Electronic Supplementary Material (ESI) for Chemical Communications
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Supporting information for

Bu_4NI-Catalyzed Benzylic Acyloxylation of Alkylarenes with Aromatic Aldehydes

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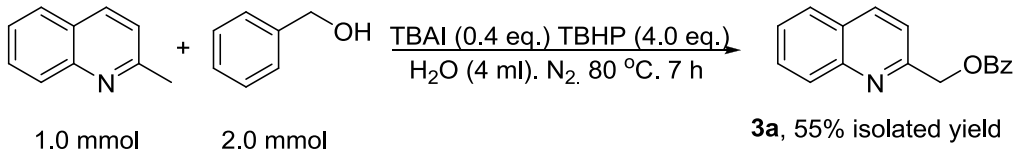
1. Investigation of Mechanism

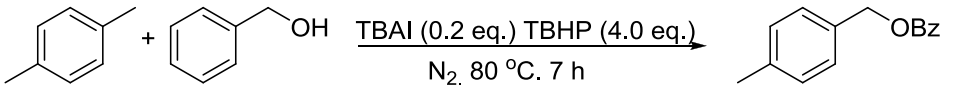
a) Control reactions for exploring Cannizaro pathway



(1S)

1.0 mmol 2.0 mmol

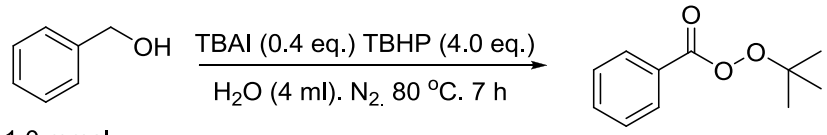
3a, 55% isolated yield



(2S)

10 mmol 1.0 mmol

5c, 60% isolated yield



(3S)

1.0 mmol

TBPB, 75% isolated yield

Based on these results of Eq. 1S-3S, we think that Cannizaro disproportionation is also possible in this transformation. This pathway has been presented in the main text.

b) Control reactions for exploring radical chain pathway

One would argue that the homolysis of TBPB would lead to benzoyloxy radical and *tert*-butoxyl radical at high temperature. The thus-generated radicals could abstract a hydrogen atom from benzylic C-H bond to form a benzylic radical, which would react with benzoyloxy radical to give the ester. However, TEMPO did not affect the reaction when TBPB was used instead of benzaldehyde and the desirable ester was obtained in 72% yield (Eq. 4S). Furthermore, the reaction of TBPB with 2-methylquinonline could not occur in the absence of nBu$_4$NI, even at 100 °C (Eq. 5S). Thus, these results indicate that the radical chain pathway is not possible.

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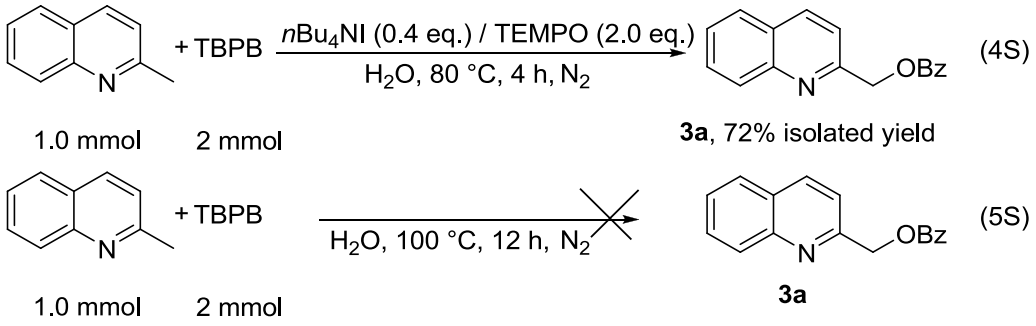

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2. General Information

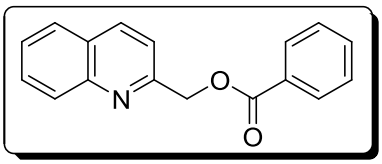
^{1}H NMR and ^{13}C NMR spectra were recorded on a Bruker AVANCE AV400 (400MHz and 100MHz), unless otherwise noted. Signal positions were recorded in ppm with the abbreviations s, d, t, and m denoting singlet, doublet, triplet, and multiplet respectively. All NMR spectra were recorded in $CDCl_3$, and chemical shifts were referenced to residual $CHCl_3$ at 7.26 ppm for ^{1}H or 77.0 ppm for ^{13}C. All coupling constants J were quoted in Hz. Data were reported as follows: chemical shift, multiplicity, coupling constant and integration. High resolution mass spectrometry was conducted using a Varian 7.0 T FTICR-MS or VG ZAB-HS by ESI technique. Reactions were monitored by thin-layer chromatography (TLC) on 0.25mm silica gel glass plates coated with 60 F_{254}. Column chromatography was performed on silica gel (200-300 mesh) using a mixture of petroleum ether (60-90°C)/ethyl acetate as eluant. Reactions were carried out under a nitrogen atmosphere. Commercially available reagents were used as received without purification.

3. General Procedure

General procedure for acyloxylation of 2-methyl azaarenes:
To a Schlenk tube charged with *n*-Bu_4NI (73.8 mg, 0.2 mmol, 0.4 equiv) was added aldehyde (1.0 mmol, 2.0 equiv), 2-methylquinoline (0.5 mmol, 1.0 equiv), *t*BuOOH (3.0 mmol, 6.0 equiv), H_2O (4 mL) under N_2 seperately. The mixture was stirred at 80 °C for 12 h. And then the mixture was extracted by ethyl acetate for 3 times. The combined organic phase was concentrated under reduced pressure. And the residue was purified by silica gel column chromatography (petroleum ether/ethyl acetate) to give the products.
General procedure for acyloxylation of alkylarenes:
To a Schlenk tube charged with *n*-Bu_4NI (73.8 mg, 0.2 mmol, 0.2 equiv) was added aldehyde (1.0 mmol, 1.0 equiv), toluene (10 mmol, 10.0 equiv), *t*BuOOH (4.0 mmol, 4.0 equiv), H_2O (2 mL) under N_2 seperately. The mixture was stirred at 80 °C for 17 h. And then the mixture was extracted by ethyl acetate for 3 times. The combined organic phase was concentrated under reduced pressure. And the residue was purified by silica gel column chromatography (petroleum ether/ethyl acetate) to give the products.

4. Characterization Data of Compounds

3a



^{1}H NMR (400 MHz, $CDCl_3$): 8.22-8.09 (m, 4H); 7.85-7.82 (m, 1H); 7.77-7.72 (m, 1H); 7.61-7.54 (m, 3H); 7.50-7.45 (m, 2H); 5.67 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): 166.30; 156.40; 147.66; 137.08; 133.28; 130.02; 129.87; 129.18; 128.49; 127.90; 127.66; 127.59; 126.72; 119.41; 67.90;

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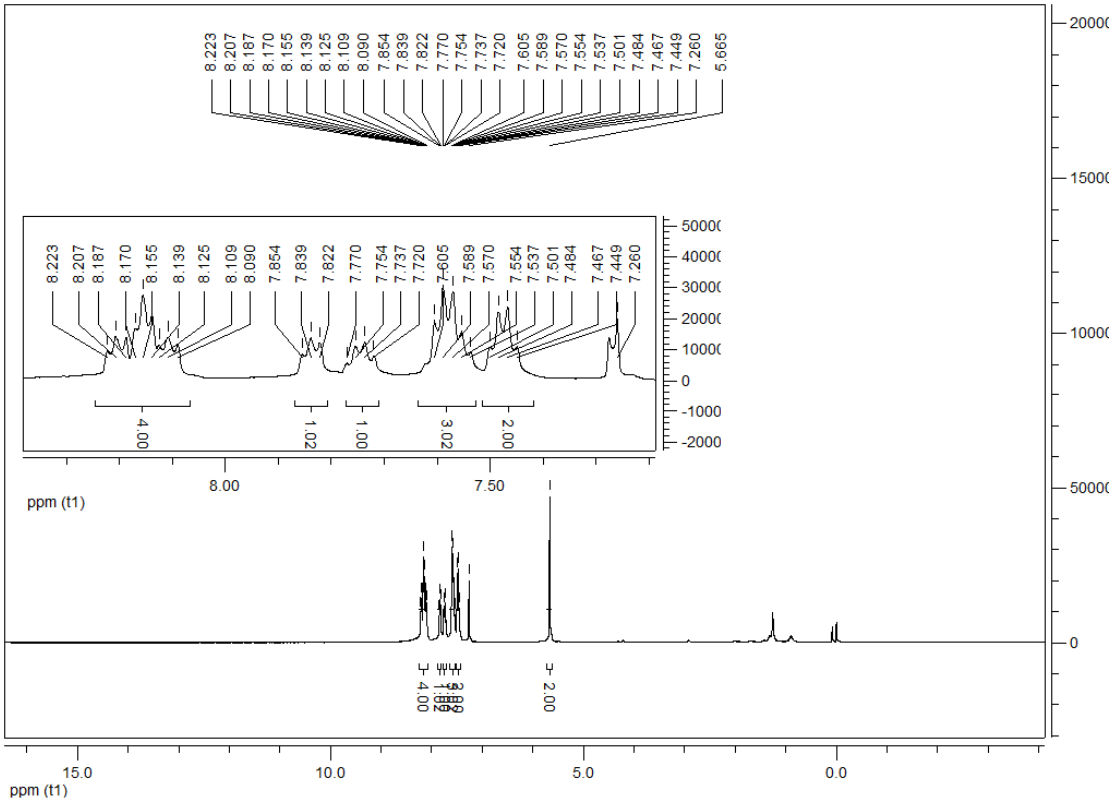
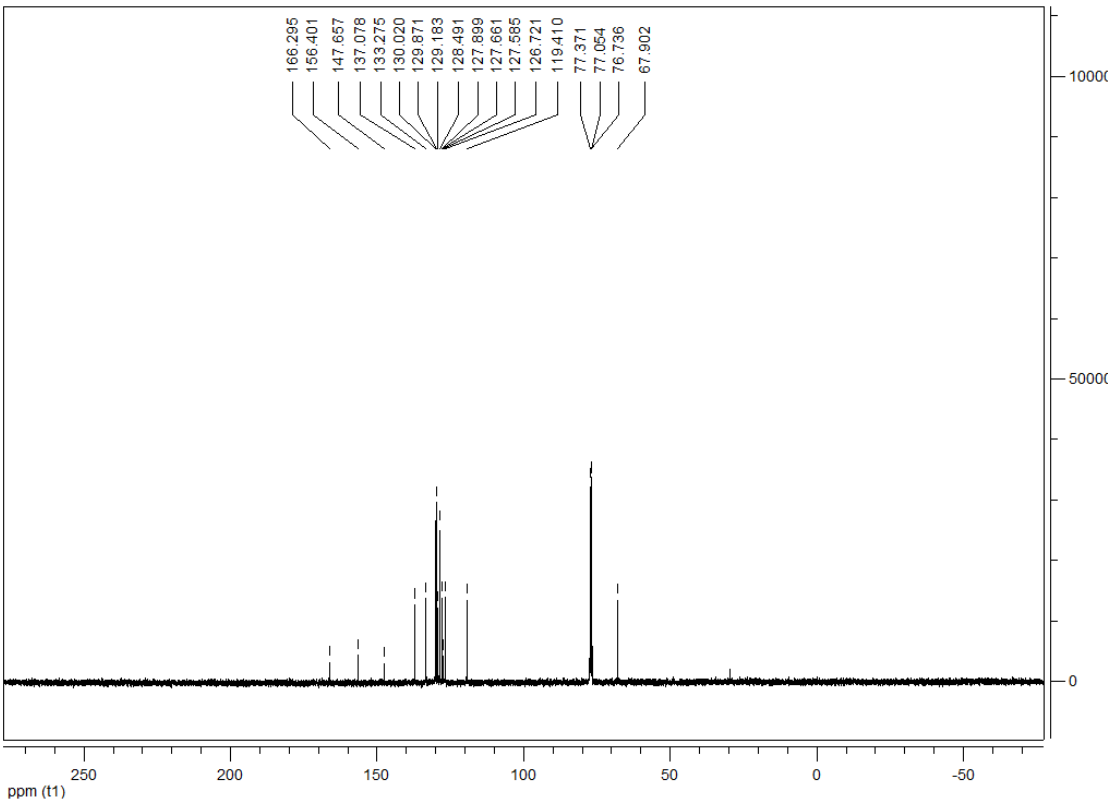
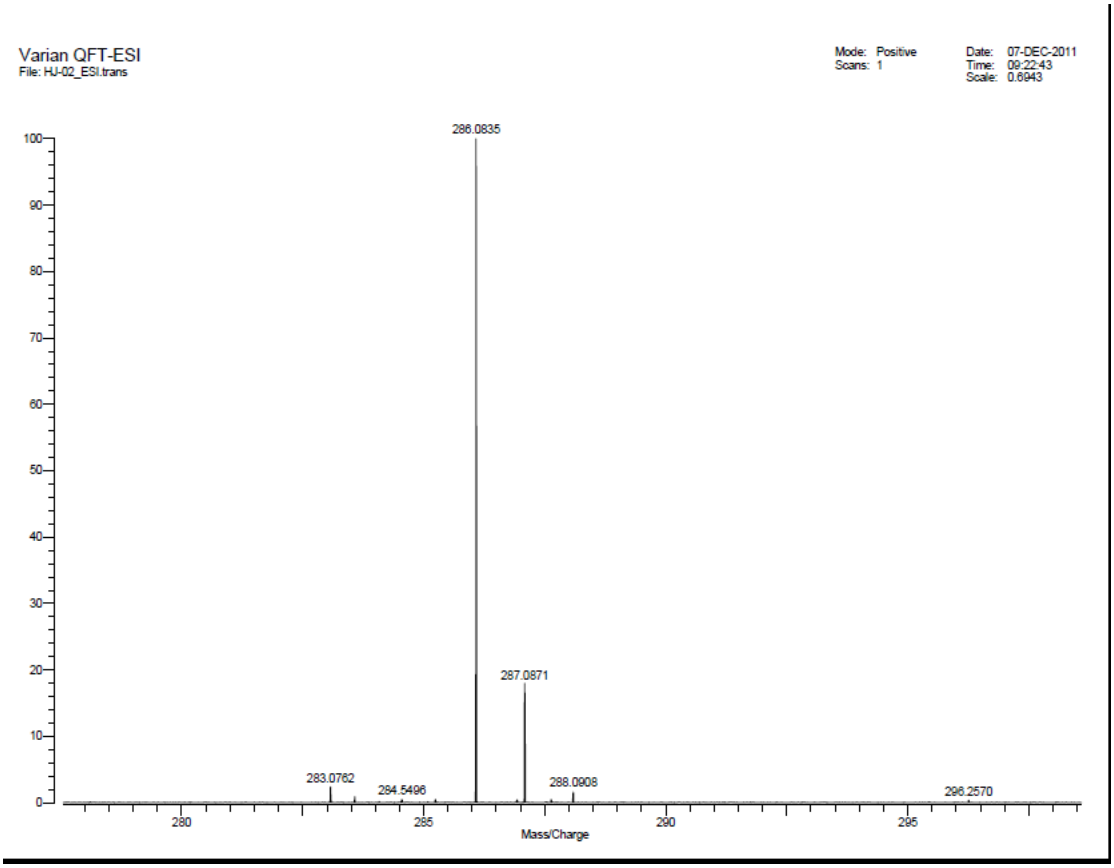
HRMS[ESI]: calculated for $C_{17}H_{13}NO_2Na$, $[M+Na]^+$: 286.0838, found 286.0835.







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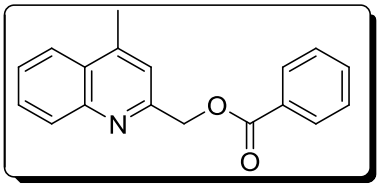

^{1}H NMR (300 MHz, $CDCl_3$): 8.16-8.13 (m, 3H); 8.01 (d, *J* = 8.1 Hz, 1H); 7.75 (t, *J* = 7.2 Hz, 1H); 7.62-7.57 (m, 2H); 7.50-7.42 (m, 3H); 5.65 (s, 2H); 2.74 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): 163.40; 152.97; 146.33; 144.95; 132.59; 129.46; 129.14; 128.84; 128.60; 128.00; 127.42; 126.13; 122.65; 118.11; 90.33; 18.02; HRMS[ESI]: calculated for $C_{18}H_{16}NO_2$, $[M+H]^+$: 278.1176, found: 278.1178.

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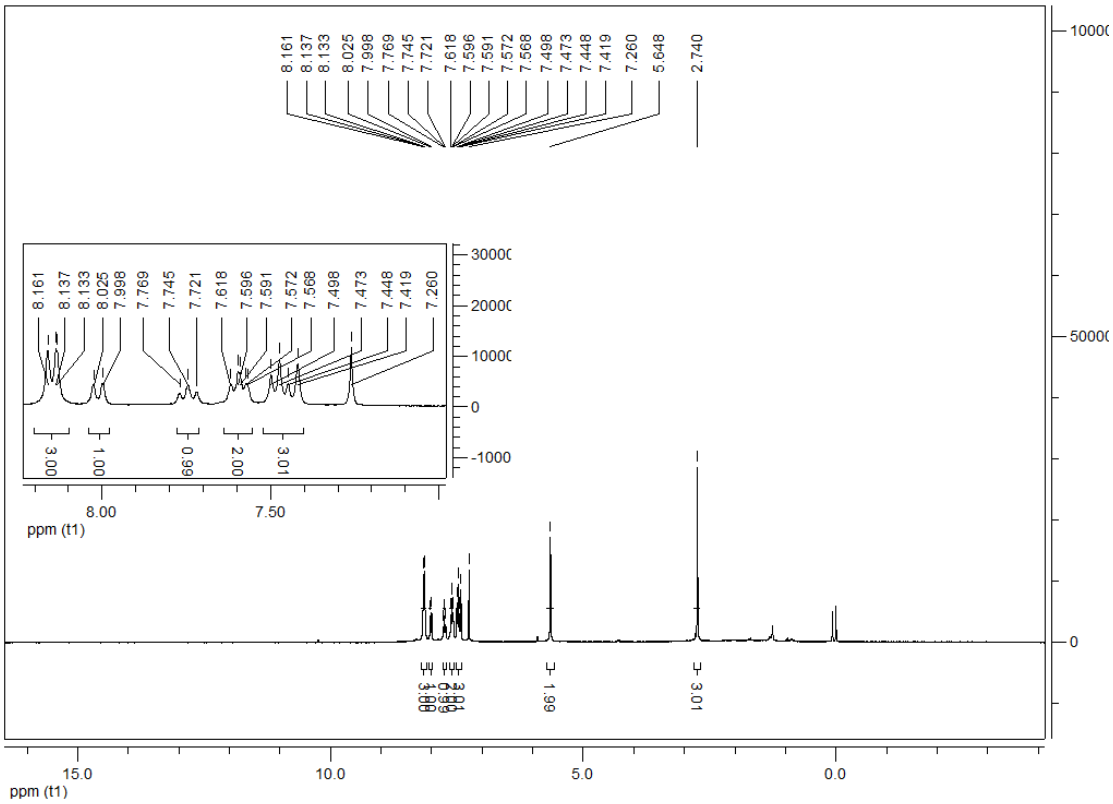

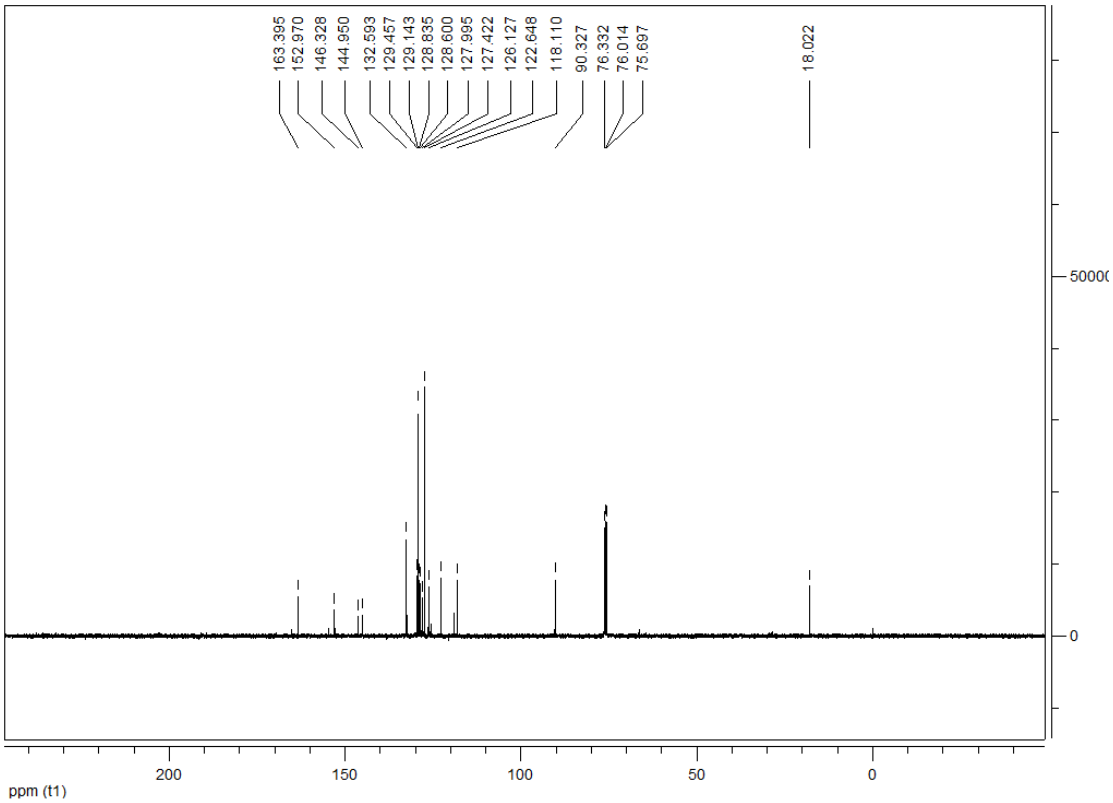

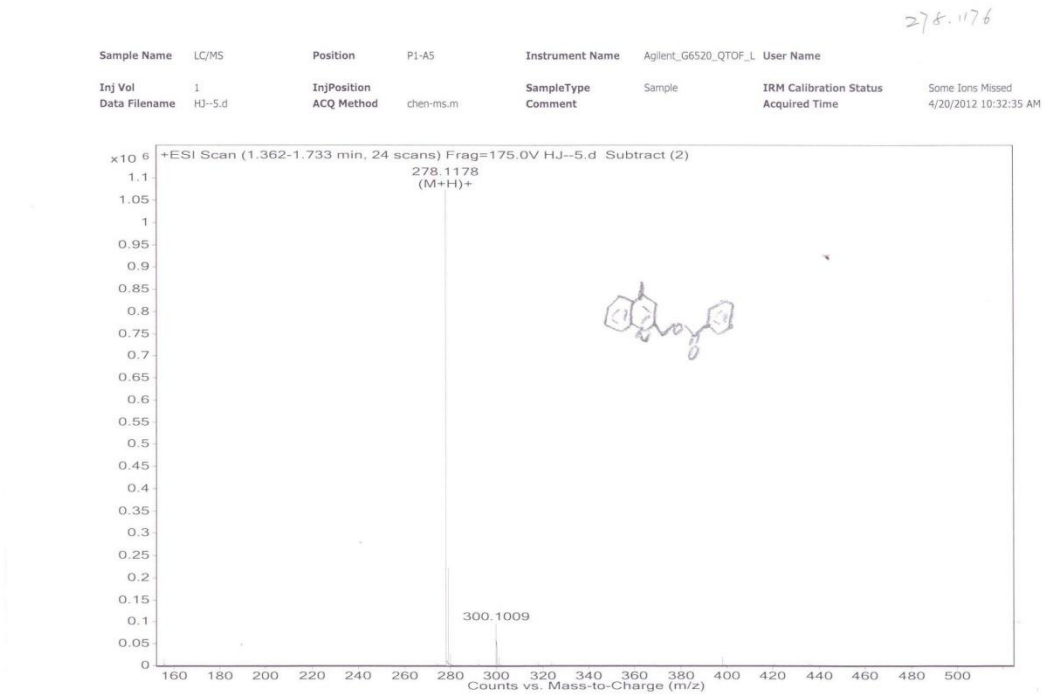

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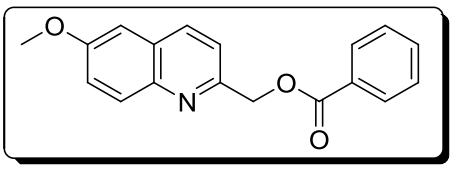

^{1}H NMR (400 MHz, $CDCl_3$): 8.13 (d, *J* = 7.6 Hz, 2H); 8.08 (d, *J* = 8.4 Hz, 1H); 8.00 (d, *J* = 9.2 Hz, 1H); 7.60-7.52 (m, 2H); 7.47-7.44 (m, 2H); 7.39-7.37 (m, 1H); 7.08 (s, 1H); 5.63 (s, 2H); 3.93 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): 166.33; 157.97; 153.70; 143.69; 135.81; 133.21; 130.56; 129.93; 129.86; 128.65; 128.46; 122.68; 119.96; 105.08; 67.91; 55.58; HRMS[ESI]: calculated for $C_{18}H_{16}NO_3$, $[M+H]^+$: 294.1125, found: 294.1127.

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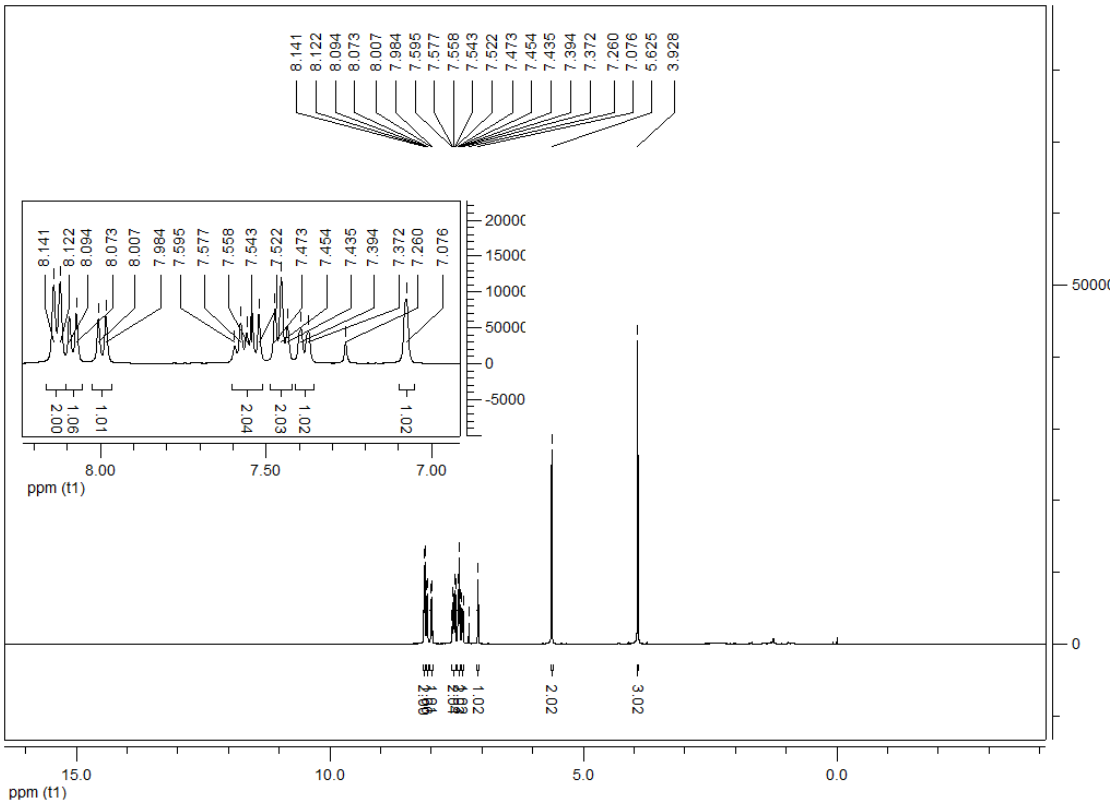

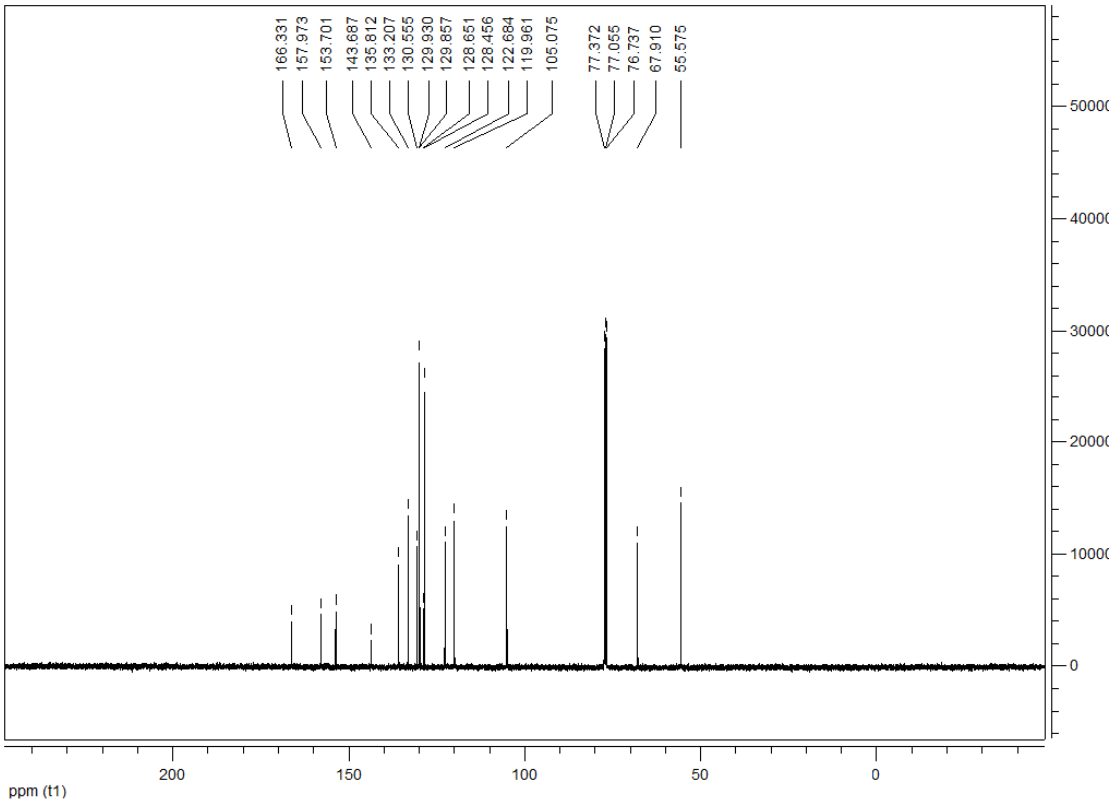

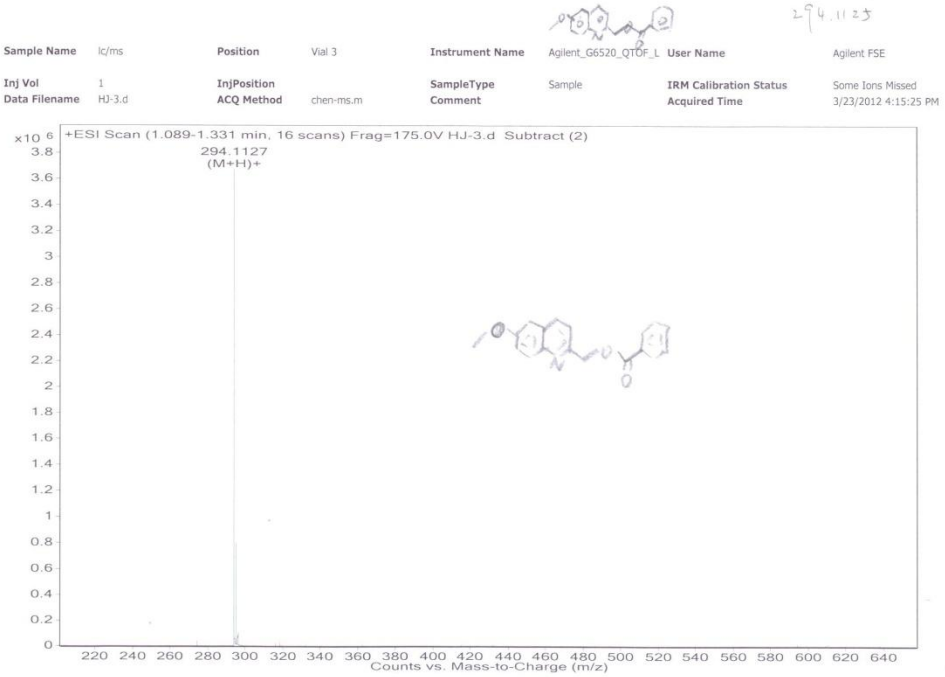

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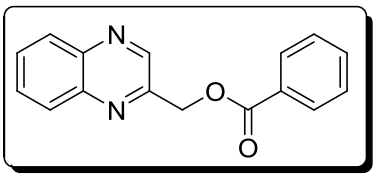

^{1}H NMR (400 MHz, $CDCl_3$): 9.05 (s, 1H); 8.14-8.09 (m, 4H); 7.81-7.79 (m, 2H); 7.62-7.58 (m, 1H); 7.49-7.45 (m, 2H); 5.70 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): 166.17; 151.03; 144.21; 142.21; 141.85; 133.48; 130.48; 130.19; 129.90; 129.44; 129.37; 129.31; 128.56; 66.04; HRMS[ESI]: calculated for $C_{16}H_{13}N_2O_2$, $[M+H]^+$: 265.0972, found: 265.0975.

