Electronic Supplementary Material (ESI) for Chemical Communications.

Microwave-Assisted Chemoselective Transamidation of Secondary Amides by Selective N-C(O) bond Cleavage Under Catalyst, Additive and Solvent-Free Conditions

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Supporting information

Contents

Experimental Section

General Information

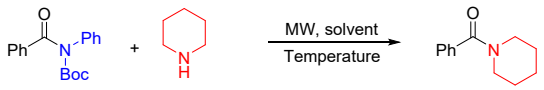
All the chemicals were purchased from Sigma-Aldrich suppliers and used without further purification. Thin layer chromatography (TLC) was conducted with analytical thin layer percolated E. Merck 60 GF254 silica gel plates and spots were visualized using UV light and or iodine vapour and column chromatography was carried out using silica gel of 60-120 mesh size. The melting points were determined in open capillary melting point apparatus and are uncorrected. The microwave irradiation was carried out in CEM's Discover BenchMate single-mode microwave reactor (BenchMate model, USA) system using safe pressure regulation 10-cm^3 pressurised vials with ''snap-on'' caps. ^1H and ^{13}C NMR spectra were recorded on Bruker Avance 500 MHz spectrometer in $CDCl_3$ and DMSO-d_6 using TMS as the internal standard at 500 and 126 MHz frequency respectively. All products synthesised were confirmed by using melting point, ^1H, ^{13}C NMR, mass spectra and the reported compounds were compared with the literature data.

Optimization of the reaction conditions

Initially, the unactivated amide, such as *N*-phenyl benzamide, was subjected to the transamidation reaction with piperidine **2a** to obtain the product **3a**. The reaction was conducted under microwave irradiation without catalysts, additives, and promoters at 150 W. However, the desired product **3a** was not obtained under the above-said conditions. Then we performed the reaction with *N*-activated secondary amide, *i.e., N*-Boc, *N*-phenylbenzamide **1a** with piperidine **2a** under the same reaction conditions. To our delight, this reaction gave the product **3a** a good yield. Encouraged by this result, *N*-Boc, *N*-phenylbenzamide **1a**, and piperidine **2a** were chosen as model substrates, and different reaction conditions were examined.

The reaction was carried out in different polar solvents like water, ethanol, methanol, DMF, 1,4- dioxane, dichloromethane, and acetonitrile under controlled microwave irradiation at 150 W in catalyst-free condition for 1 h at 60 ^oC, which offered only 30 to 55% of the desired product **3a** (Table S1, entry 1-7). Hence, the reaction was carried out in solvent-free conditions at 150 W at 60 ^oC. Surprisingly the reaction gave the product **3a** in 62% yield within 15 min (Table S1, entry 8). Next, we investigated the effect of microwave power on the yield of the product formation by varying microwave power from 150 W to 350 W in solvent-free conditions at 60 ^oC. A better yield of 80% was obtained at 300 W in 10 min (Table S1, entry 10). To find the optimal temperature, we conducted the experiments at progressively higher temperatures, 70 ^oC, 80 ^oC and 100 ^oC. Interestingly the reaction at 80 ^oC under solvent-free conditions was driven to completion with the desired product **3a** to a maximum yield of 93% in 8 min (Table S1, entry 13). Further, an increase in temperature above 80 °C did not show any improvement in yield (Table S1, entries 14). To understand the assistance effect of microwave the model reaction was conducted under the same reaction conditions in the conventional heating method (without microwave) it gave only 20 % yield of the product **3a** even after 4 h (Table S1, entries 15). This suggests that *N*-Boc, *N*-phenylbenzamide **1a**, (1.0 mmol), piperidine **2a**, (1.5 mmol) at 80 °C in MW, 300 W under catalyst and solvent-free is the optimal condition for this transamidation reaction.

Table S1. Optimization of reaction conditions for transamidation of *N*-Boc, *N*-phenylbenzamide under microwave irradiation[a]



1a **2a** **3a**

Entry	Solvent	microwave power (W)	Temp. (°C)	Time (min.)	Yields (%)[b]
1	Water	150	60	60	30
2	Ethanol	150	60	60	35
3	Methanol	150	60	60	38
4	1,4 Dioxane	150	60	60	32
5	DMF	150	60	60	55
6	DMSO	150	60	60	45
7	Acetonitrile	150	60	60	40
8	-	150	60	15	62
9	-	200	60	12	75
10	-	300	60	10	80
11	-	350	60	10	80
12	-	300	70	10	85
13	-	300	80	8	93
14	-	300	100	8	93
15[c]	-	-	80	4 h	20

[a]**Reaction conditions:** *tert*-butylbenzoyl(phenyl)carbamate **1a** (1. 0 mmol), piperidine **2a** (1.5 mmol), in solvent (1ml) under Microwave-irradiation. [b]Isolated yield. [c]Conventional heating at 80 °C for 4 h.

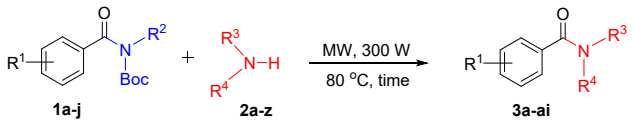
General procedure for the synthesis of amides

All amides used in the study were synthesized by previously reported methods.[1]

General procedure for Synthesis of *N*-Boc activated secondary amides

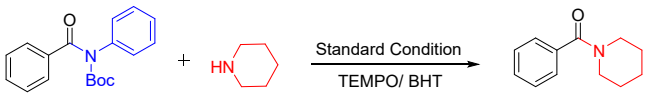
N-Boc-activated amides were synthesized according to the reported method.[2] To an oven-dried round bottom flask, amide (1.0 equiv.), DMAP (0.1 equiv.) and dichloromethane were added, the reaction temperature was maintained at 0 °C to this Boc anhydride (1.5 equiv.) was added dropwise. After the addition of Boc anhydride, the reaction mixture was stirred for 14-24 h at room temperature. The progress of the reaction was monitored with TLC, after the completion of the reaction, mixture was concentrated under reduced pressure and purified by column chromatography and the product was obtained in excellent yield.

General procedure for metal-free transamidation of *N*-Boc activated secondary amides with amines



1a-j **2a-z** **3a-ai**

A mixture of appropriate *N*-Boc activated amide (1.0 mmol) and amine (1.5 mmol) was placed in a 10-mL pressurised vials with ''snap-on'' cap and irradiated in the microwave using 300 W power at 80 °C for 8-10 min. The completion of the reaction was monitored with TLC, after completion the reaction mixture was cooled to room temperature and diluted with ethyl acetate, and washed water. The organic layer was dried over Na_2SO_4 and concentrated under vacuum and the crude product was purified by column chromatography on silica gel using *n*-hexane-ethyl acetate as eluent to give the desired products.

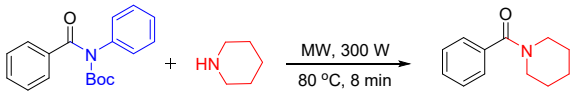


1a **2a** **3a**, >90% yield

Scheme S1. Control experiments with radical scavengers.

Gram-scale synthesis of 3a

Tested the practical applicability of this protocol in multigram scale synthesis (Scheme S2). The reaction of *N*-Boc, *N*-phenylbenzamide **1a** (1.56 g, 5.0 mmol), and piperidine **2a** (0.64 ml, 7.5 mmol) gave the desired transamidated product **3a** in (1.95g) 89% yield under the optimized reaction conditions.



1a 5 mmol **2a** 7.5 mmol **3a** 89 % Yield

Scheme S2. Gram-scale procedure for transamidation of *N*-Boc amide with amine.

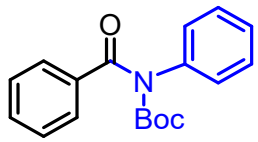
Author Contributions

Vishal Singh: Methodology, investigation, data curation, formal analysis and writing draft; K. Rajput: Investigation, data curation and analysis; A. Mishra: Data curation; S. Singh: Analysis and review; Vandana Srivastava: Supervision, conceptualization, resources, review, and final editing.

Compounds Characterization

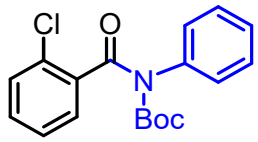
Characterization Data of Starting Materials

***tert*-butyl benzoyl(phenyl)carbamate (1a)**[2]



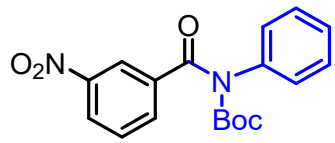
Yield 95%; white solid; m.p. 97 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.76 (d, 2H), 7.54 – 7.53 (m, 1H), 7.47 – 7.43 (m, 4H), 7.37 – 7.36 (m, 1H), 7.30 (d, 2H), 1.25 (s, 9H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 172.9, 153.5, 139.3, 137.1, 131.9, 129.4, 128.4, 128.3, 128.1, 127.9, 83.6, 27.6; HRMS (ESI) for $C_{18}H_{19}NO_3$ (m/z) $[M + H]^+$ calcd: 298.1365, found: 298.1382.

***tert*-butyl (2-chlorobenzoyl)(phenyl)carbamate (1b)**[3]



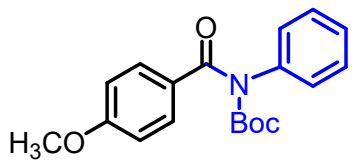
Yield 94%; white solid; m.p. 235–238 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.52 – 7.40 (m, 3H), 7.39 –7.28 (m, 6H), 1.22 (s, 9H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 170.1, 152.6, 138.8, 138.2, 131.2, 130.6, 129.9, 129.7, 129.2, 128.8, 128.8, 127.5, 84.4, 27.9; HRMS (ESI) for $C_{18}H_{18}ClNO_3$ (m/z) $[M + H]^+$ calcd: 332.0975, found: 332.0963.

***tert*-butyl (3-nitrobenzoyl)(phenyl)carbamate (1c)**[3,4]



Yield 95%; white solid; m.p. 223–225 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.45 (s, 1H), 8.30 (d, 1H), 7.96 – 7.94 (d, 1H), 7.58 – 7.55 (t, 1H), 7.40 – 7.36 (t, 2H), 7.32 – 7.29 (t, 1H), 7.29 –7.18 (m, 2H), 1.20 (s, 9H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 170.3, 152.9, 148.0, 138.5, 133.8, 129.6, 129.5, 128.4, 128.1, 126.0, 123.0, 84.5, 28.5, 27.7; HRMS (ESI) for $C_{18}H_{18}N_2O_5$ (m/z) $[M + H]^+$ calcd: 343.1216, found: 343.1243.

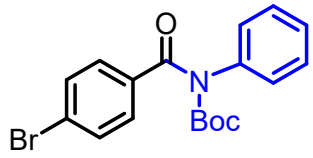
***tert*-butyl (4-methoxybenzoyl)(phenyl)carbamate (1d)**[5]



Yield 88%; white solid; m.p. 143–145°C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.45 (d, 2H), 7.33 (t, 2H), 7.23 (d, 2H), 7.16 (t, 1H), 6.79 (d, 2H), 3.71 (s, 3H), 1.08 (s, 9H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 172.7, 162.3, 153.8, 138.2, 130.0, 129.6, 128.5, 128.1,

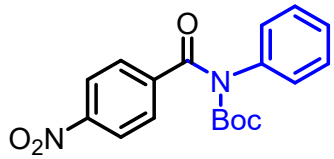
127.4, 113.4, 82.8, 55.4, 27.5; HRMS (ESI) for $C_{19}H_{21}NO_4$ (m/z) [M + H]+ calcd: 328.1471, found: 328.1467.

***tert*-butyl (4-bromobenzoyl)(phenyl)carbamate (1e)**[5]



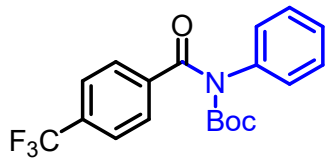
Yield 88%; white solid; m.p. 83–85°C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.71 (d, 2H), 7.62 (d, 2H), 7.39 – 7.27 (m, 4H), 7.13 (t, 1H), 1.21 (s, 9H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 172.8, 162.4, 153.4, 138.2, 130.2, 129.8, 128.6, 128.2, 127.5, 113.5, 79.3, 27.7; HRMS (ESI) for $C_{18}H_{18}BrNO_3$ (m/z) [M + H]+ calcd: 376.0470, found: 376.0483.

***tert*-butyl (4-nitrobenzoyl)(phenyl)carbamate (1f)**[5]



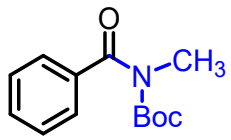
Yield 88%; white solid; (m.p. 103 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.33 (d, 2H), 7.92 (d, 2H), 7.39 – 7.30 (m, 4H), 7.29 – 7.11 (m, 1H), 1.21 (s, 9H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 172.4, 162.0, 153.5, 137.9, 129.8, 129.3, 128.2, 127.8, 127.0, 113.0, 28.6, 27.2; HRMS (ESI) for $C_{18}H_{18}N_2O_5$ (m/z [M + H]+ calcd: 343.1216, found: 343.1204.

***tert*-butyl b(4-trifluoromethyl)(benzoyl)(phenyl)carbamate (1g)**[5]



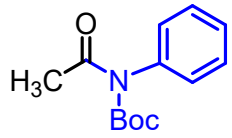
Yield 88%; white solid; m.p. 125–127°C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.61 (d, 2H), 7.55 (d, 2H), 7.38 – 7.36 (t, 2H), 7.31 (d, 2H), 7.24 (t, 1H), 1.09 (s, 9H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 172.2, 153.4, 141.6, 137.9, 132.7 (q, J = 32.8 Hz, 1C), 129.0, 128.6, 128.0, 127.8, 125.6 (q, J = 3.8 Hz, 1C), 125.2 (q, J = 272.1 Hz, 1C), 84.3, 27.8; ^{19}F NMR (471 MHz, $CDCl_3$): δ -63.2; HRMS (ESI) for $C_{19}H_{18}F_3NO_3$ (m/z) [M + H]+ calcd: 366.1239, found: 366.1254.

***tert*-butyl benzoyl(methyl)carbamate (1h)**[2]



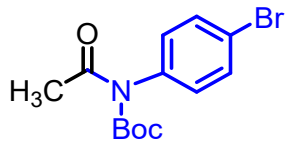
Yield 87%; yellow oil; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.52 (m, 2H), 7.47 – 7.45 (m, 1H), 7.41 – 7.38 (m, 2H), 3.32 (s, 3H), 1.16 (s, 9H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 173.7, 153.6, 137.9, 130.9, 128.1, 127.5, 83.0, 71.8, 32.6, 27.4; HRMS (ESI) for $C_{13}H_{17}NO_3$ (m/z) $[M + H]^+$ calcd: 236.1208, found: 236.1219.

***tert*-butyl acetyl(phenyl)carbamate (1i)**[6]



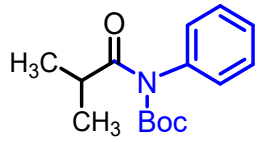
Yield 84%; white solid; (m.p. 58 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.43 – 7.36 (m, 2H), 7.35 – 7.28 (m, 1H), 7.11 – 7.10 (m, 2H), 2.59 (s, 3H), 1.40 (s, 9H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 172.9, 152.8, 138.9, 128.9, 128.2, 127.8, 83.2, 27.8, 26.3; HRMS (ESI) for $C_{13}H_{17}NO_3$ (m/z) $[M + H]^+$ calcd: 236.1208, found: 236.1251.

***tert*-butyl acetyl(4-bromophenyl)carbamate (1j)**[7]



Yield 84%; white solid; (m.p. 122 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.54 (d, 2H), 6.99 (d, 2H), 2.61 (s, 3H), 1.41 (s, 9H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 172.8, 152.4, 137.9, 132.2, 129.9, 121.7, 83.6, 27.9, 26.5; HRMS (ESI) for $C_{13}H_{16}BrNO_3$ (m/z) $[M + H]^+$ calcd: 314.0314, found: 314.0308.

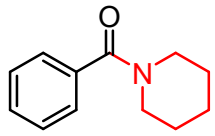
***tert*-butyl isobutyryl(phenyl)carbamate (1k)**[8]



Yield 82%; yellow oil; (^{1}H NMR (500 MHz, $CDCl_3$): δ 7.30 –7.27 (t, 2H), 7.23 – 7.21 (d, 1H) 6.99 – 6.97 (m, 2H), 3.57 –3.53 (m, 1H), 1.30 (s, 9H), 1.15 (d, 6H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 180.5, 152.8, 139.5, 128.9, 128.2, 128.2, 127.5, 82.9, 34.8, 34.7, 27.9, 19.6; HRMS (ESI) for $C_{15}H_{21}NO_3$ (m/z) $[M + H]^+$ calcd: 264.1521, found: 264.1543.

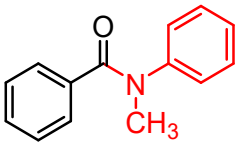
Characterization Data of Transamidation Products

phenyl(piperidin-1-yl)methanone (3a)[9]



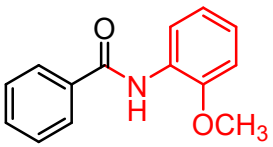
Yield 93%; white solid; m.p. 48 °C; ^{1}H NMR (500 MHz, $CDCl_3$): *δ* 7.43 – 7.29 (m, 5H), 3.74 (s, 2H), 3.36 (s, 2H), 1.77 (s, 2H), 1.70 (s, 2H), 1.54 (s, 2H); ^{13}C NMR (126 MHz, $CDCl_3$): δ 170.5, 135.3, 129.8, 128.6, 127.0, 48.7, 43.0, 24.5; HRMS (ESI) for $C_{12}H_{15}NO$ (m/z) $[M + H]^+$ calcd: 190.1189, found: 190.1223.

***N*-methyl-*N*-phenylbenzamide (3b)**[10]



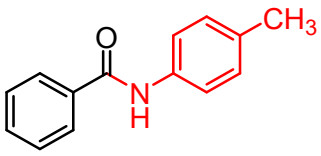
Yield 87%; yellow oil; (^{1}H NMR (500 MHz, $CDCl_3$): δ 7.25 (d, 2H), 7.18 – 7.11 (m, 3H), 7.09 – 7.05 (m, 3H), 6.98 – 6.97 (d, 2H), 3.44 (s, 3H); ^{13}C NMR (126 MHz, $CDCl_3$): δ 170.8, 145.0, 126.0, 129.7, 129.3, 128.8, 127.8, 127.0, 123.6, 38.5; HRMS(ESI) for $C_{14}H_{13}NO$ (m/z) $[M + H]^+$ calcd: 212.0997, found: 212.1023.

_N_-(2-methoxyphenyl)benzamide (3c)[11]



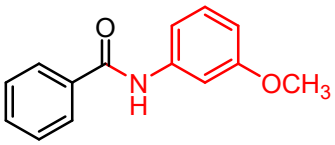
Yield 91%; white solid; m.p. 60 °C; ^{1}H-NMR (500 MHz, $CDCl_3$): δ 8.54 (d, 2H), 7.90 (m, 2H), 7.55 – 7.51 (m, 3H), 7.50 (m, 2H), 6.93 (s, 1H), 3.92 (s, 3H); ^{13}C-NMR (125 MHz, $CDCl_3$): δ 165.5, 148.4, 135.6, 131.9, 129.0, 128.1, 127.3, 124.1, 121.5, 121.5, 120.1, 110.2, 56.1; HRMS (ESI) for $C_{14}H_{13}NO_2$ (m/z) $[M + H]^+$ calcd: 228.0946, found: 228.0932.

_N_-(4-methylphenyl)benzamide (3d)[11]



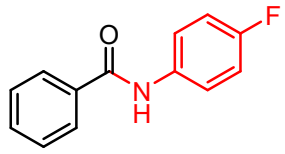
Yield 92%; white solid; m.p. 158 °C; ^{1}H NMR (500 MHz, DMSO-d_6): δ 10.17 (s, 1H), 7.96 (d, 2H), 7.67 (d, 2H), 7.60 – 7.57 (m, 1H), 7.54 (d, 2H), 7.17 (d, 2H), 2.29 (s, 3H); ^{13}C NMR (126 MHz, DMSO-d_6): δ 165.8, 137.1, 135.5, 133.0, 131.9, 129.5, 128.8, 128.1, 120.9, 21.0; HRMS (ESI) for $C_{14}H_{13}NO$ (m/z) $[M + H]^+$ calcd: 212.0997, found: 212.0930.

_N_-(3-methoxylphenyl)benzamide (3e)[11]



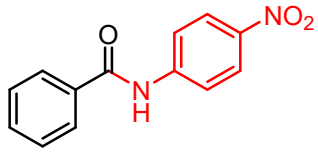
Yield 91%; white solid; m.p. 108 °C; ^{1}H NMR (500 MHz, DMSO-d_6): δ 7.68 (d, 2H), 7.39 (s, 1H), 7.67 (d, 2H), 7.36 – 7.31 (m, 3H), 7.23 – 7.16 (m, 1H), 7.15 (m, 1H), 6.93 (d, 1H), 6.74 – 6.72 (m, 1H), 3.81 (s, 3H); ^{13}C NMR (126 MHz, DMSO-d_6): δ 165.8, 156.7, 138.9, 135.2, 131.3, 129.3, 128.9, 127.1, 112.2, 110.2, 105.3, 55.6; HRMS (ESI) for $C_{14}H_{13}NO_2$ (m/z) $[M + H]^+$ calcd: 228.0946, found: 228.0957.

***N*-(4-fluorophenyl)benzamide (3f)**[12]



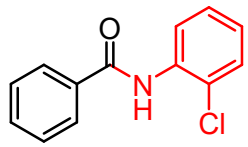
Yield 88%; white solid m.p. 185–187°C; ^{1}H NMR (500 MHz, DMSO-d_6): δ 10.36 (s, 1H), 8.00 – 7.85 (d, 2H), 7.83 (d, 2H), 7.65 (m, 1H), 7.60 (d, 2H), 7.59 – 7.23 (m, 2H); ^{13}C NMR (126 MHz, DMSO-d_6): δ 165.8, 159.6 (d, *J* = 240.6 Hz, 1C), 135.7, 135.0 (d, *J* = 6.3 Hz, 1C), 131.9, 128.7, 127.9, 122.5 (d, *J* = 7.6 Hz, 1C), 115.5 (d, *J* = 22.7 Hz, 1C); ^{19}F NMR (471 MHz, $CDCl_3$): δ - 117.8; HRMS (ESI) for $C_{13}H_{10}FNO$ (m/z) $[M + H]^+$ calcd: 216.0746, found: 216.0732.

***N*-(4-nitrophenyl)benzamide (3g)**[11]



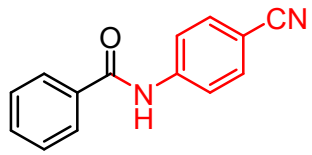
Yield 82%; white solid; m.p. 196 °C; ^{1}H NMR (500 MHz, DMSO-d_6): δ 10.84 (s, 1H), 8.29 (d, 2H), 8.08 (d, 2H), 7.67 – 7.64 (m, 1H), 8.00 (d, 2H), 7.59 – 7.57(m, 2H); ^{13}C NMR (126 MHz, DMSO-d_6): δ 166.5, 145.6, 142.7, 134.4, 132.5, 128.8, 128.1, 125.0, 120.1; HRMS (ESI) for $C_{13}H_{10}N_2O_3$ (m/z) $[M + H]^+$ calcd: 243.0691, found: 243.0684.

***N*-(2-chlorophenyl)benzamide (3h)**[11]



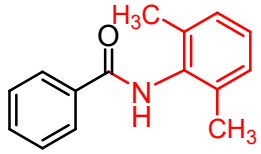
Yield 80%; white solid; m.p. 97 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.58 (d, 1H), 8.45 (s, 1H), 7.93 (d, 2H), 7.60 – 7.58 (t, 1H), 7.57 – 7.50 (t, 2H), 7.42 (dd, 1H), 7.34 – 7.26 (m, 1H), 7.08 – 7.07 (m, 1H); ^{13}C NMR (126 MHz, $CDCl_3$): δ 165.6, 135.0, 134.9, 132.5, 129.3, 129.2, 128.2, 127.4, 125.0, 123.3, 121.8; HRMS (ESI) for $C_{13}H_{10}ClNO$ (m/z) $[M + H]^+$ calcd: 231.0451, found: 231.0434.

***N*-(4-cynophenyl)benzamide (3i)**[12]



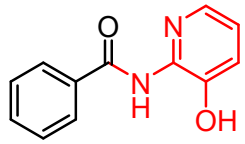
Yield 80%; yellow solid; m.p. 168–170 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.03 (s, 1H), 7.88 (d, 1H), 7.79 (d, 1H), 7.67 – 7.64 (m, 3H), 7.61 – 7.50 (m, 2H), 7.48 – 7.34 (m, 2H); ^{13}C NMR (126 MHz, $CDCl_3$): δ 173.2, 142.1, 133.6, 133.5, 129.5, 129.2, 128.9, 127.3, 120.0; HRMS (ESI) for $C_{14}H_{10}N_2O$ (m/z) $[M + H]^+$ calcd: 223.0793, found: 223.0798.

***N*-(2,6-dimethylphenyl)benzamide (3j)**[13]



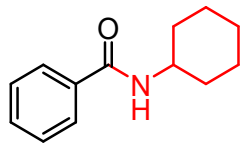
Yield 84%; white solid; m.p. 167-169 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.95 (d, 2H), 7.61 – 751 (t, 1H), 7.43 (t, 2H), 7.28 (s, 1H), 7.19 – 7.14 (m, 3H), 2.31 (s, 6H); ^{13}C NMR (126 MHz, $CDCl_3$): δ 166.3, 135.9, 134.9, 134.2, 132.2, 129.1, 128.6, 127.9, 127.6, 18.8; HRMS (ESI) for $C_{15}H_{15}NO$ (m/z) $[M + H]^+$ calcd: 226.1154, found: 226.1173.

***N*-(3-hydroxypyridin-2-yl)benzamide (3k)**[14]



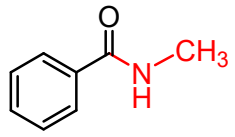
Yield 90%; White solid; m.p. 95–97 °C; ^{1}H NMR (500 MHz, DMSO-d_6): δ 7.97 (d, 1H), 7.71 (d, 2H), 7.40 – 7.35 (m, 1H), 7.29 (m, 2H,), 7.27 (s, 1H), 7.24 (d, 1H), 7.23 (m, 1H,) 4.54 (s, 1H,); ^{13}C NMR (126 MHz, DMSO-d_6): δ 168.9, 146.7, 143.3, 138.9, 134.5, 131.4, 129.9, 129.9, 124.1, 120.4; HRMS (ESI) for $C_{12}H_{10}N_2O_2$ (m/z) $[M + H]^+$ calcd: 215.0742, found: 215.0778.

***N*-cyclohexylbenzamide (3l)**[13]



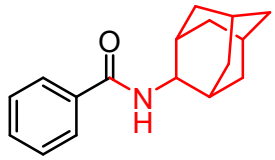
Yield 93%; white solid; m.p. 154–156 °C; ^{1}H NMR (500 MHz, $CDCl_3$):δ 7.75 – 7.74 (m, 2H), 7.49 – 7.42 (m, 1H), 7.40 – 7.26 (d, 2H), 5.99 (s, 1H), 4.00 – 3.95 (d, 1H), 2.04 – 2.02 (m, 2H), 1.76 – 1.74 (m, 2H), 1.69 – 1.64 (m, 1H), 1.46 –1.41 (m, 2H), 1.39 – 1.20 (m, 2H); ^{13}C NMR (126 MHz, $CDCl_3$): δ 166.9, 135.4, 131.6, 128.8, 127.2, 49.0, 33.6, 25.9, 25.2; HRMS (ESI) for $C_{13}H_{17}NO$ (m/z) $[M + H]^+$ calcd: 204.1310, found: 204.1329.

***N*-methylbenzamide (3m)**[13]



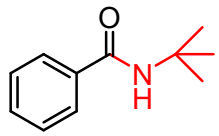
Yield 86%; yellow solid; m.p. 82–83 °C; ^{1}H NMR (500 MHz, $CDCl_3$):δ 7.76 – 7.74 (m, 2H), 7.48 – 7.39 (m, 1H), 7.38 – 7.26 (m, 2H), 6.42 (s, 1H), 2.99 – 2.98 (m, 3H); ^{13}C NMR (126 MHz, $CDCl_3$): δ 168.6, 134.8, 131.5, 128.7, 127.0, 27.0; HRMS (ESI) for C_8H_9NO (m/z) $[M + H]^+$ calcd: 136.0684, found: 136.0670.

***N*-(3s,5s,7s)-adamantan-1-yl)benzamide (3n)**[15]



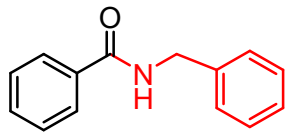
Yield 78%; white solid; (m.p. 143–145 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.74 – 7.72 (m, 2H), 7.50 – 7.46 (m, 1H), 7.44 – 7.28 (t, 2H), 5.82 (s, 1H), 2.15 (s, 9H), 1.77 (d, 6H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 166.9, 162.6, 136.3, 134.8, 131.3, 130.8, 129.1, 129.1, 128.7, 126.9, 52.5, 41.9, 36.6, 29.7; HRMS (ESI) for $C_{17}H_{21}NO$ (m/z) $[M + H]^+$ calcd: 256.1623, found: 256.1641.

***N*-(tert-butyl)benzamide (3o)**[13]



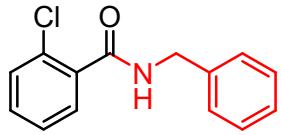
Yield 81%; white solid; m.p. 136 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.73 – 7.71 (m, 2H), 7.47 – 7.43 (m, 1H), 7.40 – 7.26 (m, 2H), 1.48 (m, 9H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 167.0, 136.0, 131.23, 128.6, 126.8, 51.7, 29.0; HRMS (ESI) for $C_{11}H_{15}NO$ (m/z) $[M + H]^+$ calcd: 178.1154, found: 178.1169.

***N*-benzylbenzamide (3p)**[16]



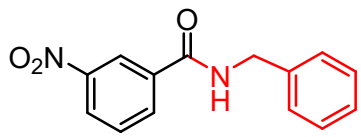
Yield 92%; white solid; m.p. 103–105 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.83 (d, 2H,), 7.55 (t, 1H), 7.48 – 7.39 (m, 2H), 7.35 – 7.29 (m, 4H), 6.43 (m, 1H), 4.69 (d, 2H); ^{13}C NMR (126 MHz, $CDCl_3$): δ 167.5, 138.4, 134.6, 131.8, 129.0, 128.8, 128.1, 127.8, 127.1, 44.4; HRMS (ESI) for $C_{14}H_{13}NO$ (m/z) $[M + H]^+$ calcd: 212.0997, found: 212.0981.

***N*-benzyl-4-fluorobenzamide (3q)**[6]



Yield 92%; white solid; m.p. 104–106 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.67 – 7.37 (m, 1H), 7.35 – 7.26 (m, 7H), 6.54 (d, 1H), 4.66 (d, 2H); ^{13}C NMR (126 MHz, $CDCl_3$): δ 165.7, 152.4, 149.2, 144.6, 131.8, 129.0, 120.7, 99.3, 59.8, 53.9, 18.3, 14.5; HRMS (ESI) for $C_{14}H_{12}ClNO$ (m/z) $[M + H]^+$ calcd: 246.0607, found: 246.0618.

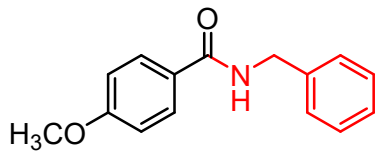
***N*-benzyl-3-nitrobenzamide (3r)**[6]



Yield 92%; white solid; m.p. 94–96 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.62 (s, 1H), 8.35 (d, 1H), 8.19 (d, 1H), 7.64 (m, 1H), 7.36 – 7.35 (m, 5H), 6.90 (t, 1H), 4.67 (d, 2H); ^{13}C NMR (126

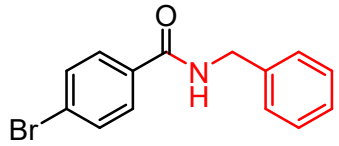
MHz, $CDCl_3$):δ 165.0, 148.1, 137.5, 135.9, 133.3, 129.9, 128.9, 127.9, 127.9, 126.1, 121.8, 44.4; HRMS (ESI) for $C_{14}H_{12}N_2O_3$ (m/z) $[M + H]^+$ calcd: 257.0848, found: 257.0832.

***N*-benzyl-4-methoxybenzamide (3s)**[17]



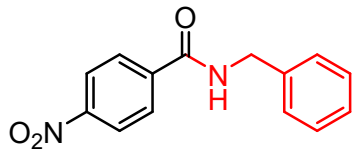
Yield 86%; white solid; m.p. 125 °C; ^1H NMR (500 MHz, $CDCl_3$): δ 8.00 (d, 1H), 7.67 (d, 2H), 7.25 – 7.16 (m, 4H), 6.89 (d, 2H), 6.80 (s, 1H), 4.54 (d, 2H), 3.80 (s, 3H); ^{13}C NMR (126 MHz, $CDCl_3$): δ 167.1, 167.1, 164.8, 162.5, 162.5, 138.6, 133.0, 129.08, 129.0, 128.1, 127.8, 126.9, 121.5, 114.3, 114.0, 55.6, 44.3; HRMS (ESI) for $C_{15}H_{15}NO_2$ (m/z) $[M + H]^+$ calcd: 242.1103, found: 242.1137.

***N*-benzyl-4-bromobenzamide (3t)**[6]



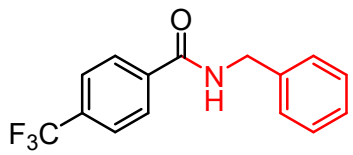
Yield 86%; white solid; m.p. 161–162 °C; ^1H NMR (500 MHz, DMSO-d_6): δ 8.41 (s, 1H), 7.47 (d, 2H), 7.35 (d, 2H), 6.69 – 6.60 (m, 5H), 4.49 (d, 2H); ^{13}C NMR (126 MHz, DMSO-d_6): δ 165.6, 140.0, 138.0, 131.3, 130.4, 130.3, 128.7, 127.7, 127.2, 121.0, 120.9, 53.9; HRMS (ESI) for $C_{14}H_{12}BrNO$ (m/z) $[M + H]^+$ calcd: 290.0102, found: 290.0126.

***N*-benzyl-4-nitrobenzamide (3u)**[17]



Yield 91%; white solid; (m.p. 138–140 °C; ^1H NMR (500 MHz, DMSO-d_6): *δ* 9.06 (s, 1H), 7.99 (d, 2H), 7.33 –7.23 (m, 7H), 4.49 (d, 2H); ^{13}C NMR (126 MHz, DMSO-d_6):δ 165.6, 163.4, 140.0, 131.3, 130.4, 130.3, 128.7, 127., 127.2 ,115.9, 115.6, 43.1; HRMS (ESI) for $C_{14}H_{12}N_2O_3$ (m/z) $[M + H]^+$ calcd: 257.0848, found: 257.0819.

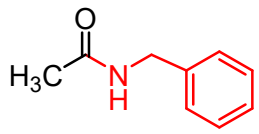
***N*-benzyl-4-fluorobenzamide (3v)**[6]



Yield 92%; white solid; m.p. 146–167 °C; ^1H NMR (500 MHz, $CDCl_3$): δ 7.79 – 7.66 (m, 3H), 7.65 – 7.61 (m, 3H), 7.49 (t, 2H), 7.26 – 7.18 (m, 1H), 4.98 (s, 2H); ^{13}C NMR (126 MHz, $CDCl_3$): δ 166.1, 137.7, 137.6, 133.4 (q, *J* = 32.7 Hz, 1C), 128.9, 127.9,

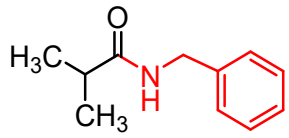
127.8, 127.5, 125.7 (q, *J* = 3.8 Hz, 1C), 124.7 (q, *J* = 273.4 Hz, 1C), 44.2; ^{19}F NMR (471 MHz, $CDCl_3$): δ - 62.9; HRMS (ESI) for $C_{15}H_{12}F_3NO$ (m/z) $[M + H]^+$ calcd: 280.0871, found: 280.0855.

_N_-benzylacetamide (3w)[6]



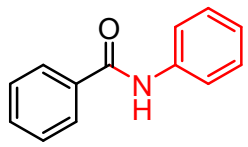
Yield 89%; white solid; m.p. 60 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.27 – 7.15 (m, 5H), 6.23 (s, 1H), 4.27 (d, 2H), 1.87 (s, 3H);^{13}C NMR (126 MHz, $CDCl_3$): δ 170.2, 138.4, 128.7, 127.9, 127.5, 59.7, 43.7, 23.2; HRMS (ESI) for $C_9H_{11}NO$ (m/z) $[M + H]^+$ calcd: 150.0841, found: 150.0868.

_N_-benzylisobutyramide (3x)[18]



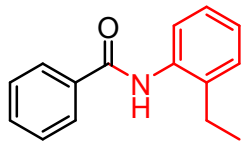
Yield 89%; white solid; m.p. 91 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.33 (d, 2H), 7.32 – 7.26 (m, 3H), 5.82 (s, 1H), 4.43 (d, 2H), 2.41 – 2.36 (m, 1H), 1.19 (d, 6H); ^{13}C NMR (126 MHz, DMSO-d_6): δ 176.9, 138.7, 128.9, 127.9, 127.6, 43.6, 35.8, 19.8; HRMS (ESI) for $C_{11}H_{15}NO$ (m/z) $[M + H]^+$ calcd: 178.1154, found: 178.1163.

_N_-phenylbenzamide (3y)[11]



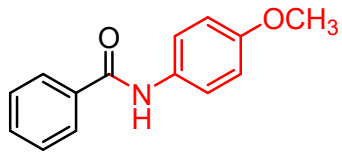
Yield 89%; white solid; m.p. 164 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.90-7.88 (d, 3H), 7.68 – 7.57 (d, 2H), 7.56 – 7.48 (t, 1H), 7.40-7.37 (t, 2H), 7.19 (t, 2H), 7.16 (t, 1H); ^{13}C NMR (126 MHz, $CDCl_3$): δ 165.8, 137.9, 135.0, 131.8, 129.1, 128.8, 127.0, 124.6, 120.3; HRMS (ESI) for $C_{13}H_{11}NO$ (m/z) $[M + H]^+$ calcd: 198.0841, found: 198.0853.

_N_-(2-ethylphenyl)benzamide (3z)[6]



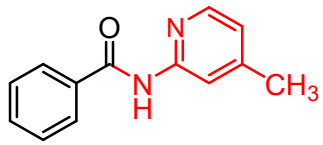
Yield 82%; white solid; m.p. 159 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.97 (d, 1H), 7.90 (d, 2H), 7.60 (s, 1H), 7.58 (t, 1H), 7.52 (t, 2H), 7.29 (t, 2H), 7.19 (t, 1H), 2.73 (q, 2H), 1.32 (t, 3H); ^{13}C NMR (126 MHz, $CDCl_3$): δ 166.0, 135.6, 135.3, 135.2, 132.0, 129.0, 128.8, 127.2, 127.0, 125.9, 124.1, 24.6, 14.2; HRMS (ESI) for $C_{15}H_{15}NO$ (m/z) $[M + H]^+$ calcd: 226.1154, found: 226.1132.

_N_-(4-methoxyphenyl)benzamide (3aa)[15]



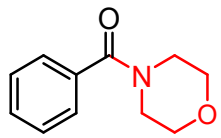
Yield 91%; green solid; m.p. 154–156 °C;^{1}H NMR (500 MHz, $CDCl_3$): δ 7.89 (m, 3H), 7.55 (m, 3H), 7.50 – 7.47 (m, 2H), 6.29 (d, 2H), 3.83 (s,3H);^{13}C NMR (126 MHz, $CDCl_3$): δ 165.7, 135.0, 131.7, 131.0, 128.7, 127.0, 122.2, 114.3, 99.3, 55.2; HRMS (ESI) for $C_{14}H_{13}NO_2$ (m/z) $[M + H]^+$ calcd: 228.0946, found: 228.0977.

_N_-(4-methylpyridin-2-yl)benzamide (3ab)[14]



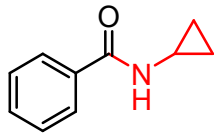
Yield 90%; White solid; m.p. 115–116 °C; ^{1}H NMR (500 MHz, DMSO-d_6): δ 8.12 (d, 1H), 7.76 (d, 2H), 7.63 (s, 1H), 7.63 – 7.51 (m, 1H), 7.33 – 7.28 (m, 2H), 7.23 (s, 1H), 7.06 (s, 1H), 2.31 (s, 3H); ^{13}C NMR (126 MHz, DMSO-d_6): δ 165.8, 152.8, 152.3, 148.2, 133.0, 131.9, 129.5, 128.8, 127.7, 120.8, 19.2; HRMS (ESI) for $C_{13}H_{12}N_2O$ (m/z) $[M + H]^+$ calcd: 213.0950, found: 213.0978.

Morpholino(phenyl)methanone (3ac)[9]



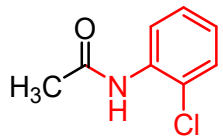
Yield 91%; yellow solid; m.p.73–75°C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.42 – 7.40 (m, 5H), 3.77 – 3.45 (m, 8H), ^{13}C NMR (126 MHz, $CDCl_3$): δ 170.5, 135.3, 129.9, 128.6, 127.0, 66.9, 48.2, 42.6; HRMS (ESI) for $C_{11}H_{13}NO_2$ (m/z) $[M + H]^+$ calcd: 192.0946, found: 192.0955.

_N_-cyclopropylbenzamide (3ad)[6]



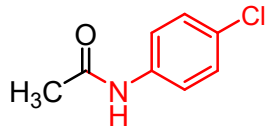
Yield 83%; white solid; m.p. 55–57 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.65 (d, 2H), 7.38 – 7.17 (m, 3H), 6.36 (d, 1H), 2.80 – 2.77 (m, 1H), 0.75 (s, 2H), 0.52 (s, 2H); ^{13}C NMR (126 MHz, $CDCl_3$): δ 169.1, 134.6, 131.6, 128.7, 127.0, 23.3, 6.9; HRMS (ESI) for $C_{10}H_{11}NO$ (m/z) $[M + H]^+$ calcd: 162.0841, found: 162.0867.

_N_-(2-chlorophenyl)acetamide (3ae)[19]



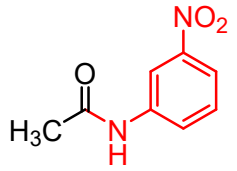
Yield 84%; white solid; m.p. 84–86 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.28 (d, 1H), 7.55 (s, 1H, NH), 7.29 (d, 1H), 7.20 (m, 1H), 7.19 – 6.19 (m, 1H), 2.16 (s, 3H); ^{13}C NMR (126 MHz, $CDCl_3$): δ 168.4, 134.7, 129.1, 127.8, 124.7, 122.7, 121.8, 25.0; HRMS (ESI) for C_8H_8ClNO (m/z) $[M + H]^+$ calcd: 170.0294, found: 170.0263.

_N_-(4-chlorophenyl)acetamide (3af)[20]



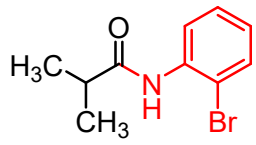
Yield 87%; white solid; m.p. 178 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.75 (s, 1H), 7.42 (m, 4H), 2.17 (s, 3H); ^{13}C NMR (126 MHz, $CDCl_3$): δ 168.4, 136.9, 131.9, 121.5, 116.9, 24.6; HRMS (ESI) for C_8H_8ClNO (m/z) $[M + H]^+$ calcd: 170.0294, found: 170.0298.

***N*-(2-nitrophenyl)acetamide (3ag)**[20]



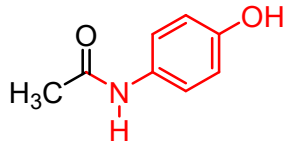
Yield 83%; white solid; m.p. 93 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.57 (s, 1H), 8.08 (s, 1H), 7.73 (d, 1H), 7.54 (d, 1H), 7.33 – 7.28 (m, 1H), 2.17 (s, 3H); ^{13}C NMR (126 MHz, $CDCl_3$): δ 168.8, 150.7, 138.0, 127.3, 124.3, 122.4, 120.1, 24.5; HRMS (ESI) for $C_8H_8N_2O_3$ (m/z) $[M + H]^+$ calcd: 181.0535, found: 181.0553.

***N*-(2-bromophenyl)isobutyramide (3ah)**[18]



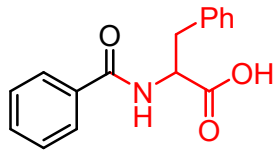
Yield 82%; white solid; m.p. 95 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.42 (d, 1H), 7.73 (s, 1H), 7.39 (d, 1H), 7.30 (m, 2H), 7.29 – 7.03 (m, 1H), 4.01 (d, 2H), 2.65 – 2.59 (m, 1H), 1.10 (d, 6H); ^{13}C NMR (126 MHz, $CDCl_3$): δ 175.29, 134.80, 129.04, 127.88, 124.57, 122.57, 129.02, 121.67, 37.12, 19.70; HRMS(ESI) for $C_{10}H_{12}BrNO$ (m/z) $[M + H]^+$ calcd: 242.0102, found: 242.0132.

