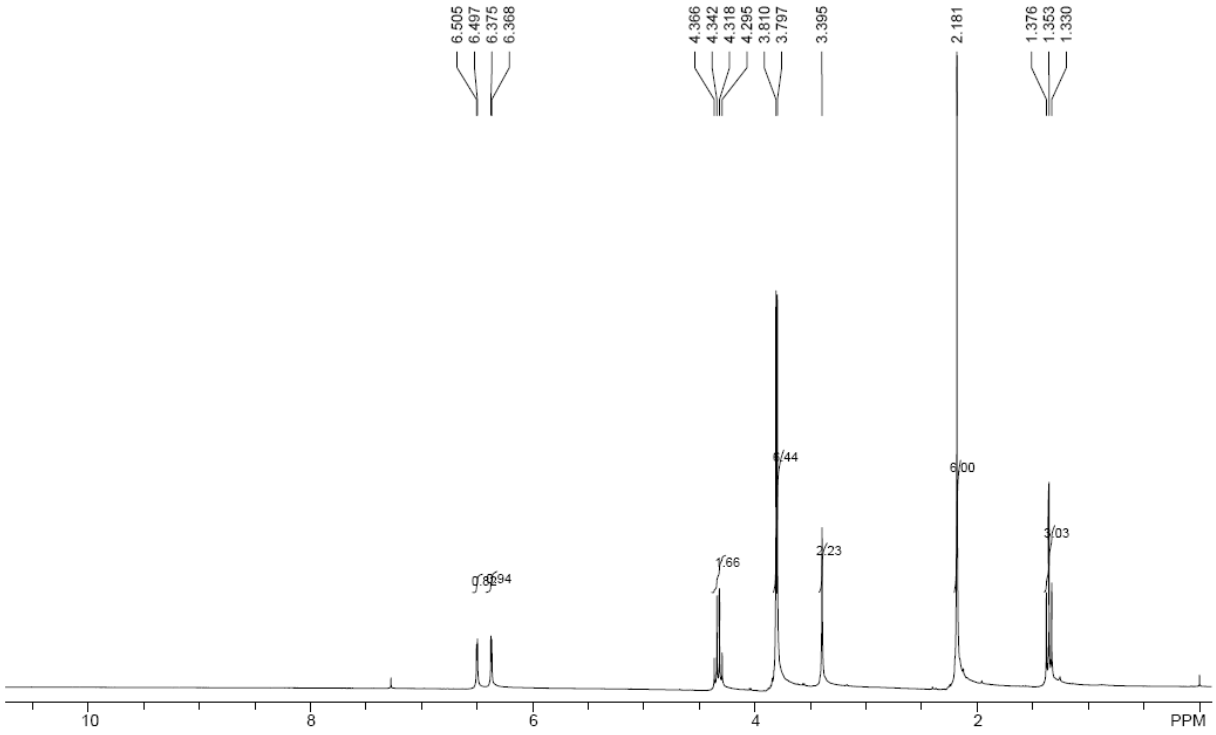
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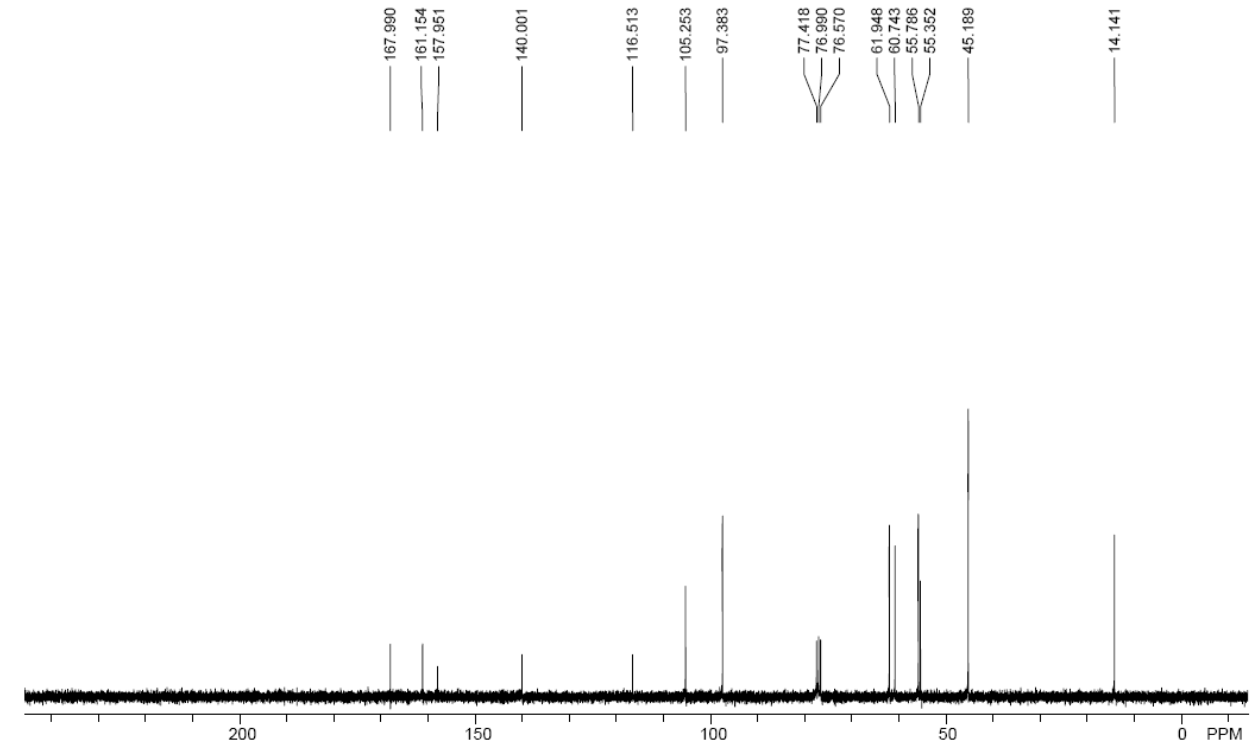
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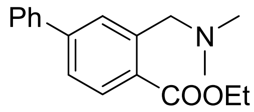
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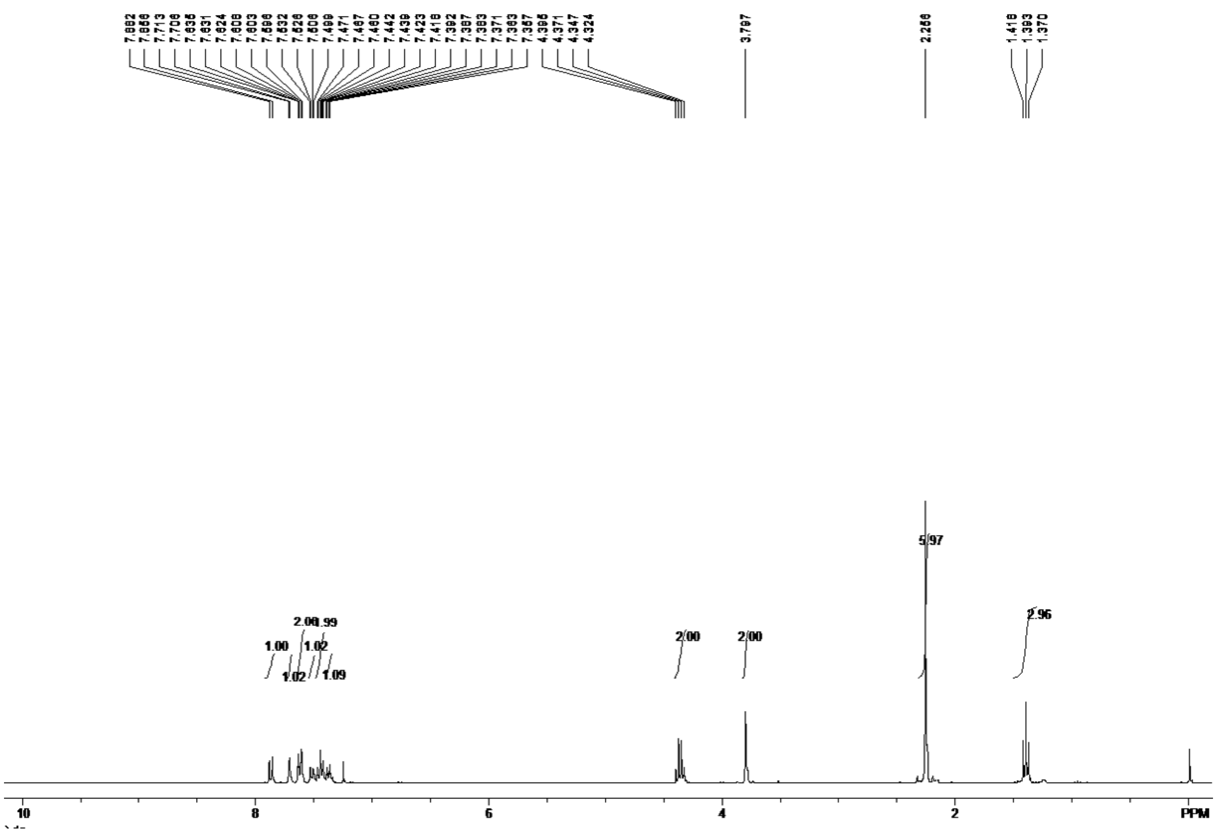
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7.506
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7.423
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7.392
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7.363
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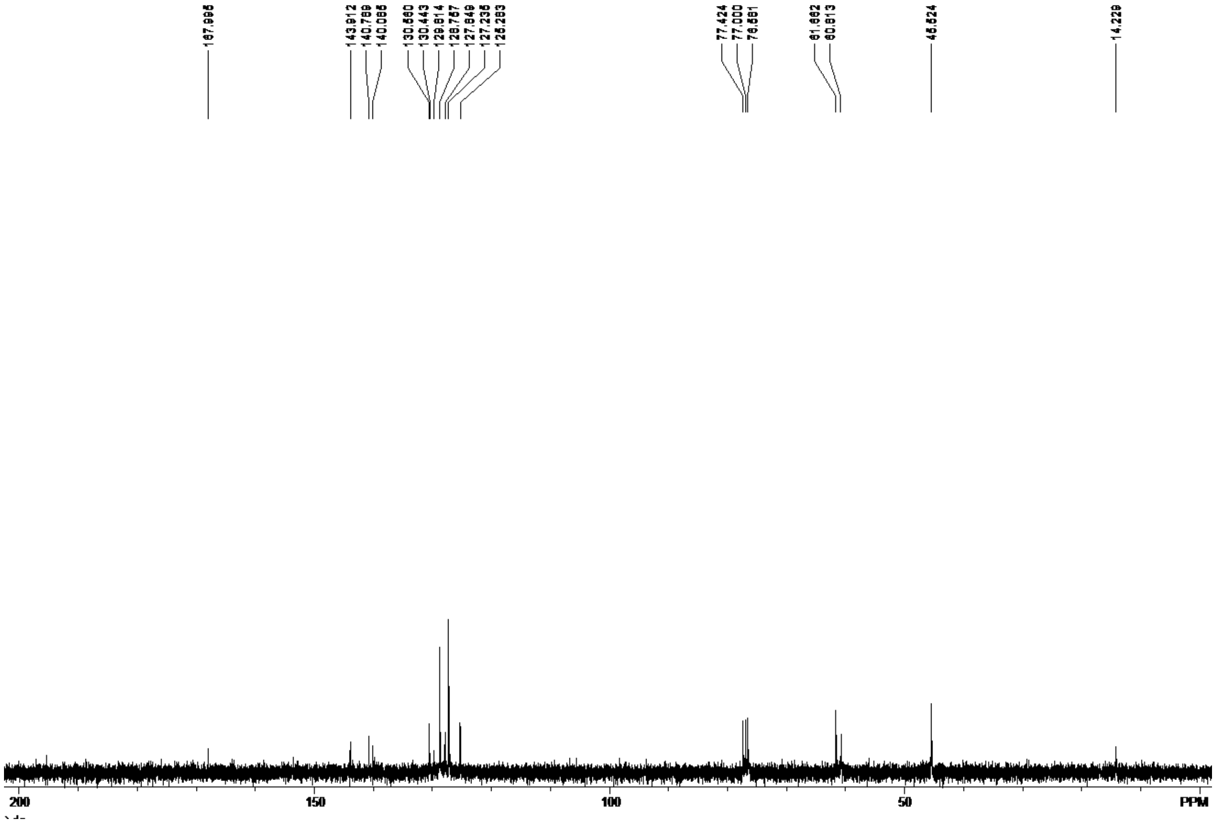
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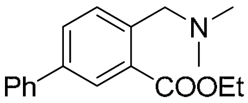
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COOEt

