

Waste-minimized Protocol for the Synthesis of Sulfonylated *N*-heteroaromatics in Water

Long-Yong Xie^a, Sha Peng^a, Jia-Xi Tan^a, Rong-Xia Sun^a, Xianyong Yu^b, Ning-Ning Dai^b,
Zi-Long Tang^b, Xinhua Xu^c and Wei-Min He^{*a,c}

^a Department of Chemistry, Hunan University of Science and Engineering, Yongzhou 425100, China

^b Key Laboratory of Theoretical Organic Chemistry and Functional Molecule of Ministry of Education, Hunan University of Science and Technology, Xiangtan 411201, China

^c State Key Laboratory of Chemo/Biosensing and Chemometrics, Hunan University, Changsha, 410082, China

E-mail: weiminhe2016@yeah.net

Total number of pages: 65

Total number of Figures: 94 (pages S19 – S65)

Table of Content

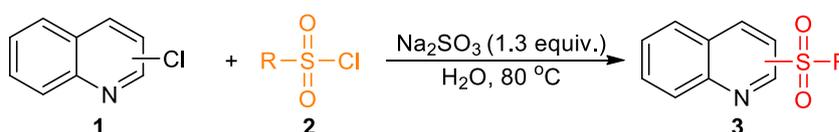
1. General information	S2
2. Experimental Section	S2
3. Characterization data of products	S5
4. References	S17
5. ¹H and ¹³C NMR spectra of products	S19

1. General information

Unless otherwise specified, all reagents and solvents were obtained from commercial suppliers and used without further purification. All reagents were weighed and handled in air at room temperature. ^1H NMR spectra were recorded at 400 MHz and ^{13}C NMR spectra were recorded at 100 MHz by using a Bruker Avance 400 spectrometer. Chemical shifts were calibrated using residual undeuterated solvent as an internal reference (^1H NMR: CDCl_3 7.26 ppm, ^{13}C NMR: CDCl_3 77.0 ppm). The following abbreviations were used to describe peak splitting patterns when appropriate: s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet, brs = broad singlet. Mass spectra were performed on a spectrometer operating on ESI-TOF.

2. Experimental Section

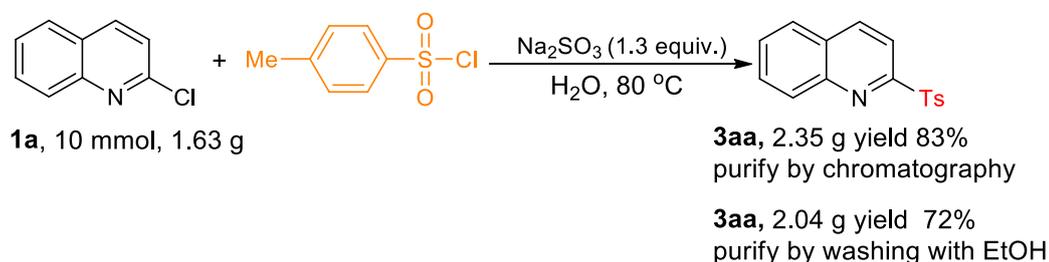
2.1 General procedure for the synthesis of sulfonylated *N*-heteroaromatics



In a pressure tube was consecutively placed halogenated *N*-heteroaromatic (0.5 mmol), H_2O (2 mL), sulfonyl chloride (0.6 mmol) and Na_2SO_3 (0.65 mmol), then the mixtures were heated to $80\text{ }^\circ\text{C}$. The progress of the reaction was monitored by TLC. The reaction typically took within 2 hours. Upon completion, the reaction was cooled to room temperature, stand for 4h, then the crude product was collected via filtration, it was further purified by column chromatography on silica gel (eluent: petroleum ether/EtOAc = 10:1 - 4:1) to obtain sulfonylated *N*-heteroaromatics.

2.2 Gram – scale Synthesis of 3aa

2.2.1 Synthesis of 3aa with 10mmol of 2-chloroquinoline



In a round-bottom flask was consecutively placed 2-chloroquinoline (10mmol, 1.63 g), H_2O (20 mL), tosyl chloride (12 mmol, 2.28 g) and Na_2SO_3 (13 mmol, 1.64 g), then the mixtures were heated to $80\text{ }^\circ\text{C}$ for 2h, Upon completion, the reaction was cooled to room temperature, stand for 4h, then the crude product was collected via filtration, it was further purified by column chromatography on silica gel (eluent: petroleum ether/EtOAc

= 10:1 - 4:1) to obtain 2.35 gram of **3aa**, yield 83%. The crude product could also be purified by washing with 2mL of EtOH to obtain 2.04 gram of **3aa**, yield 72% purity 94%. The solid form of **3aa** obtained by washing crude product with EtOH is as follows (Figure 1)

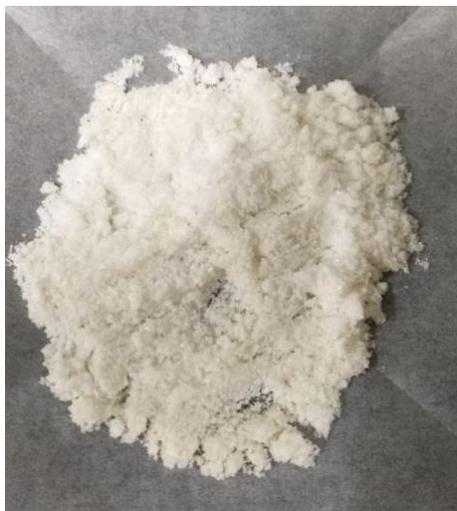
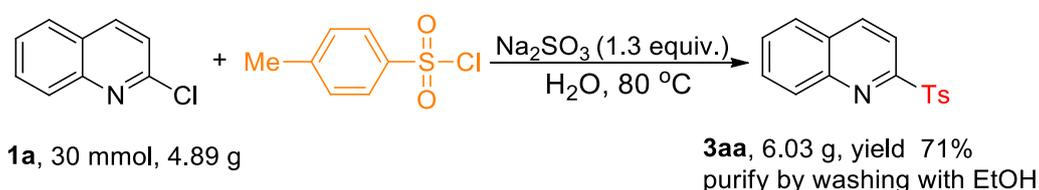