***N*-(4-hydroxyphenyl)acetamide (3ai)**



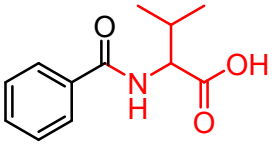
Yield 84%; white solid; m.p. 168 °C; ^{1}H NMR (500 MHz, DMSO-d_6): δ 9.64 (s, 1H), 9.13 (s, 1H), 7.34 – 7.32 (m, 2H), 6.68 – 6.66 (m, 2H), 1.98 (s, 3H); ^{13}C NMR (126 MHz, DMSO-d_6): δ 167.5, 153.1, 131.0, 120.8, 114.9, 23.7; HRMS (ESI) for $C_8H_9NO_2$ (m/z) $[M + H]^+$ calcd: 152.0633, found: 152.0701.

benzoylphenylalanine (6a)



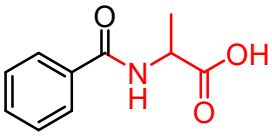
Yield 87%; white solid; m.p. 181–183 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.61 (d, 2H), 7.43 (t, 1H), 7.33 (t, 2H), 7.23 –7.16 (m, 3H), 7.13 (d, 2H), 6.59 (d, 1H), 5.01 (t, 1H), 3.30 – 3.16 (dd, 2H); ^{13}C NMR (126 MHz, $CDCl_3$): δ 174.6, 167.8, 135.7, 133.4, 132.0, 129.4, 128.7, 127.3, 127.1, 53.7, 37.3; HRMS (ESI) for $C_{16}H_{15}NO_3$ (m/z) $[M + H]^+$ calcd: 270.1052, found: 270.1073.

Benzoylvaline (6b)



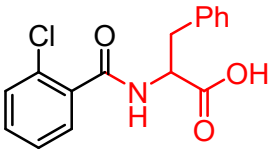
Yield 85%; white solid; m.p. 130 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.81 (d, 2H), 7.50 (t, 1H), 7.45 (t, 2H), 6.80 (d, 1H), 4.80 – (m, 1H), 2.36 (t, 1H), 1.05 (d, 6H); ^{13}C NMR (126 MHz, DMSO-d_6): δ 175.8, 168.1, 168.0, 133.8, 131.9, 128.7, 127.1, 57.6, 31.3, 19.0, 17.8; HRMS (ESI) for $C_{12}H_{15}NO_3$ (m/z) $[M + H]^+$ calcd: 222.1051, found: 222.1040.

Benzoylalanine (6c)[20]



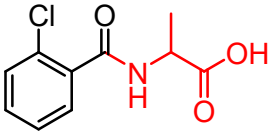
Yield 86%; white solid; m.p. 163 – 165 °C; ^{1}H NMR (500 MHz, DMSO-d_6): δ 8.67 (d, 1H), 7.90 (d, 2H), 7.56 (t, 1H), 7.48 (t, 2H), 5.14 (s, 1H), 4.45 – 4.42 (m, 1H), 1.41 (d, 3H); ^{13}C NMR (126 MHz, DMSO-d_6): δ 174.7, 166.7, 134.4, 131.8, 128.1, 127.9, 18.6, 17.3; HRMS (ESI) for $C_{10}H_{11}NO_3$ (m/z) $[M + H]^+$ calcd: 194.0739, found: 194.0714.

2-chlorobenzoyl)phenylalanine (6d)



Yield 88%; white solid; m.p. 190 – 192 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.75 (d, 1H), 7.40 (d, 1H), 7.35 (t, 1H), 7.29 (t, 1H), 7.24 (dd, 2H), 7.18 (dd, 2H), 7.15 (t, 1H), 6.61 (d, 1H), 5.01 (t, 1H), 3.30 (dd, 2H); ^{13}C NMR (126 MHz, $CDCl_3$): δ 174.6, 167.8, 135.7, 134.0, 133.4, 132.0, 129.4, 128.7, 127.3, 59.8, 127.1, 53.7, 38.0; HRMS (ESI) for $C_{16}H_{14}ClNO_3$ (m/z) $[M + H]^+$ calcd: 304.0662, found: 304.0683.

(2-chlorobenzoyl)alanine (6e)



Yield 87%; white solid; m.p. 171–173°C; ^{1}H NMR (500 MHz, DMSO-d_6): δ 8.69 (d, 1H), 8.33 (d, 1H), 8.32 (t, 1H), 7.64 (t, 1H), 7.57 (d, 1H), 4.45 (m, 1H), 1.43 (d, 3H); ^{13}C NMR (126 MHz, DMSO-d_6): δ 174.8, 166.7, 134.4, 131.9, 129.4, 128.7, 127.9, 49.6, 19.7; HRMS (ESI) for $C_{10}H_{10}ClNO_3$ (m/z) $[M + H]^+$ calcd: 228.0349, found: 228.0356.

4. References

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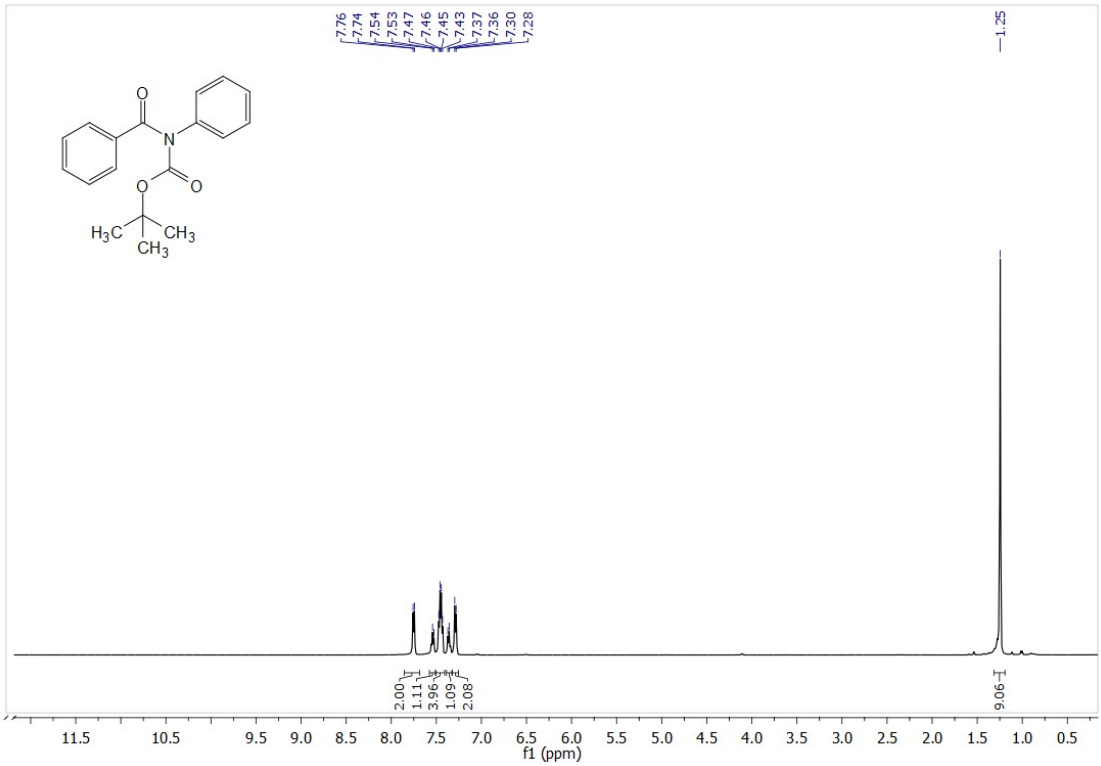
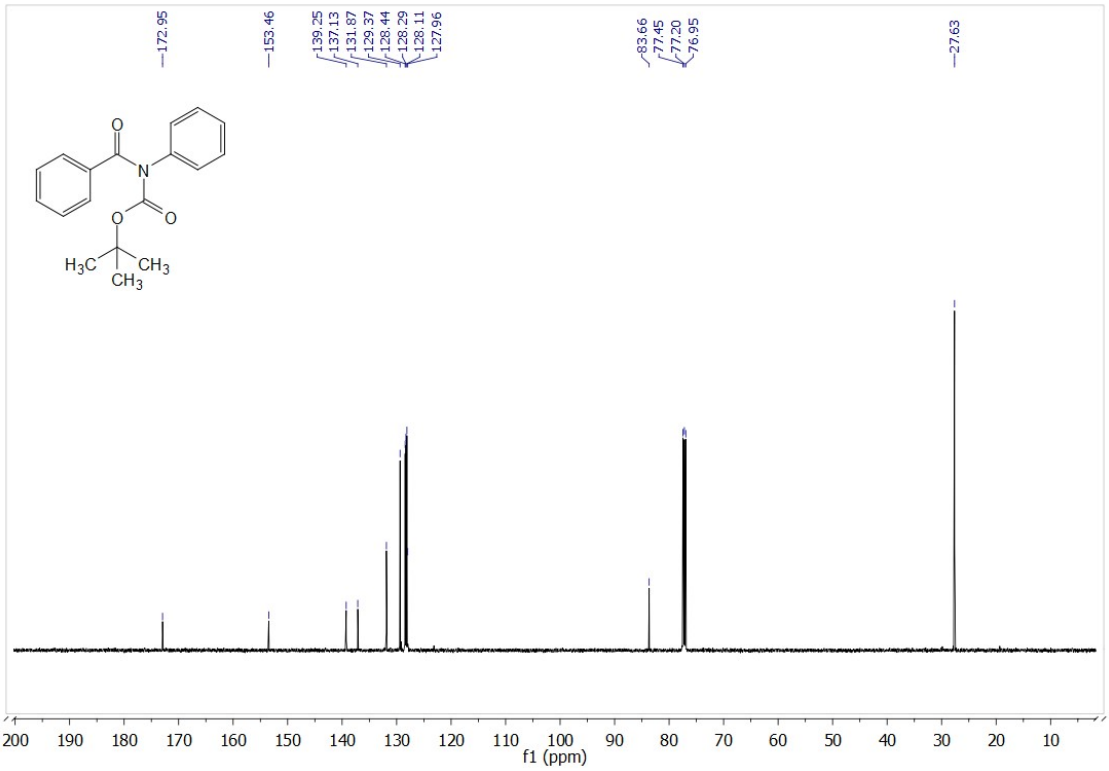
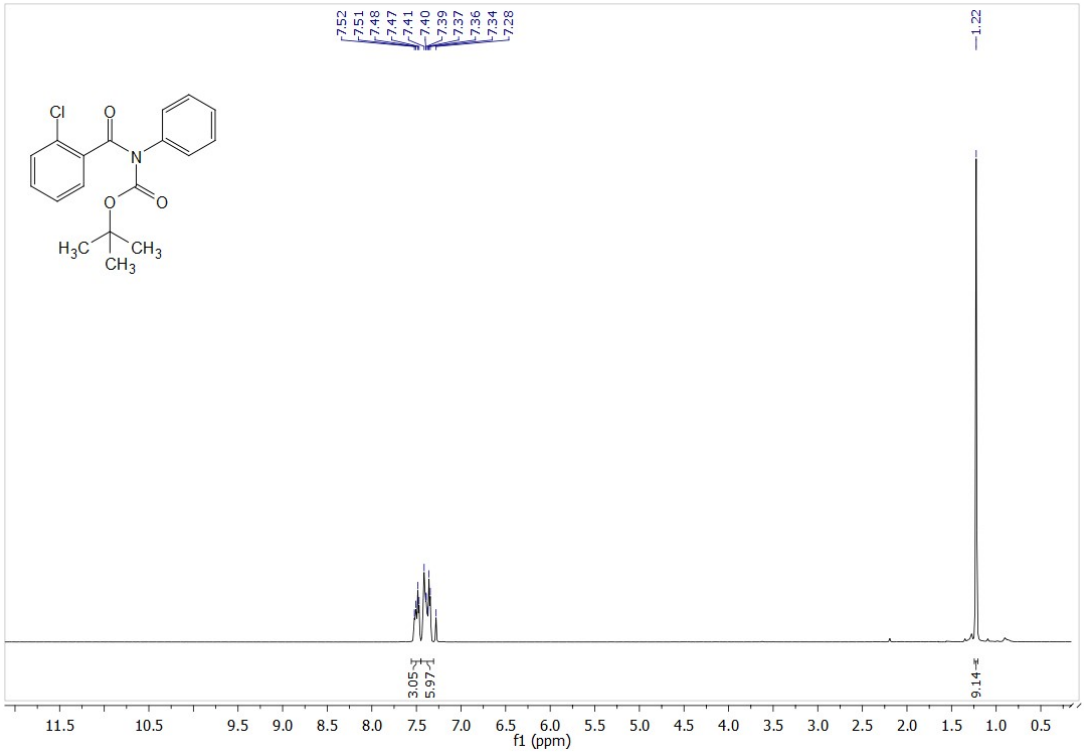
^{1}H and ^{13}C NMR Spectra of starting products

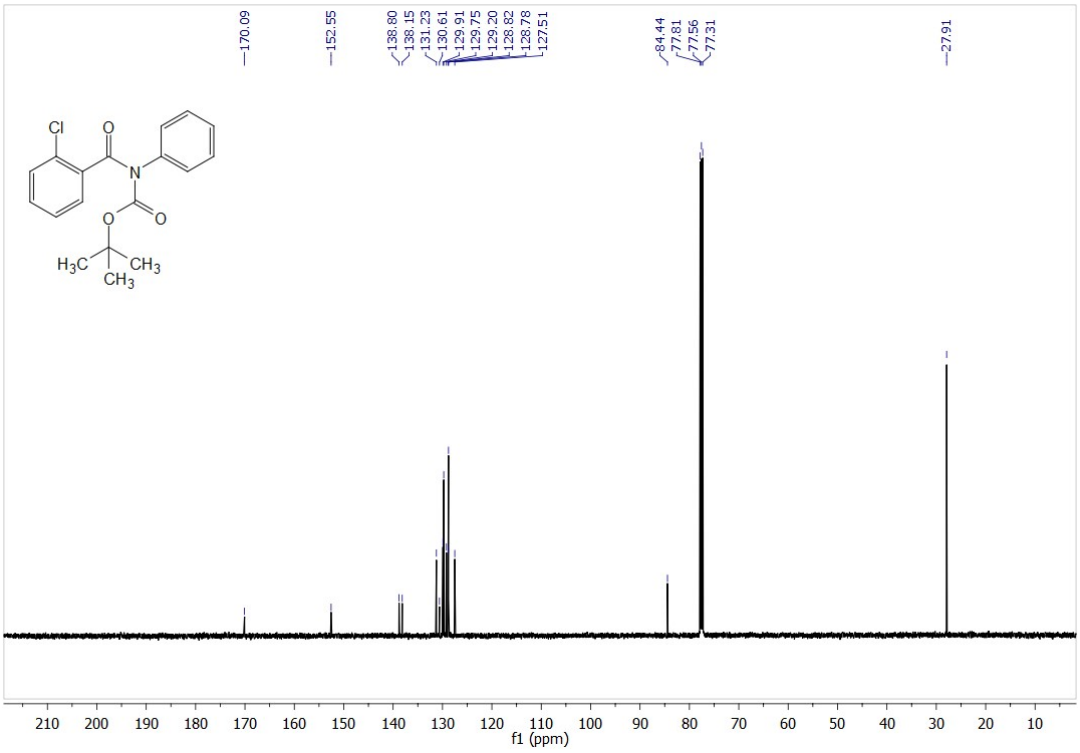
^{1}H and ^{13}C NMR Spectra of *tert*-butyl benzoyl(phenyl)carbamate (1a)



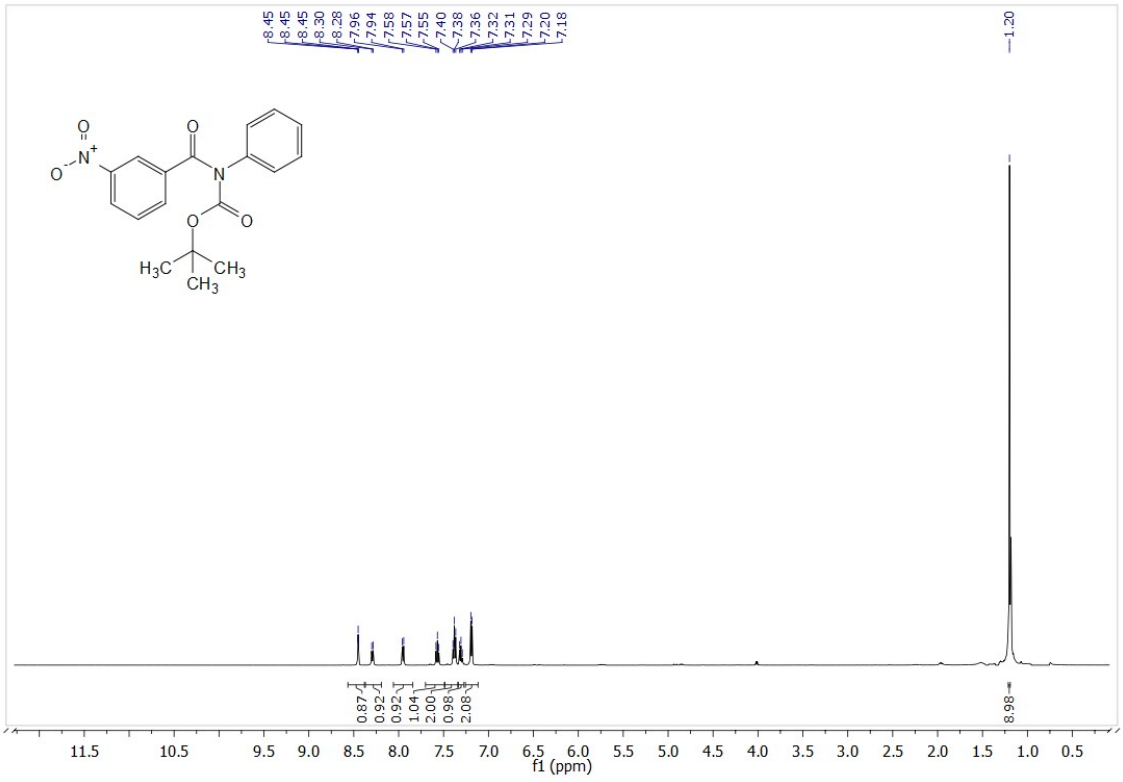


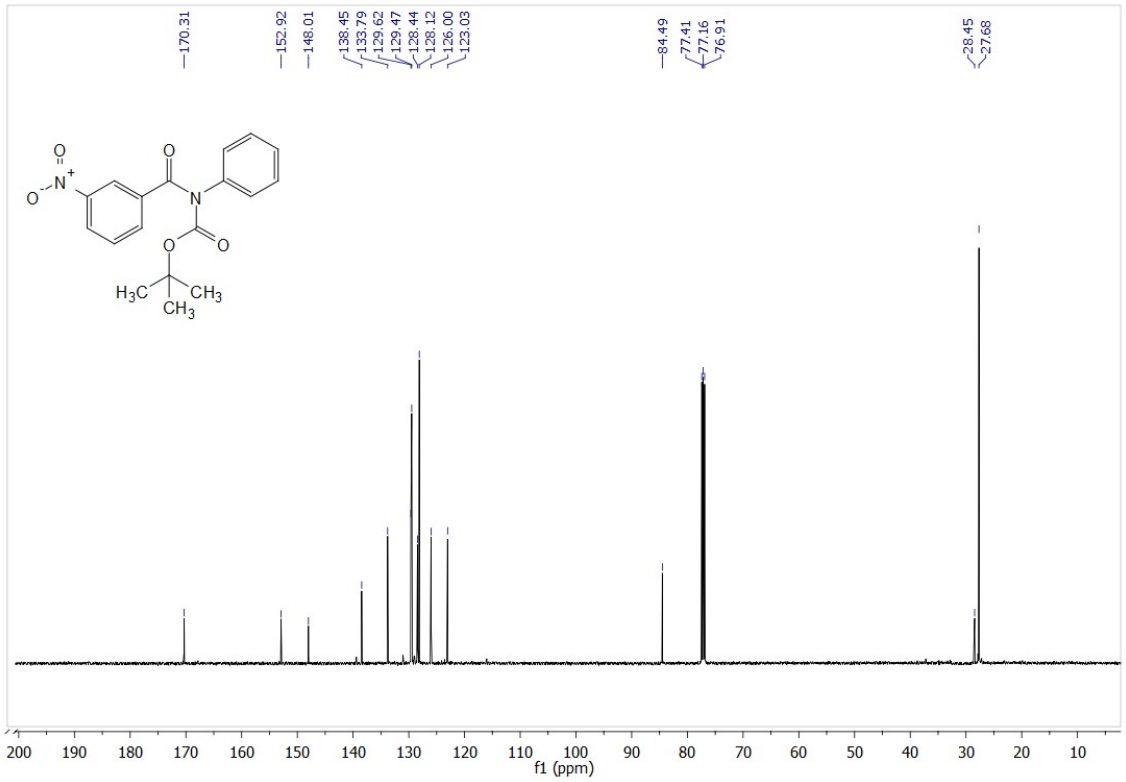
^{1}H and ^{13}C NMR Spectra of *tert*-butyl (2-chlorobenzoyl)(phenyl)carbamate (1b)



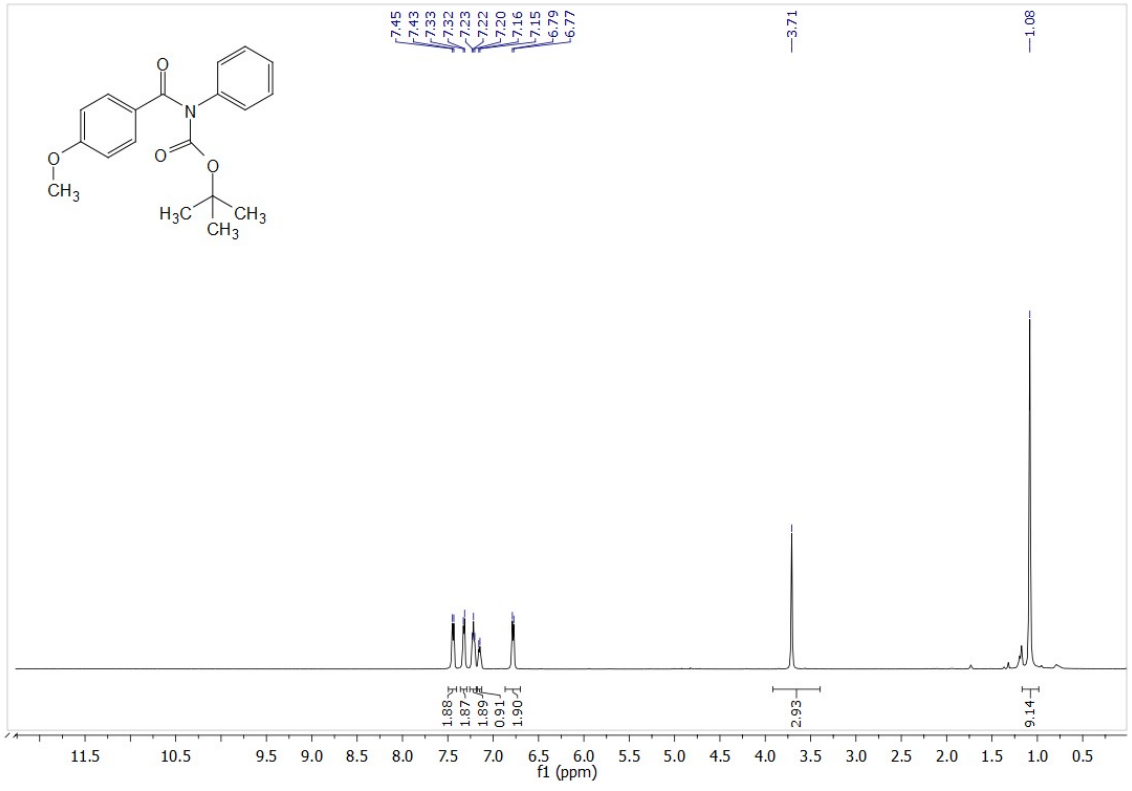


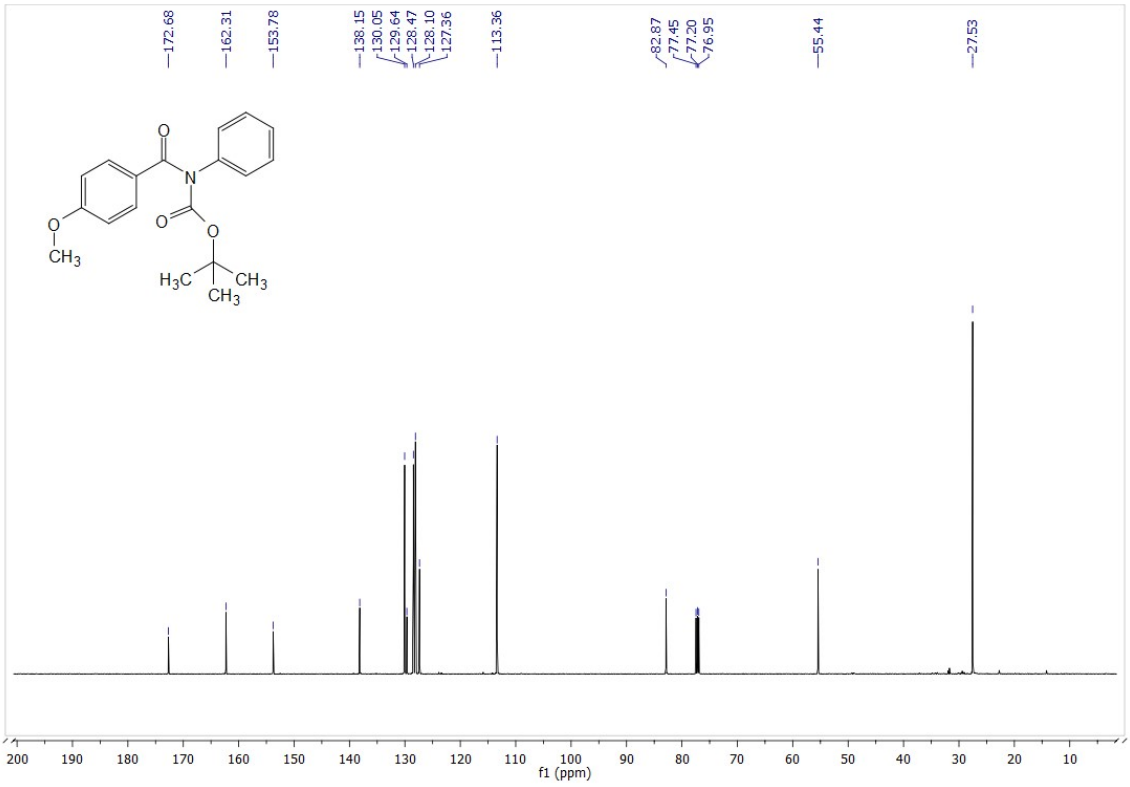
^{1}H and ^{13}C NMR Spectra of *tert*-butyl (3-nitrobenzoyl)(phenyl)carbamate (1c)



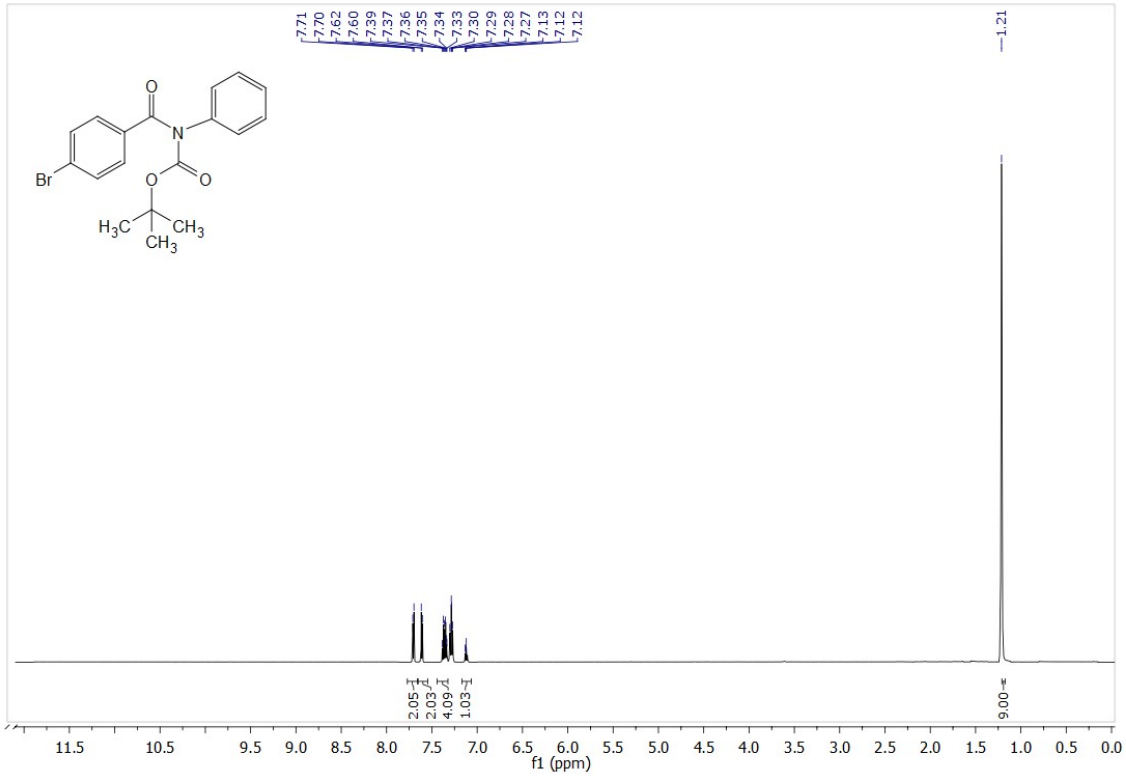


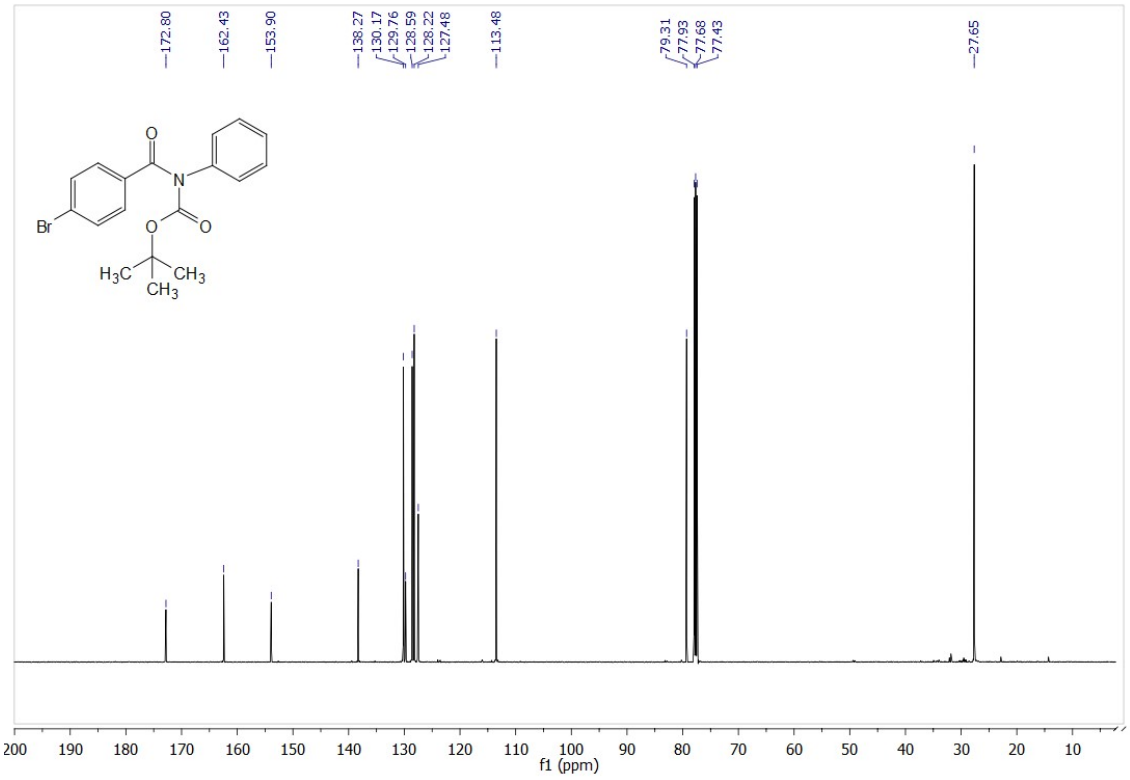
^{1}H and ^{13}C NMR Spectra of *tert*-butyl (4-methoxybenzoyl)(phenyl)carbamate (1d)



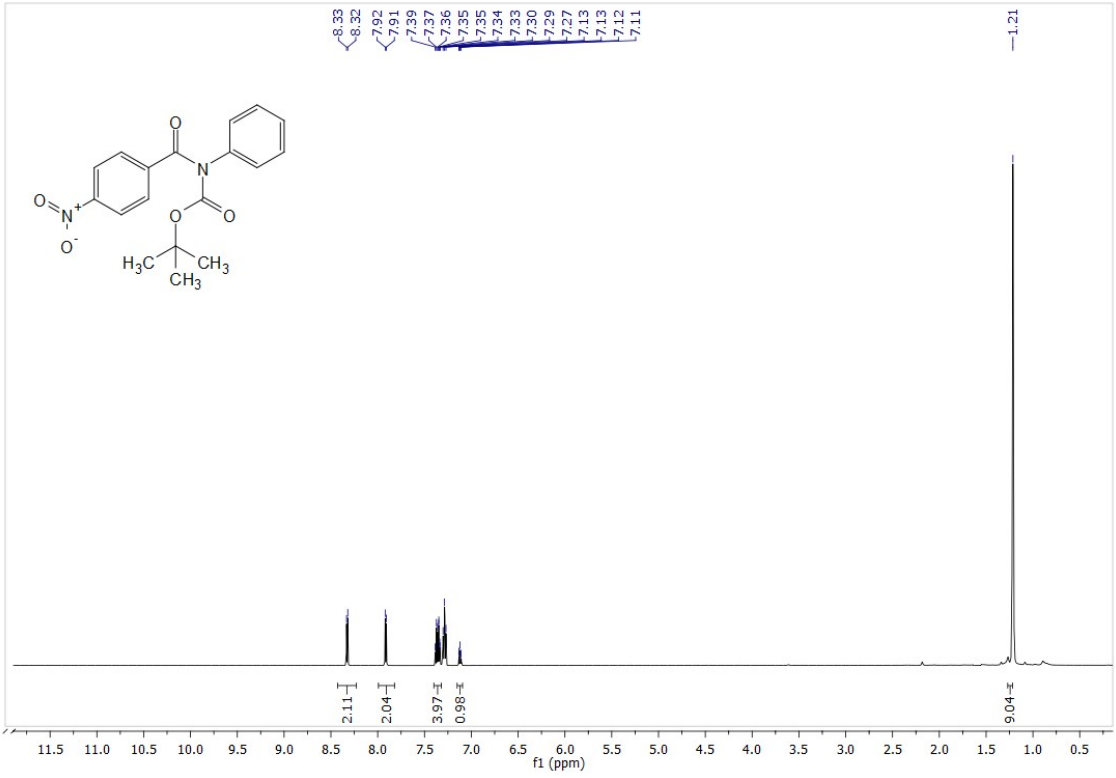


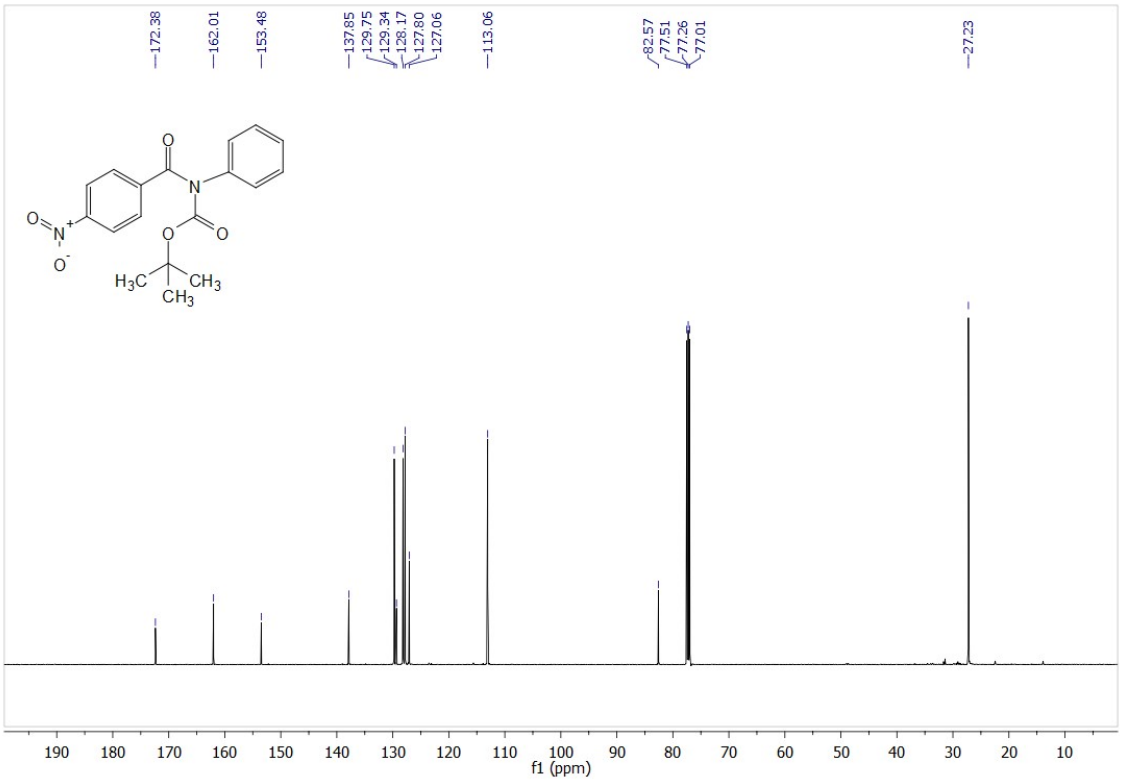
^{1}H and ^{13}C NMR Spectra of *tert*-butyl (4-bromobenzoyl)(phenyl)carbamate (1e)



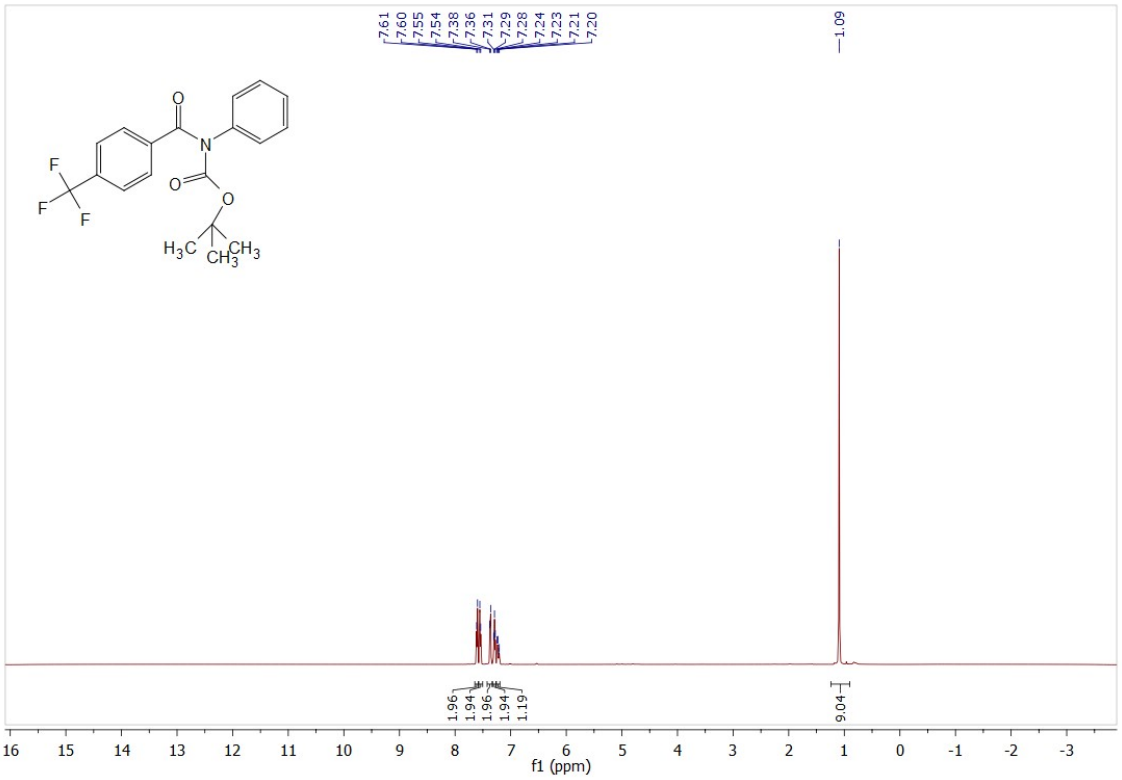


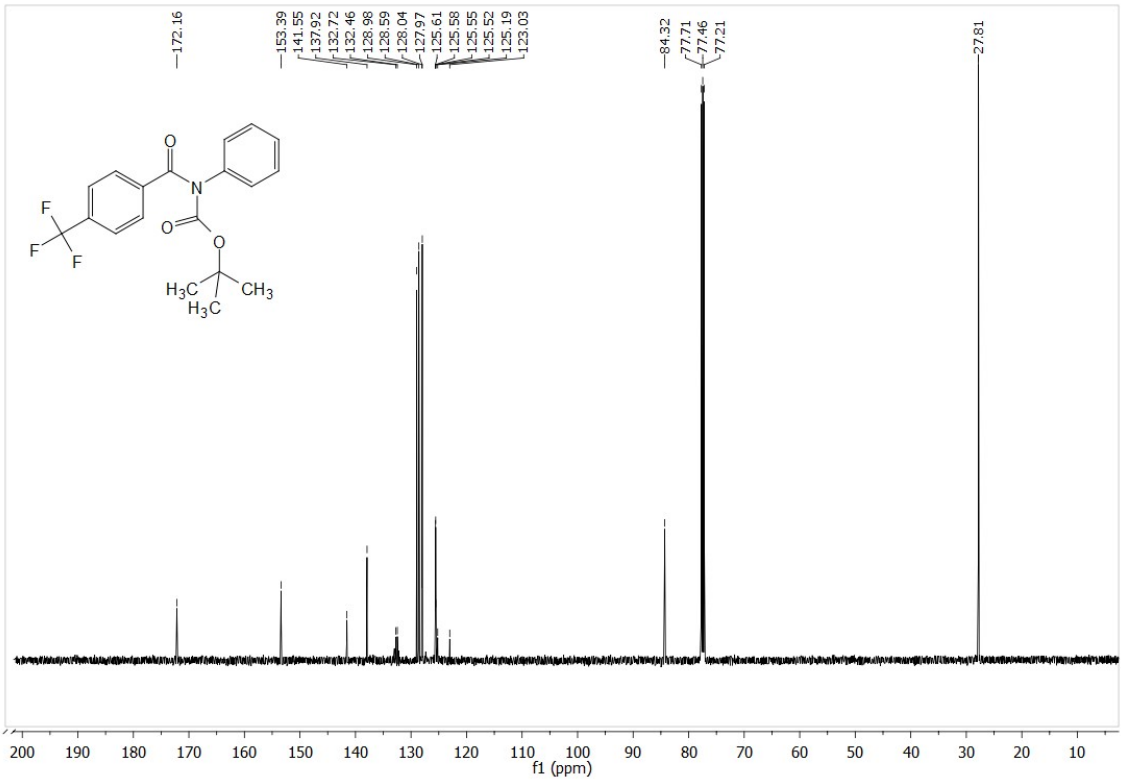
^{1}H and ^{13}C NMR Spectra of *tert*-butyl (4-nitrobenzoyl)(phenyl)carbamate (1f)

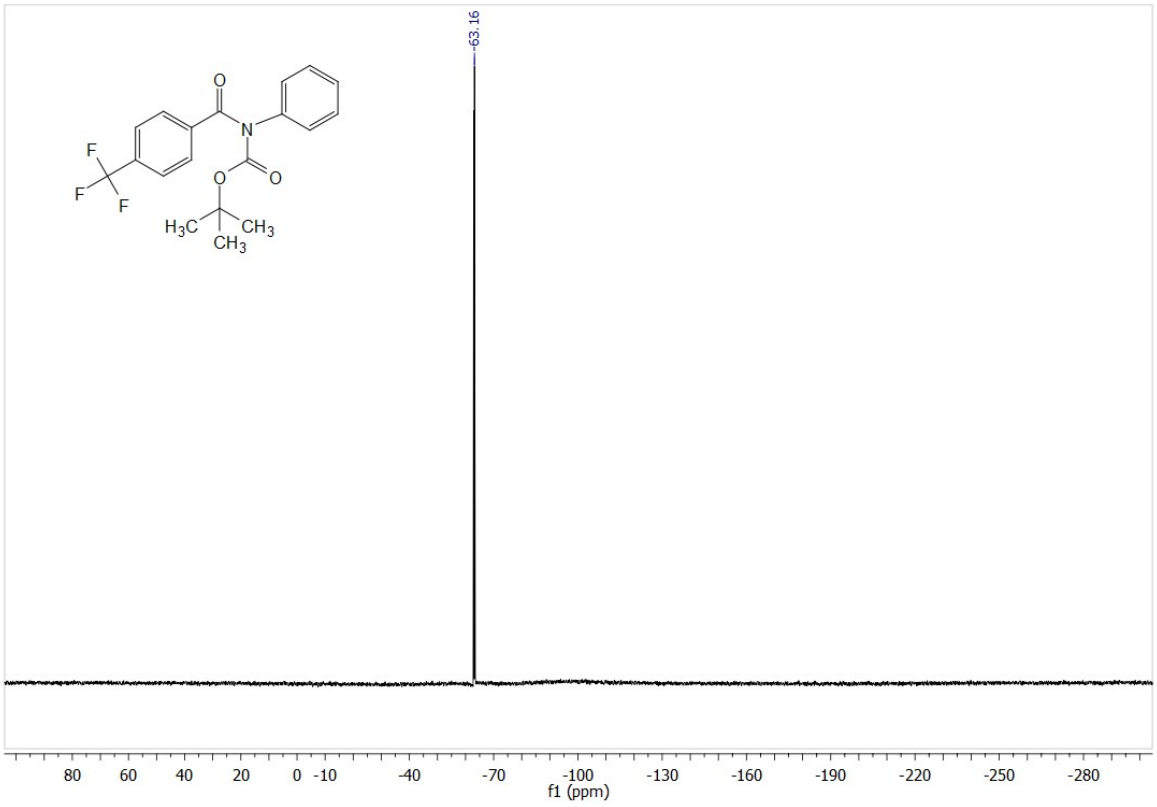




^{1}H, ^{13}C and ^{19}F NMR Spectra of *tert*-butyl (4-trifluoromethyl)(benzoyl)(phenyl)carbamate (1g)