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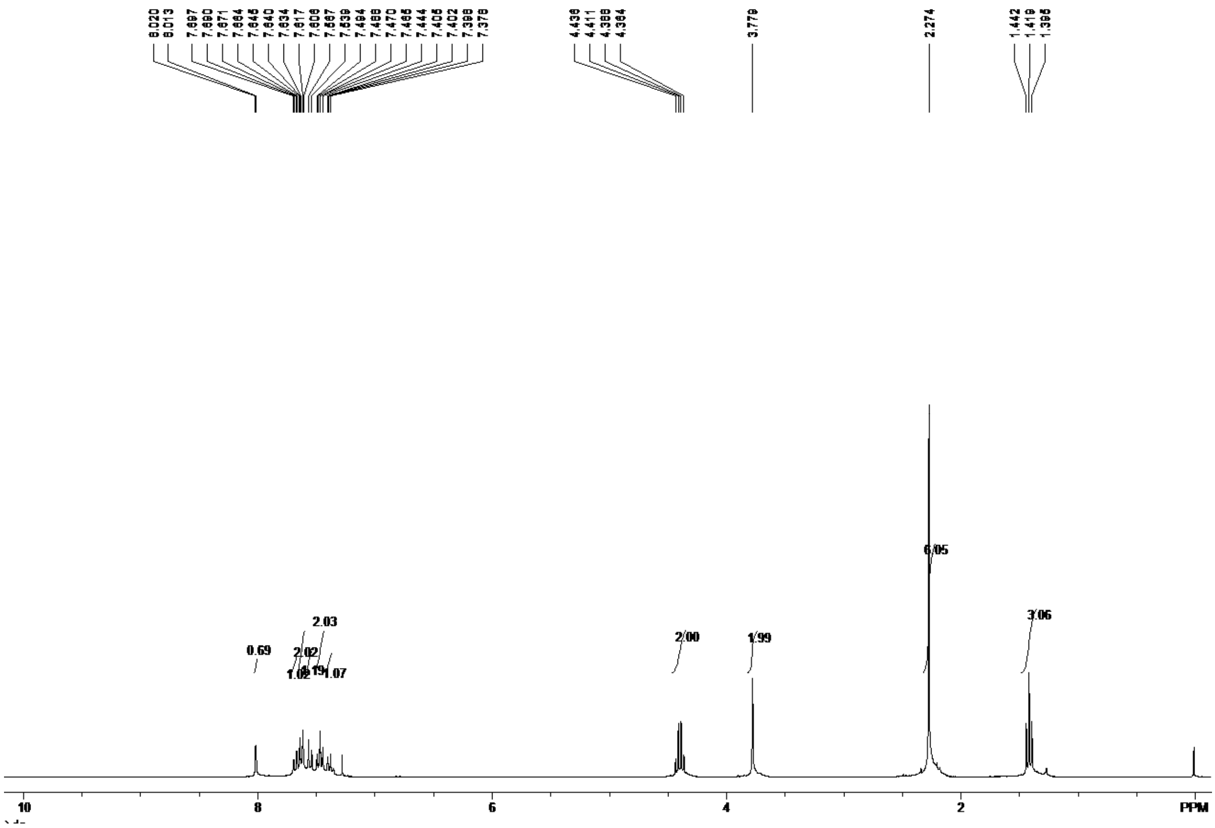
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7.402
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3.06
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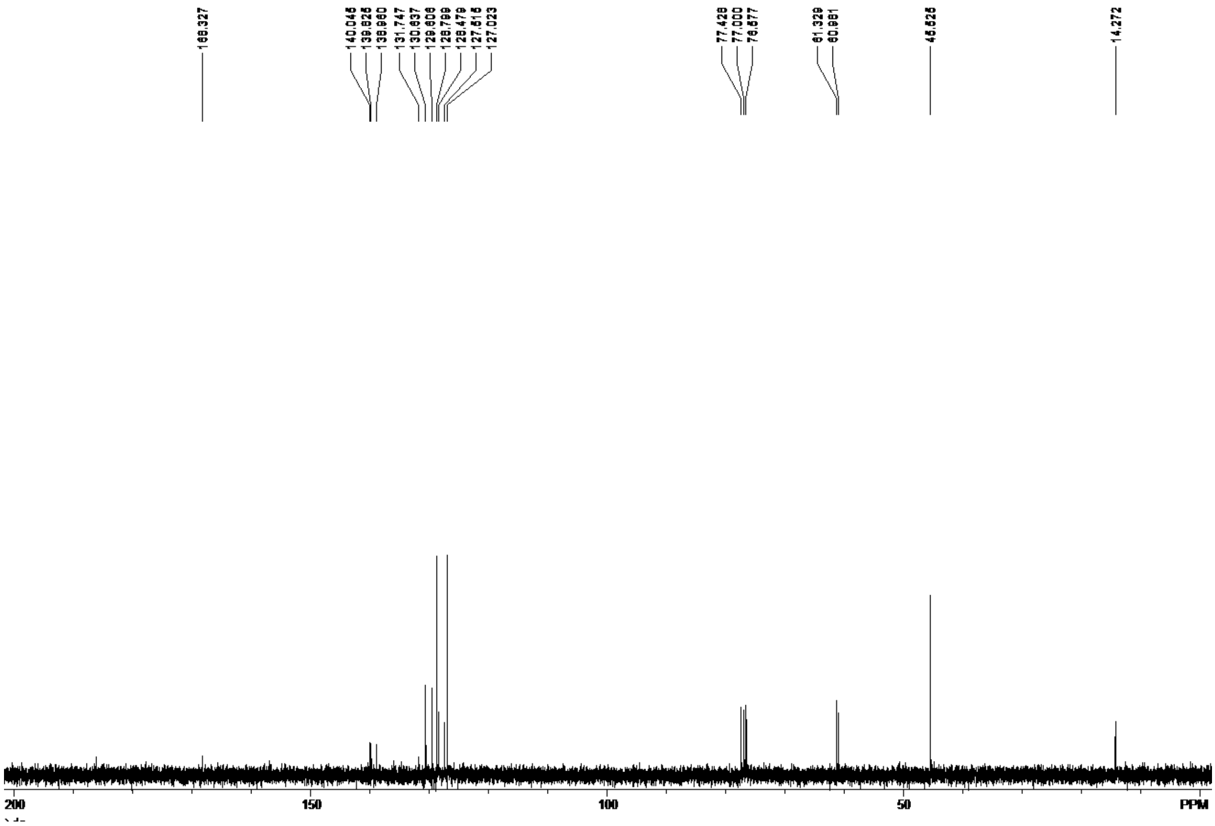
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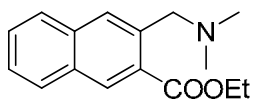
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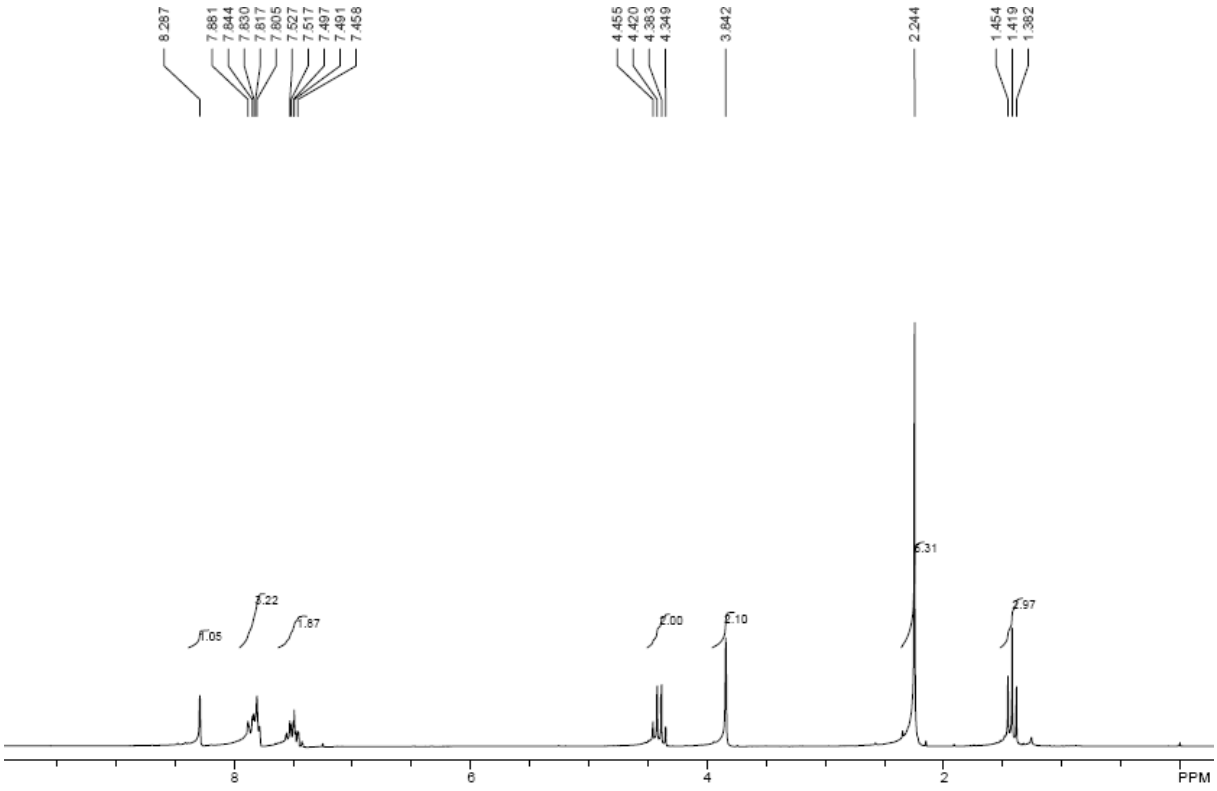
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4.420
4.383
4.349