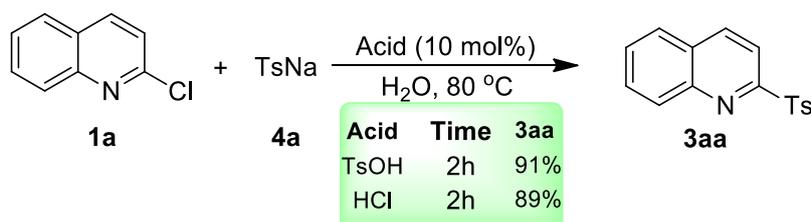
Figure 1 Solid form of purified **3aa**

2.2.2 Synthesis of **3aa** with 30mmol of 2-chloroquinoline



In a round-bottom flask was consecutively placed 2-chloroquinoline (30mmol, 4.89 g), H₂O (60 mL), tosyl chloride (36 mmol, 7.14 g) and Na₂SO₃ (39 mmol, 4.92 g), then the mixtures were heated to 80 °C for 2h, Upon completion, the reaction was cooled to room temperature, stand for 4h, then the crude product was collected via filtration, it was further purified by washing with 6mL of EtOH to obtain 6.03 gram of **3aa**, yield 71%, purity 94%.

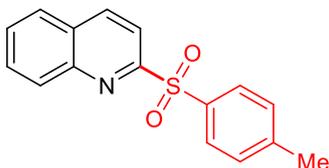
2.3 Control Experiments



In a pressure tube was consecutively placed 2-chloroquinoline (0.5 mmol, 82 mg), H₂O (2 mL), TsNa (1 mmol, 178 mg) and TsOH.H₂O or Concentrated hydrochloric acid (0.05 mmol), then the mixtures were heated to 80 °C for 2 hours, Upon completion, the reaction was cooled to room temperature, then water (5mL) was added to the reaction mixtue, it was extracted with CH₂Cl₂ (5 mL x 2) and the organic extracts were dried over anhydrous Na₂SO₄, filtered and concentrated under reduced pressure. The crude product was purified by column chromatography on silica gel (eluent: petroleum ether/EtOAc = 10:1 - 4:1) to obtain **3aa**.

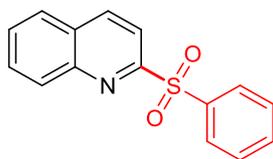
3. Characterization data of products

2-tosylquinoline (3aa)¹



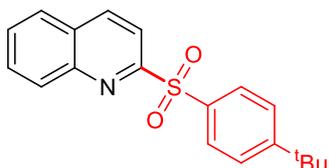
¹H NMR (400 MHz, CDCl₃): δ = 8.35 (d, *J* = 8.4 Hz, 1 H), 8.19 – 8.14 (m, 2 H), 8.01 (d, *J* = 8.0 Hz, 2 H), 7.85 (d, *J* = 8.0 Hz, 1 H), 7.77 – 7.74 (m, 1 H), 7.64 – 7.61 (m, 1 H), 7.31 (d, *J* = 8.4 Hz, 2 H), 2.37 (s, 3 H); ¹³C NMR (100 MHz, CDCl₃): δ = 158.2, 147.3, 144.7, 138.6, 136.0, 130.9, 130.3, 129.7, 129.1, 129.0, 128.7, 127.6, 117.6, 21.5.

2-(phenylsulfonyl)quinoline (3ab)²



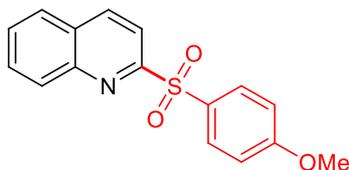
¹H NMR (400 MHz, CDCl₃): δ = 8.38 (d, *J* = 8.8 Hz, 1 H), 8.22 – 8.13 (m, 4 H), 7.88 (d, *J* = 8.4 Hz, 1 H), 7.81 – 7.77 (m, 1 H), 7.68 – 7.64 (m, 1 H), 7.61 – 7.52 (m, 3 H); ¹³C NMR (100 MHz, CDCl₃): δ = 158.1, 147.5, 139.1, 138.7, 133.7, 131.0, 130.4, 129.2, 129.1, 129.0, 128.8, 127.7, 117.7.

2-((4-(tert-butyl)phenyl)sulfonyl)quinoline (3ac)²



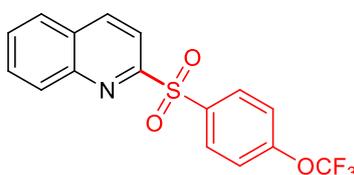
¹H NMR (400 MHz, CDCl₃): δ = 8.37 (d, *J* = 8.8 Hz, 1 H), 8.20 (d, *J* = 8.4 Hz, 2 H), 8.06 (d, *J* = 8.8 Hz, 2 H), 7.87 (d, *J* = 8.0 Hz, 1 H), 7.81 – 7.77 (m, 1 H), 7.67 – 7.64 (m, 1 H), 7.54 (d, *J* = 8.4 Hz, 2 H), 1.30 (s, 9 H); ¹³C NMR (100 MHz, CDCl₃): δ = 158.3, 157.7, 147.5, 138.7, 136.1, 130.9, 130.4, 129.1, 128.9, 128.8, 127.7, 126.2, 117.8, 35.2, 31.0.