7.61
7.60
7.55
7.54
7.38
7.36
7.31
7.29
7.28
7.24
7.23
7.21
7.20
1.09
1.96
1.94
1.96
1.94
1.19
9.04
f1 (ppm)


172.16
153.39
141.55
137.92
132.72
132.46
128.98
128.59
128.04
127.97
125.61
125.58
125.55
125.52
125.19
123.03
84.32
77.71
77.46
77.21
27.81
f1 (ppm)


-63.16
O
N
O
O
F
F
F
H3C
CH3
CH3
80
60
40
20
0
-10
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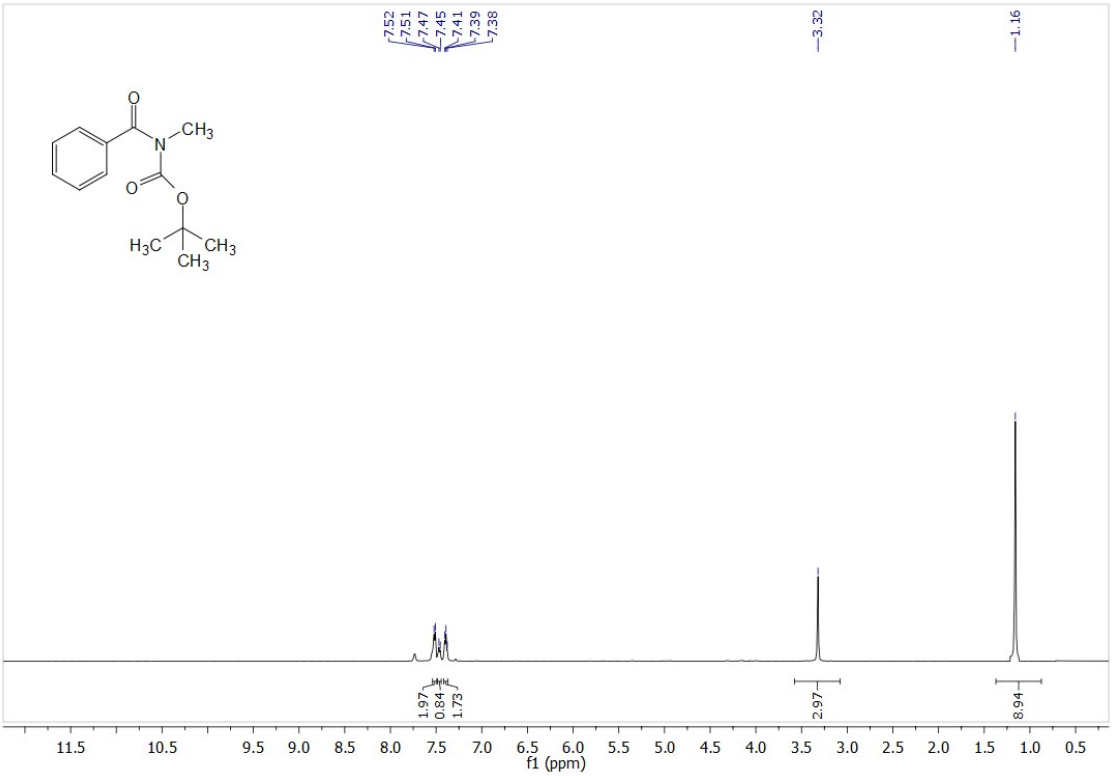
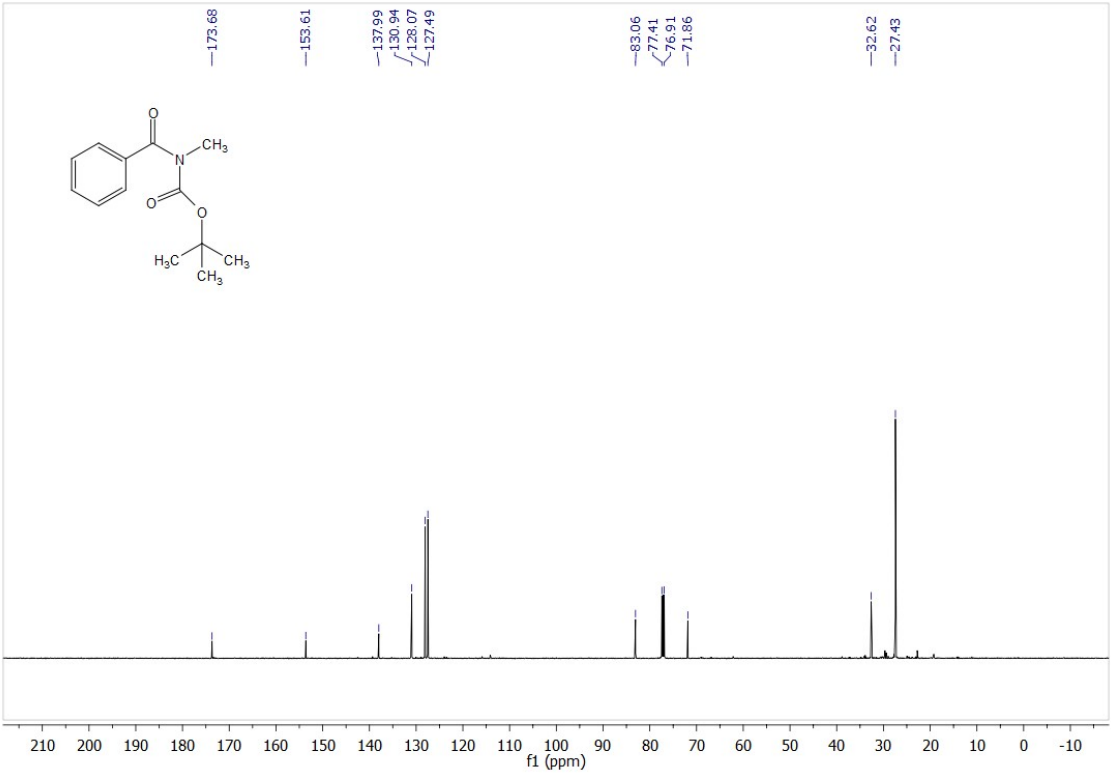
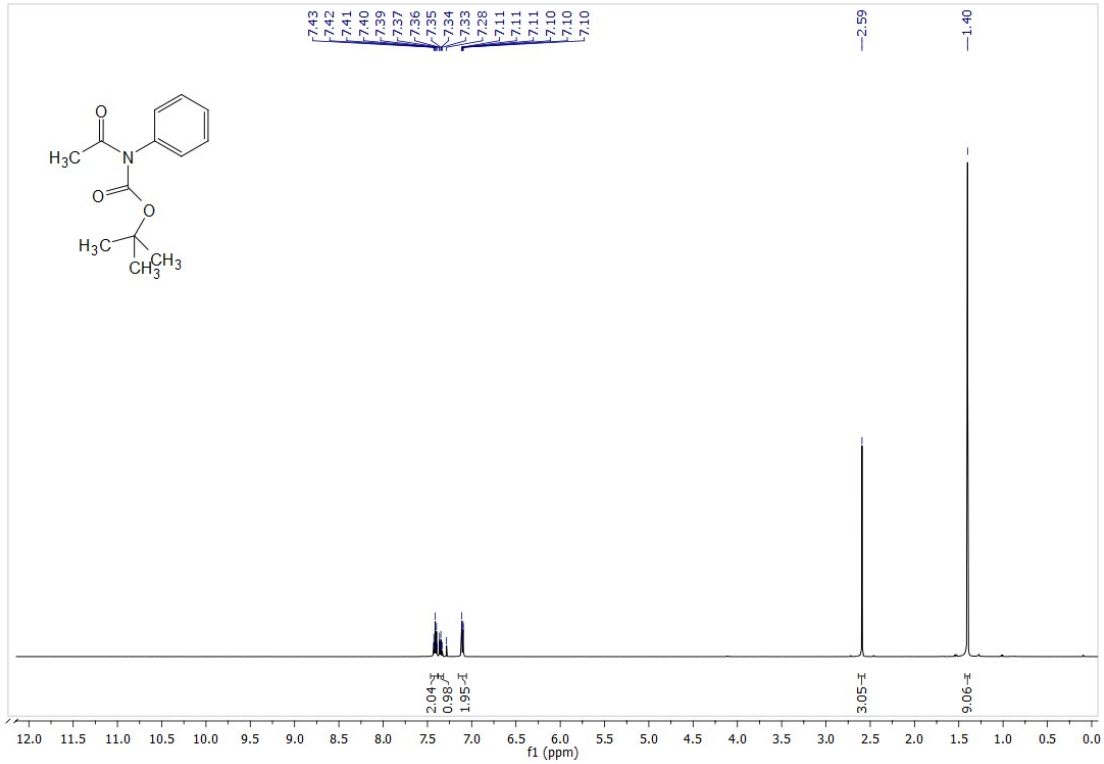
-70
-100
-130
-160
-190
-220
-250
-280
f1 (ppm)

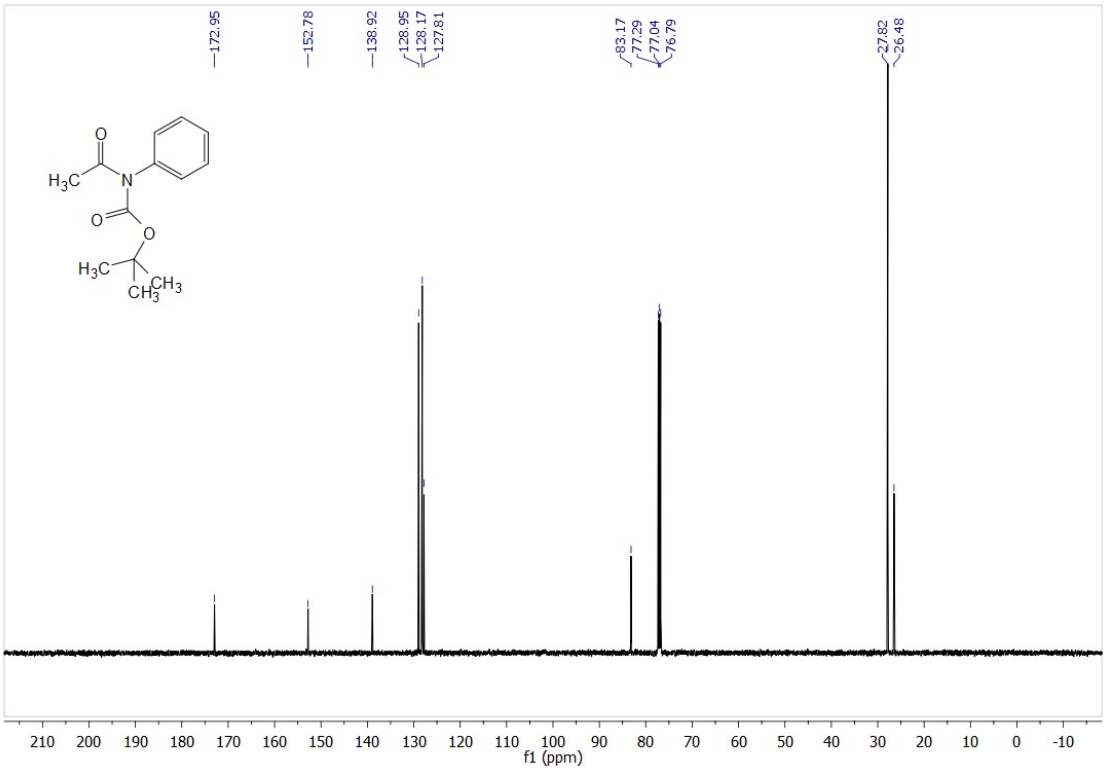
^{1}H and ^{13}C NMR Spectra of *tert*-butyl benzoyl(methyl)carbamate (1h)



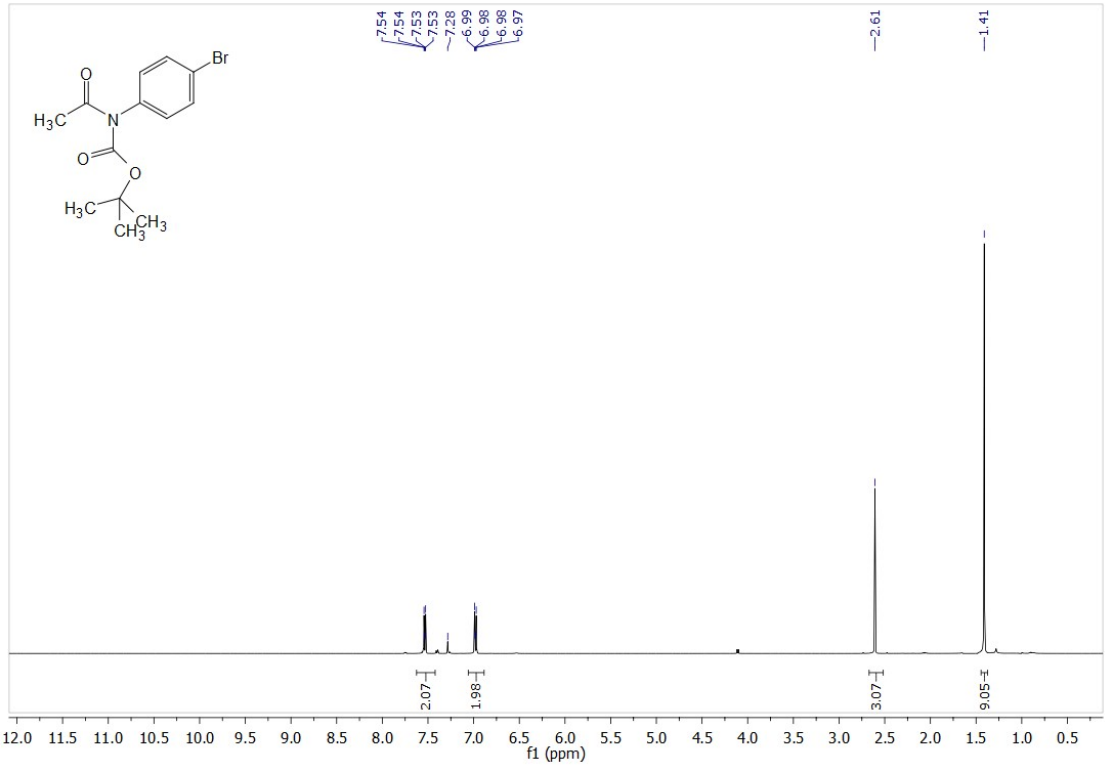


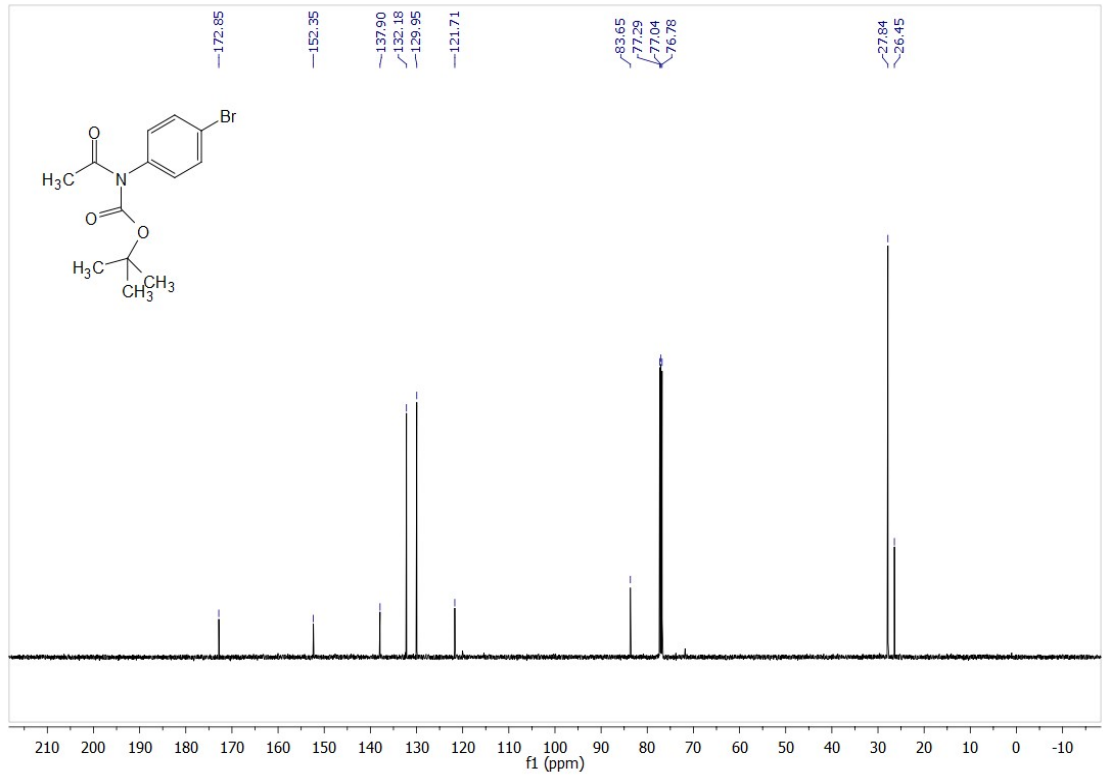
^{1}H and ^{13}C NMR Spectra of *tert*-butyl acetyl(phenyl)carbamate (1i)



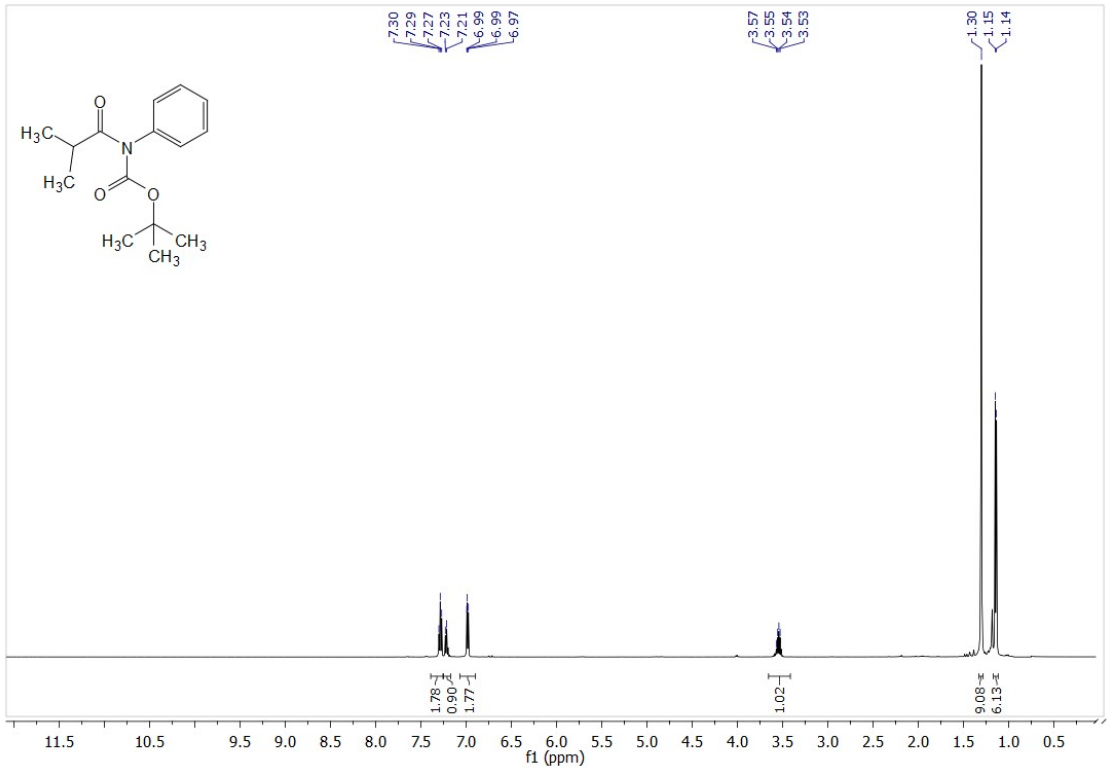


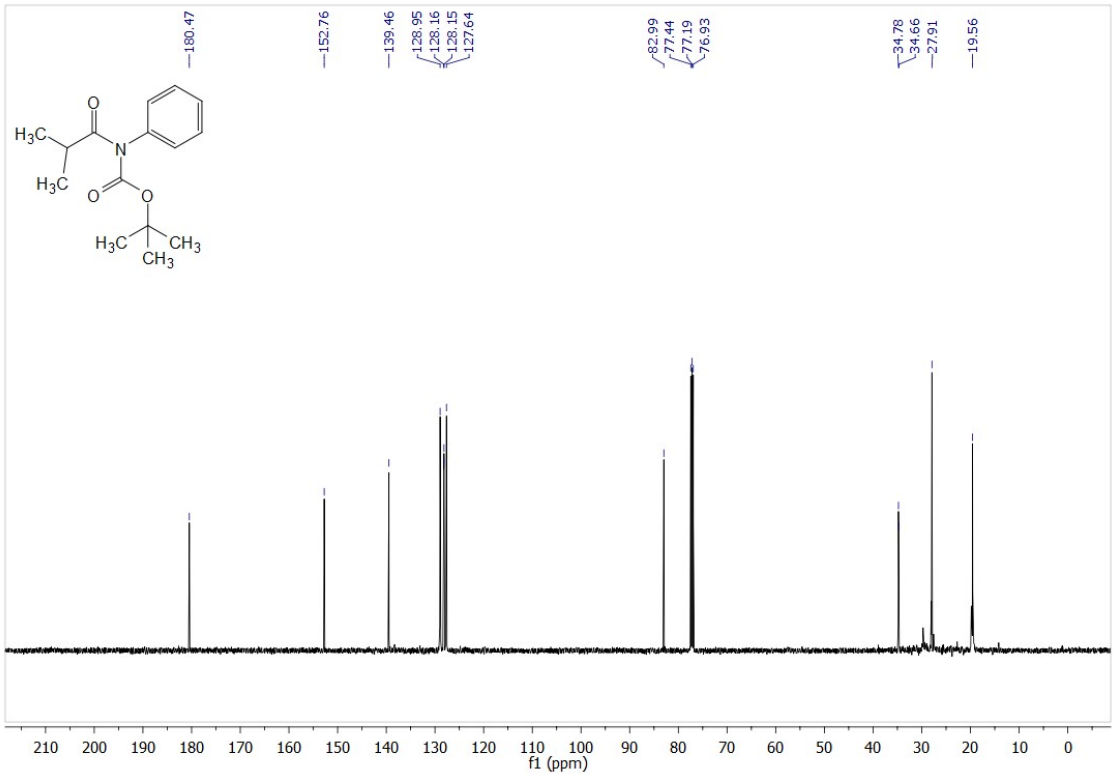
^{1}H and ^{13}C NMR Spectra of *tert*-butyl acetyl(4-bromophenyl)carbamate (1j)





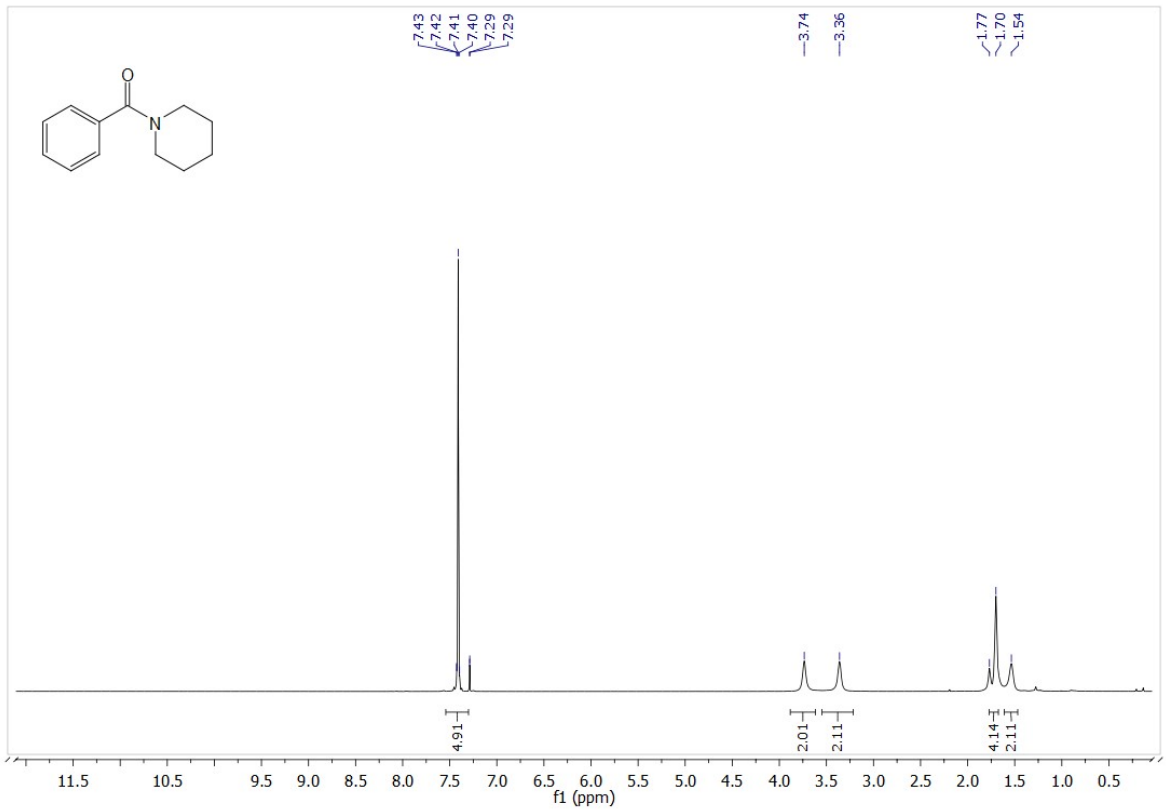
^{1}H and ^{13}C NMR Spectra of *tert*-butyl isobutyryl(phenyl)carbamate (1k)

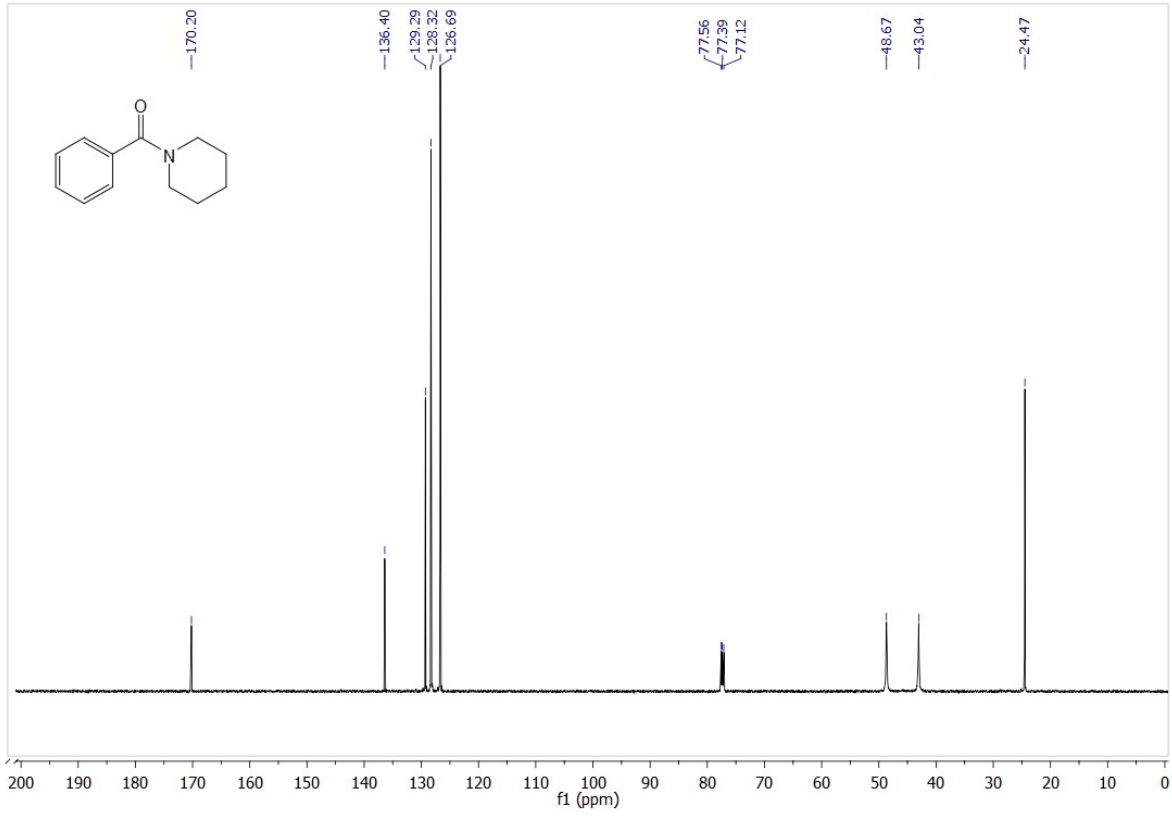




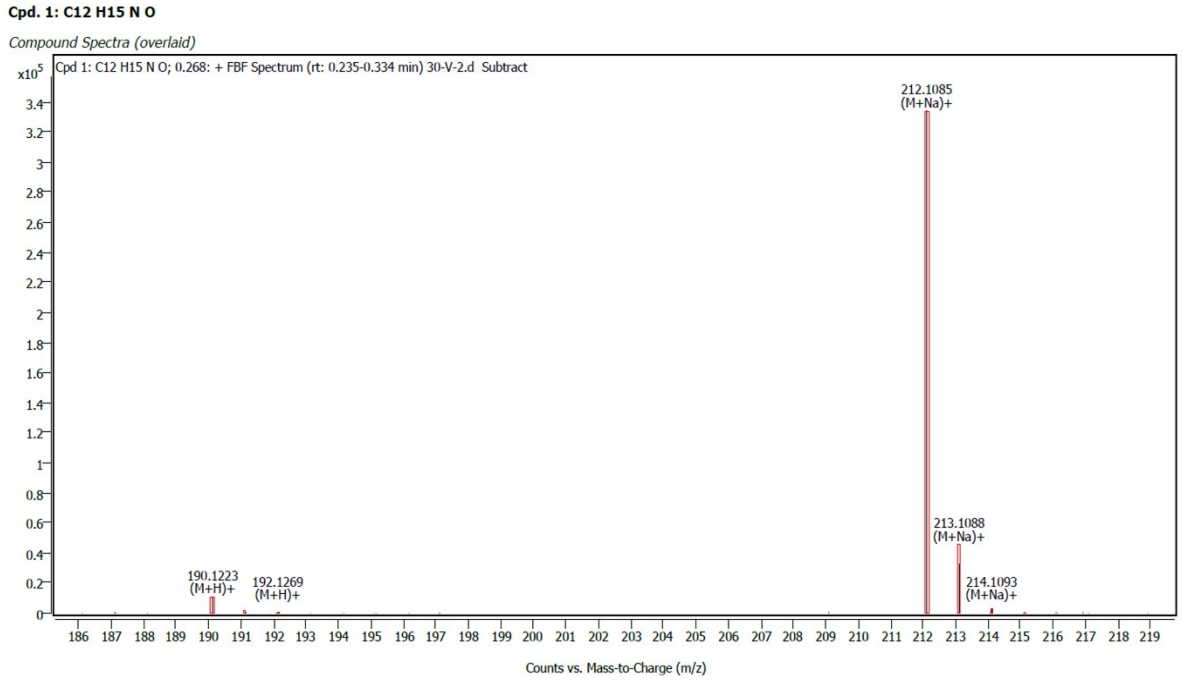
^{1}H and ^{13}C NMR Spectra of Transamidation Products

^{1}H and ^{13}C NMR Spectra of phenyl(piperidin-1-yl)methanone (3a)

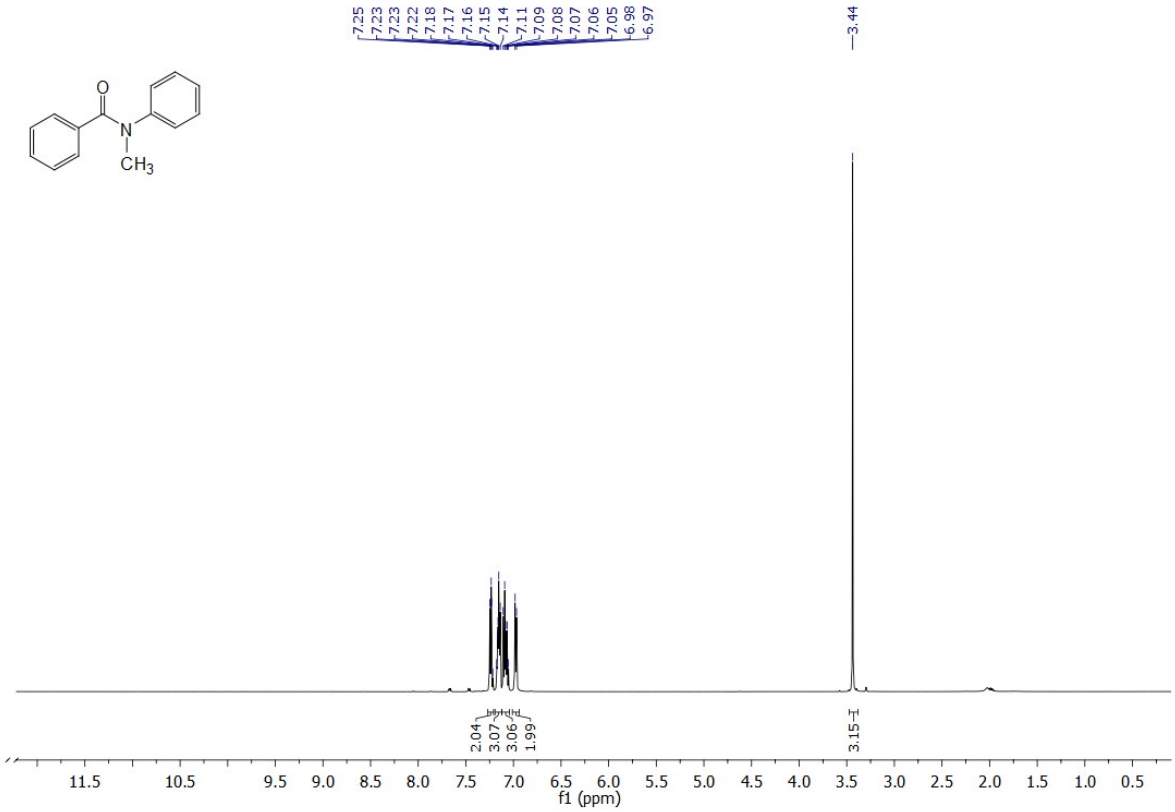


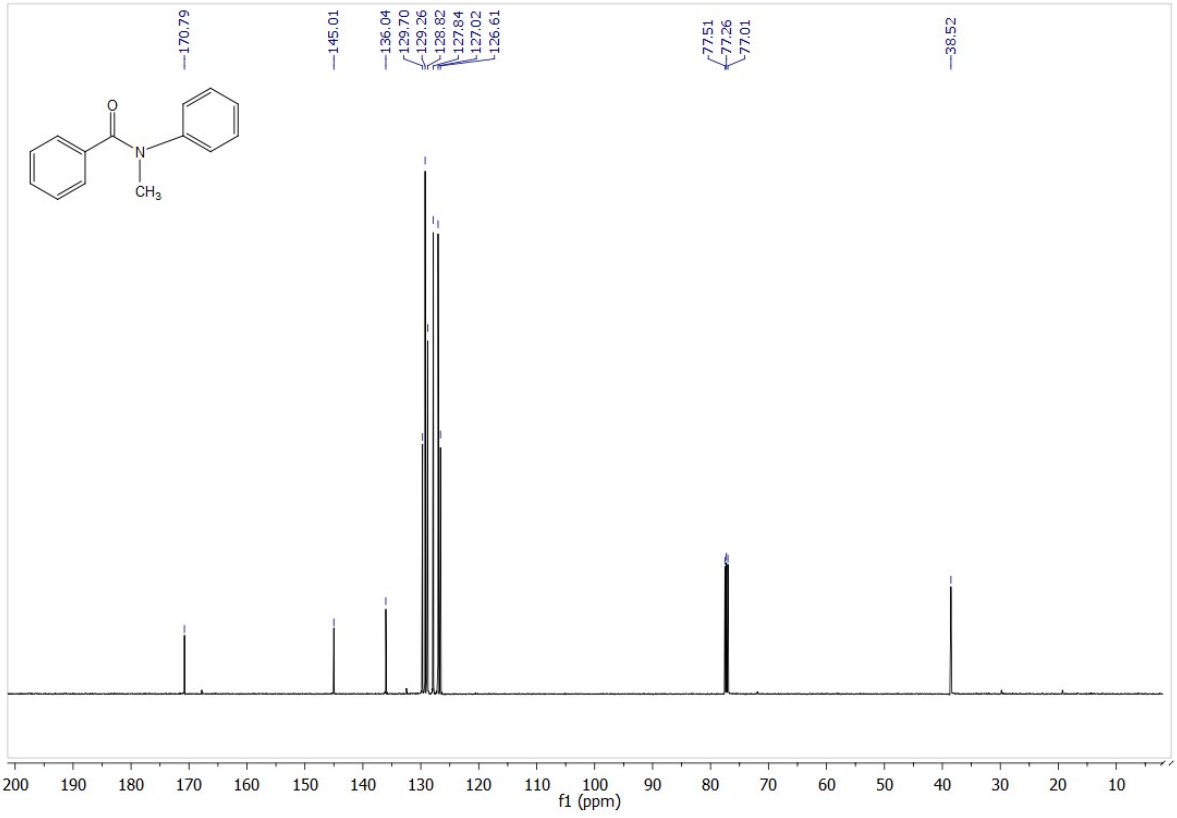


Mass Spectra of phenyl(piperidin-1-yl)methanone (3a)

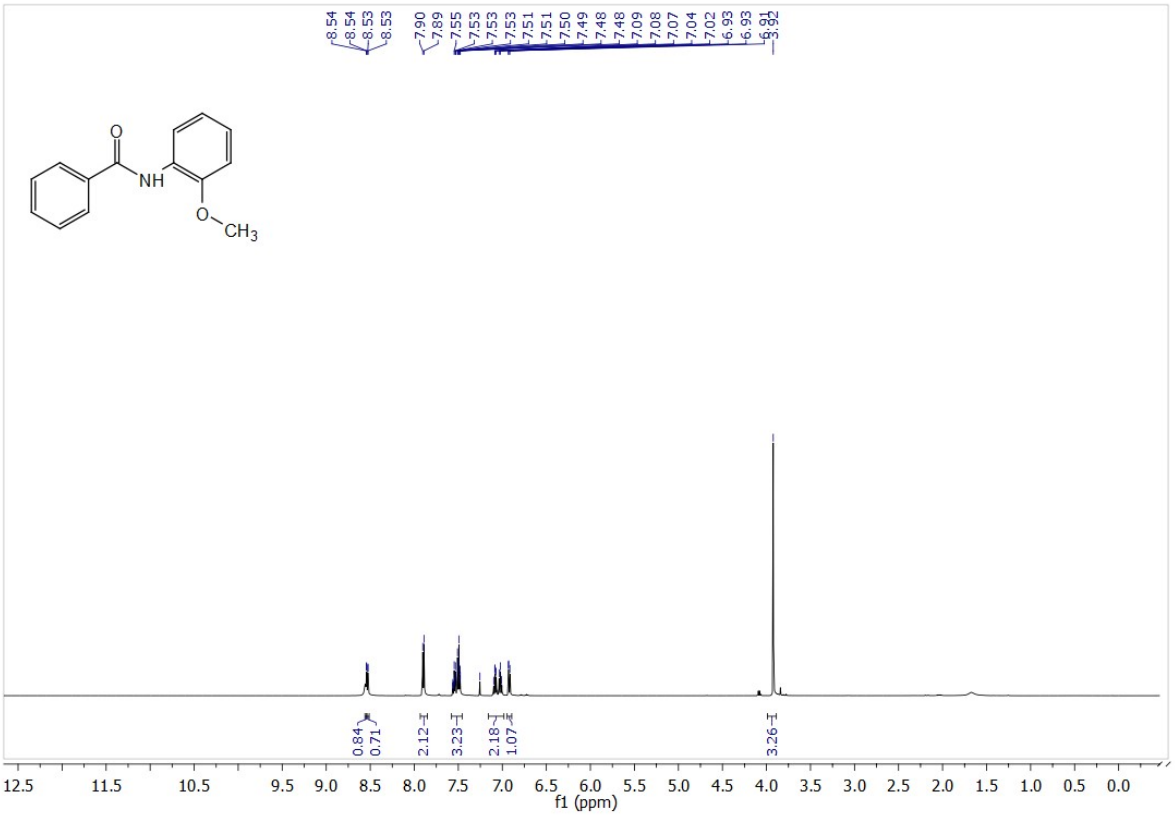


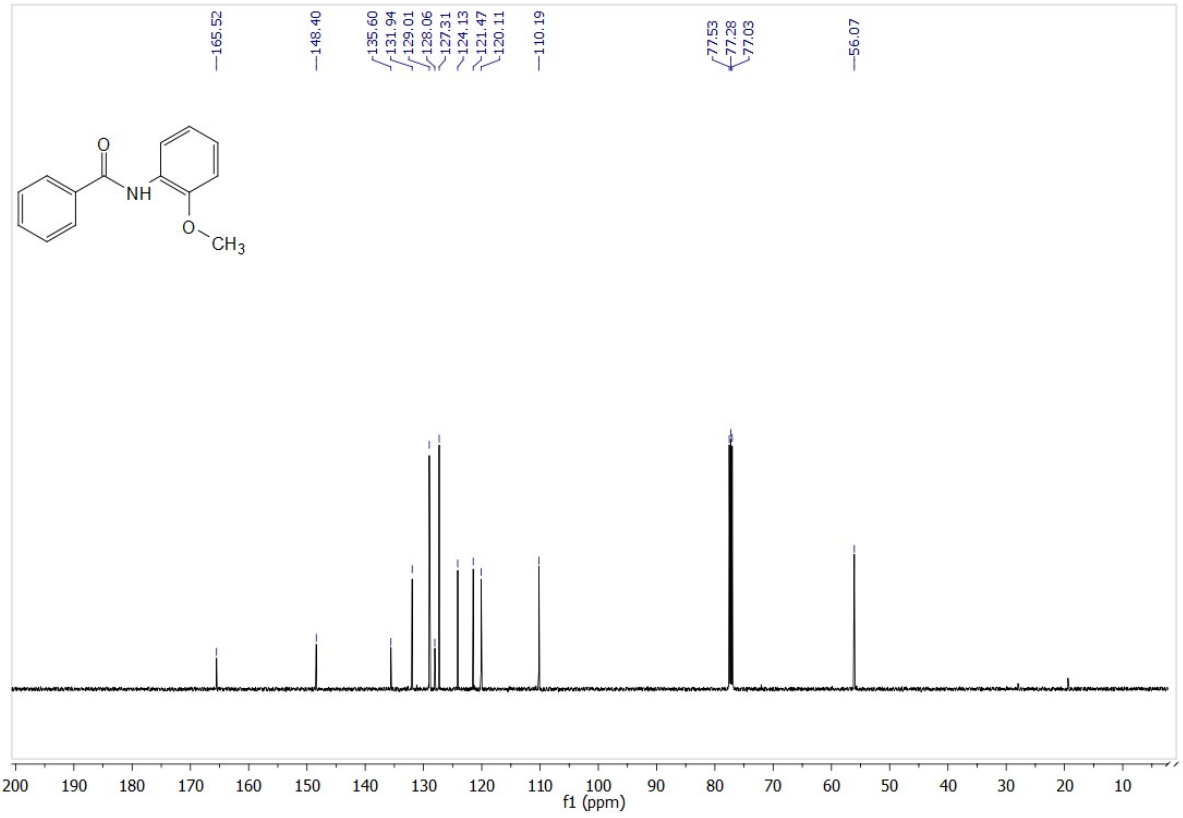
^{1}H and ^{13}C NMR Spectra of *N*-methyl-*N*-phenylbenzamide (3b)