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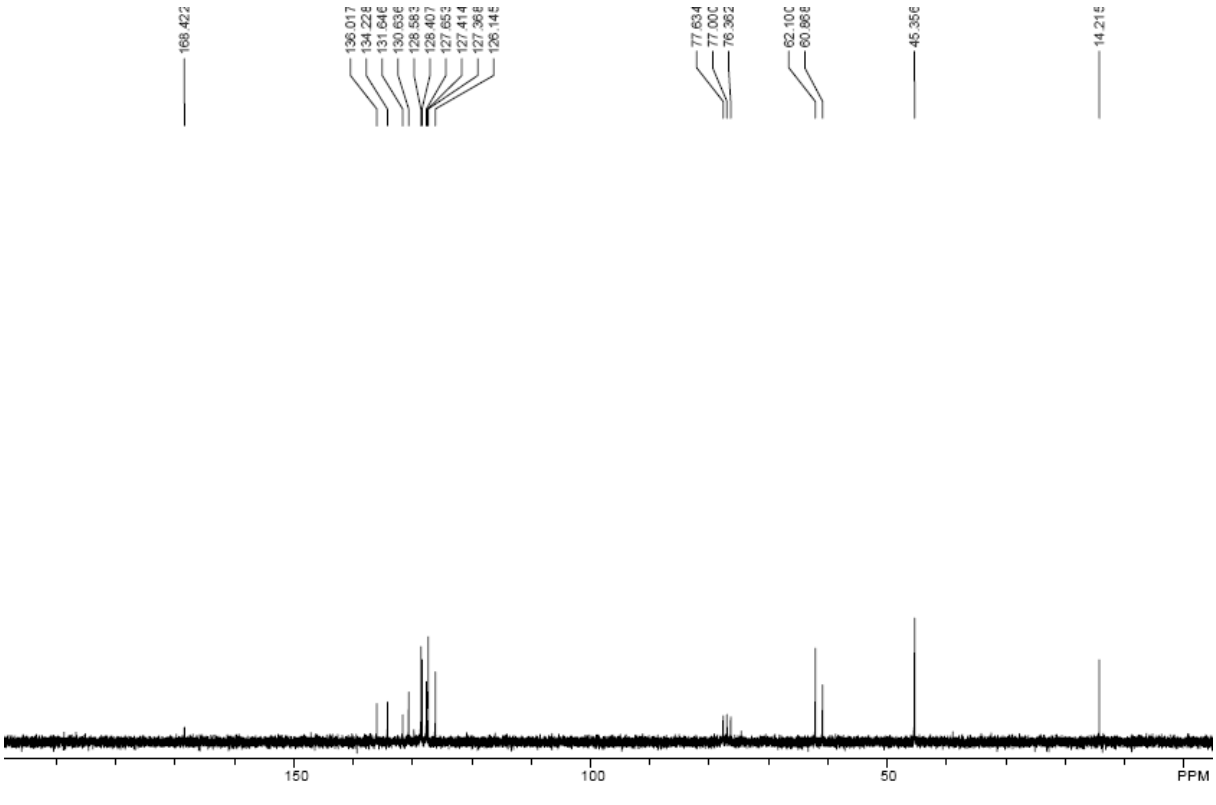
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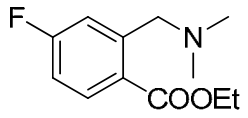
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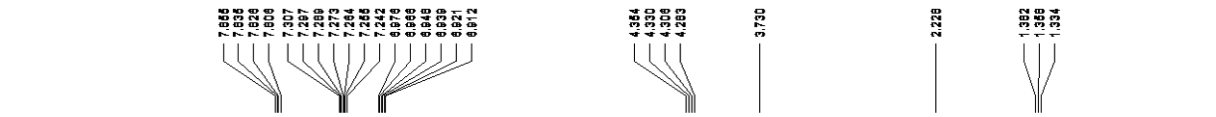
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6.956
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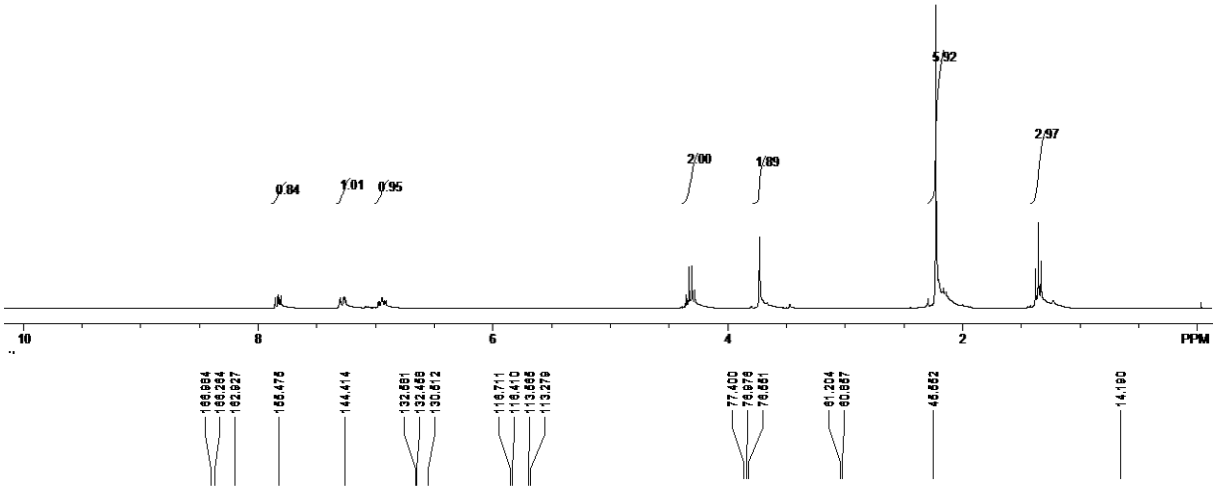
1.334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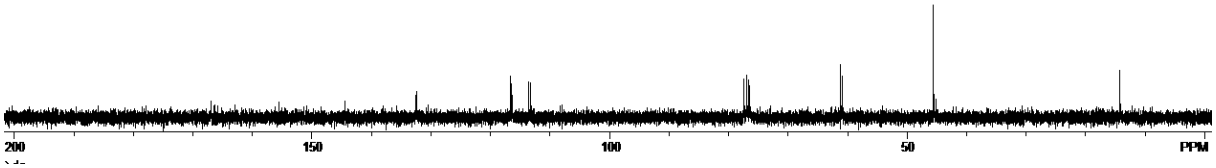
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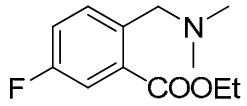