2-((4-methoxyphenyl)sulfonyl)quinoline (3ad)³



^1H NMR (400 MHz, CDCl_3): δ = 8.35 (d, J = 8.8 Hz, 1 H), 8.18 – 8.15 (m, 2 H), 8.06 (d, J = 8.8 Hz, 2 H), 7.86 (d, J = 8.0 Hz, 1 H), 7.77 (t, J = 7.6 Hz, 1 H), 7.64 (t, J = 7.6 Hz, 1 H), 6.99 (d, J = 8.8 Hz, 2 H), 3.83 (s, 3 H); ^{13}C NMR (100 MHz, CDCl_3): δ = 163.8, 158.6, 147.4, 138.6, 131.2, 130.9, 130.4, 130.3, 129.0, 128.7, 127.6, 117.5, 114.3, 55.6.

2-((4-(trifluoromethoxy)phenyl)sulfonyl)quinoline (3ae)⁴



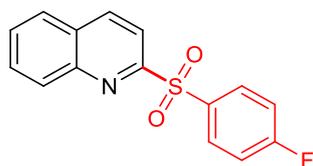
^1H NMR (400 MHz, CDCl_3): δ = 8.39 (d, J = 8.4 Hz, 1 H), 8.22 – 8.19 (m, 3 H), 8.13 (d, J = 8.8 Hz, 1 H), 7.87 (d, J = 8.4 Hz, 1 H), 7.79 – 7.75 (m, 1 H), 7.67 – 7.62 (m, 1 H), 7.34 (dd, J_1 = 8.8 Hz, J_2 = 1.2 Hz, 2 H); ^{13}C NMR (100 MHz, CDCl_3): δ = 157.5, 152.9 (q, $J_{\text{C-F}}$ = 8.4), 147.3, 138.9, 137.2, 131.3, 131.1, 130.2, 129.3, 128.8, 127.7, 120.7 (q, $J_{\text{C-F}}$ = 1.5), 120.1 (q, $J_{\text{C-F}}$ = 258.1), 117.4; ^{19}F NMR (376 MHz, CDCl_3): δ = - 57.7.

2-((1,1'-biphenyl)-4-ylsulfonyl)quinoline (3af)³



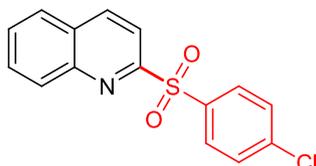
^1H NMR (400 MHz, CDCl_3): δ = 8.40 (d, J = 8.4 Hz, 1 H), 8.24 (d, J = 8.4 Hz, 1 H), 8.21 – 8.19 (m, 3 H), 7.89 (d, J = 8.0 Hz, 1 H), 7.82 – 7.78 (m, 1 H), 7.74 (d, J = 8.4 Hz, 2 H), 7.68 – 7.65 (m, 1 H), 7.58 – 7.56 (m, 2 H), 7.47 – 7.40 (m, 3 H); ^{13}C NMR (100 MHz, CDCl_3): δ = 158.2, 147.5, 146.7, 139.2, 138.8, 137.6, 131.0, 130.4, 129.6, 129.2, 129.0, 128.9, 128.6, 127.7, 127.4, 117.7.

2-((4-fluorophenyl)sulfonyl)quinoline (3ag)³



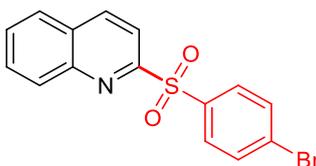
^1H NMR (400 MHz, CDCl_3): δ = 8.46 (d, J = 8.4 Hz, 1 H), 8.29 – 8.21 (m, 4 H), 7.96 (d, J = 8.4 Hz, 1 H), 7.89 - 7.85 (m, 1 H), 7.76 – 7.72 (m, 1 H), 7.30 (t, J = 8.8 Hz, 2 H); ^{13}C NMR (100 MHz, CDCl_3): δ = 167.2, 164.7, 158.0, 147.4, 138.8, 135.0, 132.0, 131.9, 131.1, 130.3, 129.3, 128.9, 127.7, 117.5, 116.5, 116.3; ^{19}F NMR (376 MHz, CDCl_3): δ = - 103.3.

2-((4-chlorophenyl)sulfonyl)quinoline (3ah)³



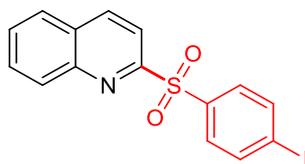
^1H NMR (400 MHz, CDCl_3): δ = 8.40 (d, J = 8.4 Hz, 1 H), 8.21 (d, J = 8.4 Hz, 1 H), 8.15 (d, J = 8.8 Hz, 1 H), 8.08 (d, J = 8.4 Hz, 2 H), 7.89 (d, J = 8.0 Hz, 1 H), 7.80 (t, J = 7.6 Hz, 1 H), 7.68 (t, J = 7.6 Hz, 1 H), 7.52 (d, J = 8.8 Hz, 2 H); ^{13}C NMR (100 MHz, CDCl_3): δ = 157.8, 147.4, 140.6, 138.9, 137.5, 131.1, 130.6, 130.3, 129.4, 129.4, 128.8, 127.7, 117.5.