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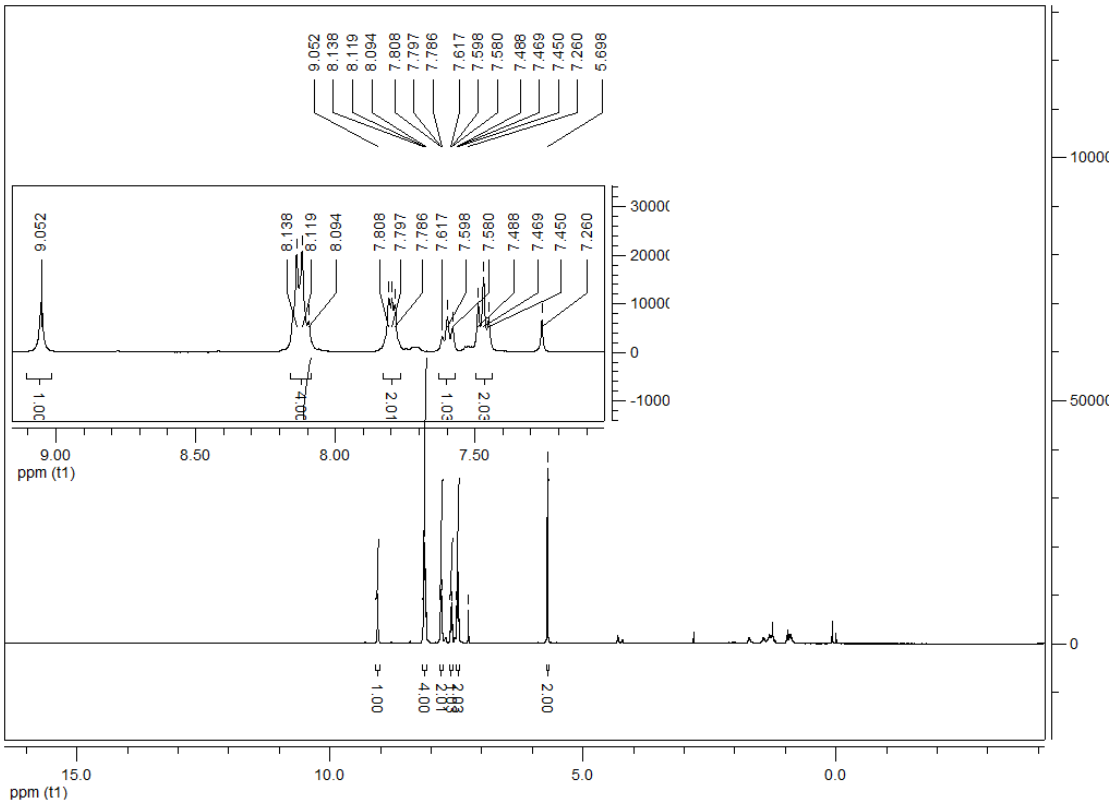

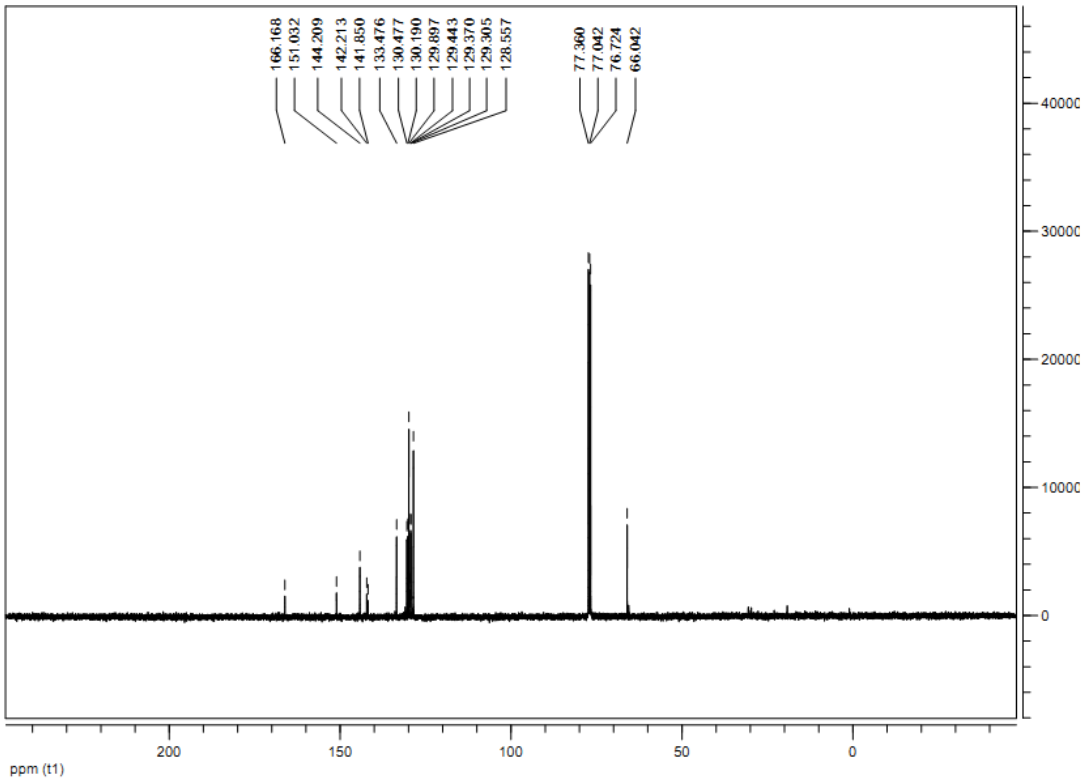

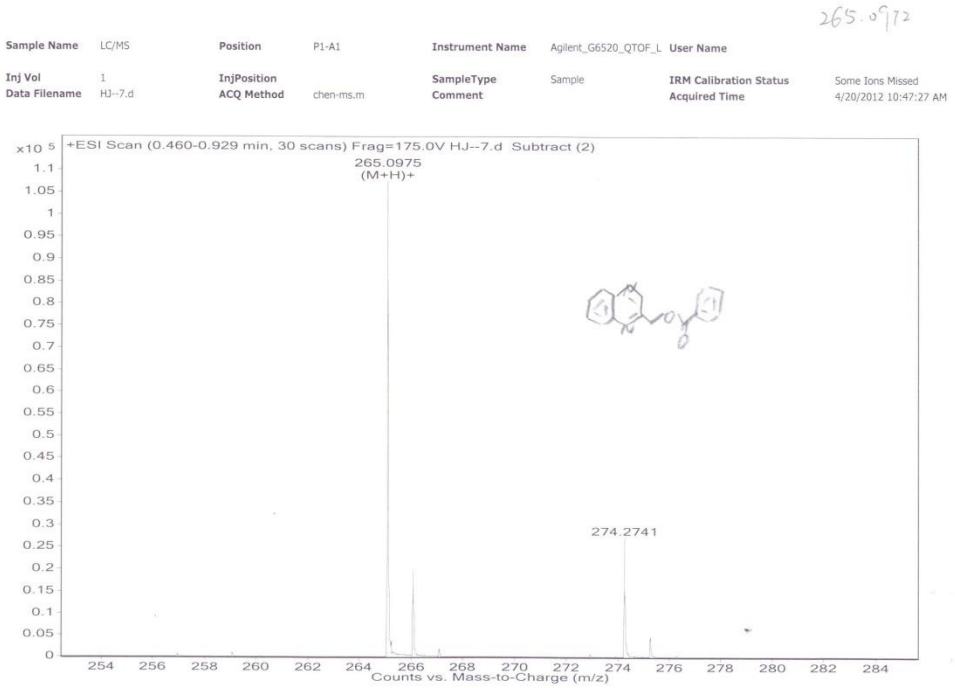

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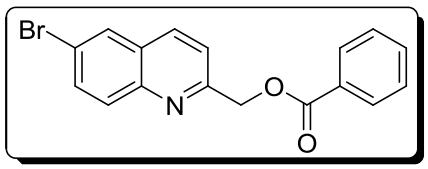

^{1}H NMR (400 MHz, $CDCl_3$): 8.15-8.10 (m, 3H); 7.99-7.95 (m, 2H); 7.81-7.78 (m, 1H); 7.62-7.58 (m, 2H); 7.47 (t, J = 7.6 Hz, 2H); 5.63 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): 166.24; 156.92; 146.20; 136.06; 133.49; 133.36; 130.91; 130.20; 129.86; 129.68; 128.64; 128.52; 120.60; 120.21; 67.64; HRMS[ESI]: calculated for $C_{17}H_{12}BrNO_2Na$, $[M+Na]^+$: 363.9944, found: 363.9948.

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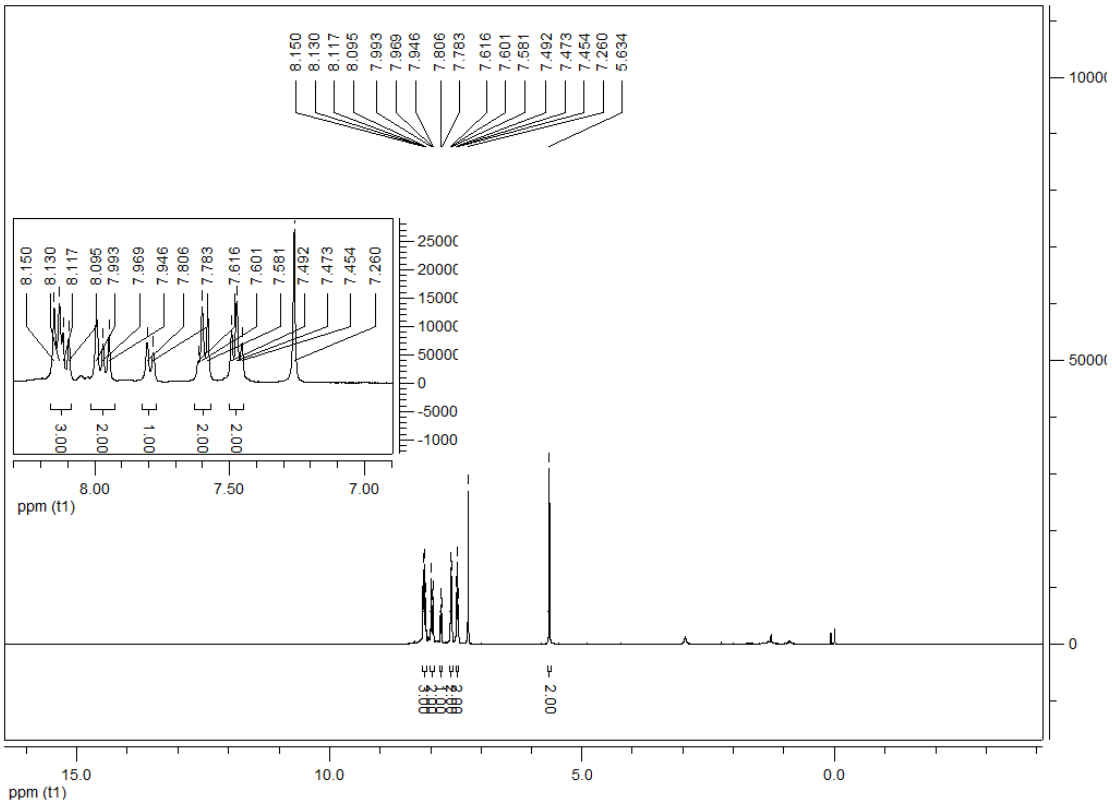

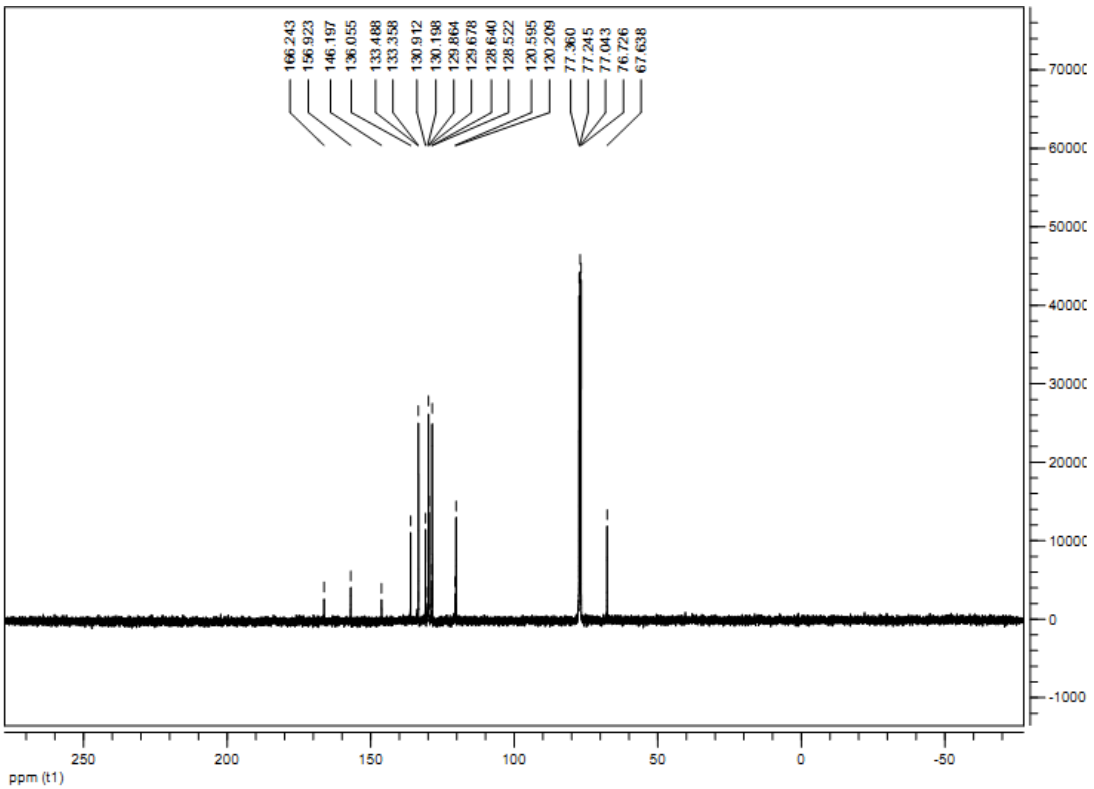

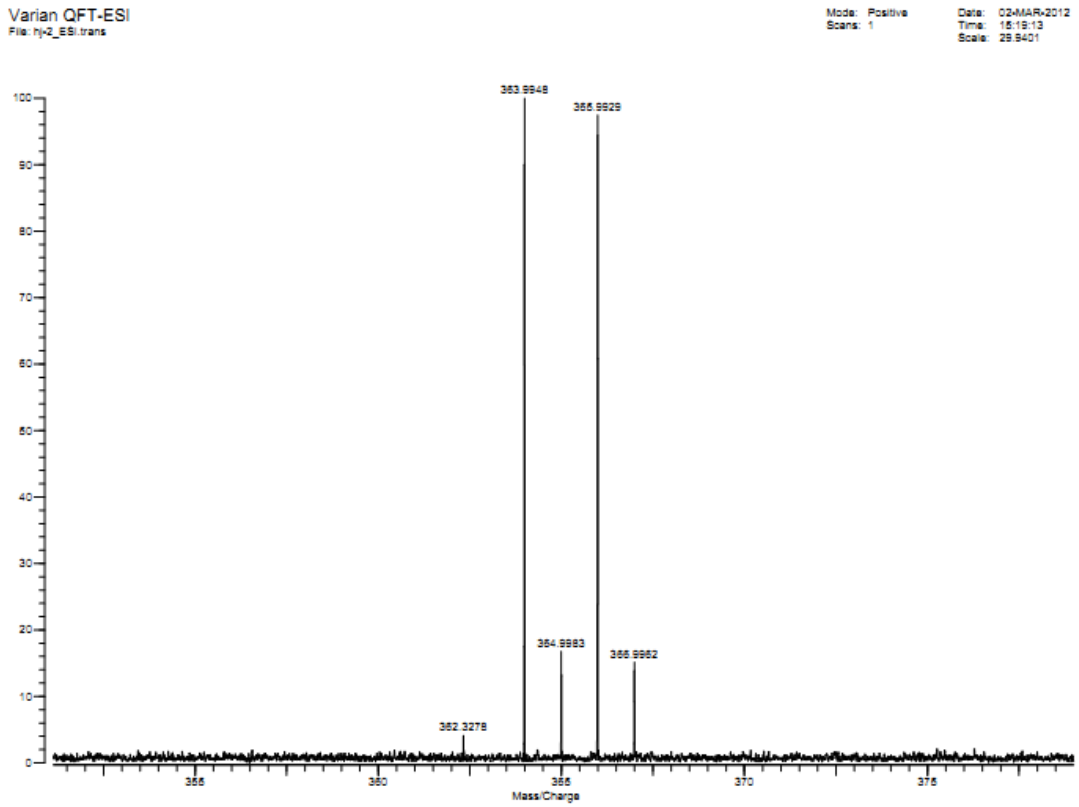

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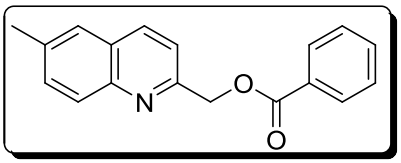

^{1}H NMR (400 MHz, $CDCl_3$): 8.15-8.10 (m, 3H); 8.00 (d, *J* = 8.4 Hz, 1H); 7.59-7.53 (m, 4H); 7.48-7.44 (m, 2H); 5.65 (s, 2H); 2.54 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): 166.31; 155.37; 136.67; 136.45; 133.24; 132.23; 129.87; 128.78; 128.57; 128.47; 127.65; 126.60; 126.49; 119.50; 67.92; 21.61; HRMS[ESI]: calculated for $C_{18}H_{16}NO_2$, $[M+H]^+$: 278.1176, found: 278.1178.

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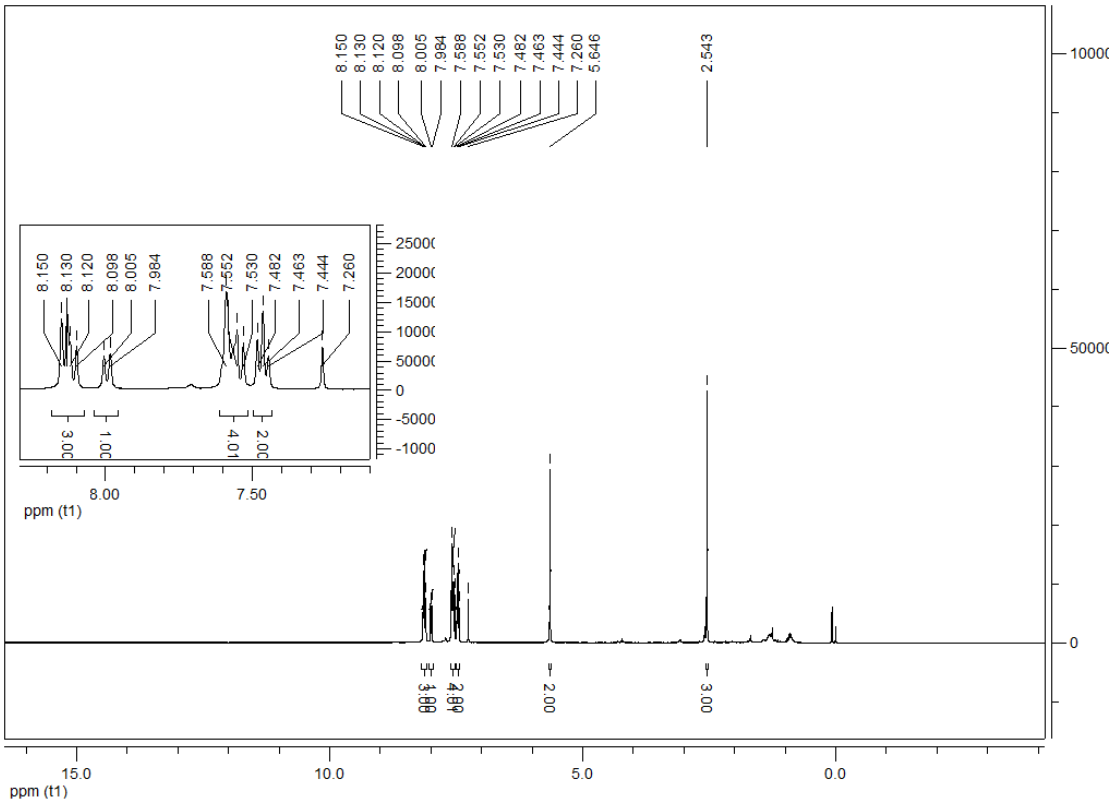

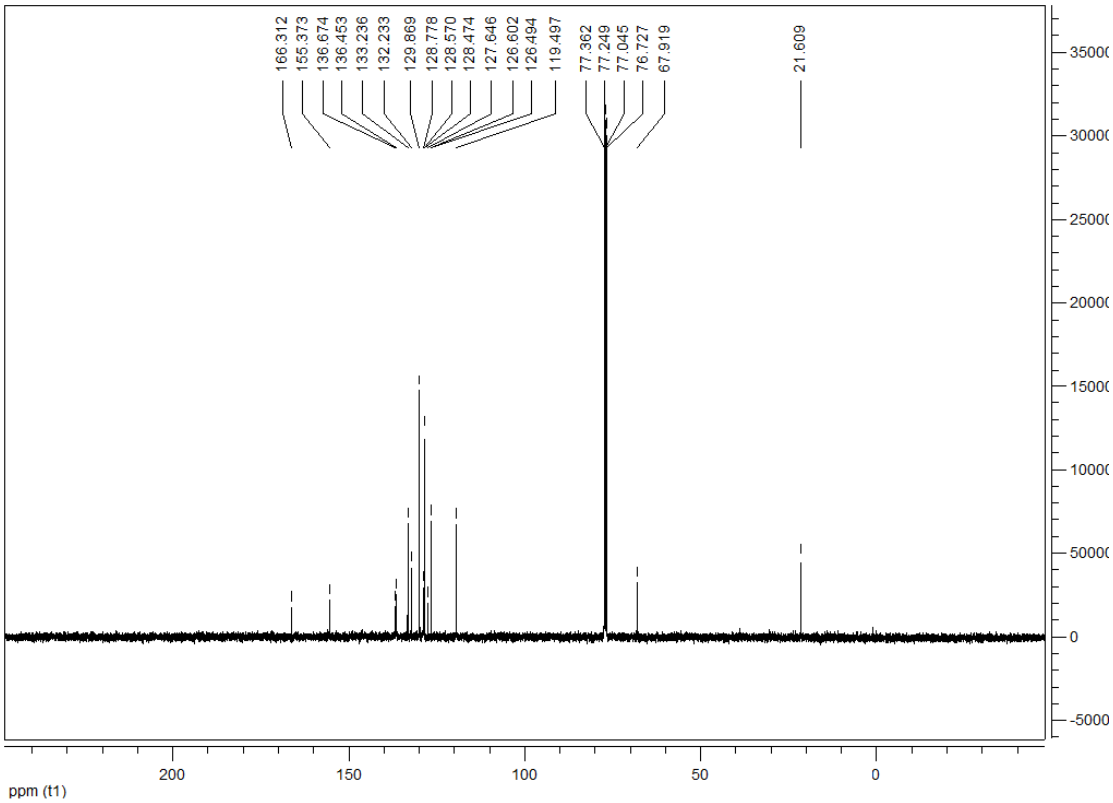

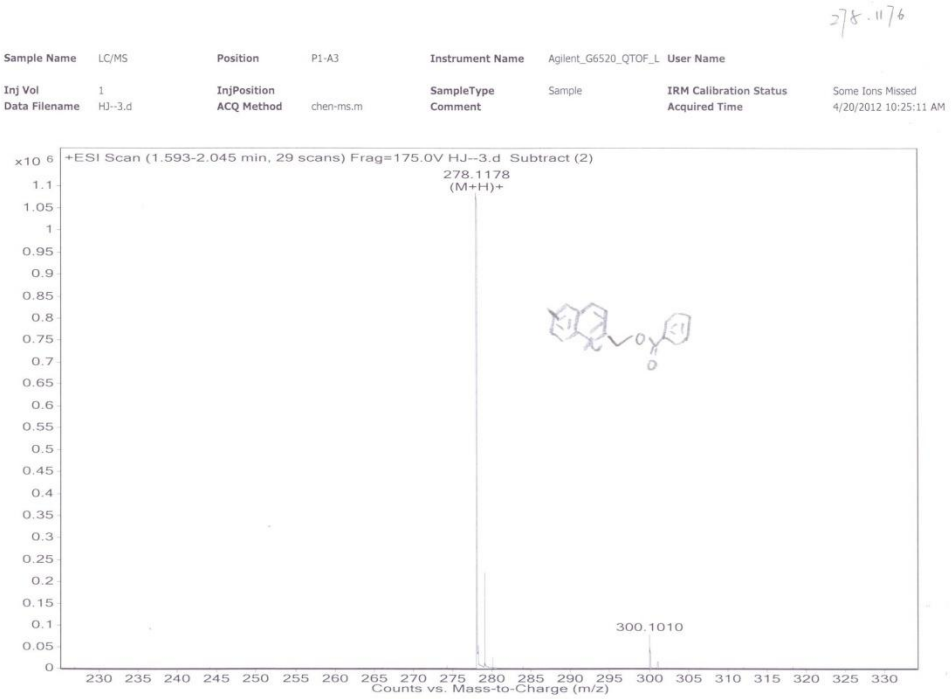

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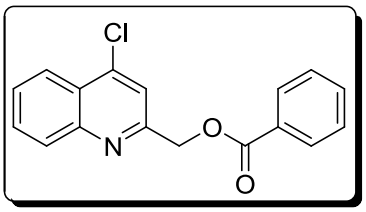

^{1}H NMR (400 MHz, $CDCl_3$): 8.23 (d, *J* = 8.0 Hz, 1H); 8.16-8.11 (m, 3H); 7.82-7.77 (m, 1H); 7.67-7.59 (m, 3H); 7.51-7.47 (m, 2H); 5.63 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): 166.17; 156.41; 148.45; 143.57; 133.41; 130.79; 129.90; 129.60; 129.55; 128.55; 127.71; 125.79; 124.10; 119.47; 67.32; HRMS[ESI]: calculated for $C_{17}H_{12}ClNO_2Na$, $[M+Na]^+$: 320.0448, found: 320.0451.

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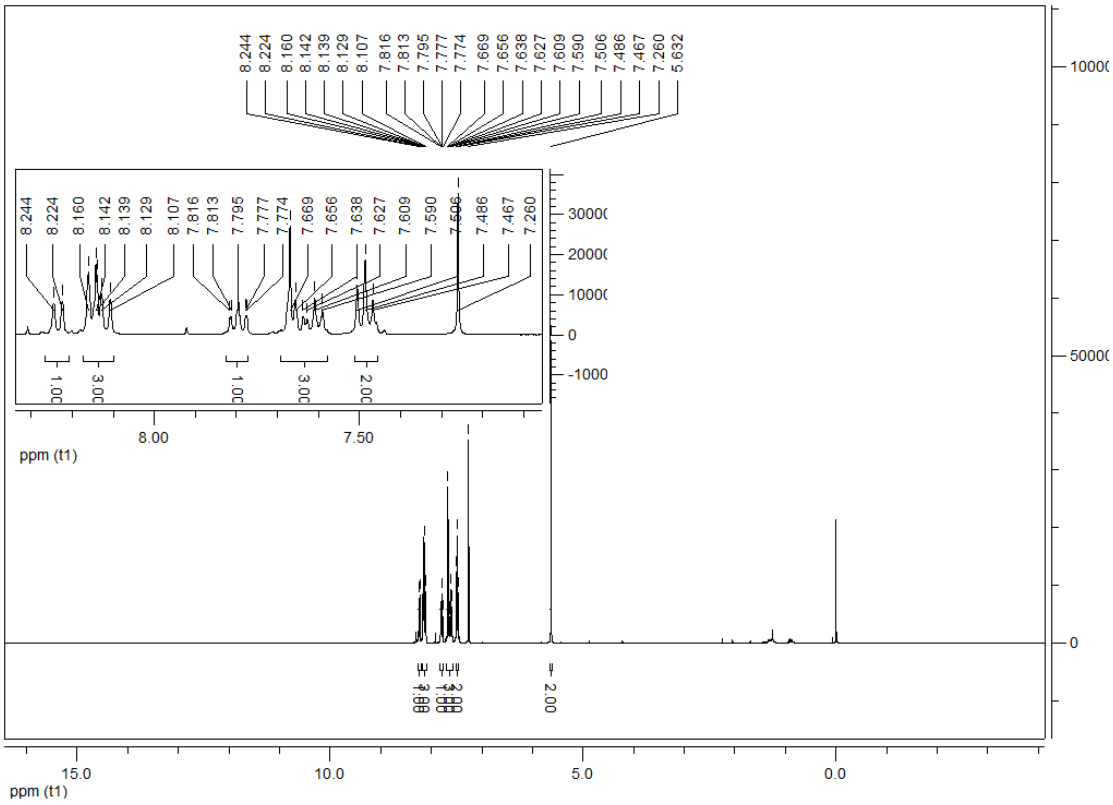

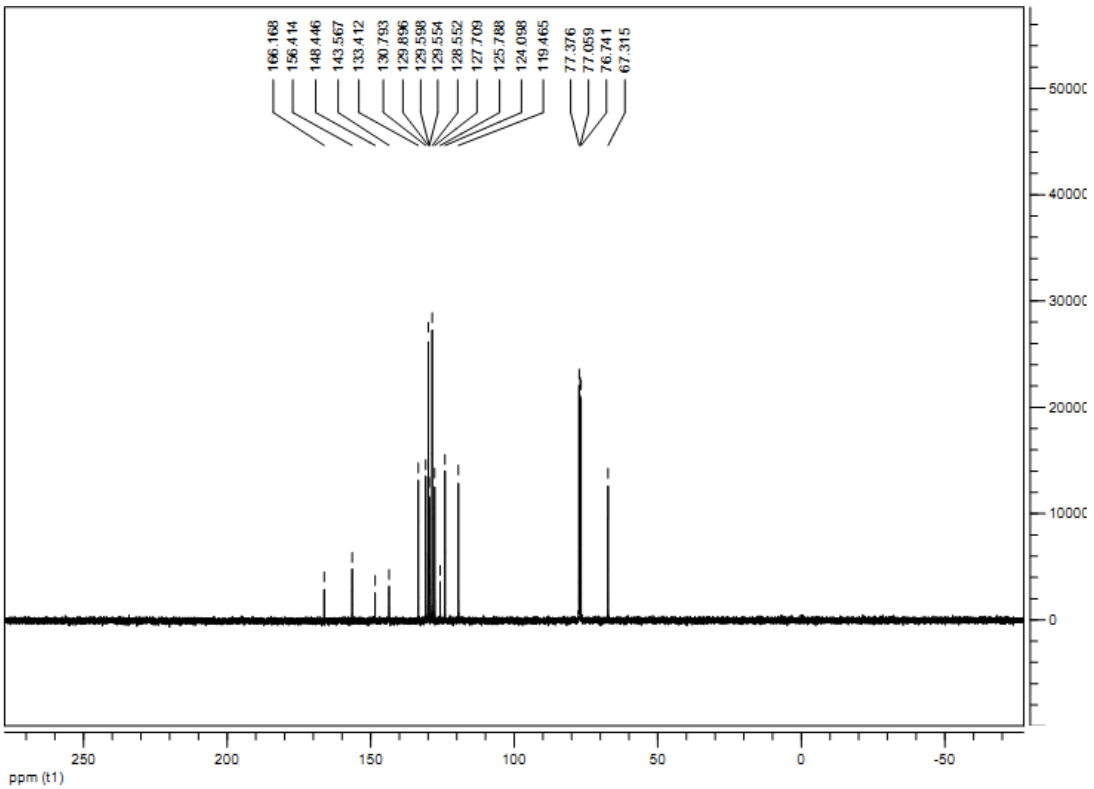

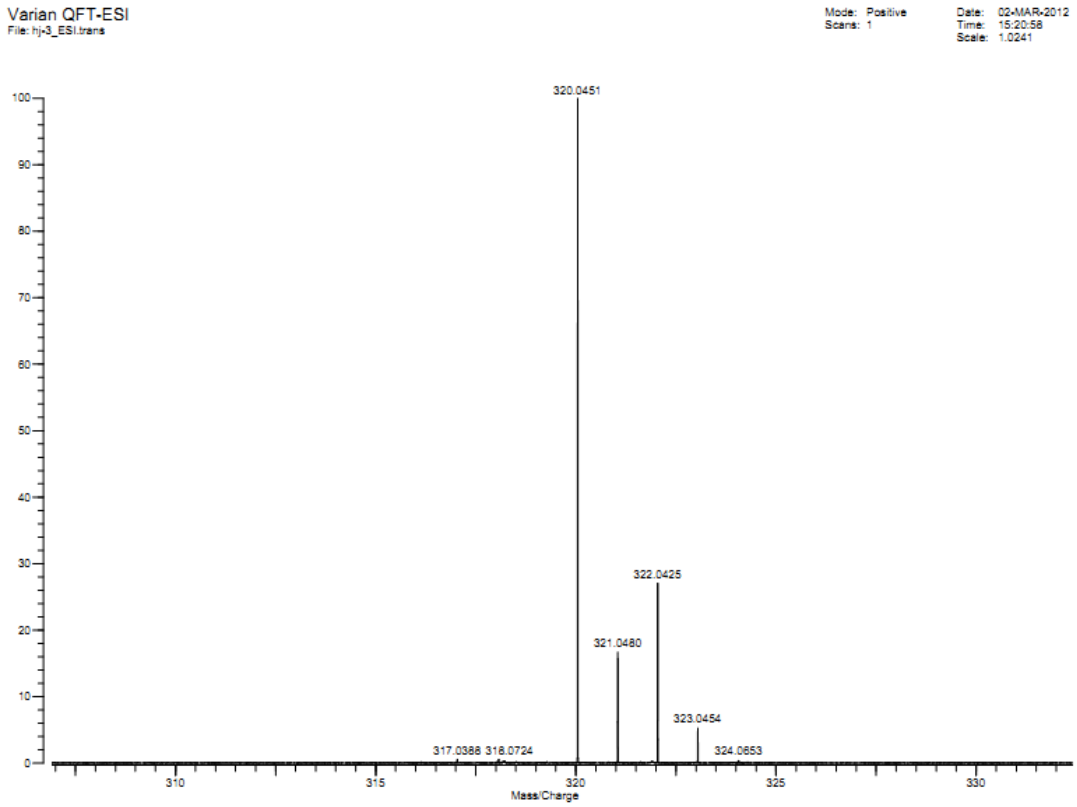

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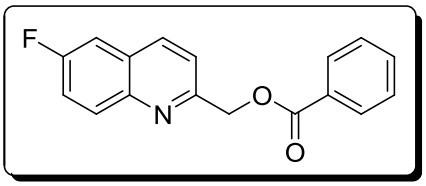

^{1}H NMR (400 MHz, $CDCl_3$): 8.15-8.07 (m, 4H); 7.60-7.57 (m, 2H); 7.53-7.42 (m, 4H); 5.64 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): 166.27; 155.78; 144.66; 136.47; 133.35; 133.31; 131.71; 129.89; 129.86; 128.54; 128.50; 120.27; 110.76; 110.58; 67.67; HRMS[ESI]: calculated for $C_{17}H_{13}FNO_2$, $[M+H]^+$: 282.0925, found: 282.0926.