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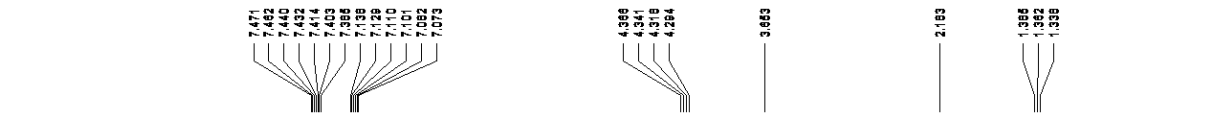
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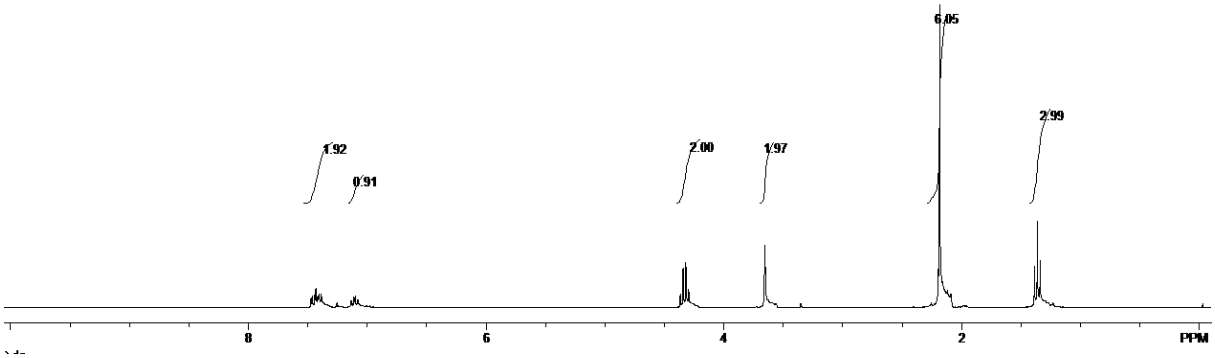
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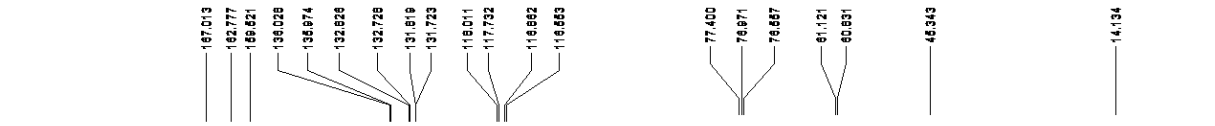
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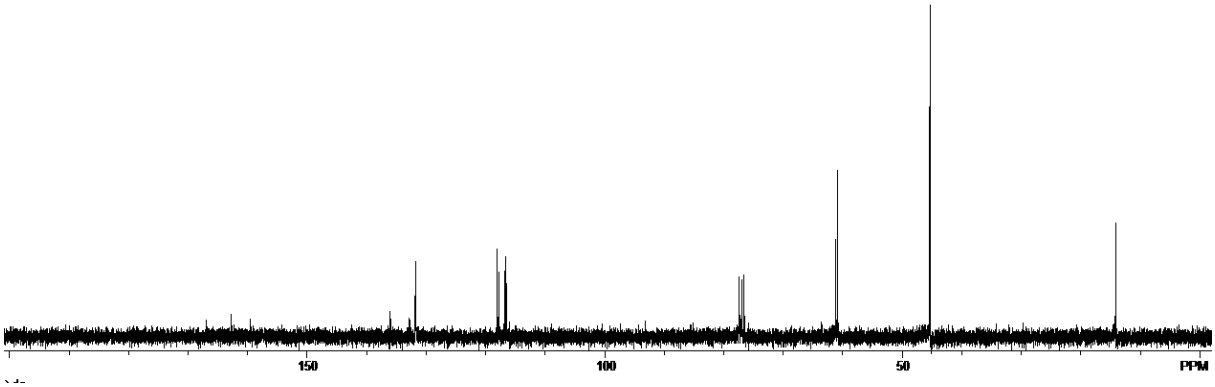
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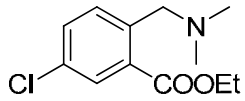
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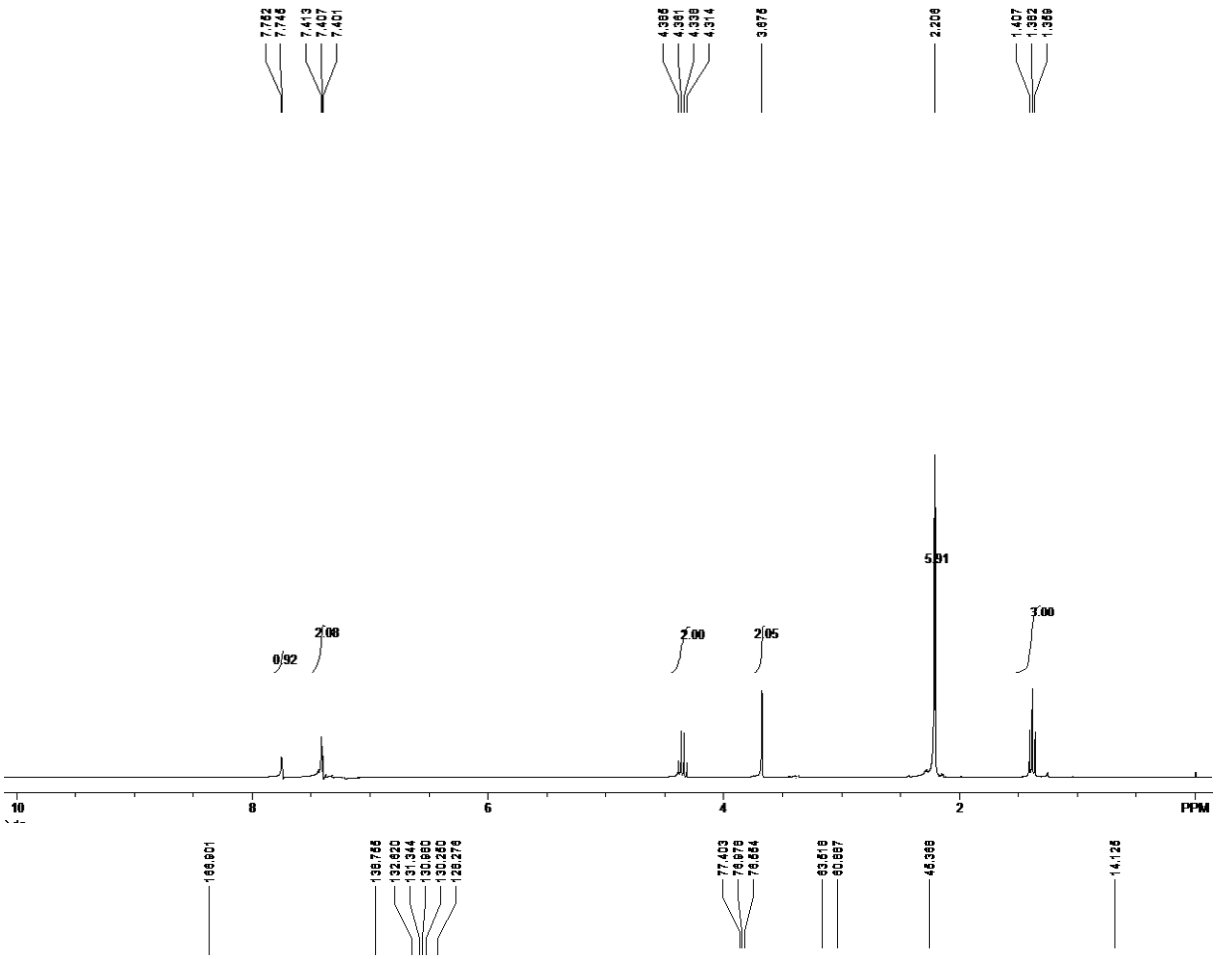
