

## **Electronic Supporting Information for:**

### **Intramolecular Povarov Reactions Involving 3-Aminocoumarins**

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- 1. Experimental procedures and characterization data for  
compounds 23, 32, 33, 35, 37, 54, 59, and 60** **S2–S7**
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## 1. Experimental Procedures and Characterization Data for Compounds **23**, **32**, **33**, **35**, **37**, **54**, **59**, and **60**.

**1. Synthesis of 2-(cinnamyloxy)benzaldehyde (23).** A mixture of salicylaldehyde (**10**) (0.54 g, 4.4 mmol), anhydrous K<sub>2</sub>CO<sub>3</sub> (0.61 g, 4.4 mmol), cinnamyl bromide (**22**) (0.79 g, 4.0 mmol) and acetone (20 mL) was stirred at room temperature under a nitrogen atmosphere for 16 h. The mixture was subjected to suction filtration and the solids were washed with acetone. The filtrate was concentrated under reduced pressure and the residue was redissolved in chloroform. The resulting solution was washed sequentially with 1 M NaOH solution and brine. The organic layer was dried over anhydrous sodium sulfate and the solvent was removed under reduced pressure. The residue was crystallized from ethyl acetate/hexanes to afford **23** (0.88 g, 91% yield). mp = 51-52 °C (lit.<sup>13</sup> 50-51 °C).  $\delta_{\text{H}}(\text{CDCl}_3)$  = 10.57 (s, 1H, CHO), 7.85 (dd,  $J$  = 7.7, 1.8 Hz, 1H), 7.55-7.51 (m, 1H), 7.41 (d,  $J$  = 7.7 Hz, 2H), 7.34 (t,  $J$  = 7.7 Hz, 2H), 7.28-7.24 (m, 1H), 7.05-7.02 (m, 2H), 6.76 (d,  $J$  = 15.3 Hz, 1H), 6.42 (dt,  $J$  = 15.4, 5.6 Hz, 1H), 4.81 (dd,  $J$  = 5.7, 1.5 Hz, 2H) ppm;  $\delta_{\text{C}}(\text{CDCl}_3)$  = 189.9, 161.2, 136.3, 136.0, 133.7, 128.9, 128.7, 128.4, 126.8, 125.4, 123.6, 121.1, 113.1, 69.4 ppm.

**2. Synthesis of 2-(4-bromocinnamyloxy)benzaldehyde (32).** A mixture of salicylaldehyde (**10**) (0.147 g, 1.20 mmol), bromide **30** (0.348 g, 1.26 mmol) and anhydrous K<sub>2</sub>CO<sub>3</sub> (0.174 g, 1.26 mmol) in acetone (12.0 mL) was heated at reflux for 4.5 h. The reaction mixture was then allowed to cool to room temperature and filtered

through a pad of Celite<sup>®</sup> under suction and washed with acetone. The solvent was removed from the filtrate under reduced pressure and the residue was subjected to flash chromatography (5-10% ethyl acetate/hexanes) to afford **32** as a white solid (0.308 g, 81%). mp = 83-84 °C.  $\delta_{\text{H}}(\text{CDCl}_3)$  = 10.56 (s, 1H, CHO), 7.86 (dd,  $J$  = 7.7, 2.3 Hz, 1H), 7.56-7.53 (m, 1H), 7.47 (m, 2H), 7.28 (m, 2H), 7.07-7.02 (m, 2H), 6.71 (d,  $J$  = 15.4 Hz, 1H, H-4'), 6.42 (dt,  $J$  = 15.6, 5.9 Hz 1H, H-3'), 4.82 (d,  $J$  = 5.3 Hz, 2H, H-2') ppm;  $\delta_{\text{C}}(\text{CDCl}_3)$  = 189.9 (CHO), 161.1, 136.1, 135.3, 132.4, 132.0, 128.9, 128.3, 125.4, 124.5, 122.2, 121.3 (C-3'), 113.1 (C-2'), 69.1 (C-1') ppm; MS  $m/z$  (relative intensity) = 318 ( $\text{M}^+ + 2$ , 15), 317 ( $\text{M}^+ + 1$ , 15), 315 (18), 299 (54), 197 (74), 116 (100), 99 (16); HRMS [ $\text{M}^+$ ] calcd for  $\text{C}_{16}\text{H}_{13}\text{BrO}_2$  316.0099, found 316.0097.

**3. Synthesis of 2-(4-nitrocinnamyloxy)benzaldehyde (33).** A mixture of salicylaldehyde (**10**) (0.140 mL, 1.33 mmol), bromide **32** (0.339 g, 1.40 mmol) and anhydrous  $\text{K}_2\text{CO}_3$  (0.194 g, 1.40 mmol) in acetone (10.0 mL) was heated at reflux for 4 h. The reaction mixture was then allowed to cool to room temperature and suction filtered through a pad of Celite<sup>®</sup>. The filter cake was washed with acetone and the solvent was removed from the filtrate under reduced pressure. The yellow residue was subjected to flash chromatography (5-20% ethyl acetate/petroleum ether) to afford **33** as a pale yellow solid (0.254 g, 67%) and recovered starting material **41** (0.049 g, 30%) as a colorless liquid. **33**: mp = 91-92 °C.  $\delta_{\text{H}}(\text{CDCl}_3)$  = 10.57 (s, 1H, CHO), 8.20 (m, 2H, H-7'), 7.87 (dd,  $J$  = 7.5, 1.1 Hz, 1H, H-6), 7.58-7.55 (m, 3H, H-4, H-6'), 7.08 (t,  $J$  = 7.2 Hz, 1H, H-5), 7.04 (d,  $J$  = 7.9 Hz, 1H, H-3), 6.86 (d,  $J$  = 15.8

Hz, 1H, H-4'), 6.62 (dt,  $J = 15.3, 4.9$  Hz, 1H, H-3'), 4.89 (dd,  $J = 5.2, 2.2$  Hz, 2H, H-2') ppm;  $\delta_{\text{C}}(\text{CDCl}_3) = 189.7$  (CHO), 160.8 (C-2), 147.5 (C-8'), 142.7 (C-5'), 136.1 (C-4), 130.8 (C-4'), 129.0 (C-6), 128.6 (C-3'), 127.3 (C-6'), 125.4 (C-1), 124.3 (C-7'), 121.5 (C-5), 113.0 (C-3), 68.6 (C-2') ppm; MS  $m/z$  (relative intensity) =  $M^+$  not observed, 266 ( $M^+-17, 22$ ), 214 (100). HRMS [ $M^+$ ] calcd for  $\text{C}_{16}\text{H}_{13}\text{NO}_4$  283.0845 found 283.0844.

**4. Synthesis of 2-(cinnamyloxy)-3-methoxybenzaldehyde (35).** A mixture of *o*-vanillin (**34**) (0.46 g, 3.0 mmol), cinnamyl bromide (0.62 g, 3.2 mmol) (**22**) and anhydrous  $\text{K}_2\text{CO}_3$  (0.44 g, 3.2 mmol) in acetone (30 mL) was heated at reflux for 3 h. The reaction mixture was allowed to cool to room temperature and then suction filtered through a pad of Celite<sup>®</sup> and the filter cake was washed with acetone. The solvent was removed from the filtrate under reduced pressure and the residue was subjected to flash chromatography (10% ethyl acetate/hexanes) to afford **35** as a thick gum (0.77 g, 96%).  $\delta_{\text{H}}(\text{CDCl}_3) = 10.49$  (s, 1H), 7.42 (dd,  $J = 7.1, 2.5$  Hz, 1H), 7.38-7.37 (m, 2H), 7.31 (t,  $J = 7.5$  Hz, 2H), 7.25 (t,  $J = 7.3$  Hz, 1H), 7.16-7.11 (m, 2H), 6.66 (d,  $J = 15.6$  Hz, 1H), 6.43 (m, 1H), 4.82 (d,  $J = 6.4$  Hz, 2H), 3.92 (s, 3H) ppm;  $\delta_{\text{C}}(\text{CDCl}_3) = 190.5, 153.3, 151.4, 136.4, 134.6, 130.4, 128.8, 128.3, 126.8, 124.4, 119.4, 118.2, 75.3, 56.3$  ppm (one carbon signal fewer than expected); MS  $m/z$  (relative intensity) =  $M^+$  not observed, 251 ( $M^+-17, 100$ ). HRMS [ $M^+$ ] calcd for  $\text{C}_{17}\text{H}_{16}\text{O}_3$  268.1099 found 268.1108.

**5. Synthesis of 5-bromo-2-(cinnamyloxy)benzaldehyde (37).** A mixture of 5-bromosalicylaldehyde (**36**) (0.10 g, 0.50 mmol), cinnamyl bromide (0.11 g, 0.53 mmol) (**22**) and anhydrous  $K_2CO_3$  (0.073 g, 0.53 mmol) in acetone (5 mL) was heated at reflux for 5 h. The reaction mixture was allowed to cool to room temperature and then suction filtered through a pad of Celite<sup>®</sup> and the filter cake was washed with acetone. The solvent was removed from the filtrate under reduced pressure and the residue was subjected to flash chromatography (10% ethyl acetate/hexanes) to afford **37** as a pale yellow solid (0.15 g, 94%). mp = 69-71 °C;  $\delta_H(CDCl_3)$  = 10.51 (s, 1H, CHO), 7.66 (d,  $J$  = 2.3 Hz, 1H), 7.42-7.39 (m, 3H), 7.32-7.30 (m, 2H), 7.24 (dd,  $J$  = 7.4, 2.6 Hz, 1H), 6.93 (d,  $J$  = 7.8 Hz, 1H), 6.72 (d,  $J$  = 15.7 Hz, 1H), 6.45-6.41 (m, 1H), 4.69 (d,  $J$  = 6.5 Hz, 2H) ppm;  $\delta_C(CDCl_3)$  = 190.7, 159.2, 136.7, 136.5, 133.8, 130.3, 128.4, 128.3, 127.9, 126.1, 124.4, 124.3, 114.2, 70.2 ppm; MS  $m/z$  (relative intensity) =  $M^+$  not observed, 118 (100);. HRMS [ $M^+$ ] calcd for  $C_{16}H_{13}BrO_2$  316.0099 found 316.0105.

**6. Synthesis of 4-acetyl-1-[(E)-cinnamyl]pyrrole-2-carbaldehyde (54).** To a clear yellow solution of **53** (0.14 g, 1.0 mmol) in freshly distilled DMF (2.0 mL) was added sodium hydride (60% dispersion in mineral oil, 0.044 g, 1.1 mmol) at 0 °C followed by the addition of cinnamyl bromide (0.22 g, 1.1 mmol) (**22**). The resulting turbid orange mixture was stirred at rt for 1 h. The reaction was quenched by the addition of few drops of methanol. Ice-cold water was then added and the mixture was suction filtered. The solids were washed with cold 5% ethyl acetate/hexanes to afford **54** as a pale yellow solid (0.12 g, 46%). The filtrate was diluted with water

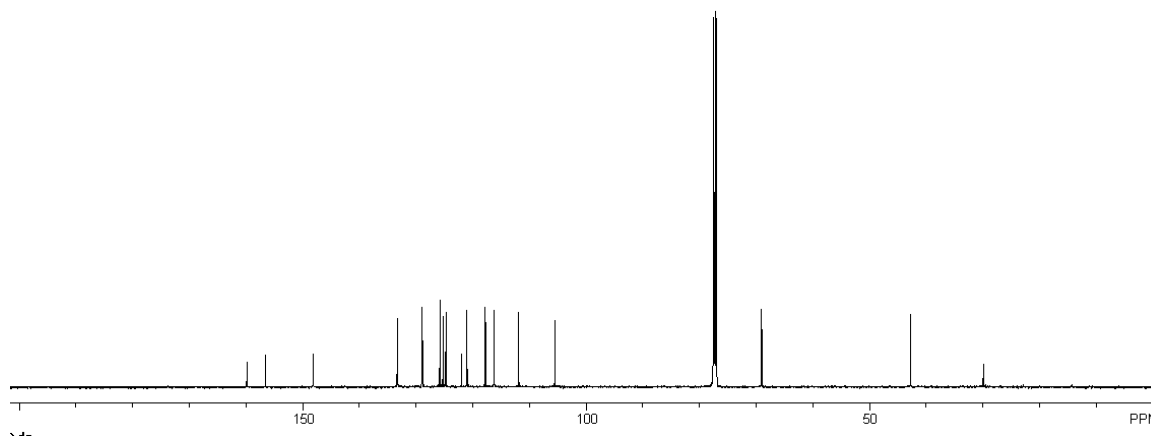
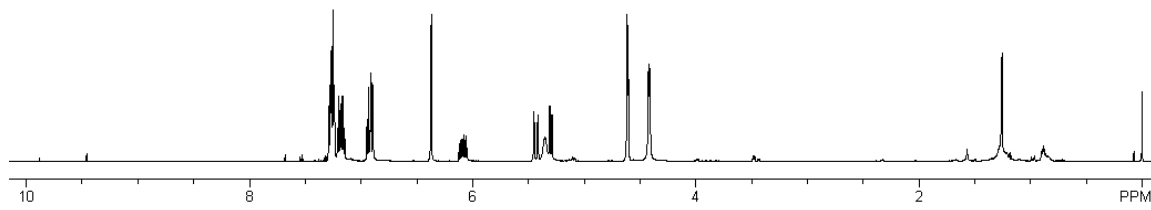
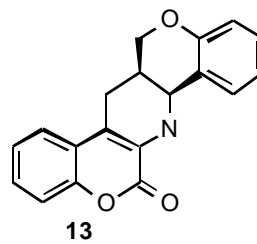
and extracted with ethyl acetate (2 × 10 mL). The combined organic layers were washed with water, washed with brine, dried over anhydrous sodium sulfate and the solvent was removed under reduced pressure. The resulting yellow residue was subjected to flash chromatography (15% ethyl acetate/hexanes) to afford **54** as a pale yellow solid (0.046 g, 18%). Combined yield = 0.166 g, 64%. mp = 161-162 °C.  $\delta_{\text{H}}(\text{CDCl}_3)$  = 9.63 (s, 1H, *CHO*), 7.59 (s, 1H), 7.36-7.35 (m, 3H), 7.32-7.29 (m, 2H), 7.25 (m, 1H), 6.54 (d,  $J$  = 15.7 Hz, 1H, H-3'), 6.30 (ddd,  $J$  = 15.9, 12.6, 3.2 Hz, 1H, H-2'), 5.13 (d,  $J$  = 6.2 Hz, 2H, H-1'), 2.44 (s, 3H, *COCH*<sub>3</sub>) ppm;  $\delta_{\text{C}}(\text{CDCl}_3)$  = 192.7 (*CHO*), 180.3 (*COCH*<sub>3</sub>), 135.9, 134.4, 133.0, 132.2, 128.8, 128.4, 126.8, 126.4, 124.2, 123.7, 51.4 (C-1'), 27.4 (*COCH*<sub>3</sub>) ppm; MS  $m/z$  (relative intensity) = 254 ( $\text{M}^+ + 1$ , 100), 211 (65); HRMS [ $\text{M}^+$ ] calcd for  $\text{C}_{16}\text{H}_{15}\text{NO}_2$  253.2958 found 253.2964.