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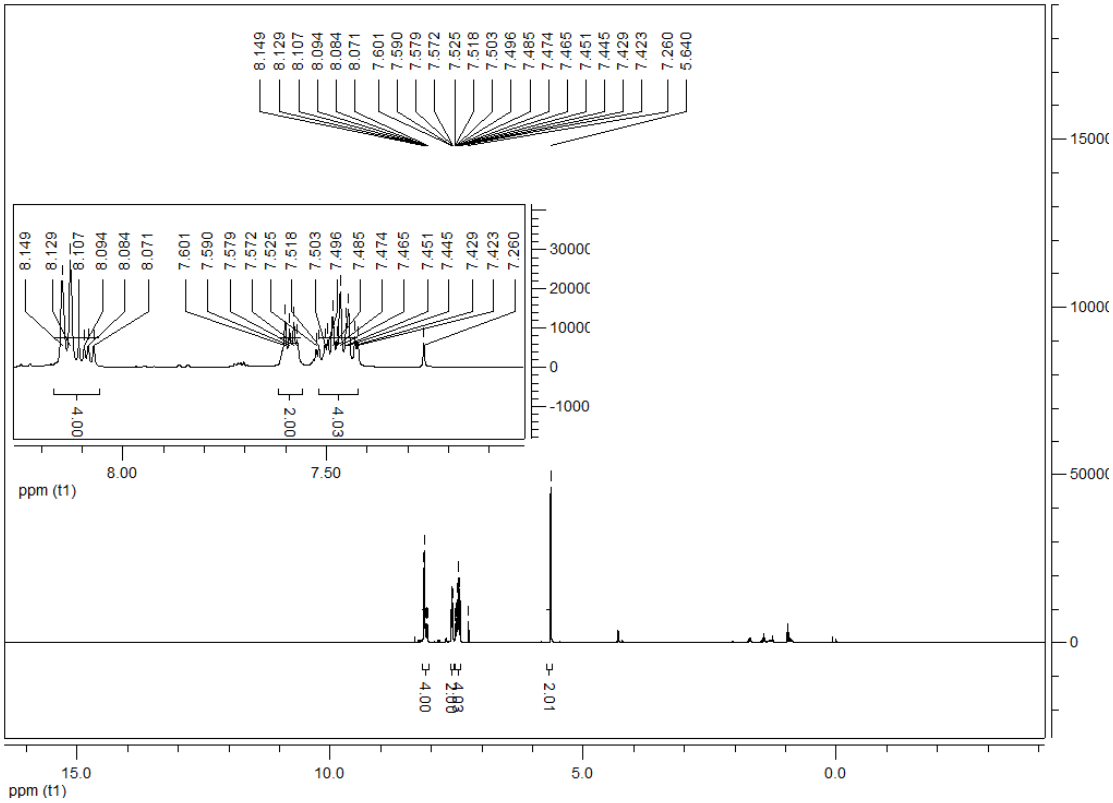

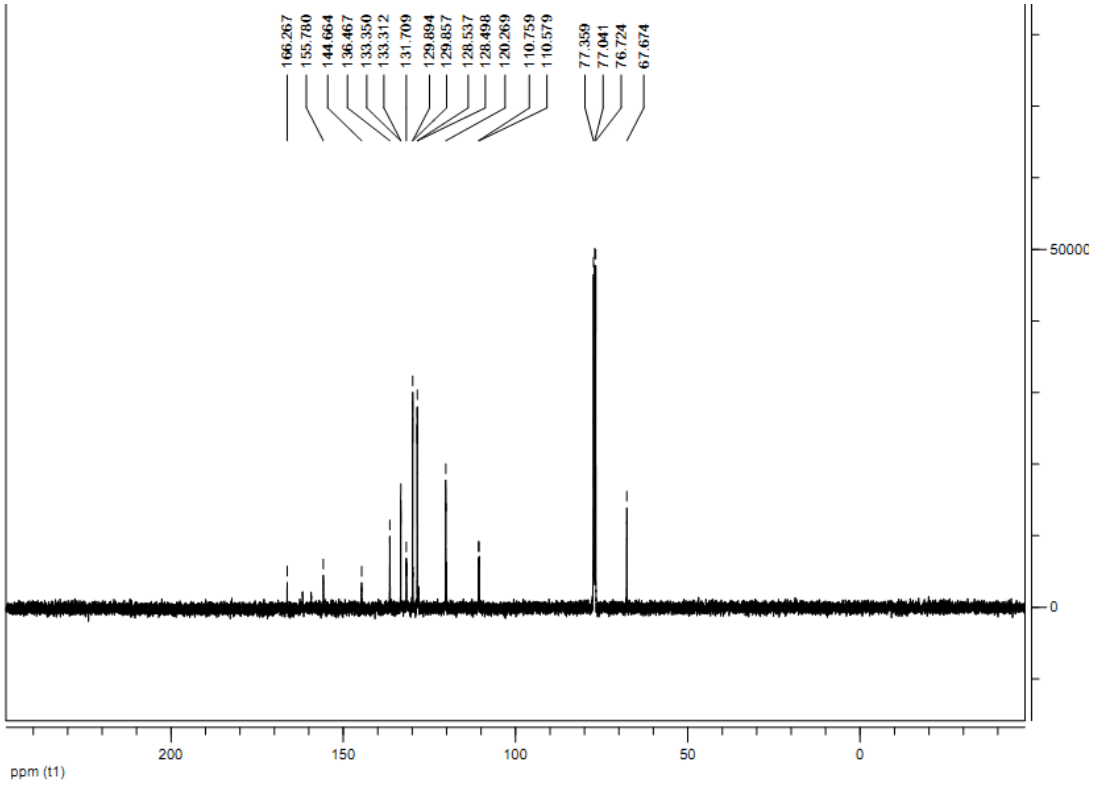

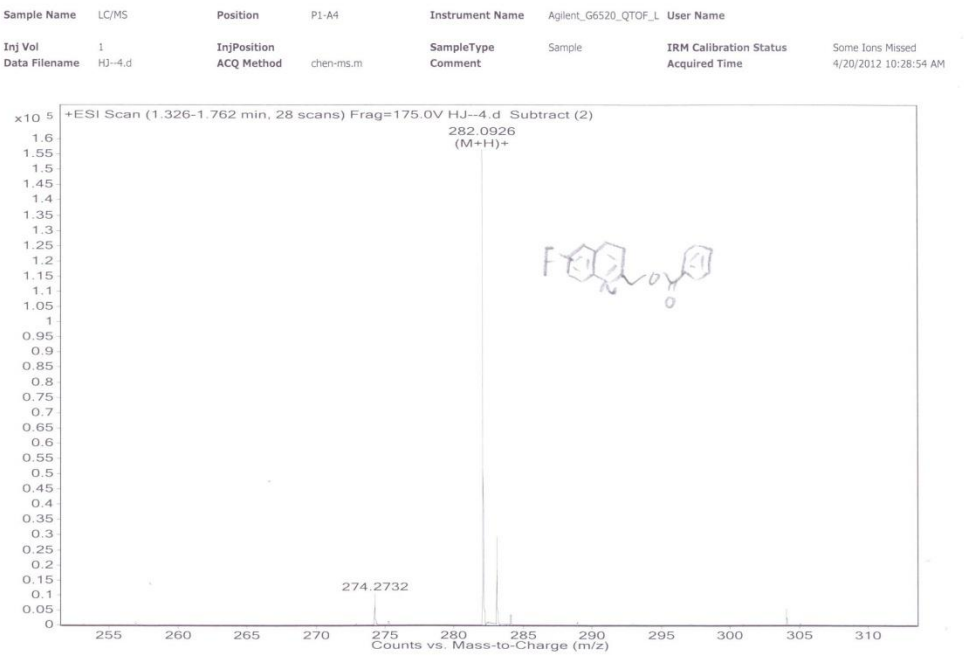

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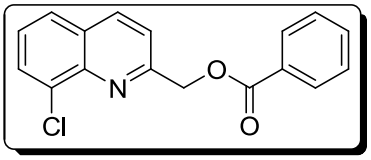

^{1}H NMR (400 MHz, $CDCl_3$): 8.22-8.15 (m, 3H); 7.84 (d, *J* = 7.2 Hz, 1H); 7.75 (d, *J* = 8.0 Hz, 1H); 7.64-7.58 (m, 2H); 7.50-7.44 (m, 3H); 5.75 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): 166.26; 157.43; 143.89; 137.46; 133.43; 133.31; 130.00; 129.87; 129.82; 128.86; 128.52; 126.79; 126.56; 119.96; 67.74; HRMS[ESI]: calculated for $C_{17}H_{13}ClNO_2$, $[M+H]^+$: 298.0629, found: 298.0634.

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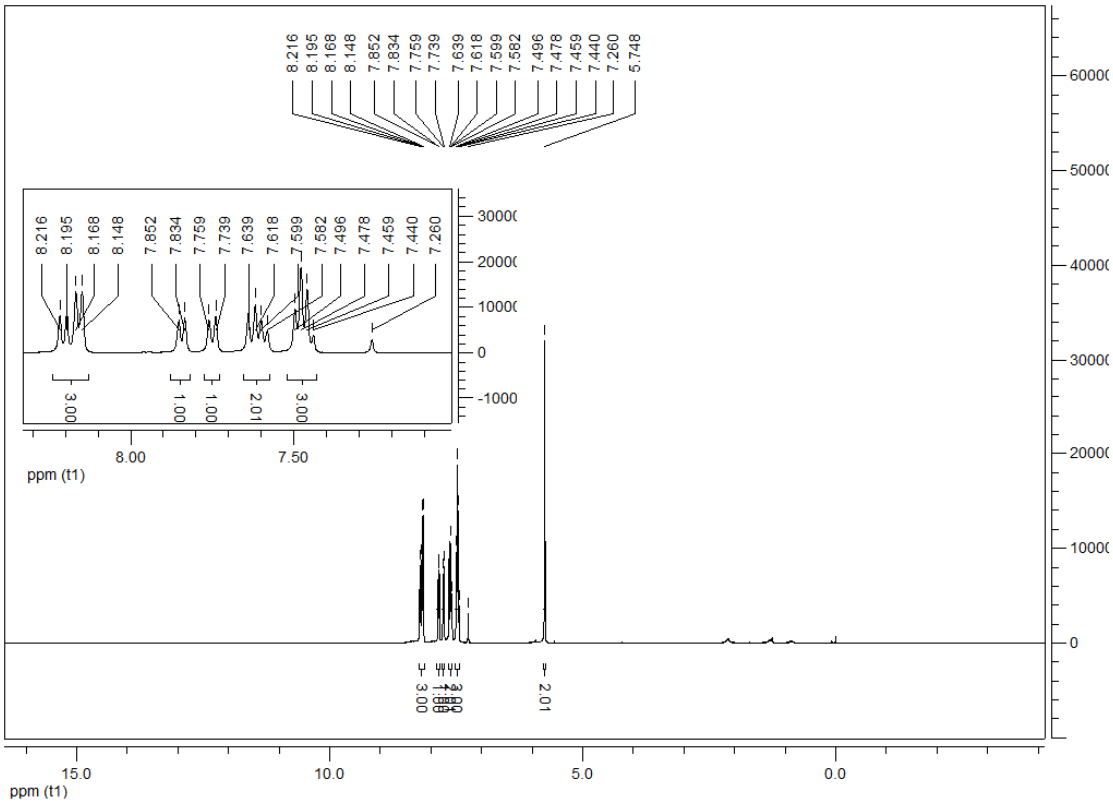
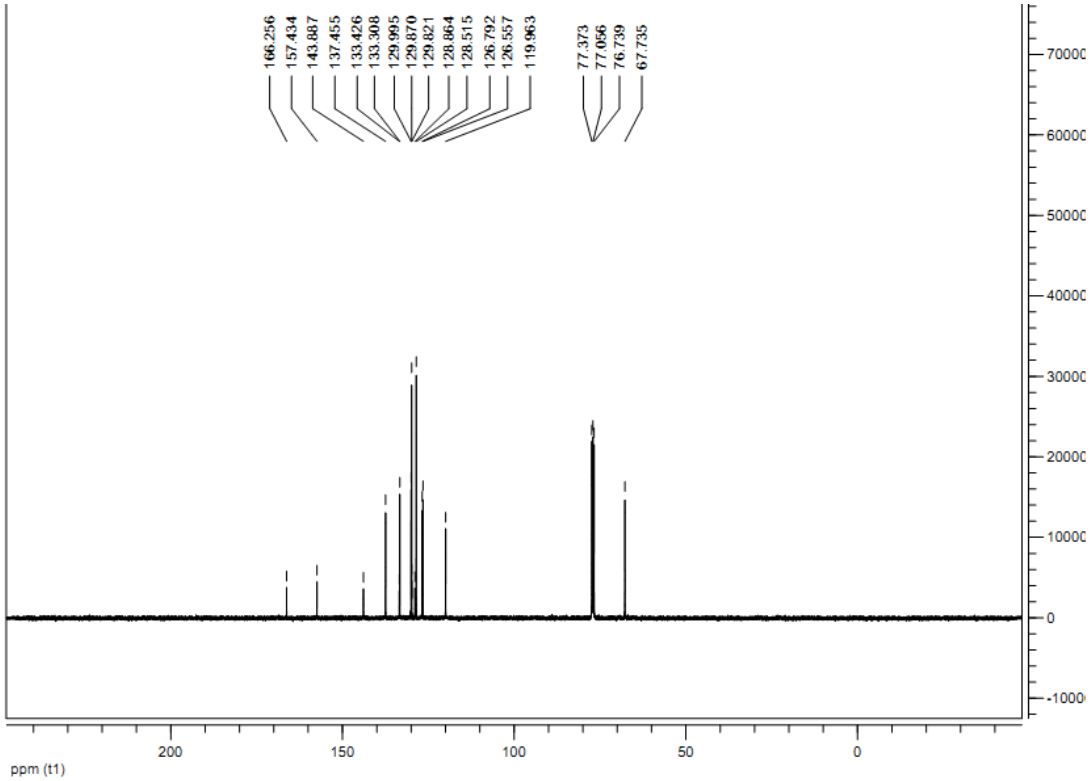
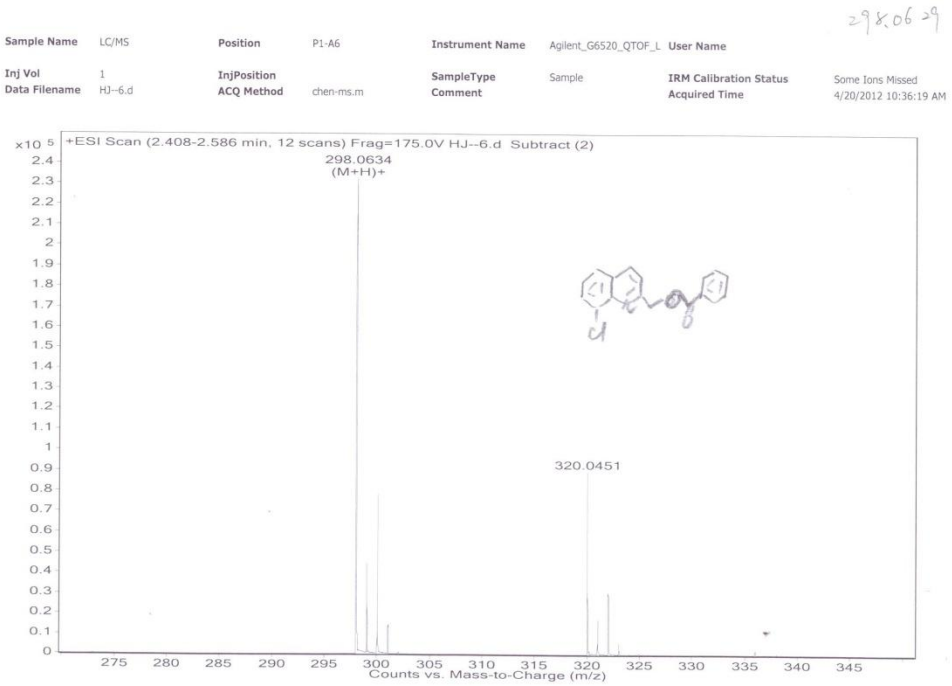
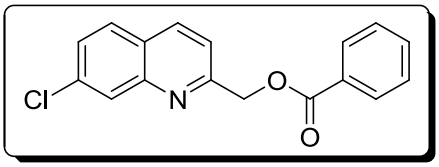






3j



^{1}H NMR (400 MHz, $CDCl_3$): 8.18-8.09 (m, 4H); 7.76 (d, *J* = 8.8 Hz, 1H); 7.62-7.55 (m, 2H); 7.51-7.45 (m, 3H); 5.64 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): 166.24; 157.58; 147.94; 136.89; 135.77; 133.36; 129.87; 129.71; 128.85; 128.53; 128.22; 127.80; 125.90; 119.47; 67.56; HRMS[ESI]: calculated for $C_{17}H_{13}ClNO_2$, $[M+H]^+$: 298.0629, found: 298.0626.

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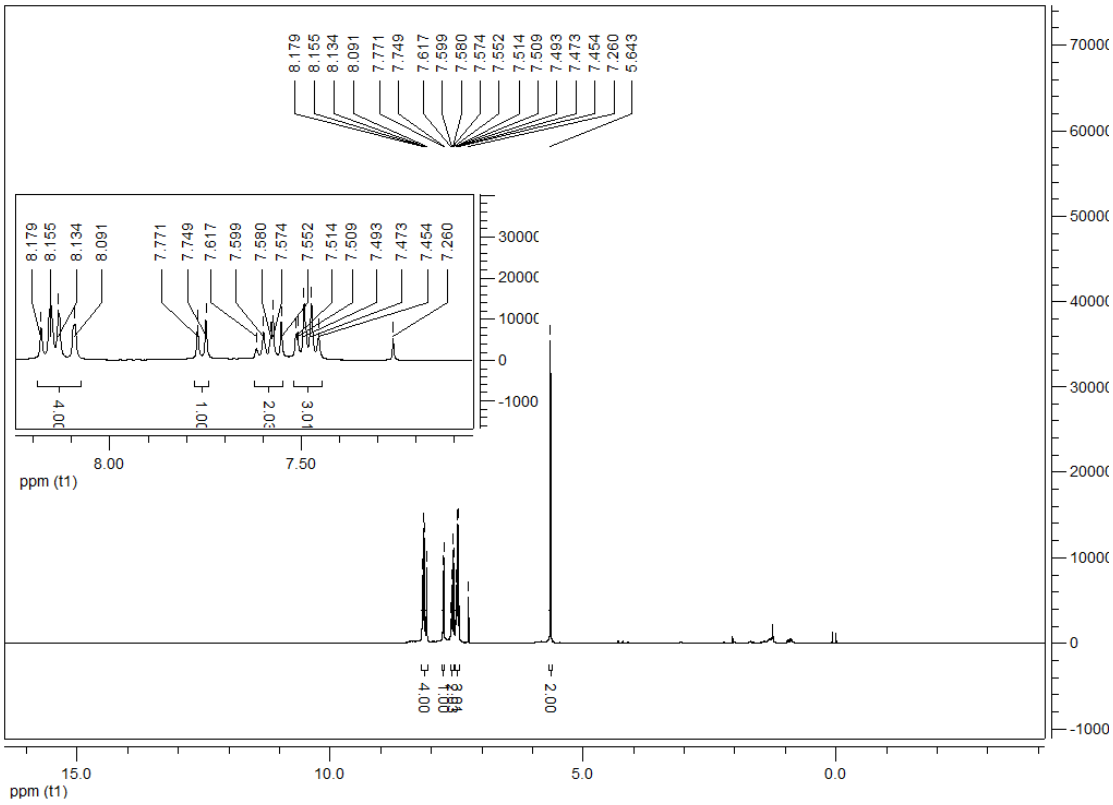
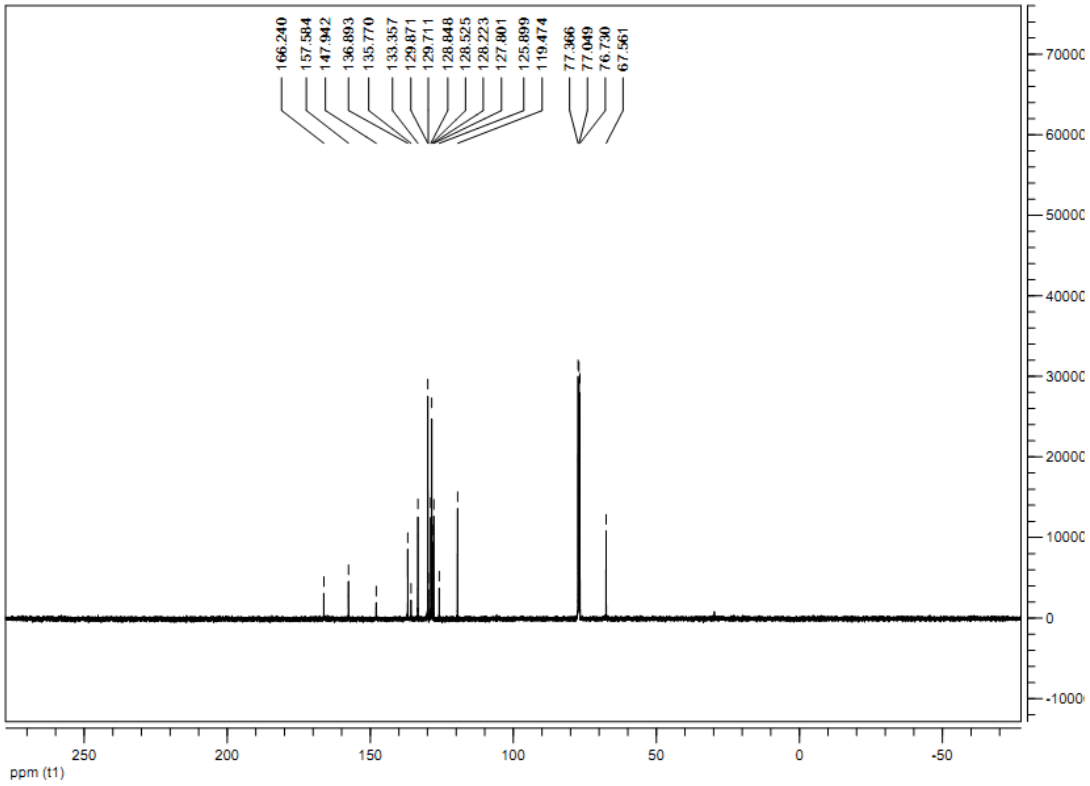
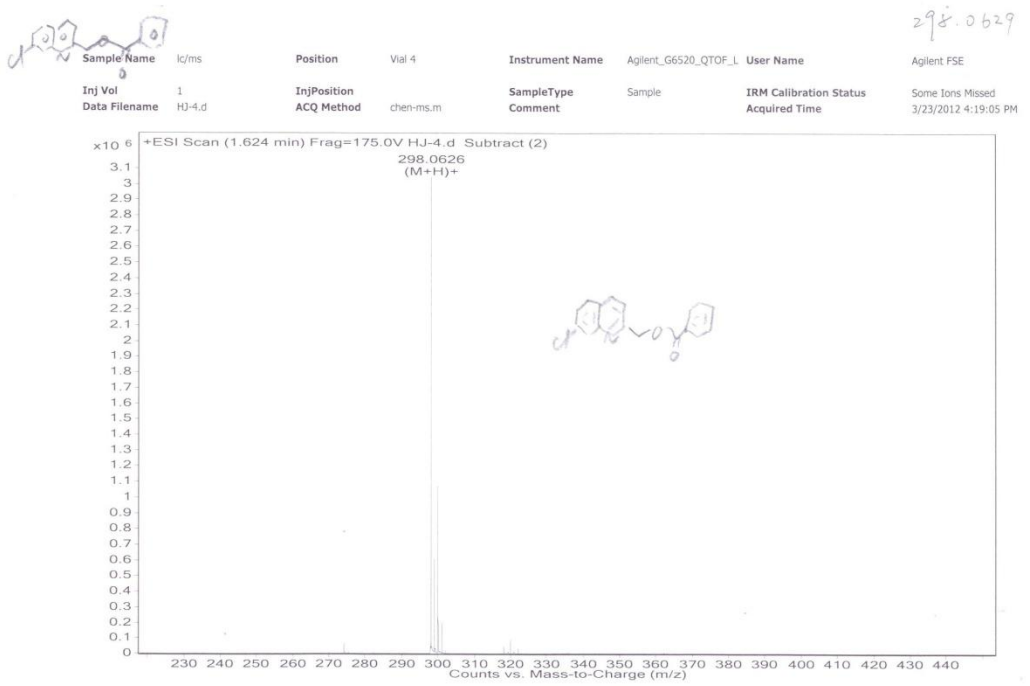
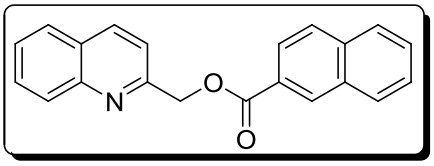






3k



^{1}H NMR (400 MHz, $CDCl_3$): 8.72 (s, 1H); 8.23 (d, *J* = 8.4 Hz, 1H); 8.14 (t, *J* = 8.8 Hz, 2H); 7.97 (d, *J* = 8.0 Hz, 1H); 7.92-7.84 (m, 3H); 7.75 (t, *J* = 7.2 Hz, 1H); 7.65-7.54 (m, 4H); 5.74 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): 165.43; 155.38; 146.61; 136.11; 134.64; 131.46; 130.44; 128.88; 128.39; 128.14; 127.39; 127.25; 126.77; 126.63; 126.57; 125.99; 125.71; 124.31; 121.36; 118.48; 66.96; HRMS[ESI]: calculated for $C_{21}H_{16}NO_2$, $[M+H]^+$: 314.1176, found: 314.1174.

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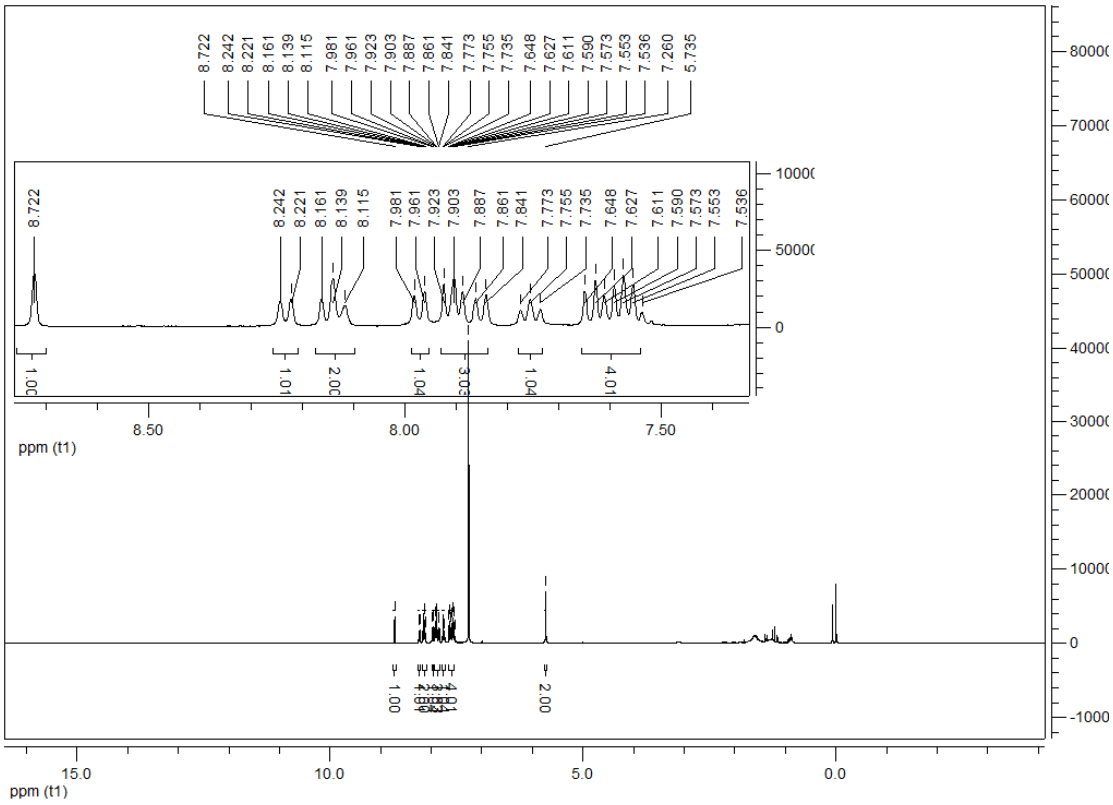

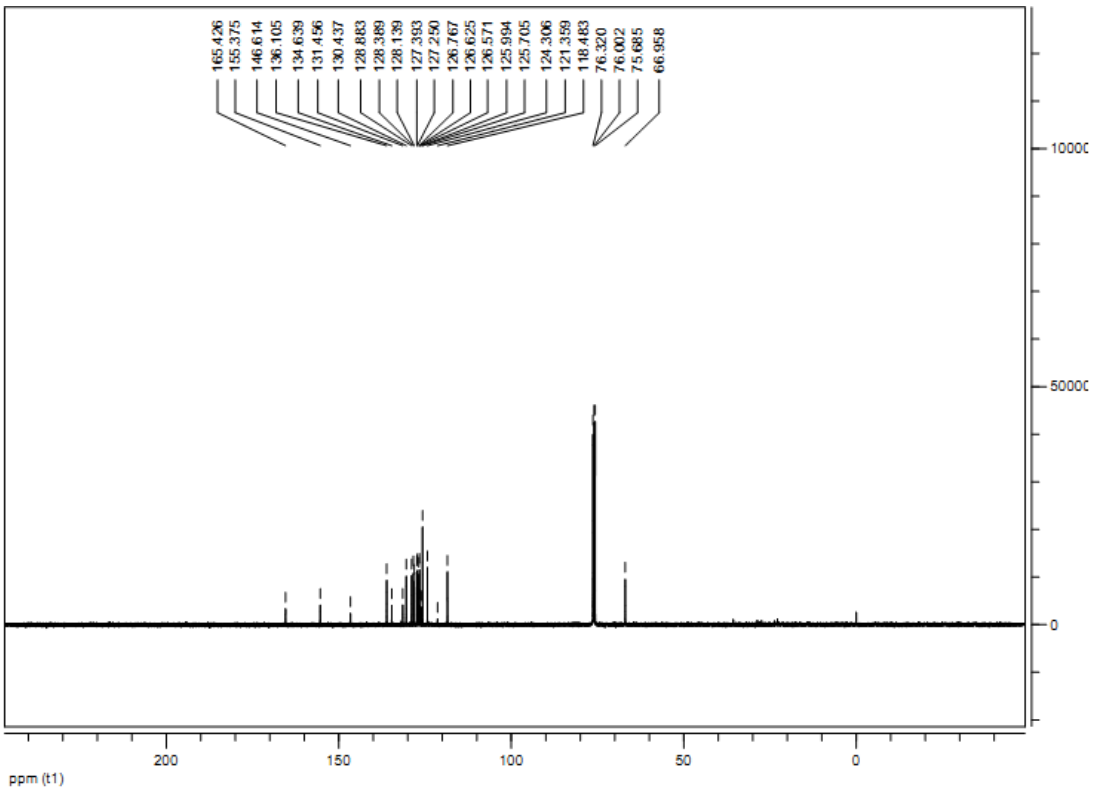

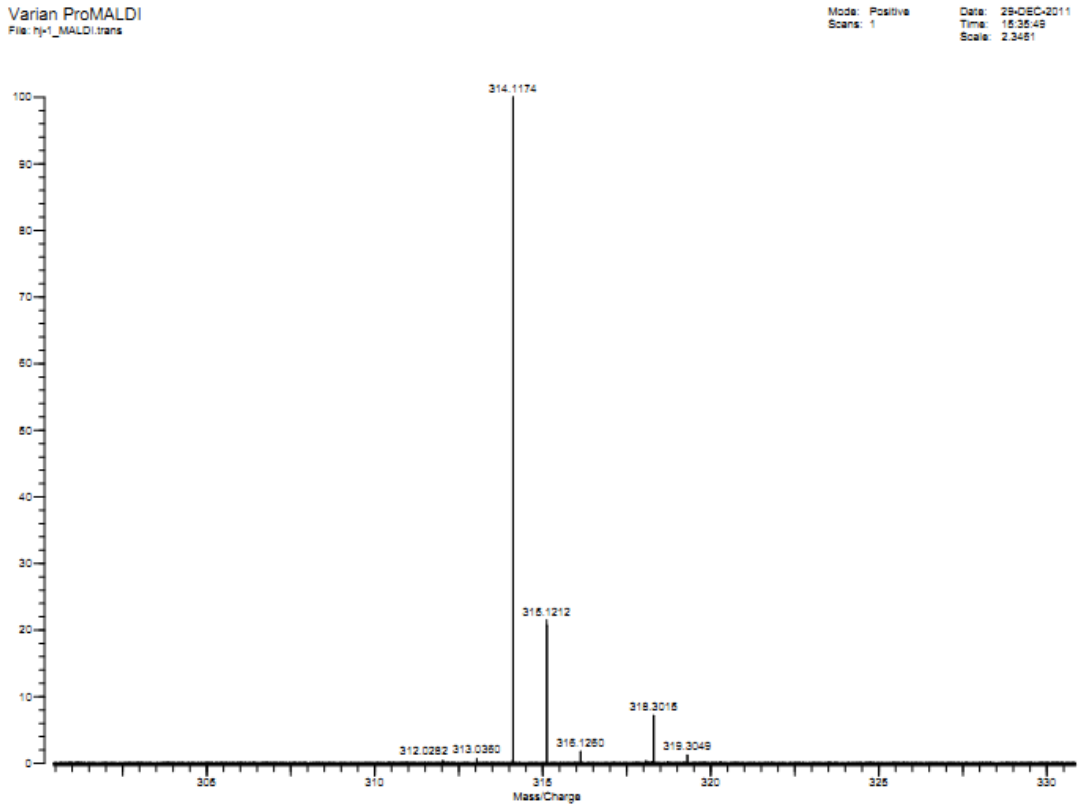

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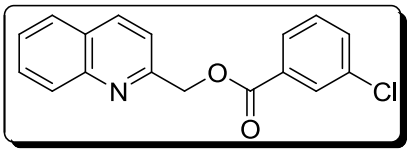

^{1}H NMR (400 MHz, $CDCl_3$): 8.30-8.29 (m, 2H); 8.11 (s, 1H); 8.03 (d, *J* = 7.6 Hz, 1H); 7.88 (d, *J* = 7.6 Hz, 1H); 7.82-7.78 (m, 1H); 7.62-7.56 (m, 3H); 7.42 (t, *J* = 7.6 Hz, 1H); 5.74 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): 165.12; 155.91; 147.69; 137.17; 134.66; 133.81; 133.31; 131.58; 129.97; 129.91; 129.83; 129.23; 128.01; 127.68; 126.83; 119.46; 68.26; HRMS[ESI]: calculated for $C_{17}H_{13}ClNO_2$, $[M+H]^+$: 298.0629, found: 298.0629.