2-((4-bromophenyl)sulfonyl)quinoline (3ai)⁵



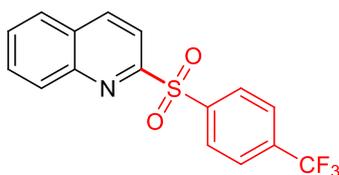
^1H NMR (400 MHz, CDCl_3): δ = 8.40 (d, J = 8.4 Hz, 1 H), 8.20 (d, J = 8.4 Hz, 1 H), 8.15 (d, J = 8.8 Hz, 1 H), 8.01 (d, J = 8.8 Hz, 2 H), 7.89 (d, J = 8.0 Hz, 1 H), 7.83 – 7.78 (m, 1 H), 7.69 – 7.66 (m, 3 H); ^{13}C NMR (100 MHz, CDCl_3): δ = 157.7, 147.4, 138.9, 138.0, 132.4, 131.1, 130.6, 130.3, 129.4, 129.2, 128.9, 127.7, 117.5.

2-((4-iodophenyl)sulfonyl)quinoline (3aj)³



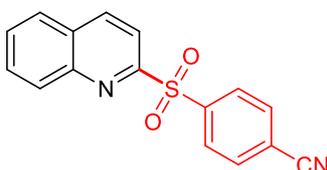
^1H NMR (400 MHz, CDCl_3): δ = 8.39 (d, J = 8.8 Hz, 1 H), 8.20 (d, J = 8.8 Hz, 1 H), 8.15 (d, J = 8.4 Hz, 1 H), 7.91 – 7.88 (m, 3 H), 7.85 – 7.78 (m, 3 H), 7.70 – 7.66 (m, 1 H); ^{13}C NMR (100 MHz, CDCl_3): δ = 157.7, 147.5, 138.9, 138.7, 138.4, 131.1, 130.4, 130.4, 129.4, 128.9, 127.7, 117.5, 101.9.

2-((4-(trifluoromethyl)phenyl)sulfonyl)quinoline (3ak)⁴



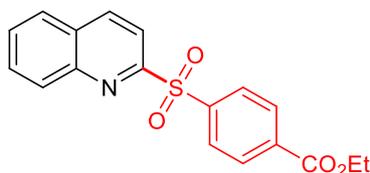
^1H NMR (400 MHz, CDCl_3): δ = 8.42 (d, J = 8.4 Hz, 1 H), 8.28 (d, J = 8.4 Hz, 2 H), 8.23 (d, J = 8.4 Hz, 1 H), 8.14 (d, J = 8.8 Hz, 1 H), 7.89 (d, J = 8.0 Hz, 1 H), 7.81 – 7.79 (m, 3 H), 7.68 (t, J = 7.2 Hz, 1 H); ^{13}C NMR (100 MHz, CDCl_3): δ = 157.3, 147.4, 142.6, 139.0, 135.7, 135.4, 135.1, 134.7, 131.2, 130.3, 129.7, 129.5, 128.9, 127.7, 126.2, 126.1, 126.1, 126.1, 124.5, 121.7, 117.5; ^{19}F NMR (376 MHz, CDCl_3): δ = - 63.2.

4-(quinolin-2-ylsulfonyl)benzonitrile (3al)⁵



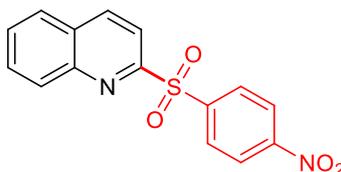
^1H NMR (400 MHz, CDCl_3): δ = 8.43 (d, J = 8.0 Hz, 1 H), 8.28 – 8.22 (m, 3 H), 8.13 (d, J = 8.0 Hz, 1 H), 7.91 (d, J = 8.4 Hz, 1 H), 7.86 – 7.80 (m, 3 H), 7.72 – 7.68 (m, 1 H); ^{13}C NMR (100 MHz, CDCl_3): δ = 157.0, 147.4, 143.2, 139.0, 132.7, 131.3, 130.2, 129.8, 129.6, 129.0, 127.8, 117.5, 117.3, 117.2.

ethyl 4-(quinolin-2-ylsulfonyl)benzoate (3am)⁴



^1H NMR (400 MHz, CDCl_3): δ = 8.41 (d, J = 8.8 Hz, 1 H), 8.24 – 8.17 (m, 5 H), 8.14 (d, J = 8.8 Hz, 1 H), 7.89 (d, J = 8.0 Hz, 1 H), 7.82 – 7.78 (m, 1 H), 7.69 – 7.65 (m, 1 H), 4.39 (q, J = 7.2 Hz, 2 H), 1.38 (t, J = 7.2 Hz, 3 H); ^{13}C NMR (100 MHz, CDCl_3): δ = 165.1, 157.6, 147.5, 142.8, 138.9, 135.1, 131.2, 130.4, 130.1, 129.4, 129.1, 127.7, 117.6, 61.7, 14.2.

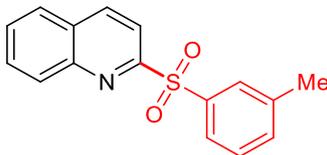
2-((4-nitrophenyl)sulfonyl)quinoline (3an)⁵



^1H NMR (400 MHz, CDCl_3): δ = 8.44 (d, J = 8.4 Hz, 1 H), 8.39 – 8.33 (m, 4 H), 8.25 (d, J =

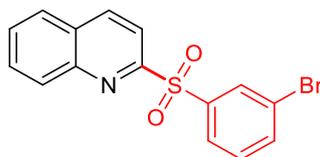
8.4 Hz, 1 H), 8.12 (d, $J = 8.8$ Hz, 1 H), 7.91 (d, $J = 8.4$ Hz, 1 H), 7.84 – 7.80 (m, 1 H), 7.70 (t, $J = 7.6$ Hz, 1 H); ^{13}C NMR (100 MHz, CDCl_3): $\delta = 156.9, 150.8, 147.5, 144.7, 139.1, 131.4, 130.6, 130.3, 129.7, 129.0, 127.8, 124.1, 117.5$.