**7. Synthesis of (*E*)-cinnamic acid 2-formylphenyl ester (**59**).** A mixture of salicylaldehyde (**10**) (0.244 g, 2.00 mmol), *trans*-cinnamic acid (**57**) (0.445 g, 3.00 mmol), DCC (0.619 g, 3.00 mmol) and DMAP (0.037 g, 0.30 mmol) in dichloromethane (5.00 mL) was stirred at room temperature for 3 h. The mixture was then diluted with dichloromethane (20 mL) and successively washed with water (2 × 10 mL), NaHSO<sub>4</sub> solution (10 mL), saturated NaHCO<sub>3</sub> solution (10 mL) and brine (10 mL). The organic layer was dried over anhydrous sodium sulfate and filtered. The solvent was removed under reduced pressure and the residue was subjected to flash chromatography (10-15% ethyl acetate/hexanes) to afford **59** as a white solid (0.455 g, 90%). mp = 76-77 °C (lit.<sup>22</sup> 76.1-76.5 °C).  $\delta_{\text{H}}(\text{CDCl}_3)$  = 10.21 (s, 1H, *CHO*), 7.96-

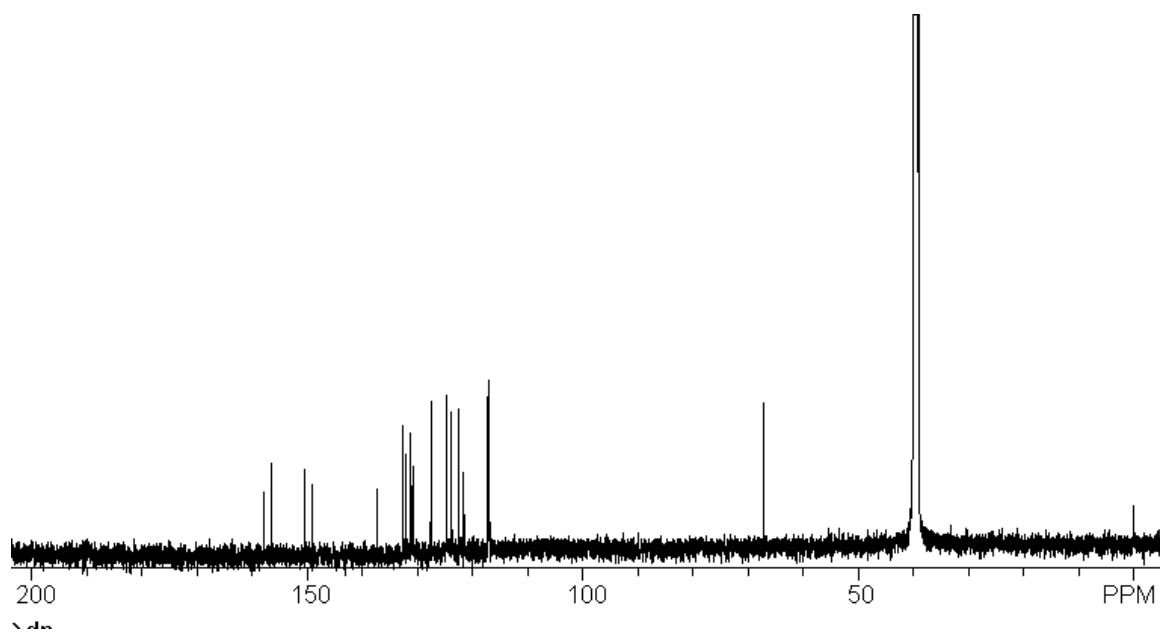
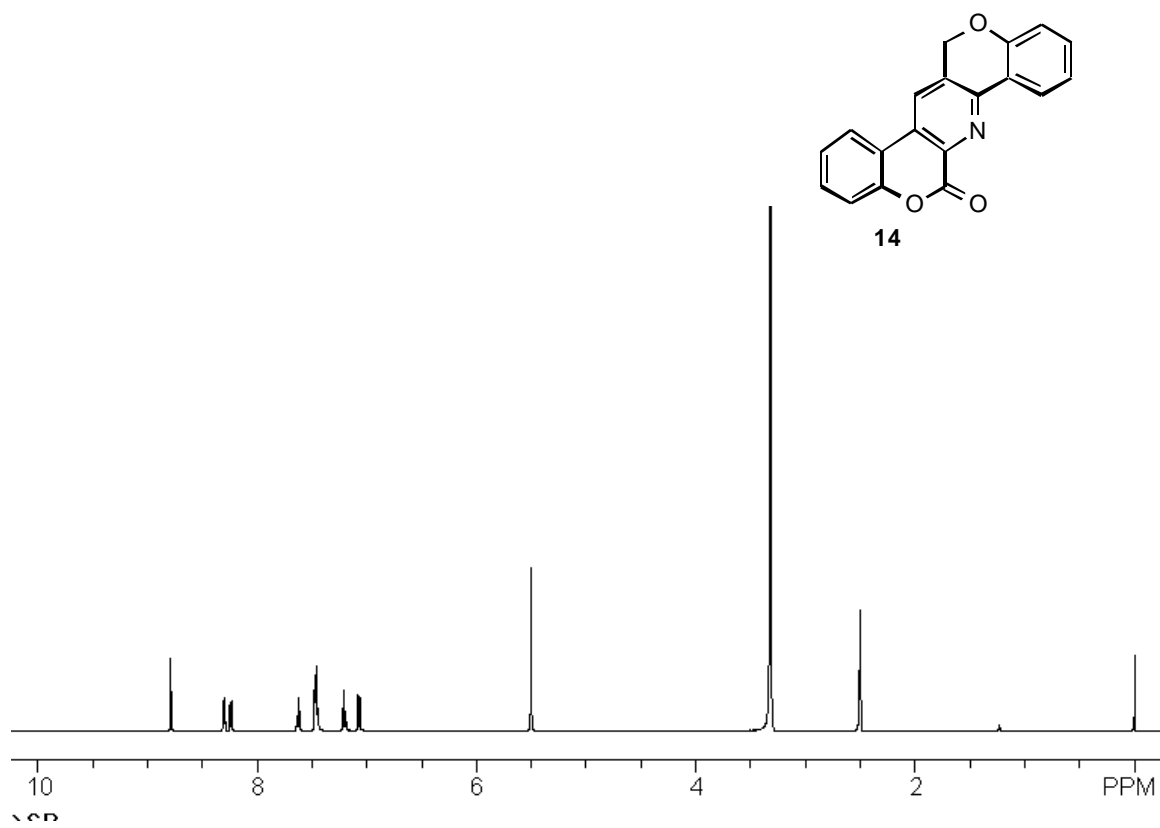
7.93 (m, 2H), 7.66-7.64 (m, 1H), 7.62 (br m, 2H), 7.44-7.40 (m, 4H), 7.29 (d,  $J = 7.9$  Hz, 1H), 6.70 (d,  $J = 15.9$  Hz, 1H) ppm;  $\delta_{\text{C}}(\text{CDCl}_3) = 188.8$  (*CHO*), 165.3, 152.3, 147.8, 135.4, 133.9, 131.2, 130.1, 129.2, 128.5, 128.2, 126.3, 123.5, 116.3 ppm.

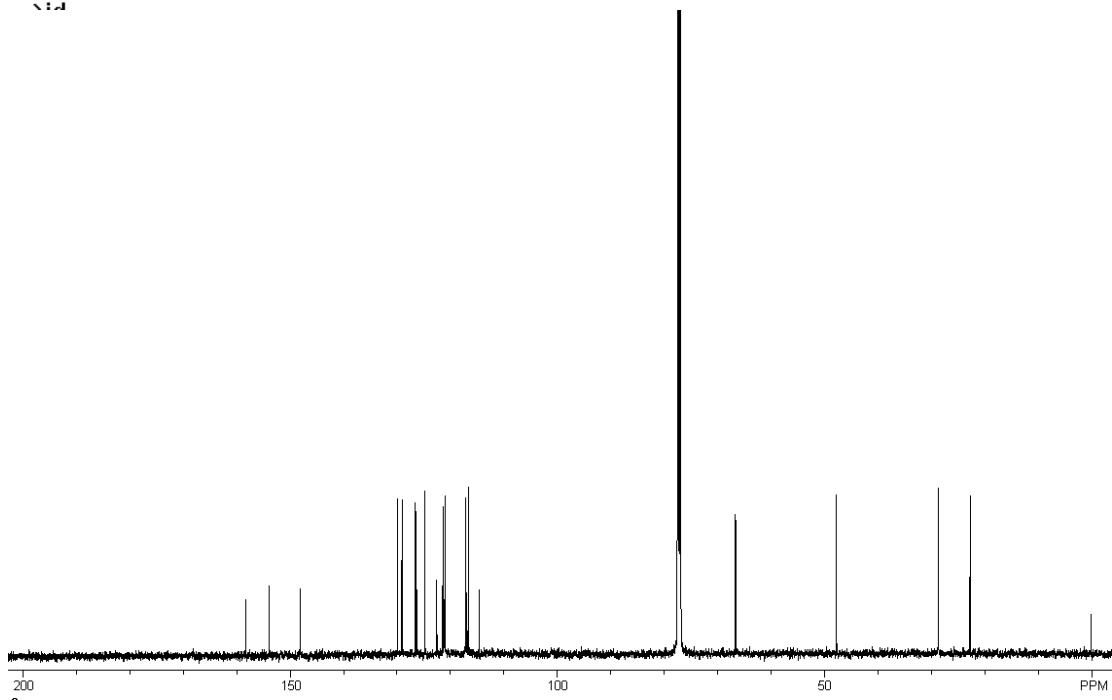
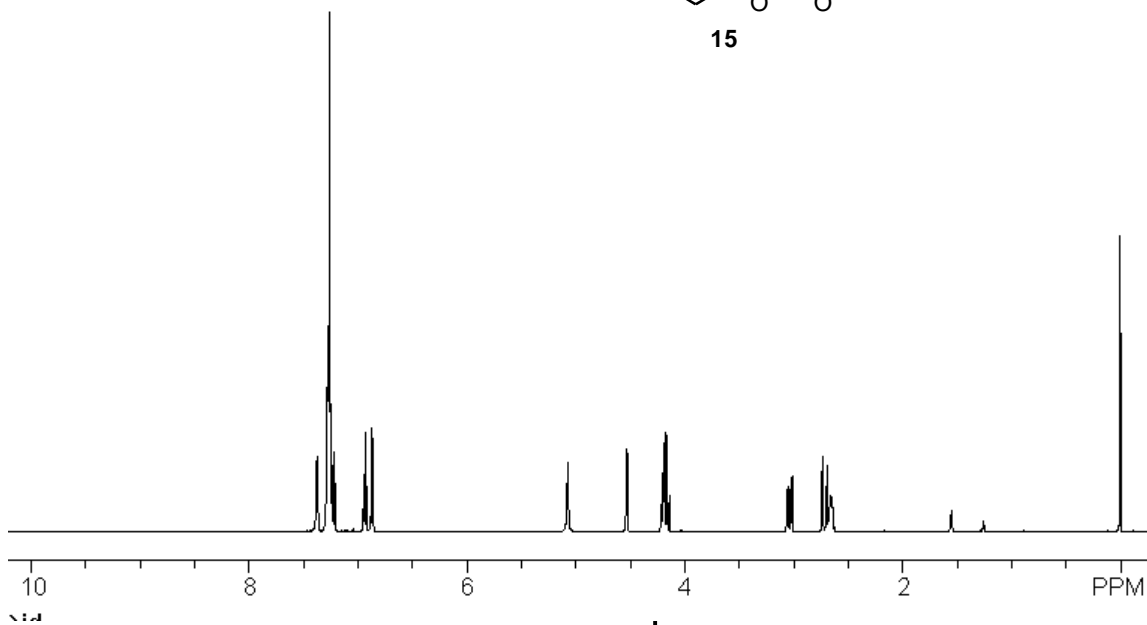
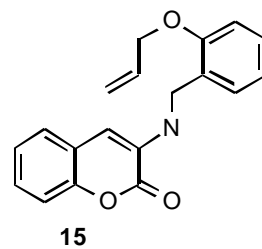
**8. Synthesis of (*E*)-2,3-dimethoxycinnamic acid 2-formylphenyl ester (60).** A mixture of salicylaldehyde (**10**) (0.244 g, 2.00 mmol), 2,3-dimethoxy *trans*-cinnamic acid (**58**) (0.625 g, 3.00 mmol), DCC (0.619 g, 3.00 mmol) and DMAP (0.049 g, 0.40 mmol) in dichloromethane (10 mL) was stirred at room temperature for 24 h and then heated at reflux for 24 h. The mixture was cooled to room temperature, diluted with dichloromethane (20 mL) and successively washed with water (2 × 10 mL), NaHSO<sub>4</sub> (10 mL), saturated NaHCO<sub>3</sub> (10 mL) and brine (10 mL). The organic layer was dried over anhydrous Na<sub>2</sub>SO<sub>4</sub>, filtered and the solvent was removed under reduced pressure. The residue was subjected to flash chromatography on silica gel column (10-15% ethyl acetate/hexanes) to afford **60** as a colorless oil (0.112 g, 18%).  $\delta_{\text{H}}(\text{CDCl}_3) = 10.23$  (s, 1H, *CHO*), 8.25 (d,  $J = 16.7$  Hz, 1H, H-3), 7.94 (dd,  $J = 7.5, 1.4$  Hz, 1H, H-3'), 7.68-7.64 (m, 1H, H-5'), 7.40 (t,  $J = 7.6$  Hz, 1H, H-4'), 7.29 (d,  $J = 8.1$  Hz, 1H), 7.24 (d,  $J = 7.6$  Hz, 1H, H-6'), 7.12 (t,  $J = 8.4$  Hz, 1H, H-8), 7.00 (d,  $J = 8.5$  Hz, 1H), 6.75 (d, 16.7 Hz, 1H, H-2), 3.91 (s, 3H), 3.90 (s, 3H) ppm;  $\delta_{\text{C}}(\text{CDCl}_3) = 188.7$  (*CHO*), 165.5, 153.4, 152.6, 149.1, 142.8, 135.5, 130.0, 128.2, 126.5, 124.5, 123.7, 119.8, 117.6, 114.9, 61.6, 56.1 ppm; IR  $\nu = 2765$  (w), 1743 (m), 1701 (s), 1636 (s), 1602 (s), 1576 (m), 1480 (w), 1448 (m), 1404 (w), 1309 (m), 1262 (w), 1195 (m), 1156 (m), 1123 (s) cm<sup>-1</sup>; MS  $m/z$  (relative intensity) = M<sup>+</sup> not observed, 287 (100).