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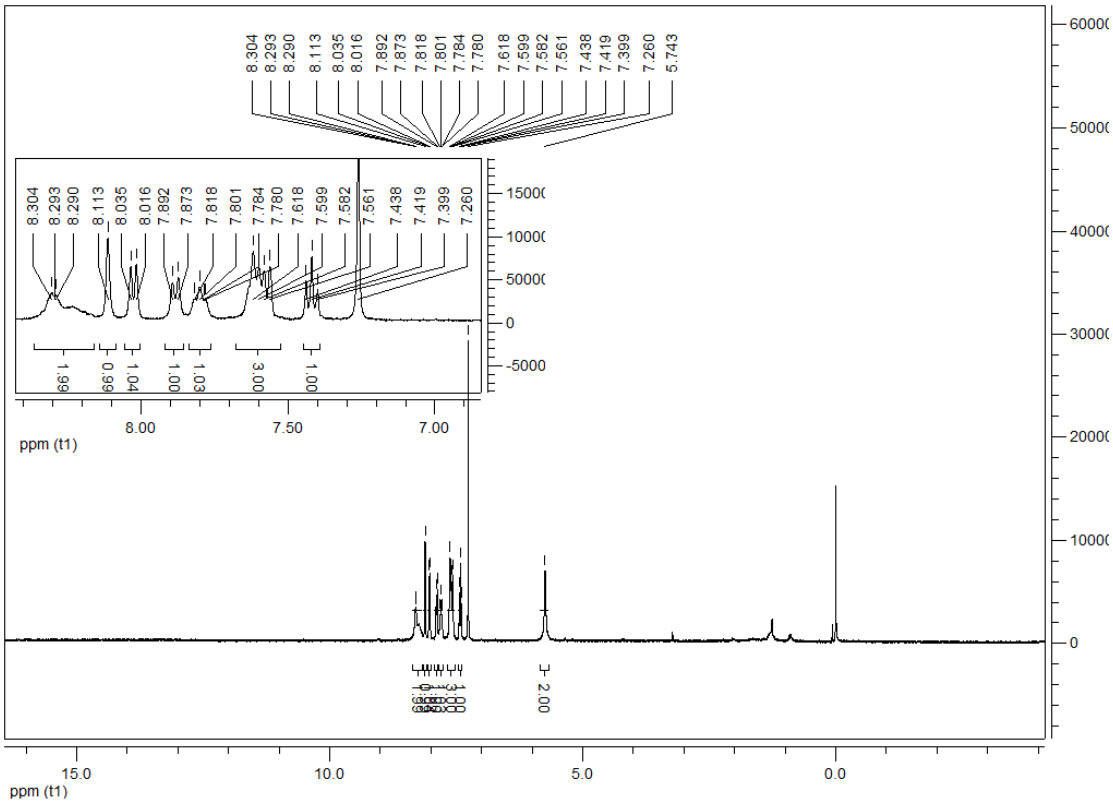
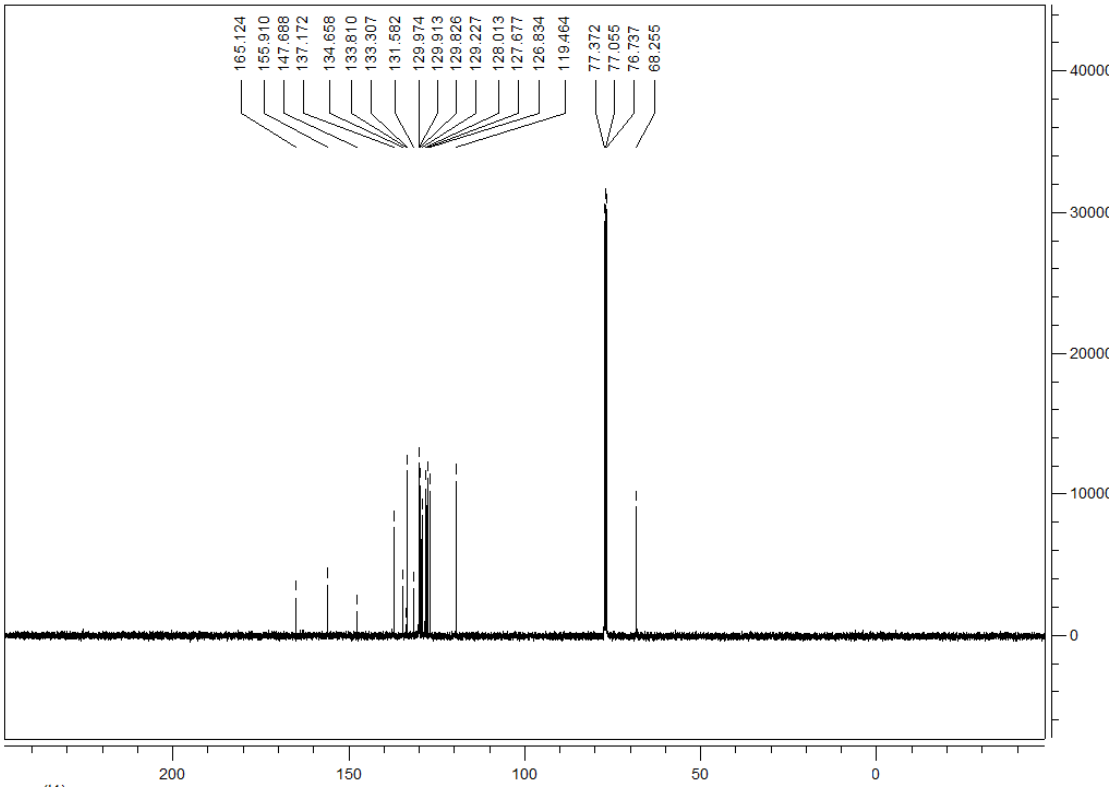
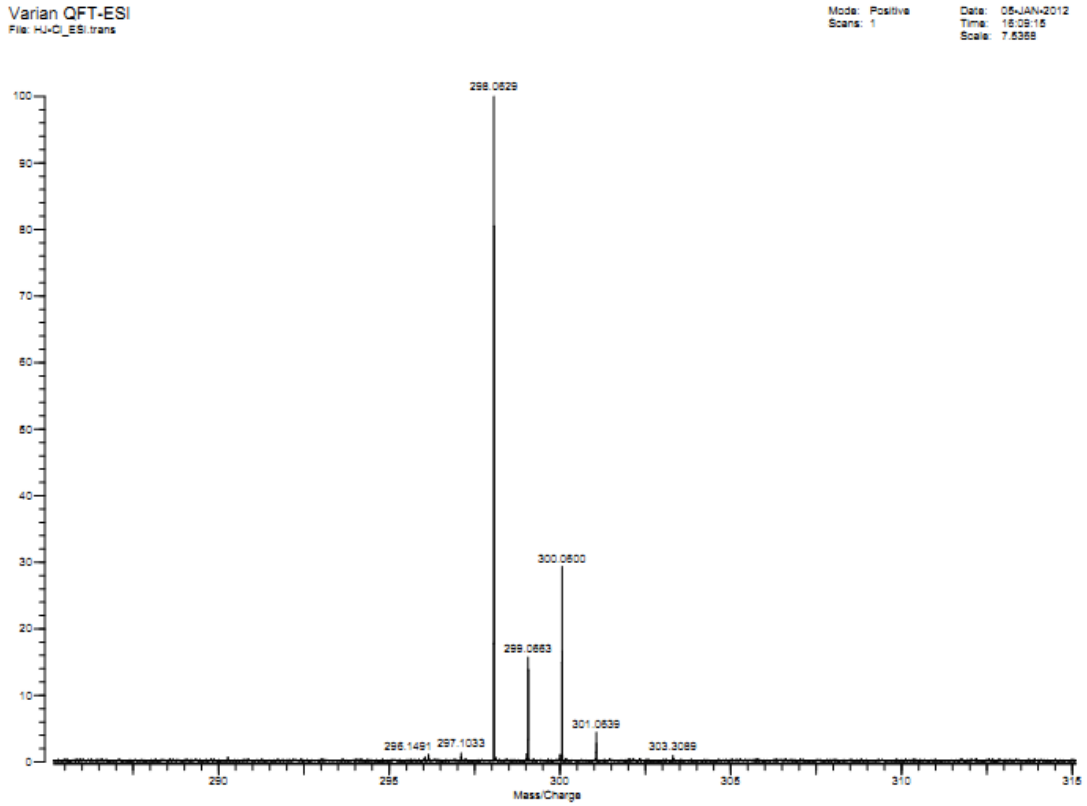
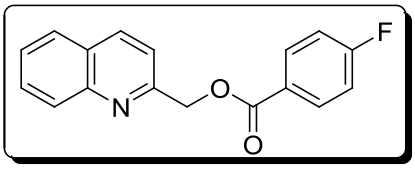






3m



^{1}H NMR (300 MHz, $CDCl_3$): 8.22-8.09 (m, 4H); 7.84 (d, *J* = 8.1 Hz, 1H); 7.77-7.72 (m, 1H); 7.59-7.55 (m, 2H); 7.13 (t, *J* = 8.4 Hz, 2H); 5.65 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): 167.25; 165.33; 164.72; 156.08; 137.51; 137.43; 132.51; 132.42; 127.68; 127.62; 126.94; 119.48; 115.80; 115.58; 67.77; HRMS[ESI]: calculated for $C_{17}H_{13}FNO_2$, $[M+H]^+$: 282.0925, found: 282.0932.

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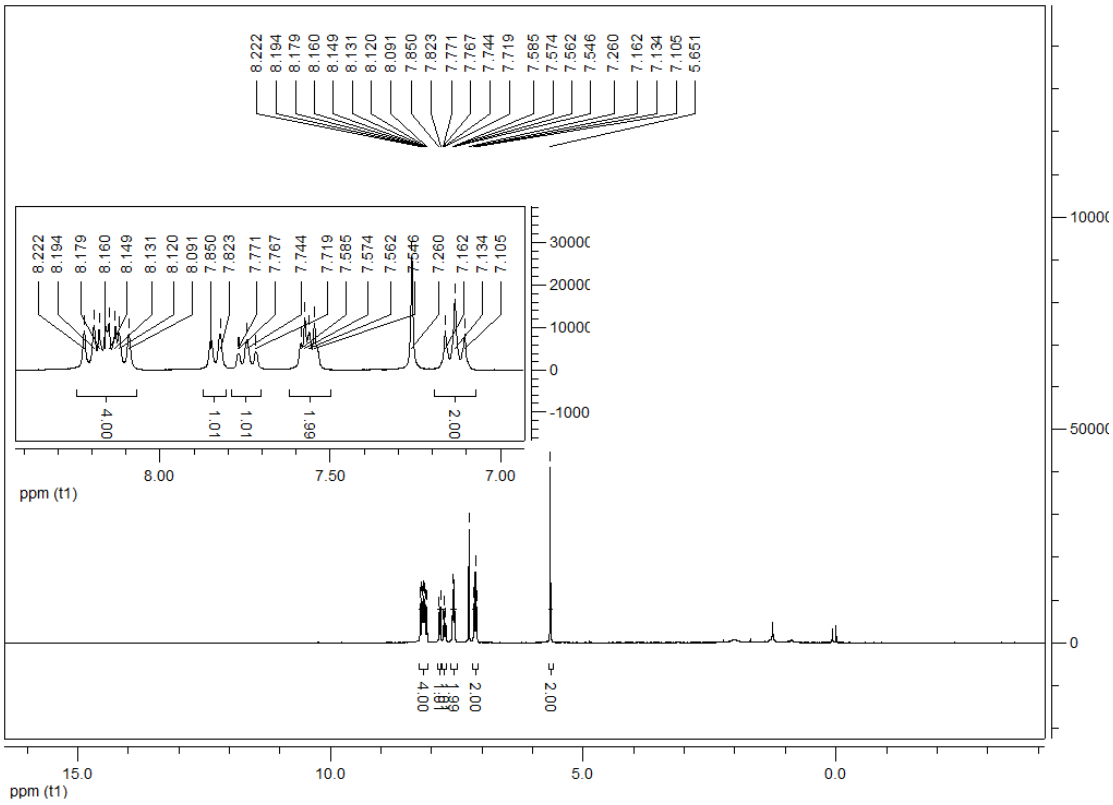

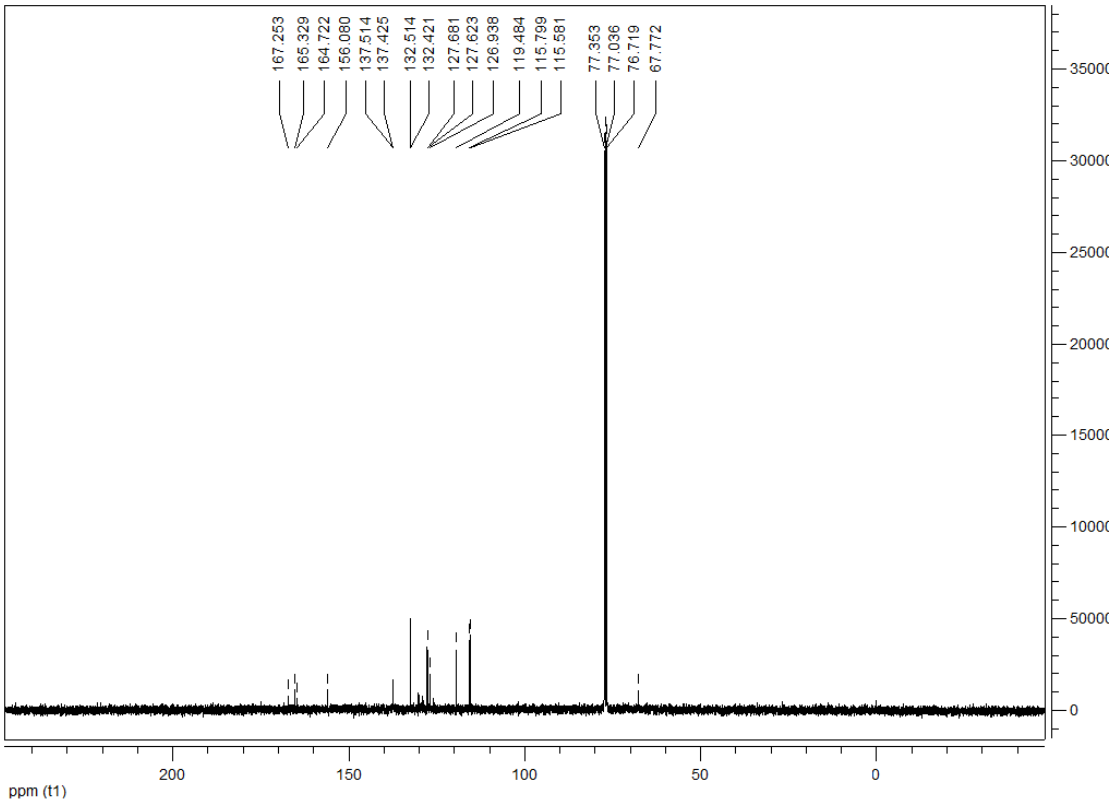

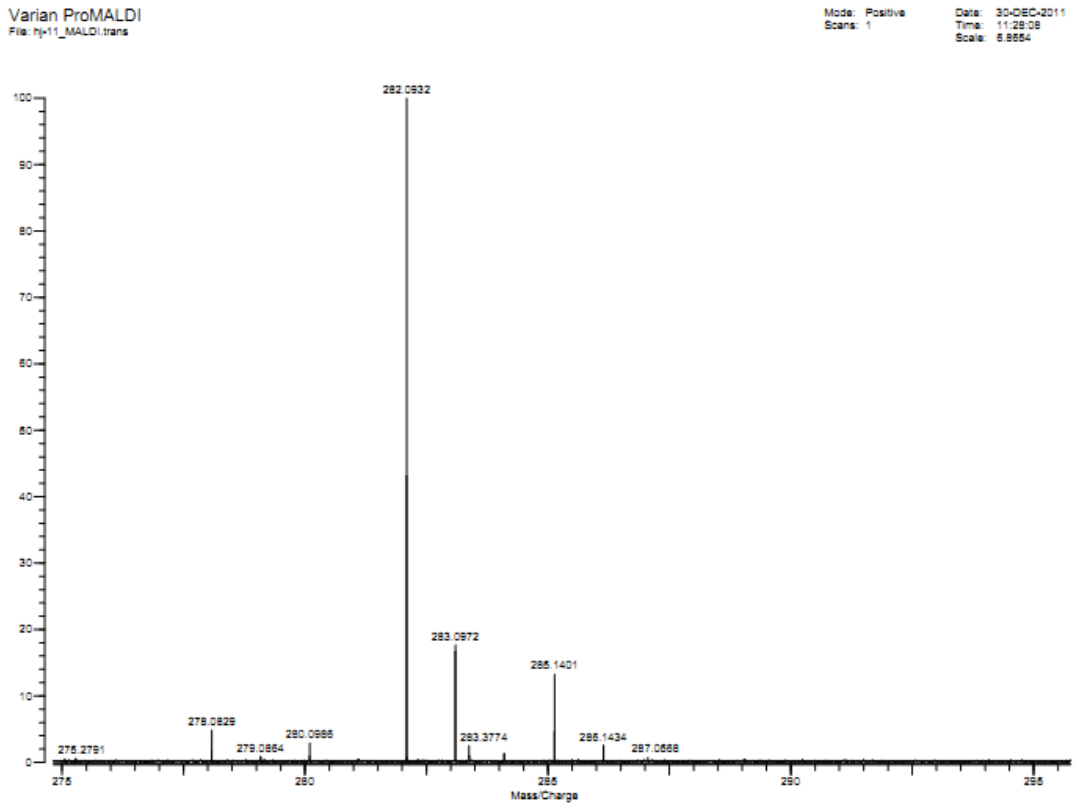

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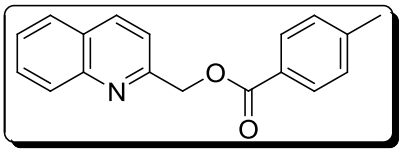

^{1}H NMR (400 MHz, $CDCl_3$): 8.21 (d, *J* = 8.8 Hz, 1H); 8.13 (d, *J* = 8.4 Hz, 1H); 8.03 (d, *J* = 8.0 Hz, 2H); 7.84 (d, *J* = 8.0 Hz, 1H); 7.75 (t, *J* = 7.2 Hz, 1H); 7.59-7.54 (m, 2H); 7.28-7.26 (m, 2H); 5.67 (s, 2H); 2.42 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): 166.33; 156.53; 147.39; 144.04; 137.28; 130.02; 129.92; 129.21; 128.99; 127.66; 127.60; 127.07; 126.79; 119.42; 67.53; 21.72; HRMS[ESI]: calculated for $C_{18}H_{16}NO_2$, $[M+H]^+$: 278.1176, found: 278.1179.

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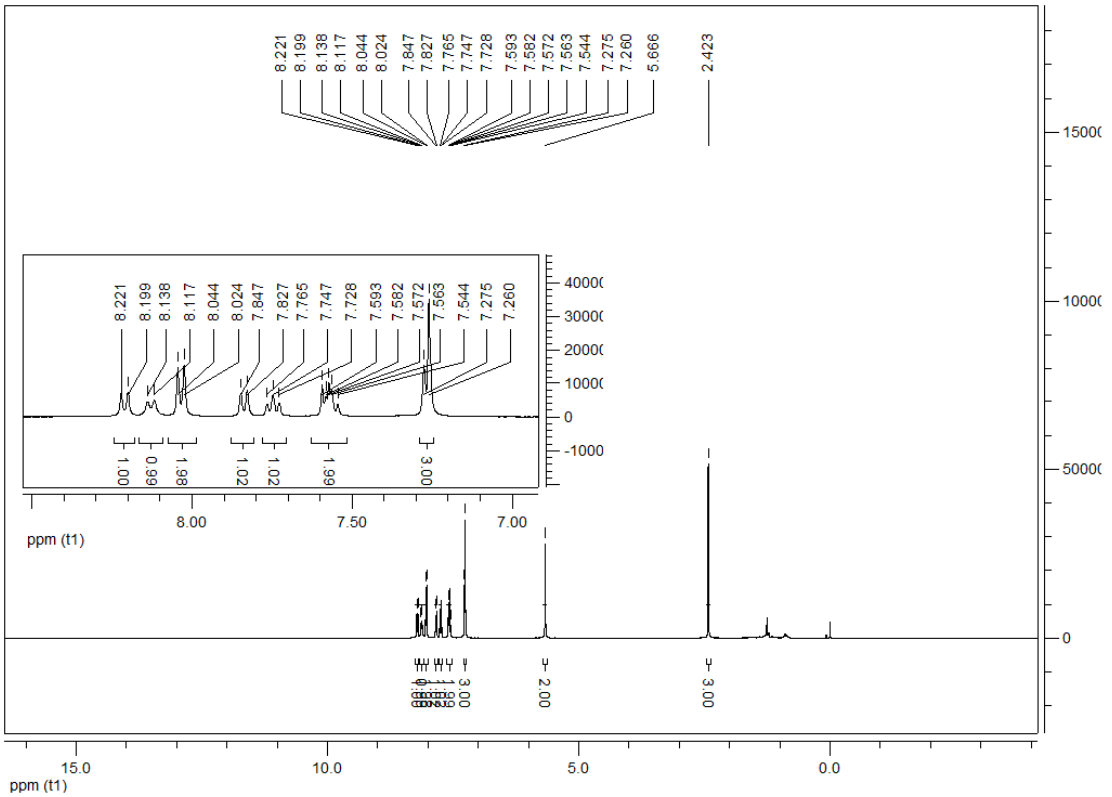

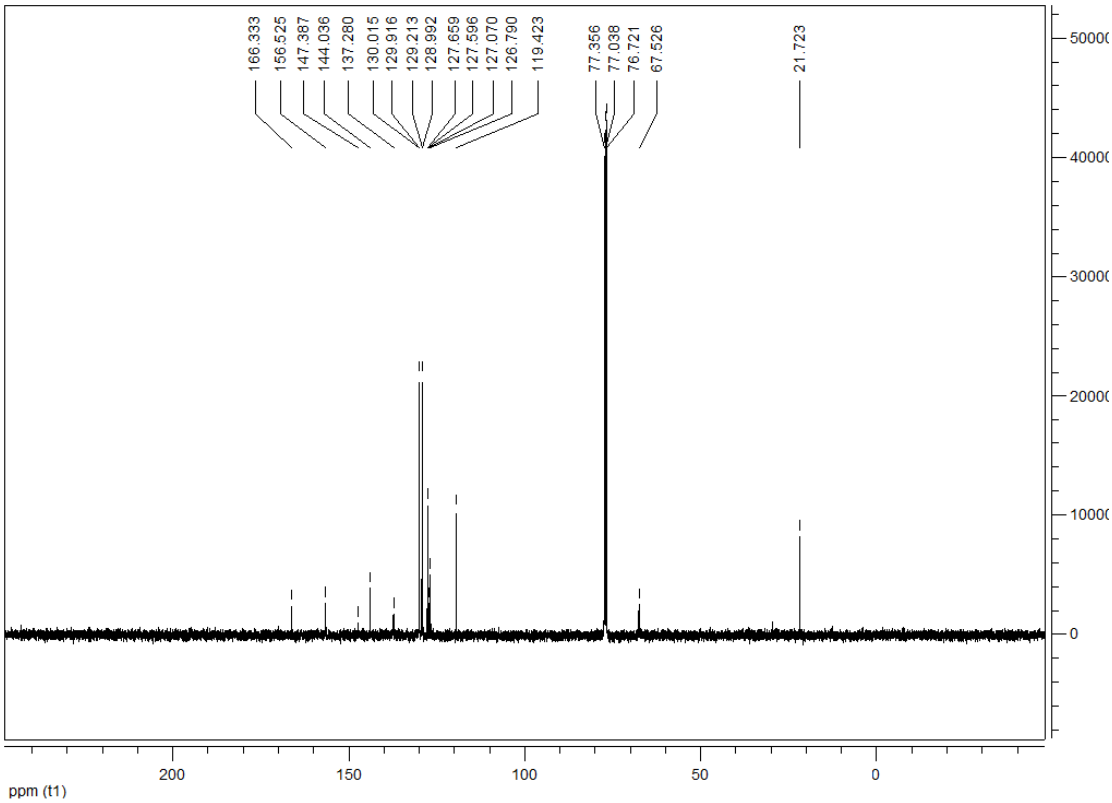

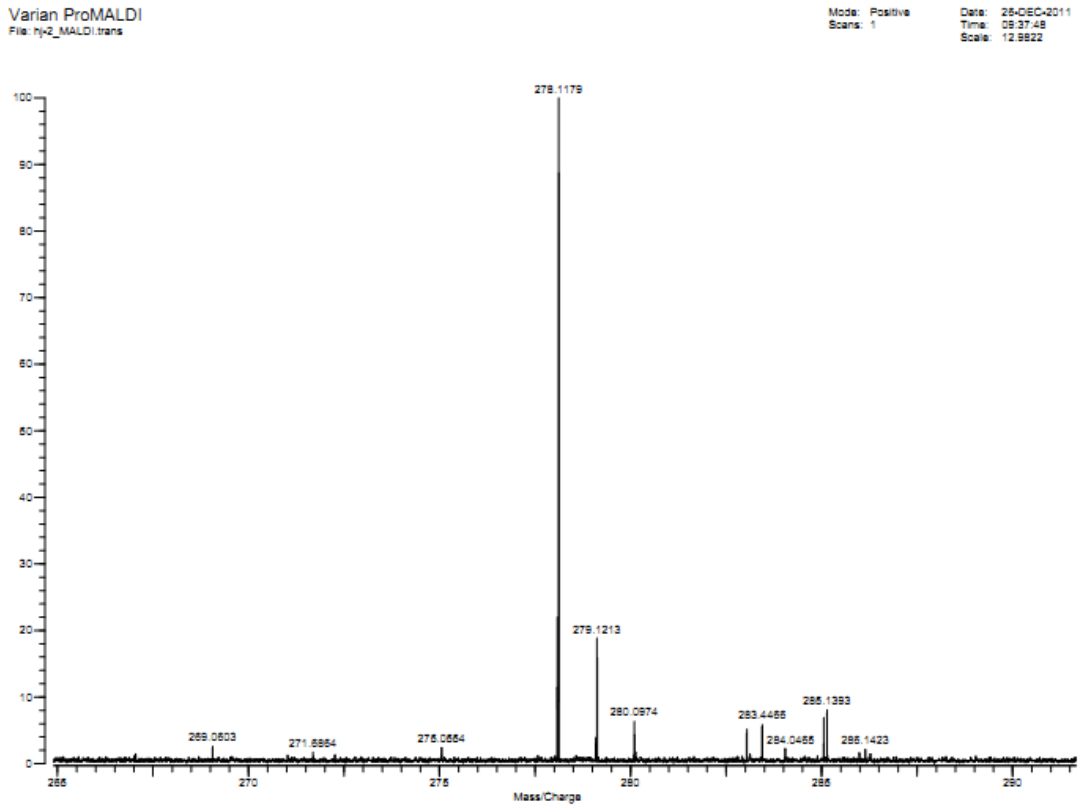

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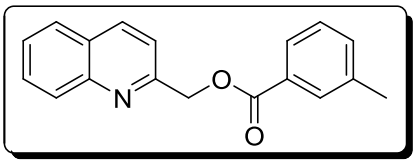

^{1}H NMR (400 MHz, $CDCl_3$): 8.20 (d, *J* = 8.4 Hz, 1H); 8.11 (d, *J* = 8.4 Hz, 1H); 7.95-7.94 (m, 2H); 7.83 (d, *J* = 8.0 Hz, 1H); 7.74 (t, *J* = 7.2 Hz, 1H); 7.59-7.54 (m, 2H); 7.41-7.33 (m, 2H); 5.66 (s, 2H); 2.41 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): 166.46; 156.45; 147.57; 138.30; 137.14; 134.04; 130.39; 129.92; 129.75; 129.12; 128.38; 127.65; 127.59; 127.01; 126.73; 119.44; 67.77; 21.29; HRMS[ESI]: calculated for $C_{18}H_{16}NO_2$, $[M+H]^+$: 278.1176, found: 278.1175.

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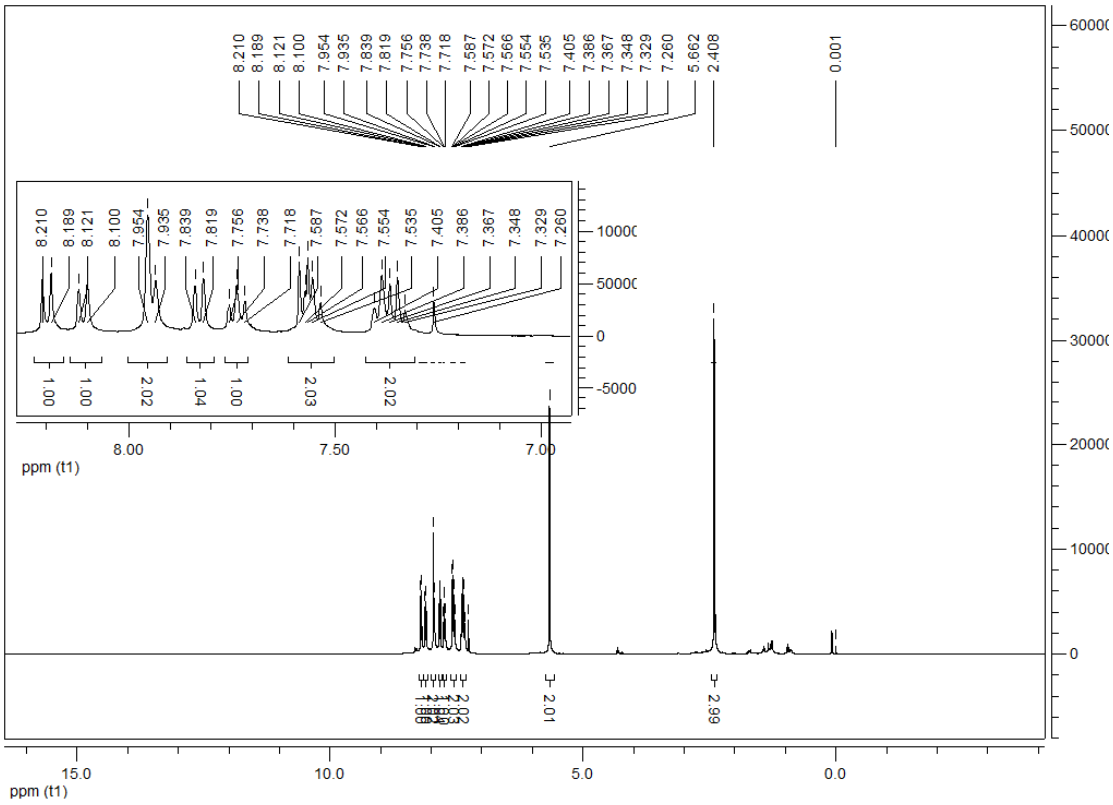

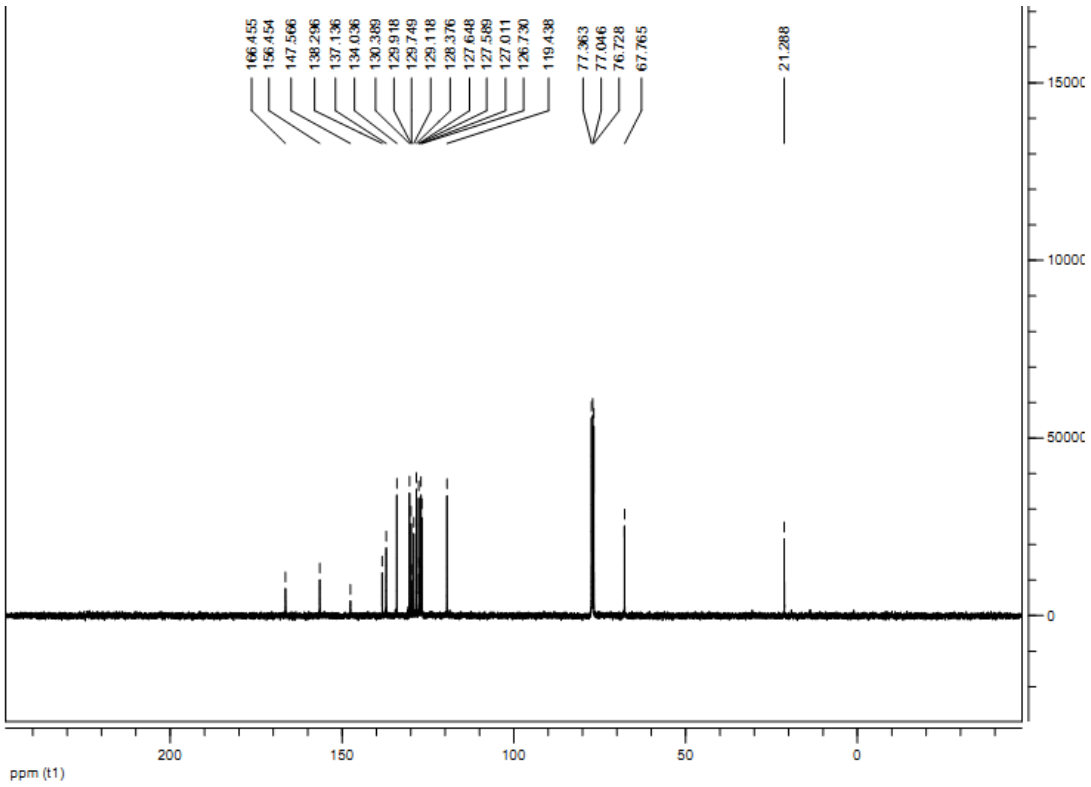

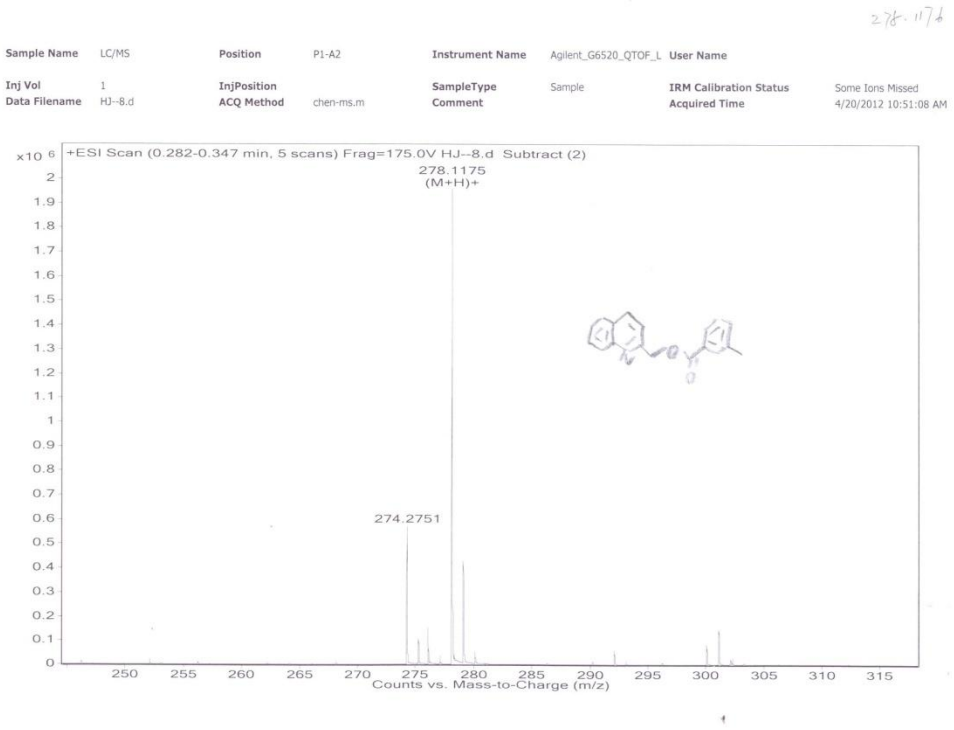

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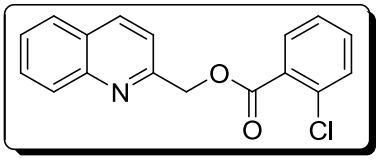

^{1}H NMR (400 MHz, $CDCl_3$): 8.24 (d, *J* = 7.6 Hz, 1H); 8.15 (d, *J* = 7.2 Hz, 1H); 7.97 (d, *J* = 7.2 Hz, 1H); 7.85 (d, *J* = 7.2 Hz, 1H); 7.76-7.74 (m, 1H); 7.64-7.62 (m, 1H); 7.59-7.56 (m, 1H); 7.48-7.45 (m, 2H); 7.36-7.34 (m, 1H); 5.70 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): 165.28; 155.80; 137.52; 134.03; 132.90; 131.80; 131.21; 130.18; 129.65; 128.87; 127.69; 127.64; 126.95; 126.70; 119.67; 119.58; 68.04; HRMS[ESI]: calculated for $C_{17}H_{13}ClNO_2$, $[M+H]^+$: 298.0629, found: 298.0635.