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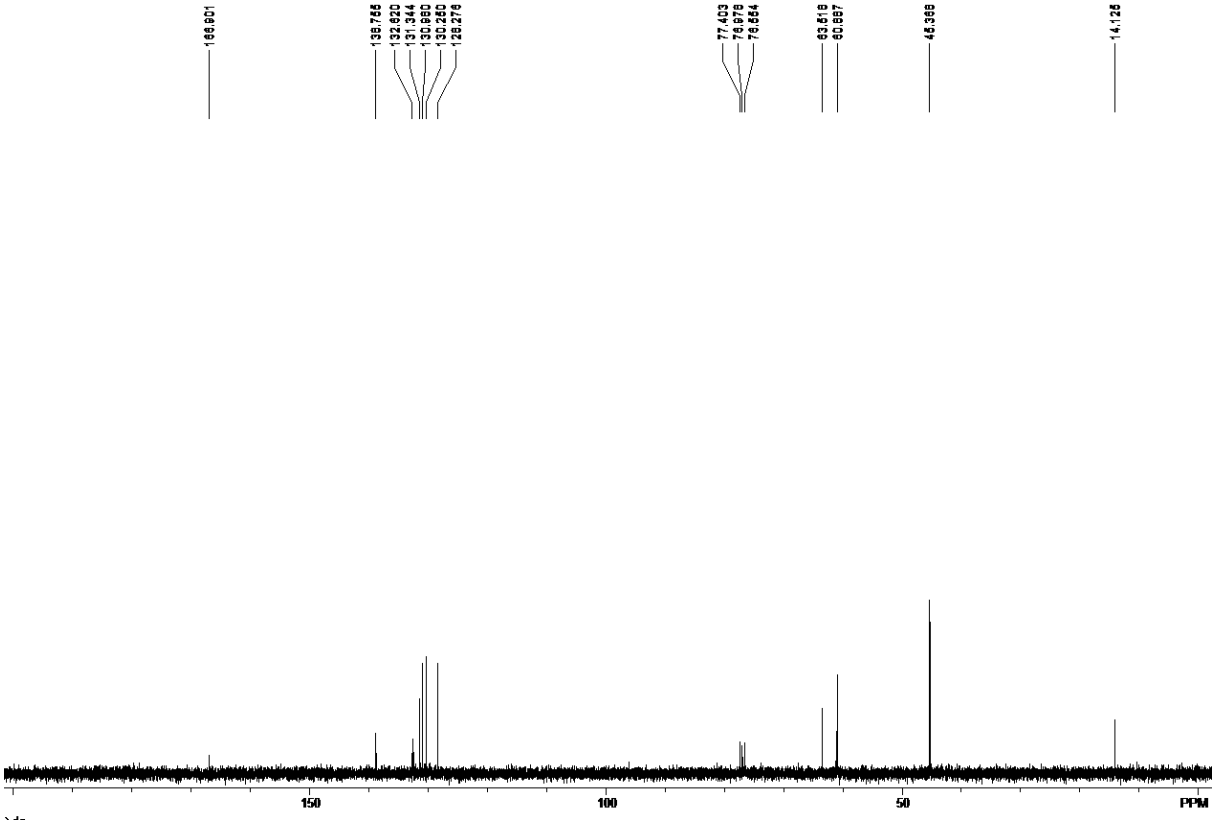
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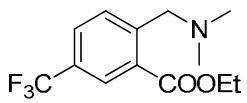
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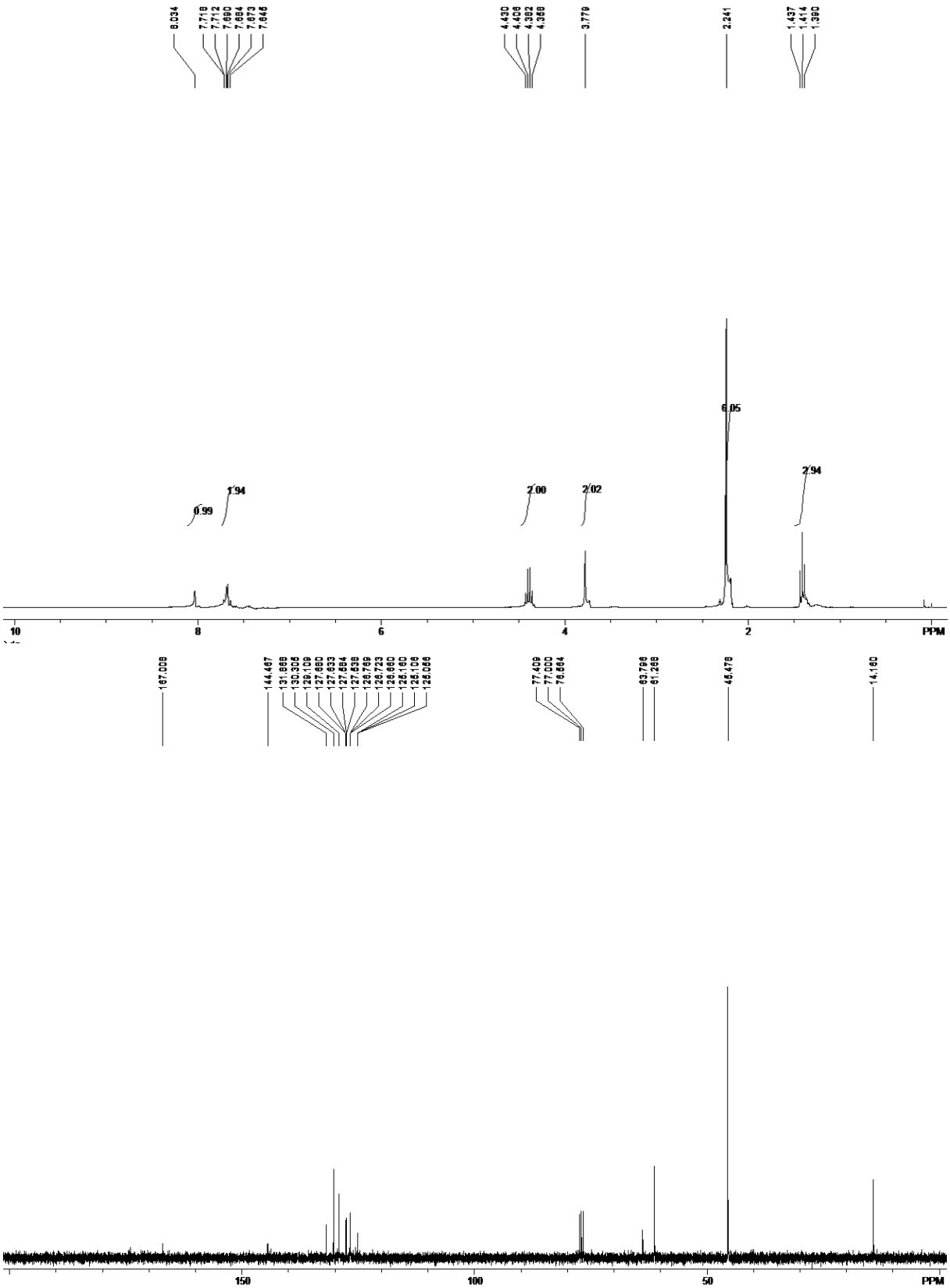
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PPM
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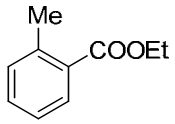
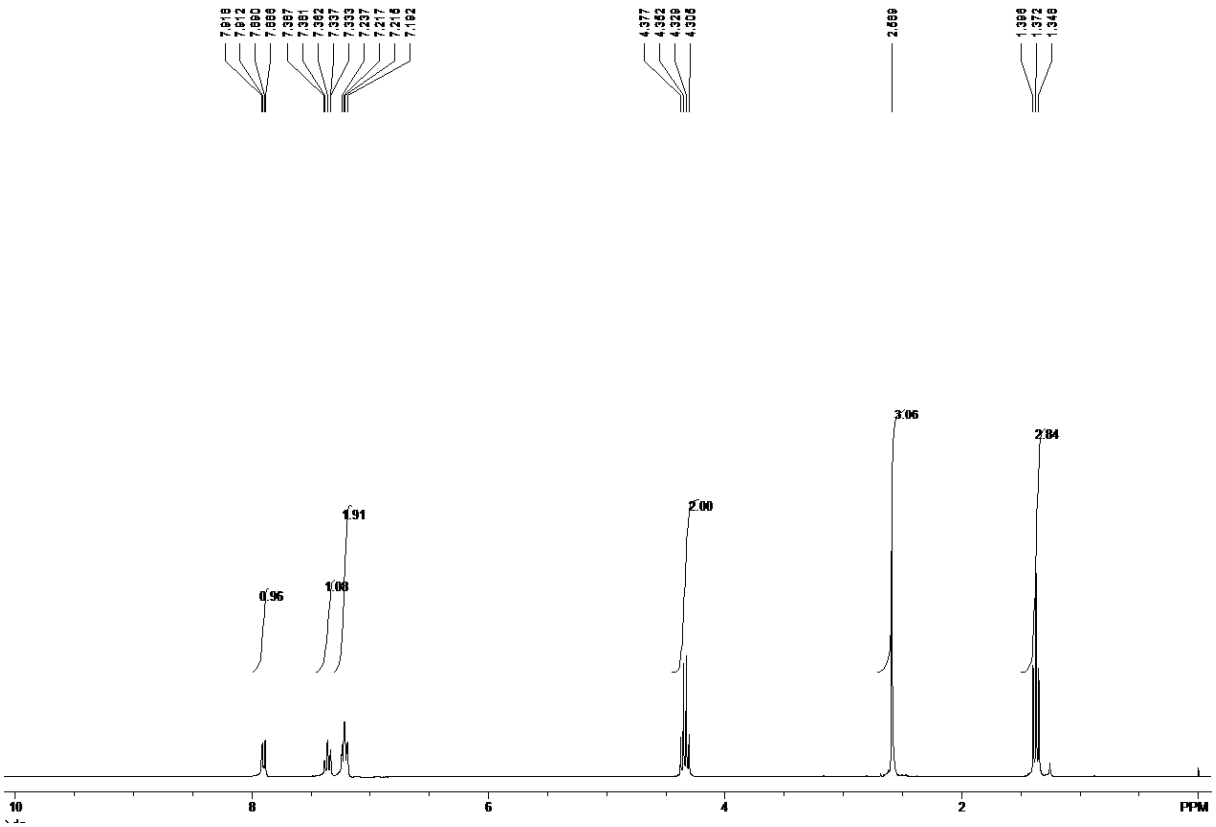
127.880
127.633
127.584
127.538
126.769
126.723
126.680
126.160
126.108
126.056
77.409
77.000
76.594
63.798
61.266
45.478
14.160
150
100
50
PPM