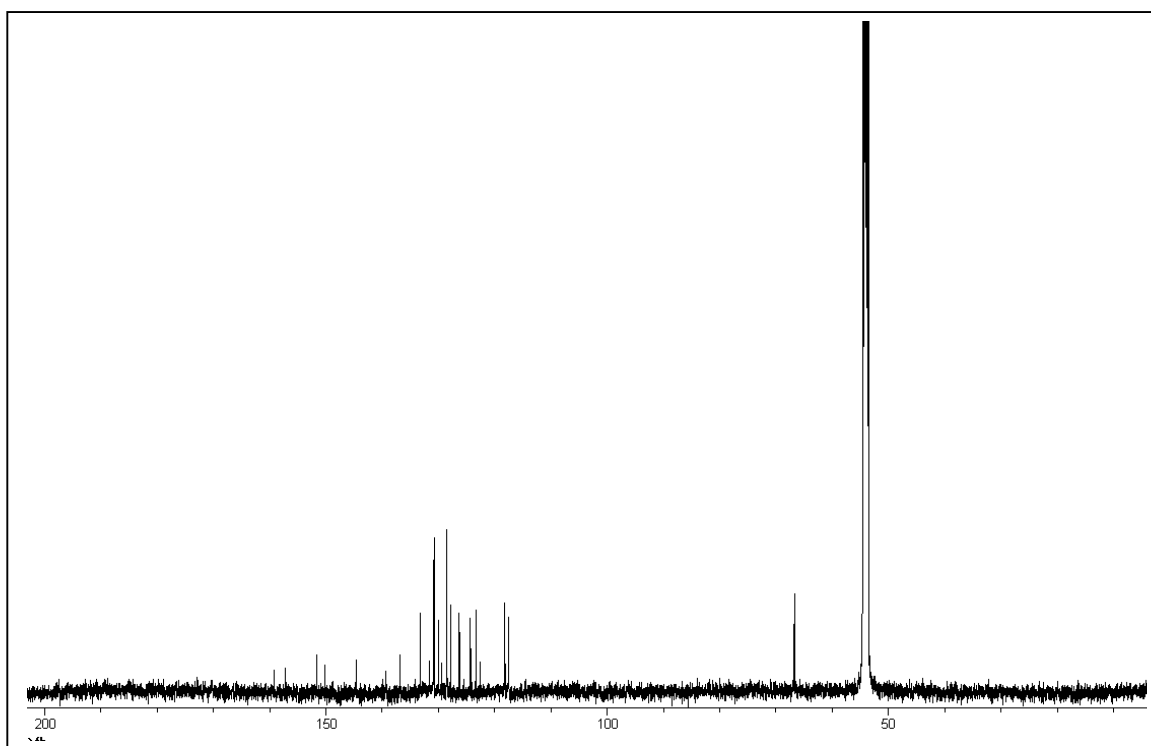
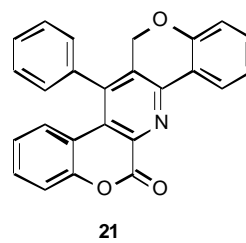
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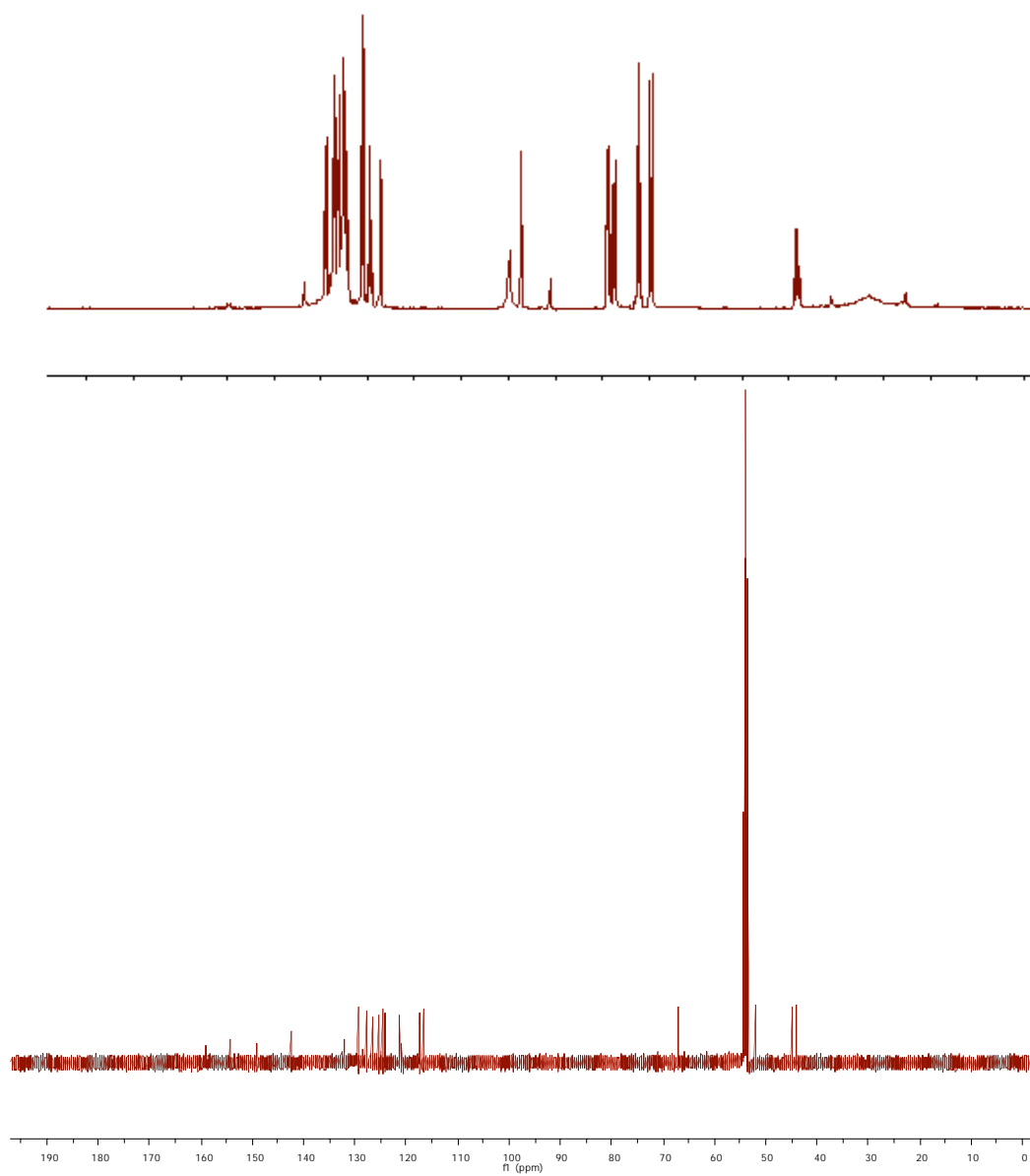
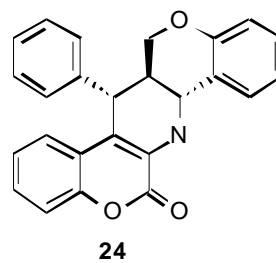


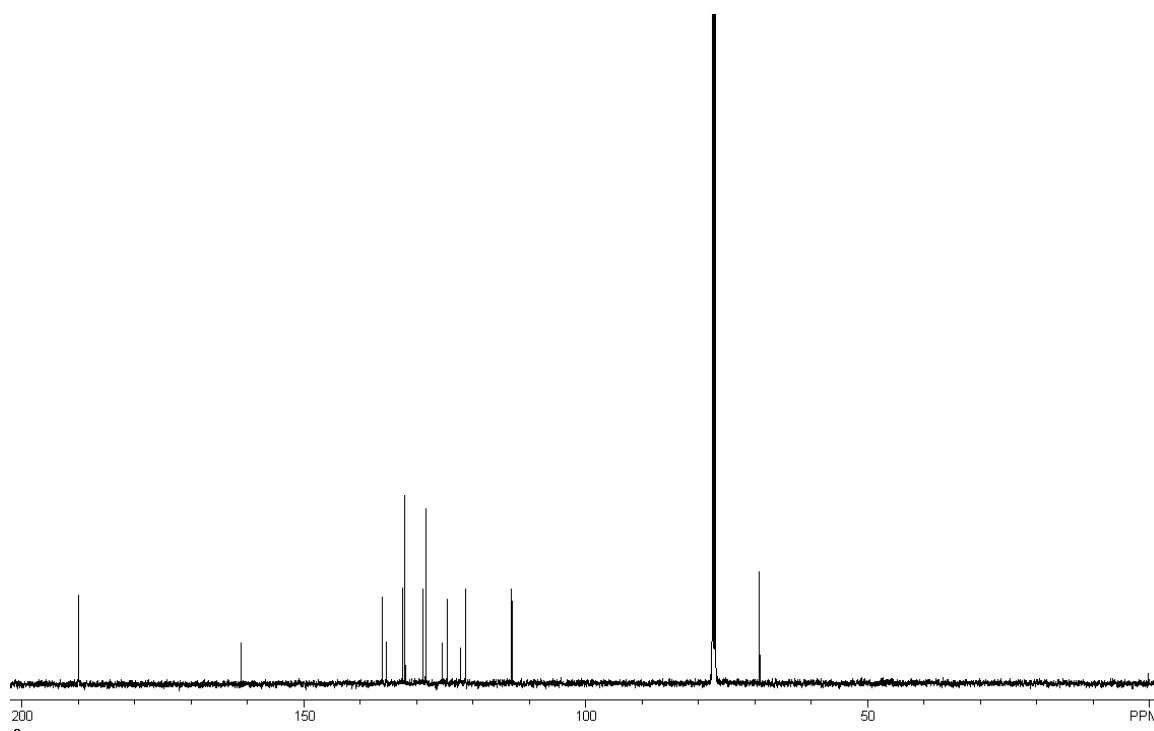
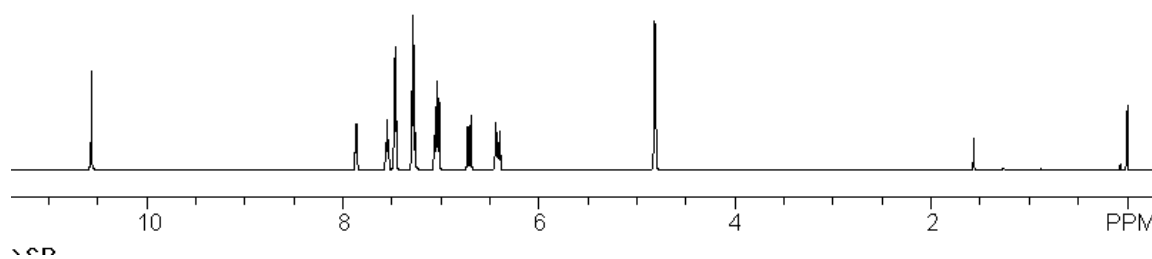
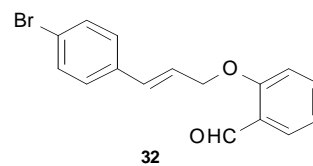


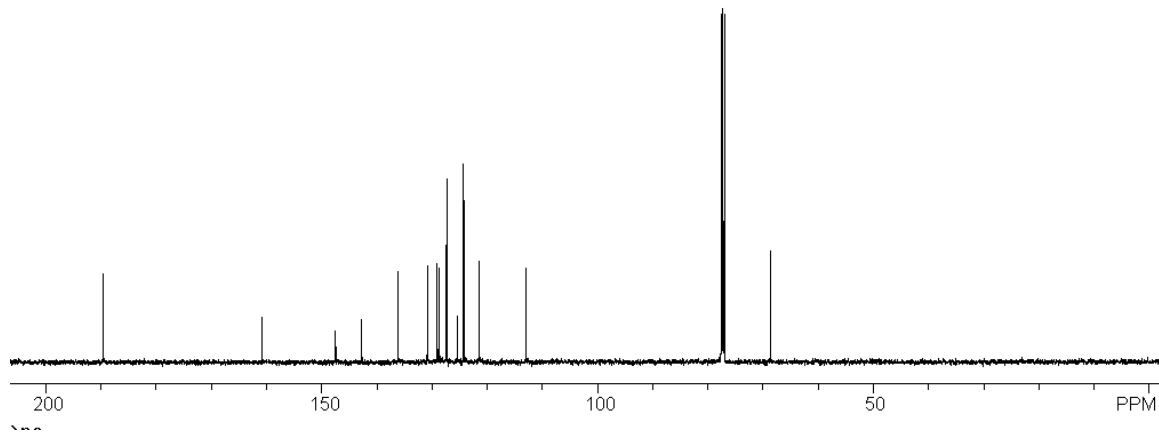
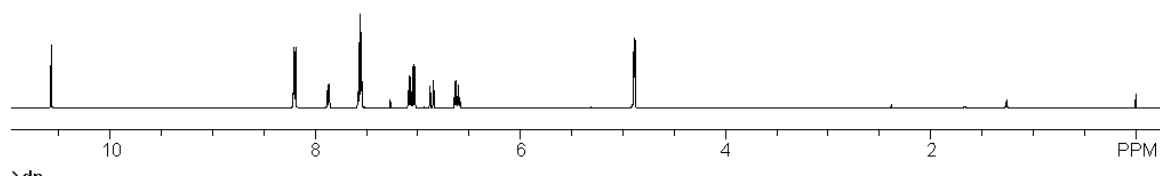
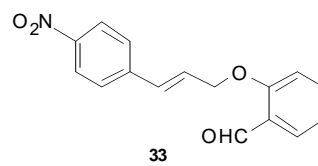


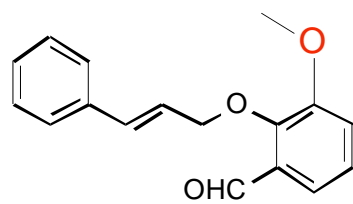




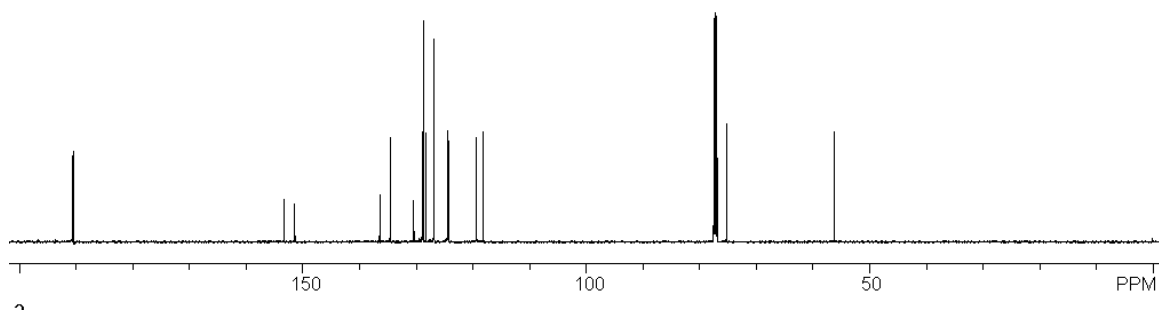
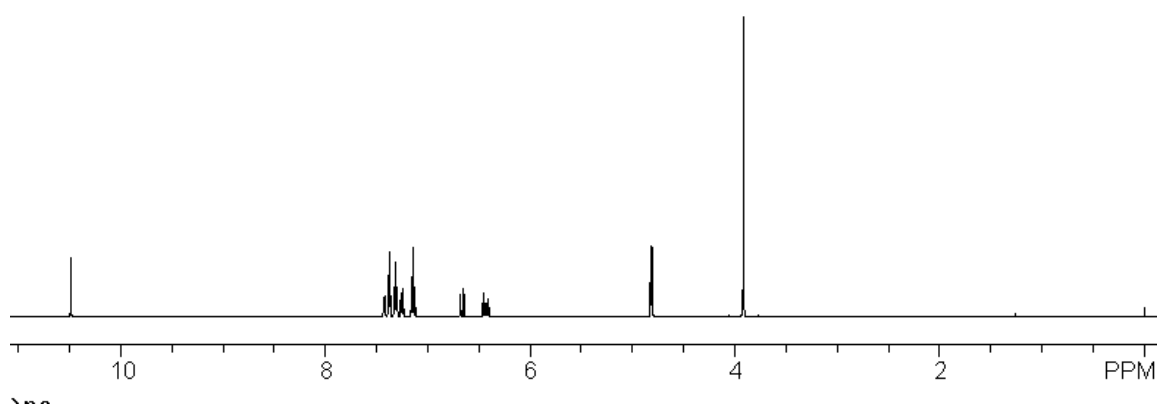