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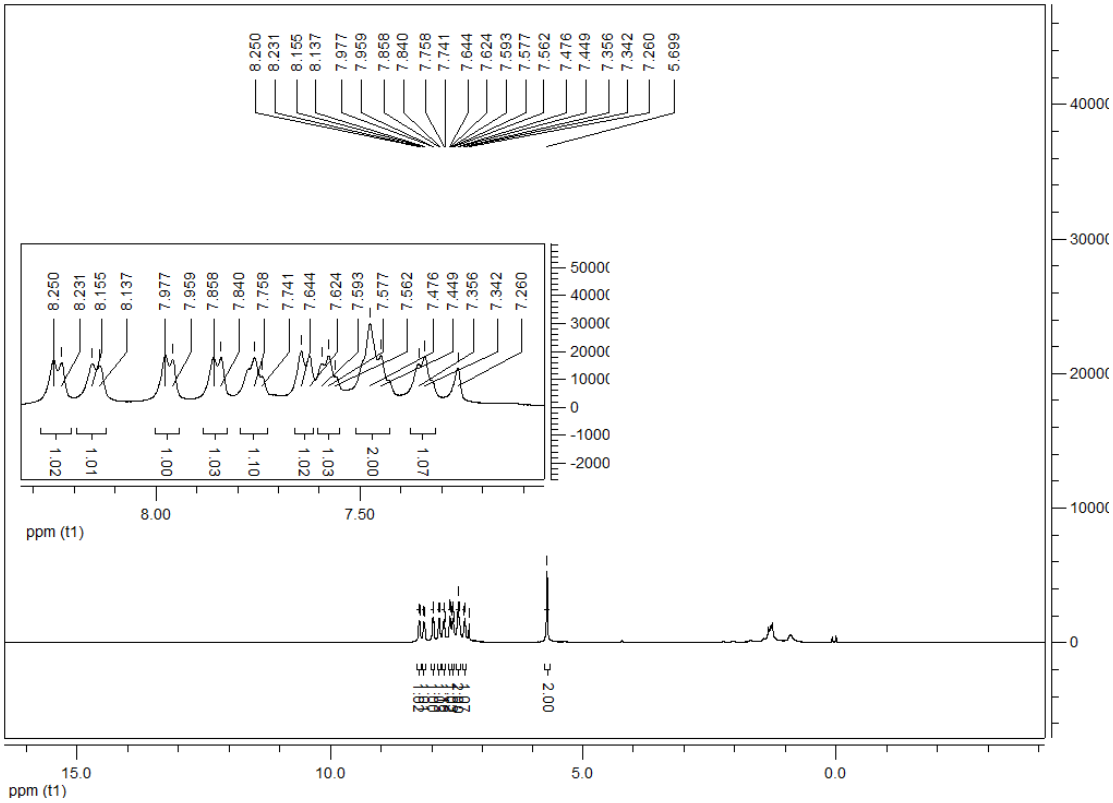

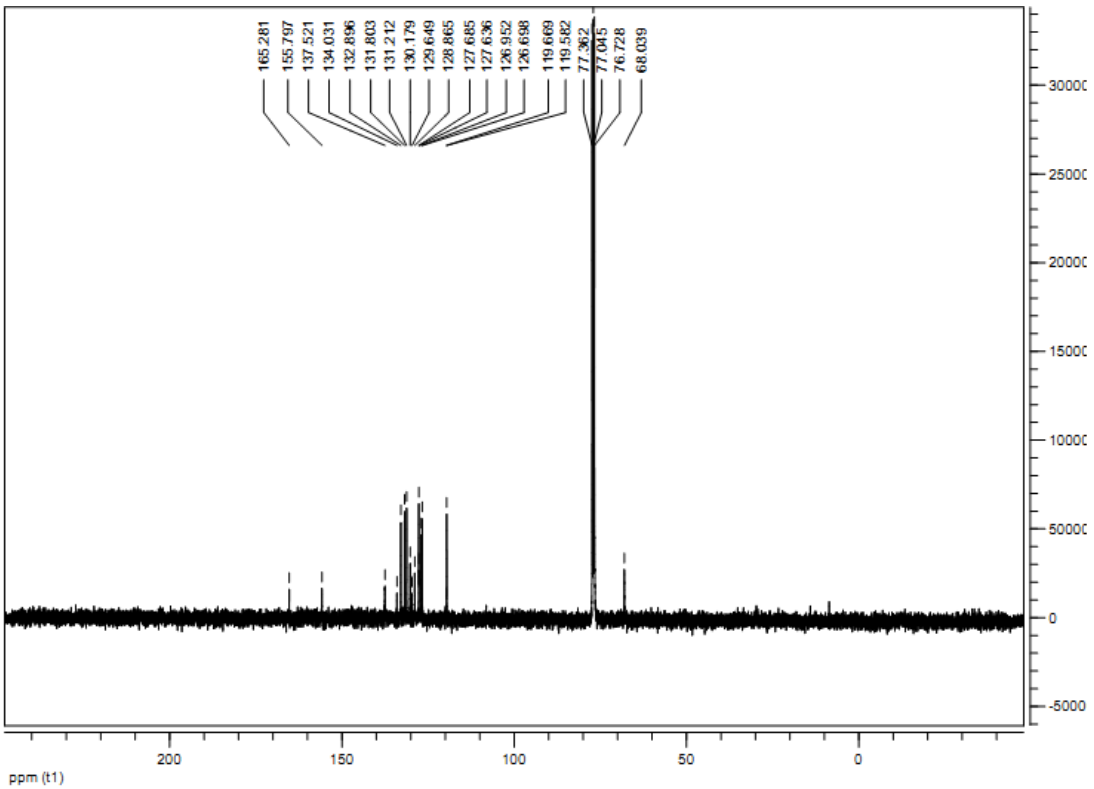

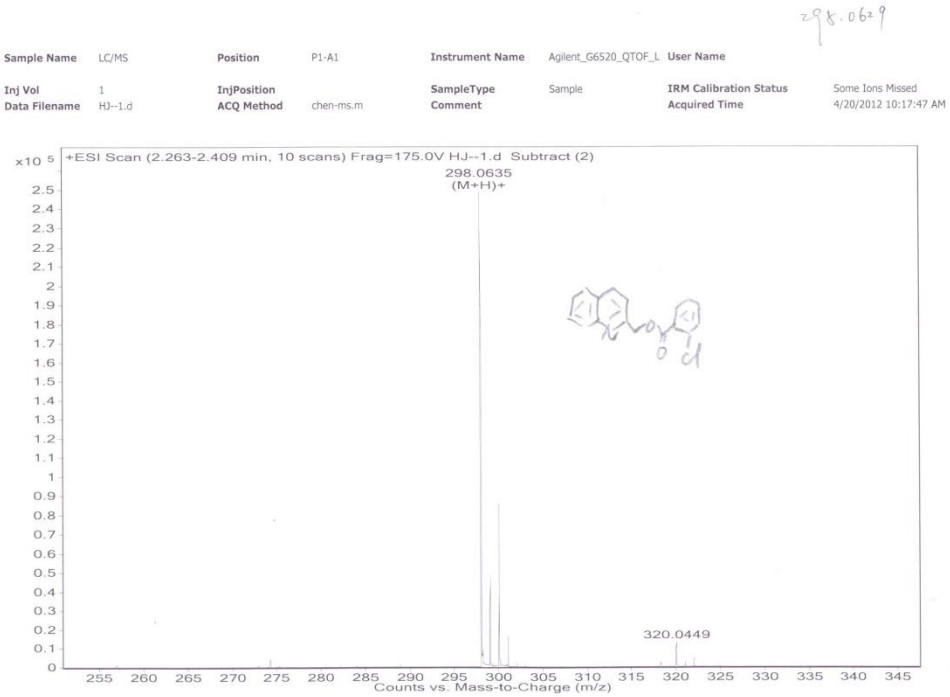

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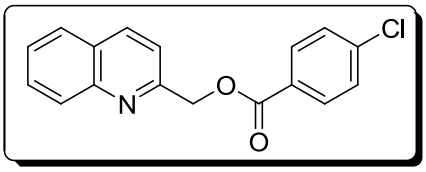

^{1}H NMR (400 MHz, $CDCl_3$): 8.23 (d, *J* = 8.4 Hz, 1H); 8.13 (d, *J* = 8.4 Hz, 1H); 8.07 (d, *J* = 8.4 Hz, 2H); 7.85 (d, *J* = 8.0 Hz, 1H); 7.76 (t, *J* = 7.2 Hz, 1H); 7.60-7.56 (m, 2H); 7.44 (d, *J* = 8.0 Hz, 2H); 5.67 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): 165.45; 155.96; 139.80; 131.27; 130.13; 128.99; 128.86; 128.24; 127.67; 127.62; 127.43; 126.93; 119.48; 112.05; 67.90; HRMS[ESI]: calculated for $C_{17}H_{13}ClNO_2$, $[M+H]^+$: 298.0629, found: 298.0635.

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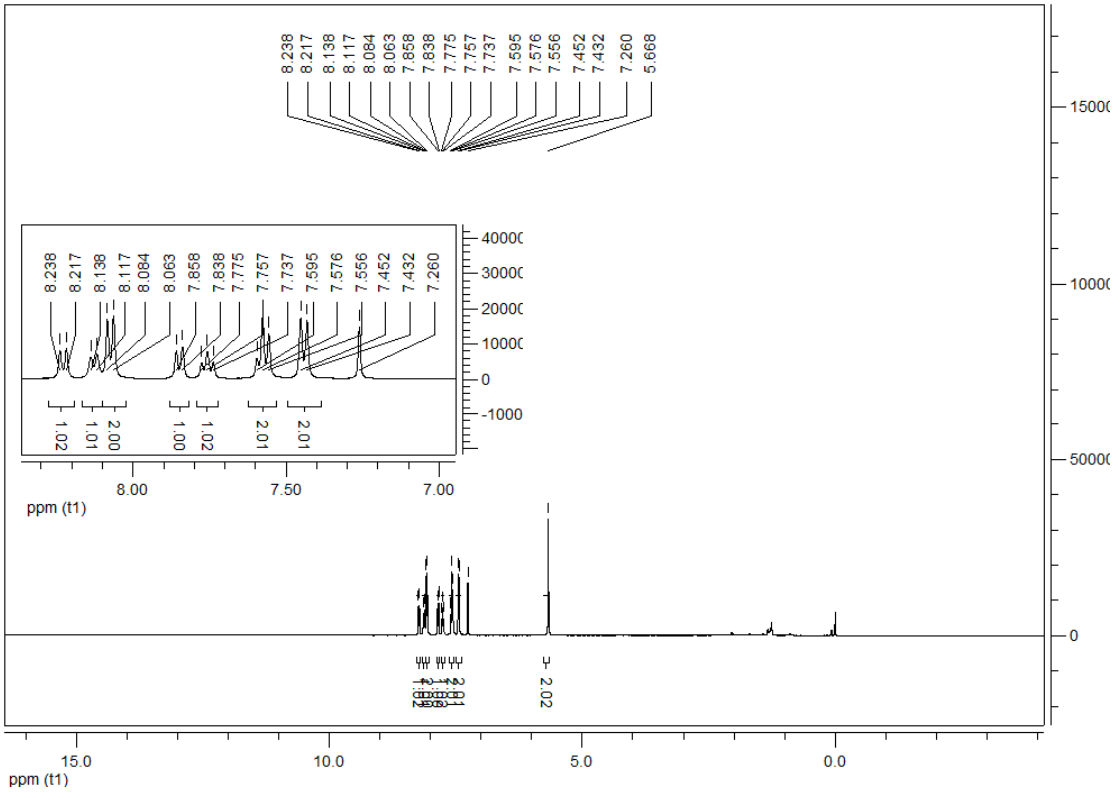

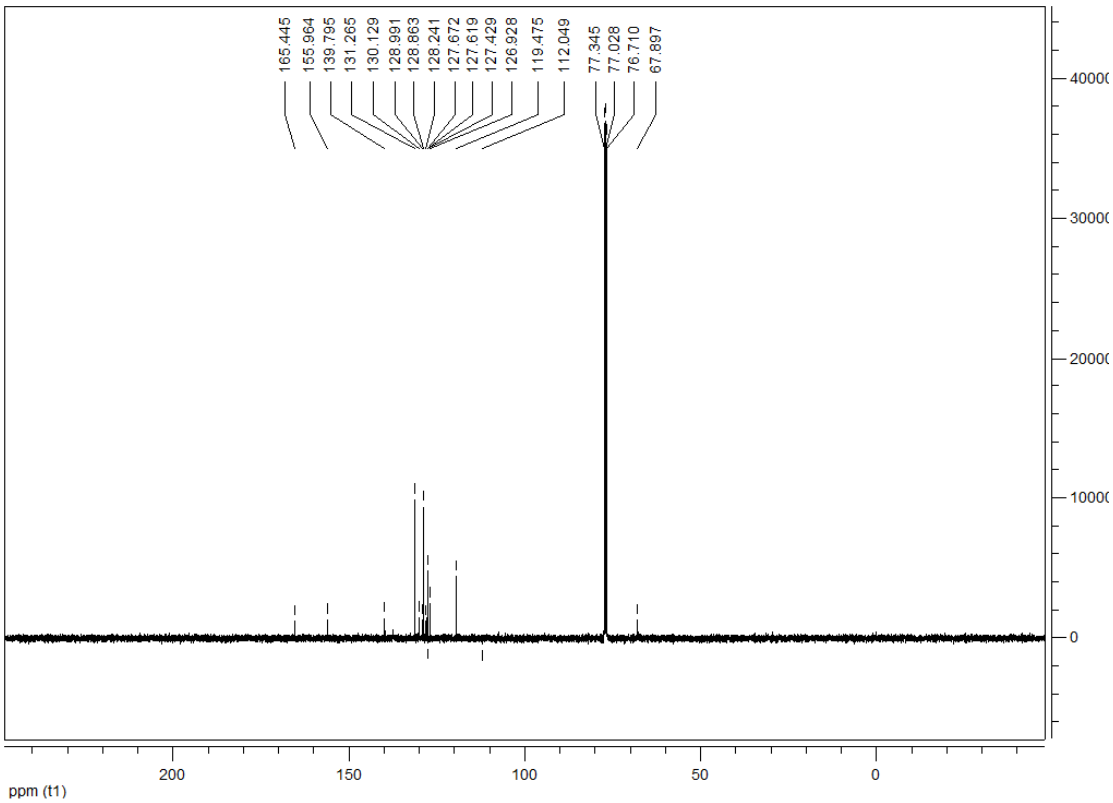

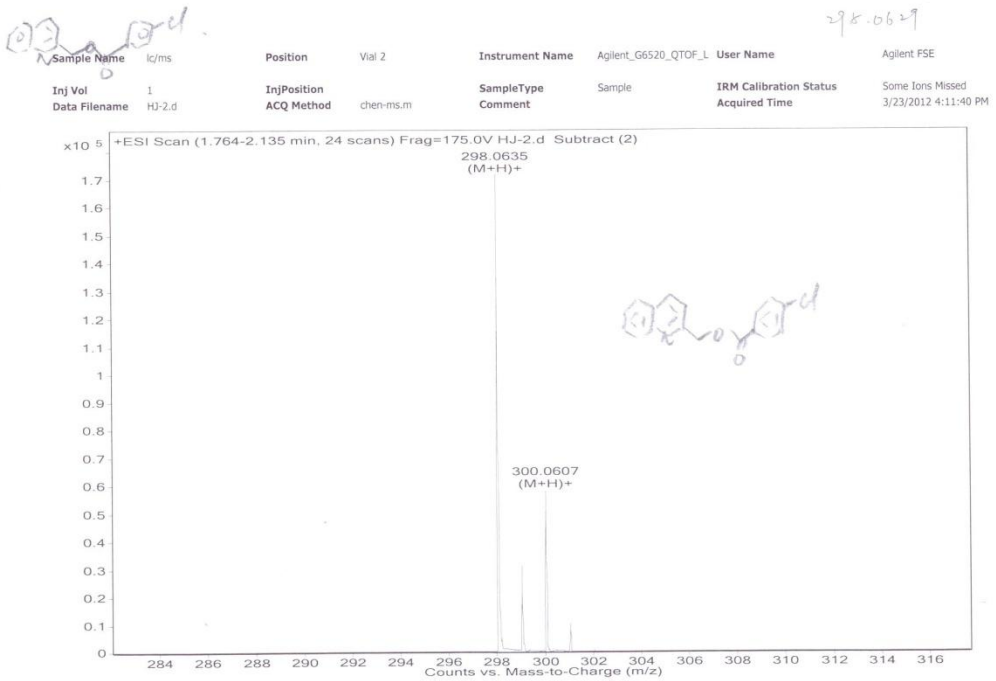

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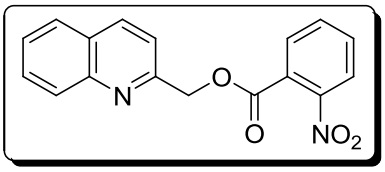

^{1}H NMR (400 MHz, $CDCl_3$): 8.22 (d, *J* = 8.4 Hz, 1H); 8.10 (d, *J* = 8.4 Hz, 1H); 7.94 (d, *J* = 8.0 Hz, 1H); 7.85-7.82 (m, 2H); 7.75-7.63 (m, 3H); 7.58-7.54 (m, 2H); 5.66 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): 165.14; 155.07; 148.17; 147.40; 137.41; 133.08; 131.97; 130.14; 130.03; 129.04; 127.70; 127.38; 127.05; 126.94; 124.03; 119.69; 69.08; HRMS[ESI]: calculated for $C_{17}H_{13}N_2O_4$, $[M+H]^+$: 309.0870, found: 309.0875.

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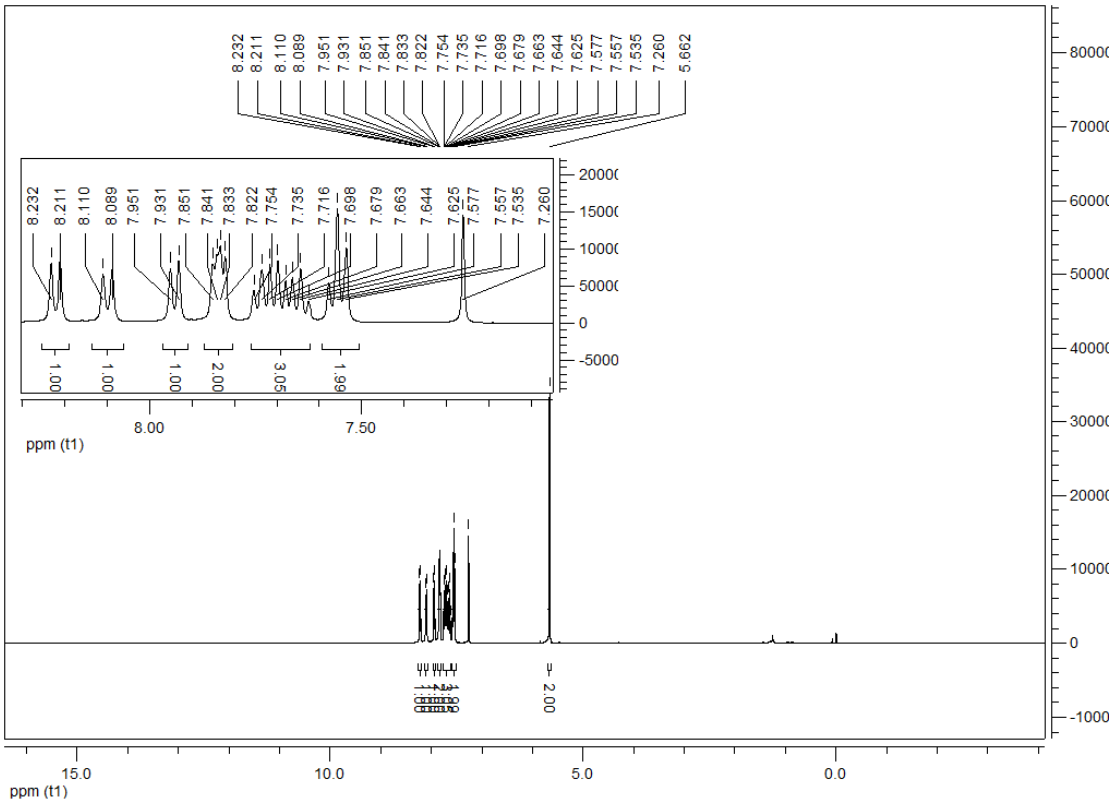
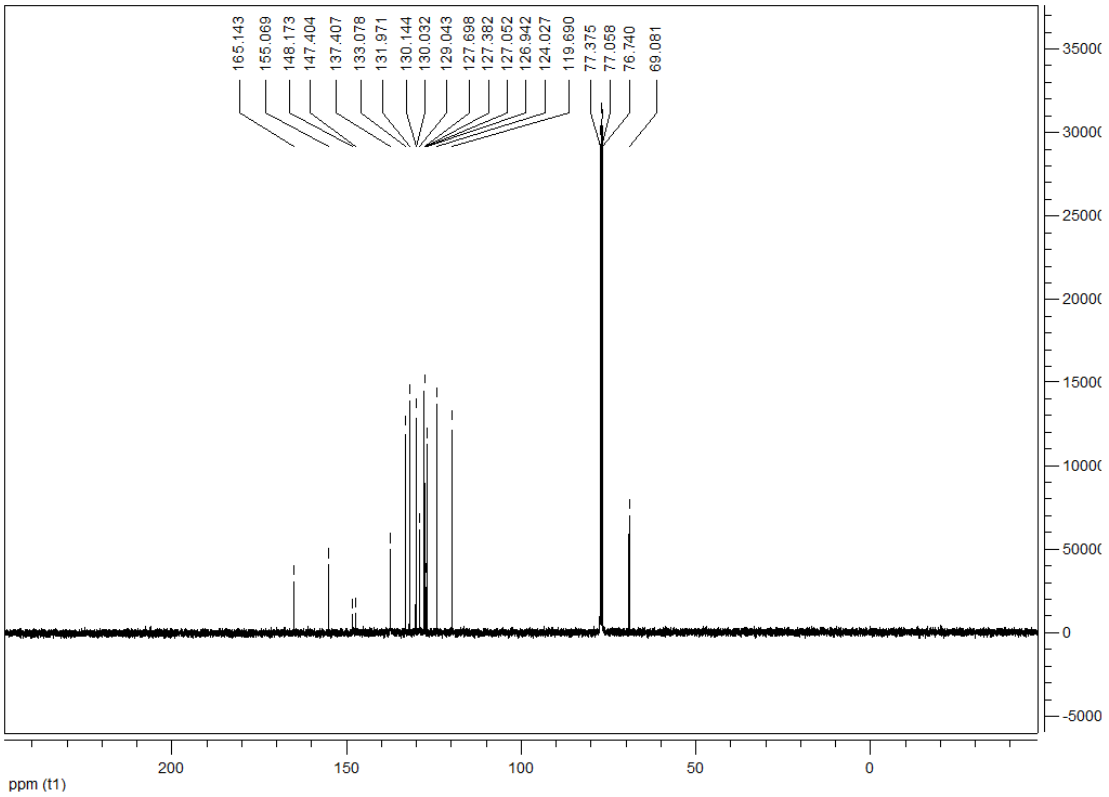
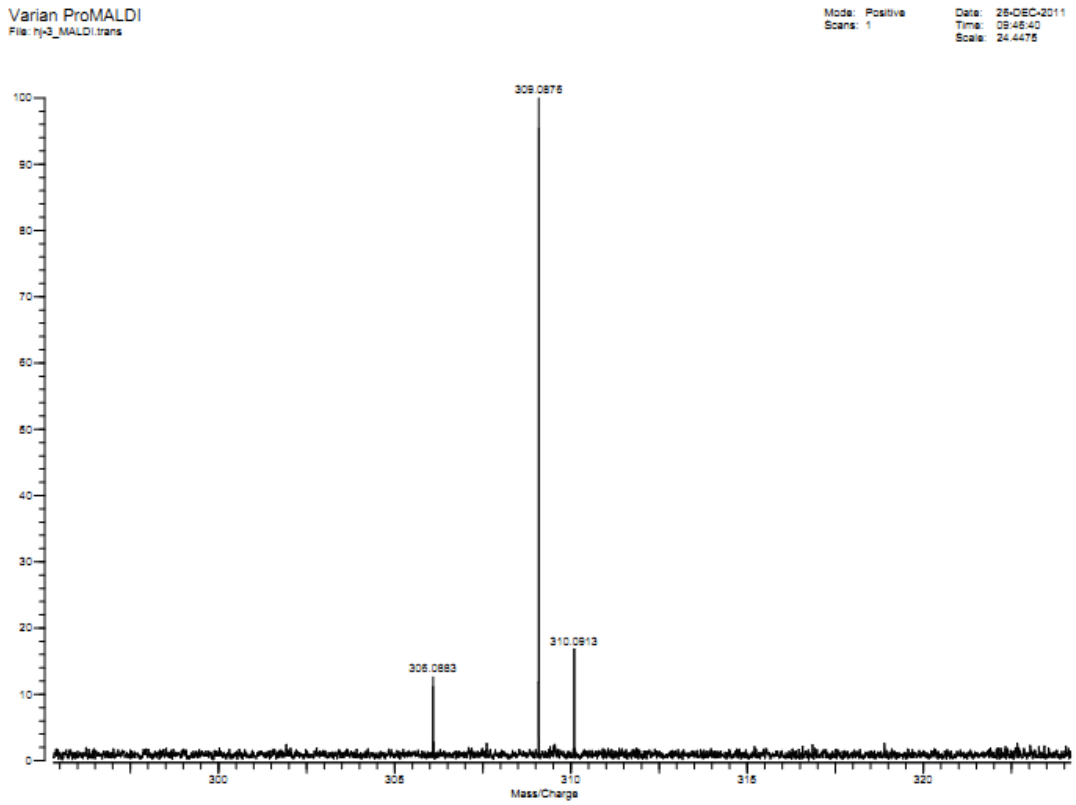
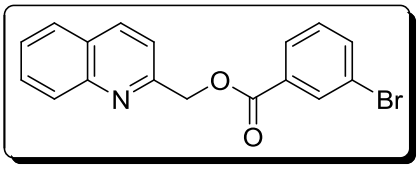






3s



^{1}H NMR (400 MHz, $CDCl_3$): 8.29-8.27 (m, 2H); 8.21 (d, *J* = 7.6 Hz, 1H); 8.07 (d, *J* = 7.6 Hz, 1H); 7.87 (d, *J* = 8.0 Hz, 1H); 7.79 (t, *J* = 7.2 Hz, 1H); 7.72 (d, *J* = 8.0 Hz, 1H); 7.62-7.58 (m, 2H); 7.35 (t, *J* = 7.6 Hz, 1H); 5.72 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): 164.98; 155.84; 147.53; 137.30; 136.22; 133.04; 132.82; 131.74; 130.07; 129.11; 128.46; 127.68; 127.62; 126.89; 122.57; 119.48; 68.15; HRMS[ESI]: calculated for $C_{17}H_{13}BrNO_2$, $[M+H]^+$: 342.0124, found: 342.0120.

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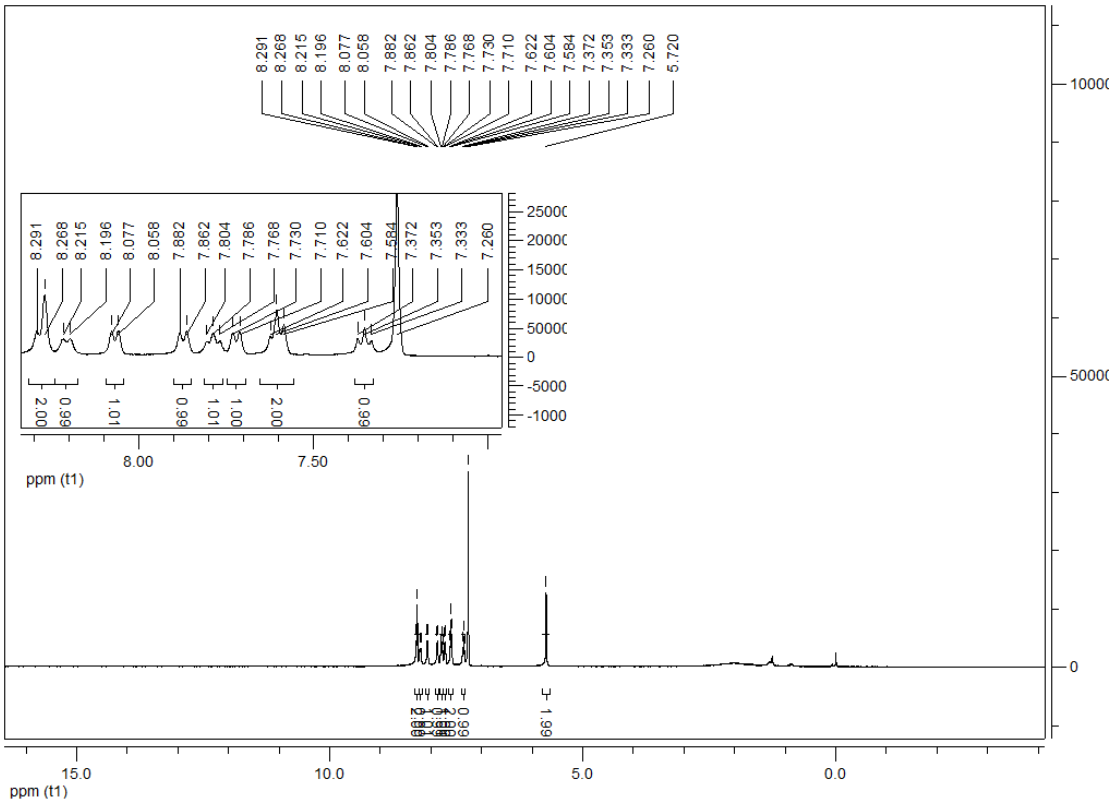
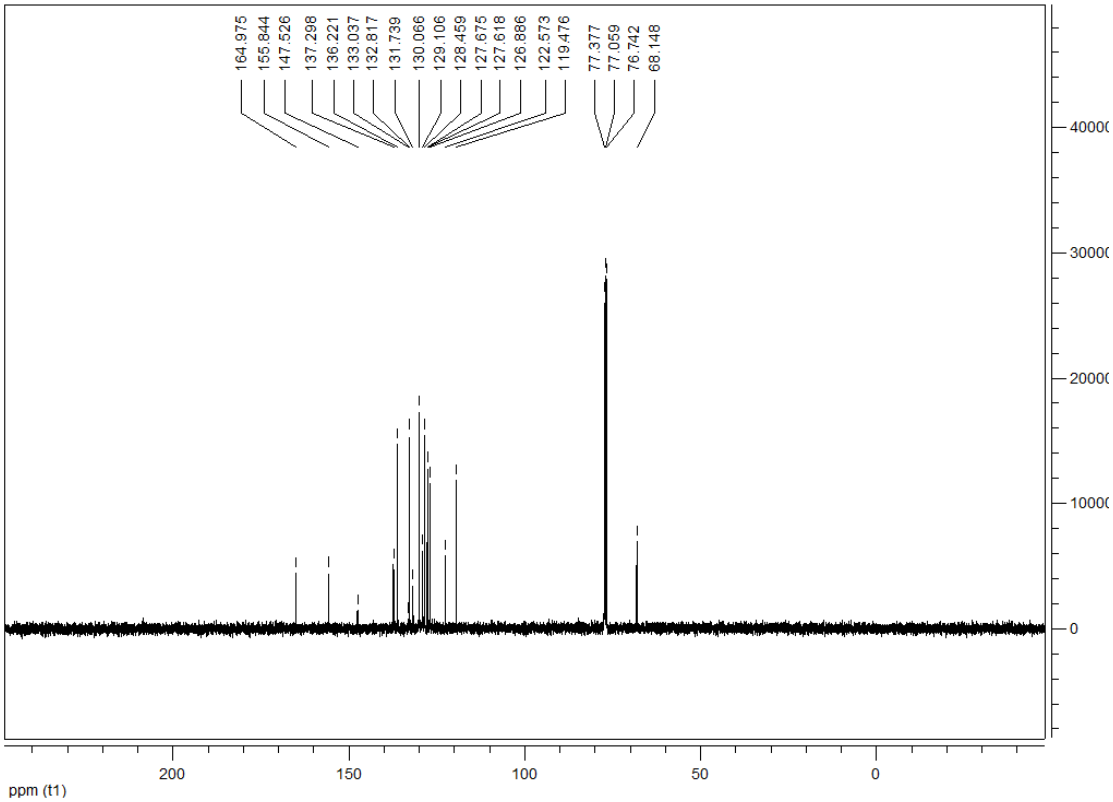
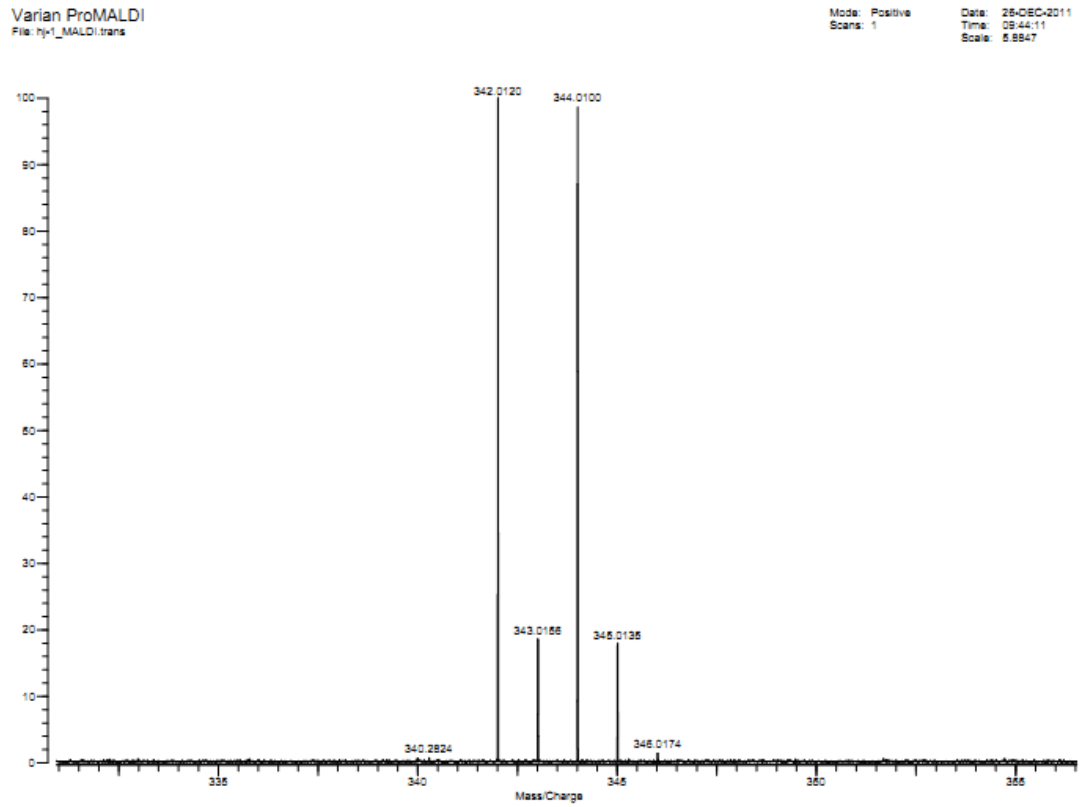
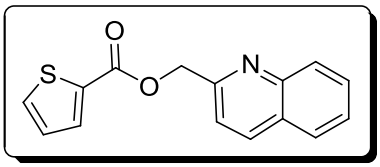






3t



^{1}H NMR (400 MHz, $CDCl_3$): 8.21 (d, *J* = 8.4 Hz, 1H); 8.10 (d, *J* = 8.8 Hz, 1H); 7.90 (dd, *J* = 1.2 Hz, *J* = 4.0 Hz, 1H); 7.83 (d, *J* = 8.0 Hz, 1H); 7.74 (td, *J* = 1.6 Hz, *J* = 6.8 Hz, 1H); 7.61-7.54 (m, 3H); 7.13 (dd, *J* = 3.6 Hz, *J* = 5.0 Hz, 1H); 5.64 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): 161.89; 156.16; 147,52; 137.20; 134.05; 133.21; 132.92; 129.96; 129.09; 127.93; 127.67; 127.60; 126.77; 119.33; 67.81; HRMS[ESI]: calculated for $C_{15}H_{12}NO_2S$, $[M+H]^+$: 270.0583, found: 270.0587.