Me
COOEt

10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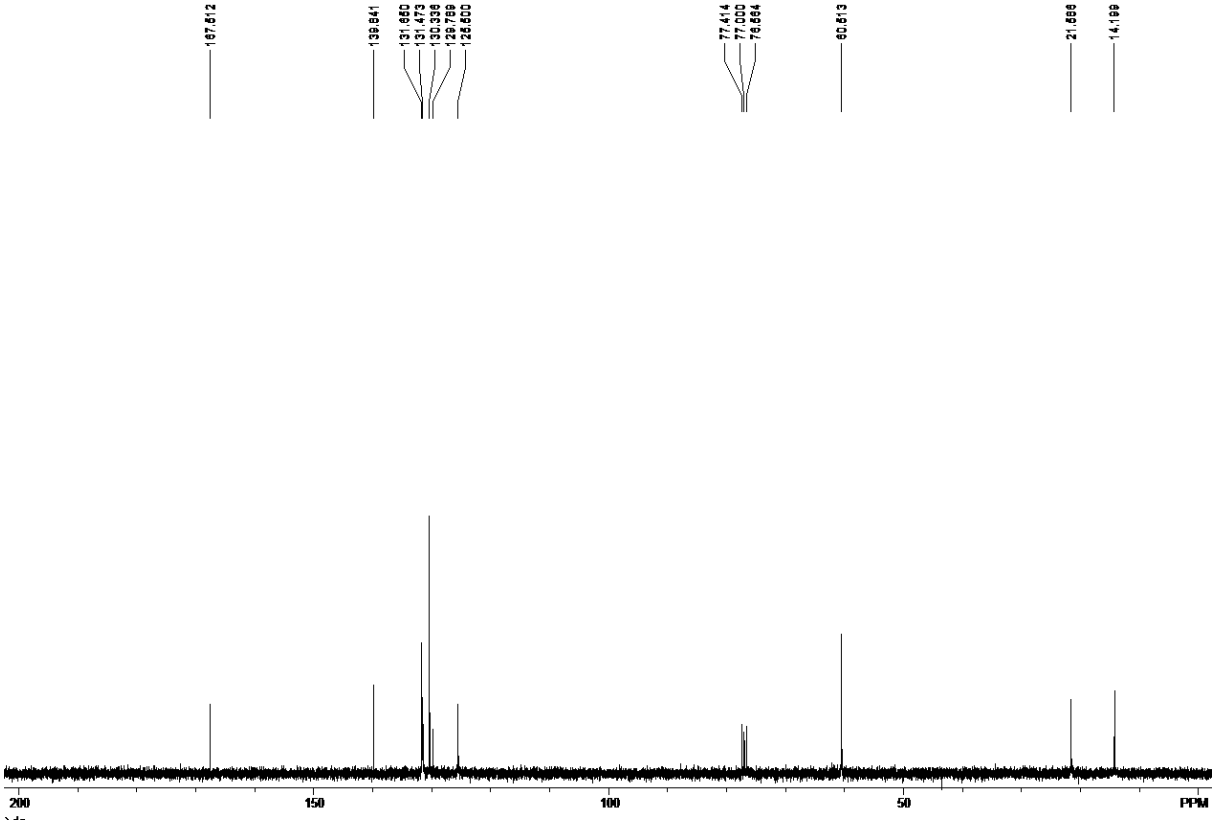
7.612
7.600
7.586
7.367
7.351
7.342
7.337
7.333
7.237
7.217
7.216
7.192
4.377
4.362
4.329
4.305
2.659
1.396
1.372
1.346
0.96
1.00
1.91
2.00
3.06
2.84
10
8
6
4
2
PPM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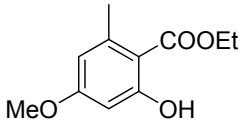
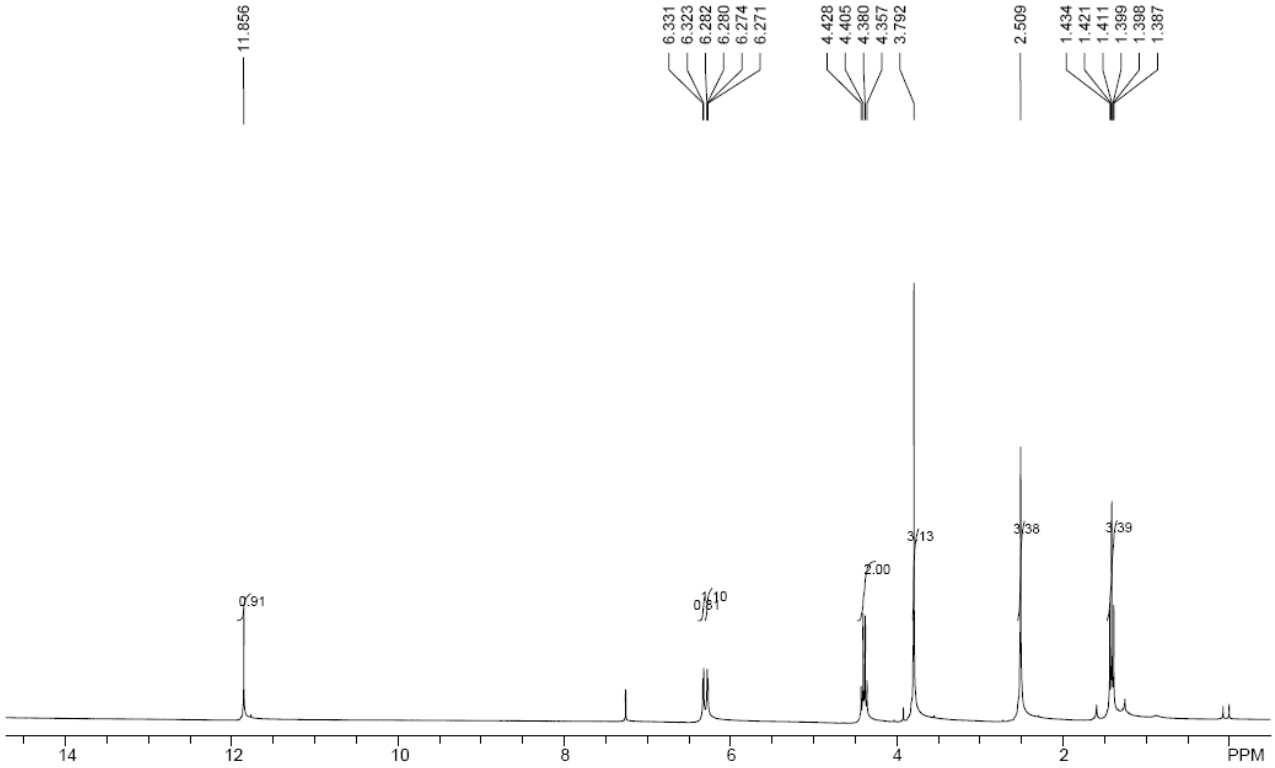
139.841
131.660
131.473
130.338
129.789
128.800
77.414
77.000
76.584
60.613
21.666
14.199
200
150
100
50
PPM