2-(*m*-tolylsulfonyl)quinoline (3ao)



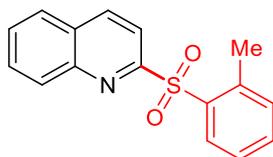
^1H NMR (400 MHz, CDCl_3): $\delta = 8.36$ (d, $J = 8.4$ Hz, 1 H), 8.20 – 8.16 (m, 2 H), 7.94 – 7.92 (m, 2 H), 7.86 (d, $J = 8.4$ Hz, 1 H), 7.79 – 7.75 (m, 1 H), 7.66 – 7.62 (m, 1 H), 7.42 – 7.38 (m, 2 H), 2.39 (s, 3 H); ^{13}C NMR (100 MHz, CDCl_3): $\delta = 158.1, 147.4, 139.3, 138.9, 138.7, 134.5, 131.5, 130.9, 130.3, 129.1, 129.1, 128.9, 127.6, 126.1, 117.7, 21.2$; HRMS (ESI) m/z calcd. for $\text{C}_{16}\text{H}_{14}\text{NO}_2\text{S}[\text{M}+\text{H}]^+$: 284.0740, found 284.0743.

2-(3-bromophenylsulfonyl)quinoline (3ap)⁶



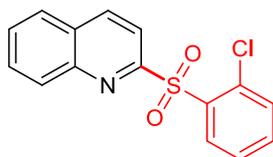
^1H NMR (400 MHz, CDCl_3): $\delta = 8.44$ (d, $J = 8.4$ Hz, 1 H), 8.32 – 8.31 (m, 1 H), 8.25 (d, $J = 8.4$ Hz, 1 H), 8.21 (dd, $J_1 = 8.8$ Hz, $J_2 = 0.8$ Hz, 1 H), 8.13 – 8.10 (m, 1 H), 7.93 (d, $J = 8.8$ Hz, 1 H), 7.86 – 7.82 (m, 1 H), 7.77 – 7.70 (m, 2 H), 7.45 (t, $J = 8.0$ Hz, 1 H); ^{13}C NMR (100 MHz, CDCl_3): $\delta = 157.5, 147.5, 140.9, 138.9, 136.8, 131.8, 131.2, 130.5, 130.4, 129.7, 129.4, 127.7, 127.7, 123.0, 117.6$.

2-(*o*-tolylsulfonyl)quinoline (3aq)⁵



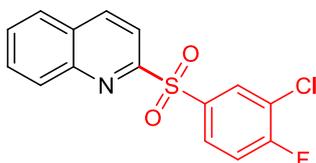
^1H NMR (400 MHz, CDCl_3): $\delta = 8.39$ (d, $J = 8.4$ Hz, 1 H), 8.30 (dd, $J_1 = 8.0$ Hz, $J_2 = 1.6$ Hz, 1 H), 8.17 (d, $J = 8.4$ Hz, 1 H), 8.11 (d, $J = 8.8$ Hz, 1 H), 7.89 (d, $J = 8.0$ Hz, 1 H), 7.79 – 7.75 (m, 1 H), 7.68 – 7.64 (m, 1 H), 7.52 – 7.48 (m, 1 H), 7.42 (t, $J = 7.6$ Hz, 1 H), 7.25 (d, $J = 7.6$ Hz, 1 H), 2.56 (s, 3 H); ^{13}C NMR (100 MHz, CDCl_3): $\delta = 158.2, 147.1, 139.1, 138.6, 137.1, 133.9, 132.4, 130.9, 130.6, 130.4, 129.1, 128.9, 127.7, 126.4, 117.7, 20.7$.

2-(2-chlorophenylsulfonyl)quinoline (3ar)³



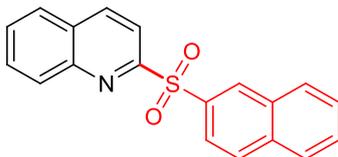
^1H NMR (400 MHz, CDCl_3): δ = 8.52 – 8.50 (m, 1 H), 8.44 (d, J = 8.8 Hz, 1 H), 8.34 (d, J = 8.4 Hz, 1 H), 8.05 (d, J = 8.4 Hz, 1 H), 7.92 (d, J = 8.4 Hz, 1 H), 7.79 – 7.75 (m, 1 H), 7.70 – 7.66 (m, 1 H), 7.59 – 7.56 (m, 2 H), 7.43 – 7.41 (m, 1 H); ^{13}C NMR (100 MHz, CDCl_3): δ = 157.4, 147.2, 138.4, 136.7, 134.9, 133.1, 132.2, 131.5, 130.9, 130.3, 129.2, 129.0, 127.8, 127.2, 118.4.

2-((3-chloro-4-fluorophenyl)sulfonyl)quinoline (3as)⁴



^1H NMR (400 MHz, CDCl_3): δ = 8.41 (d, J = 8.8 Hz, 1 H), 8.23 – 8.19 (m, 2 H), 8.14 (d, J = 8.4 Hz, 1 H), 8.08 – 8.04 (m, 1 H), 7.89 (d, J = 8.4 Hz, 1 H), 7.80 (t, J = 8.0 Hz, 1 H), 7.68 (t, J = 7.2 Hz, 1 H), 7.30 (t, J = 8.4 Hz, 1 H); ^{13}C NMR (100 MHz, CDCl_3): δ = 162.6, 160.1, 157.4, 147.4, 139.0, 136.0, 135.9, 132.0, 131.2, 130.2, 129.8, 129.7, 129.4, 128.9, 127.7, 122.6, 122.4, 117.5, 117.4, 117.3; ^{19}F NMR (376 MHz, CDCl_3): δ = - 105.5.