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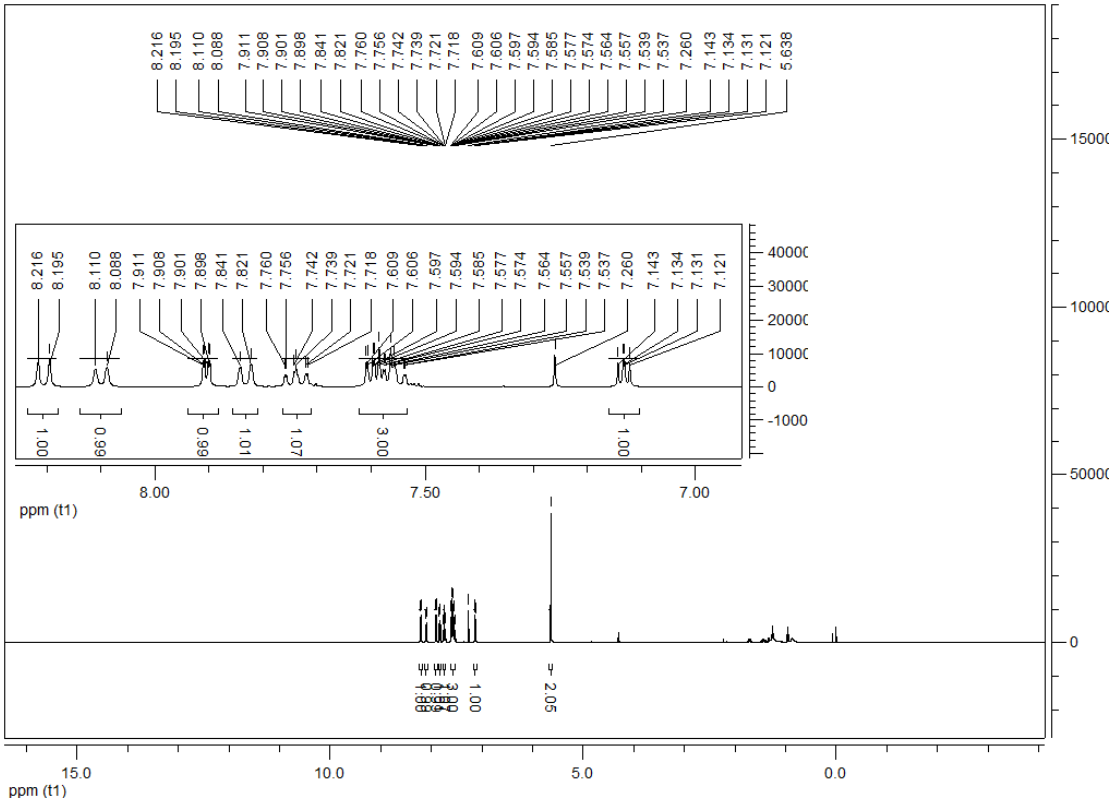
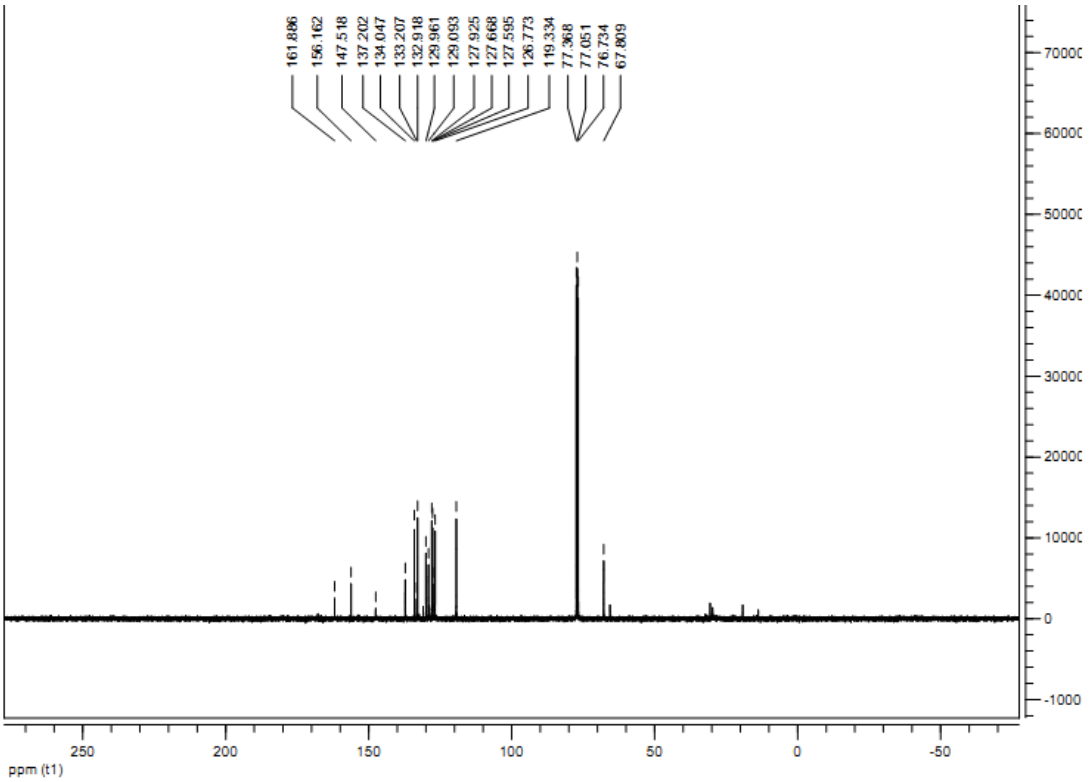
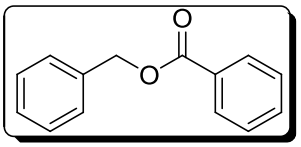




5a



^{1}H NMR (400 MHz, $CDCl_3$): 8.11-8.09 (m, 2H); 7.59-7.55 (m, 1H); 7.48-7.36 (m, 7H); 5.38 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): 166.39; 136.01; 133.00; 130.08; 129.67; 128.56; 128.34; 128.21; 128.13; 66.65;

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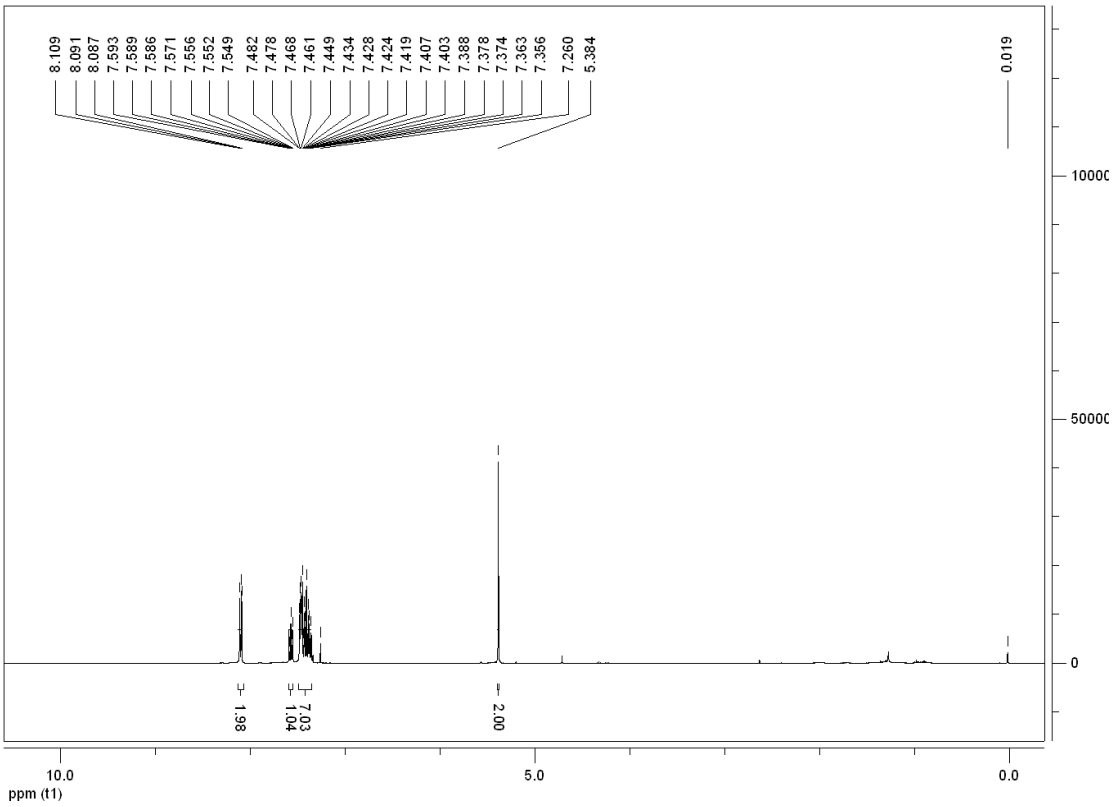

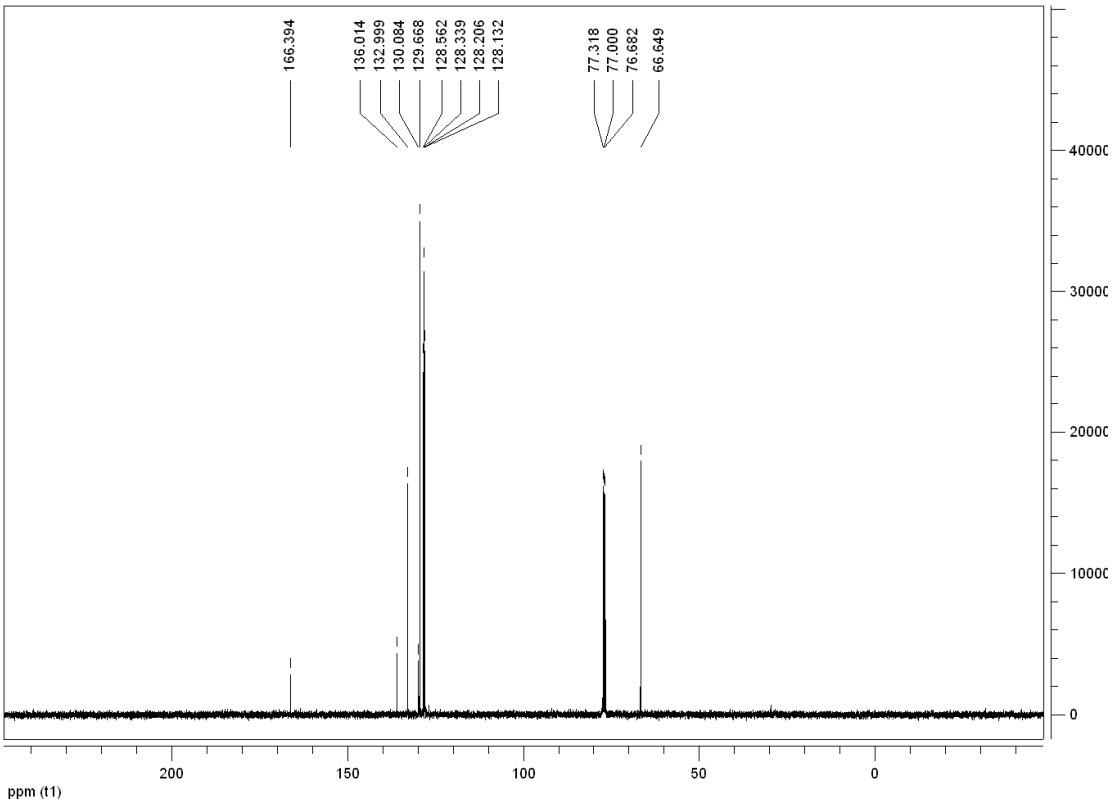

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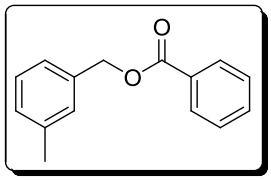
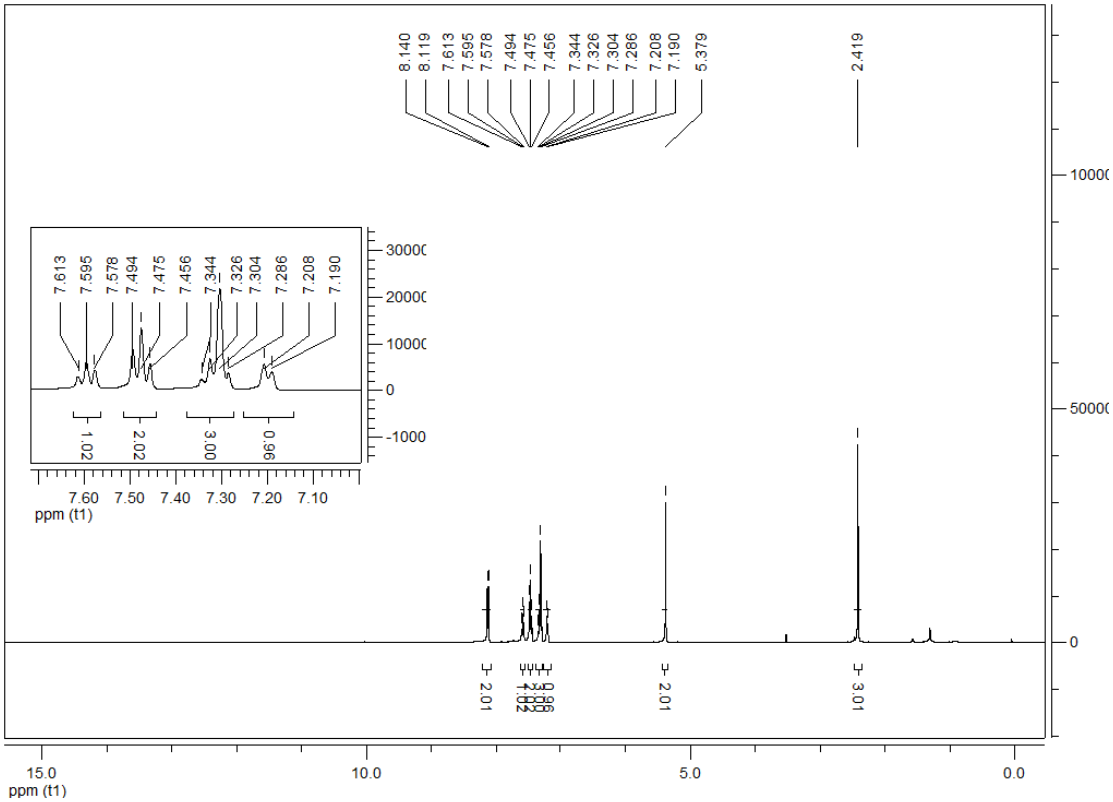
5b



^{1}H NMR (400 MHz, $CDCl_3$): 8.13 (d, *J* = 8.4 Hz, 2H); 7.60 (t, *J* = 7.2 Hz, 1H); 7.48 (t, *J* = 7.6 Hz, 2H); 7.34-7.29 (m, 3H); 7.20 (d, *J* = 7.2 Hz, 1H); 5.38 (s, 2H); 2.42 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): 166.41; 138.24; 135.94; 132.95; 130.16; 129.67; 128.96; 128.89; 128.47; 128.31; 125.23; 66.71; 21.35; HRMS (ESI): calculated for $C_{15}H_{14}O_2Na$, $[M+Na]^+$: 249.0886, found 249.0888.



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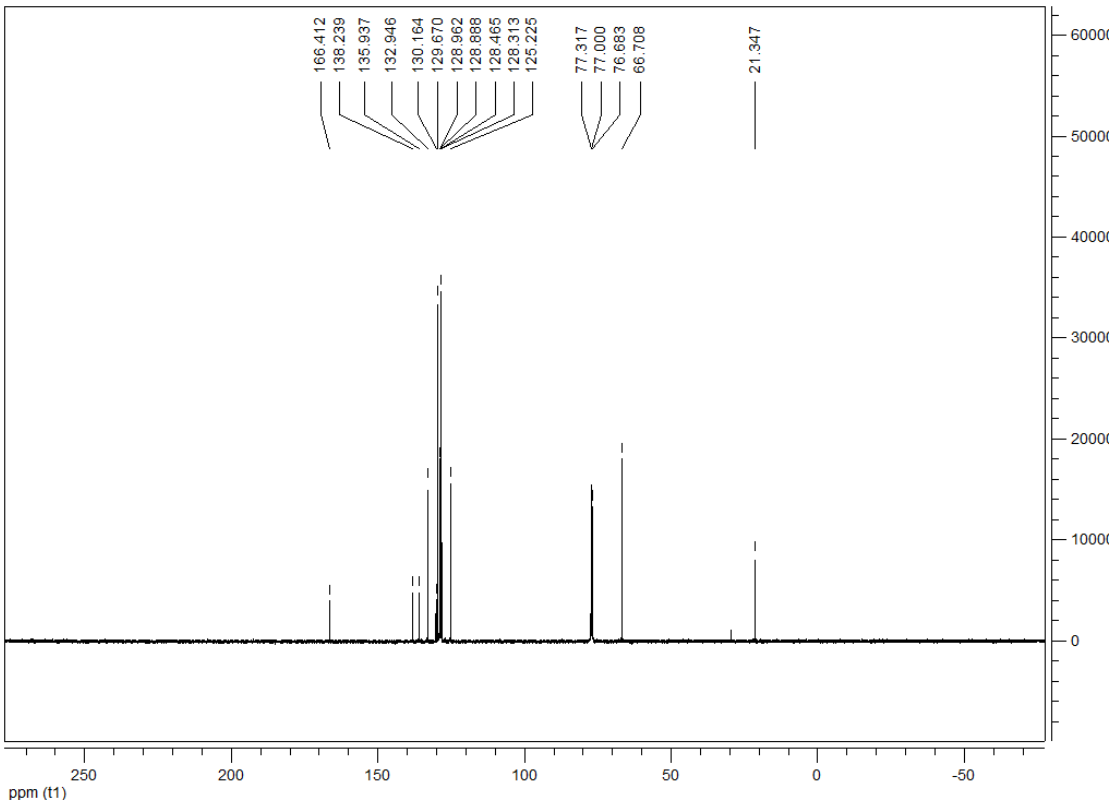

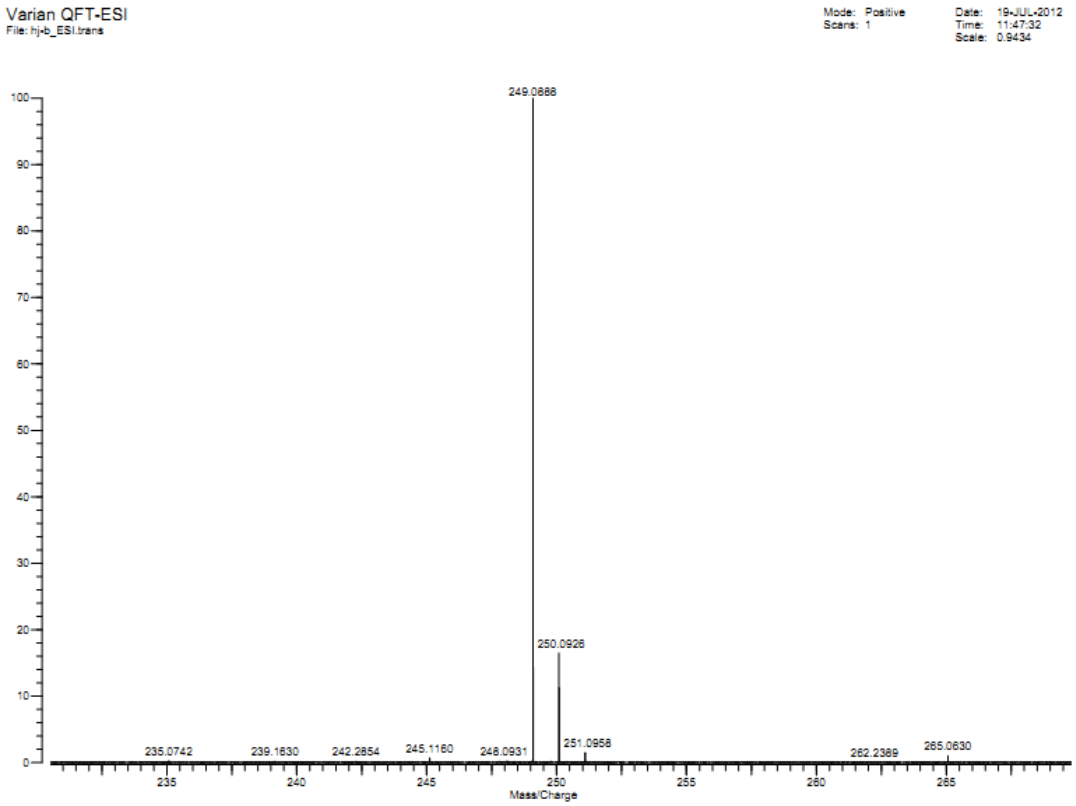

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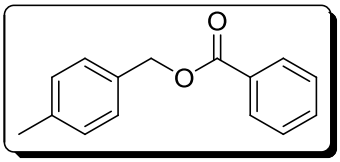
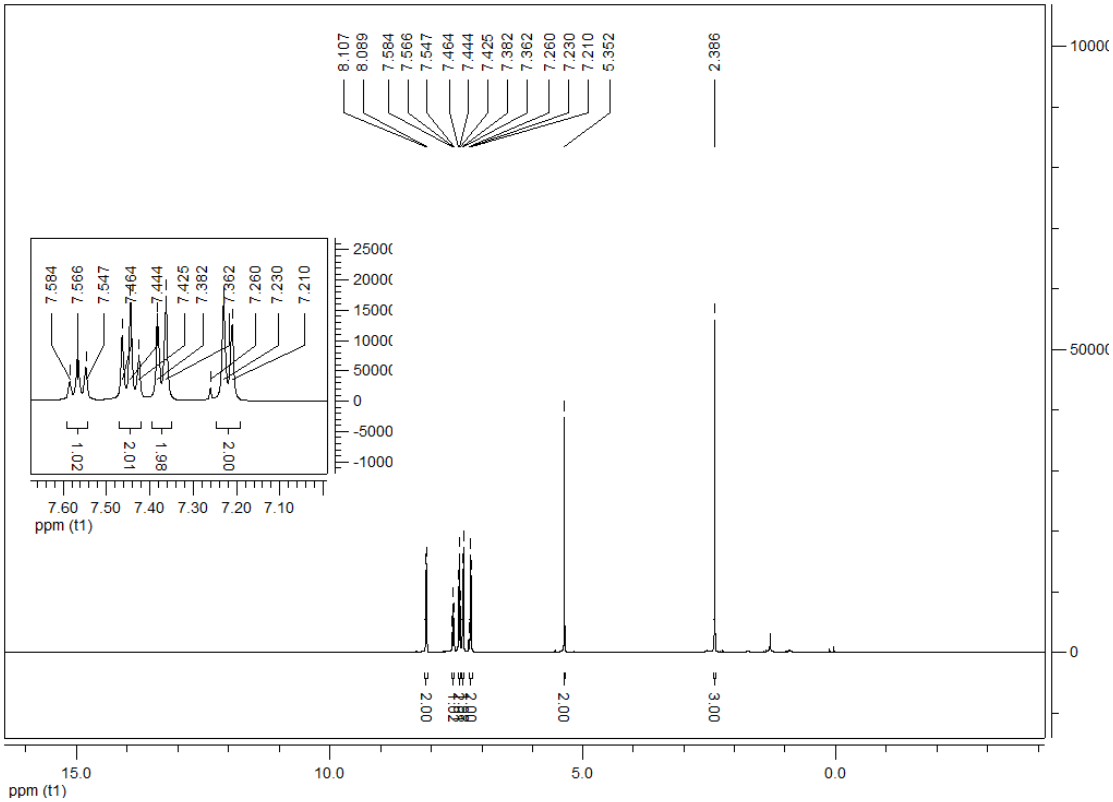
5c



^{1}H NMR (400 MHz, $CDCl_3$): 8.10 (d, *J* = 7.2 Hz, 2H); 7.57 (t, *J* = 7.2 Hz, 1H); 7.44 (t, *J* = 8.0 Hz, 2H); 7.37 (d, *J* = 8.0 Hz, 2H); 7.22 (d, *J* = 8.0 Hz, 2H); 5.35 (s, 2H); 2.39 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): 166.42; 138.03; 133.00; 132.91; 130.18; 129.64; 129.22; 128.29; 128.29; 66.61; 21.17; HRMS (ESI): calculated for $C_{15}H_{14}O_2Na$, $[M+Na]^+$: 249.0886, found 249.0888.



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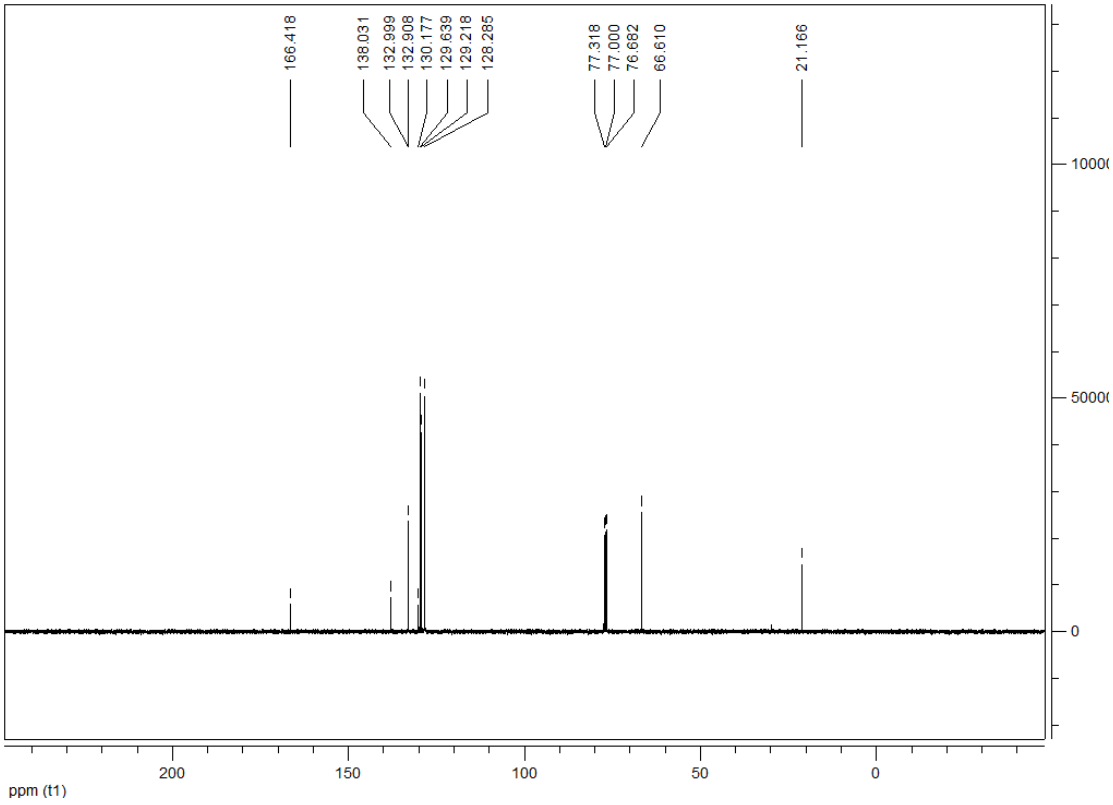

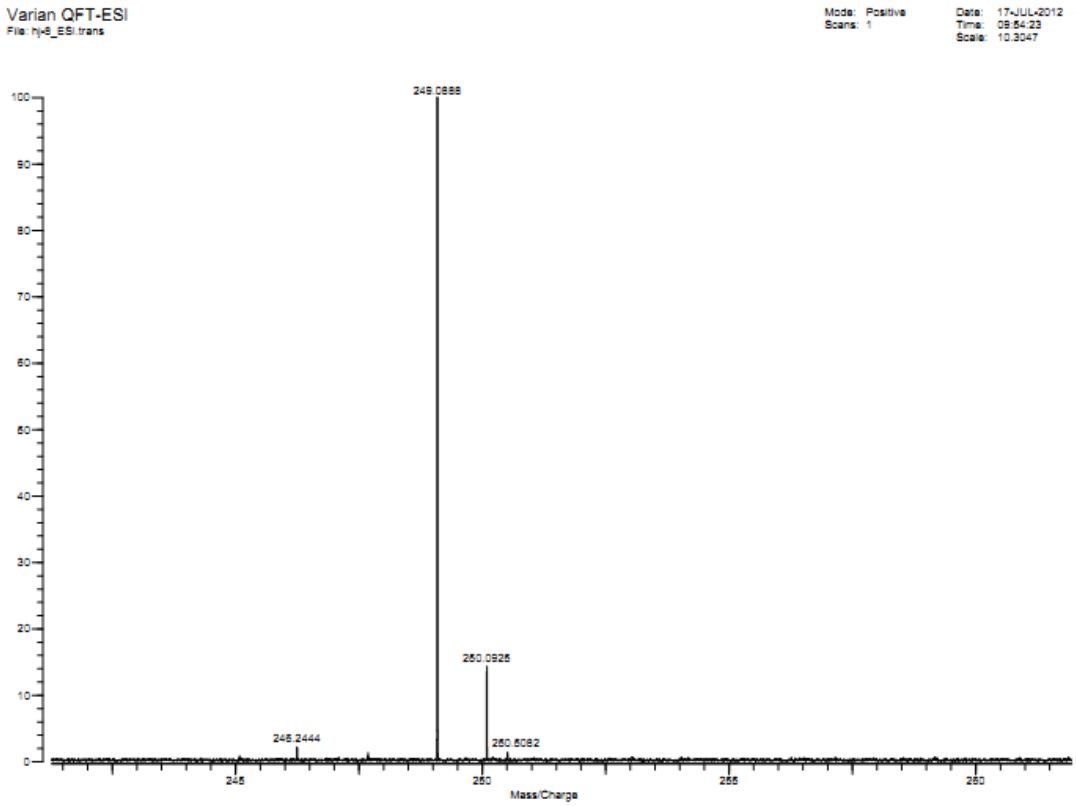

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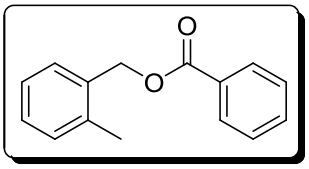
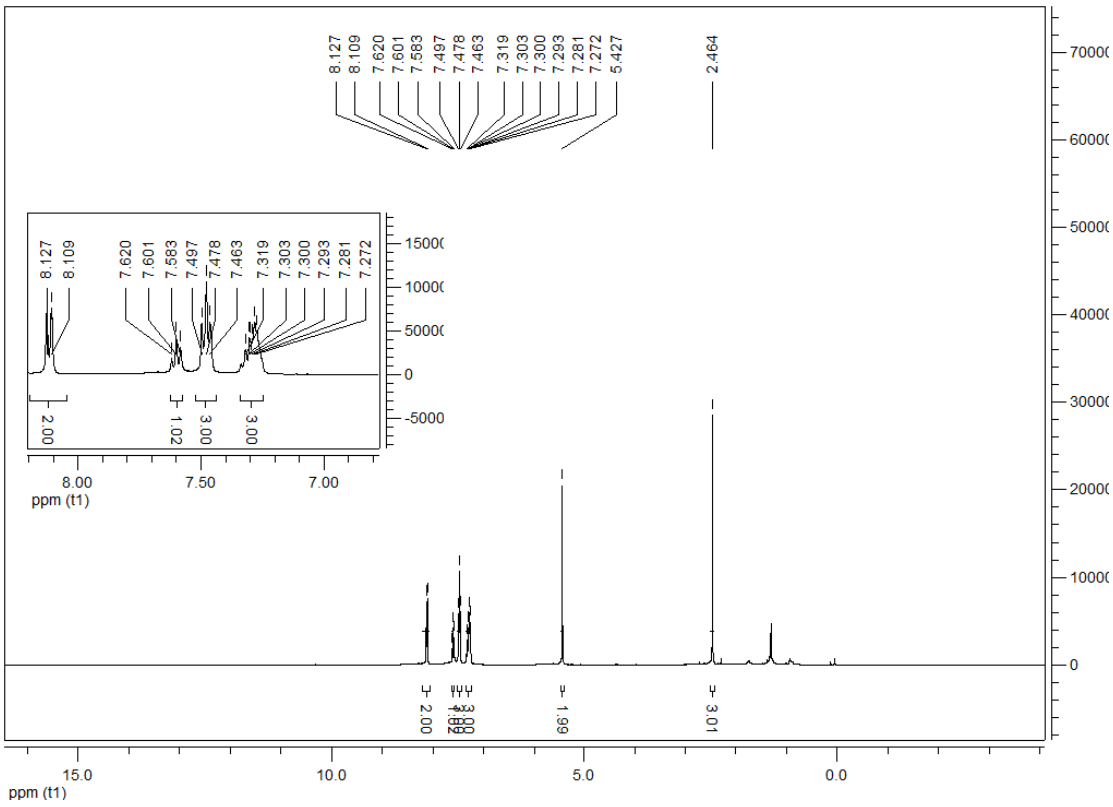
5d