COOEt
MeO
OH

11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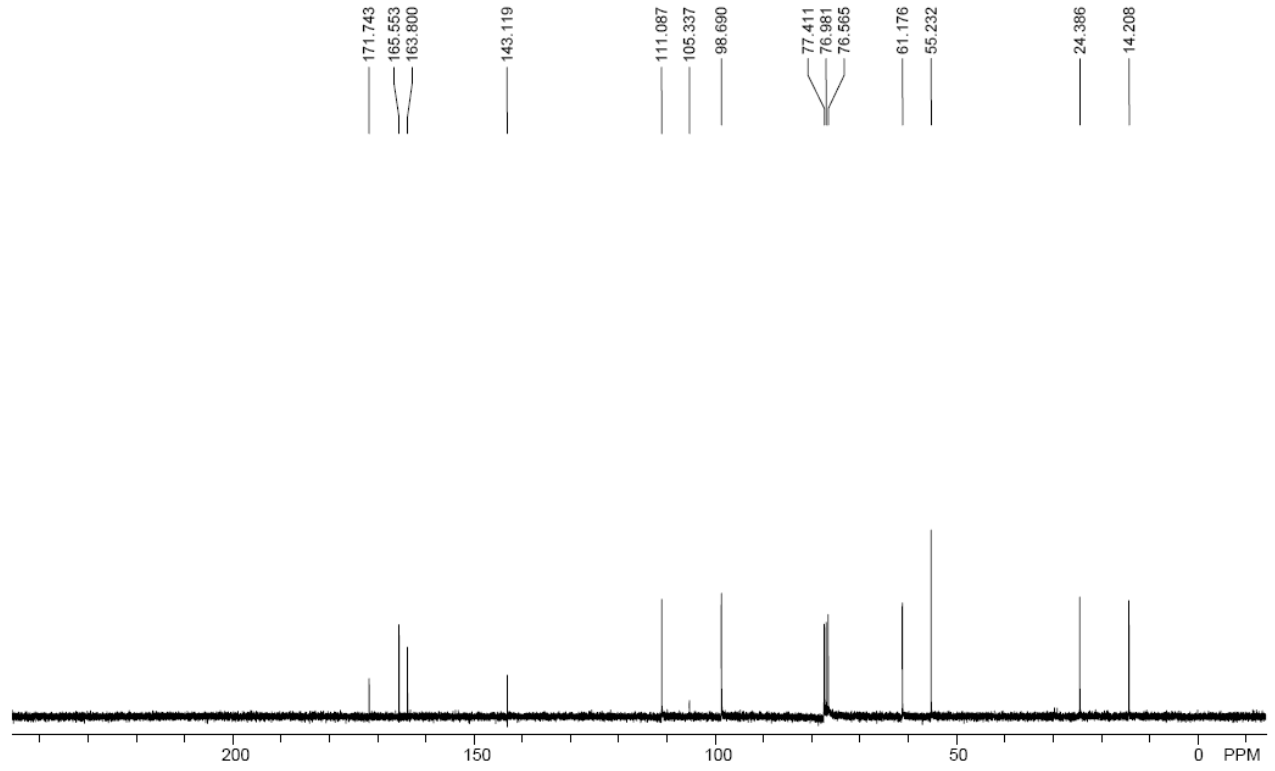
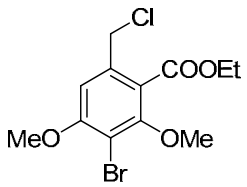
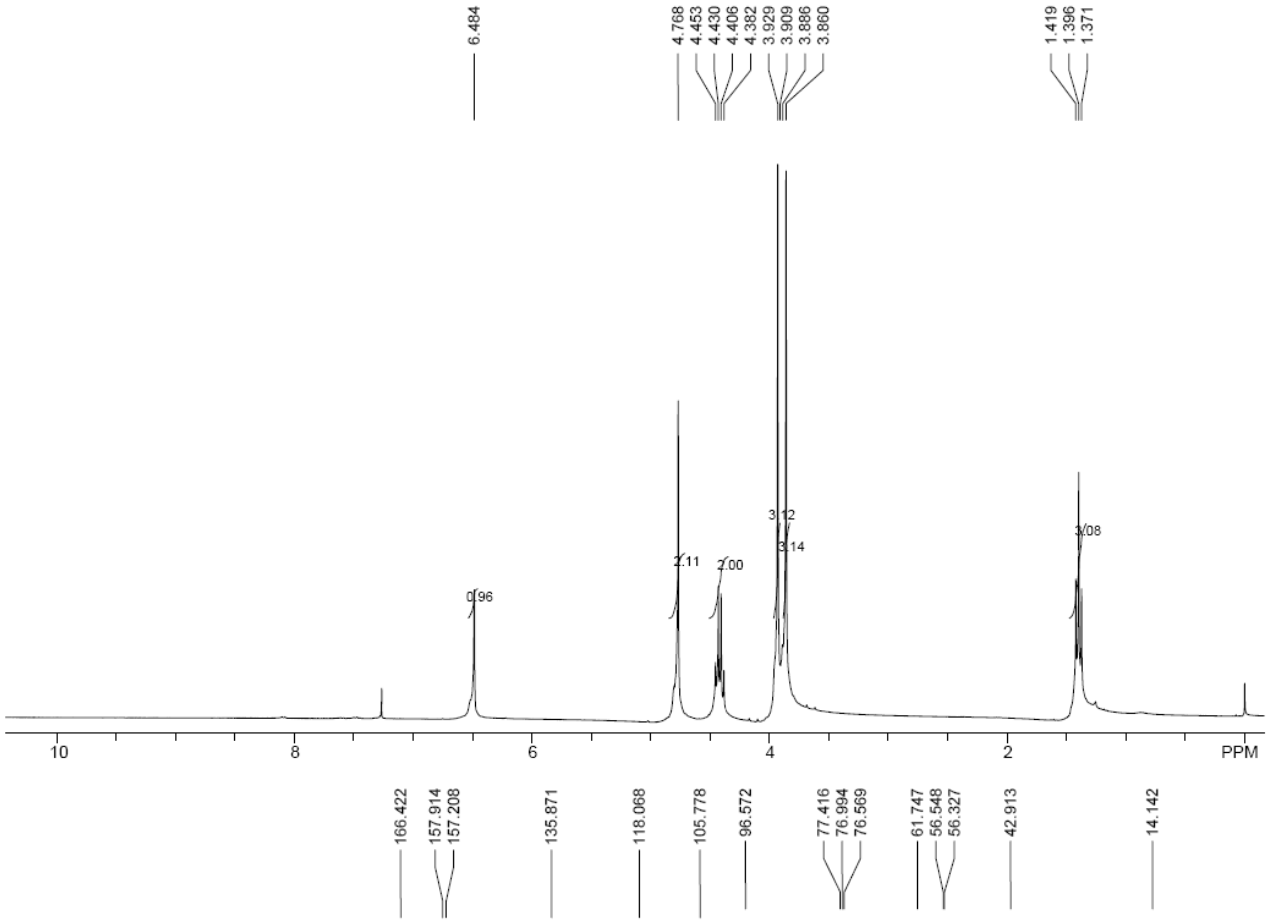
6.331
6.323
6.282
6.280
6.274
6.271
4.428
4.405
4.380
4.357
3.792
2.509
1.434
1.421
1.411
1.399
1.398
1.387
0.91
0.81
1.10
2.00
3.13
3.38
3.39
14
12
10
8
6
4
2
PPM


171.743
165.553
163.800
143.119
111.087
105.337
98.690
77.411
76.981
76.565
61.176
55.232
24.386
14.208
200
150
100
50
0
PPM


Cl
COOEt
MeO
OMe
Br

12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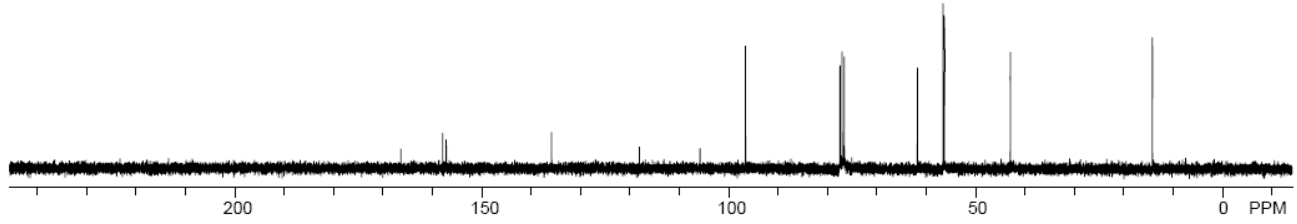
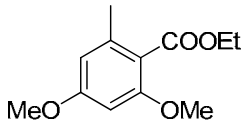
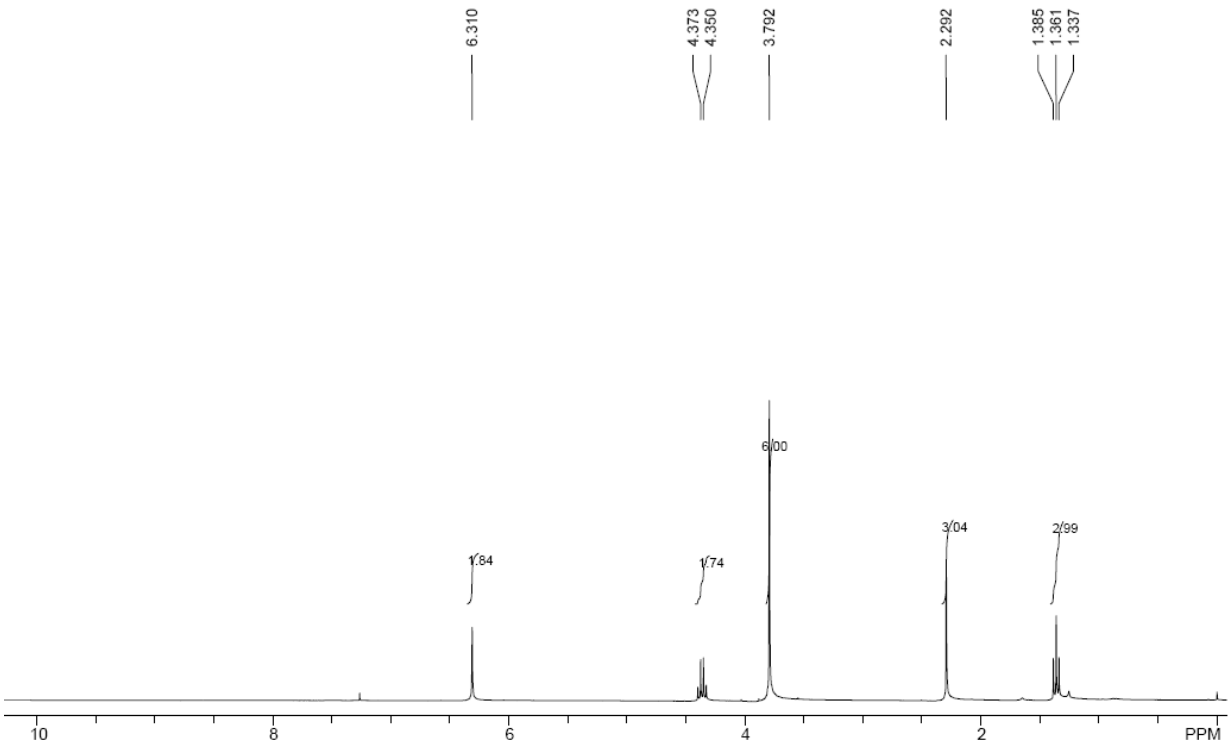
4.768
4.453
4.430
4.406
4.382
3.929
3.909
3.886
3.860
1.419
1.396
1.371
0.96
2.11
2.00
3.12
3.14
3.08
10
8
6
4
2
PPM