2-(naphthalen-2-ylsulfonyl)quinoline (3at)²



^1H NMR (400 MHz, CDCl_3): δ = 8.75 (s, 1 H), 8.38 (d, J = 8.4 Hz, 1 H), 8.27 (d, J = 8.4 Hz, 1 H), 8.16 (d, J = 8.8 Hz, 1 H), 8.08 (dd, J = 8.4 Hz, 1.6 Hz, 1 H), 8.00 (d, J = 7.6 Hz, 1 H), 7.95 (d, J = 8.8 Hz, 1 H), 7.88 – 7.85 (m, 2 H), 7.78 – 7.74 (m, 1 H), 7.65 – 7.57 (m, 3 H); ^{13}C NMR (100 MHz, CDCl_3): δ = 158.1, 147.4, 138.7, 136.0, 135.3, 132.1, 131.0, 130.8, 130.3, 129.5, 129.3, 129.2, 128.8, 127.9, 127.7, 127.5, 123.7, 117.8.

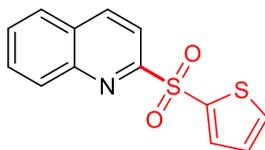
2-((2,3-dihydrobenzofuran-5-yl)sulfonyl)quinoline (3au)



^1H NMR (400 MHz, CDCl_3): δ = 8.36 (d, J = 8.8 Hz, 1 H), 8.18 (d, J = 8.4 Hz, 2 H), 7.94 – 7.91 (m, 2 H), 7.87 (d, J = 8.4 Hz, 1 H), 7.80 – 7.76 (m, 1 H), 7.67 – 7.63 (m, 1 H), 6.86 (d, J

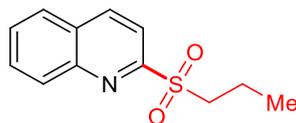
= 8.0 Hz, 1 H), 4.65 (t, J = 8.8 Hz, 2 H), 3.25 (t, J = 8.8 Hz, 2 H); ^{13}C NMR (100 MHz, CDCl_3): δ = 164.9, 158.7, 147.4, 138.6, 130.9, 130.9, 130.4, 129.0, 128.5, 127.7, 126.3, 117.6, 109.7, 72.4, 28.9; HRMS (ESI) m/z calcd. for $\text{C}_{17}\text{H}_{14}\text{NO}_3\text{S}[\text{M}+\text{H}]^+$: 312.0689, found 312.0685.

2-(thiophen-2-ylsulfonyl)quinoline (3av)²



^1H NMR (400 MHz, CDCl_3): δ = 8.39 (d, J = 8.8 Hz, 1 H), 8.22 – 8.20 (m, 2 H), 7.92 – 7.88 (m, 2 H), 7.83 – 7.79 (m, 1 H), 7.73 (dd, J_1 = 5.2 Hz, J_2 = 1.6 Hz, 1 H), 7.70 – 7.66 (m, 1 H), 7.14 – 7.12 (m, 1 H); ^{13}C NMR (100 MHz, CDCl_3): δ = 157.9, 147.4, 139.7, 138.9, 135.3, 135.2, 131.1, 130.3, 129.3, 128.9, 127.8, 127.7, 117.3.

2-(propylsulfonyl)quinoline (3aw)



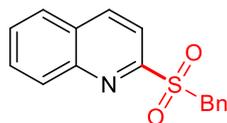
^1H NMR (400 MHz, CDCl_3): δ = 8.42 (d, J = 8.8 Hz, 1 H), 8.22 (d, J = 9.6 Hz, 1 H), 8.12 (d, J = 8.8 Hz, 1 H), 7.93 (d, J = 8.4 Hz, 1 H), 7.86 – 7.82 (m, 1 H), 7.72 – 7.68 (m, 1 H), 3.54 – 3.50 (m, 2 H), 1.88 – 1.82 (m, 2 H), 1.04 (t, J = 7.2 Hz, 3 H); ^{13}C NMR (100 MHz, CDCl_3): δ = 156.9, 147.2, 138.8, 131.1, 130.1, 129.2, 129.1, 127.8, 117.2, 53.5, 16.0, 13.1; HRMS (ESI) m/z calcd. for $\text{C}_{12}\text{H}_{14}\text{NO}_2\text{S}[\text{M}+\text{H}]^+$: 236.0740, found 236.0742.

2-(cyclopropylsulfonyl)quinoline (3ax)³



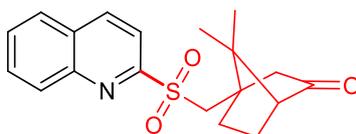
^1H NMR (400 MHz, CDCl_3): δ = 8.39 (d, J = 8.4 Hz, 1 H), 8.22 (d, J = 8.4 Hz, 1 H), 8.03 (d, J = 8.4 Hz, 1 H), 7.91 (dd, J_1 = 8.0 Hz, J_2 = 1.2 Hz, 1 H), 7.84 – 7.80 (m, 1 H), 7.70 – 7.66 (m, 1 H), 3.00 – 2.94 (m, 1 H), 1.42 – 1.38 (m, 2 H), 1.12 – 1.06 (m, 2 H); ^{13}C NMR (100 MHz, CDCl_3): δ = 157.5, 147.3, 138.6, 131.0, 130.1, 129.0, 129.0, 127.8, 117.1, 29.6, 5.51; HRMS (ESI) m/z calcd. for $\text{C}_{12}\text{H}_{12}\text{NO}_2\text{S}[\text{M}+\text{H}]^+$: 234.0583, found 234.0579.