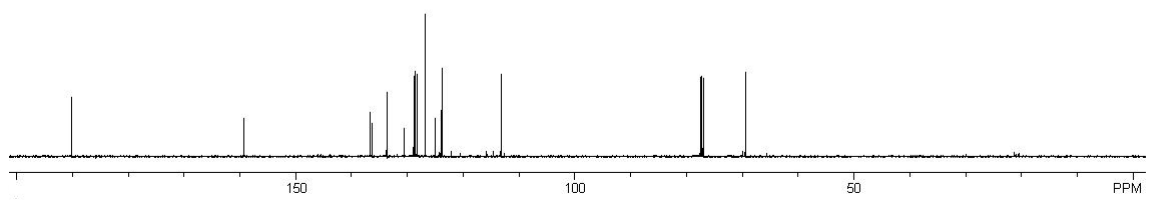
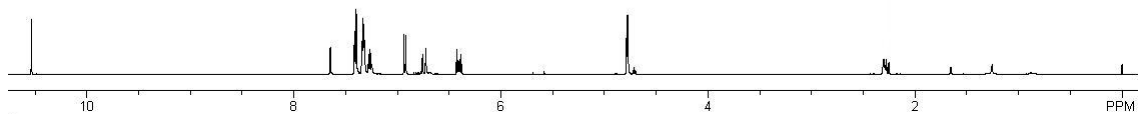
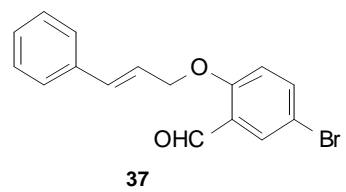




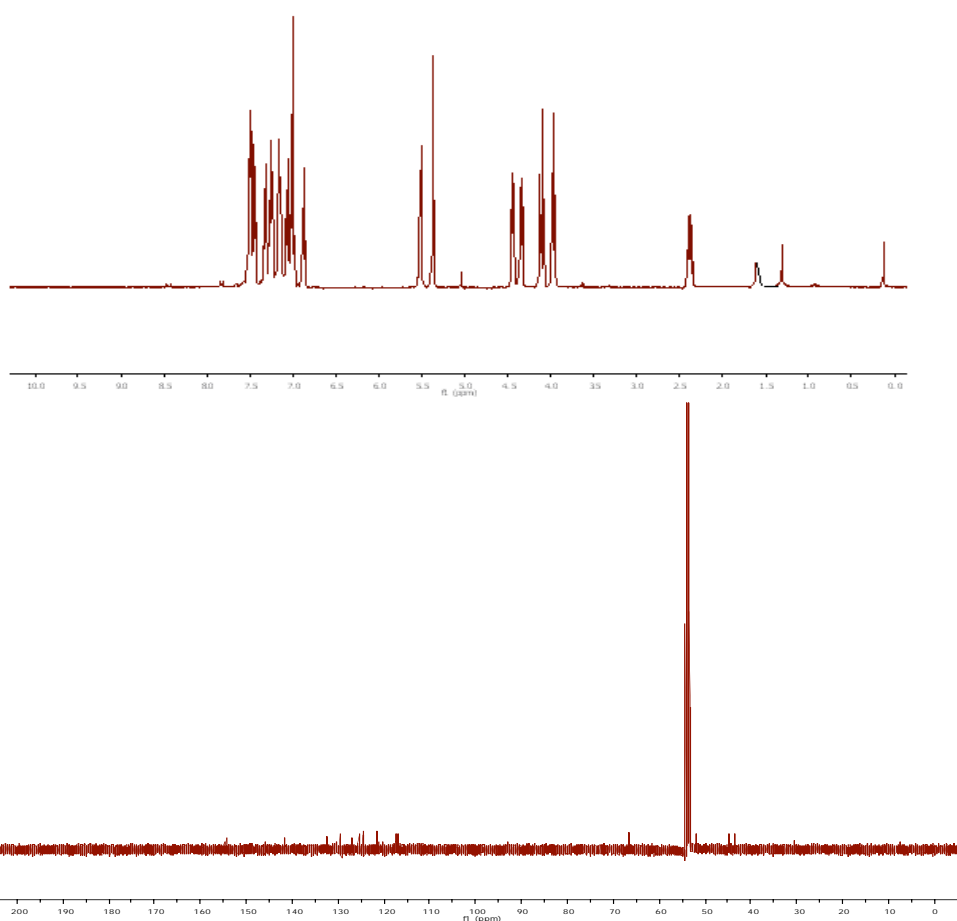
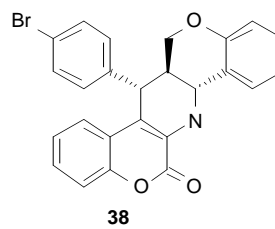


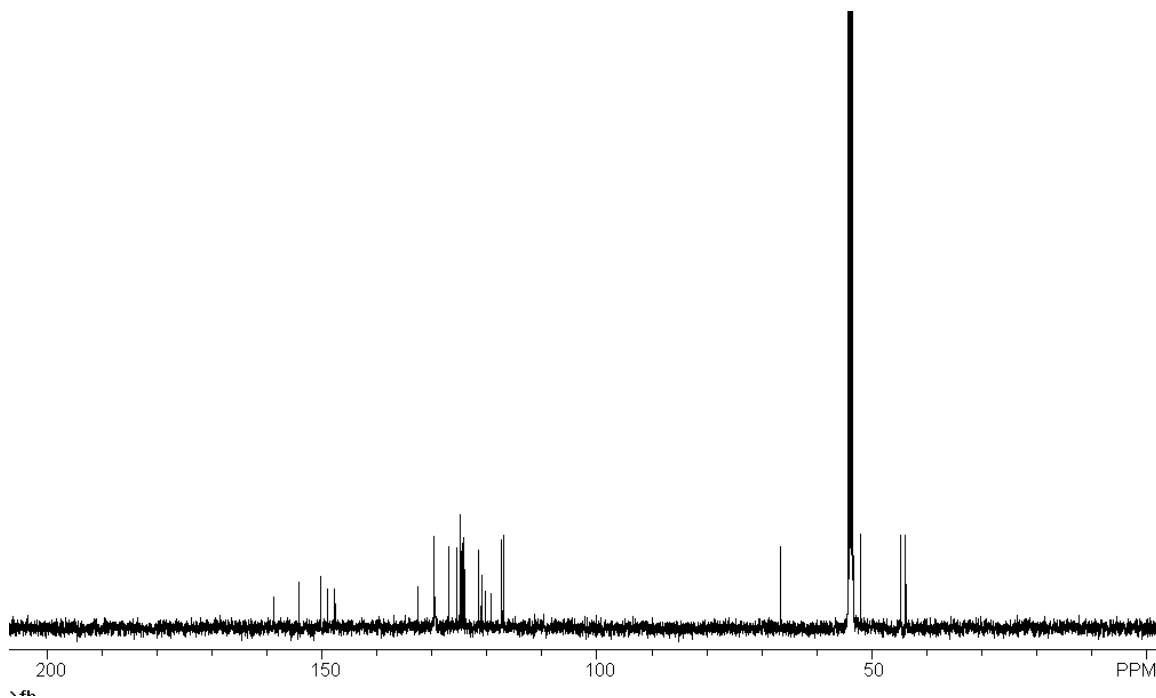
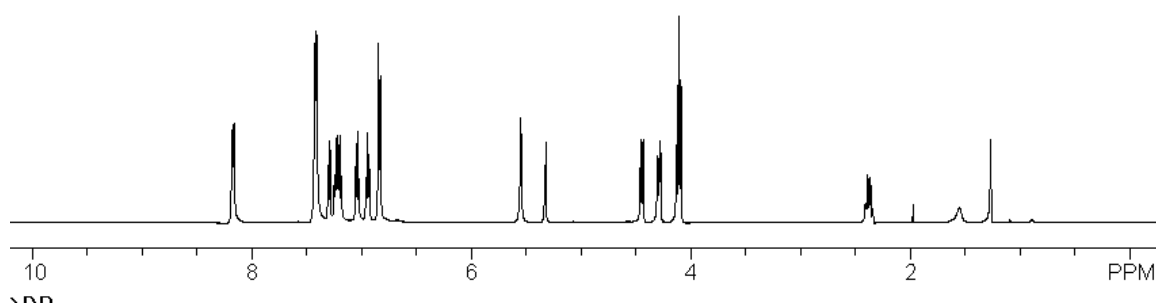
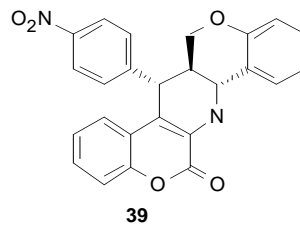
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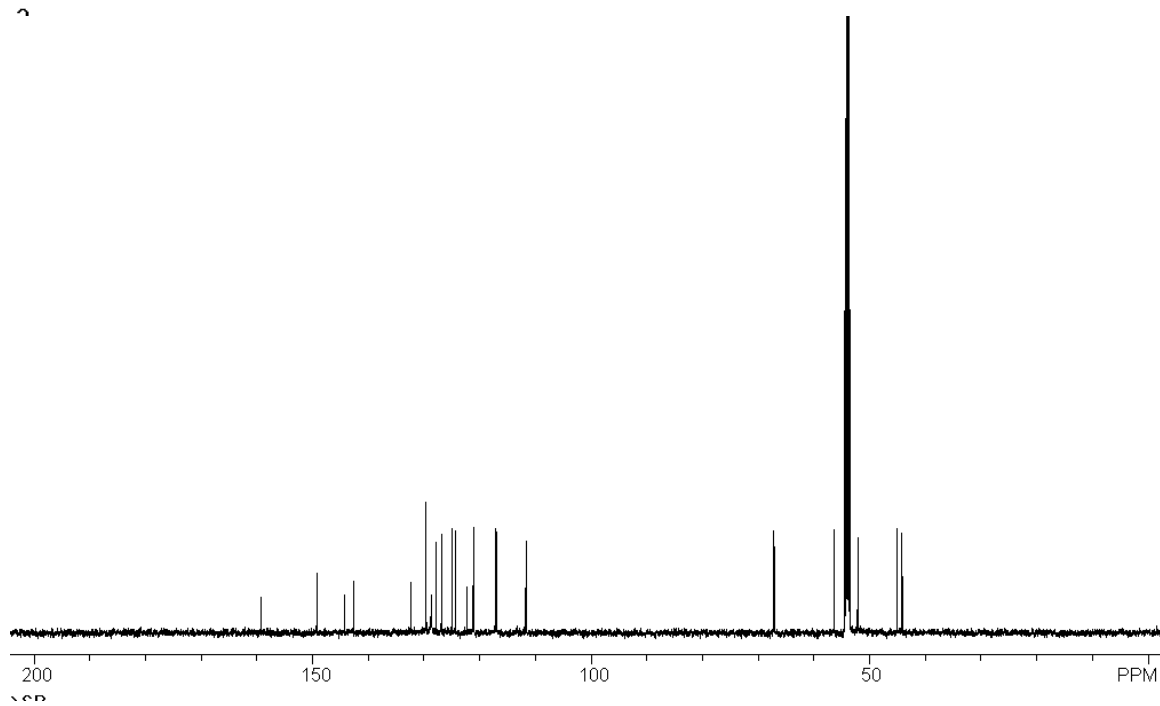
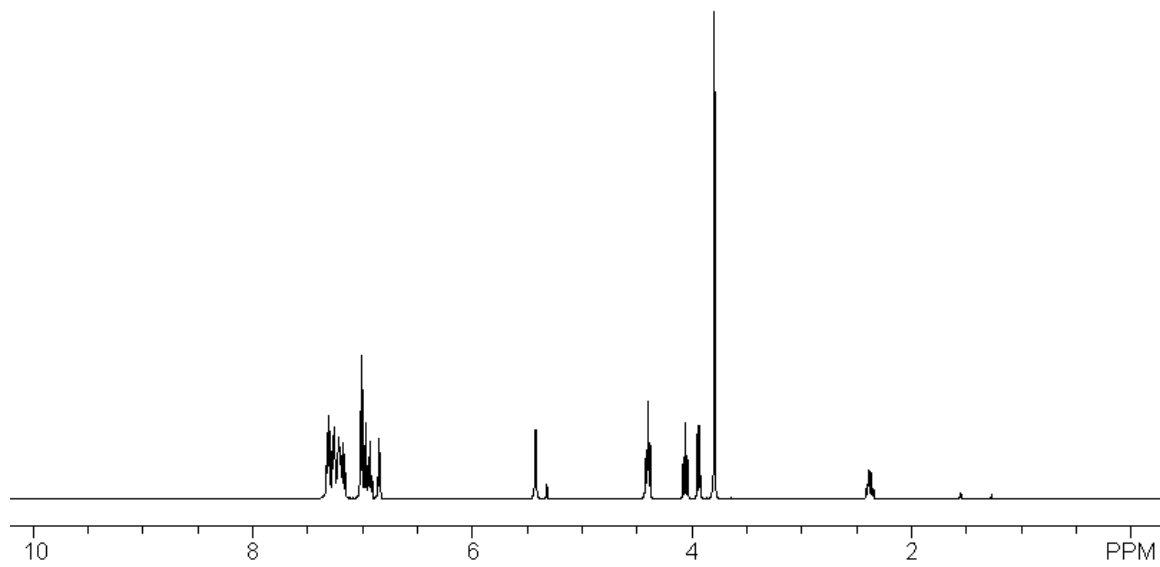
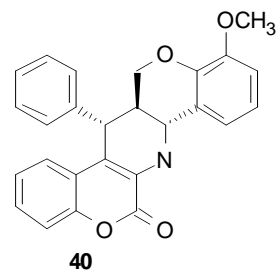