^{1}H NMR (400 MHz, $CDCl_3$): 8.12 (d, *J* = 7.2 Hz, 2H); 7.60 (t, *J* = 7.6 Hz, 1H); 7.50-7.46 (m, 3H); 7.32-7.27 (m, 3H); 5.43 (s, 2H); 2.46 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): 166.47; 137.12; 134.02; 133.05; 130.45; 130.18; 129.72; 129.30; 128.60; 128.42; 126.09; 65.26; 19.05;



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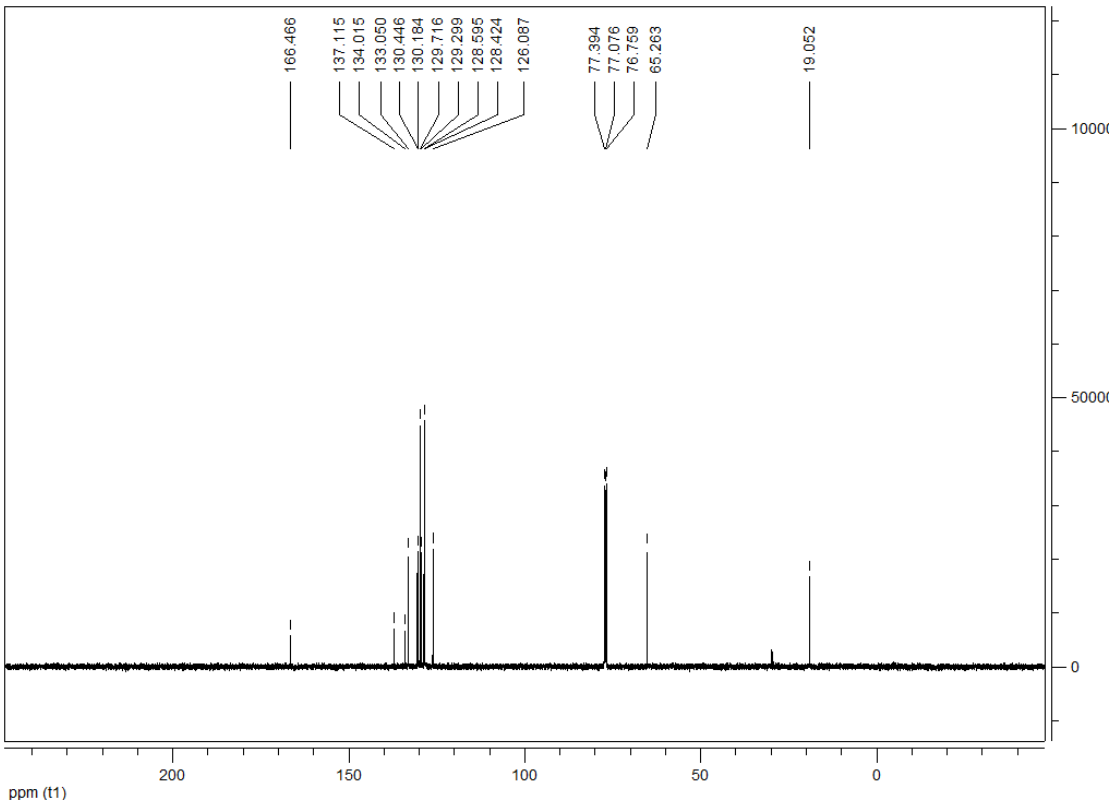

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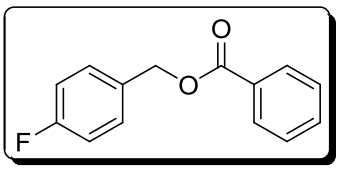

^{1}H NMR (400 MHz, $CDCl_3$): 8.07 (d, *J* = 7.2 Hz, 2H); 7.57 (t, *J* = 7.2 Hz, 1H); 7.46-7.42 (m, 4H); 7.08 (t, *J* = 8.4 Hz, 2H); 5.33 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): 166.40; 163.92; 133.14; 130.27; 130.19; 129.71; 128.43; 115.66; 115.45; 66.01; HRMS (ESI): calculated for $C_{14}H_{11}FO_2Na$, $[M+Na]^+$: 253.0635, found 253.0631.

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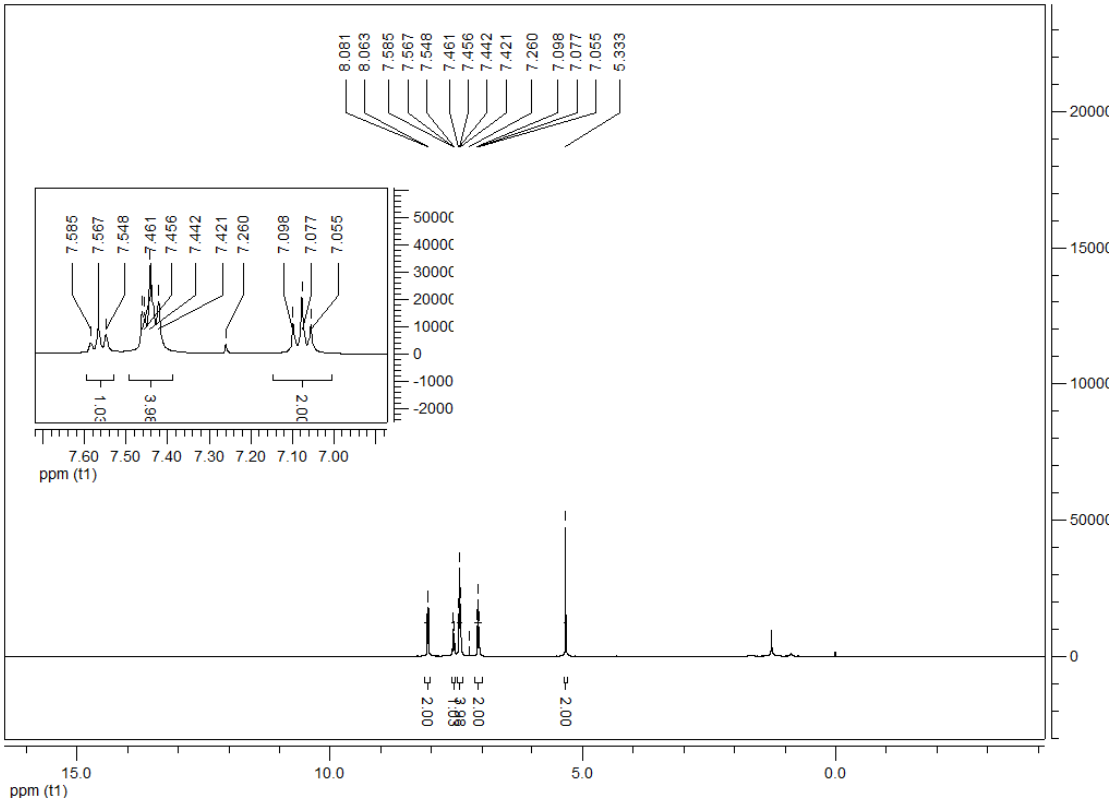

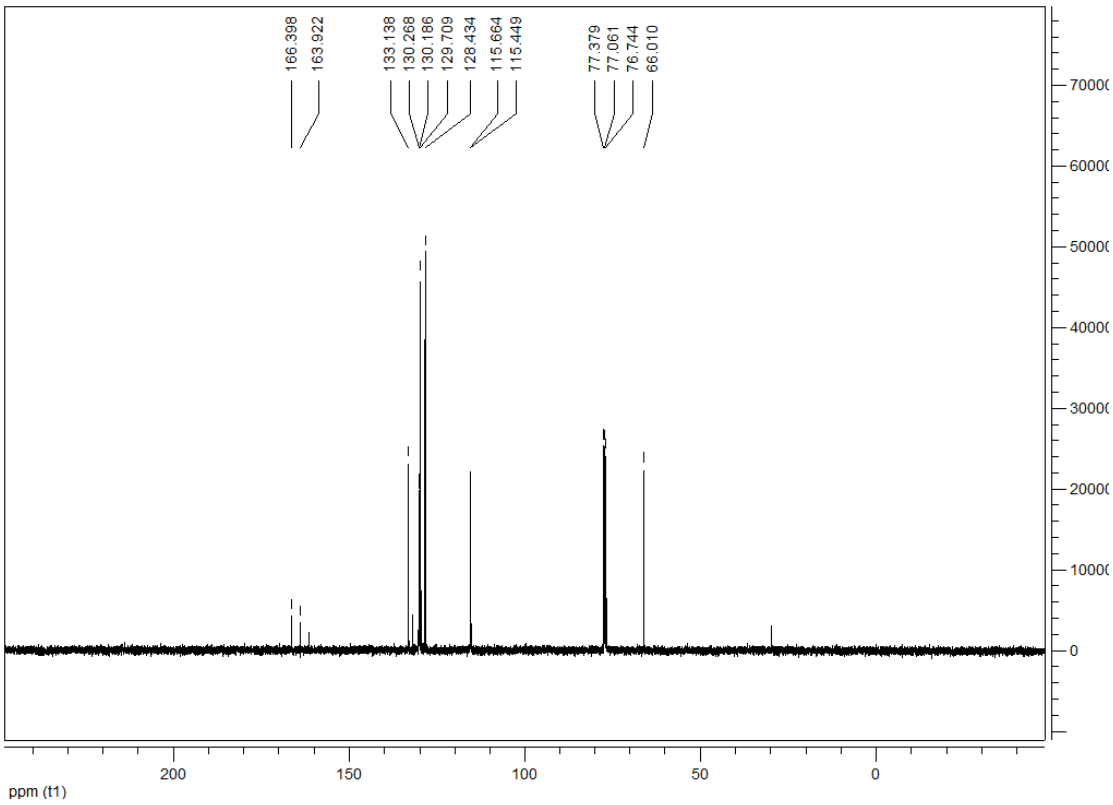

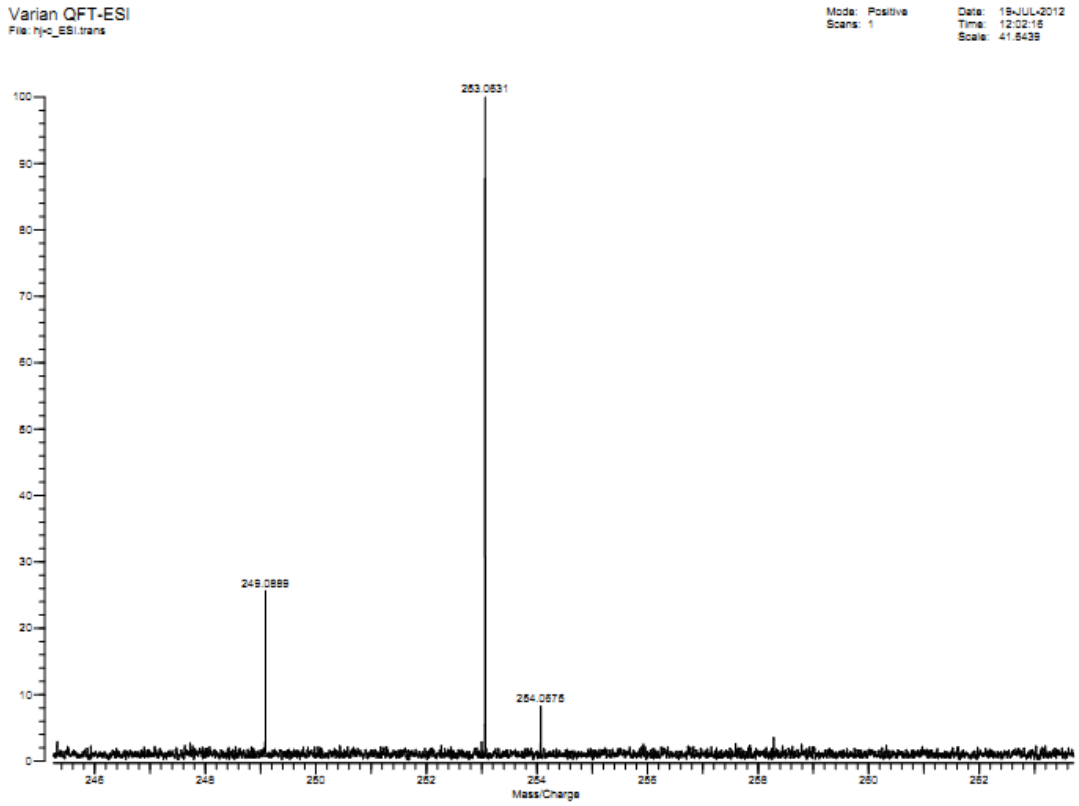

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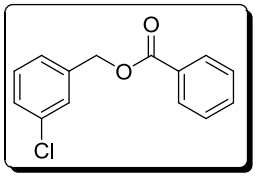

^{1}H NMR (400 MHz, $CDCl_3$): 8.09 (d, *J* = 8.0 Hz, 2H); 7.58 (t, *J* = 7.6 Hz, 1H); 7.48-7.44 (m, 3H); 7.33 (s, 3H); 5.34 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): 166.27; 138.08; 134.51; 133.23; 129.92; 129.86; 129.75; 128.47; 128.42; 128.15; 126.16; 65.78; HRMS (ESI): calculated for $C_{14}H_{11}ClO_2Na$, $[M+Na]^+$: 269.0340, found 269.0339.

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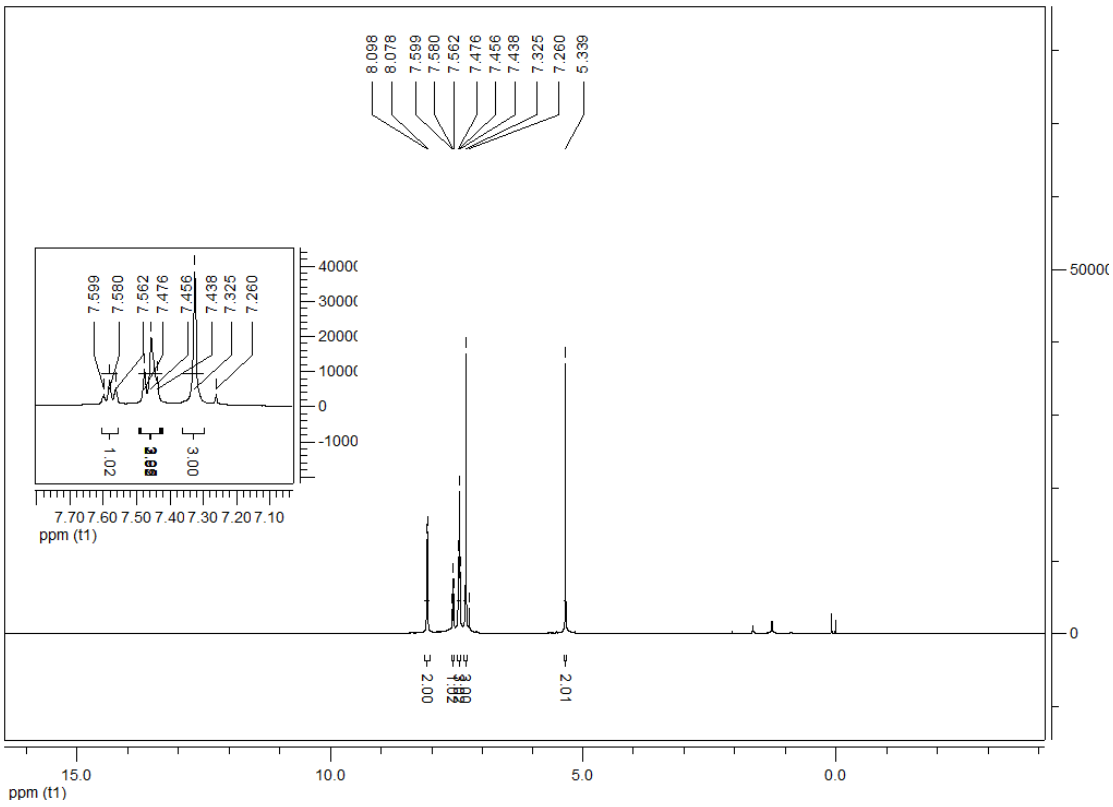

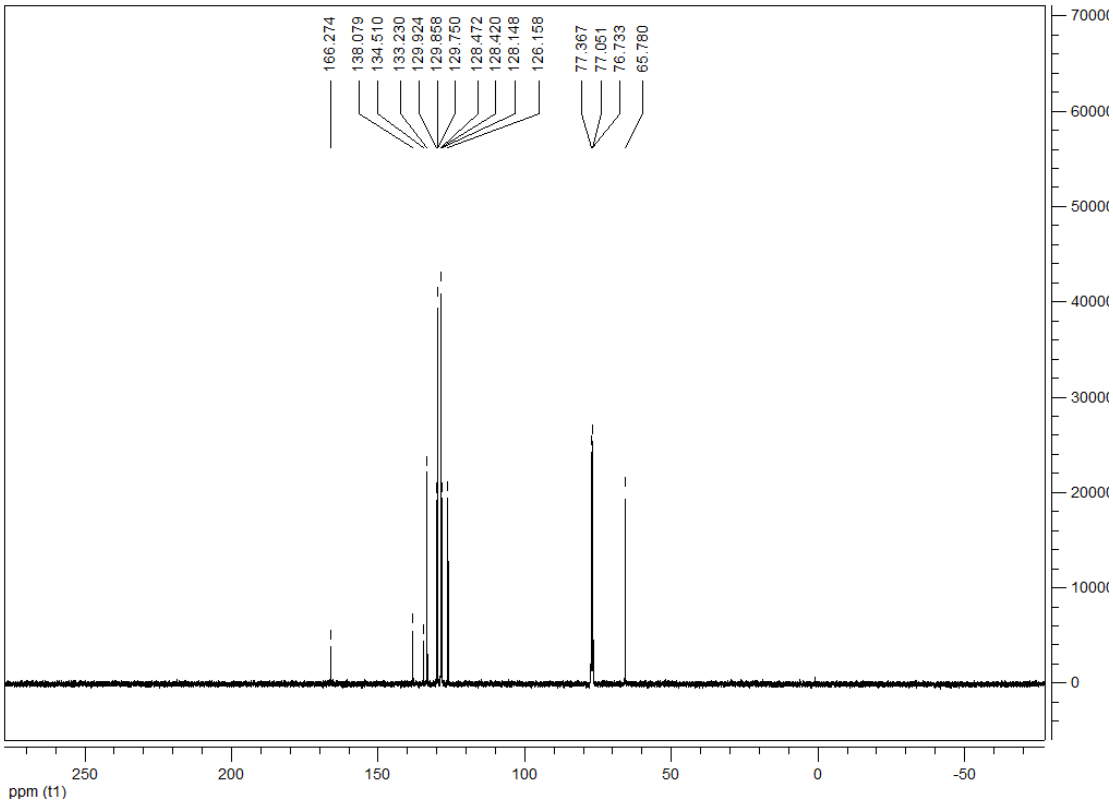

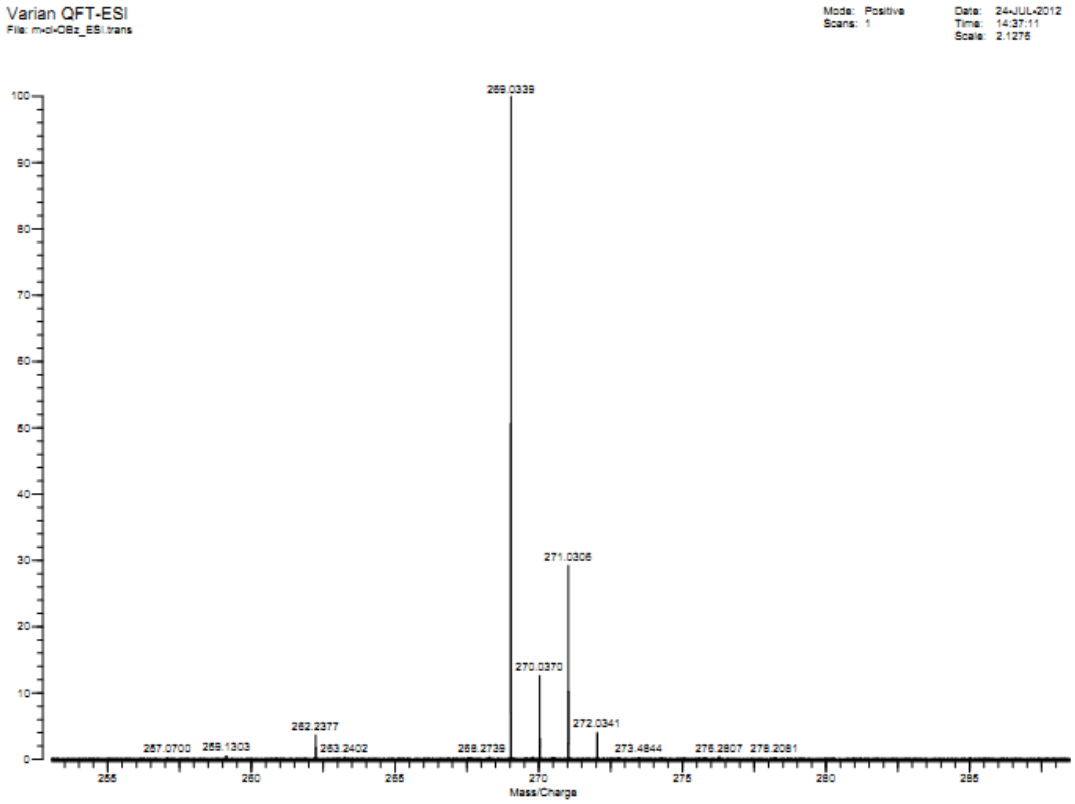

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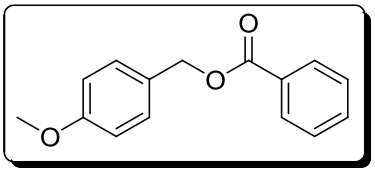

^{1}H NMR (400 MHz, $CDCl_3$): 8.07 (d, *J* = 8.0 Hz, 2H); 7.55 (t, *J* = 7.2 Hz, 1H); 7.42 (q, *J* = 7.6 Hz, 4H); 6.92 (d, *J* = 8.4 Hz, 2H); 5.31 (s, 2H); 3.82 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): 166.53; 159.68; 132.96; 130.30; 130.09; 129.69; 128.35; 128.21; 114.00; 66.56; 55.31; HRMS (ESI): calculated for $C_{15}H_{14}O_3Na$, $[M+Na]^+$: 265.0835, found 265.0829.

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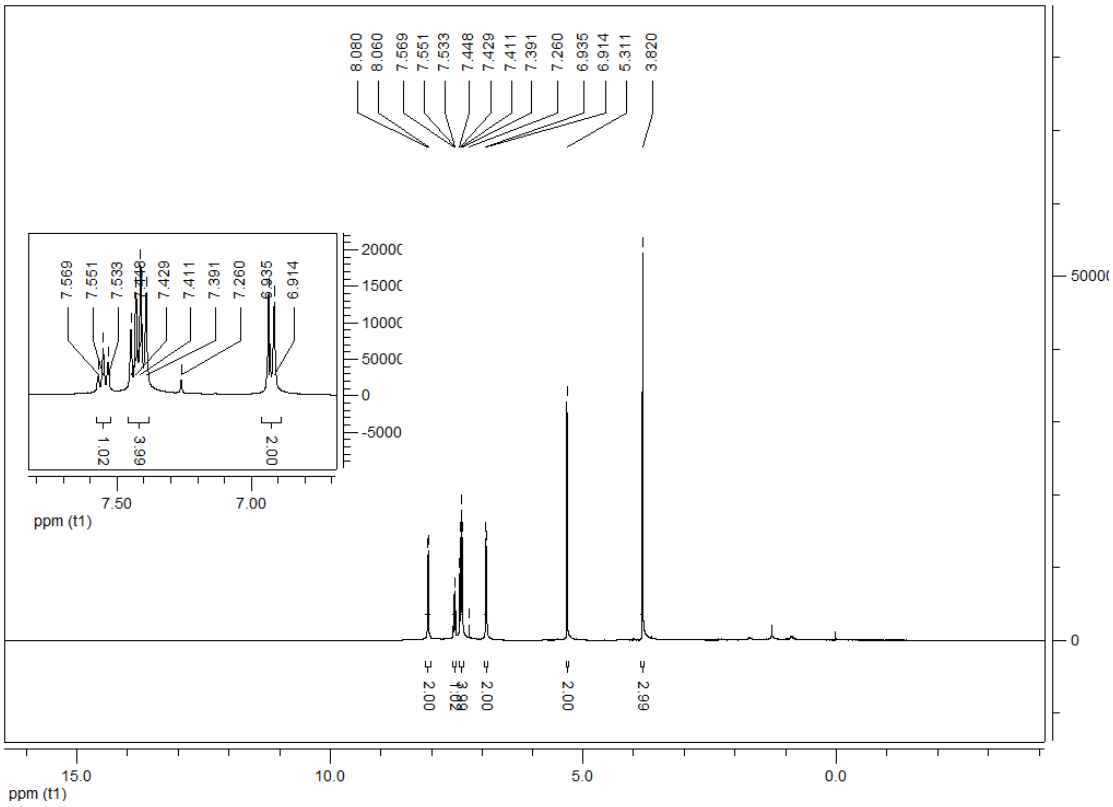

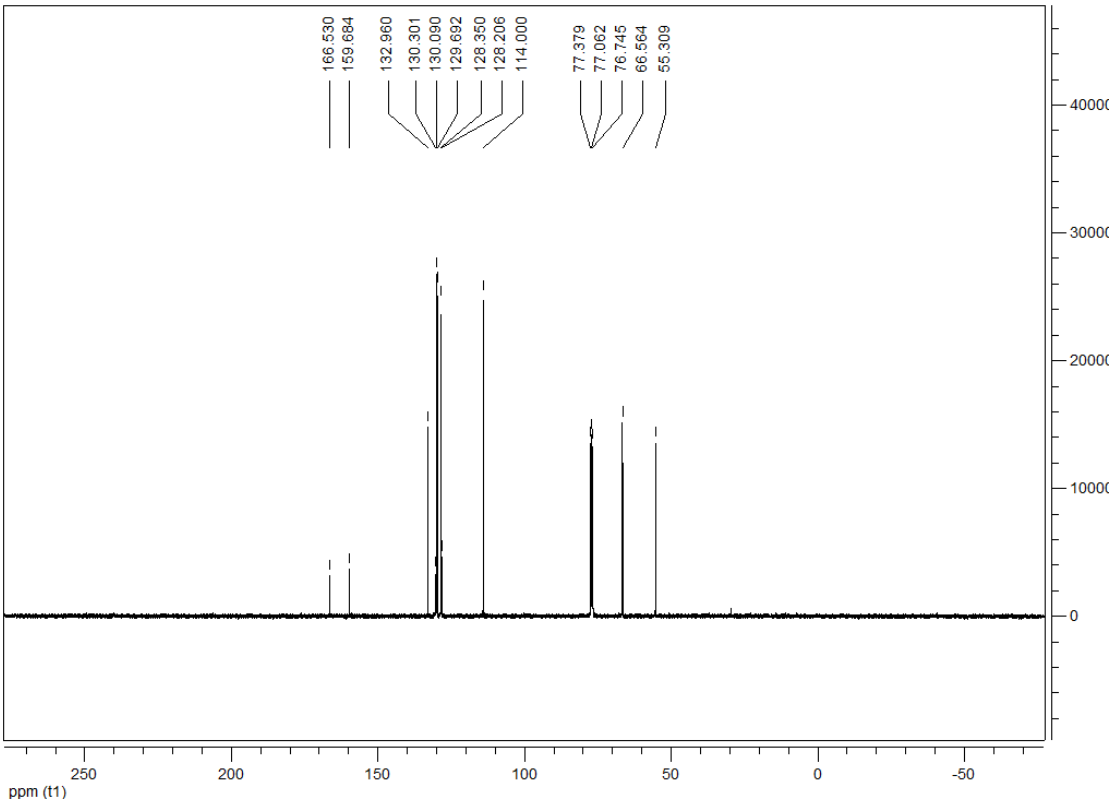

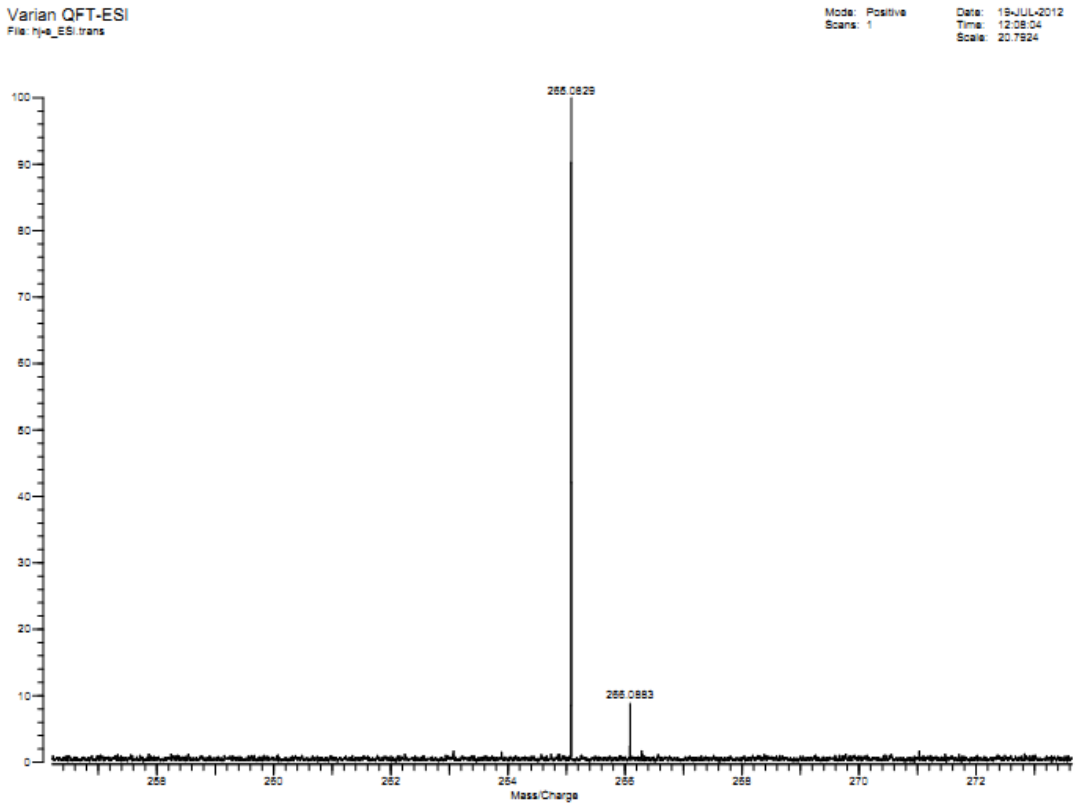

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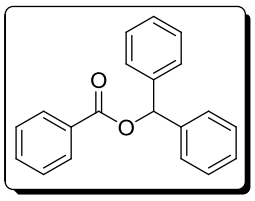

^{1}H NMR (400 MHz, $CDCl_3$): 8.21 (d, *J* = 7.2 Hz, 2H); 7.60 (t, *J* = 7.2 Hz, 1H); 7.51-7.47 (m, 6H); 7.40 (t, *J* = 7.2 Hz, 4H); 7.33 (t, *J* = 7.2 Hz, 2H); 7.19 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): 165.49; 140.23; 133.09; 130.16; 129.73; 128.51; 128.39; 127.91; 127.08; 76.68;

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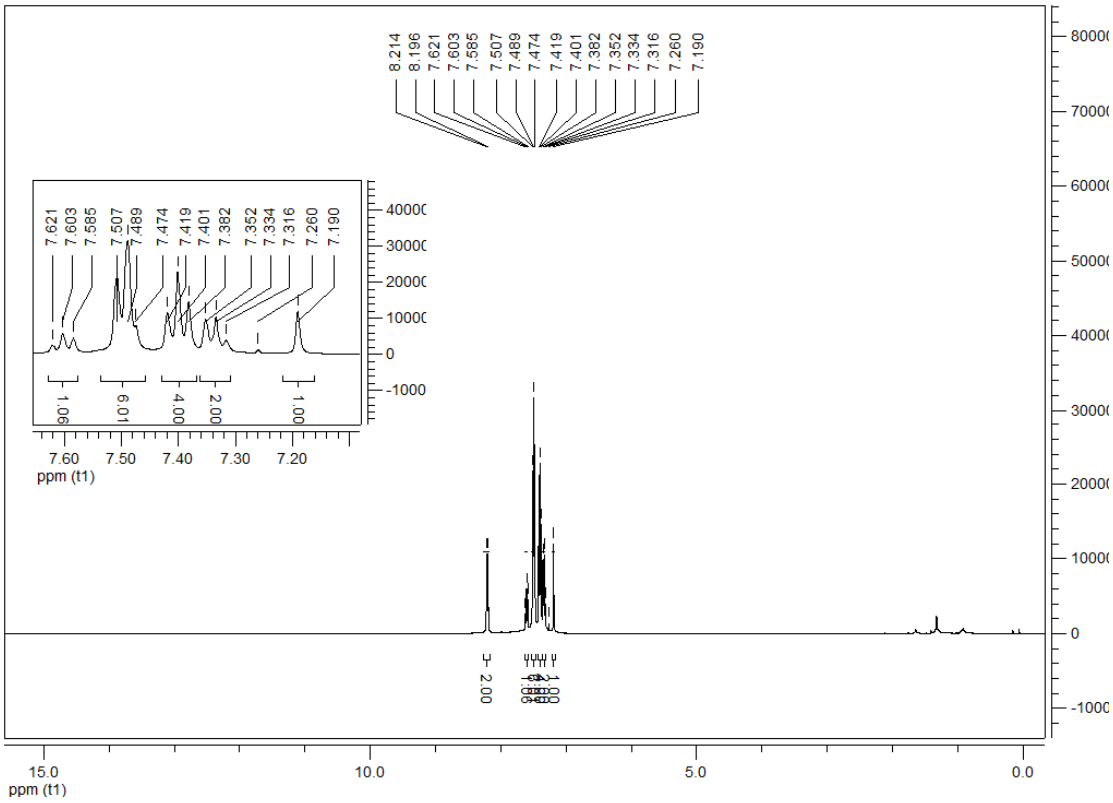