2-(benzylsulfonyl)quinoline (3ay)



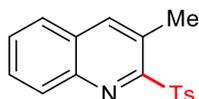
^1H NMR (400 MHz, CDCl_3): δ = 8.32 – 8.28 (m, 2 H), 7.92 – 7.86 (m, 3 H), 7.73 (t, J = 8.0 Hz, 1 H), 7.24 – 7.19 (m, 5 H), 4.80 (s, 2 H); ^{13}C NMR (100 MHz, CDCl_3): δ = 156.2, 147.1, 138.4, 131.2, 131.1, 130.1, 129.3, 129.1, 128.6, 128.6, 127.9, 127.4, 117.9, 58.2; HRMS (ESI) m/z calcd. for $\text{C}_{16}\text{H}_{14}\text{NO}_2\text{S}[\text{M}+\text{H}]^+$: 284.0740, found 284.0742.

7,7-dimethyl-4-((quinolin-2-ylsulfonyl)methyl)bicyclo[2.2.1]heptan-2-one (3az)



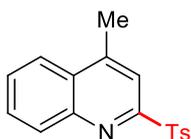
^1H NMR (400 MHz, CDCl_3): δ = 8.40 (d, J = 8.0 Hz, 1 H), 8.20 (d, J = 8.4 Hz, 1 H), 8.12 (d, J = 8.4 Hz, 1 H), 7.90 (d, J = 8.0 Hz, 1 H), 7.83 – 7.78 (m, 1 H), 7.69 – 7.65 (m, 1 H), 4.09 (d, J = 14.8 Hz, 1 H), 3.44 (d, J = 14.8 Hz, 1 H), 2.44 – 2.27 (m, 2 H), 2.07 (t, J = 4.8 Hz, 1 H), 2.01 – 1.97 (m, 1 H), 1.87 – 1.79 (m, 2 H), 1.42 – 1.35 (m, 1 H), 1.11 (m, 3 H), 0.88 (m, 3 H); ^{13}C NMR (100 MHz, CDCl_3): δ = 214.3, 158.1, 146.8, 138.6, 131.0, 130.0, 129.0, 129.0, 127.8, 116.7, 58.9, 48.8, 48.2, 42.5, 42.4, 26.9, 25.2, 19.8, 19.7; HRMS (ESI) m/z calcd. for $\text{C}_{19}\text{H}_{22}\text{NO}_3\text{S}[\text{M}+\text{H}]^+$: 344.1315, found 344.1309.

3-methyl-2-tosylquinoline (3ba)³



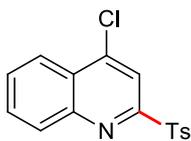
^1H NMR (400 MHz, CDCl_3): δ = 8.05 (s, 1 H), 7.95 – 7.91 (m, 3 H), 7.75 (d, J = 8.0 Hz, 1 H), 7.64 (t, J = 7.2 Hz, 1 H), 7.58 (t, J = 7.2 Hz, 1 H), 7.36 (d, J = 8.0 Hz, 1 H), 2.86 (s, 3 H), 2.46 (s, 3 H); ^{13}C NMR (100 MHz, CDCl_3): δ = 157.0, 144.7, 144.5, 139.8, 135.8, 129.9, 129.7, 129.4, 129.3, 129.1, 128.9, 128.5, 126.6, 21.7, 18.8.

4-methyl-2-tosylquinoline (3ca)²



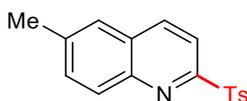
^1H NMR (400 MHz, CDCl_3): δ = 8.15 (d, J = 8.0 Hz, 1 H), 8.02 – 7.98 (m, 4 H), 7.74 (t, J = 7.2 Hz, 1 H), 7.64 (t, J = 7.2 Hz, 1 H), 7.31 (d, J = 8.0 Hz, 2 H), 2.76 (s, 3 H), 2.38 (s, 3 H); ^{13}C NMR (100 MHz, CDCl_3): δ = 157.9, 147.9, 147.1, 144.6, 136.2, 131.0, 130.4, 129.7, 128.9, 128.8, 128.7, 123.7, 118.0, 21.6, 19.1.

4-chloro-2-tosylquinoline (3da)⁴



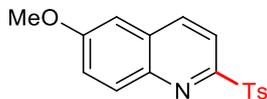
¹H NMR (400 MHz, CDCl₃): δ = 8.26 (s, 1 H), 8.23 – 8.21 (m, 1 H), 8.18 – 8.15 (m, 1 H), 8.01 (d, *J* = 8.4 Hz, 2 H), 7.83 – 7.79 (m, 1 H), 7.75 – 7.70 (m, 1 H), 7.33 (d, *J* = 8.4 Hz, 2 H), 2.39 (s, 3 H); ¹³C NMR (100 MHz, CDCl₃): δ = 158.1, 148.0, 145.1, 135.5, 131.7, 130.7, 130.1, 129.8, 129.1, 126.9, 124.1, 117.8, 21.6.

6-methyl-2-tosylquinoline (3ea)²



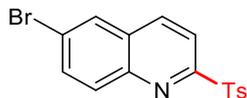
¹H NMR (400 MHz, CDCl₃): δ = 8.25 (d, *J* = 8.4 Hz, 1 H), 8.14 (d, *J* = 8.4 Hz, 1 H), 8.06 (d, *J* = 8.4 Hz, 1 H), 8.01 (d, *J* = 8.4 Hz, 2 H), 7.60 (d, *J* = 8.4 Hz, 2 H), 7.32 (d, *J* = 8.0 Hz, 2 H), 2.54 (s, 3 H), 2.39 (s, 3 H); ¹³C NMR (100 MHz, CDCl₃): δ = 157.4, 146.1, 144.6, 139.6, 137.7, 136.3, 133.3, 130.0, 129.7, 129.0, 128.9, 126.4, 117.7, 21.8, 21.6.