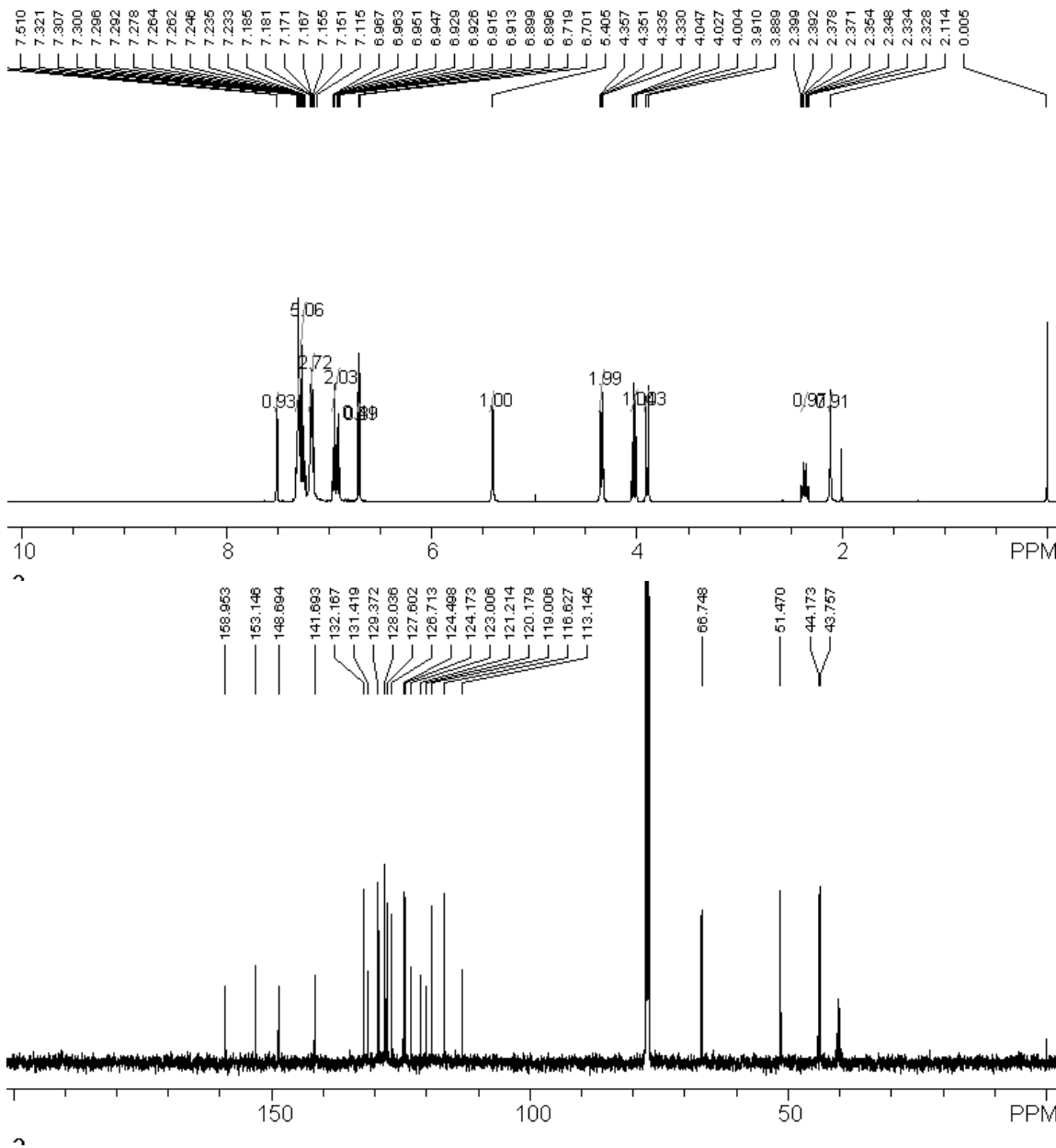
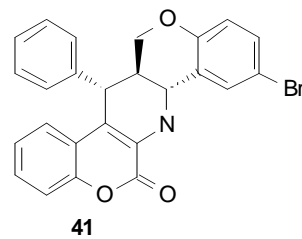


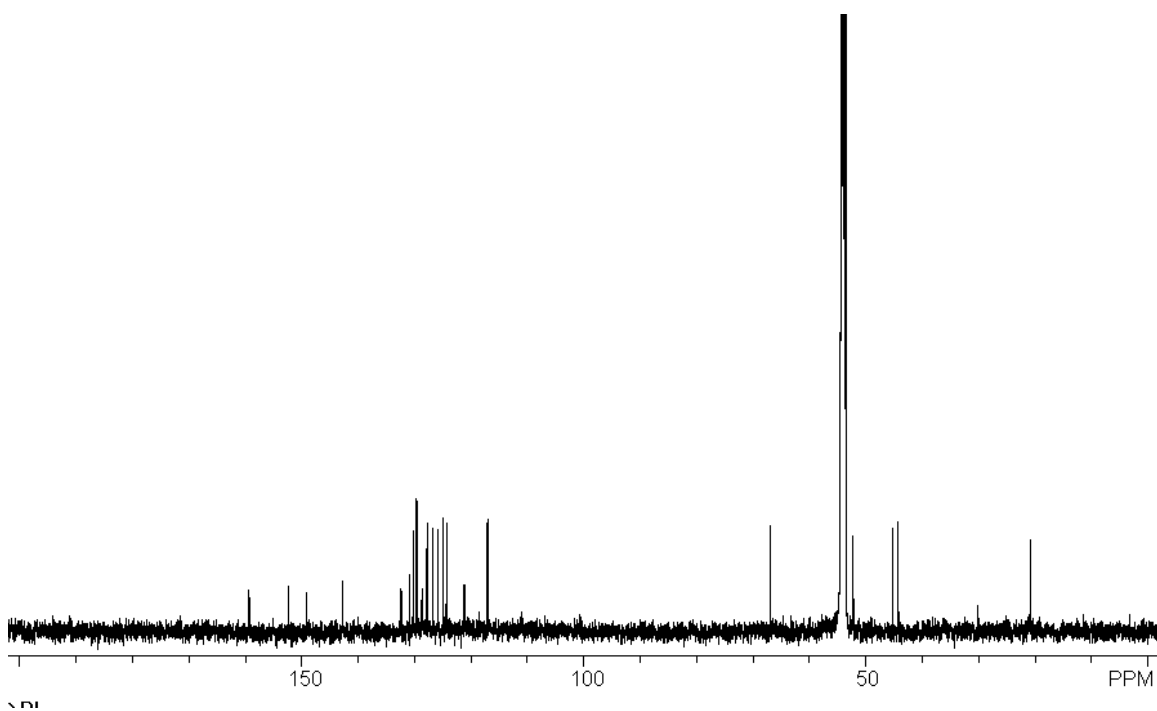
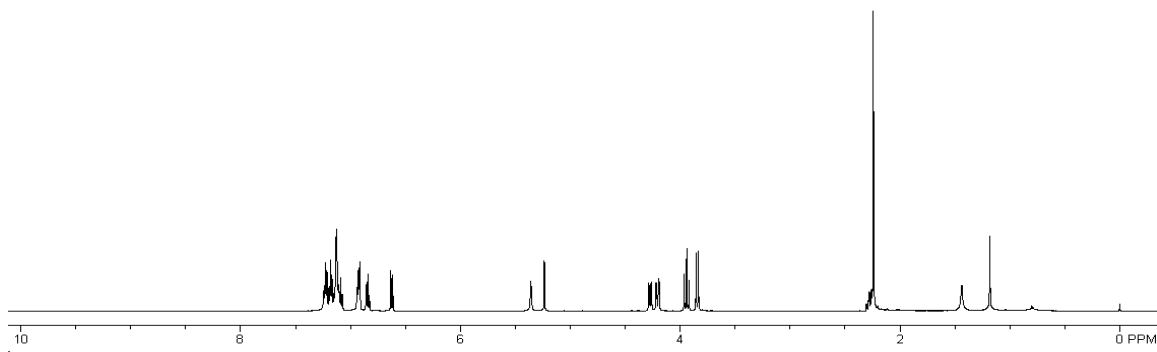
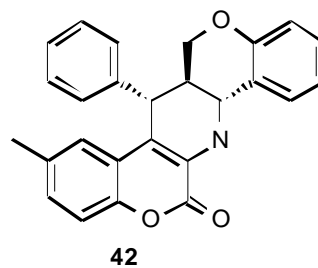


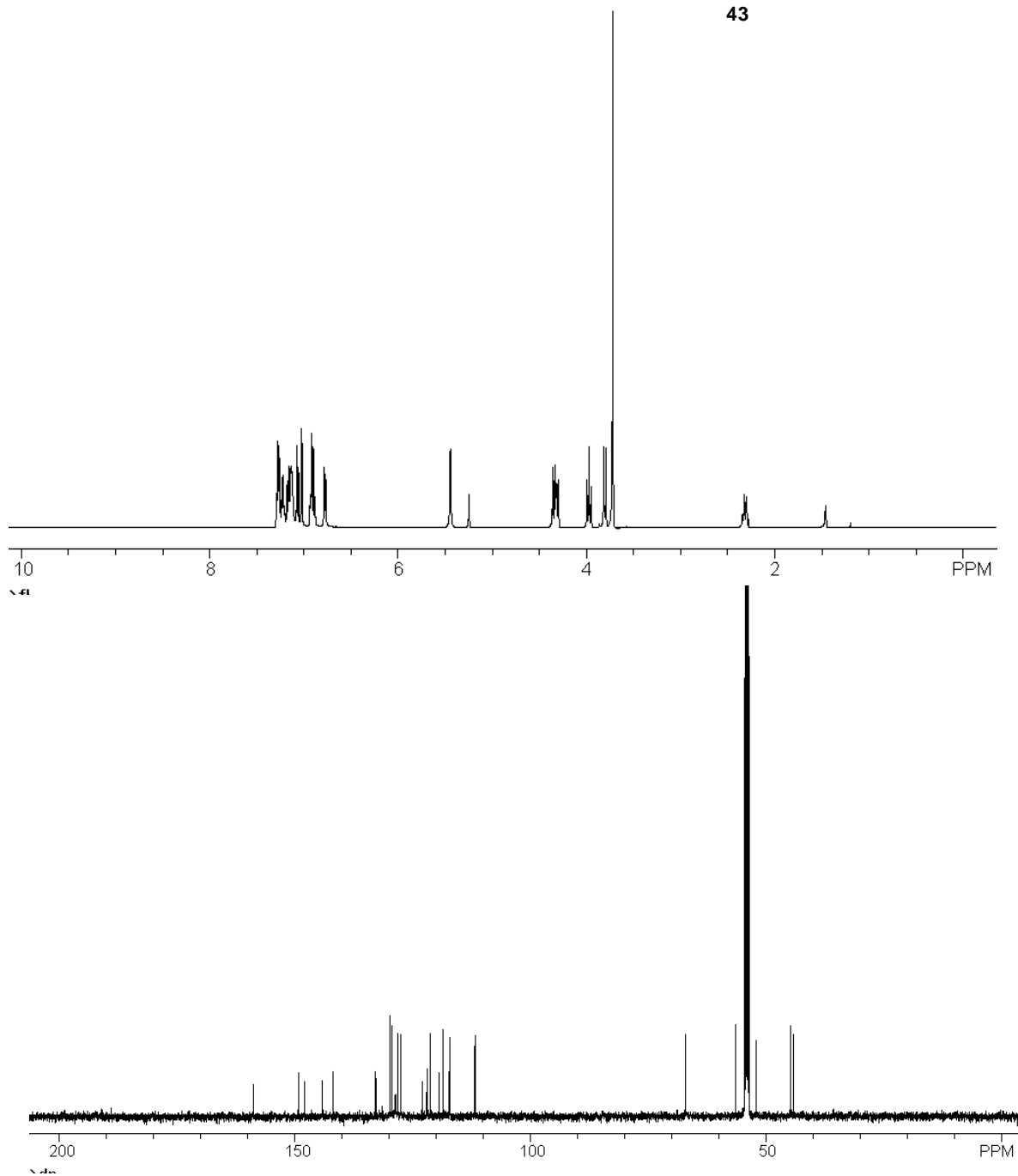
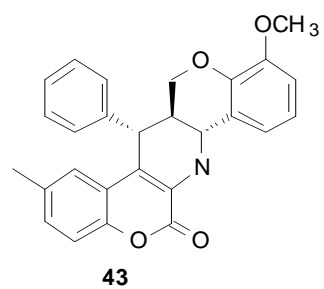


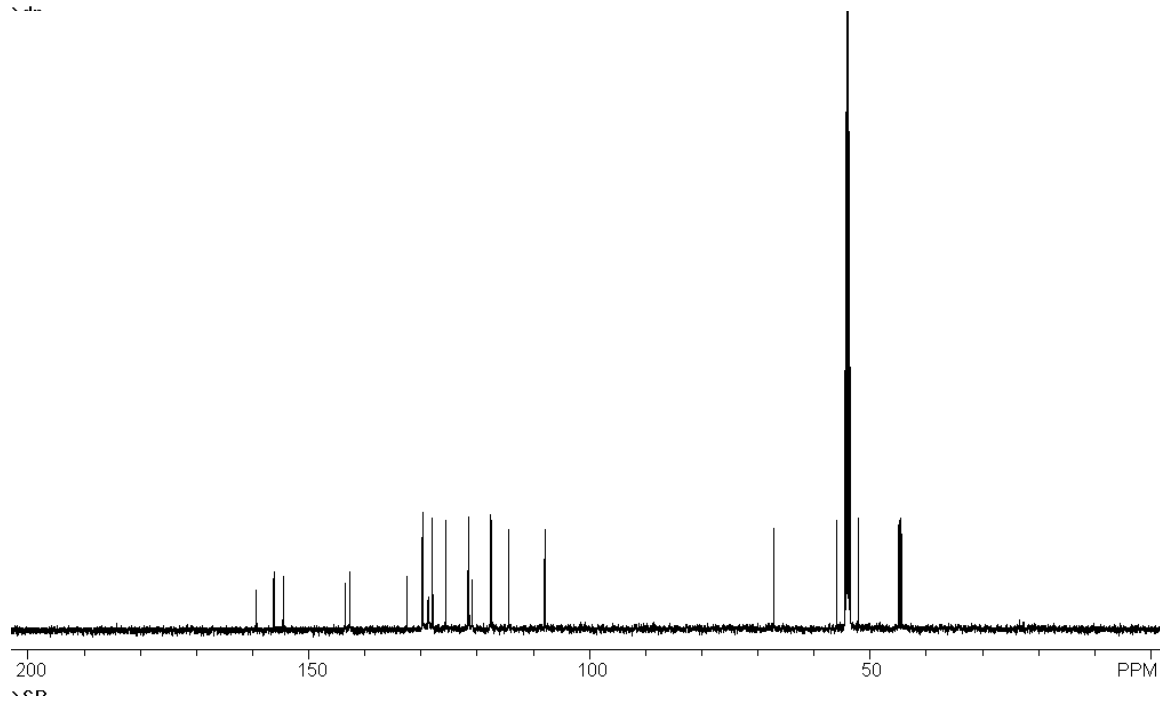
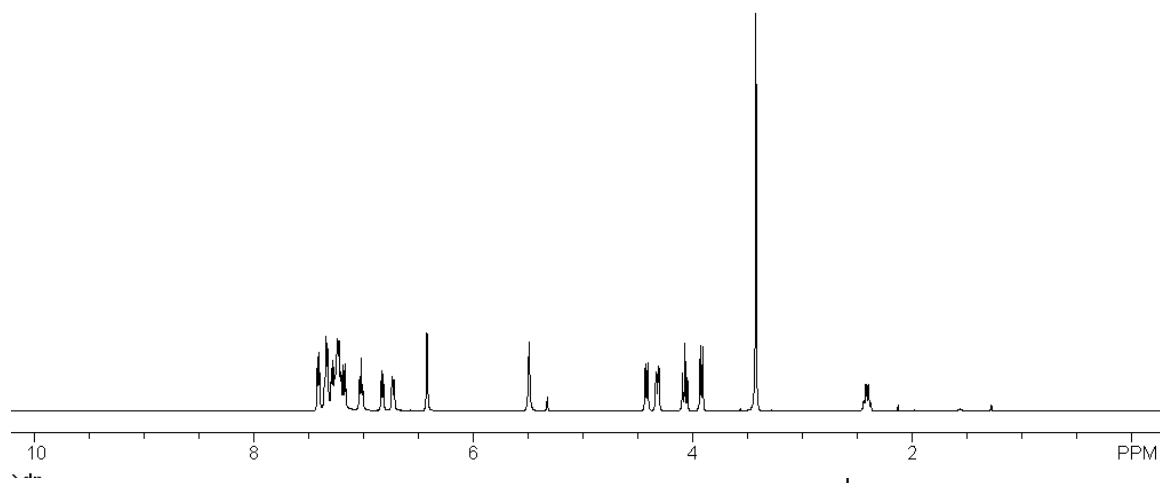
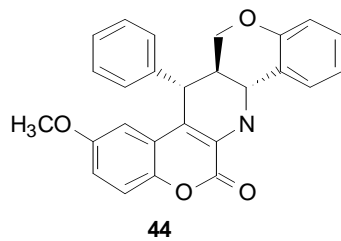