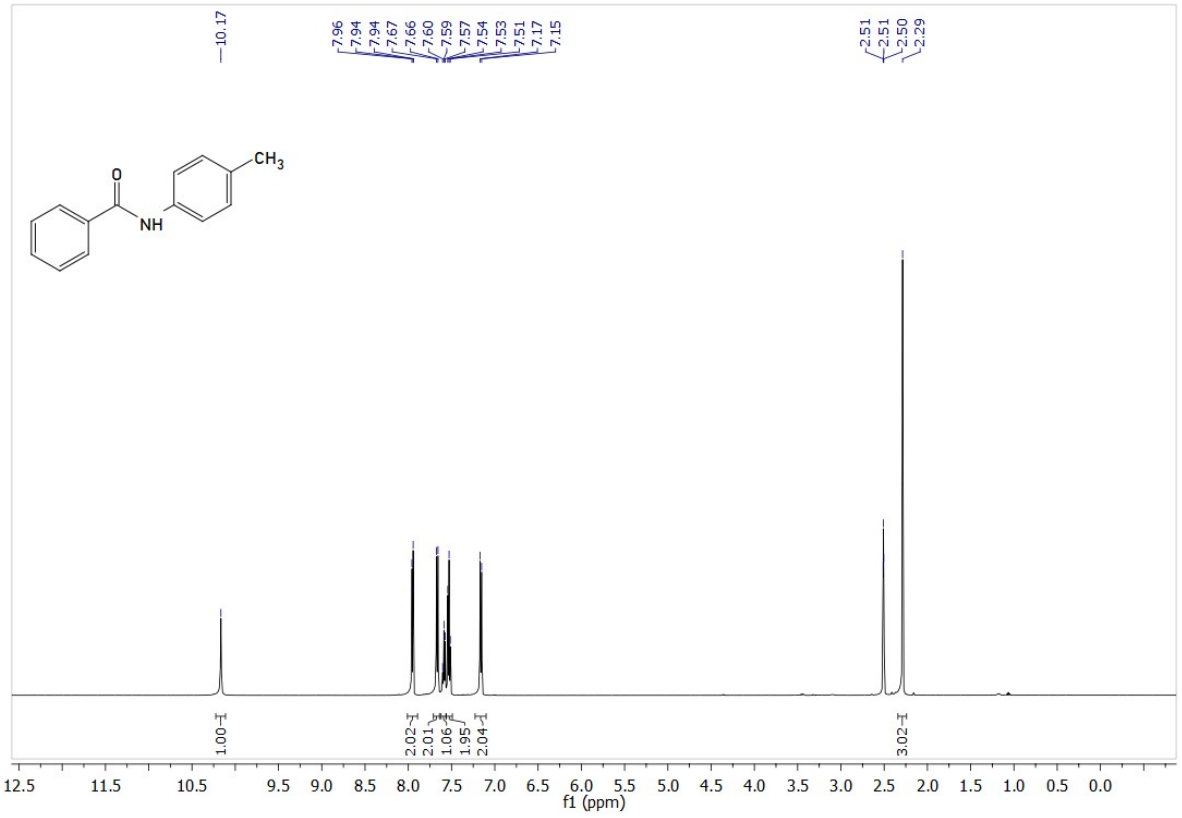


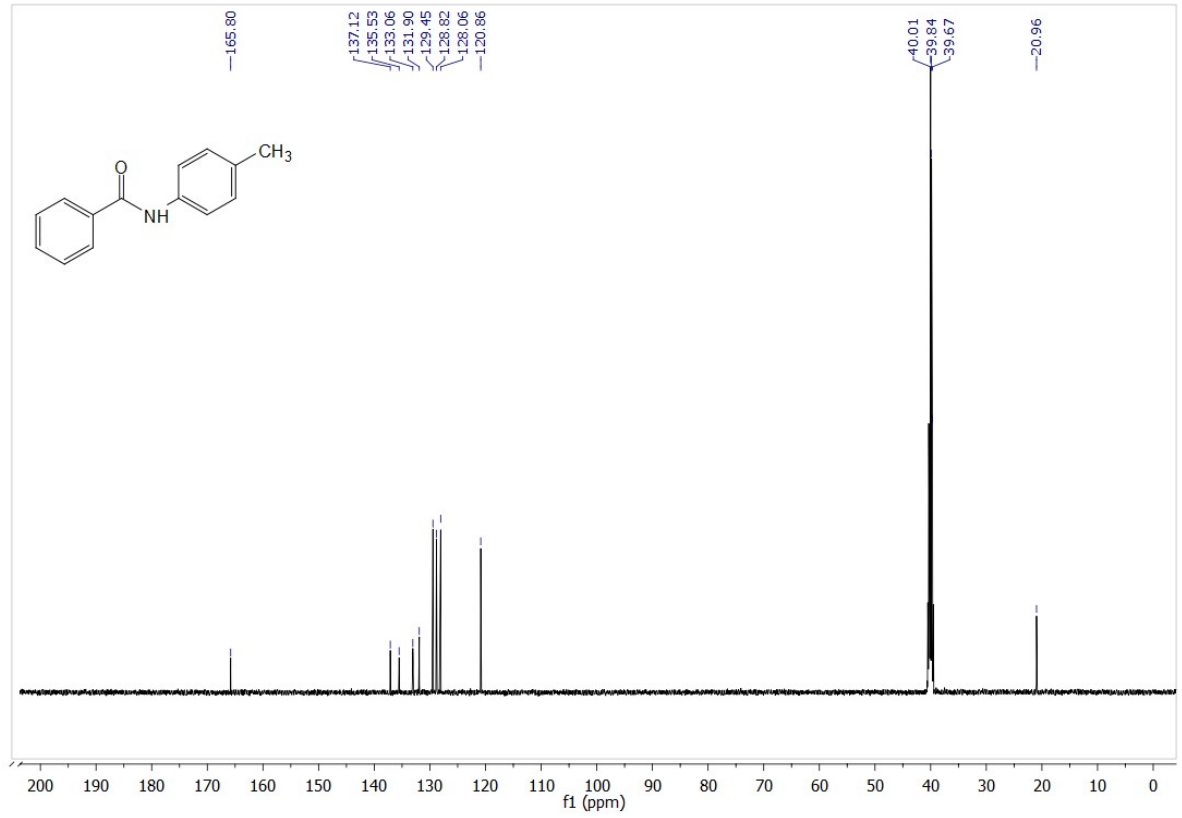
^{1}H and ^{13}C NMR Spectra of *N*-(2-methoxyphenyl)benzamide (3c)



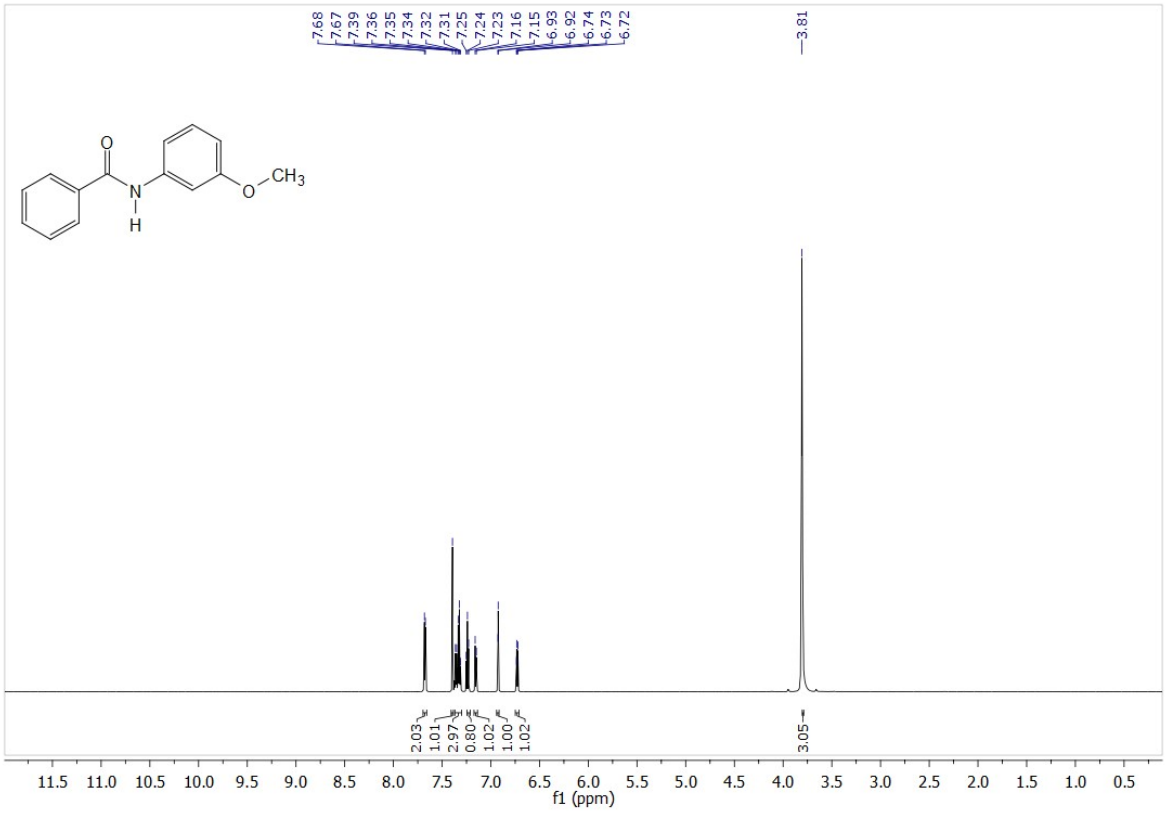


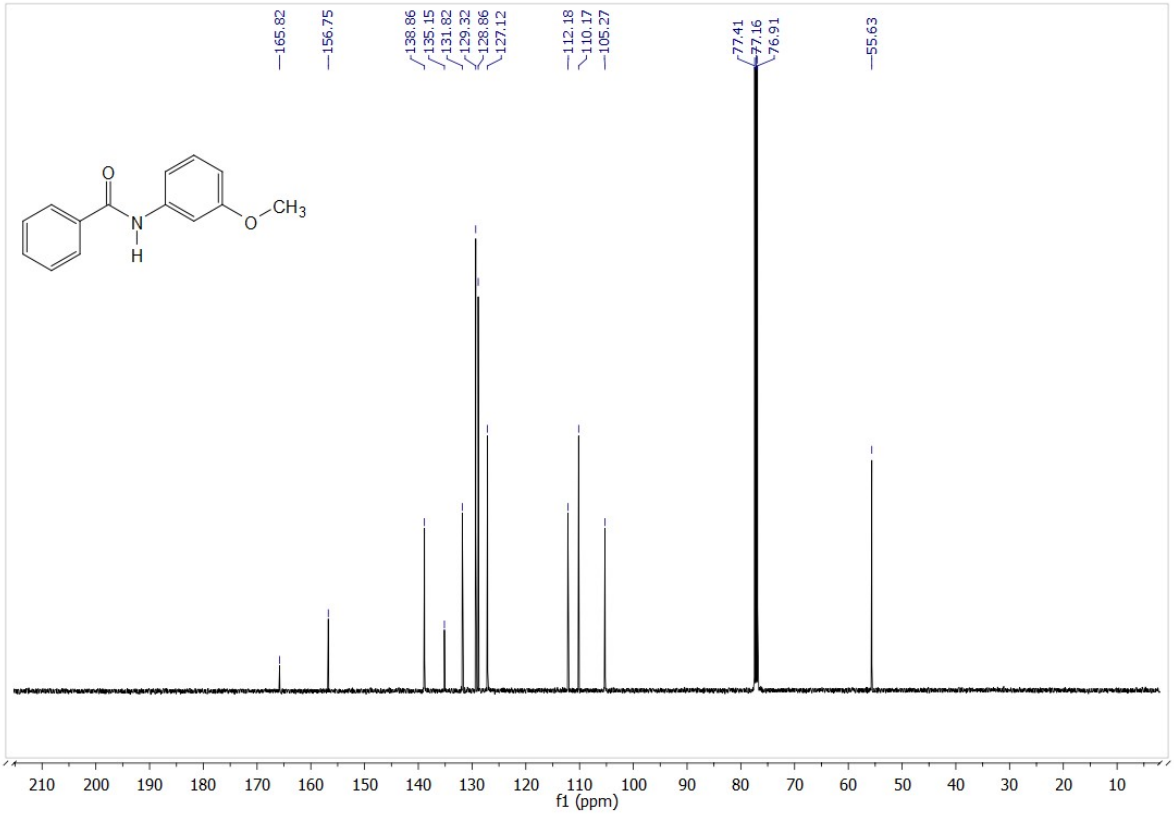
^{1}H and ^{13}C NMR Spectra of *N*-(4-methylphenyl)benzamide (3d)



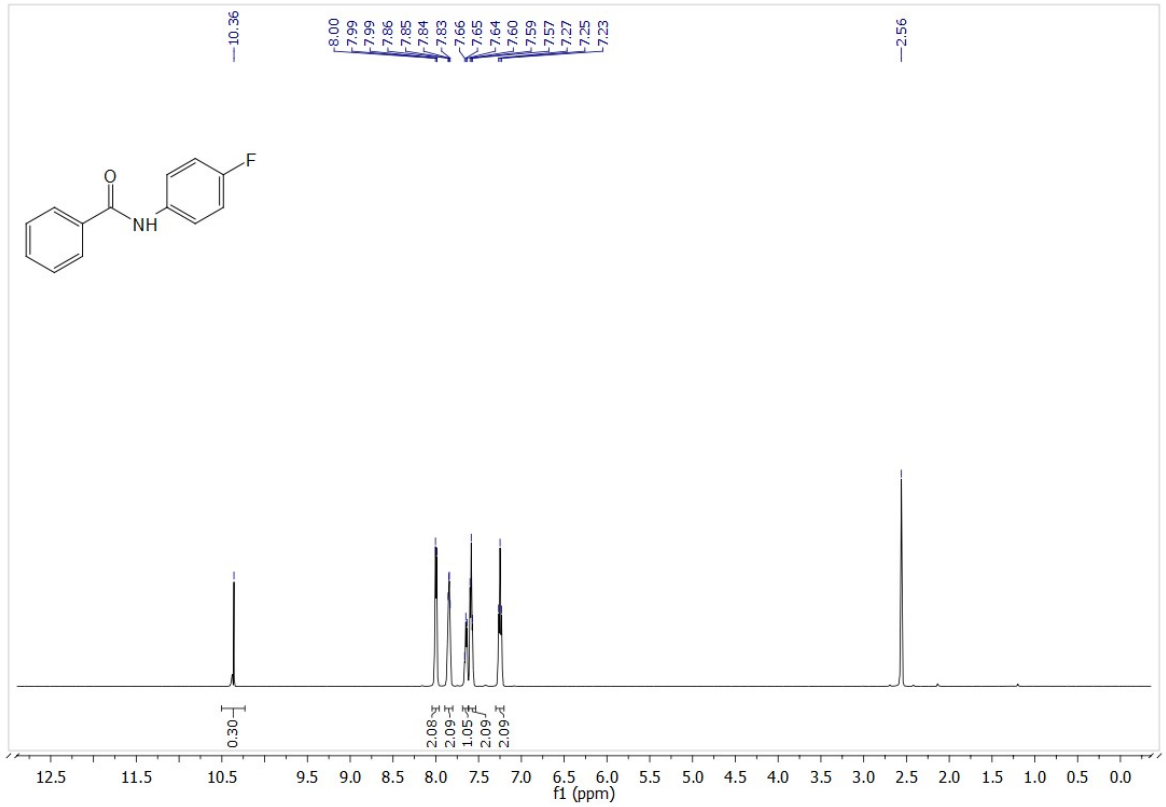


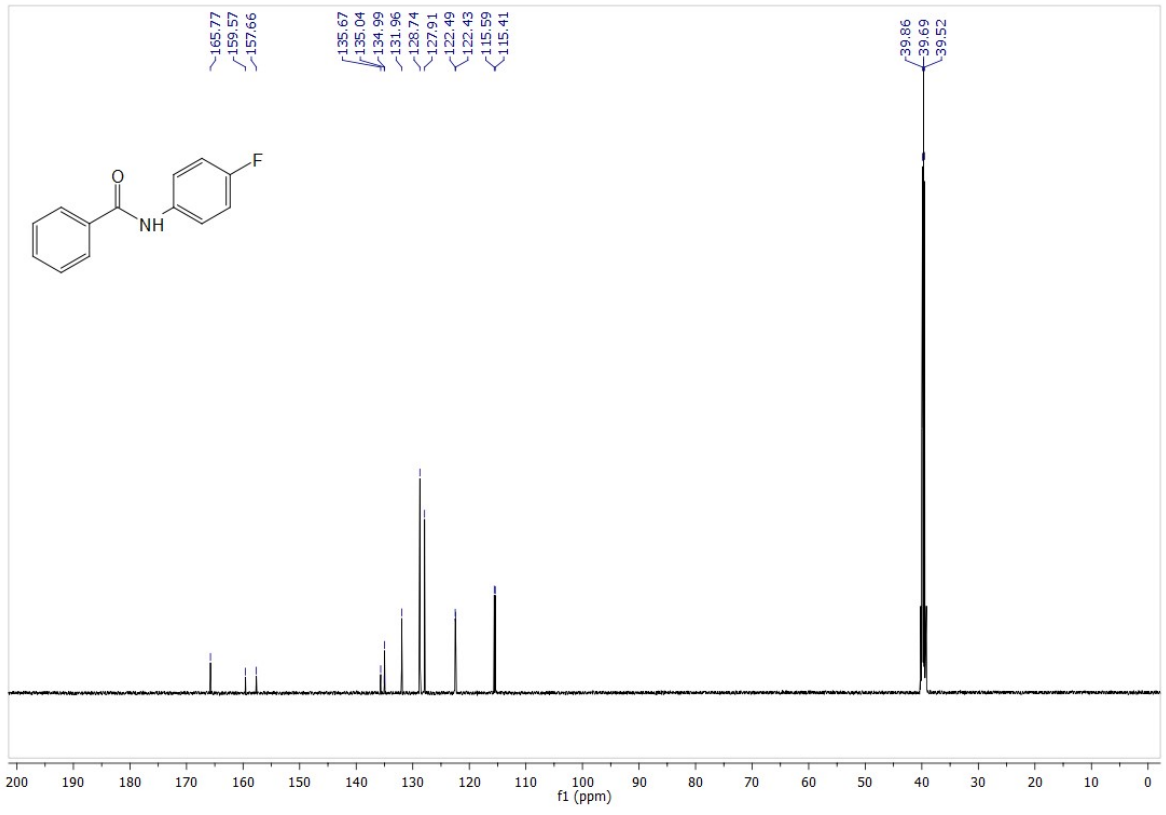
^{1}H and ^{13}C NMR Spectra of *N*-(3-methoxylphenyl)benzamide (3e)

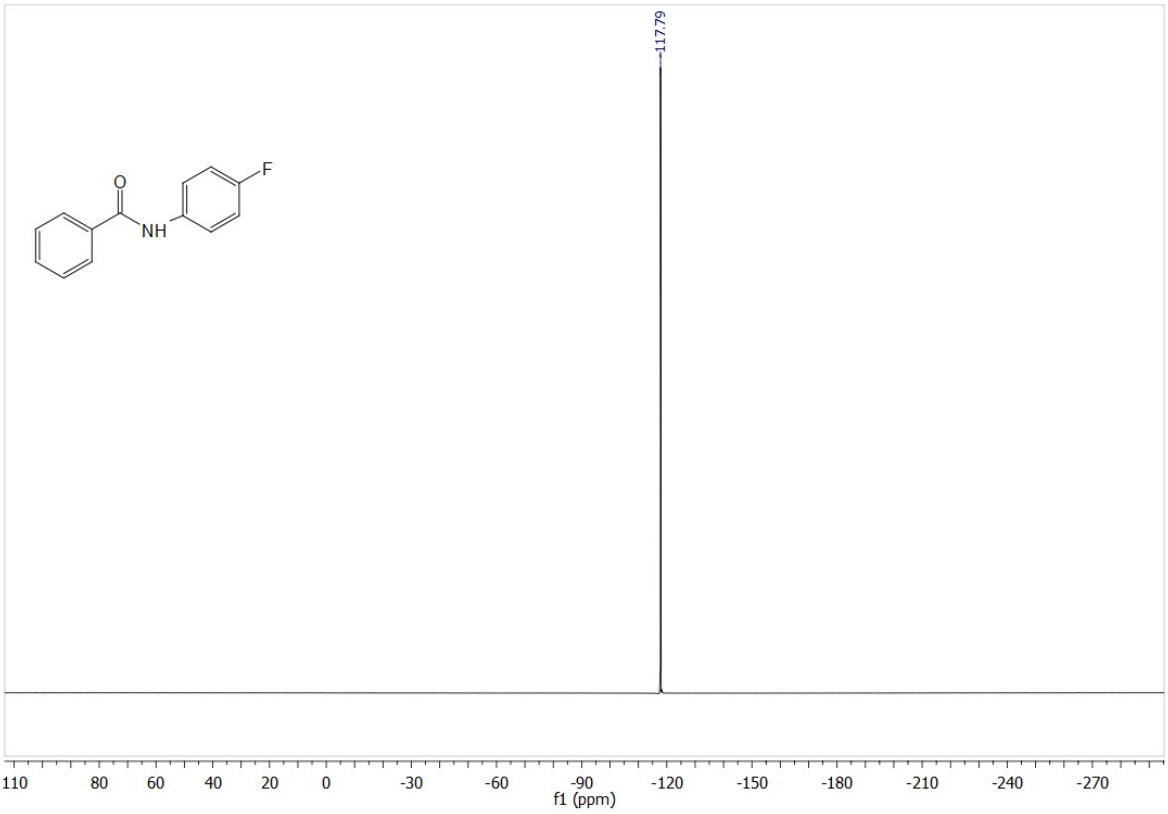




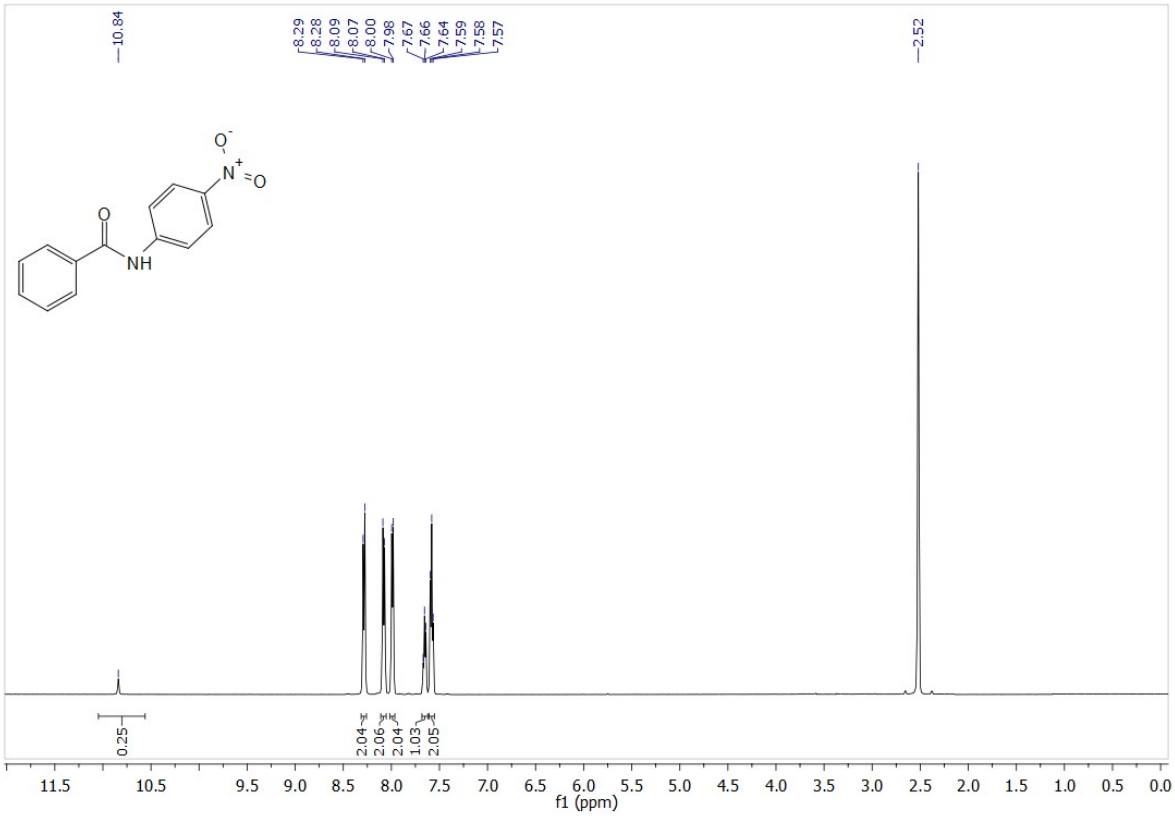
^{1}H, ^{13}C and ^{19}F NMR Spectra of *N*-(4-fluorophenyl)benzamide (3f)

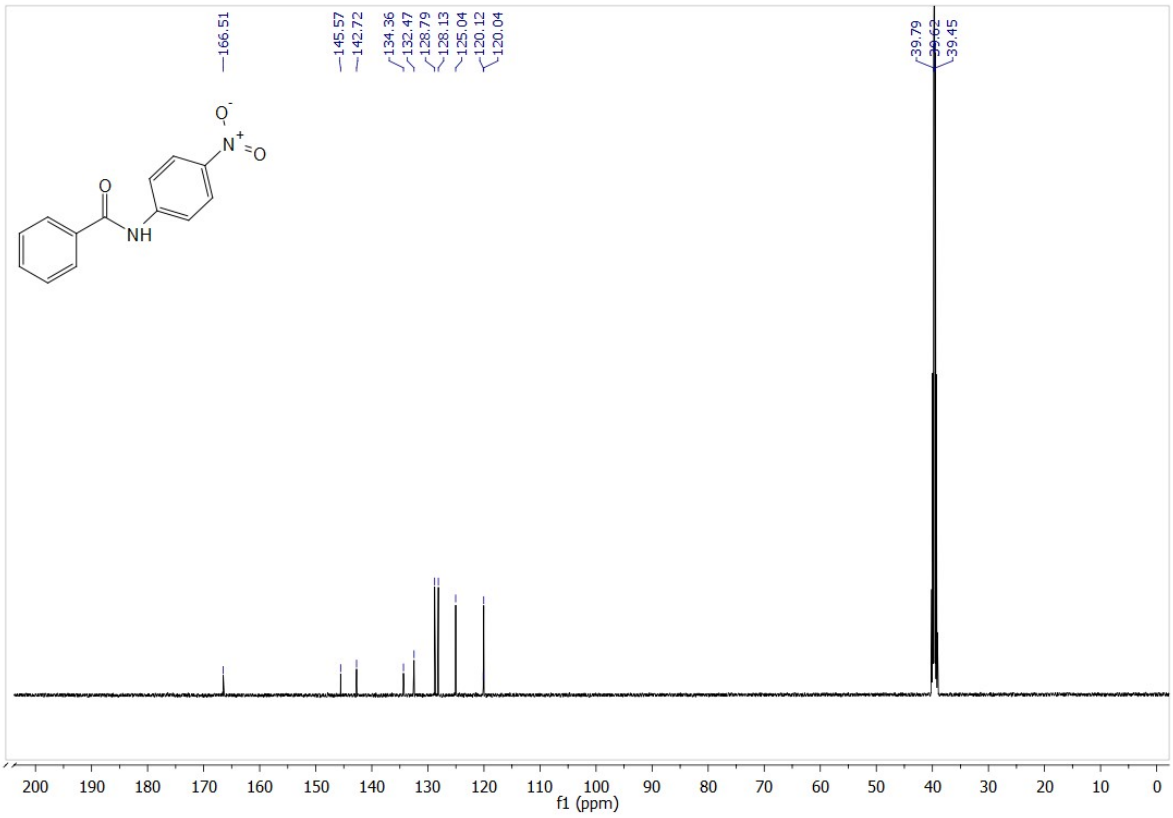




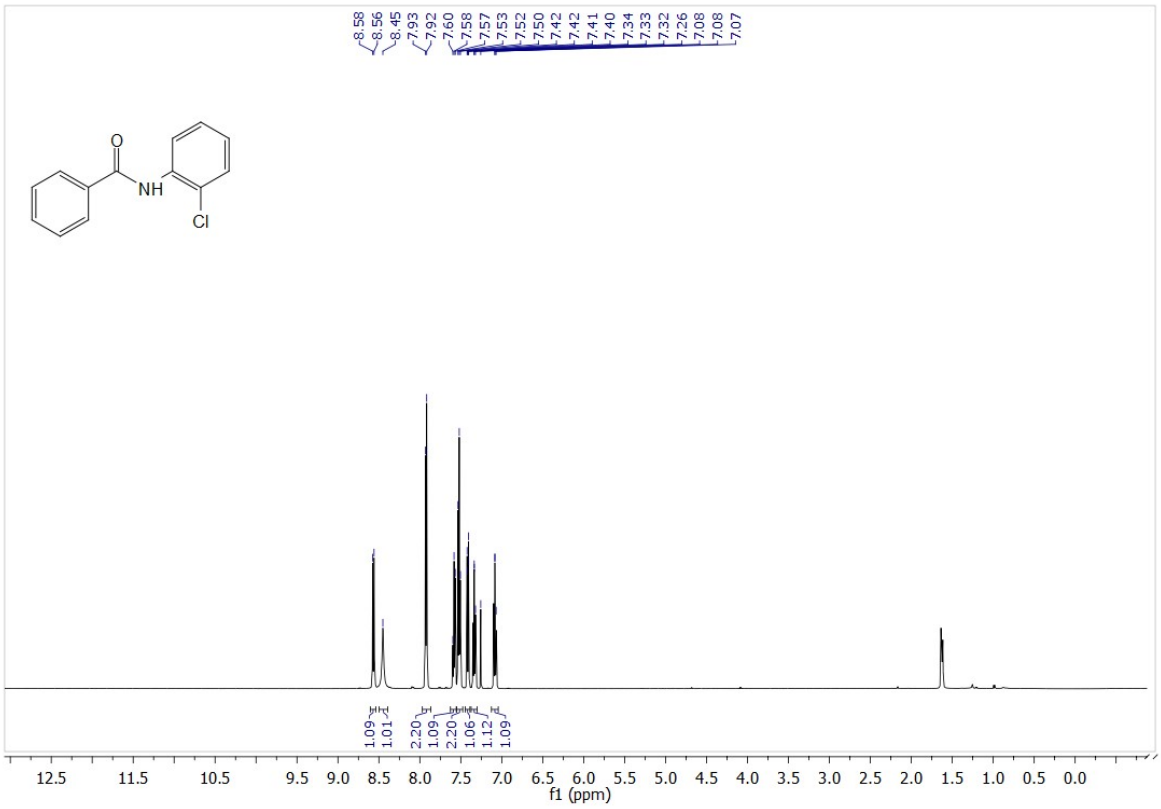

-117.79
O
NH
F
110
80
60
40
20
0
-30
-60
-90
-120
-150
-180
-210
-240
-270
f1 (ppm)

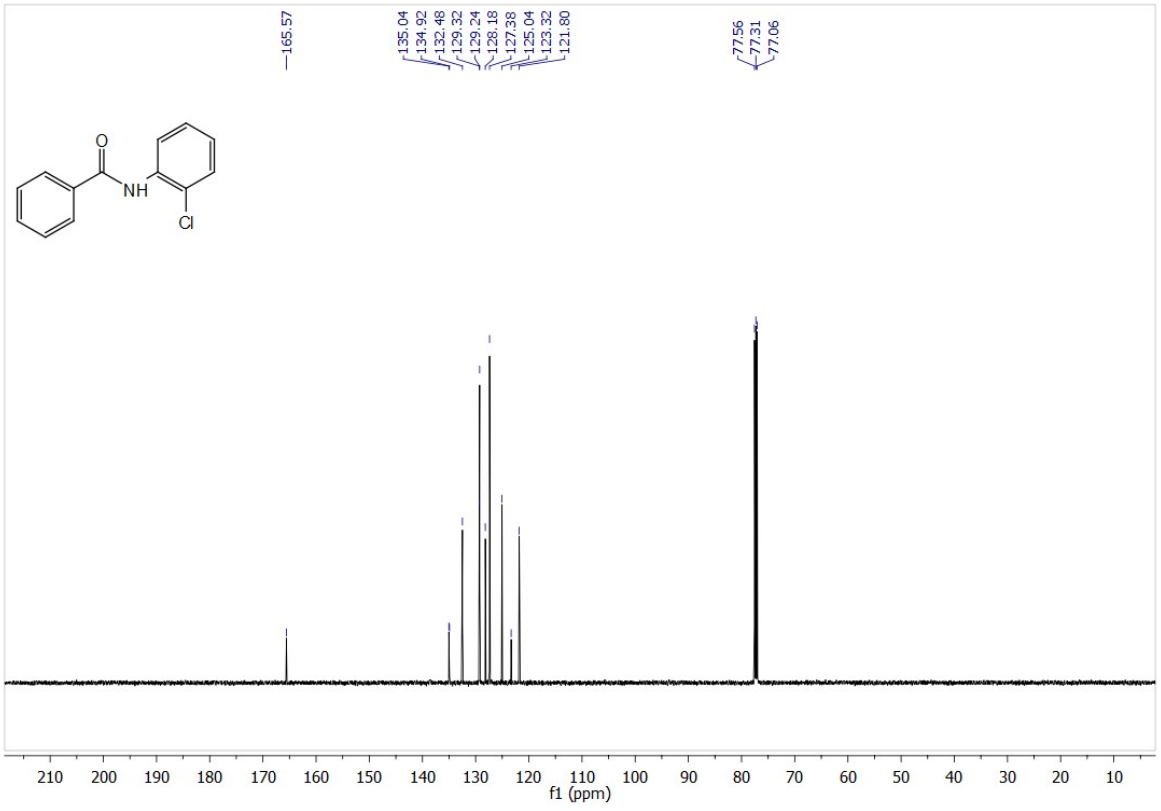
^{1}H and ^{13}C NMR Spectra of *N*-(4-nitrophenyl)benzamide (3g)



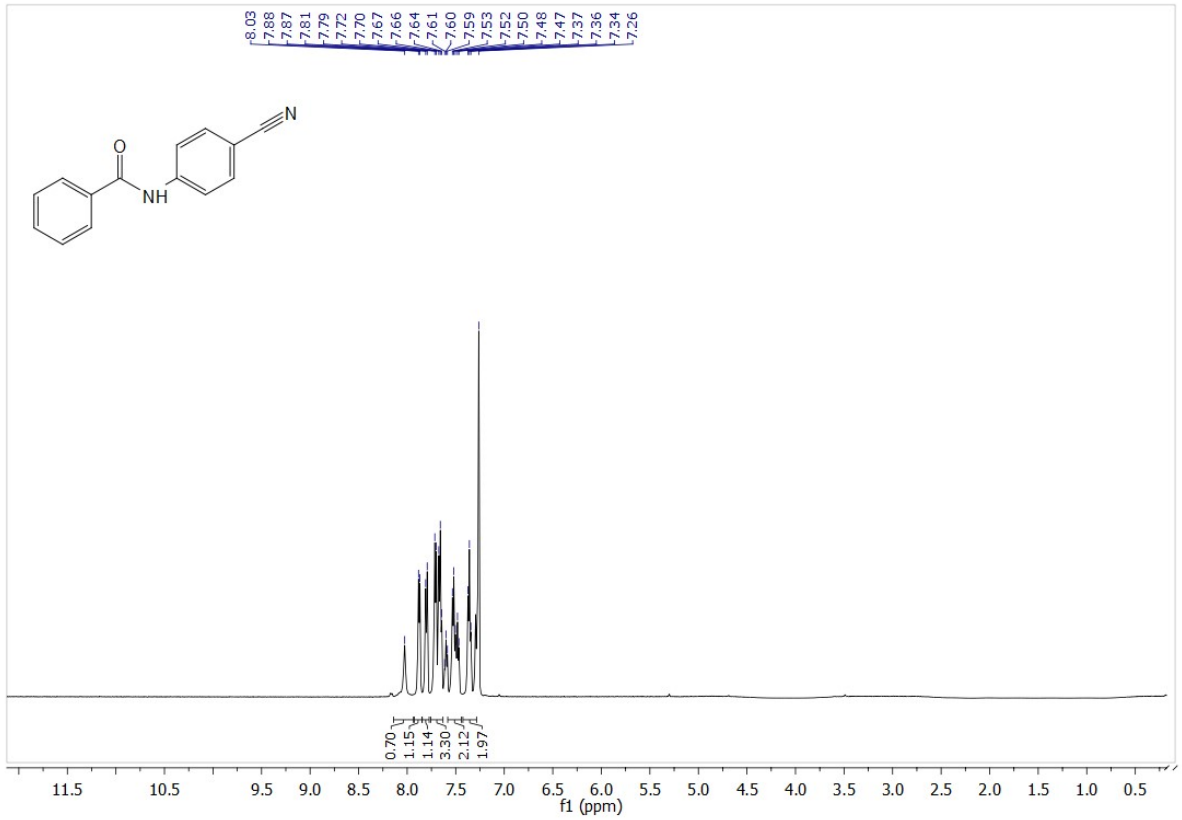


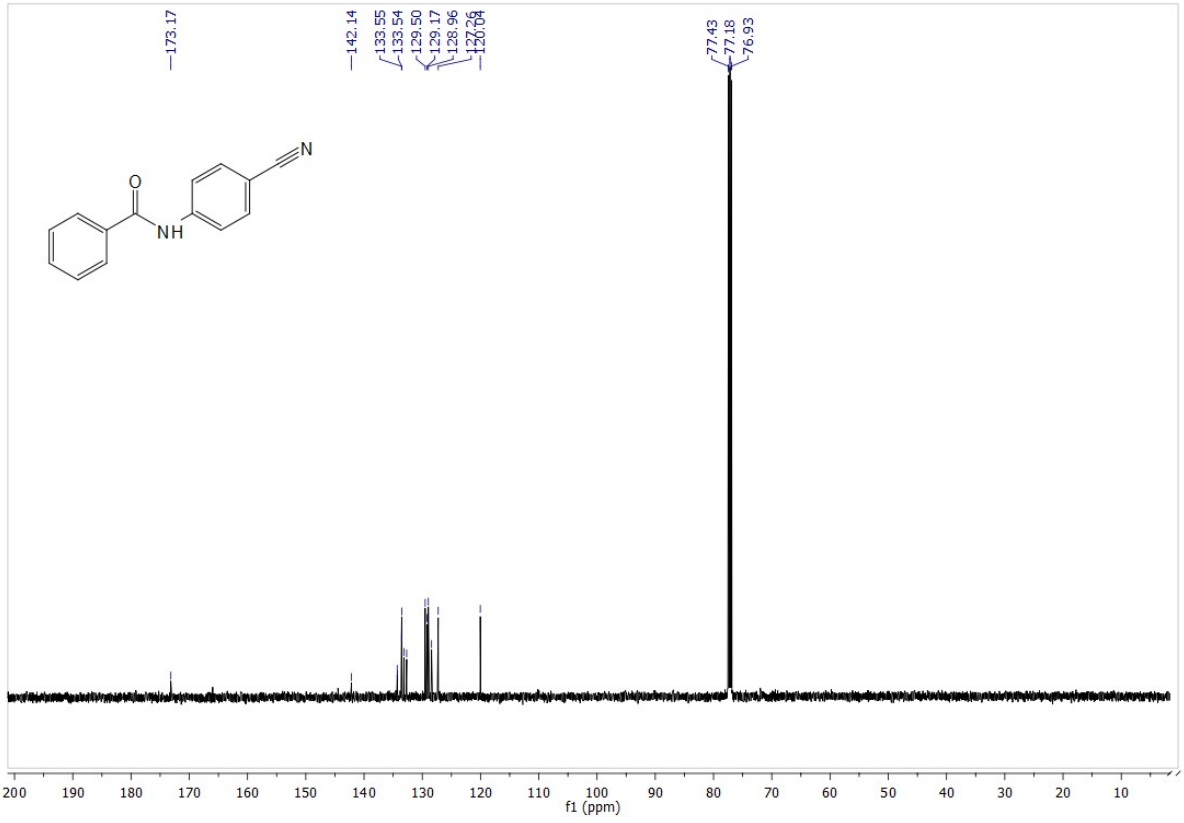
^{1}H and ^{13}C NMR Spectra of *N*-(2-chlorophenyl)benzamide (3h)



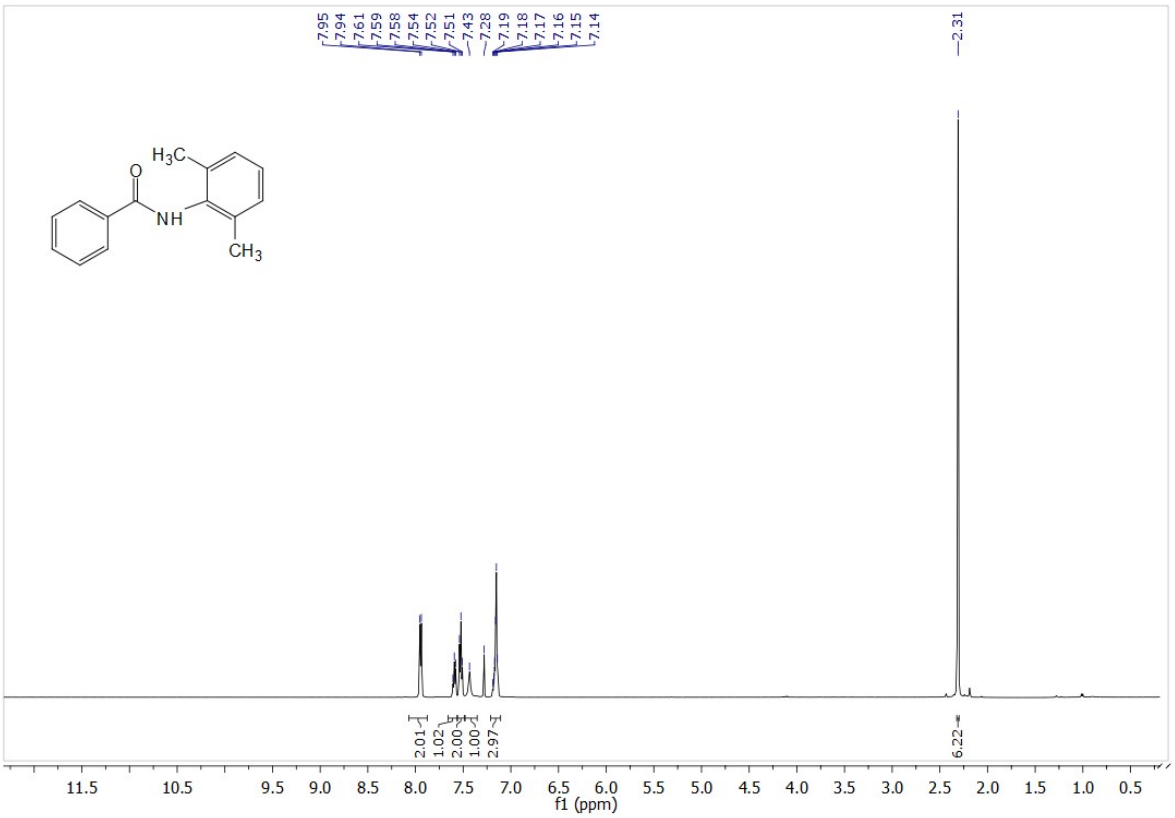


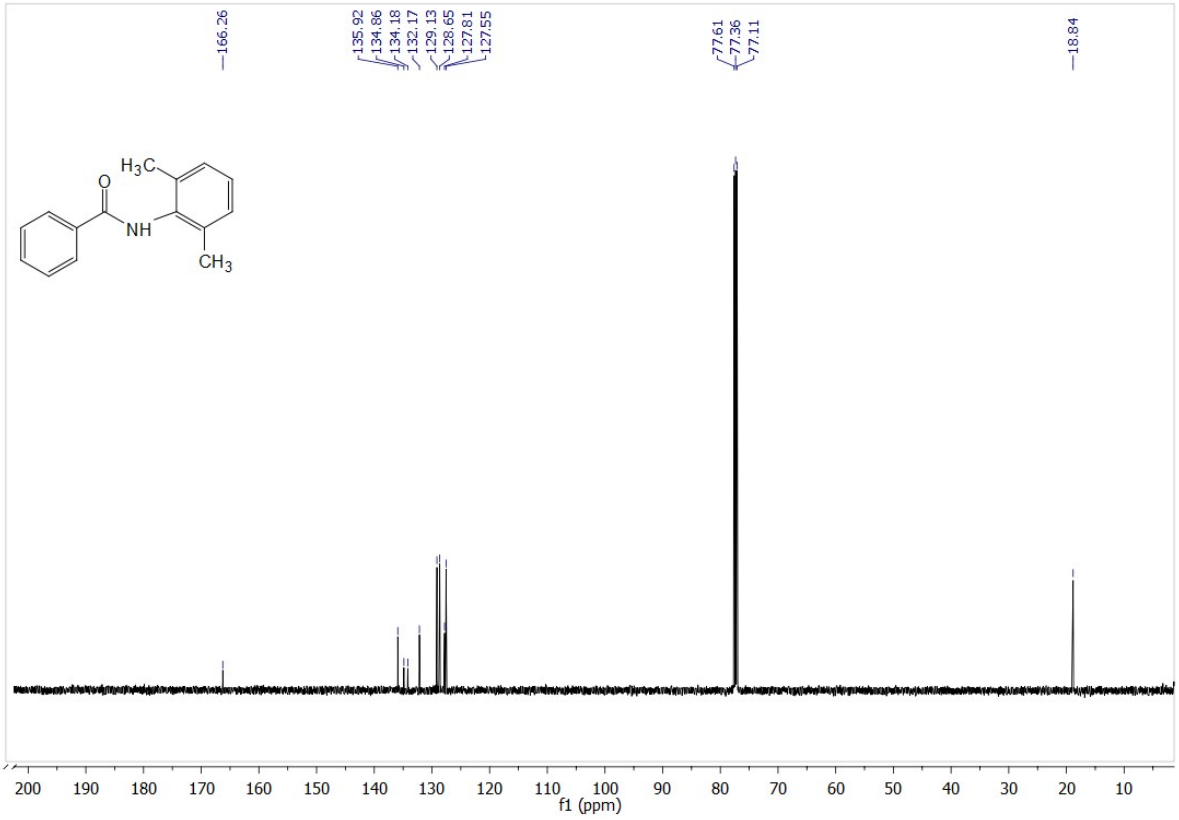
^{1}H and ^{13}C NMR Spectra of *N*-(4-cynophenyl)benzamide (3i)