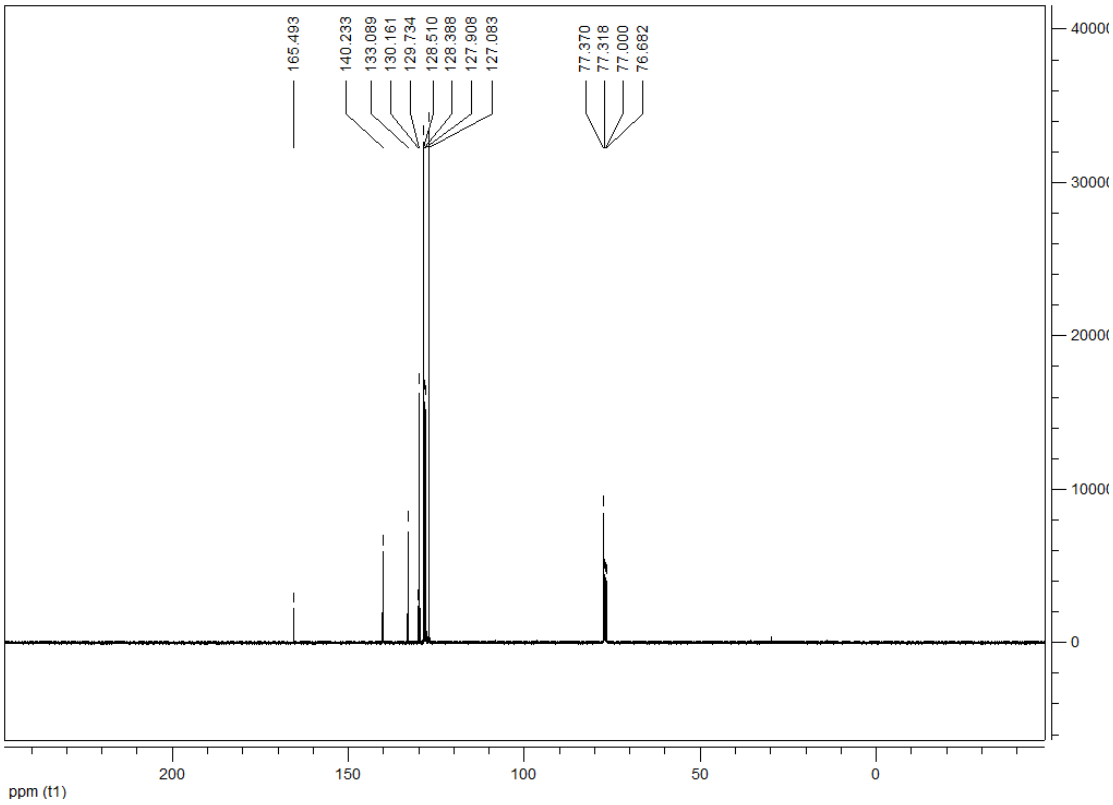

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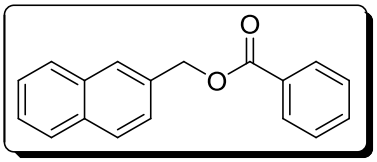
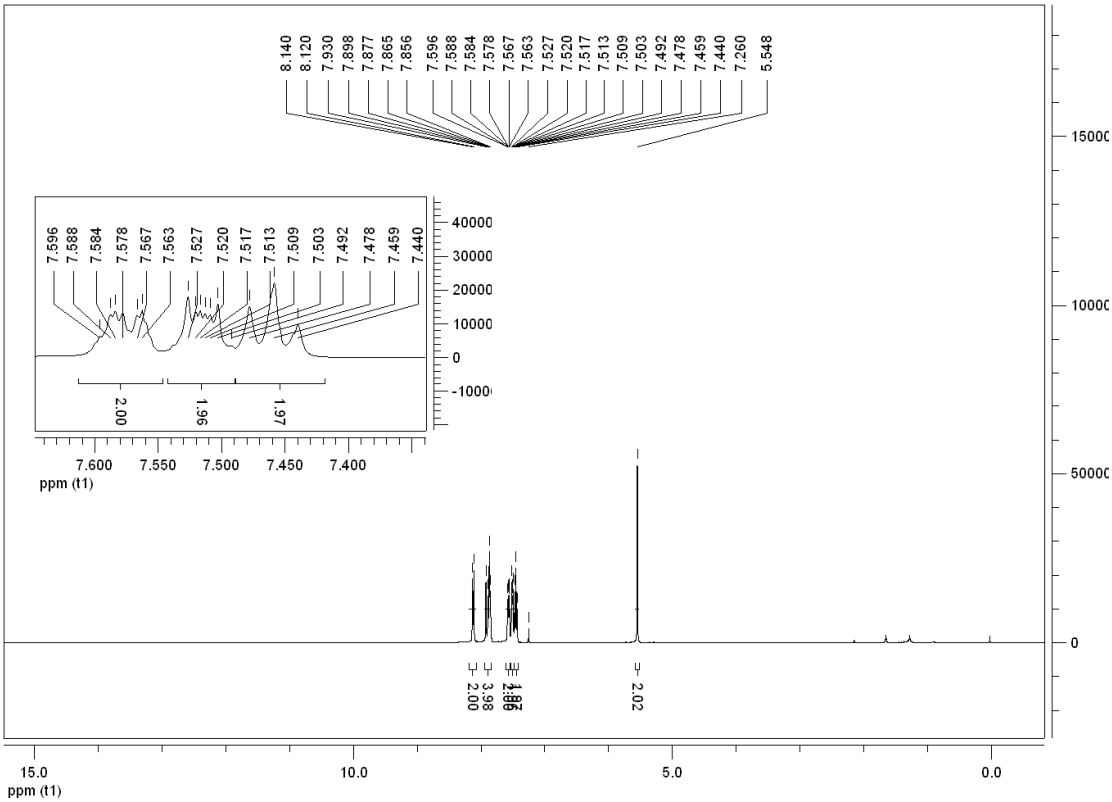


^{1}H NMR (400 MHz, $CDCl_3$): 8.13 (d, *J* = 8.0 Hz, 2H); 7.93-7.86 (m, 4H); 7.60-7.56 (m, 2H); 7.53-7.49 (m, 2H); 7.46 (t, *J* = 7.6 Hz, 2H); 5.55 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): 166.52; 133.51; 133.27; 133.19; 133.11; 130.18; 129.78; 128.45; 128.45; 128.06; 127.78; 127.38; 126.37; 126.33; 125.94; 66.92;



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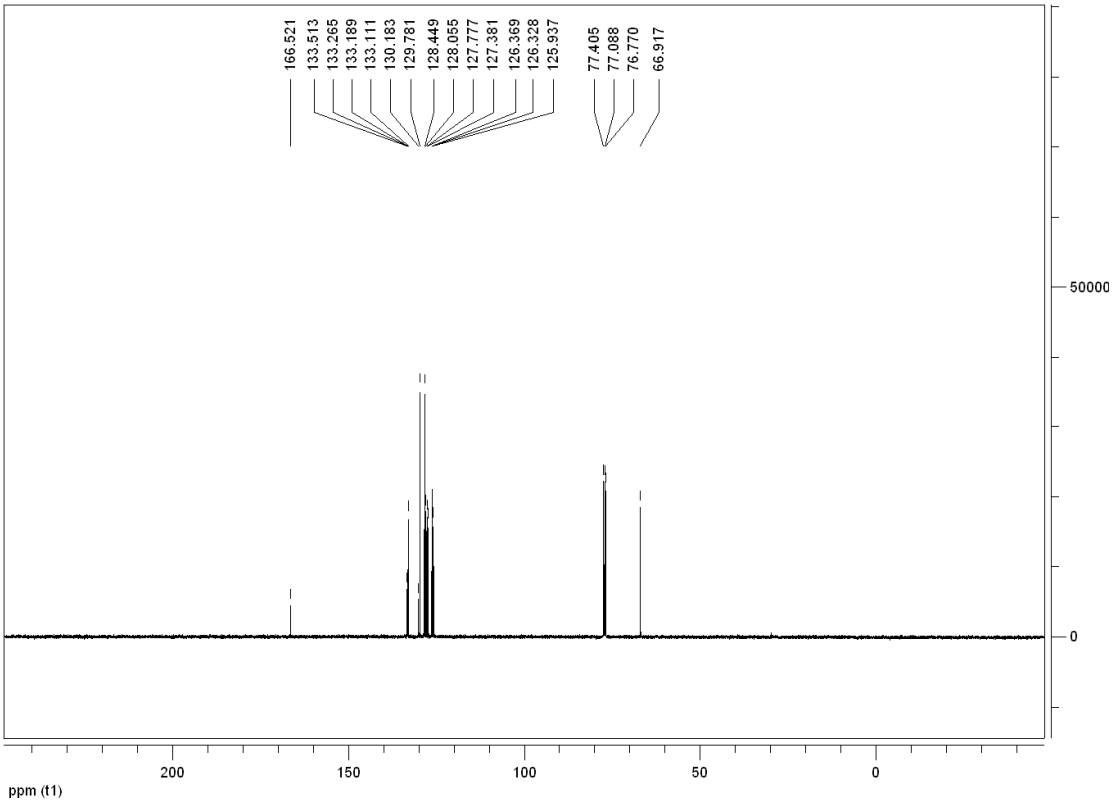

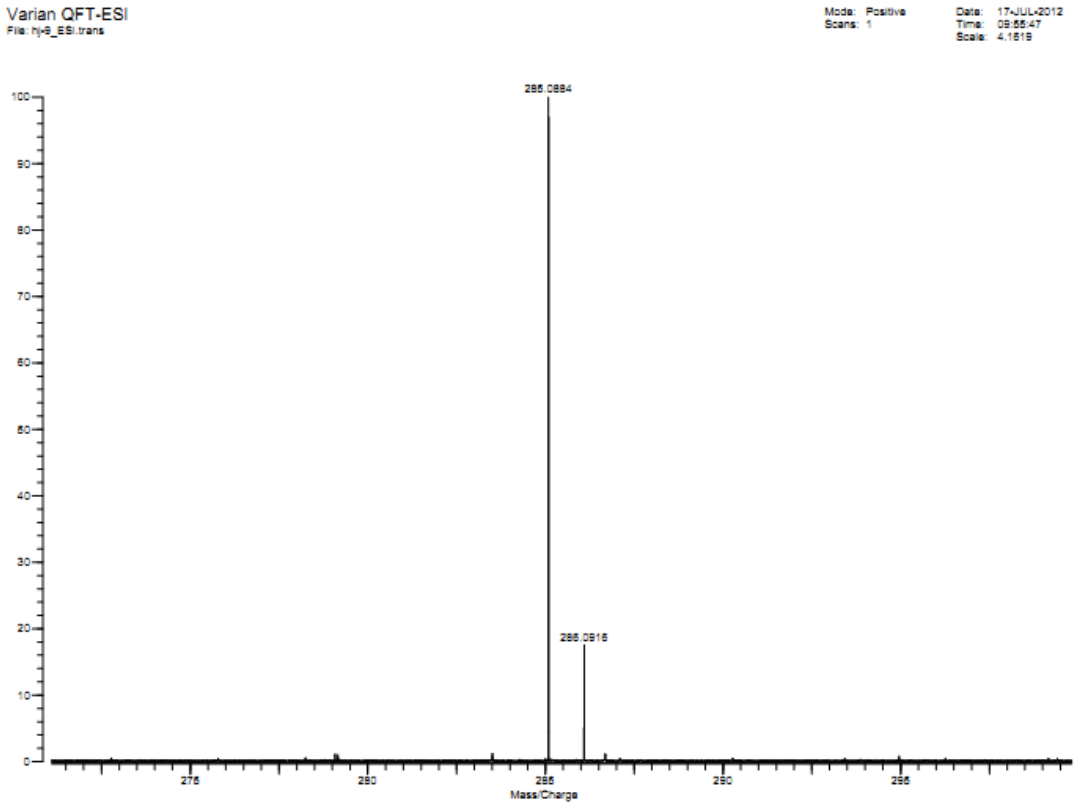

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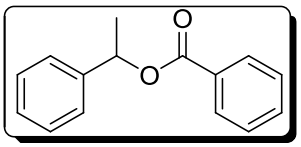
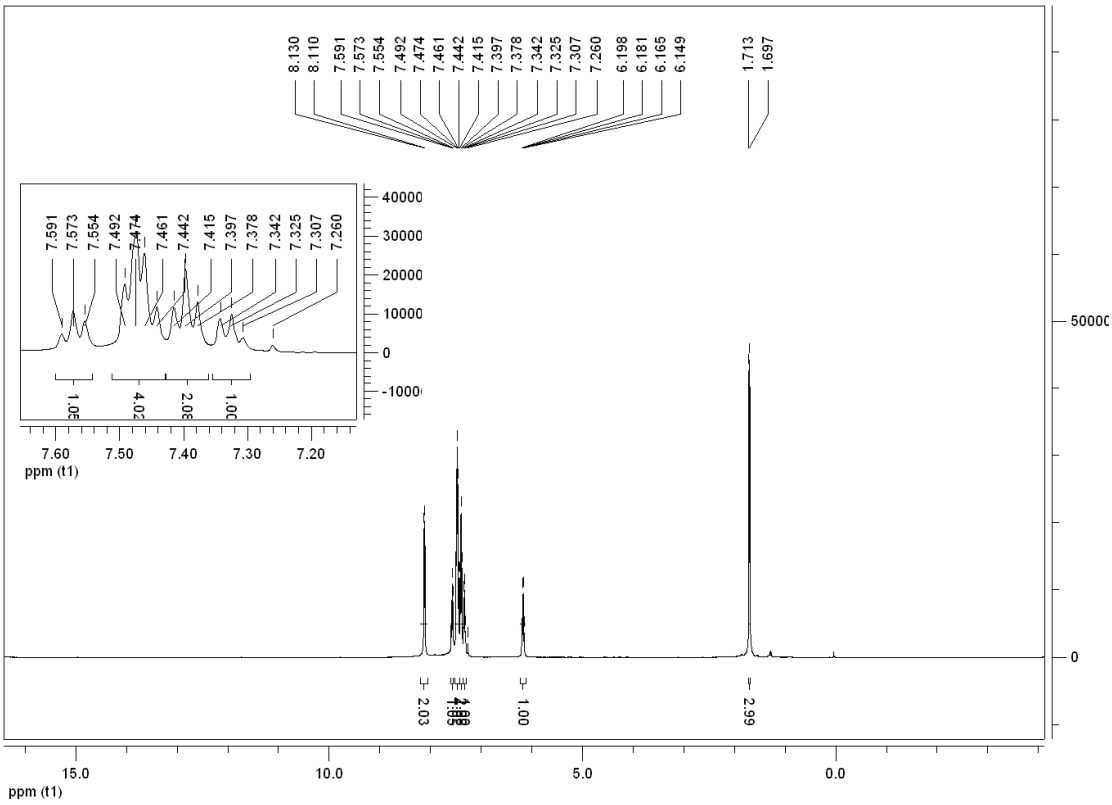
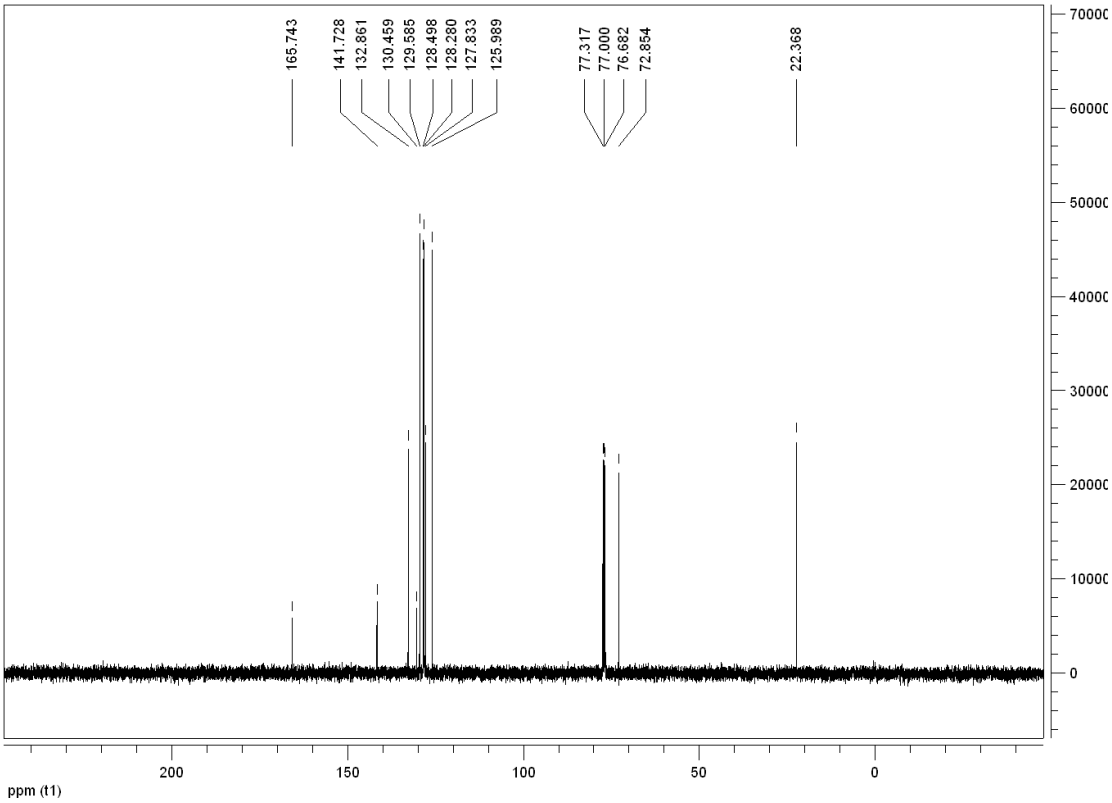
5j

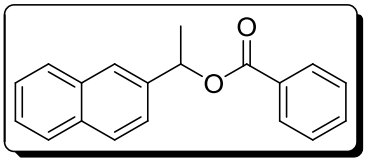


^{1}H NMR (400 MHz, $CDCl_3$): 8.12 (d, *J* = 8.0 Hz, 2H); 7.57 (t, *J* = 7.2 Hz, 1H); 7.49-7.44 (m, 4H); 7.40 (t, *J* = 7.2 Hz, 2H); 7.32 (t, *J* = 6.8 Hz, 1H); 6.17 (q, *J* = 6.8 Hz, 1H); 1.71 (d, *J* = 6.4 Hz, 3H);
^{13}C NMR (100 MHz, $CDCl_3$): 165.74; 141.73; 132.86; 130.46; 129.59; 128.50; 128.28; 127.83; 125.99; 72.85; 22.37;





5k



^{1}H NMR (400 MHz, $CDCl_3$): 8.14 (d, *J* = 7.6 Hz, 2H); 7.93-7.85 (m, 4H); 7.62-7.56 (m, 2H); 7.51-7.45 (m, 4H); 6.34 (q, *J* = 6.4 Hz, 1H); 1.79 (d, *J* = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): 165.90; 139.15; 133.25; 133.10; 132.99; 130.57; 129.72; 128.49; 128.41; 128.11; 127.72; 126.28; 126.12; 125.05; 124.12; 73.11; 22.39; HRMS (ESI): calculated for $C_{19}H_{16}O_2Na$, $[M+Na]^+$: 299.1043, found 299.1043.

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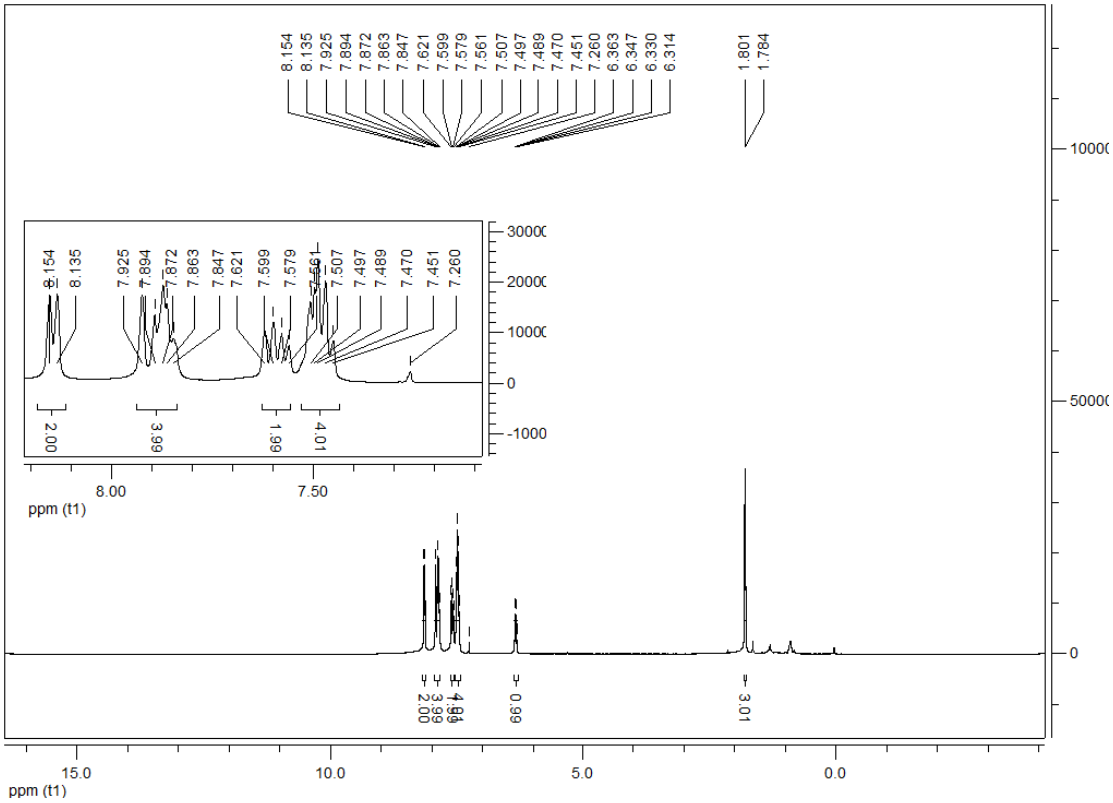
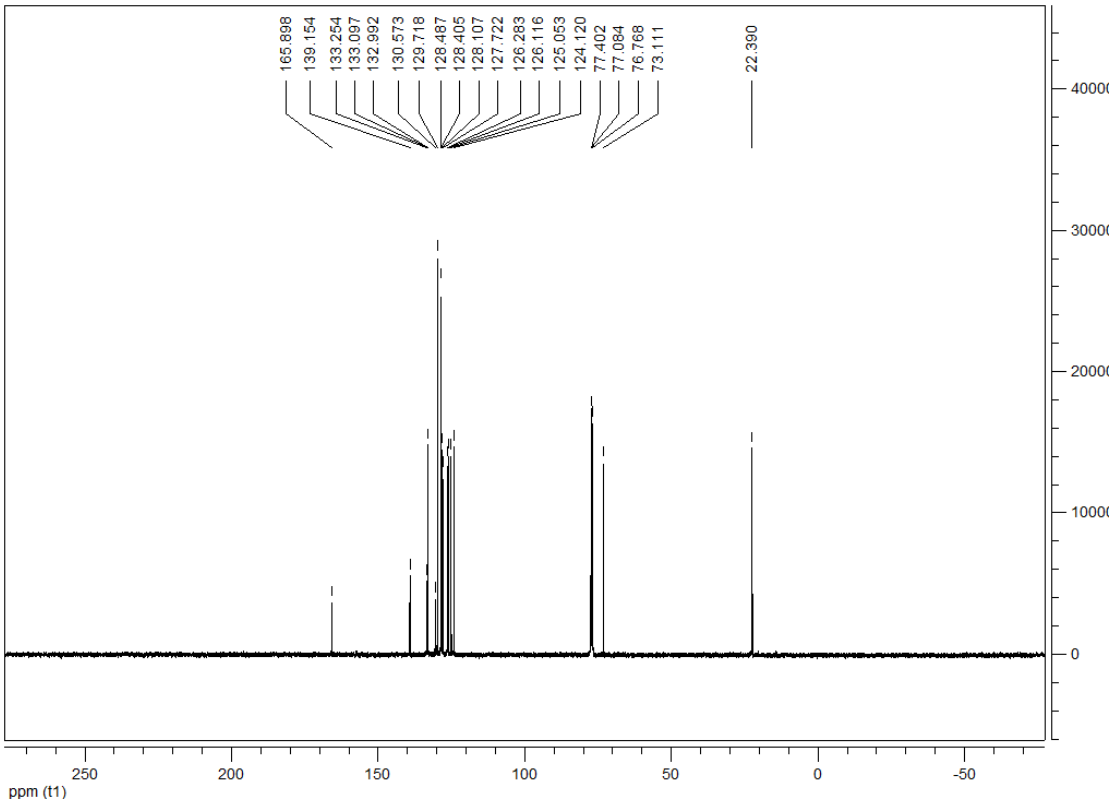
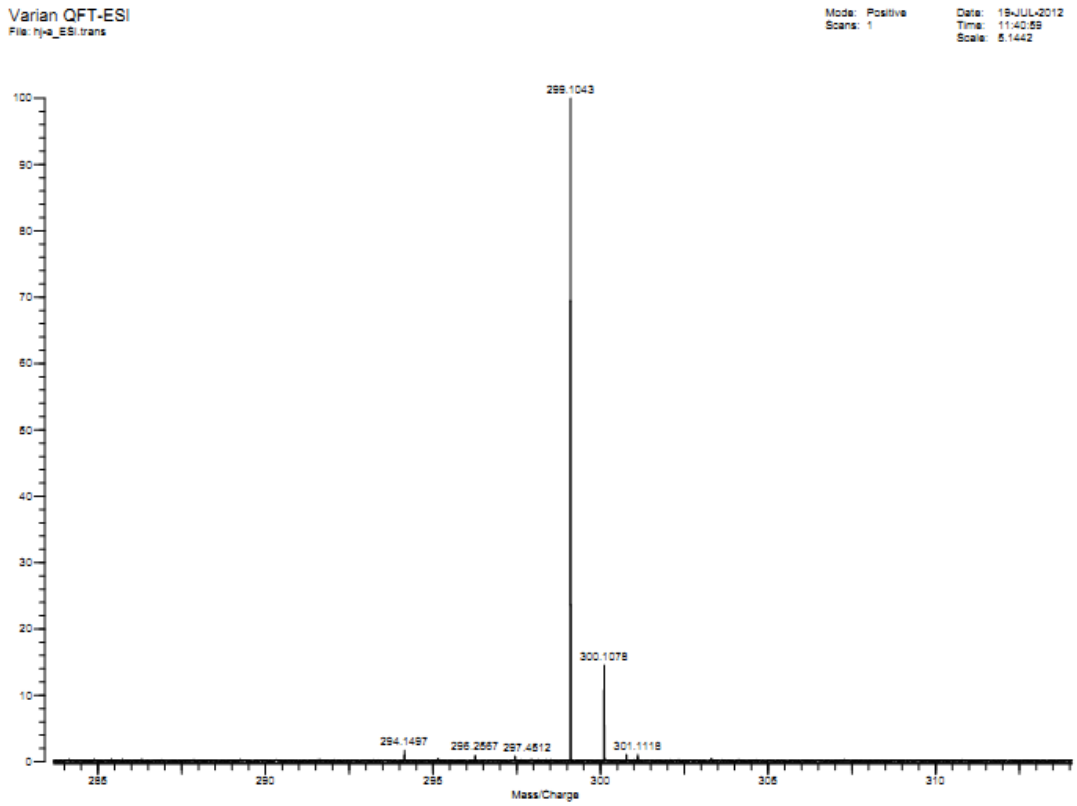
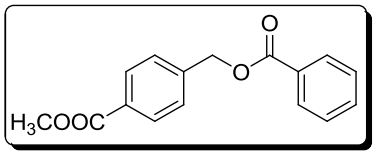






5l



^{1}H NMR (400 MHz, $CDCl_3$): 8.10-8.05 (m, 4H); 7.58 (t, *J* = 7.2 Hz, 1H); 7.51 (d, *J* = 8.0 Hz, 2H); 7.46 (t, *J* = 7.6 Hz, 2H); 5.42 (s, 2H); 3.92 (s, 3H);^{13}C NMR (100 MHz, $CDCl_3$): 166.71; 166.24; 141.08; 133.21; 129.88; 129.88; 129.78; 129.70; 128.44; 127.61; 65.88; 52.16; HRMS (ESI): calculated for $C_{16}H_{14}O_4Na$, $[M+Na]^+$: 293.0784, found 293.0785.

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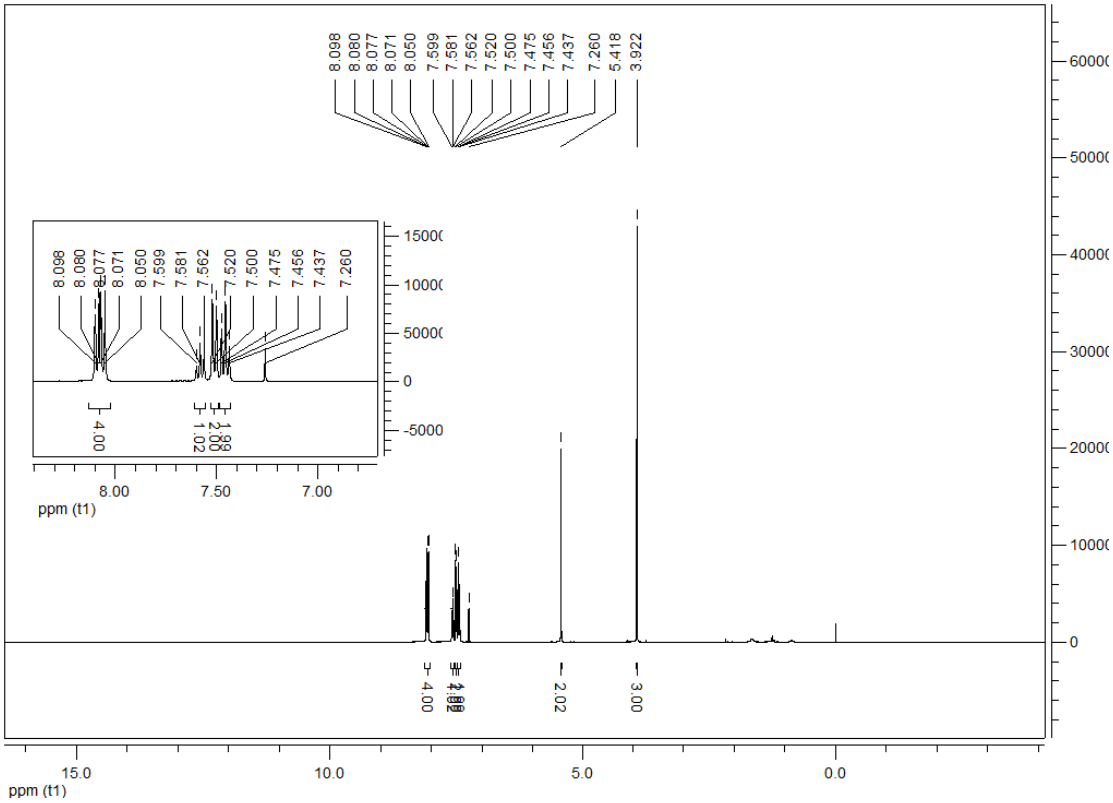

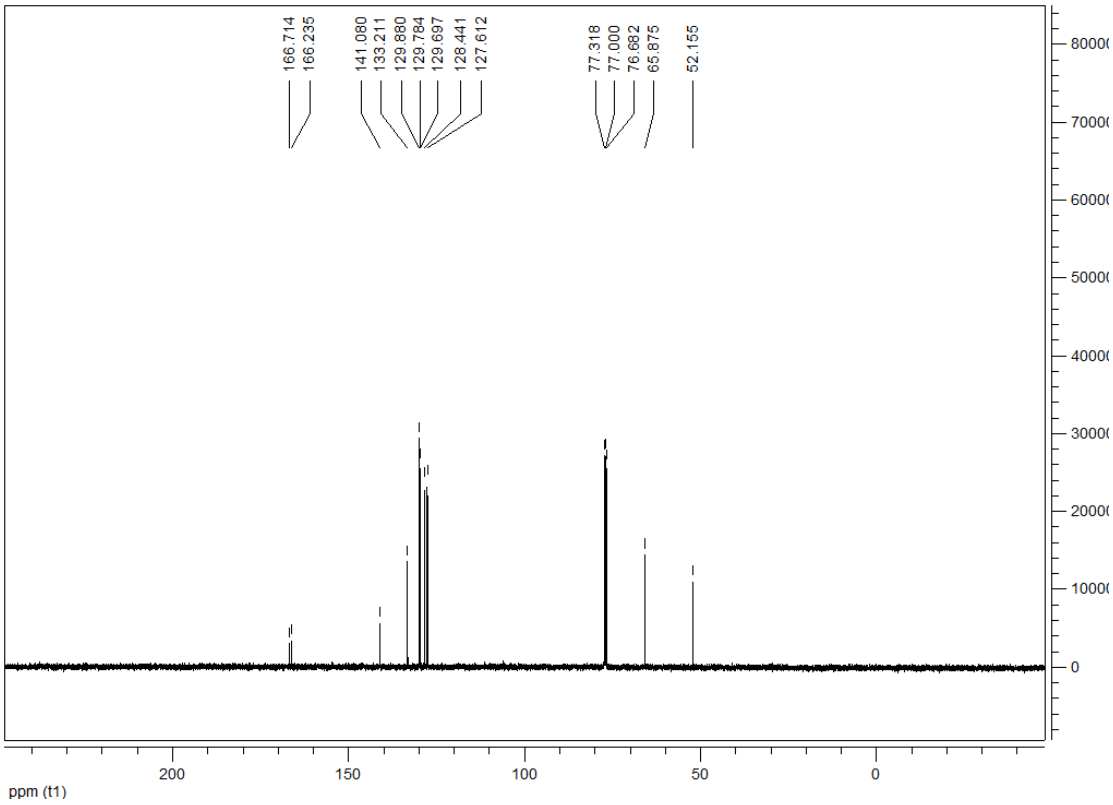

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