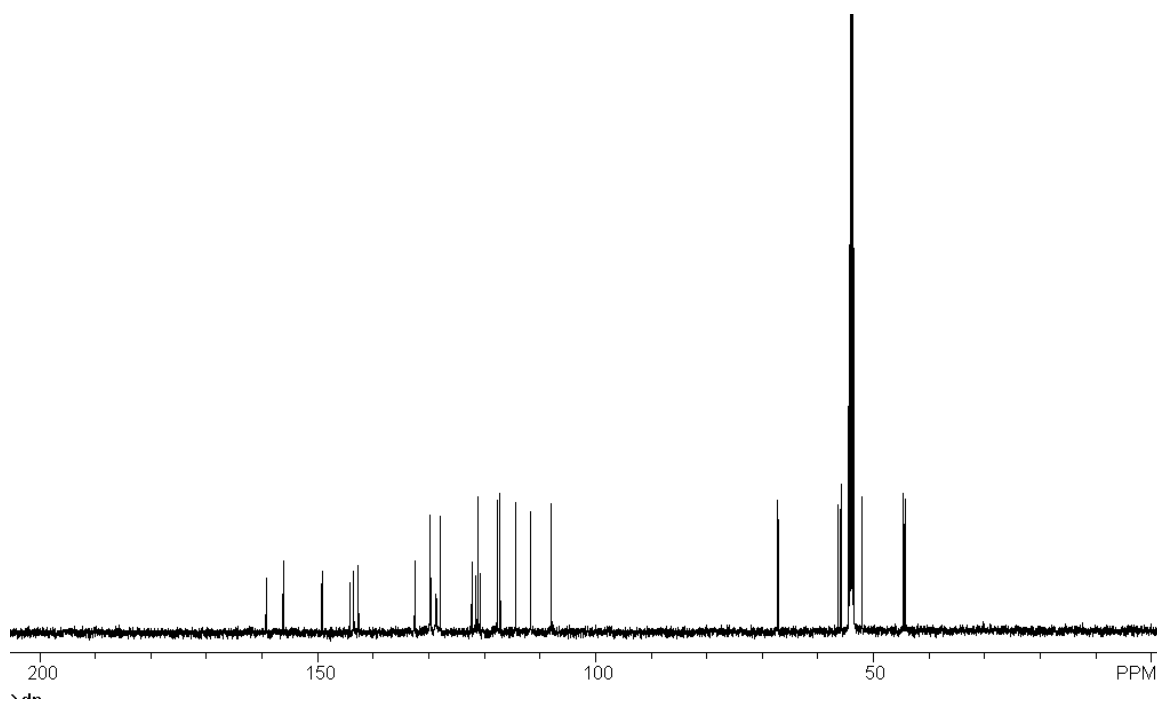
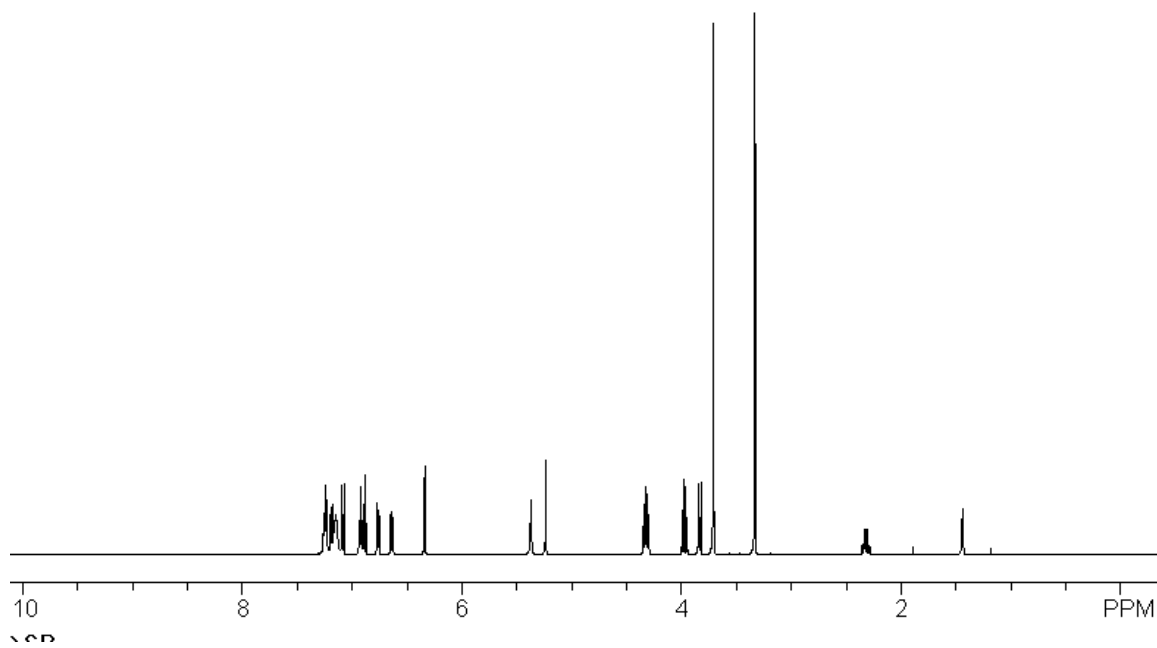
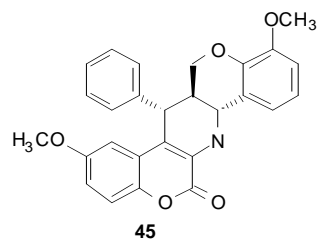




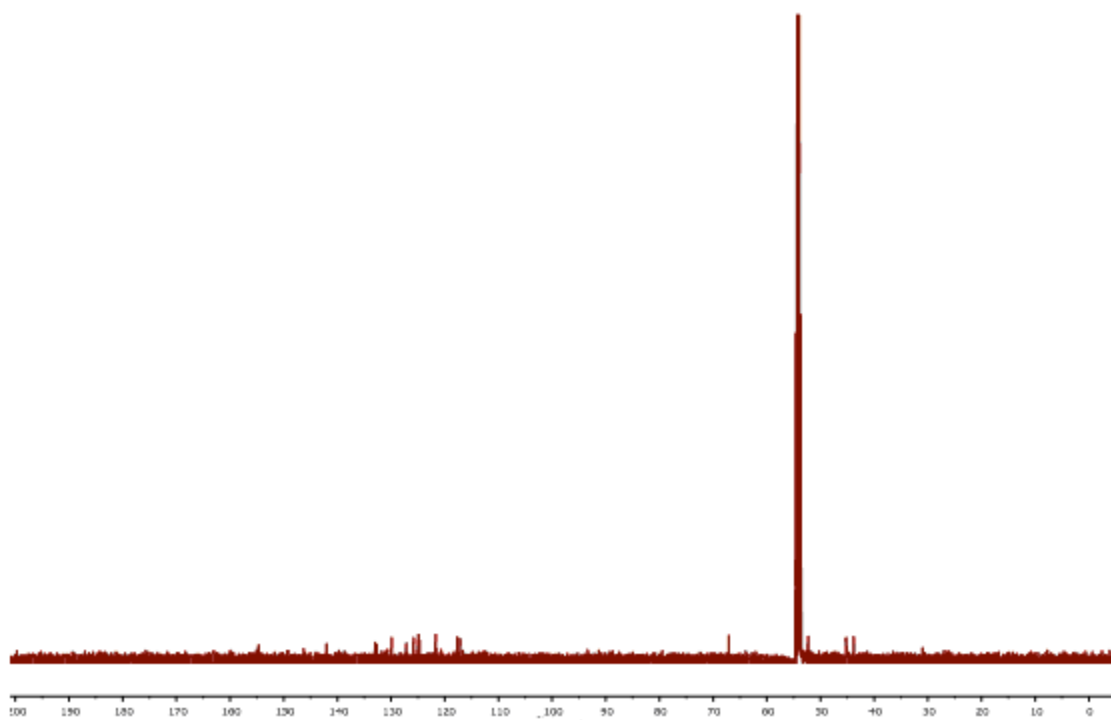
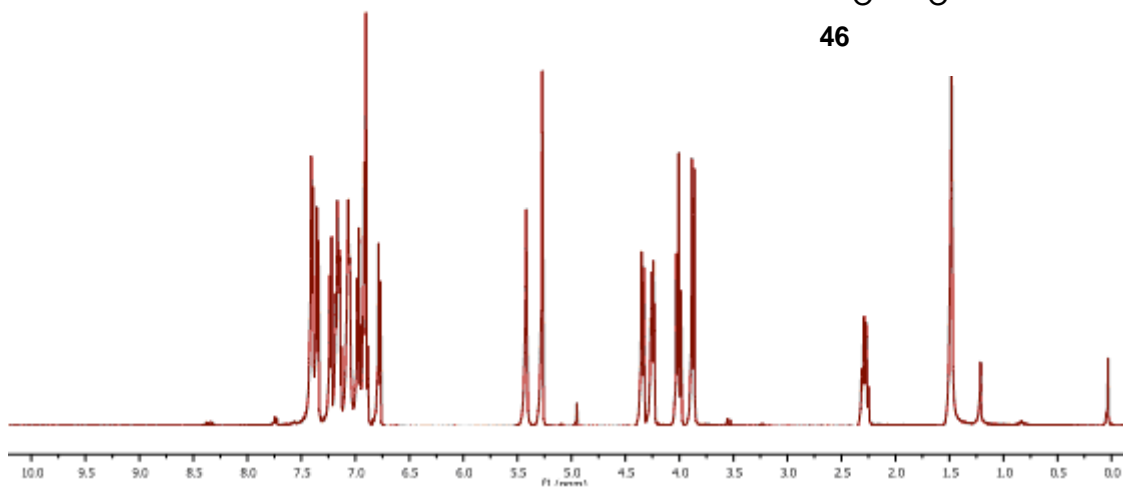
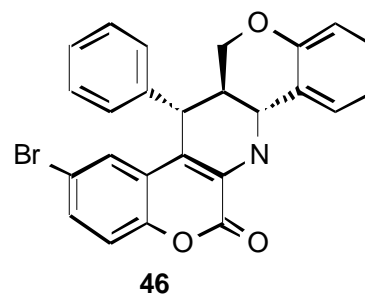


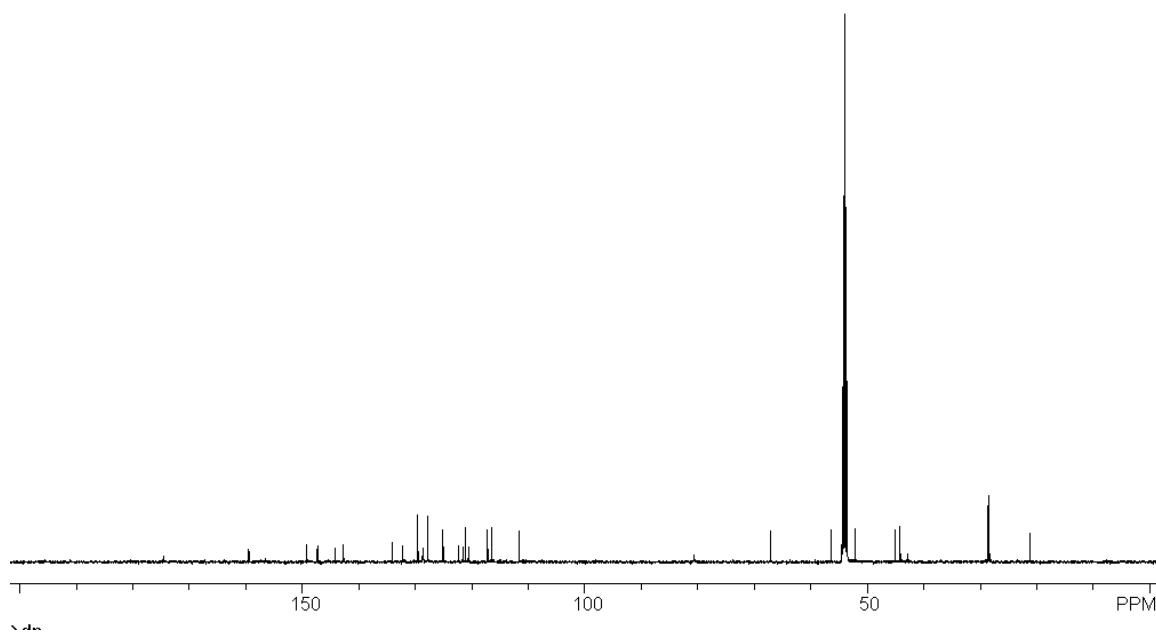
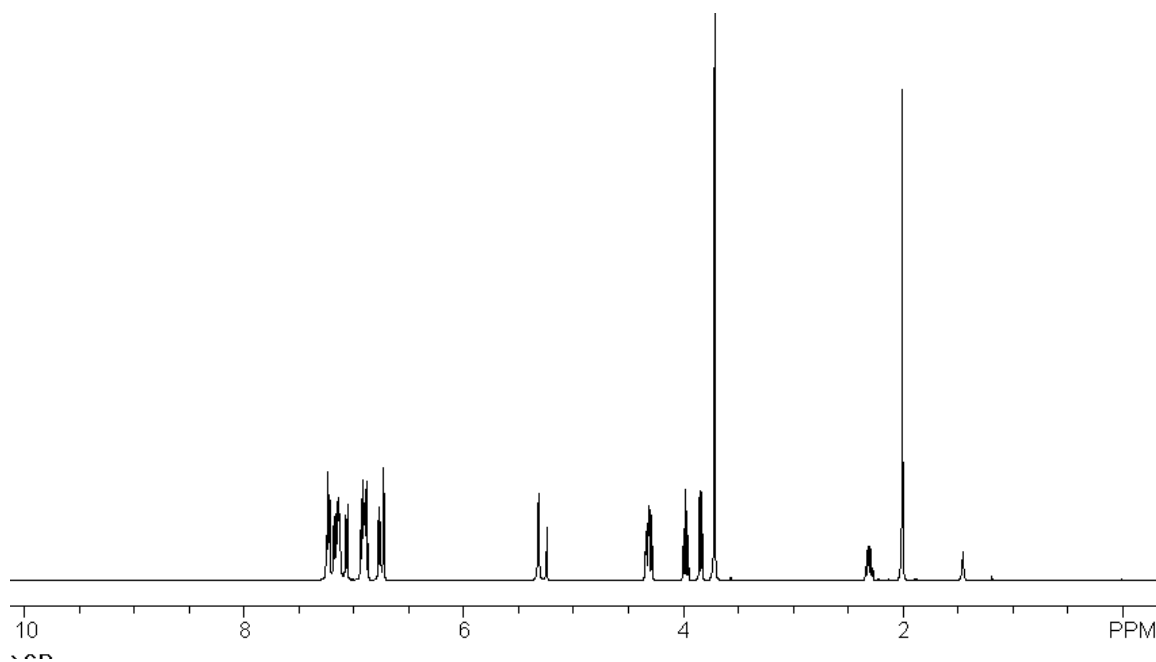
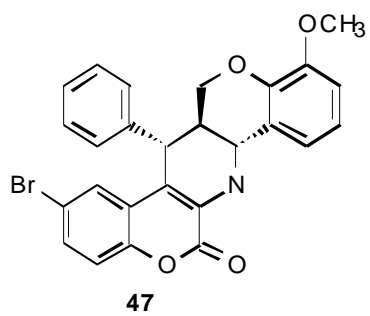