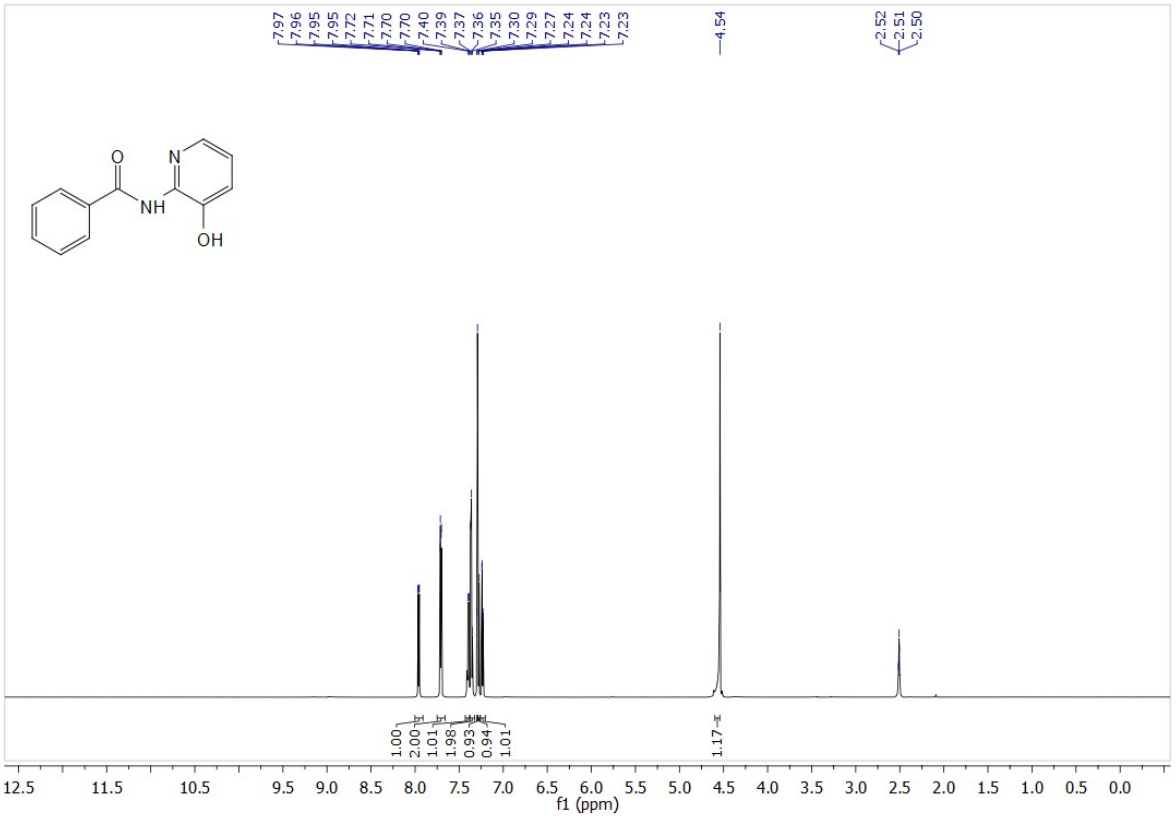


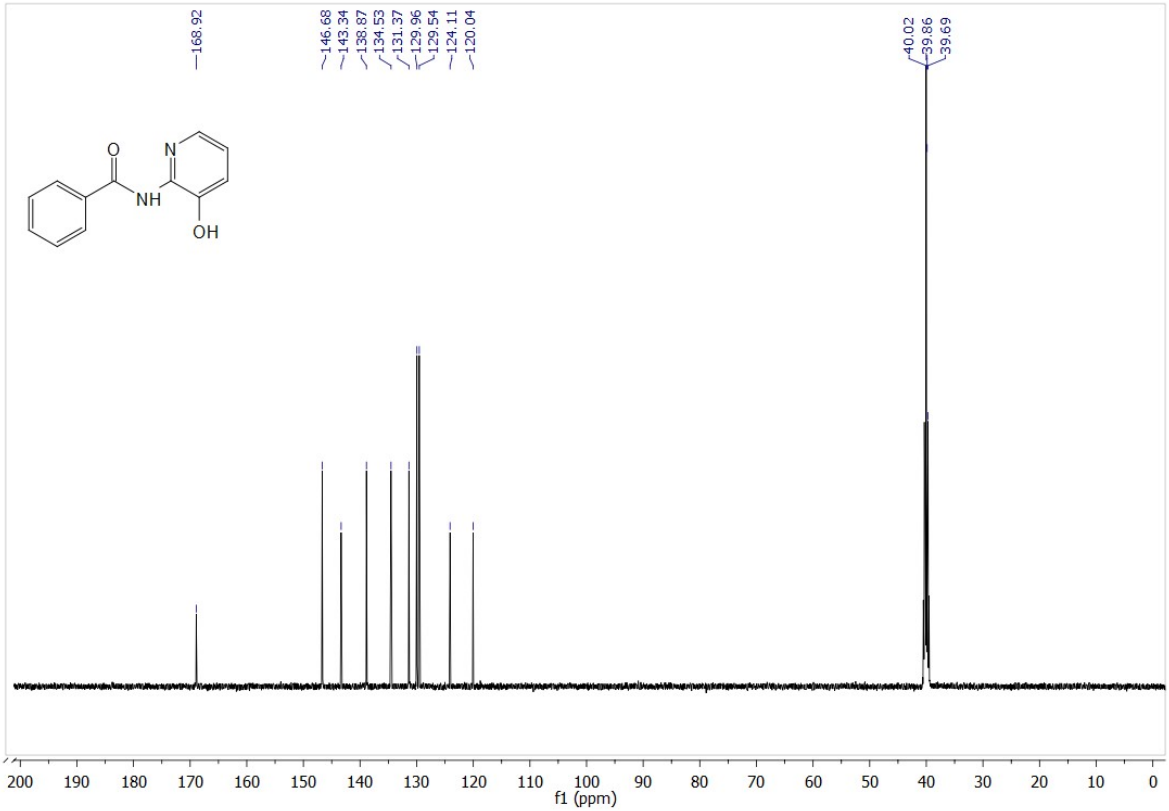
^{1}H and ^{13}C NMR Spectra of *N*-(2,6-dimethylphenyl)benzamide (3j)



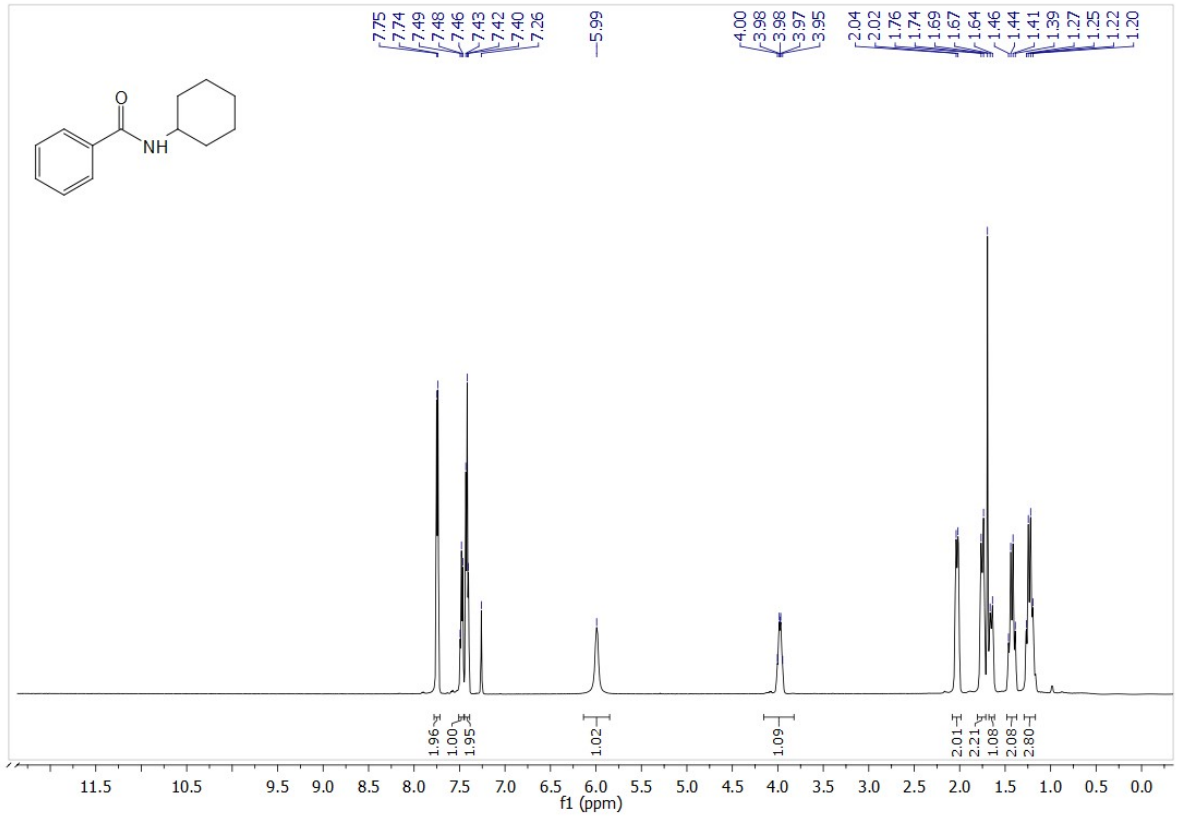


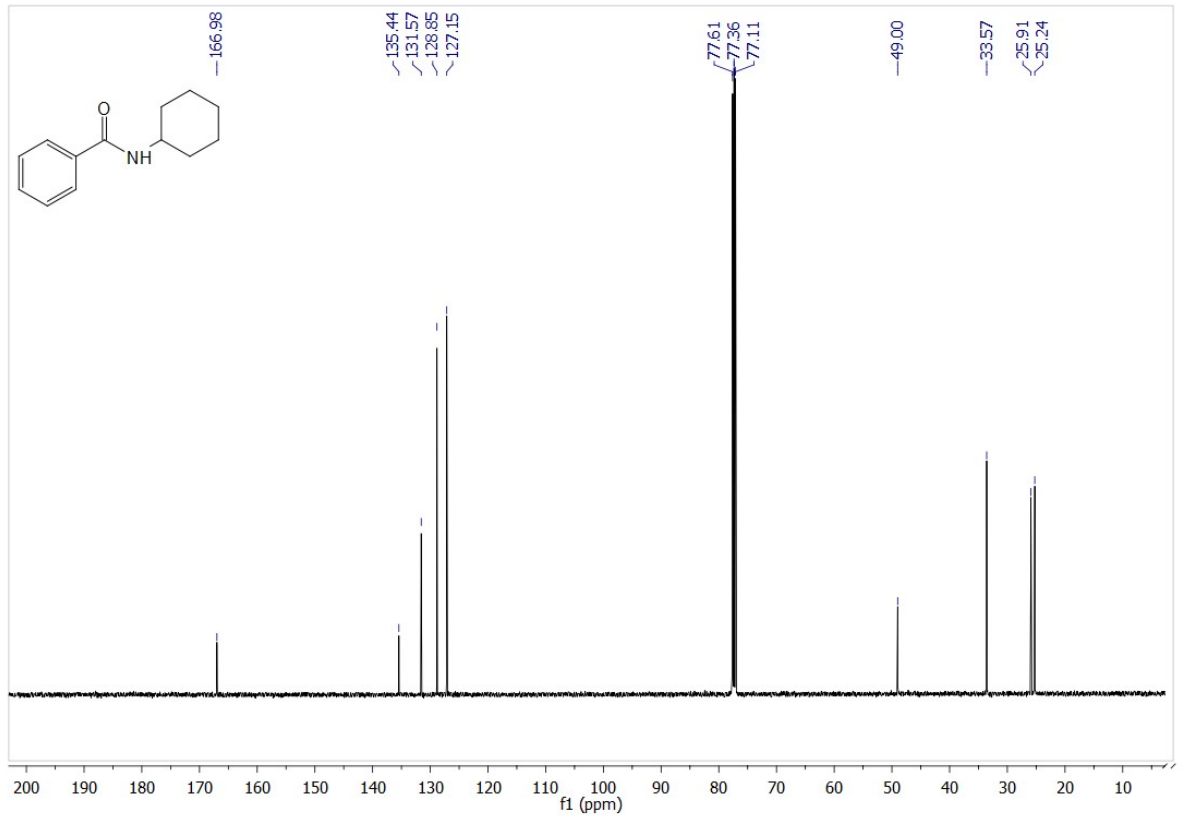
^{1}H and ^{13}C NMR Spectra of *N*-(3-hydroxypyridin-2-yl)benzamide (3k)



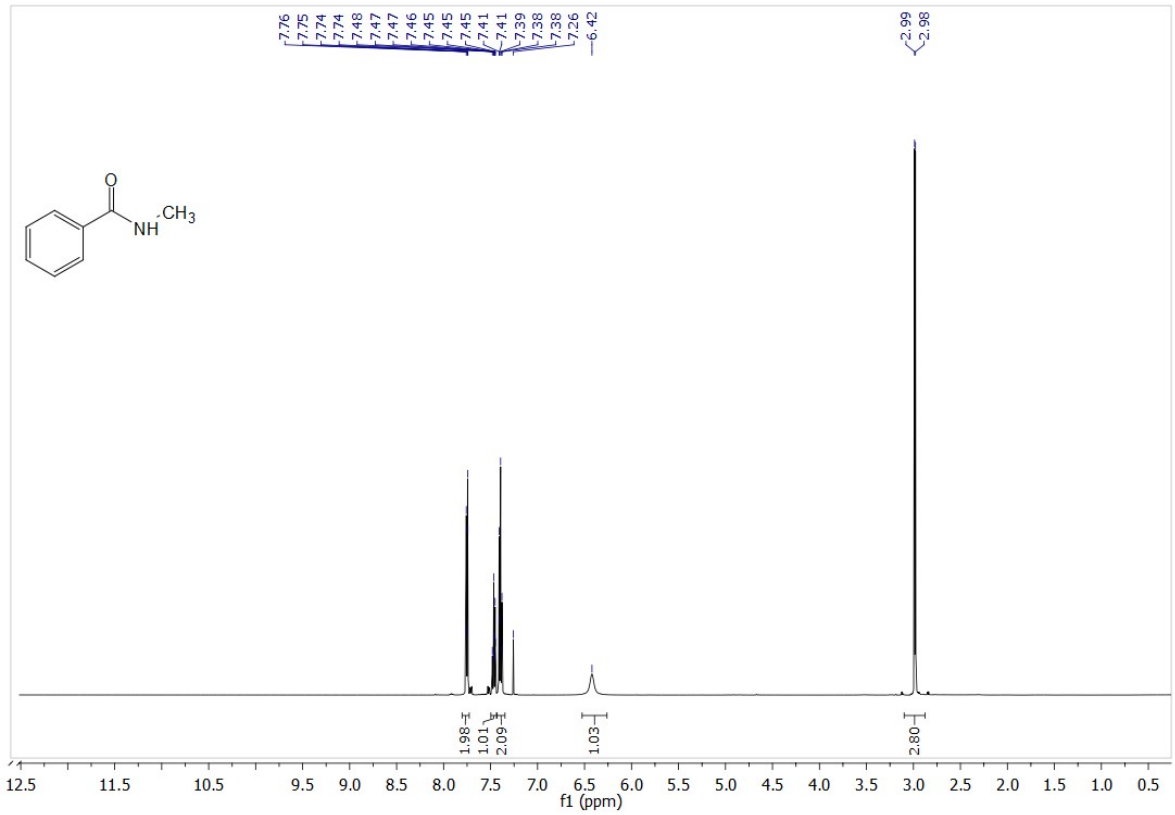


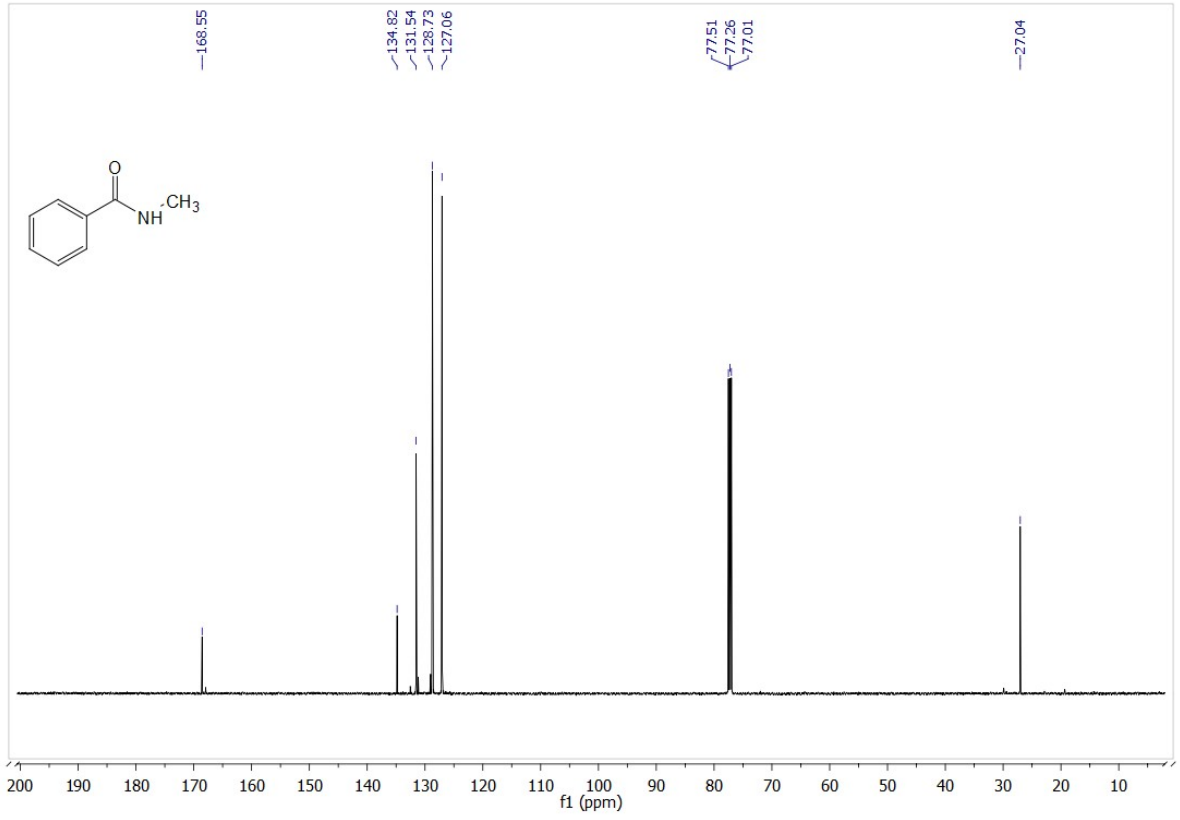
^{1}H and ^{13}C NMR Spectra of *N*-cyclohexylbenzamide (3l)



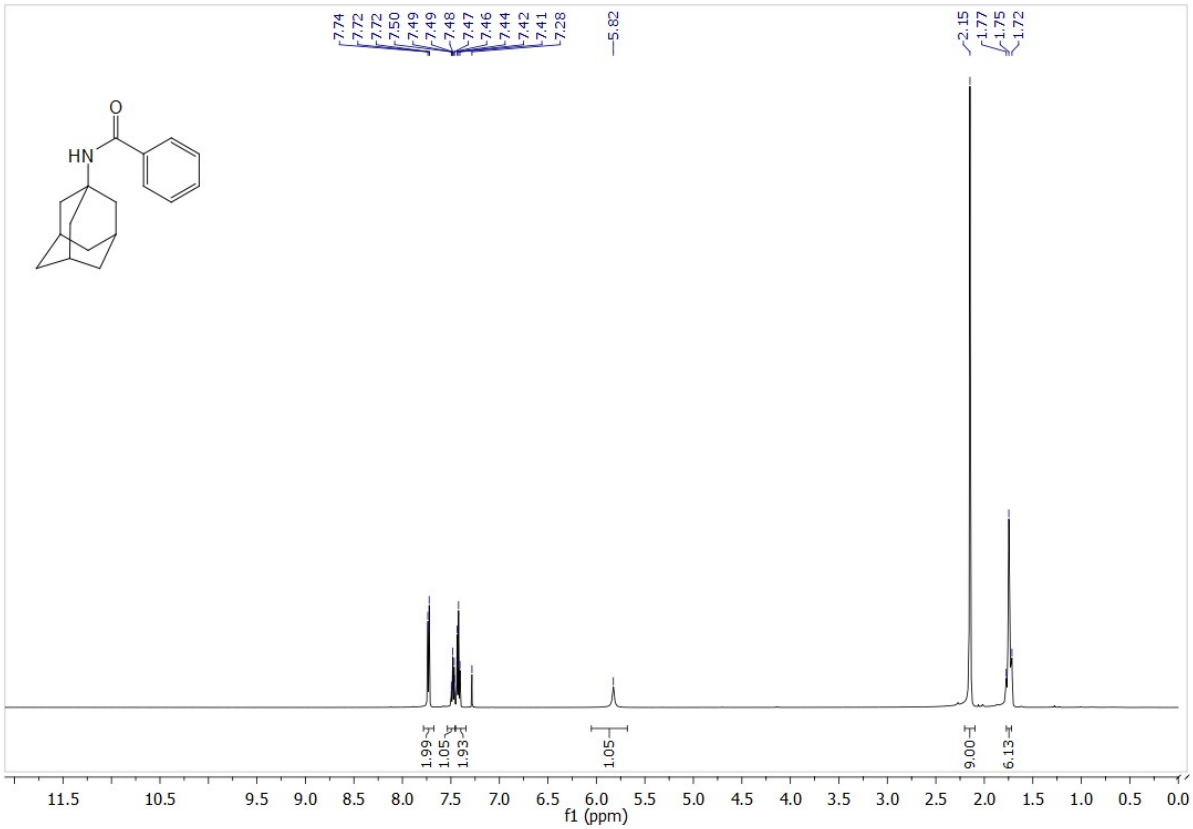


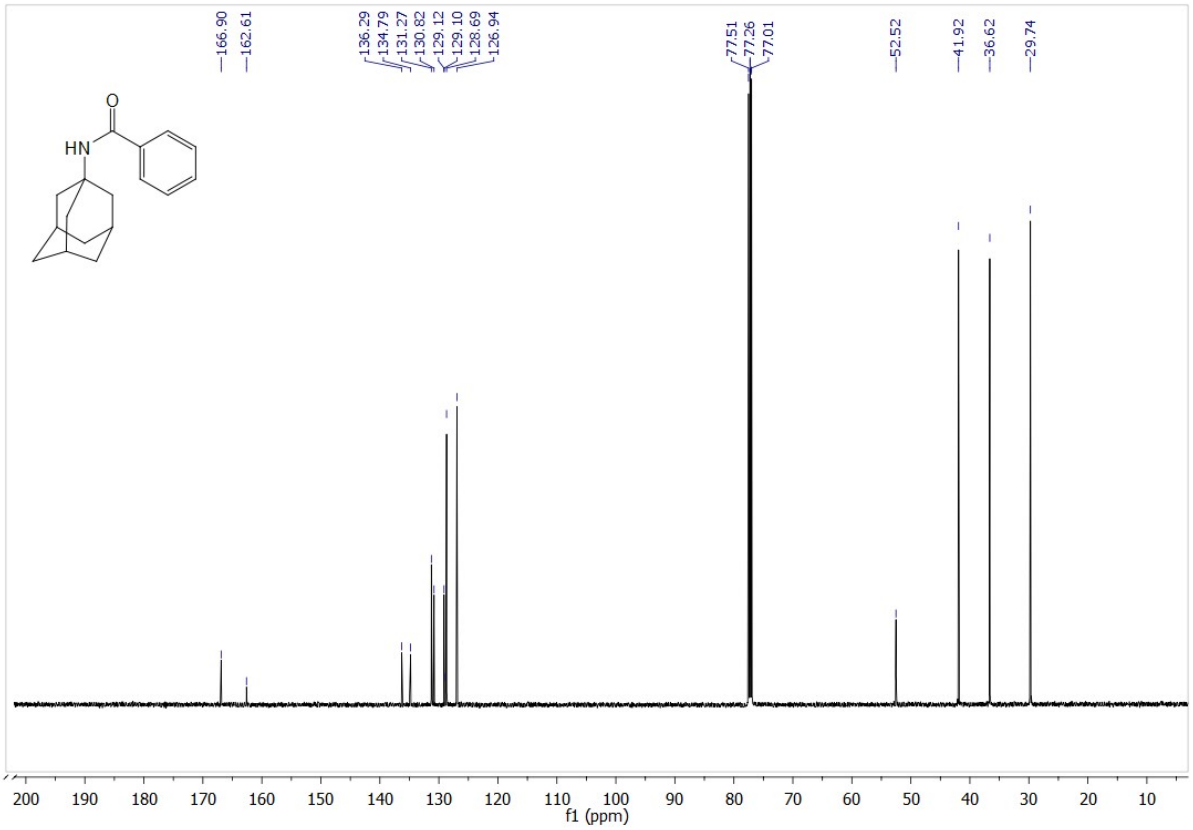
^{1}H and ^{13}C NMR Spectra of *N*-methylbenzamide (3m)



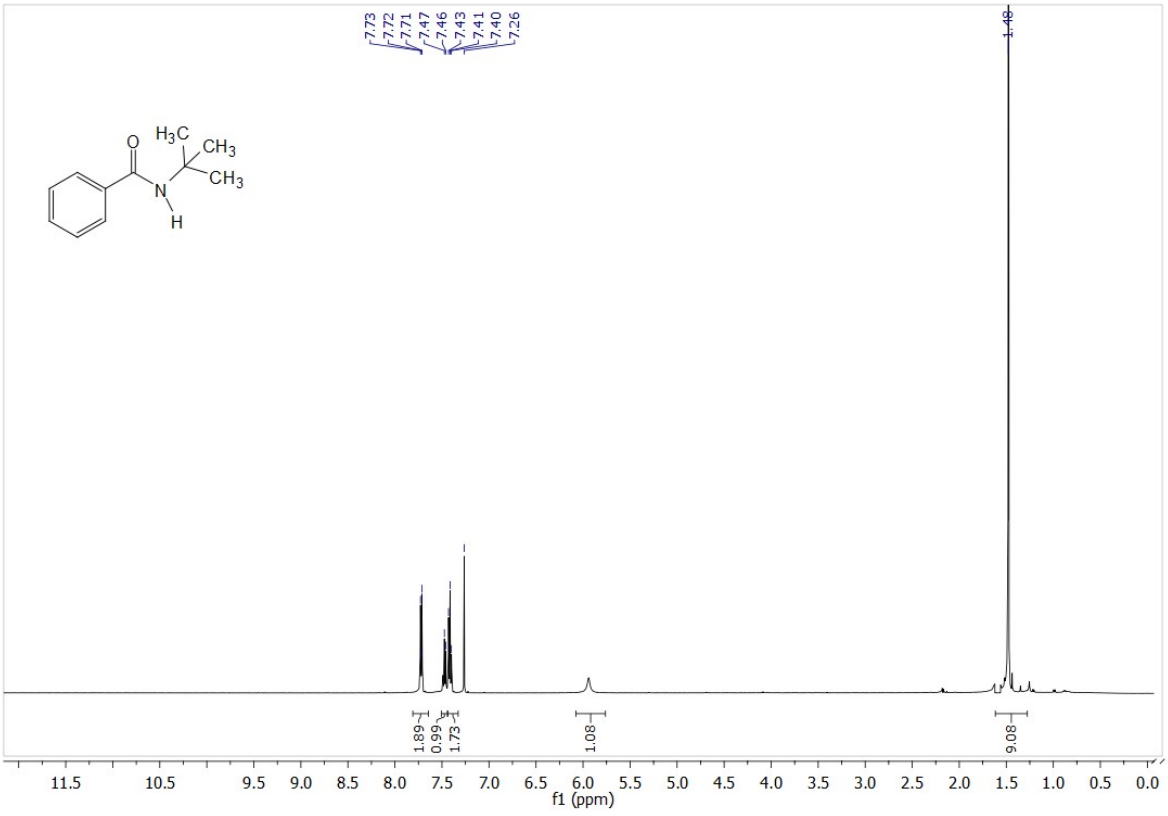


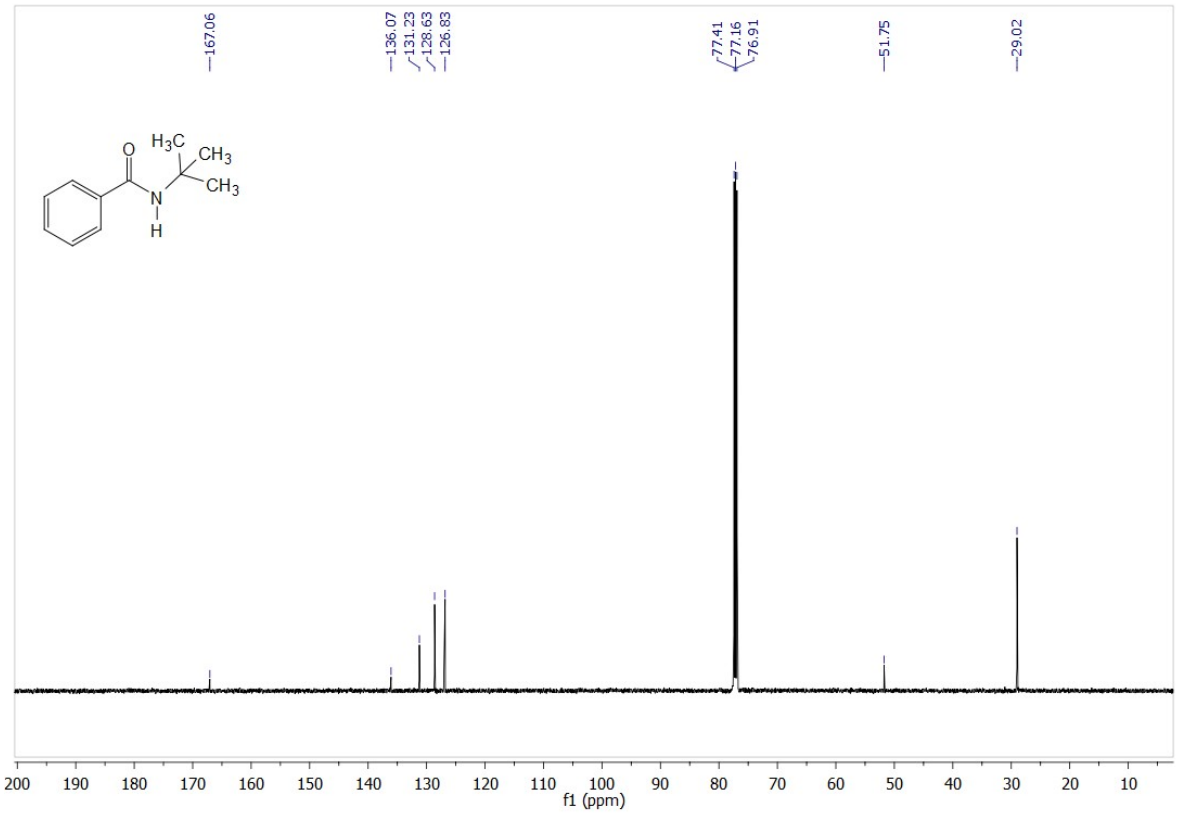
^{1}H and ^{13}C NMR Spectra of *N*-(3s,5s,7s)-adamantan-1-yl)benzamide (3n)



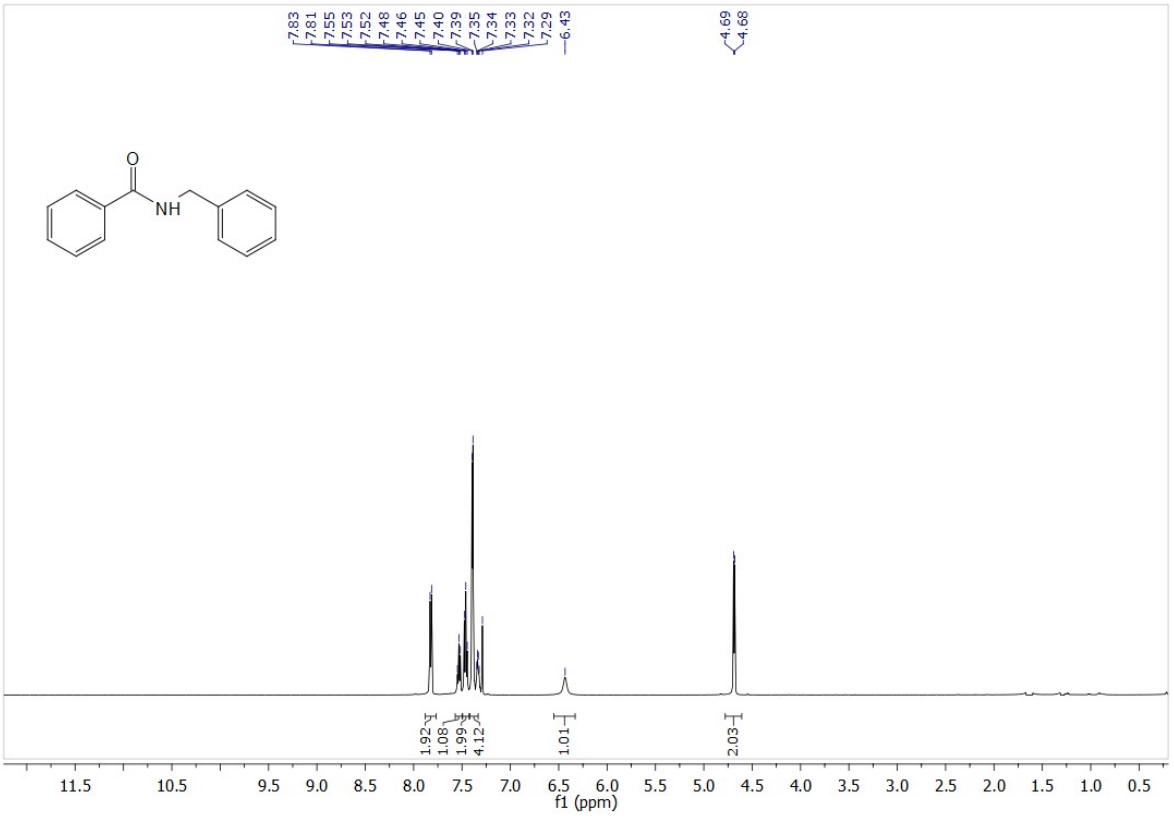


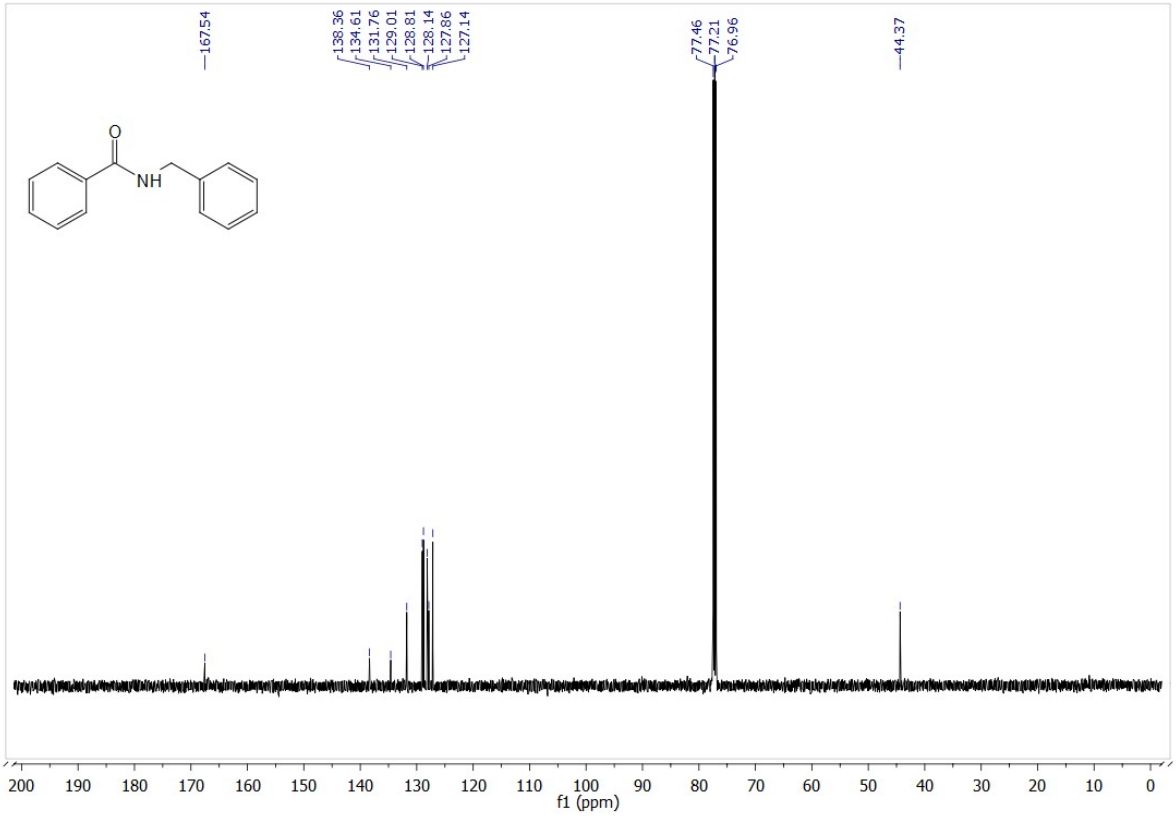
^{1}H and ^{13}C NMR Spectra of *N*-(tert-butyl)benzamide (3o)



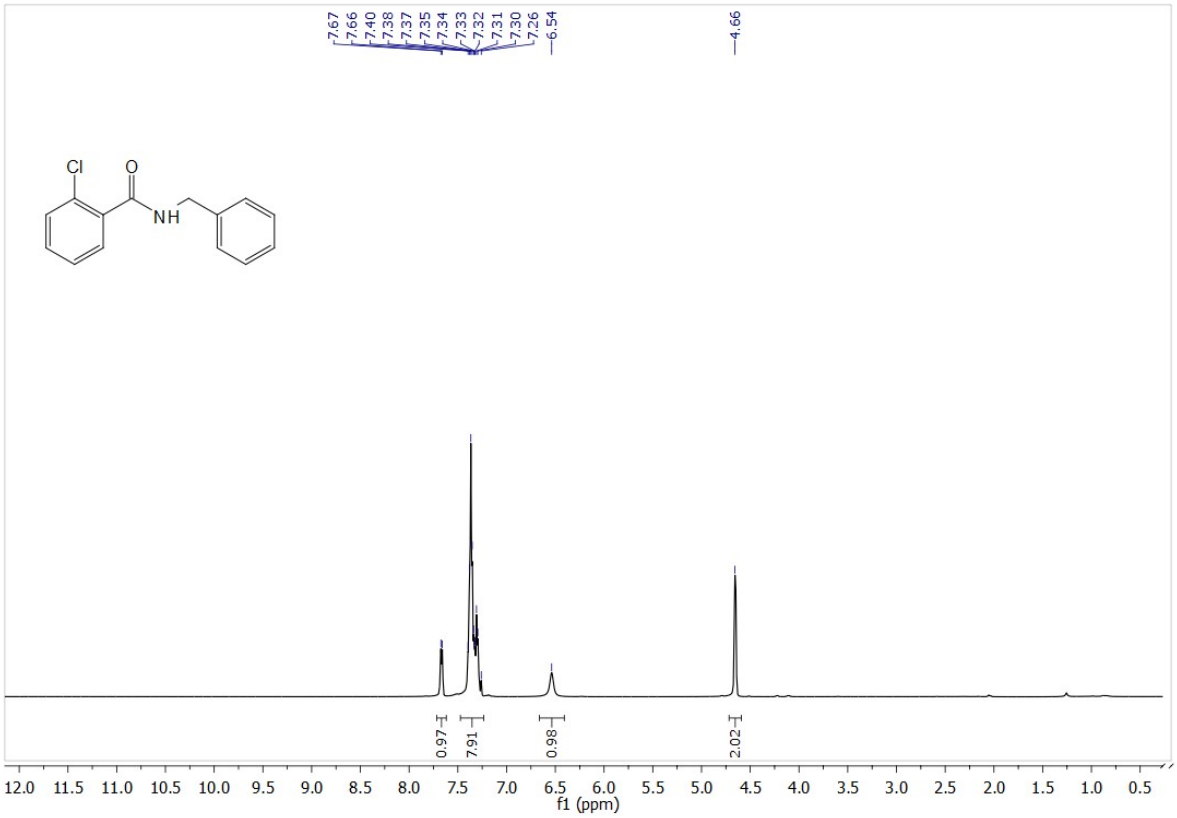


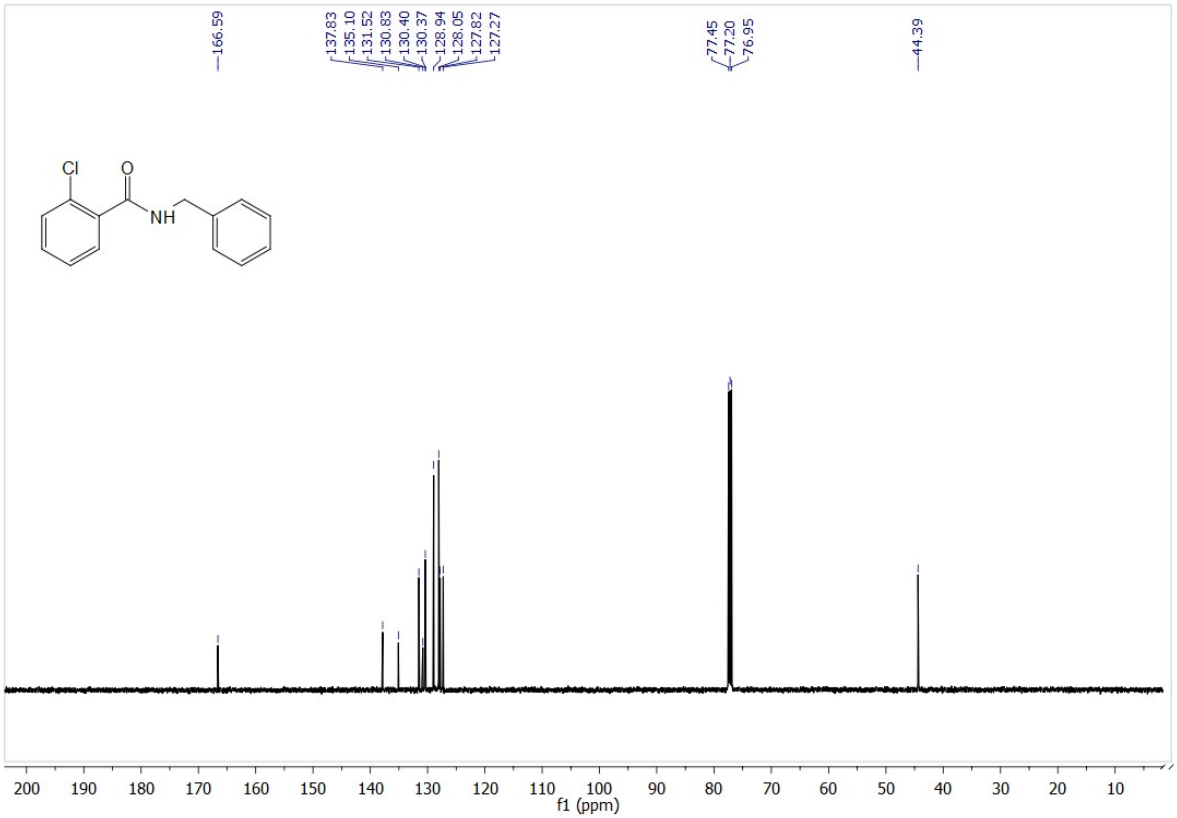
^{1}H and ^{13}C NMR Spectra of *N*-benzylbenzamide (3p)



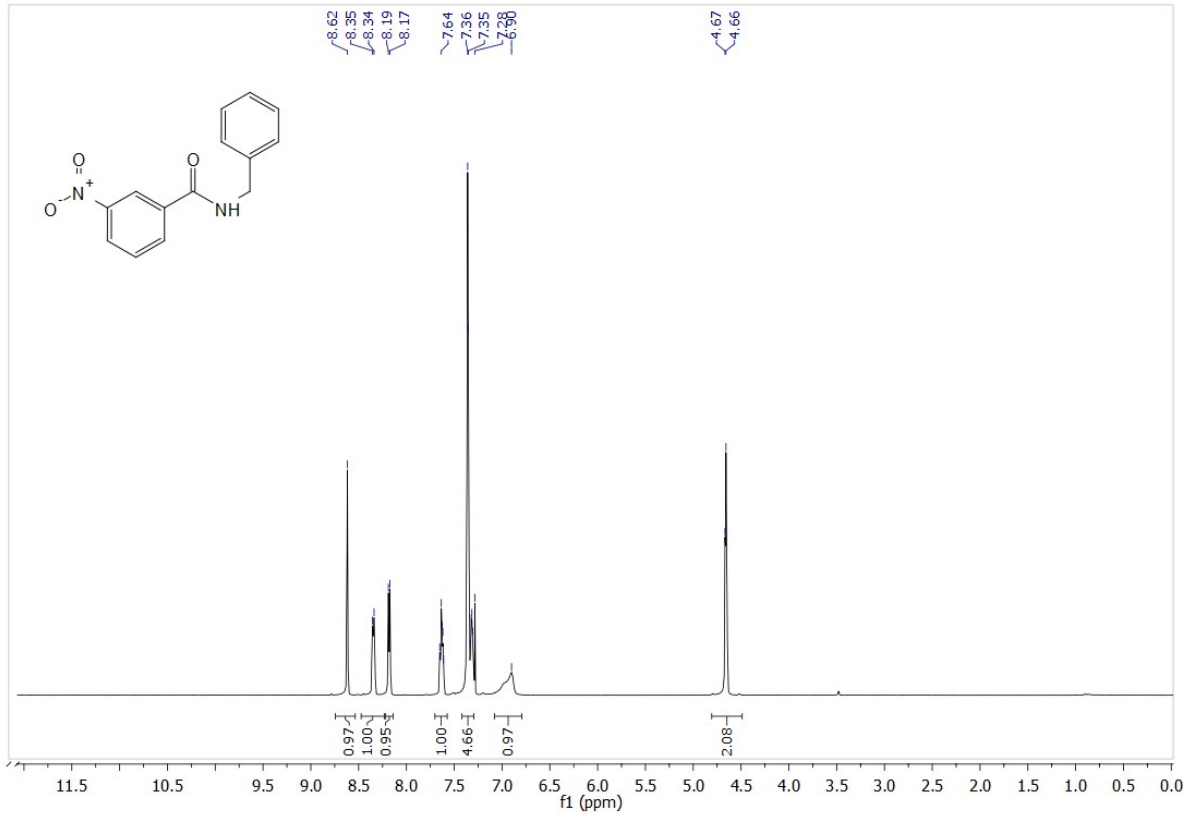


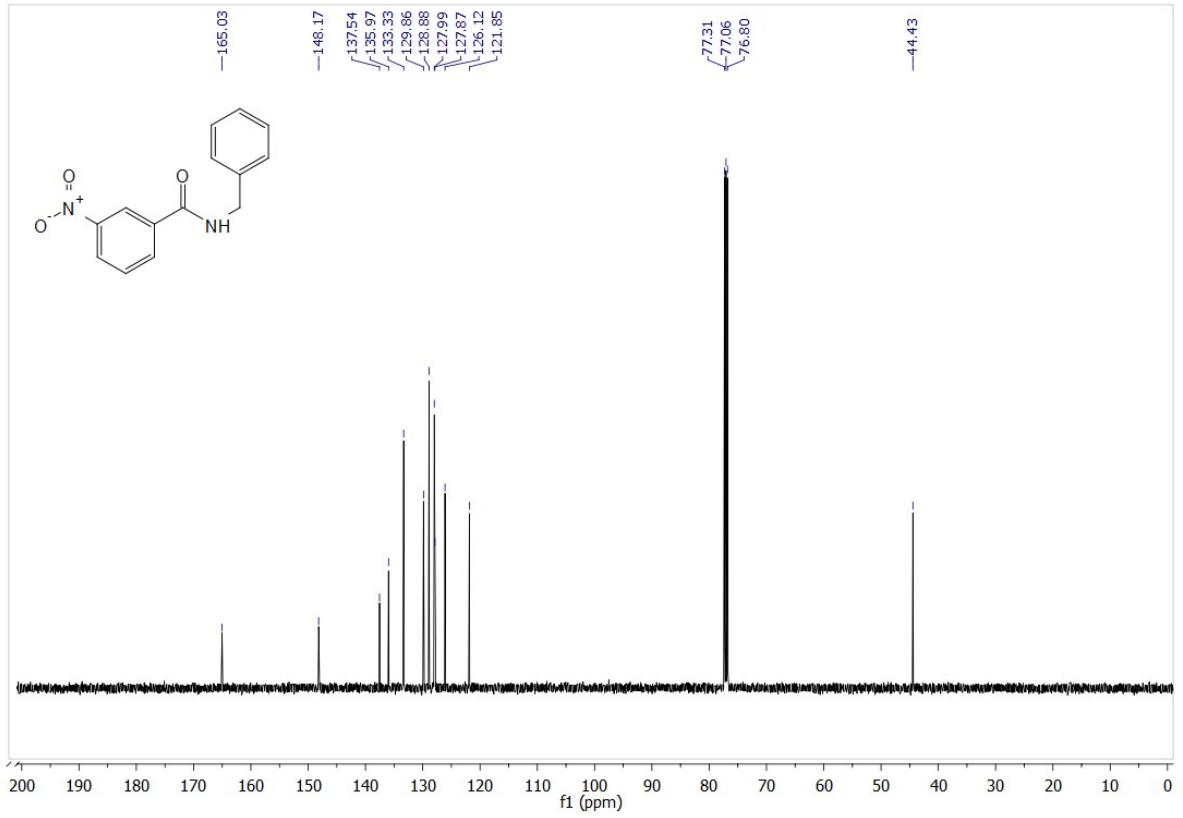
^{1}H and ^{13}C NMR Spectra of *N*-benzyl-2-chlorobenzamide (3q)