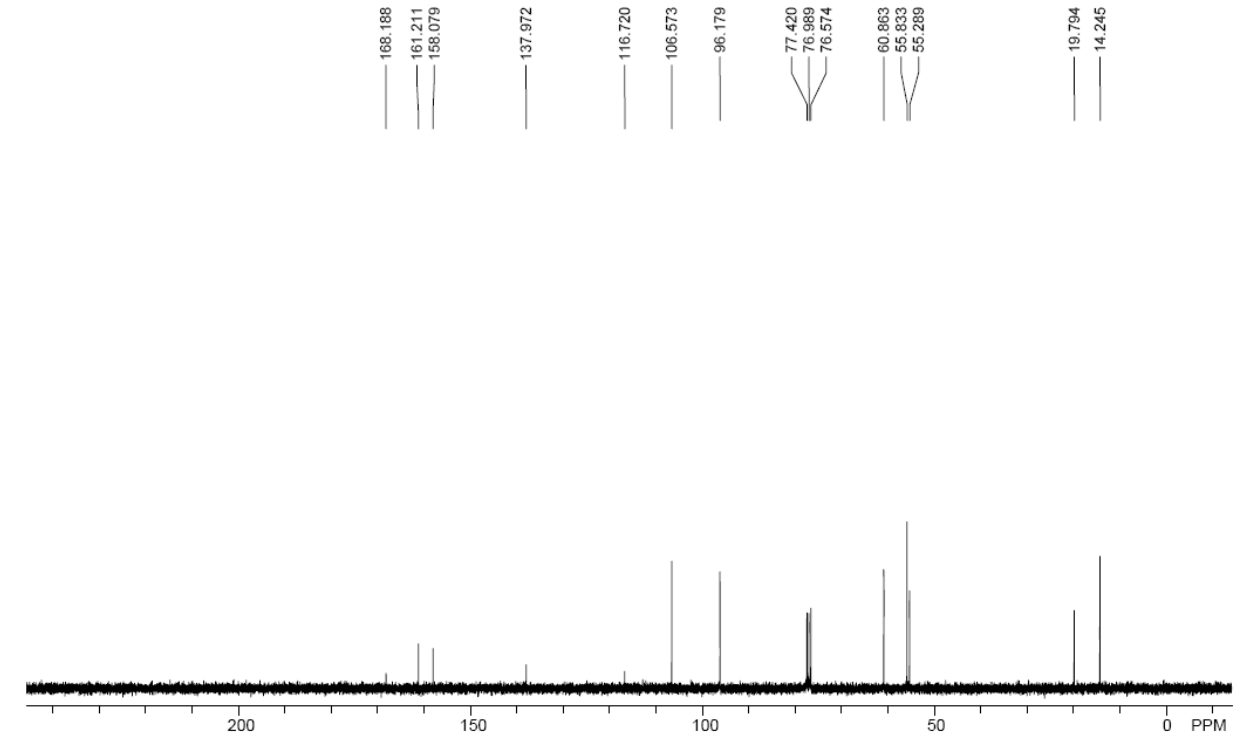
166.422
157.914
157.208
135.871
118.068
105.778
96.572
77.416
76.994
76.569
61.747
56.548
56.327
42.913
14.142

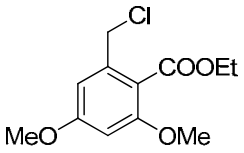

200
150
100
50
0
PPM


COOEt
MeO
OMe

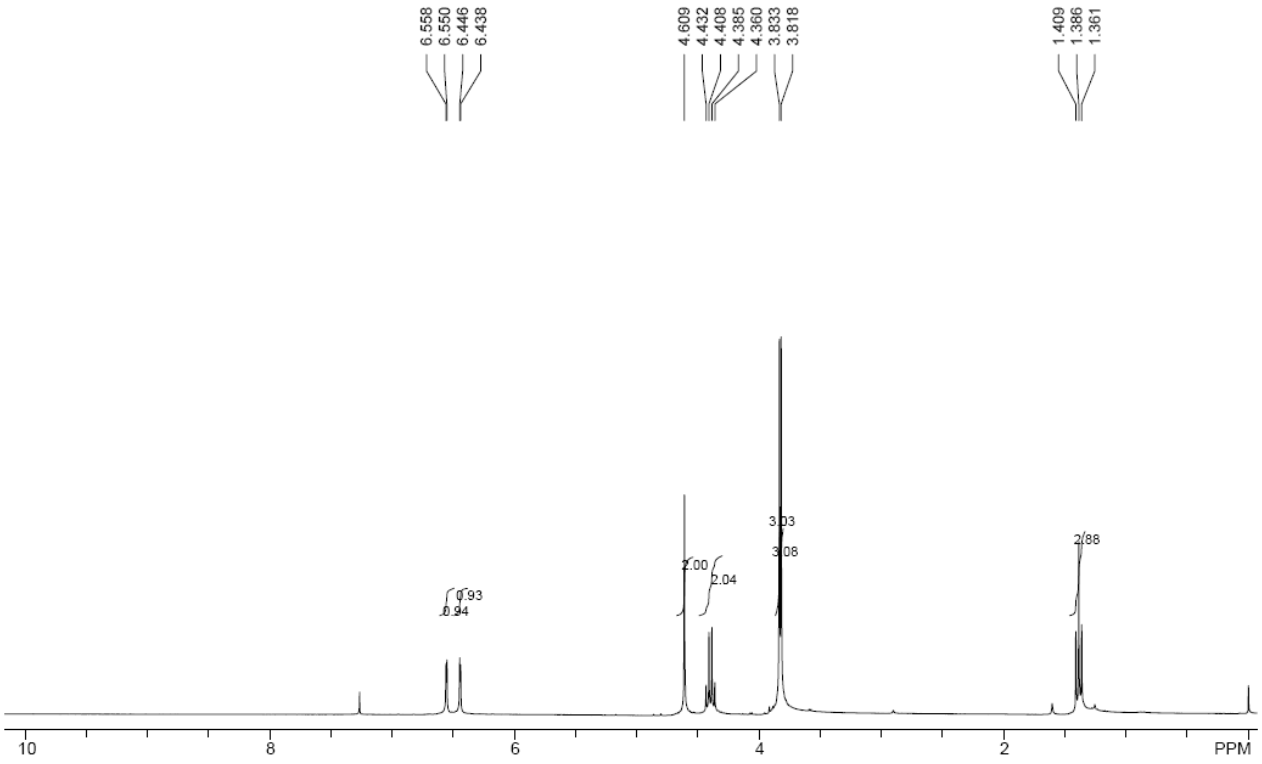
13

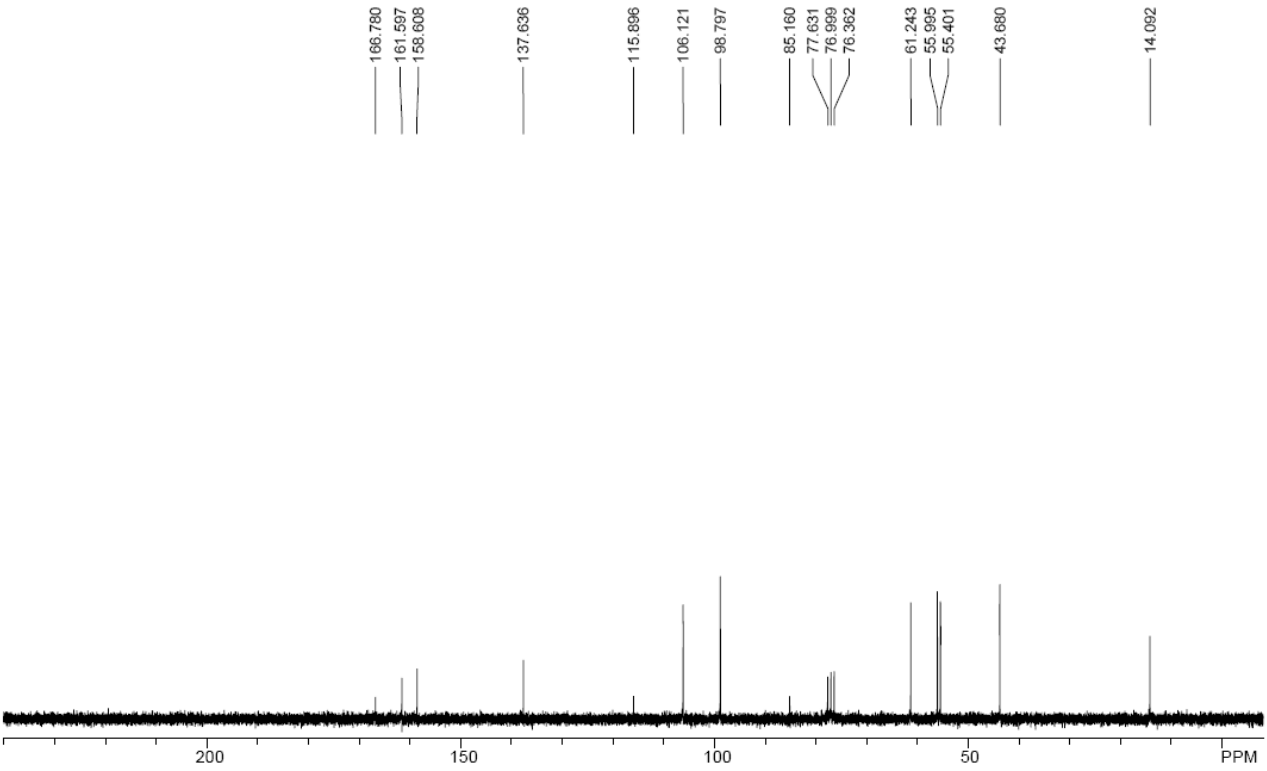

6.310
4.373
4.350
3.792
2.292
1.385
1.361
1.337
1.84
1.74
6.00
3.04
2.99
10
8
6
4
2
PPM


168.188
161.211
158.079
137.972
116.720
106.573
96.179
77.420
76.989
76.574
60.863
55.833
55.289
19.794
14.245
200
150
100
50
0
PPM


Cl
COOEt
MeO
OMe

14


6.558
6.550
6.446
6.438
4.609
4.432
4.408
4.385
4.360
3.833
3.818
1.409
1.386
1.361
0.93
0.94
2.00
2.04
3.03
3.08
2.88
10
8
6
4
2
PPM


166.780
161.597
158.608
137.636
115.896
106.121
98.797
85.160
77.631
76.999
76.362
61.243
55.995
55.401
43.680
14.092
200
150
100
50
PPM