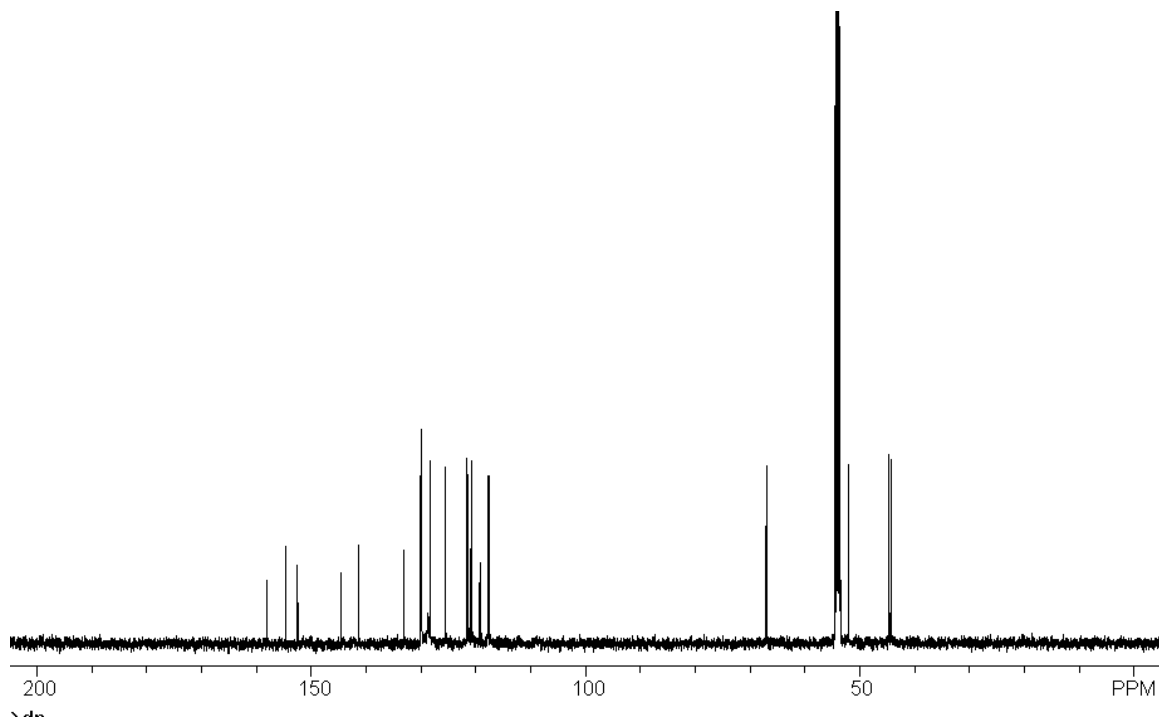
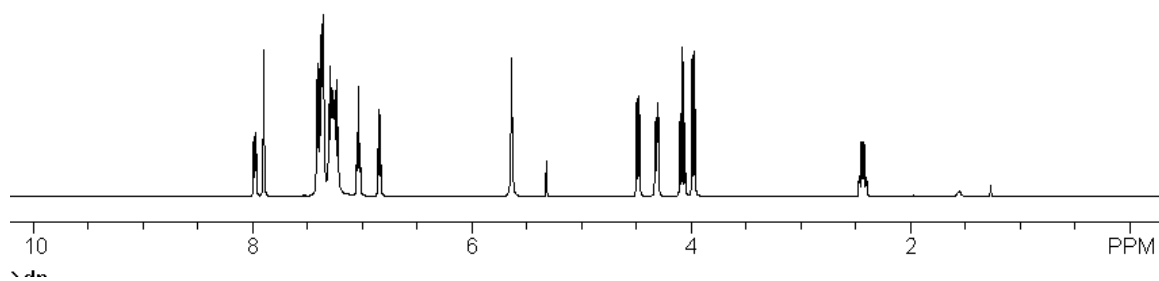
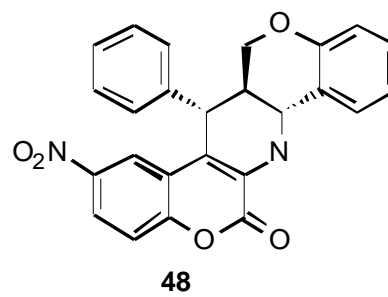


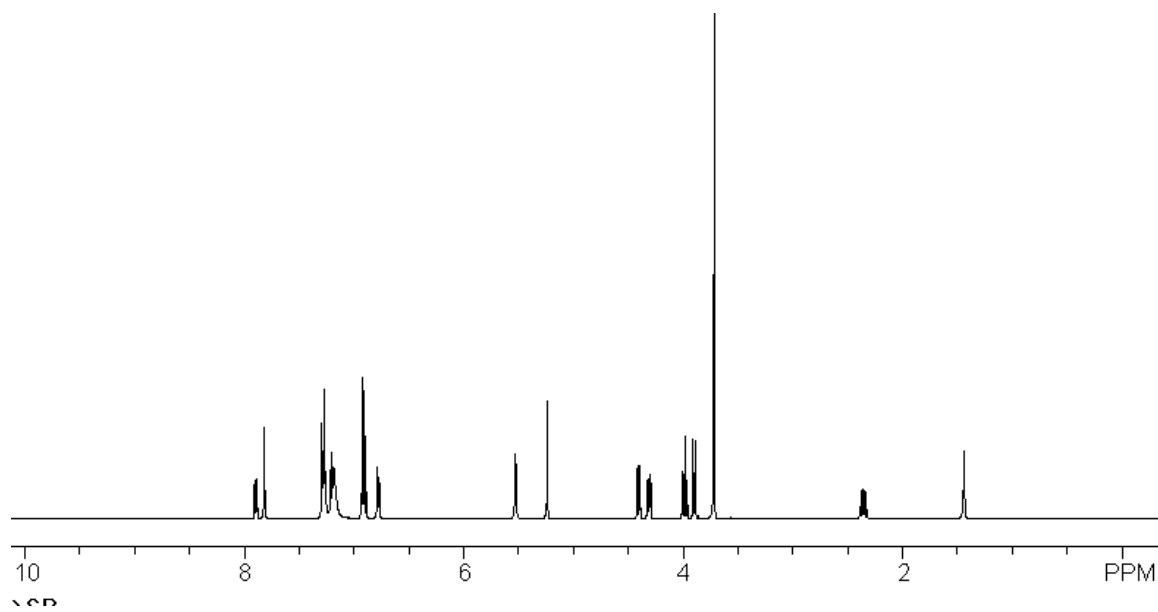
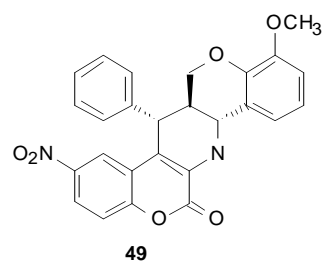


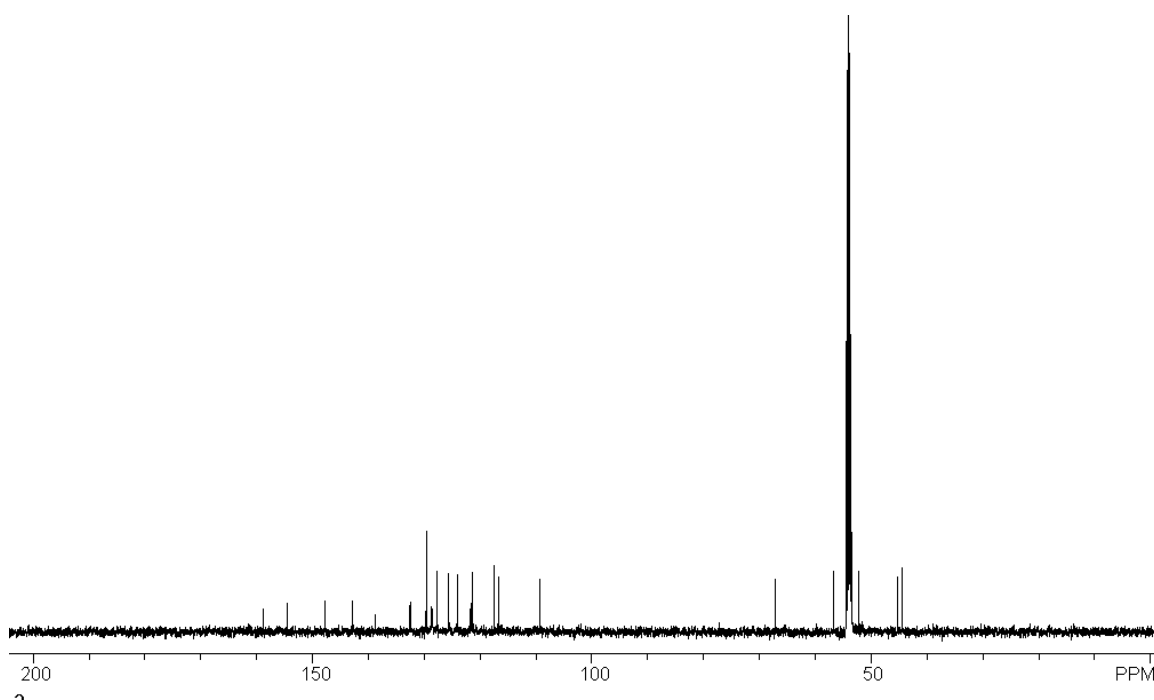
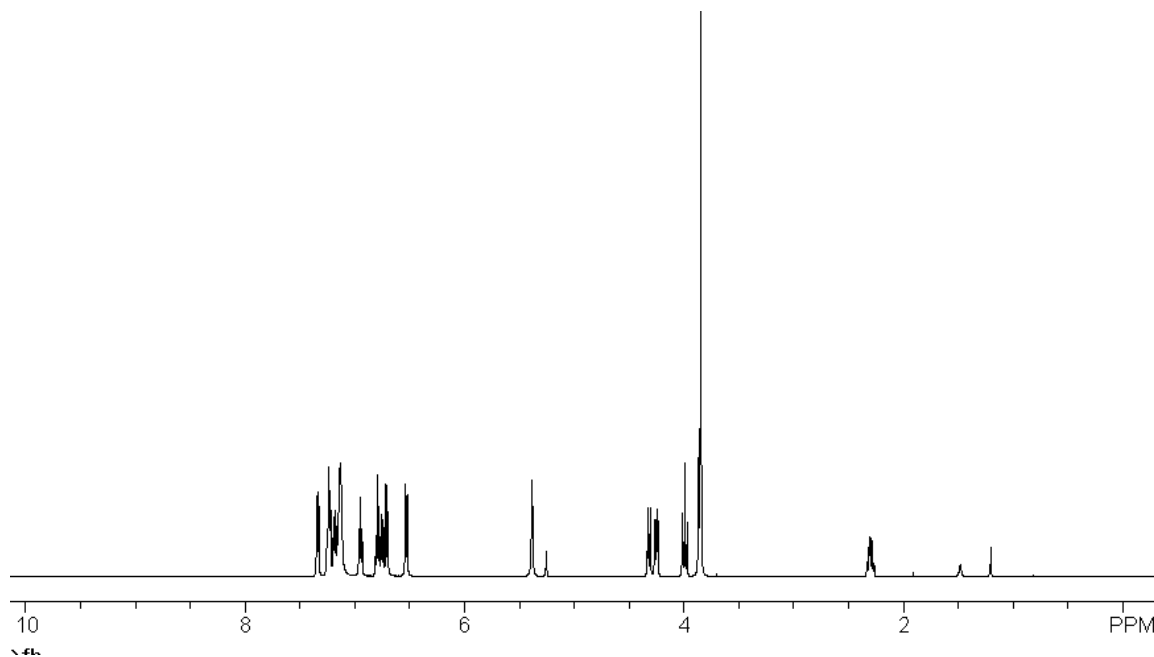
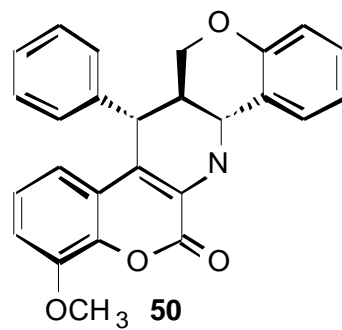


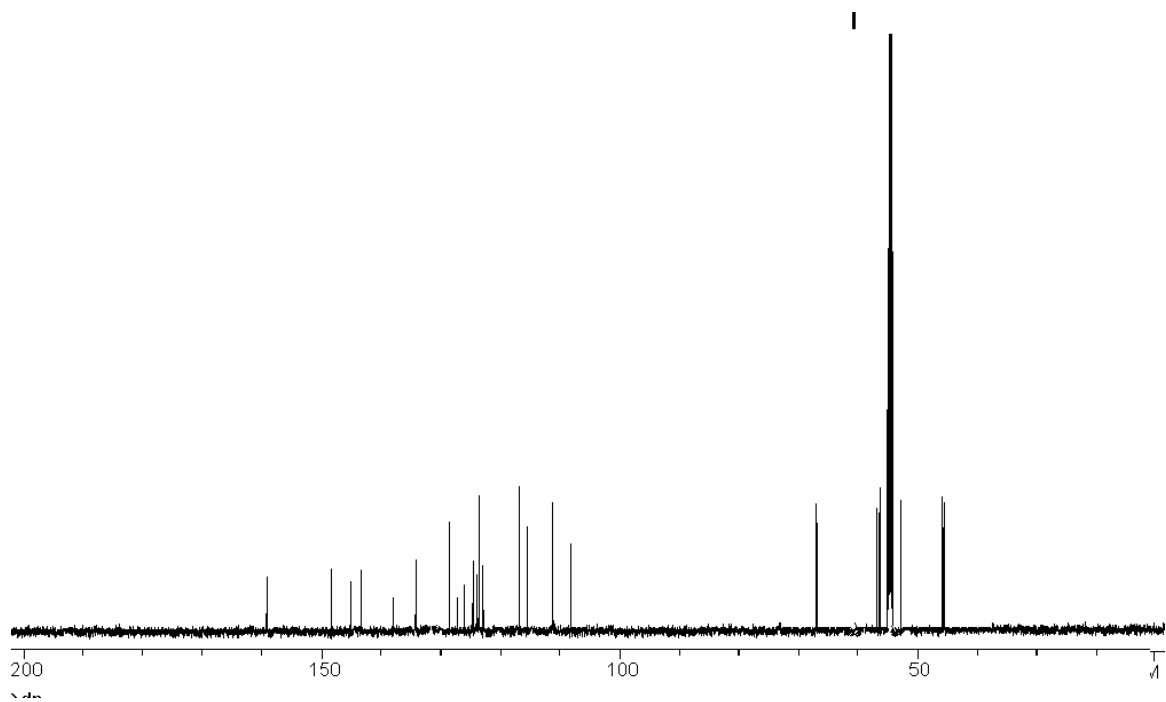
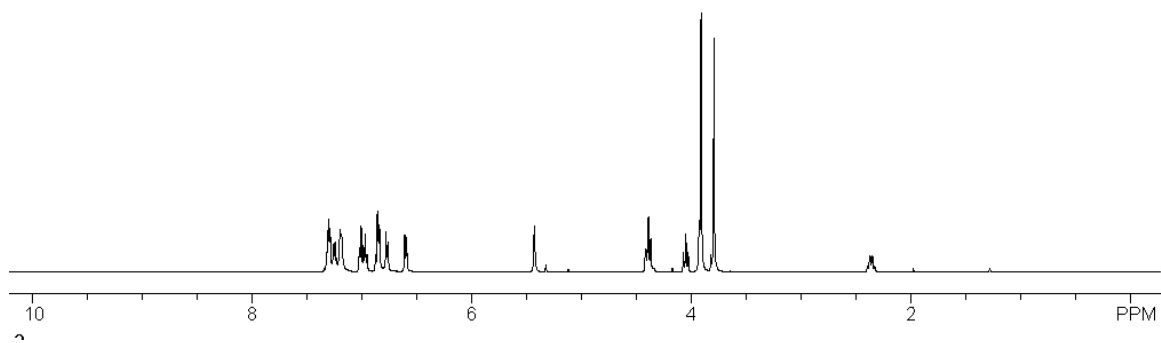
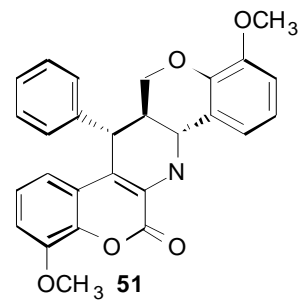