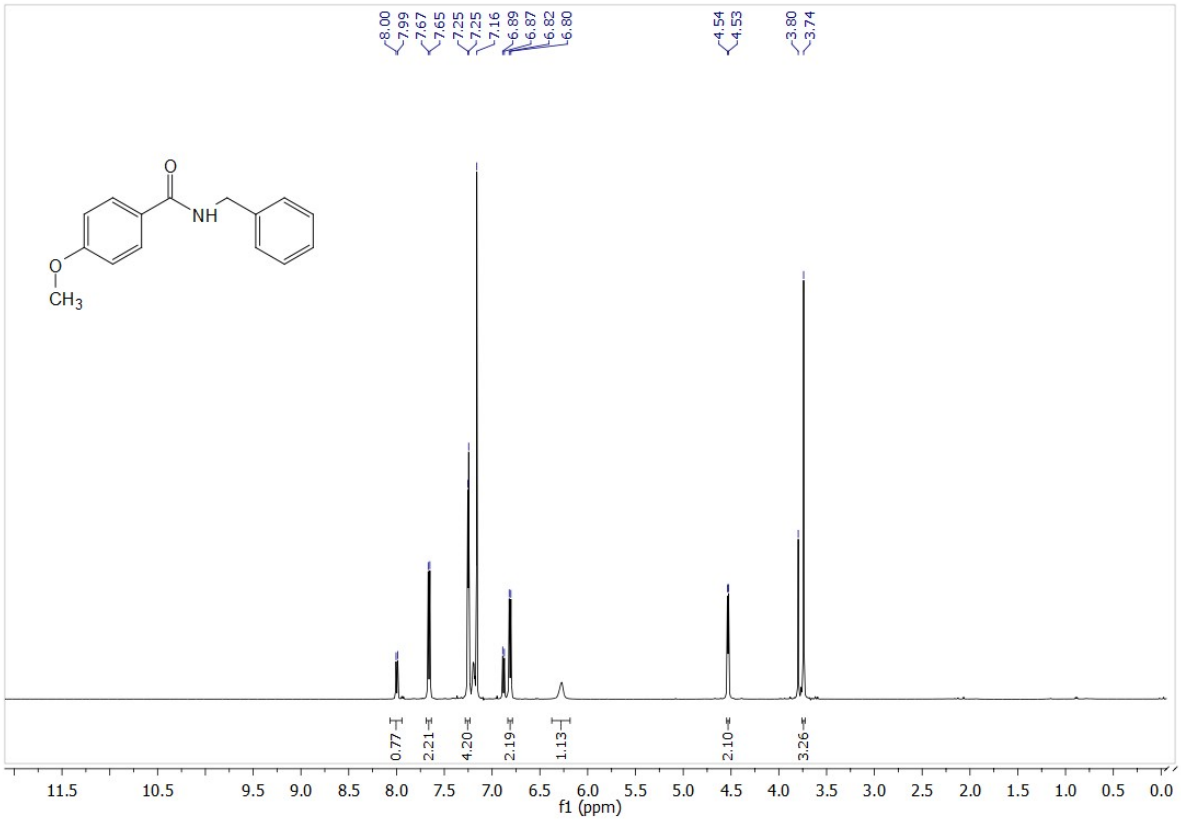


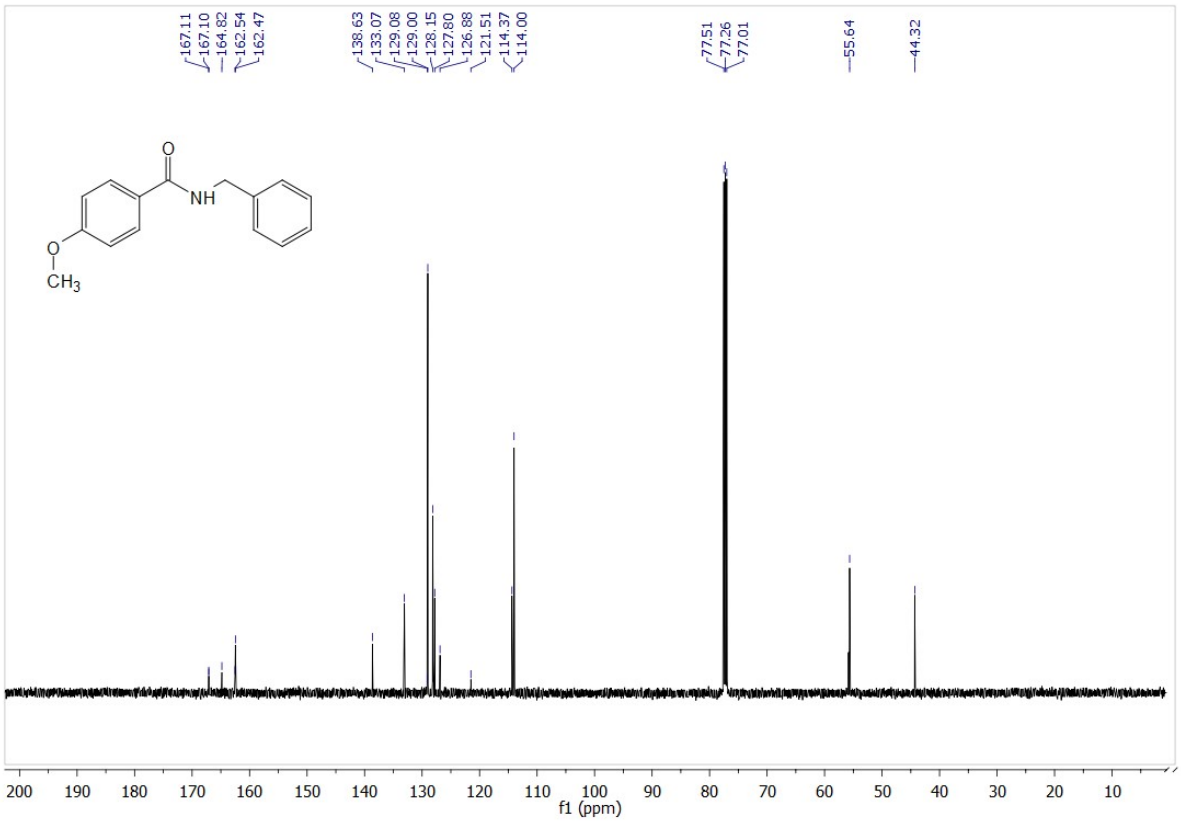
^{1}H and ^{13}C NMR Spectra of *N*-benzyl-3-nitrobenzamide (3r)



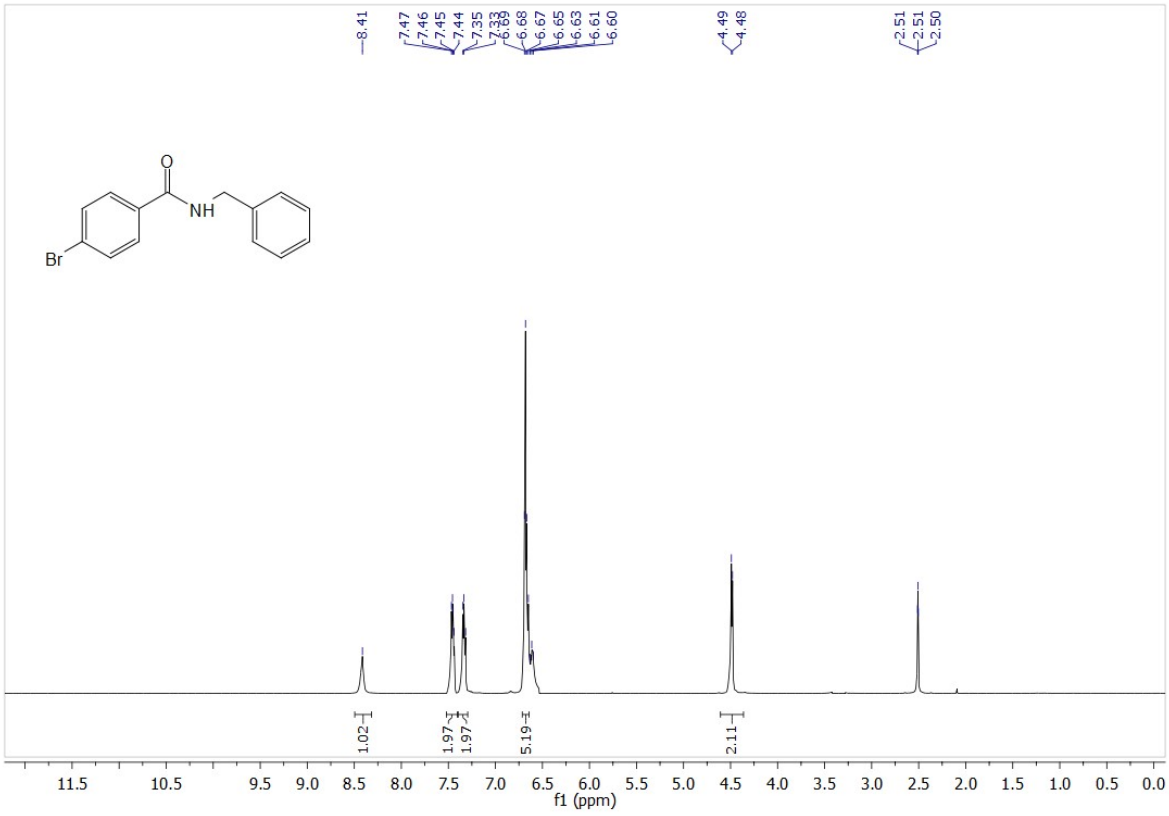


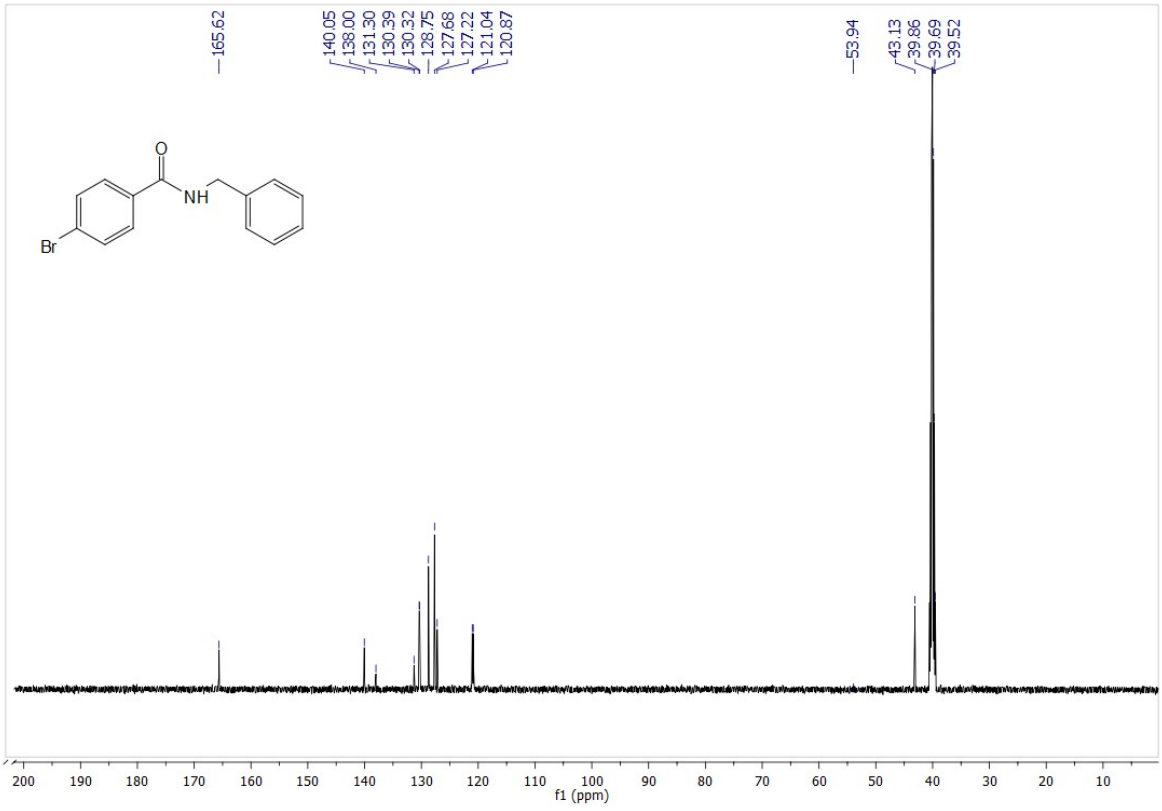
^{1}H and ^{13}C NMR Spectra of *N*-benzyl-4-methoxybenzamide (3s)



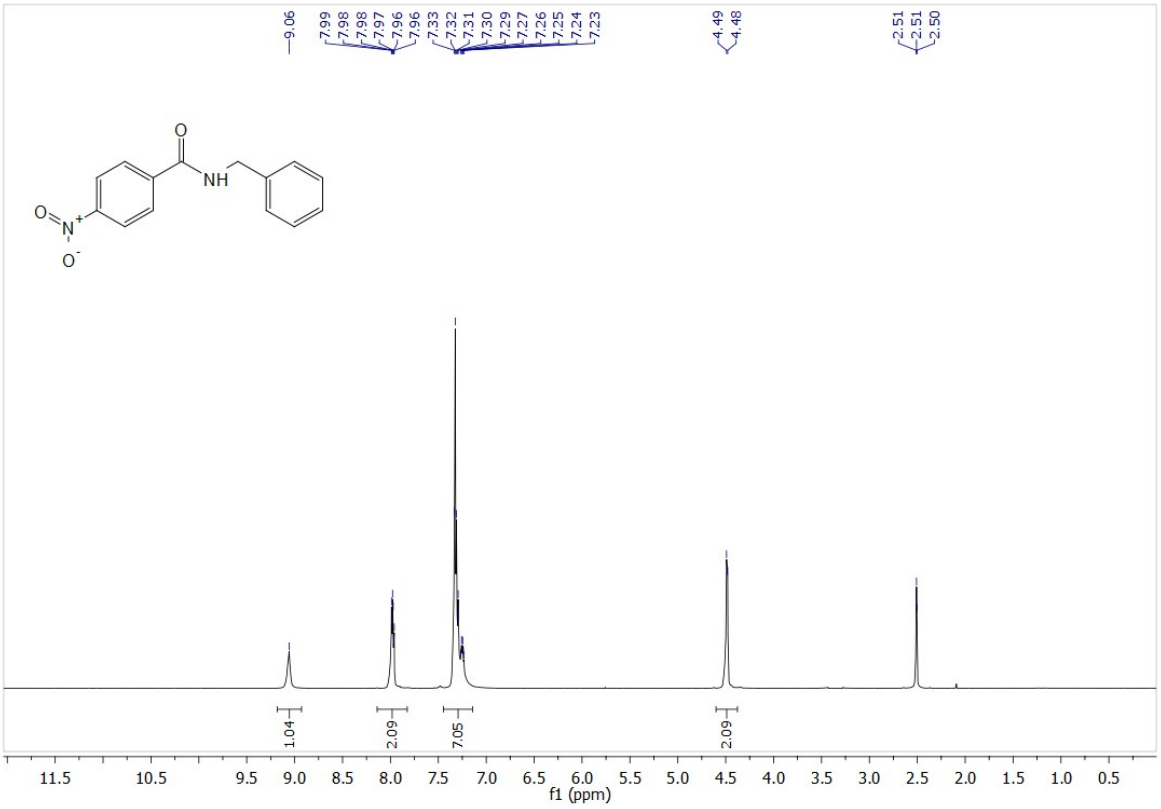


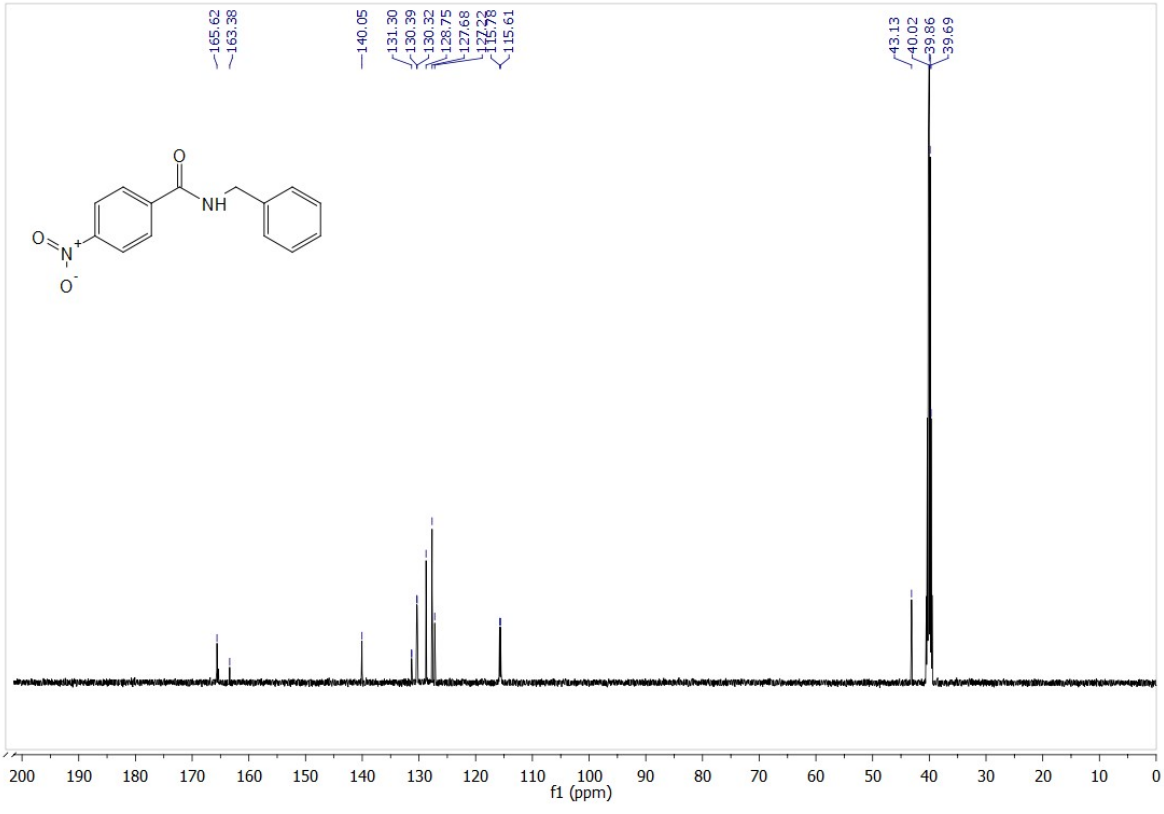
^{1}H and ^{13}C NMR Spectra of *N*-benzyl-4-bromobenzamide (3t)



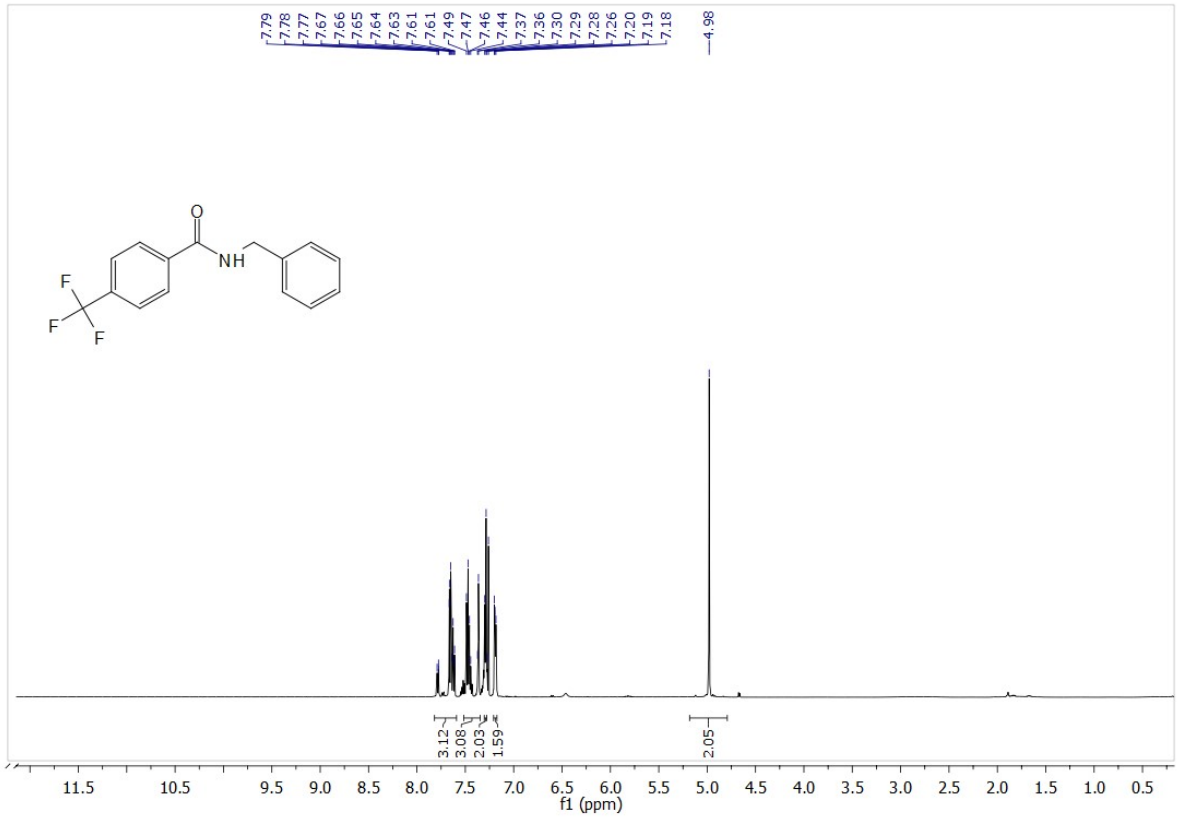


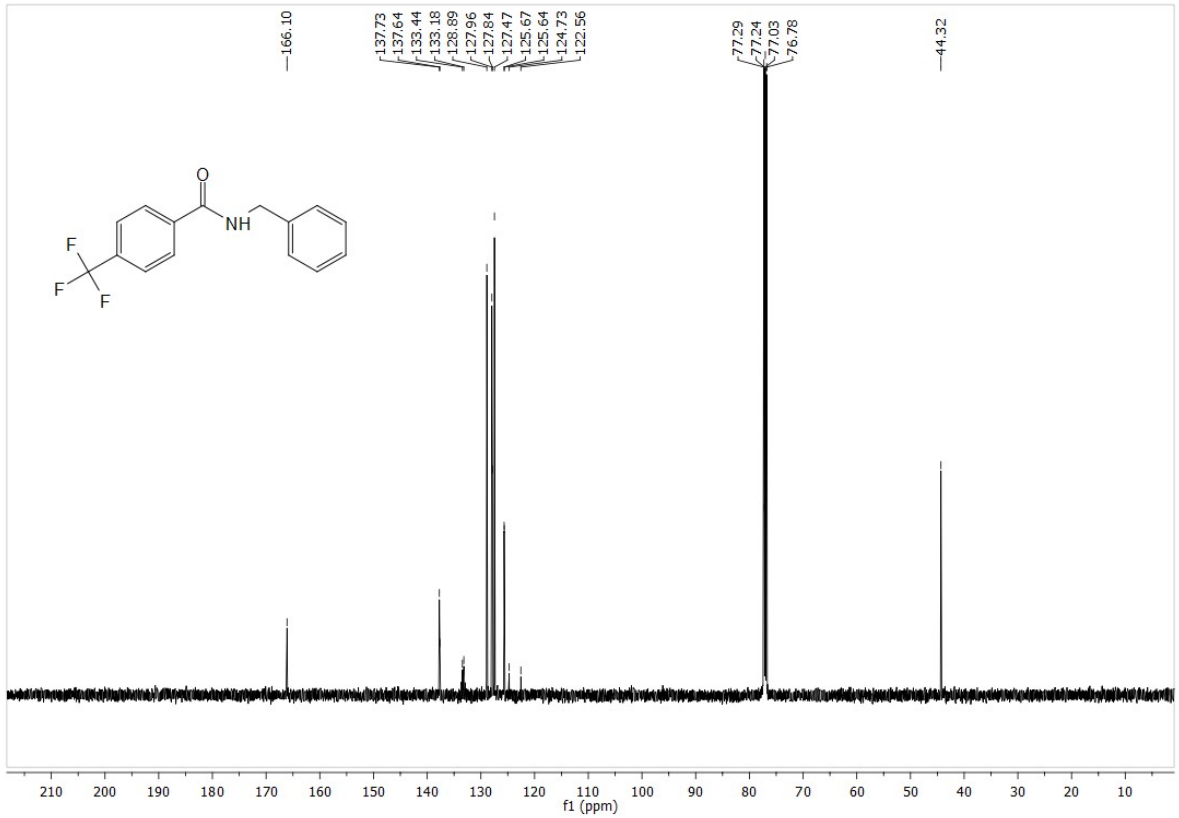
^{1}H and ^{13}C NMR Spectra of *N*-benzyl-4-nitrobenzamide (3u)

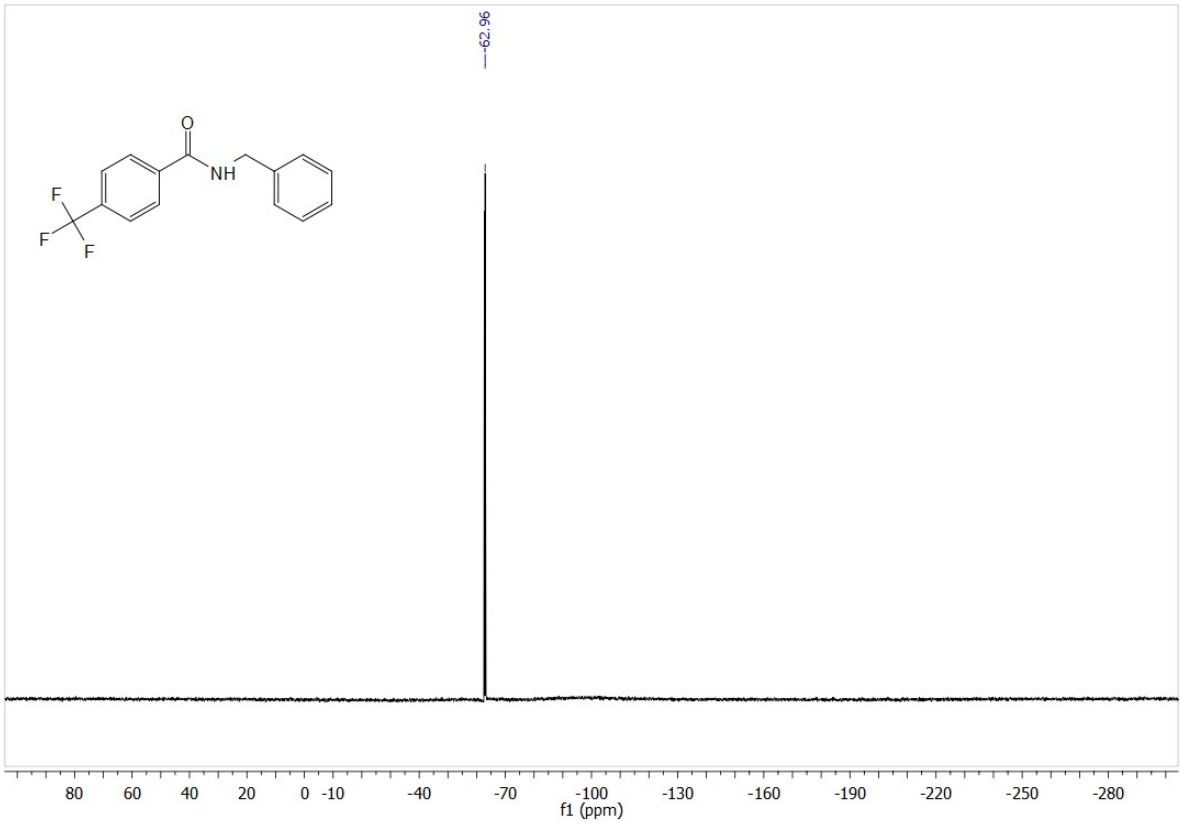




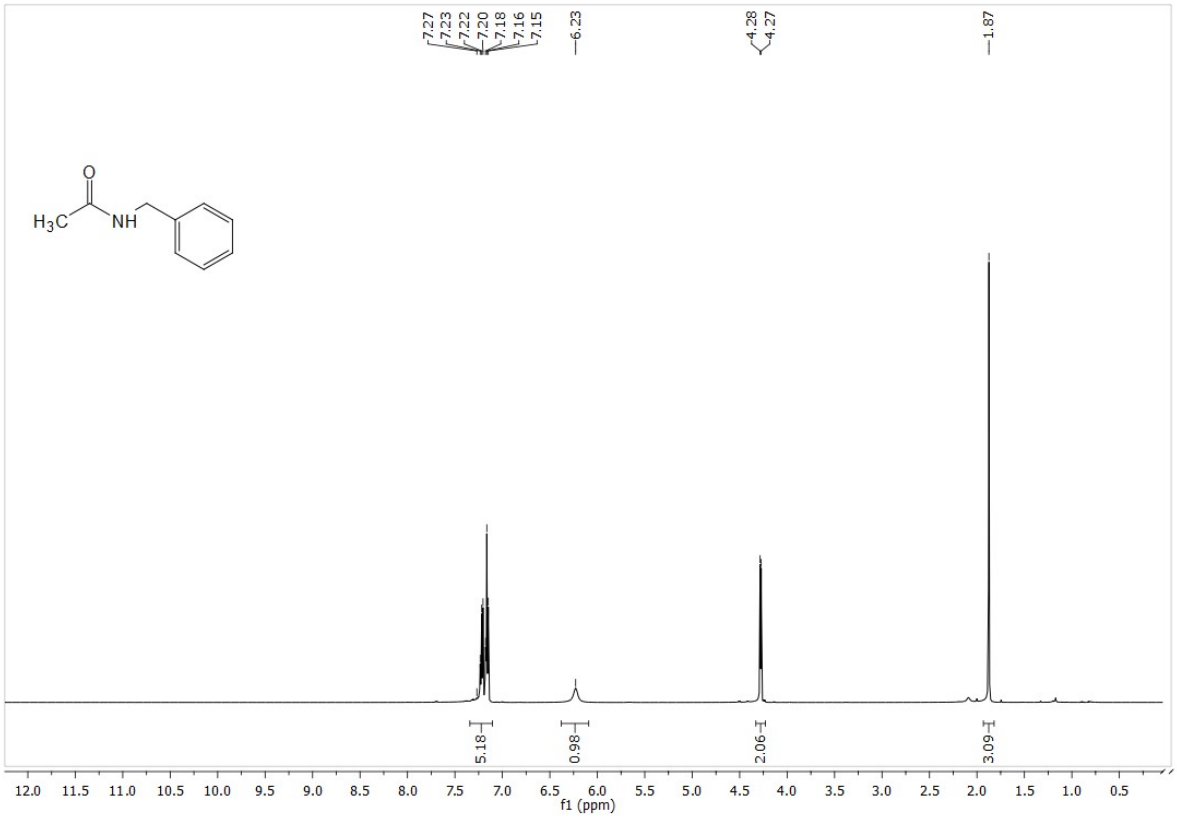
^{1}H, ^{13}C and ^{19}F NMR Spectra of *N*-benzyl-4-fluorobenzamide (3v)

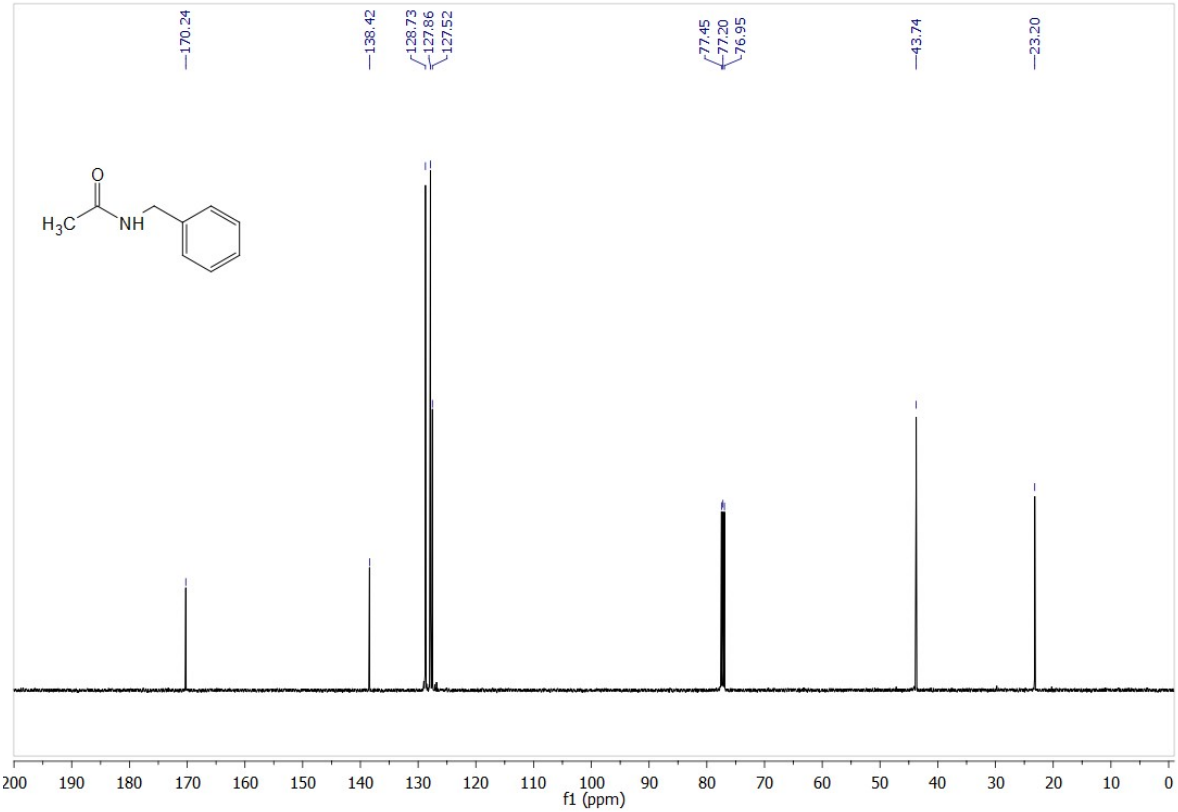




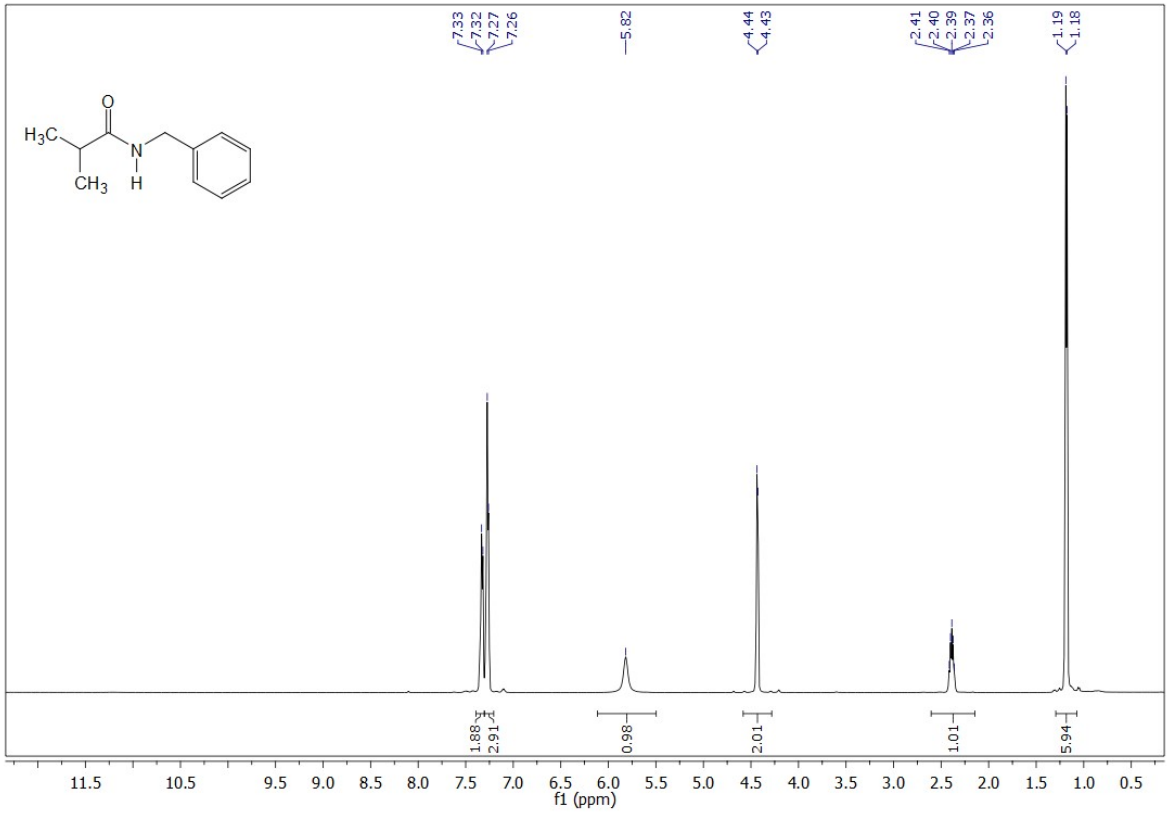

-62.96
O
NH
F
F
F
80
60
40
20
0
-10
-40
-70
-100
-130
-160
-190
-220
-250
-280
f1 (ppm)

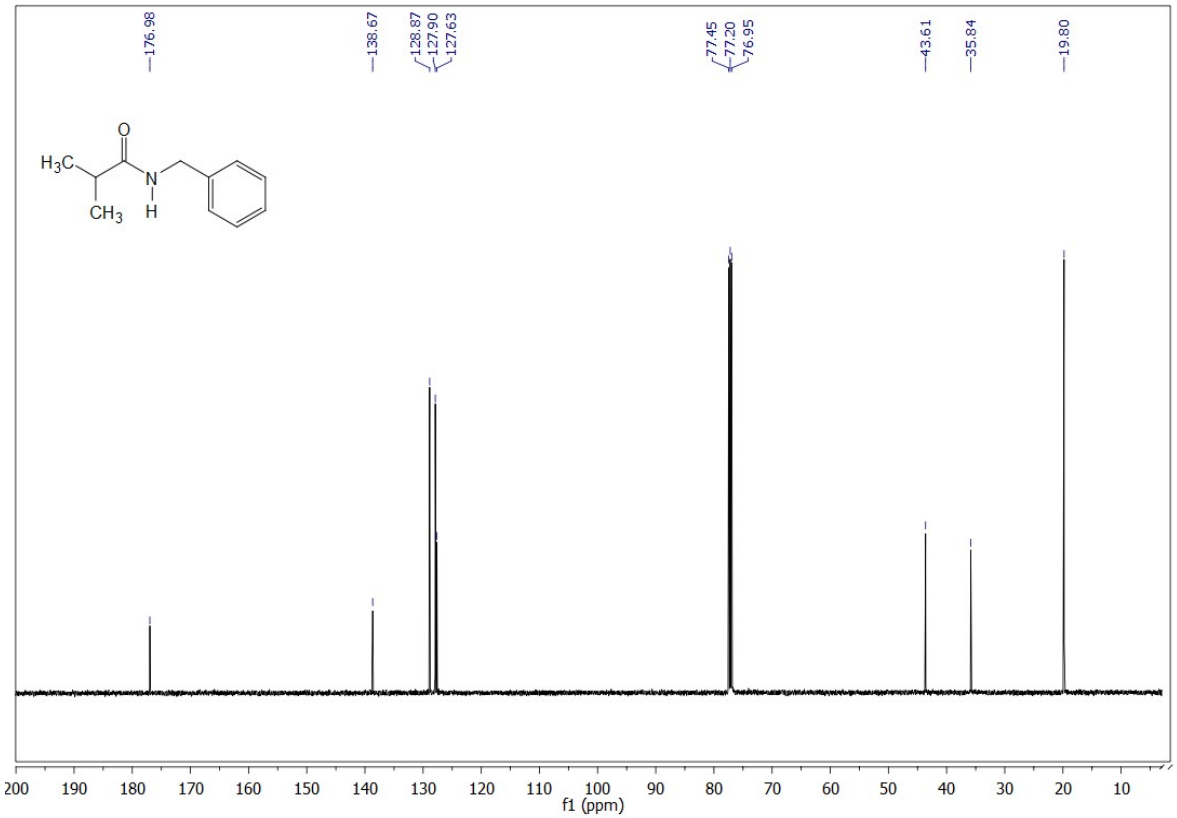
^{1}H and ^{13}C NMR Spectra of *N*-benzylacetamide (3w)