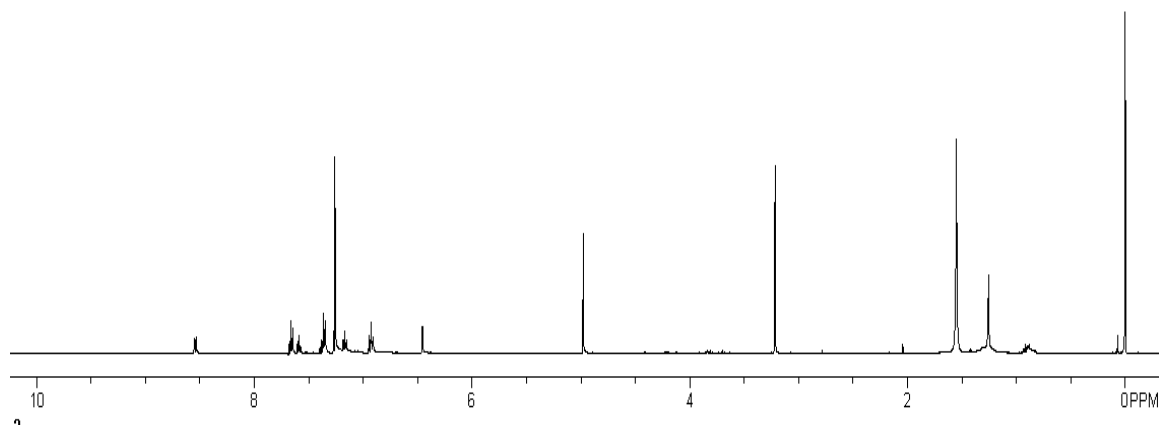
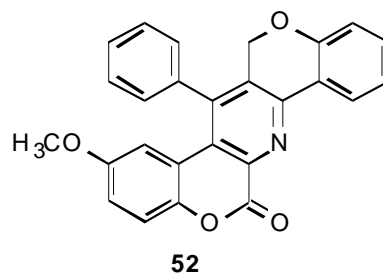


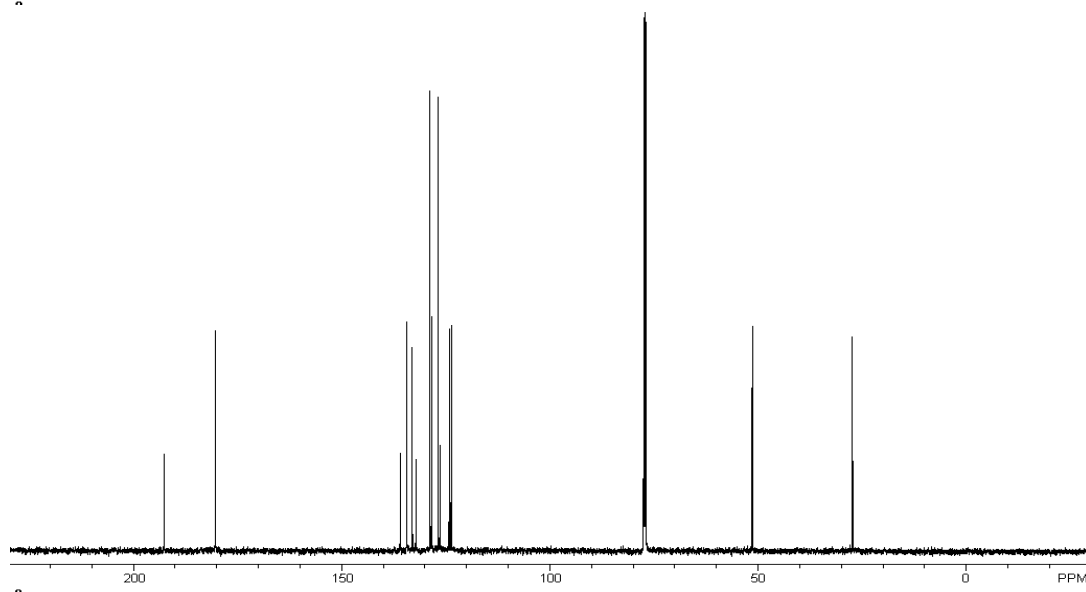
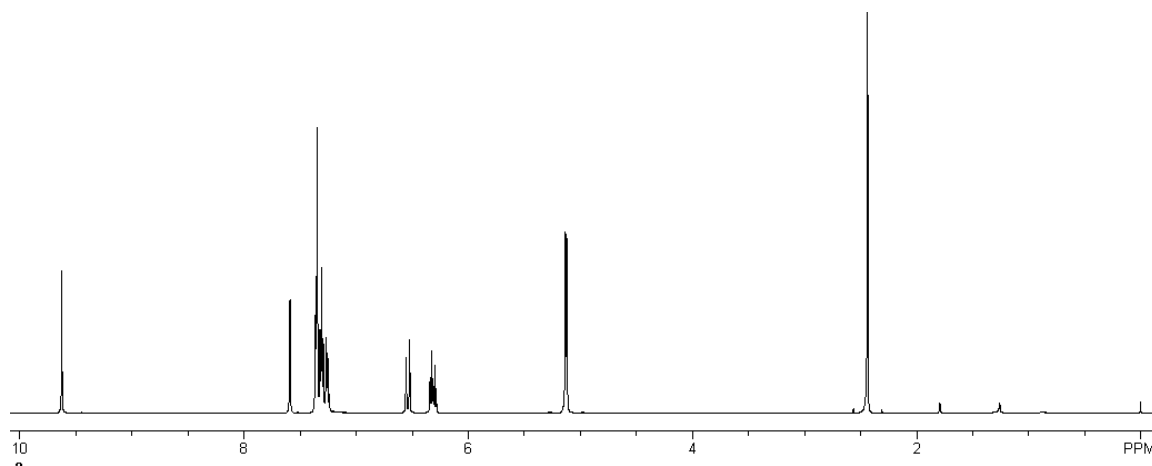
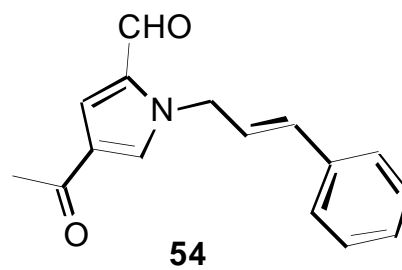




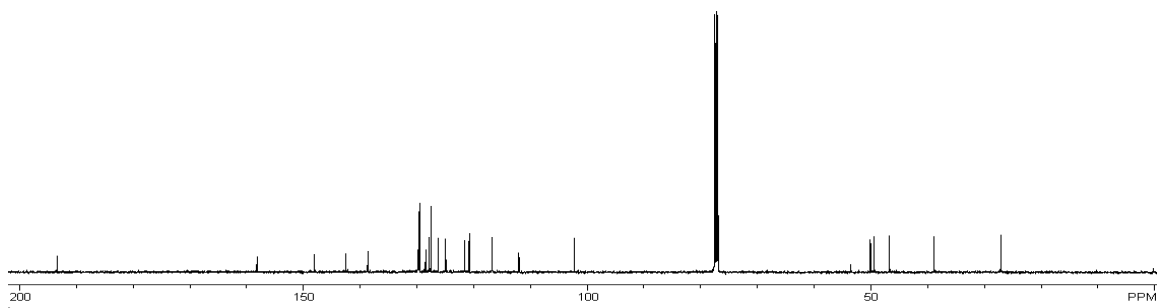
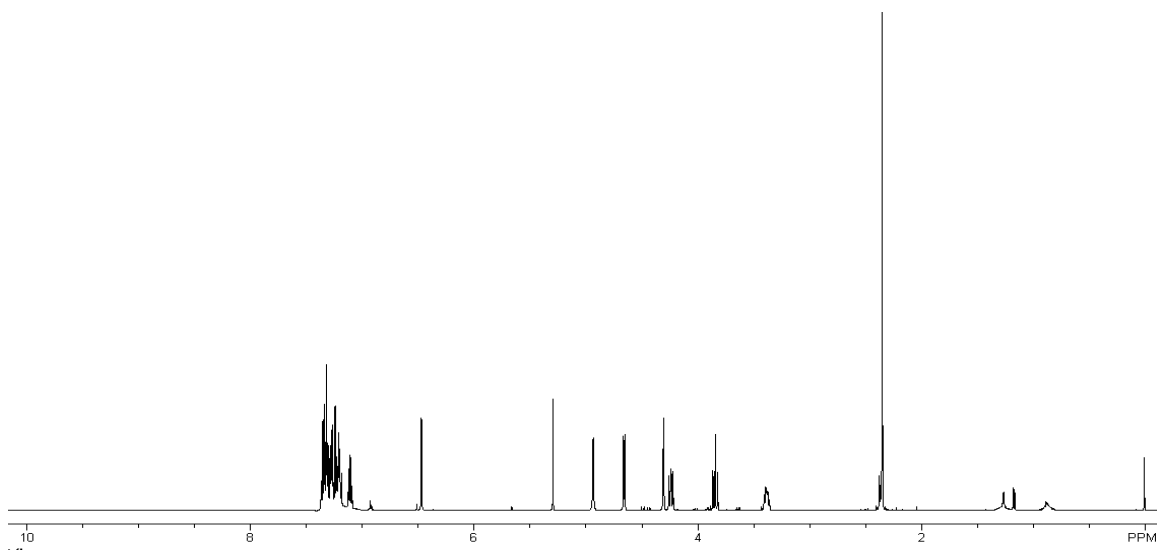
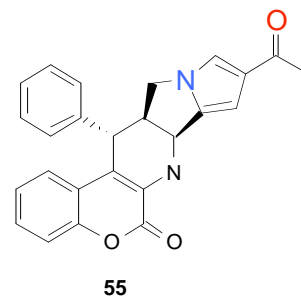


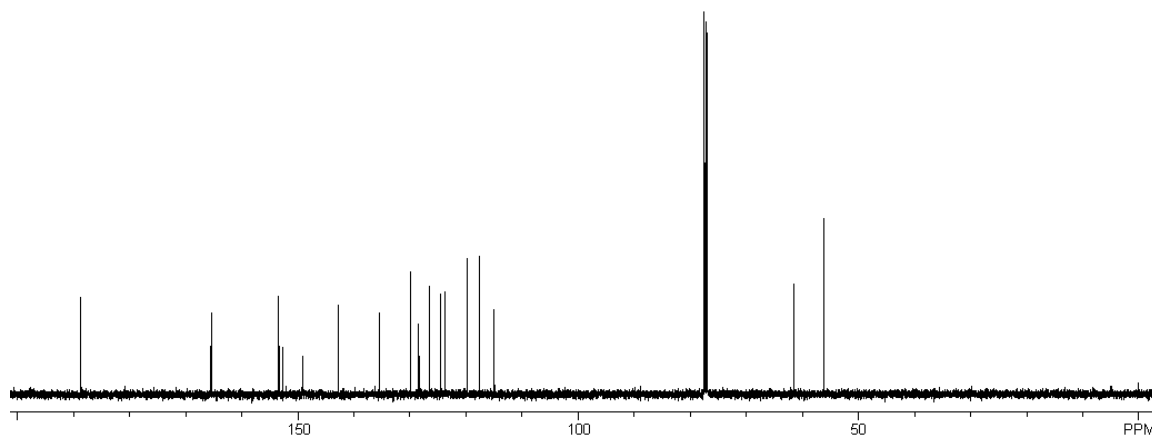
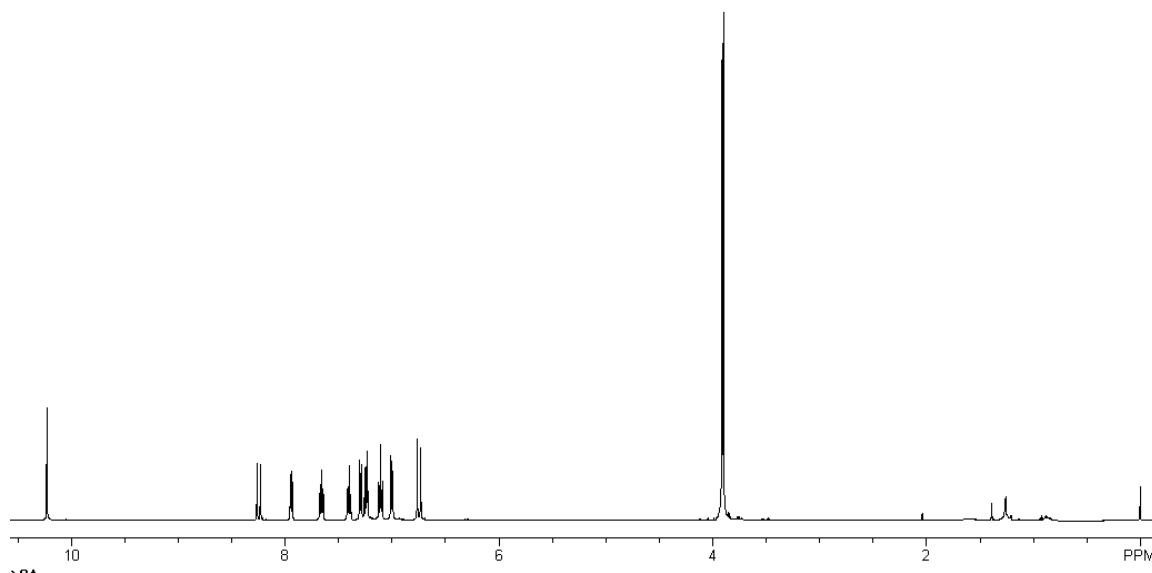
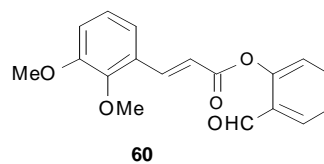












### **3. COSY and HMQC Spectra for Compound 24.**