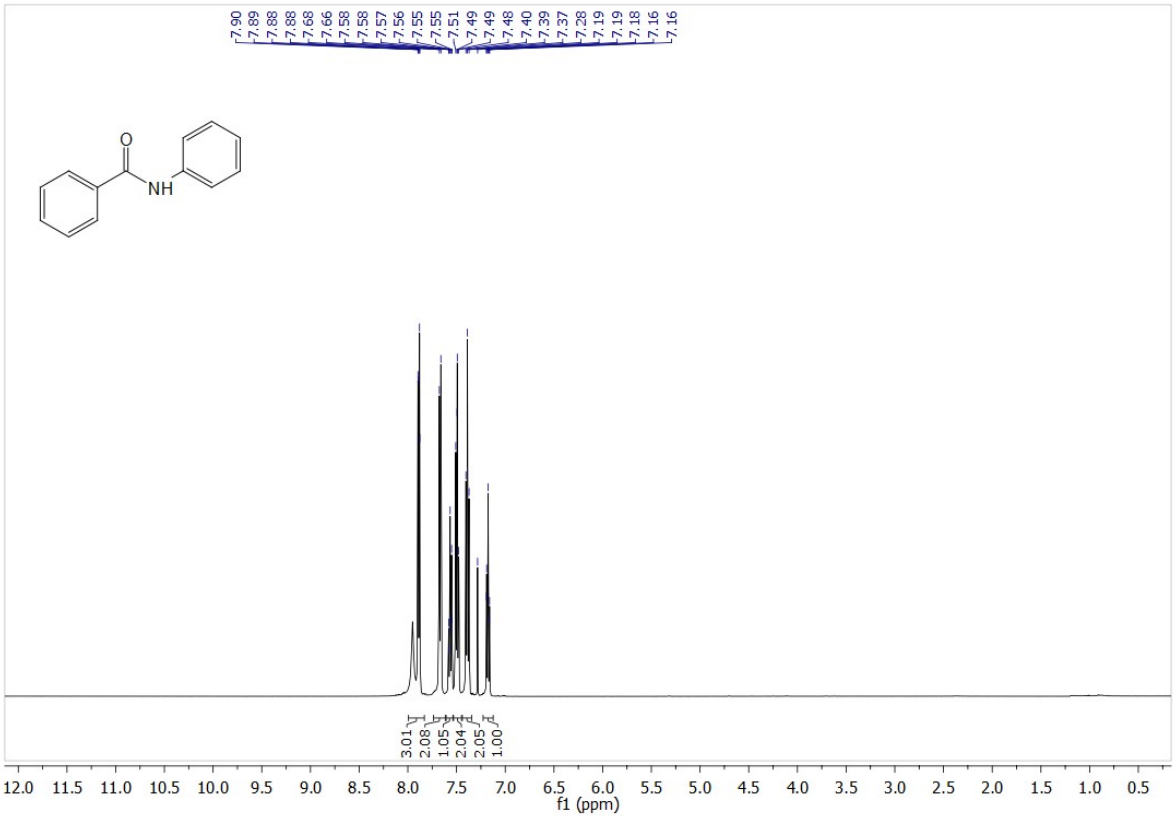


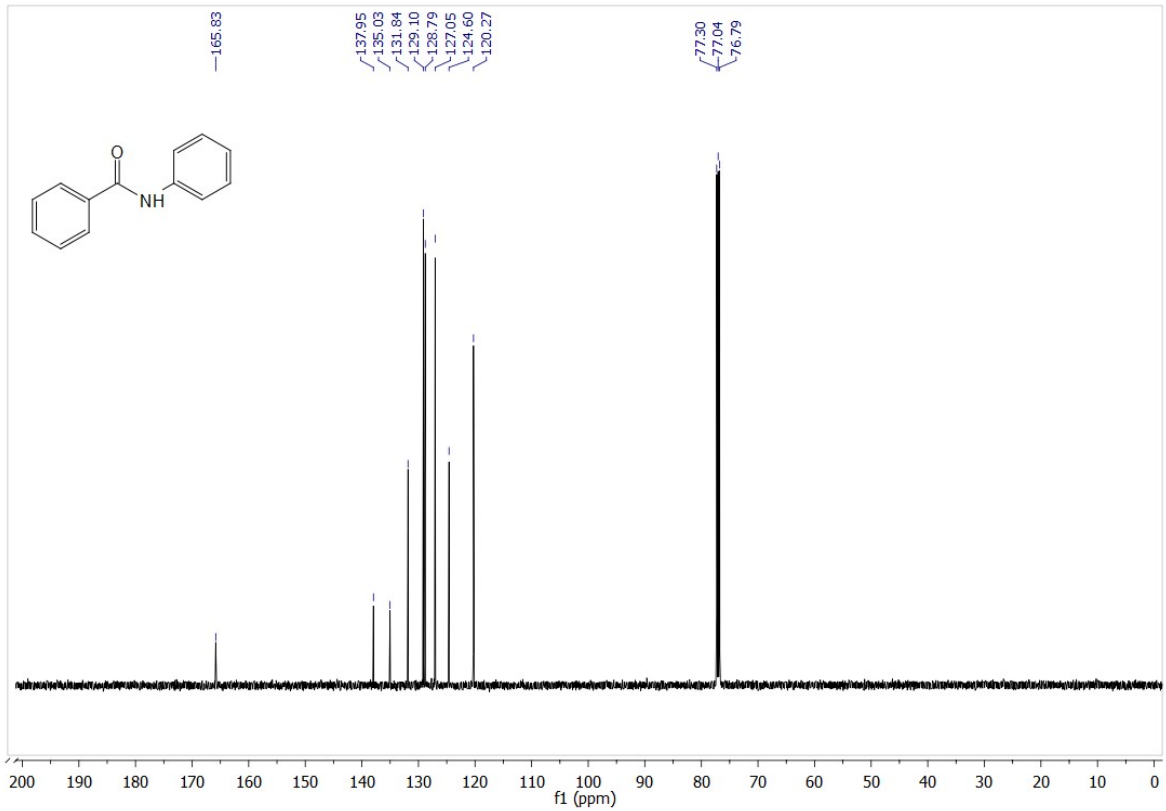
^{1}H and ^{13}C NMR Spectra of *N*-phenylisobutyramide (3x)



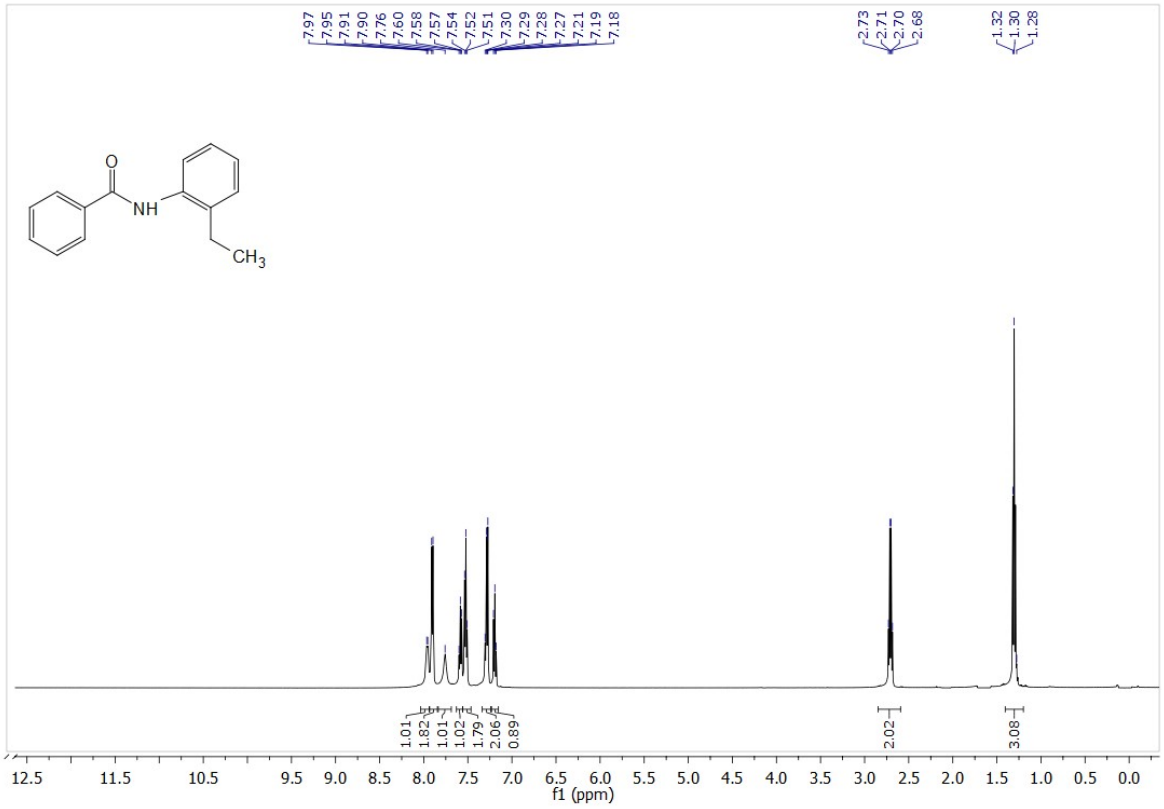


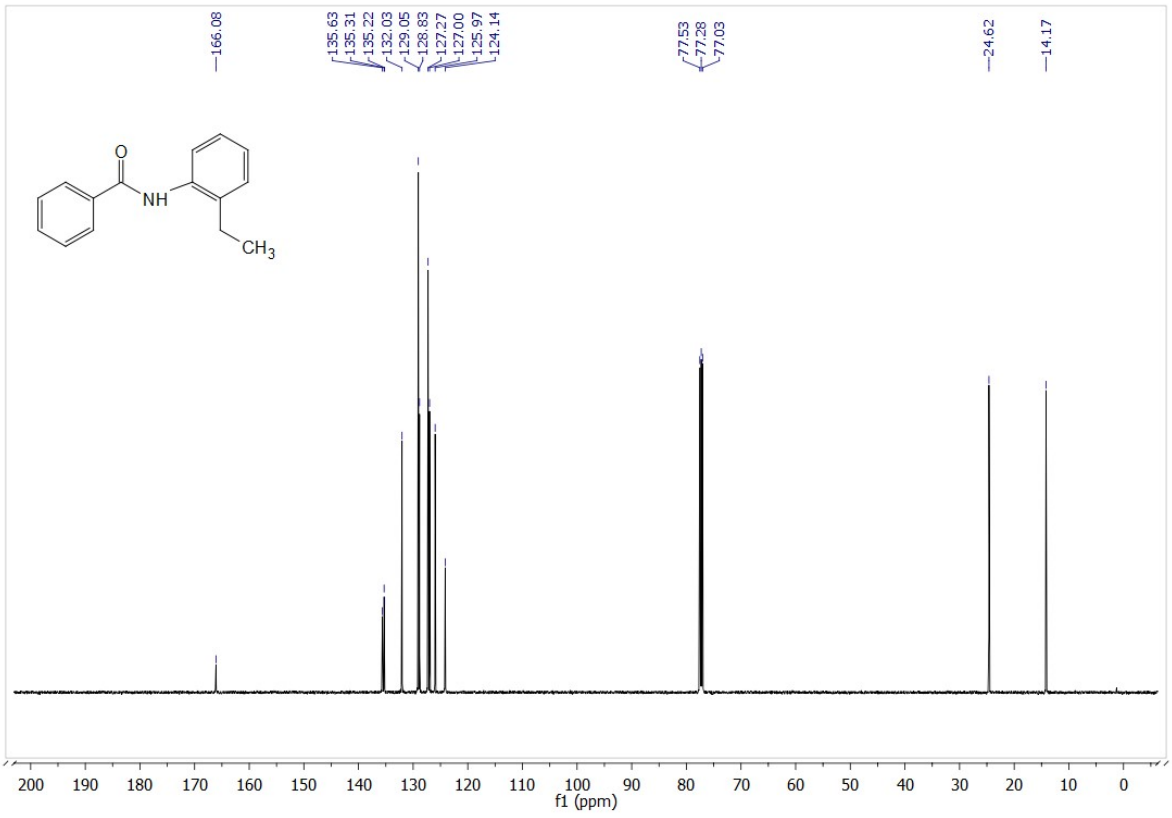
^{1}H and ^{13}C NMR Spectra of *N*-phenylbenzamide (3y)



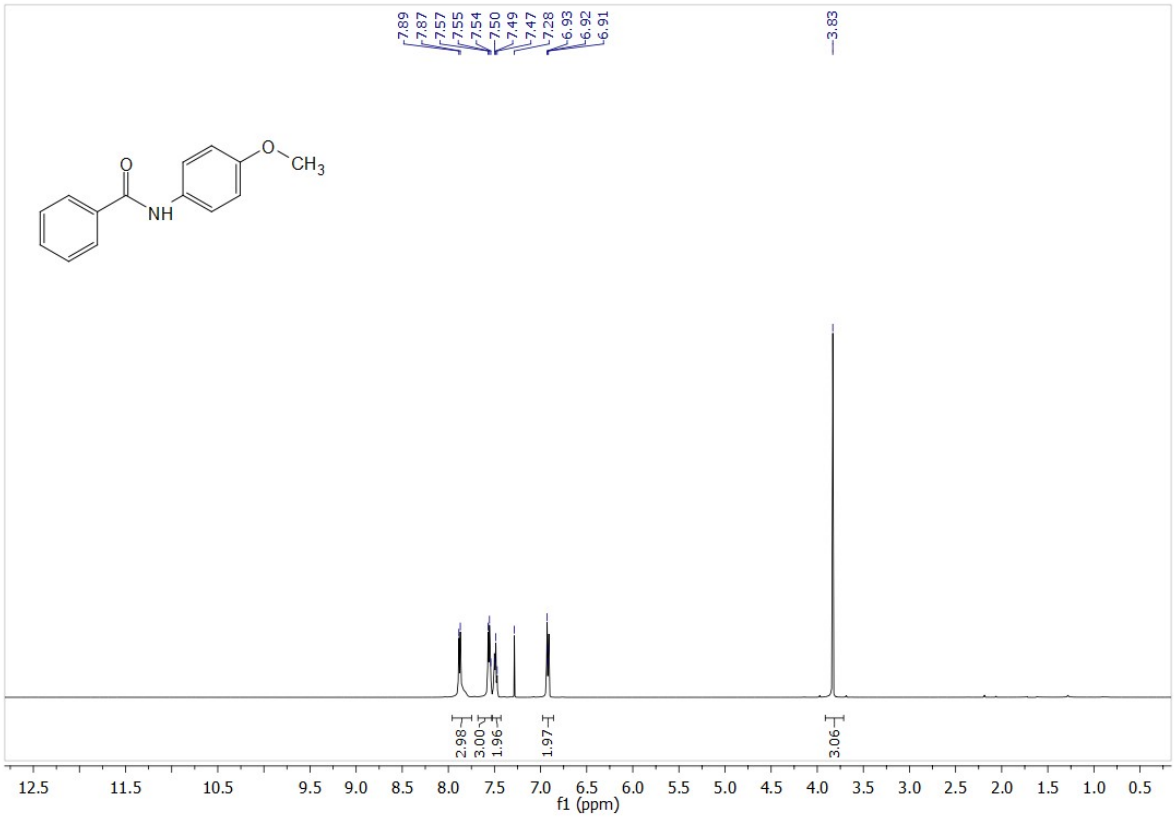


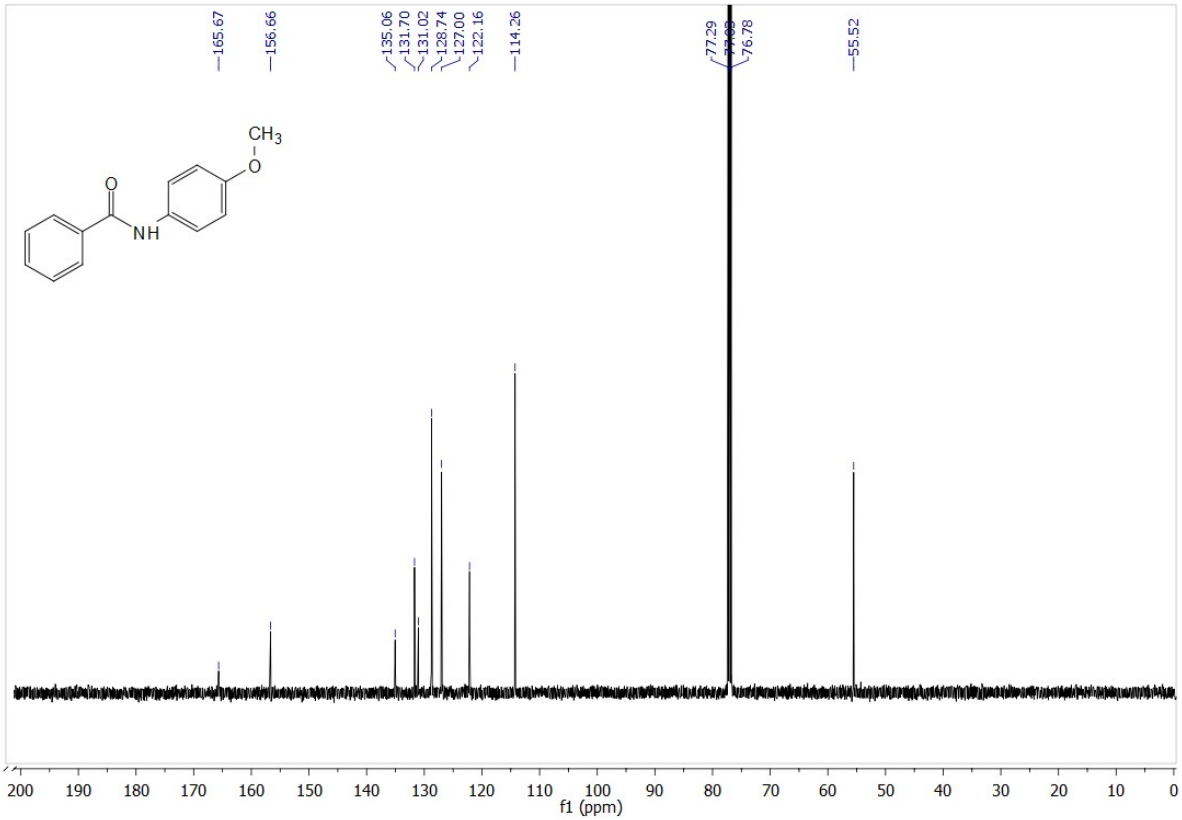
^{1}H and ^{13}C NMR Spectra of *N*-(2-ethylphenyl)benzamide (3z)



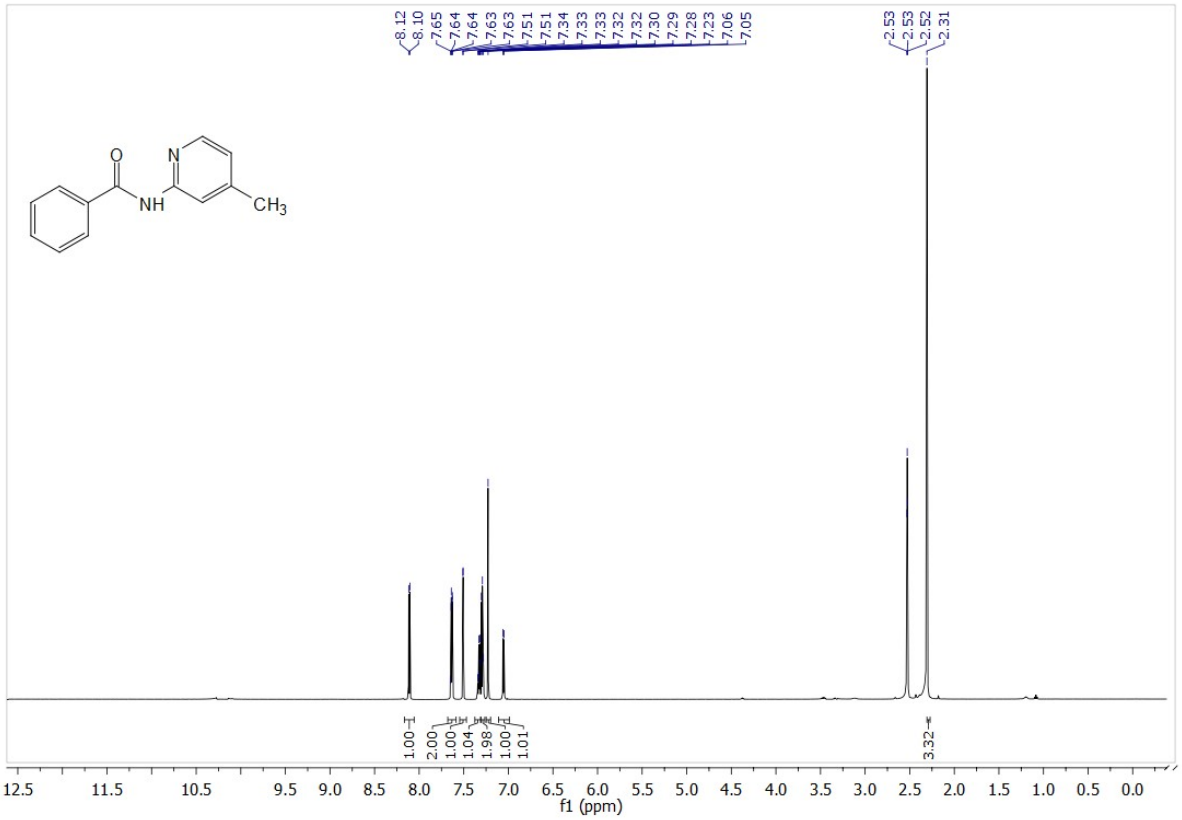


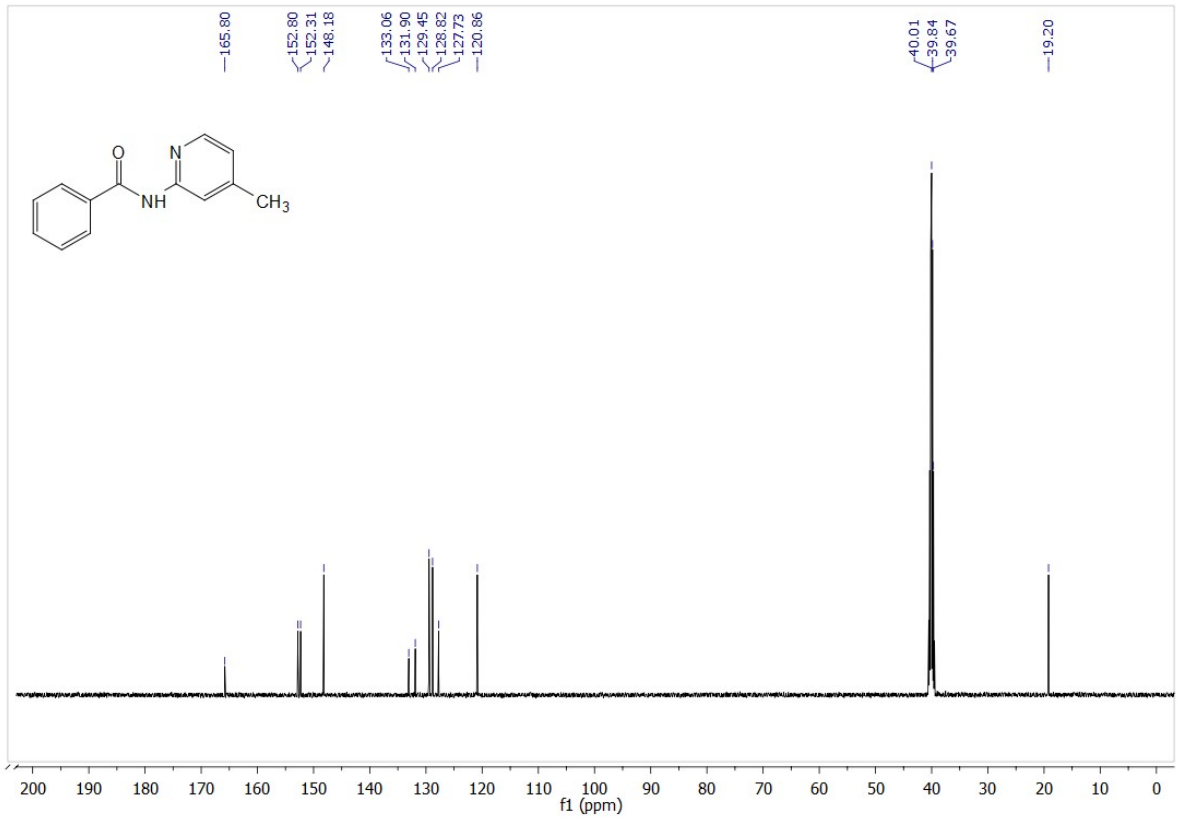
^{1}H and ^{13}C NMR Spectra of *N*-(4-methoxyphenyl)benzamide (3aa)



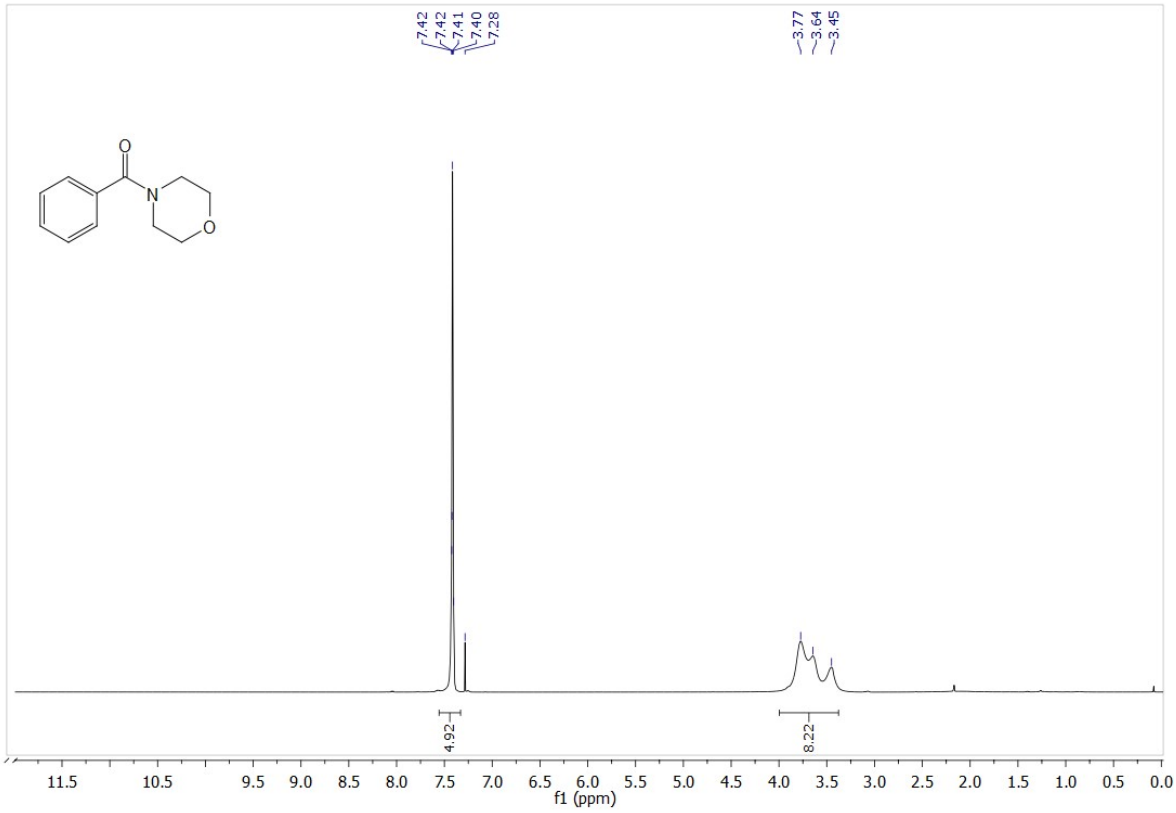


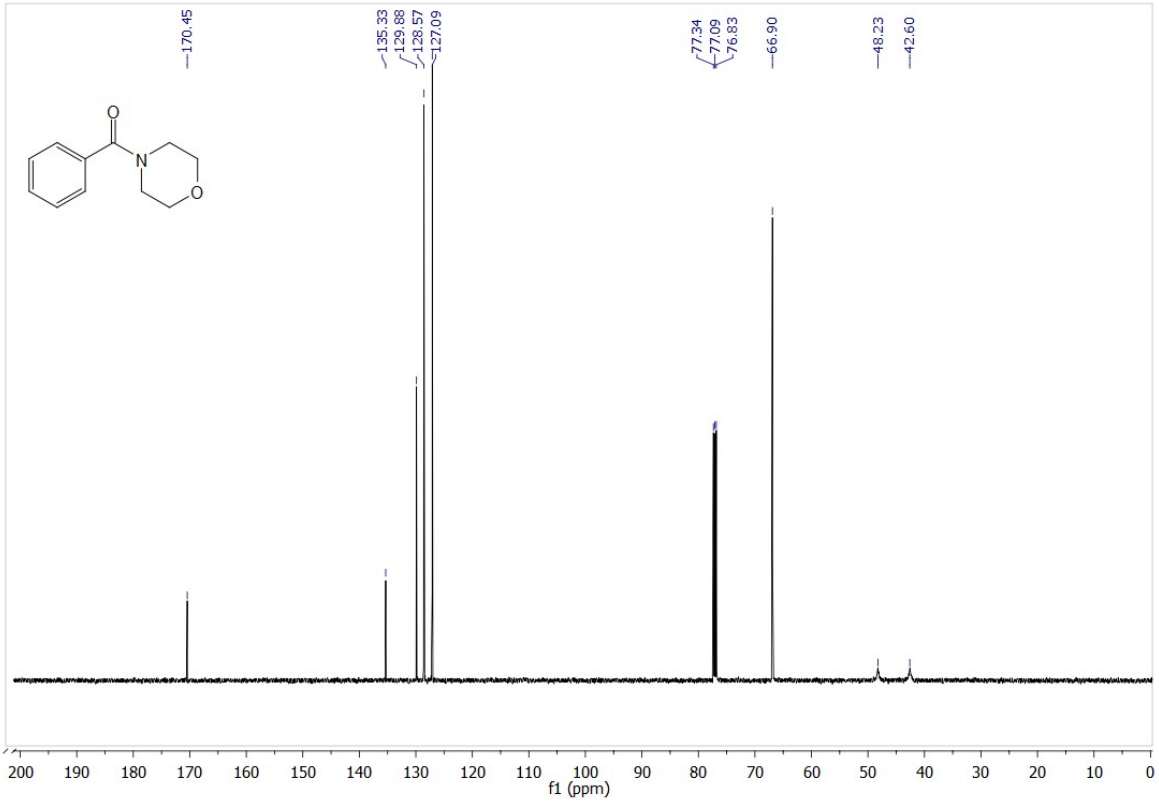
^{1}H and ^{13}C NMR Spectra of *N*-(4-methylpyridin-2-yl)benzamide (3ab)



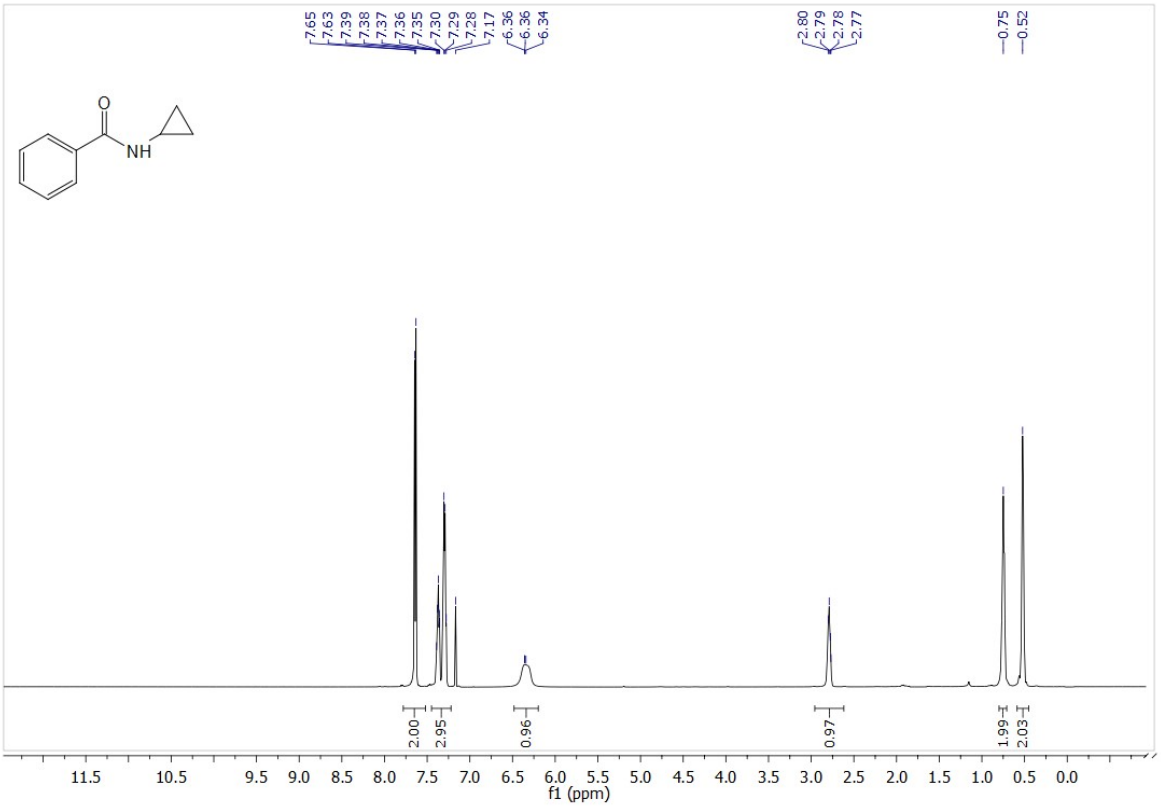


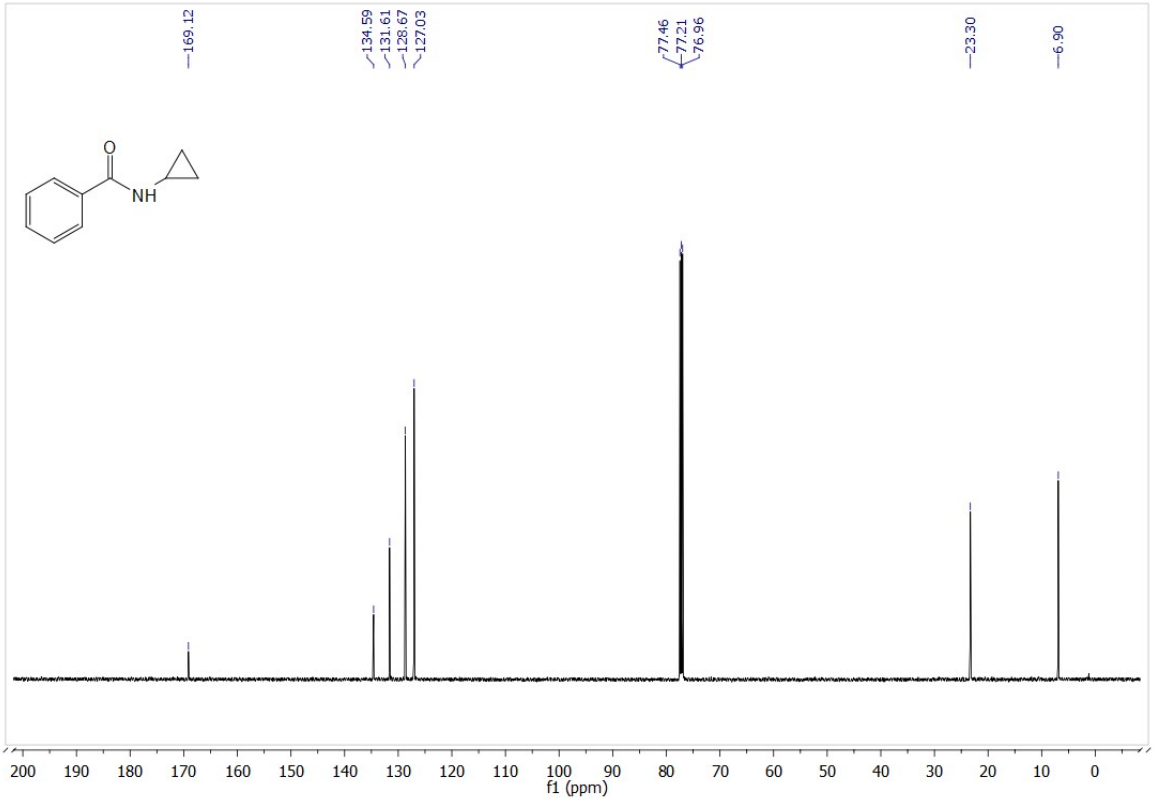
^{1}H and ^{13}C NMR Spectra of morpholino(phenyl)methanone (3ac).



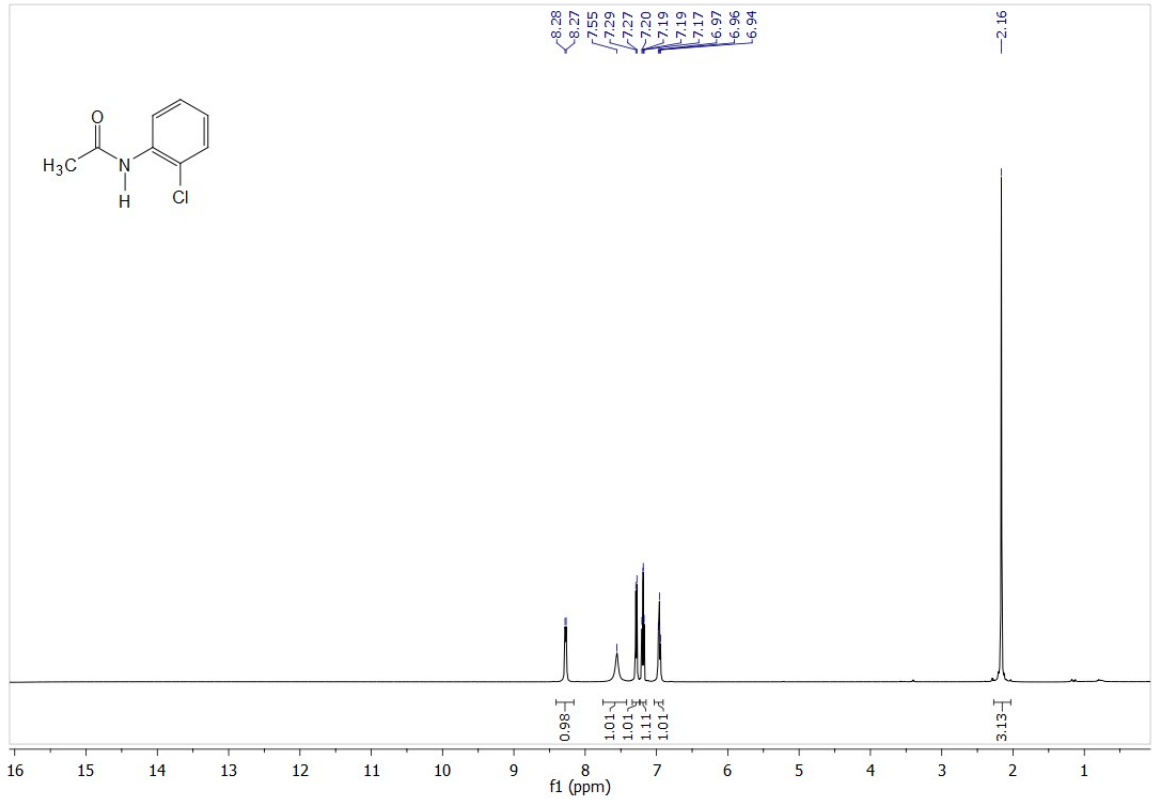


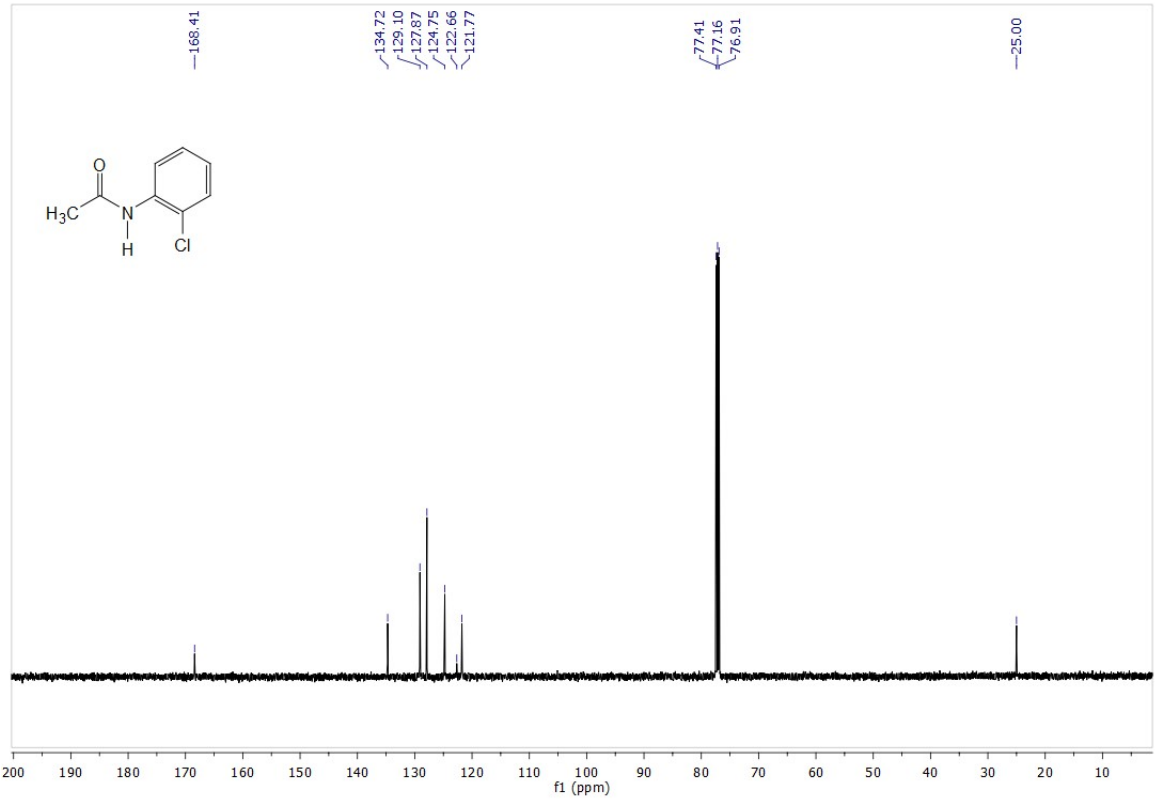
^{1}H and ^{13}C NMR Spectra of *N*-cyclopropylbenzamide (3ad)



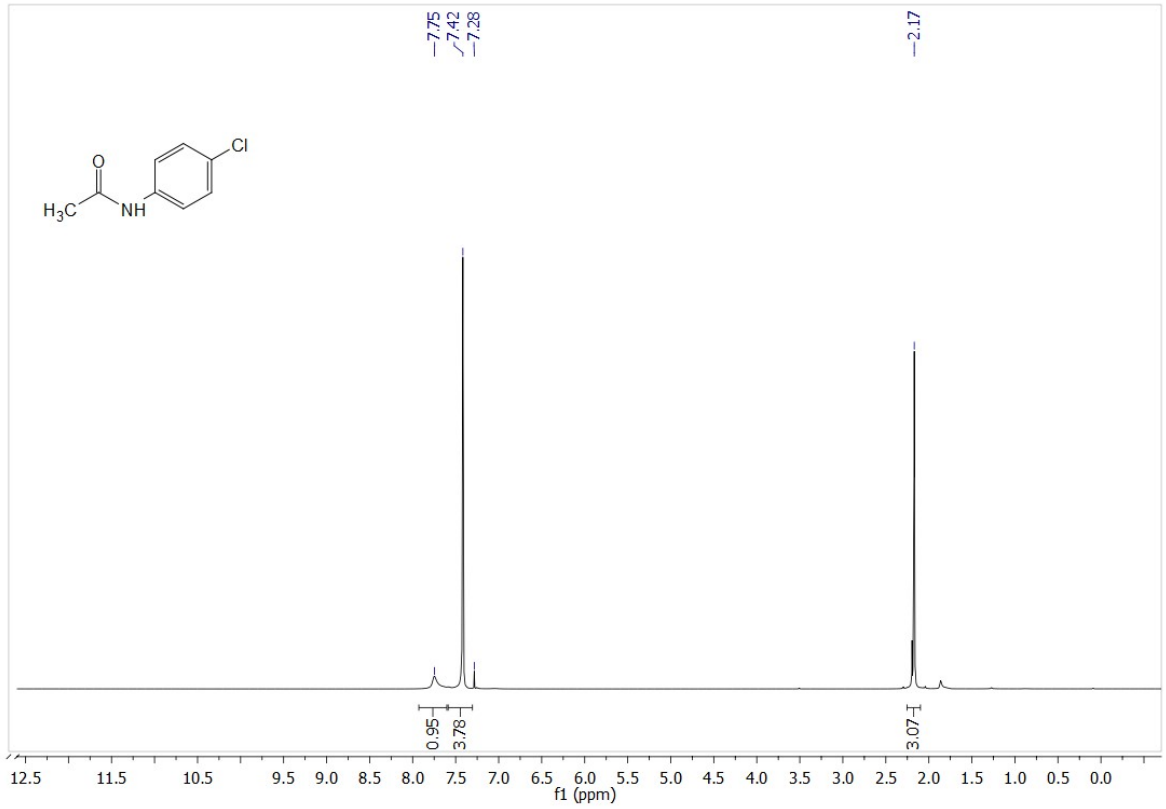


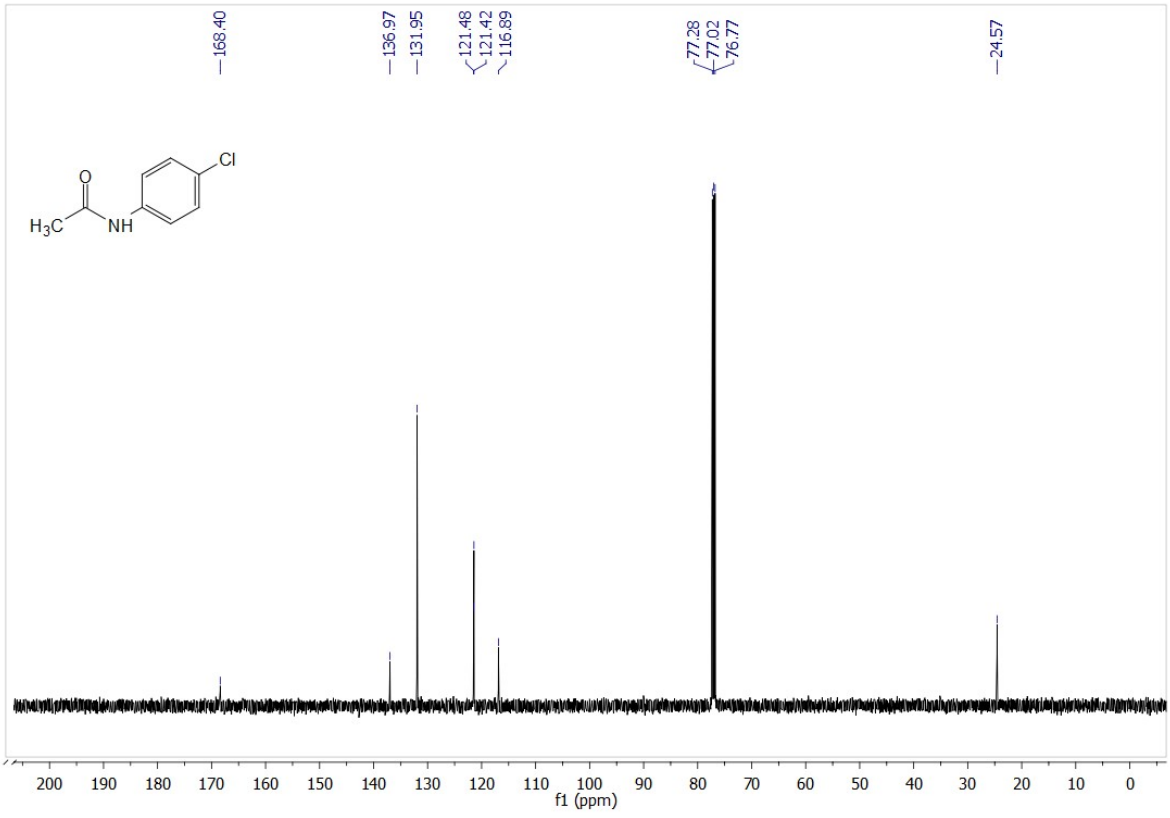
^{1}H and ^{13}C NMR Spectra of *N*-(2-chlorophenyl)acetamide (3ae)



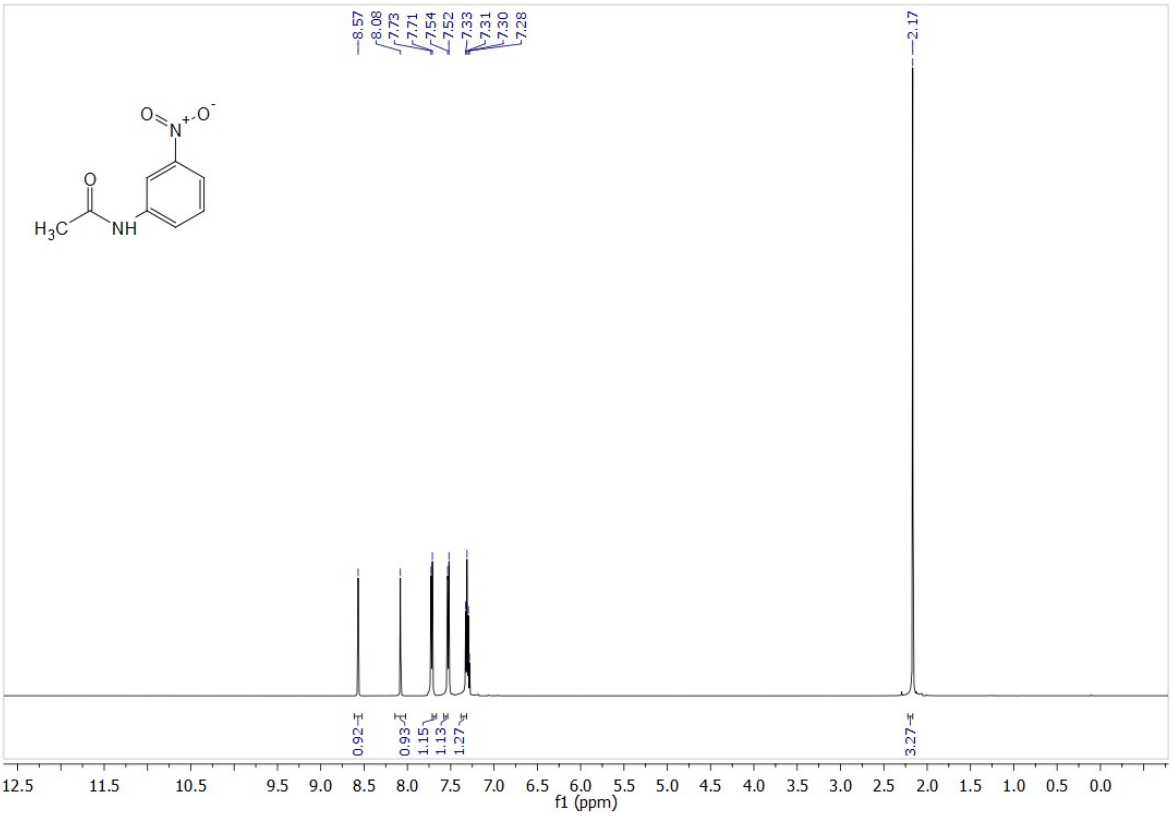


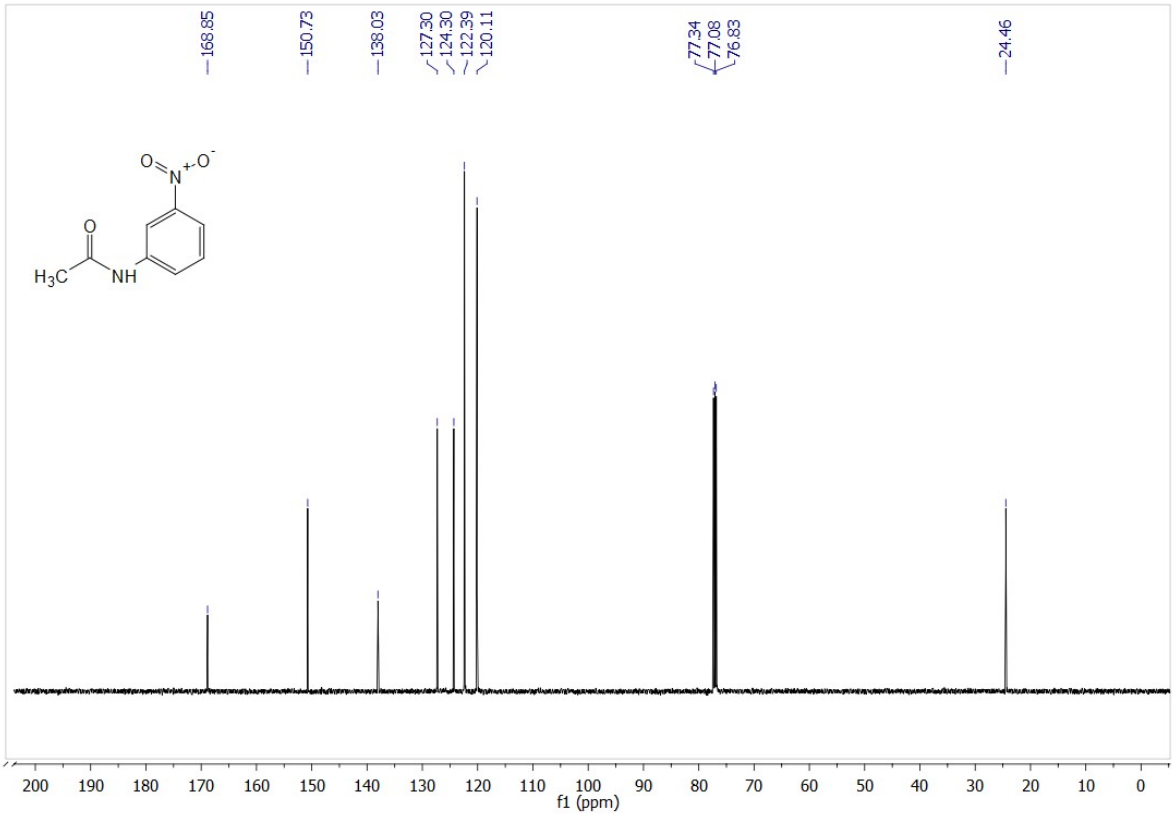
^{1}H and ^{13}C NMR Spectra of *N*-(4-chlorophenyl)acetamide (3af)



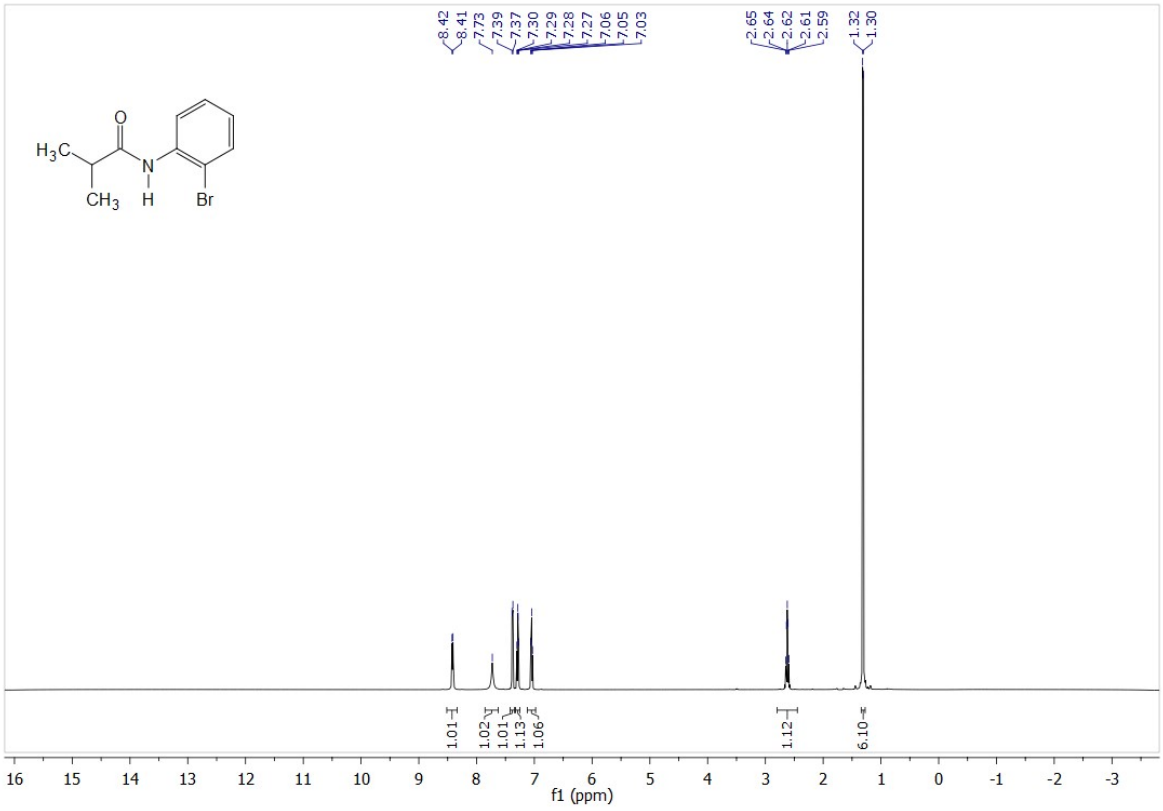


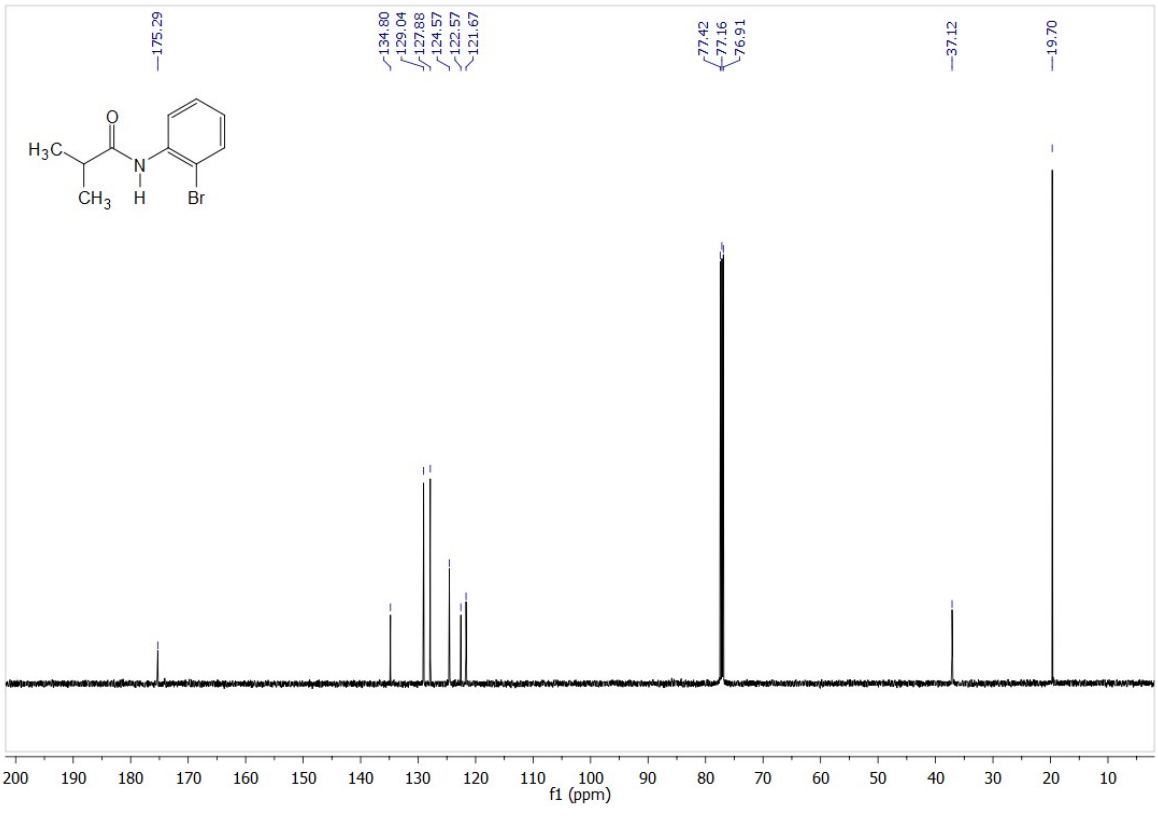
^{1}H and ^{13}C NMR Spectra of *N*-(3-nitrophenyl)acetamide (3ag)



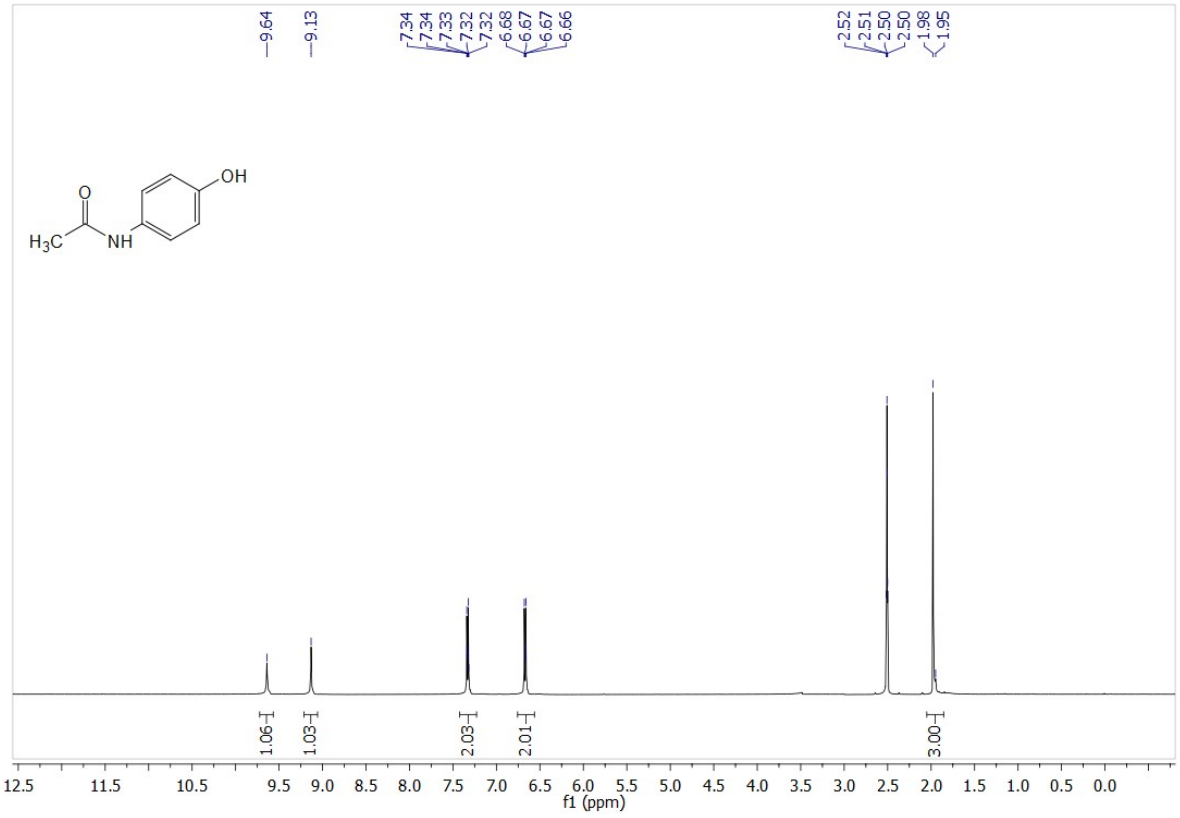


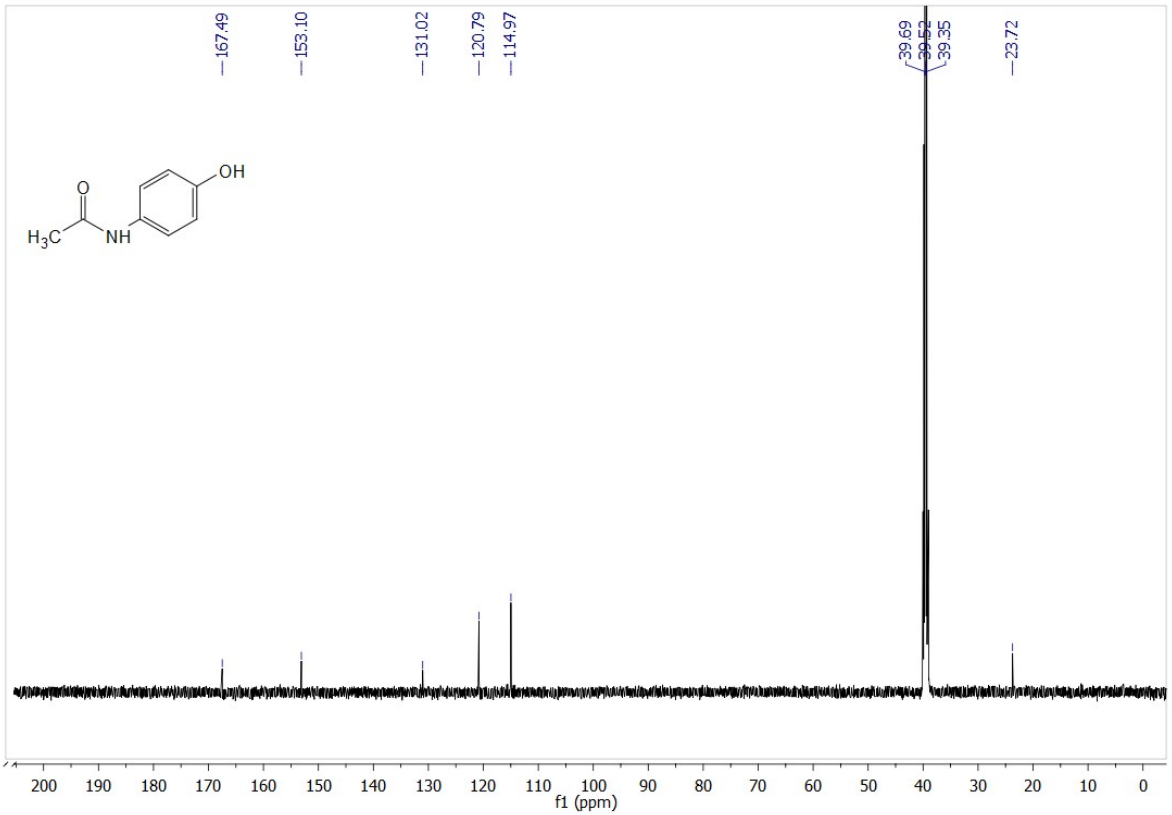
^{1}H and ^{13}C NMR Spectra of *N*-(2-bromophenyl)isobutyramide (3ah)



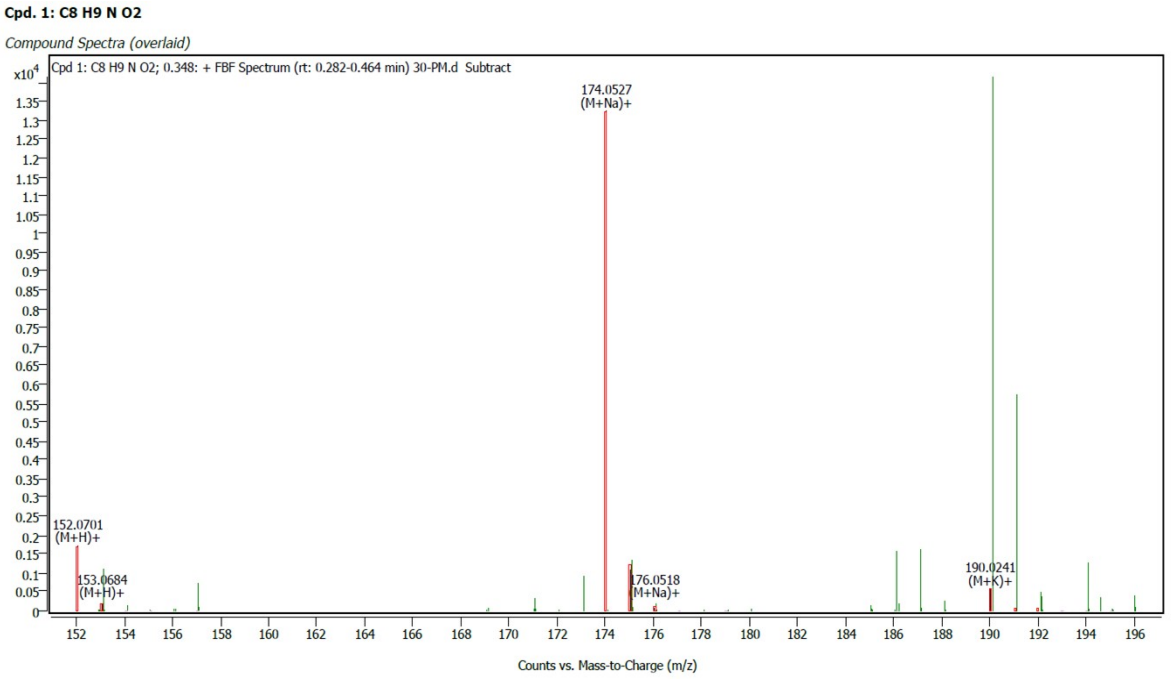


^{1}H and ^{13}C NMR Spectra of *N*-(4-hydroxyphenyl)acetamide (3ai)

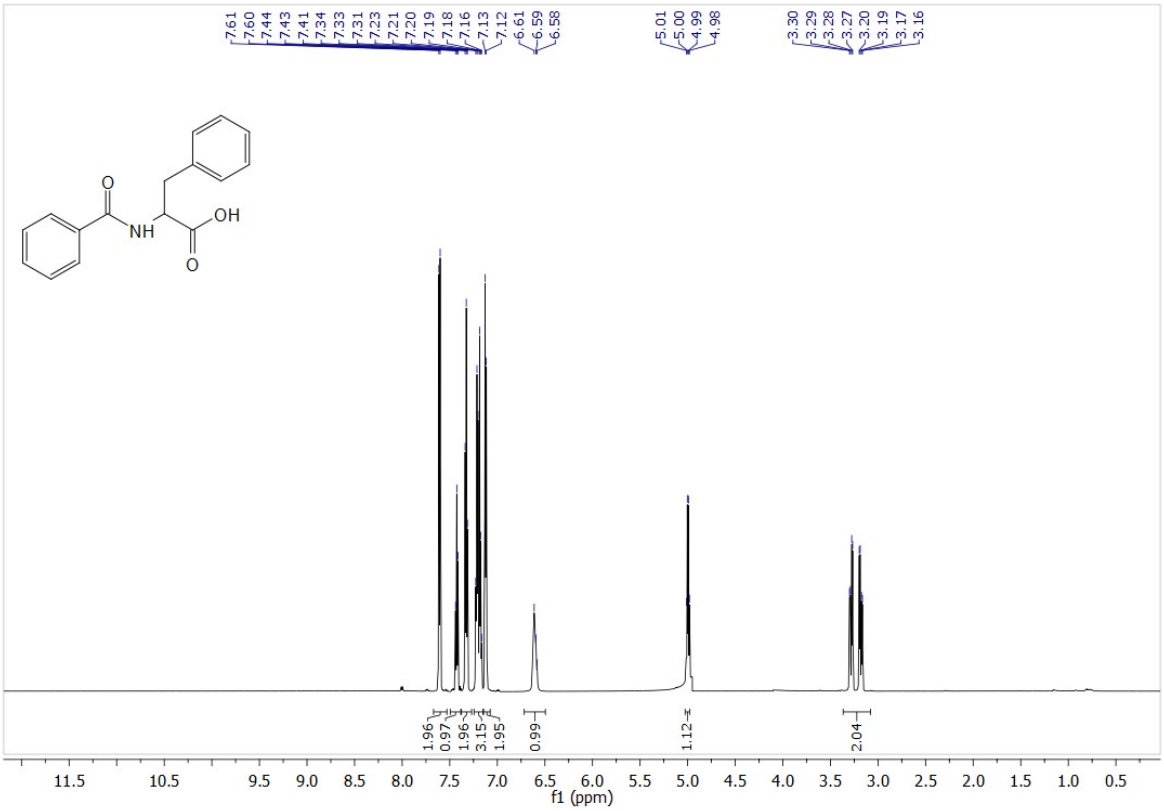


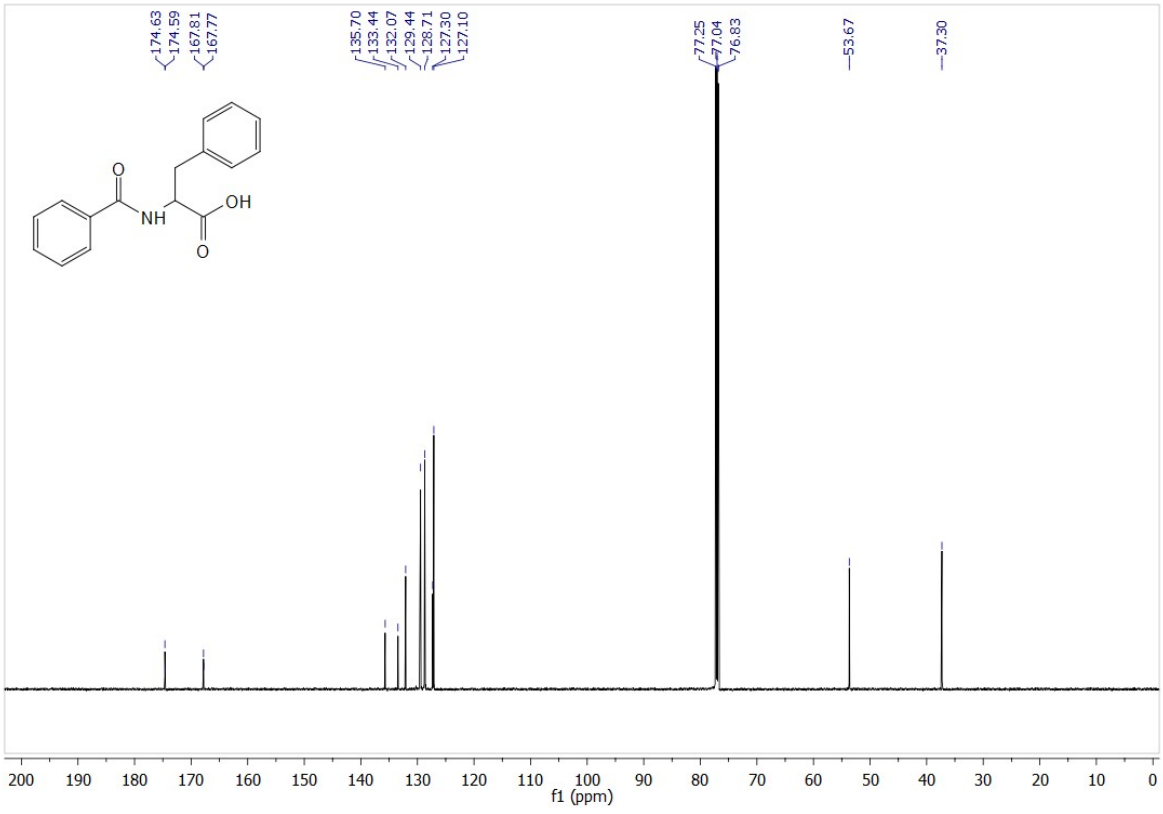


Mass spectra of *N*-(4-hydroxyphenyl)acetamide (3ai)

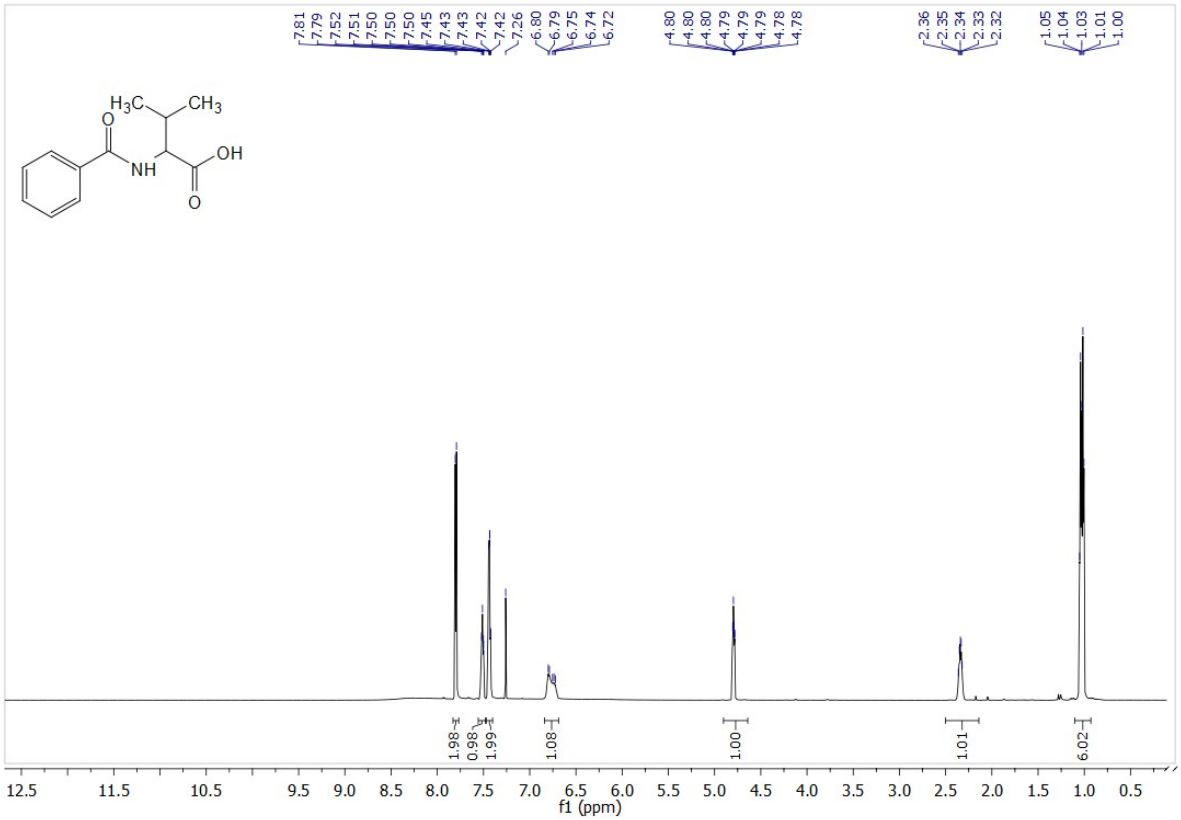


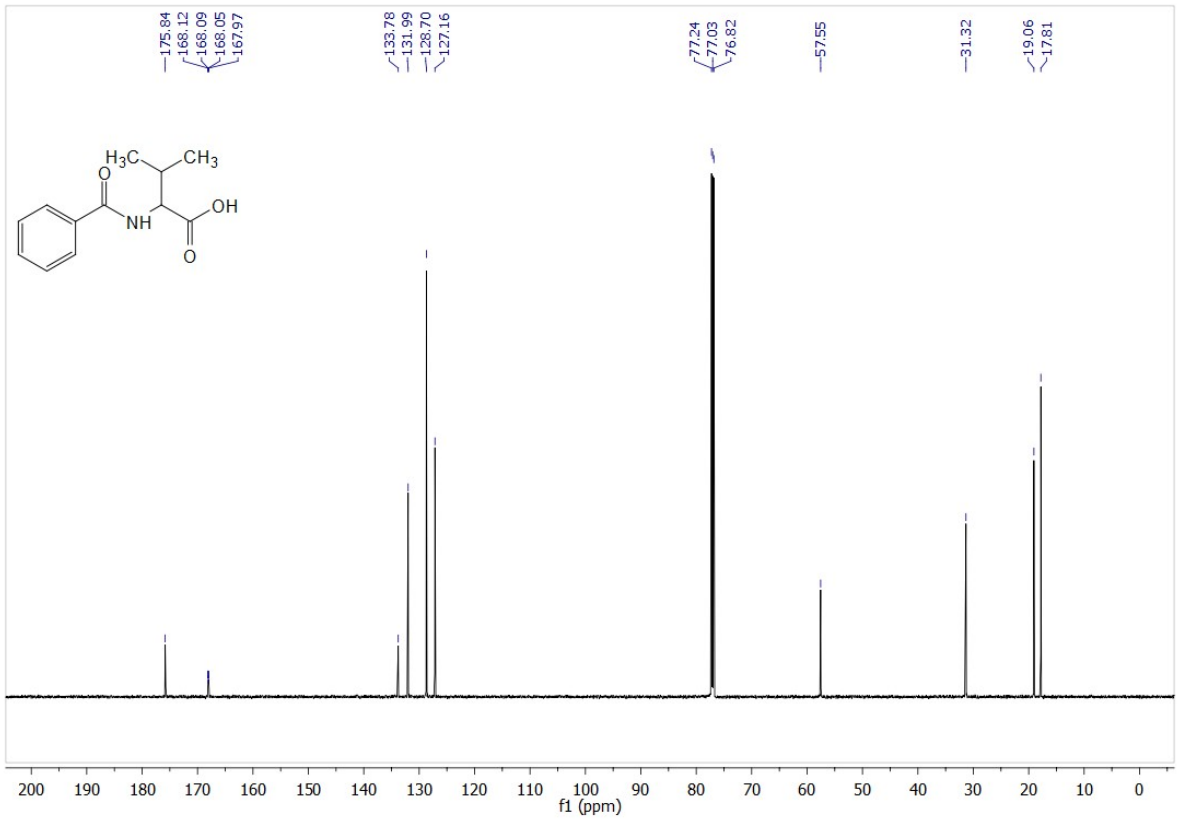
^{1}H and ^{13}C NMR Spectra of benzoylphenylalanine (6a)



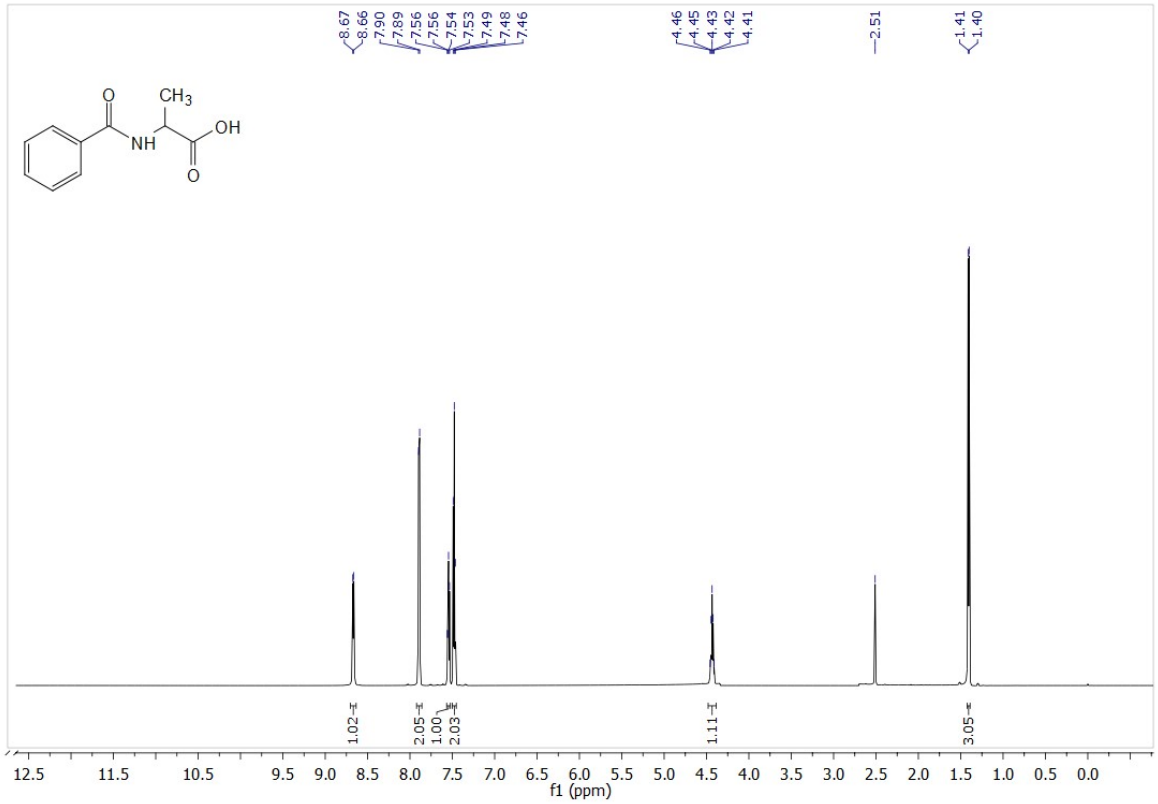


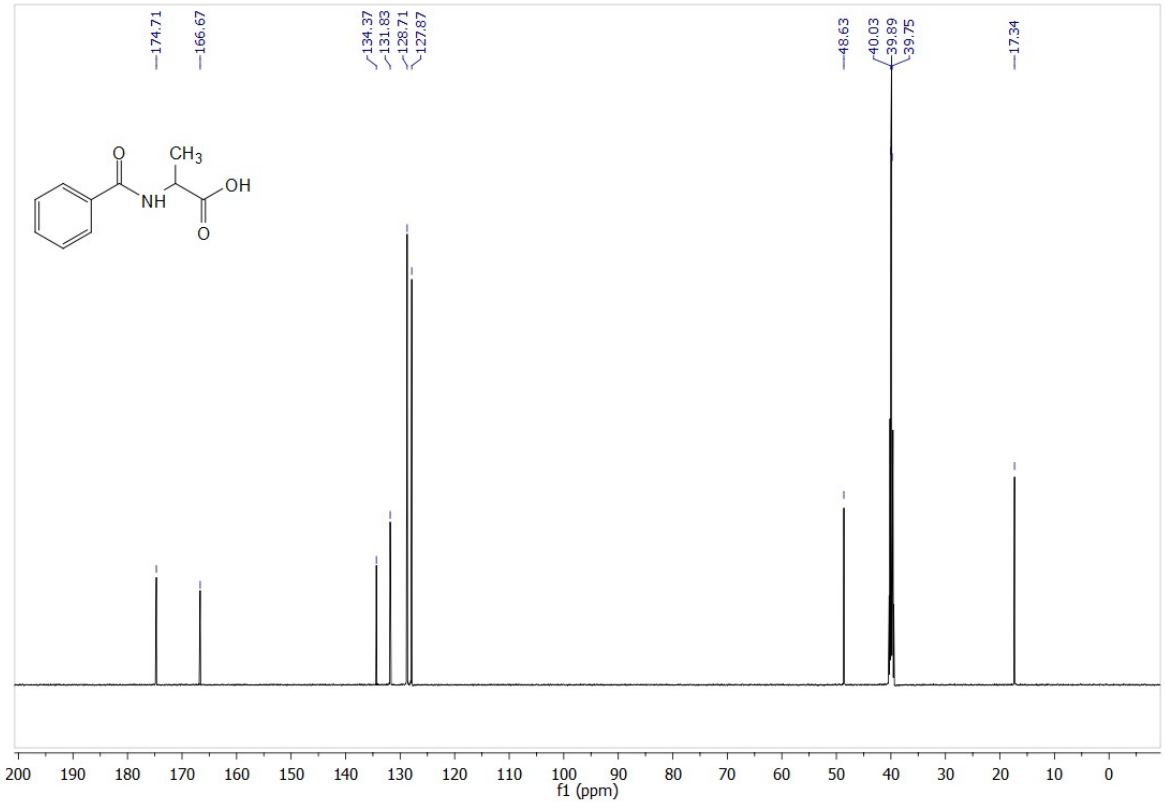
^{1}H and ^{13}C NMR Spectra of benzoylvaline (6b)



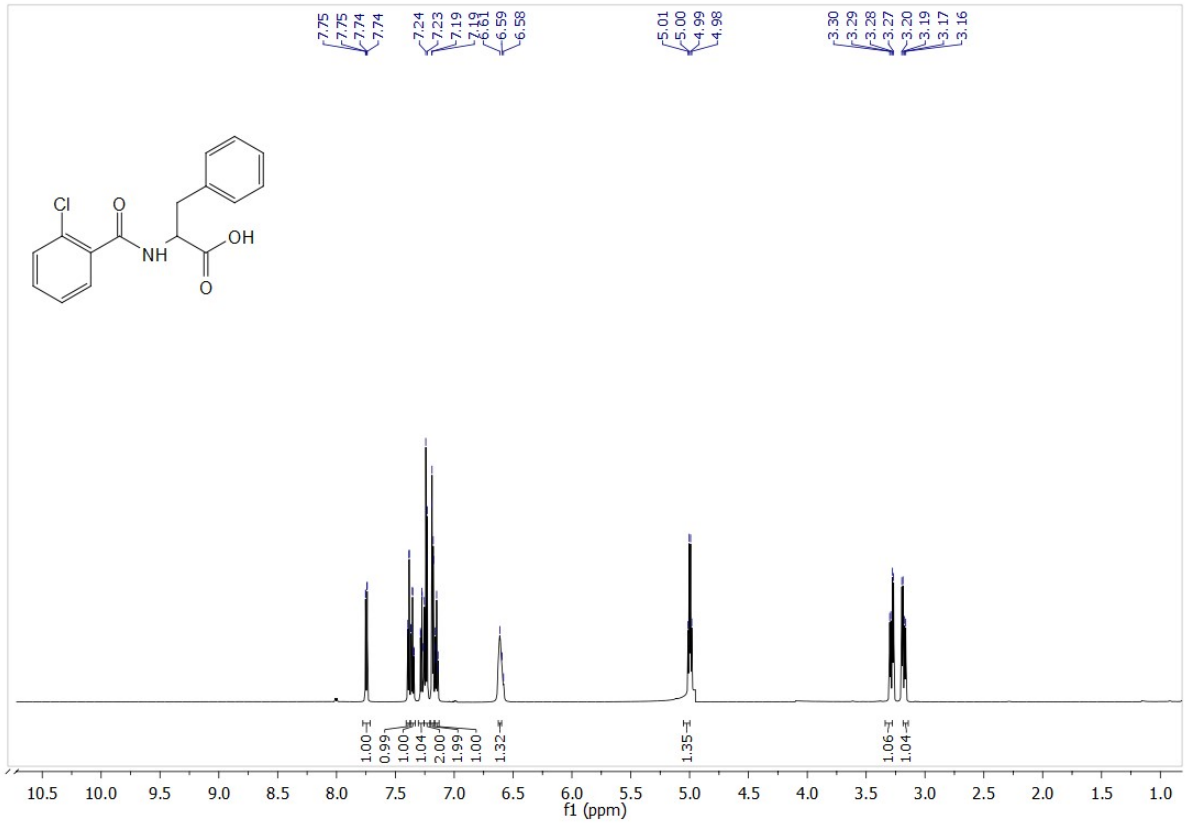


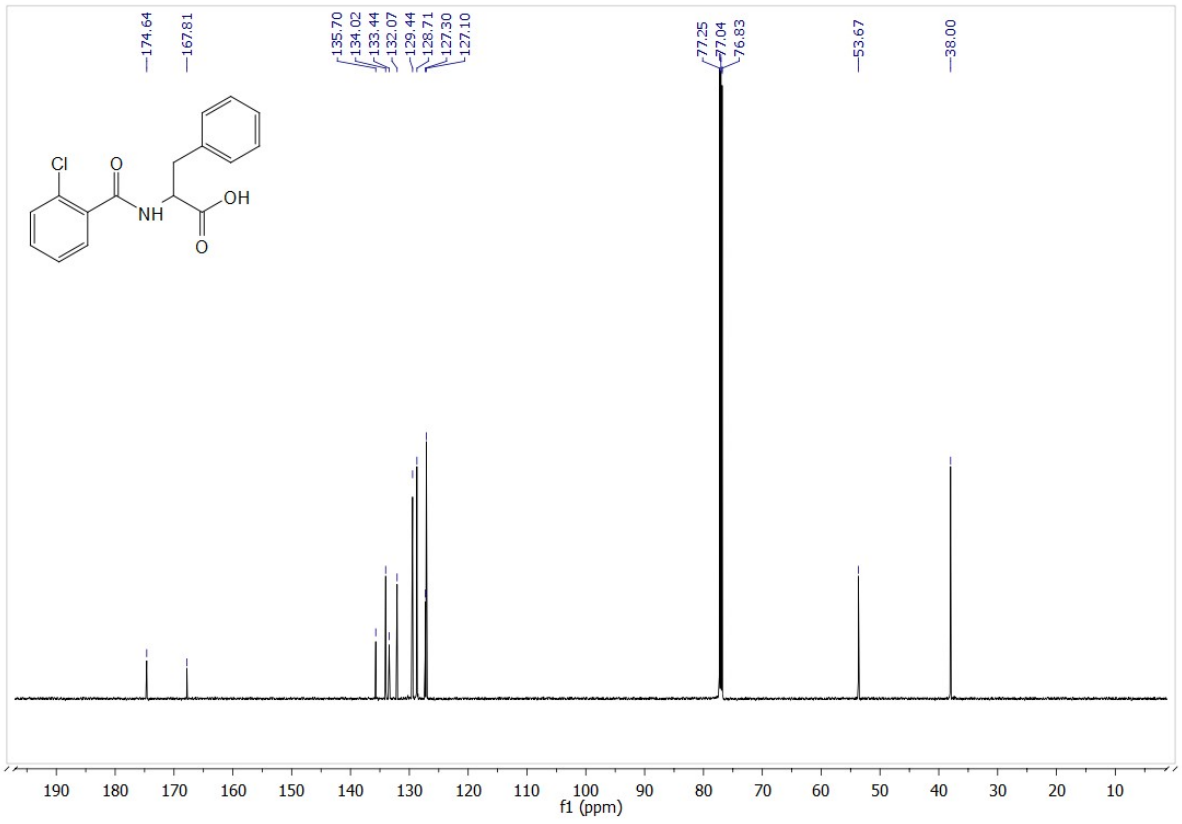
^{1}H and ^{13}C NMR Spectra of benzoylalanine (6c)





^{1}H and ^{13}C NMR Spectra of (2-chlorobenzoyl)phenylalanine (6d)





^{1}H and ^{13}C NMR Spectra of (2-chlorobenzoyl)alanine (6e)