6-methoxy-2-tosylquinoline (3fa)⁷



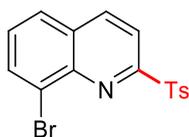
¹H NMR (400 MHz, CDCl₃): δ = 8.21 (d, *J* = 8.4 Hz, 1 H), 8.13 (d, *J* = 8.4 Hz, 1 H), 8.05 (d, *J* = 9.6 Hz, 1 H), 7.99 (d, *J* = 8.4 Hz, 2 H), 7.42 (dd, *J*₁ = 9.2 Hz, *J*₂ = 2.8 Hz, 1 H), 7.31 (d, *J* = 8.4 Hz, 2 H), 7.07 (d, *J* = 2.4 Hz, 1 H), 3.93 (s, 3 H), 2.39 (s, 3 H); ¹³C NMR (100 MHz, CDCl₃): δ = 159.7, 155.6, 144.6, 143.6, 136.8, 136.4, 131.8, 130.3, 129.7, 128.8, 124.2, 118.2, 104.5, 55.7, 21.6.

6-bromo-2-tosylquinoline (3ga)¹



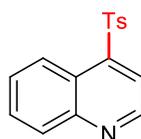
¹H NMR (400 MHz, CDCl₃): δ = 8.28 (d, *J* = 8.8 Hz, 1 H), 8.21 (d, *J* = 8.4 Hz, 1 H), 8.05 – 7.99 (m, 4 H), 7.84 (dd, *J*₁ = 8.8 Hz, *J*₂ = 2.0 Hz, 1 H), 7.34 (d, *J* = 8.4 Hz, 2 H), 2.41 (s, 3 H); ¹³C NMR (100 MHz, CDCl₃): δ = 158.8, 146.0, 145.0, 137.6, 135.8, 134.6, 131.9, 129.8, 129.7, 129.1, 123.5, 118.6, 21.7.

8-bromo-2-tosylquinoline (3ha)



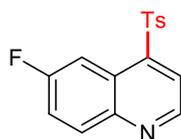
^1H NMR (400 MHz, CDCl_3): δ = 8.36 (d, J = 8.4 Hz, 1 H), 8.25 (d, J = 8.4 Hz, 1 H), 8.13 (d, J = 8.4 Hz, 2 H), 8.07 (dd, J_1 = 7.6 Hz, J_2 = 1.2 Hz, 1 H), 7.82 (d, J = 8.4 Hz, 1 H), 7.47 (t, J = 7.6 Hz, 1 H), 7.36 (d, J = 8.4 Hz, 2 H), 2.42 (s, 3 H); ^{13}C NMR (100 MHz, CDCl_3): δ = 159.4, 145.0, 144.4, 139.2, 135.2, 134.5, 130.0, 129.8, 129.5, 129.3, 127.4, 125.8, 117.8, 21.7; HRMS (ESI) m/z calcd. for $\text{C}_{16}\text{H}_{13}\text{BrNO}_2\text{S}[\text{M}+\text{H}]^+$: 361.9845, found 361.9844.

4-tosylquinoline (3ia)



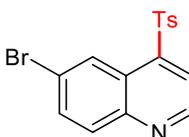
^1H NMR (400 MHz, CDCl_3): δ = 9.11 (d, J = 4.4 Hz, 1 H), 8.66 (d, J = 8.8 Hz, 1 H), 8.19 (d, J = 8.4 Hz, 1 H), 8.14 (d, J = 4.4 Hz, 1 H), 7.88 (d, J = 8.4 Hz, 2 H), 7.79 – 7.75 (m, 1 H), 7.67 – 7.63 (m, 1 H), 7.31 (d, J = 8.4 Hz, 2 H), 2.38 (s, 3 H); ^{13}C NMR (100 MHz, CDCl_3): δ = 149.7, 149.4, 145.1, 137.1, 131.5, 130.6, 130.3, 130.1, 128.8, 128.0, 124.3, 122.1, 121.0, 21.6; HRMS (ESI) m/z calcd. for $\text{C}_{16}\text{H}_{14}\text{NO}_2\text{S}[\text{M}+\text{H}]^+$: 284.0740, found 284.0740.

6-fluoro-4-tosylquinoline (3ja)



^1H NMR (400 MHz, CDCl_3): δ = 9.05 (d, J = 4.8 Hz, 1 H), 8.32 – 8.29 (m, 1 H), 8.19 – 8.15 (m, 2 H), 7.87 (d, J = 8.0 Hz, 2 H), 7.55 – 7.50 (m, 1 H), 7.31 (d, J = 8.0 Hz, 2 H), 2.37 (s, 3 H); ^{13}C NMR (100 MHz, CDCl_3): δ = 162.6, 160.0, 148.9, 148.9, 146.6, 145.3, 144.7, 144.7, 136.7, 133.2, 133.1, 130.1, 127.9, 123.1, 123.0, 121.7, 120.9, 120.6, 108.5, 108.3, 21.5; ^{19}F NMR (376 MHz, CDCl_3): δ = -107.0; HRMS (ESI) m/z calcd. for $\text{C}_{16}\text{H}_{13}\text{FNO}_2\text{S}[\text{M}+\text{H}]^+$: 302.0646, found 302.0641.

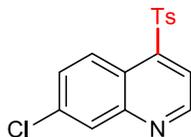
6-bromo-4-tosylquinoline (3ka)



^1H NMR (400 MHz, CDCl_3): δ = 9.09 (d, J = 4.4 Hz, 1 H), 8.86 (d, J = 2.0 Hz, 1 H), 8.13 (d, J = 4.4 Hz, 1 H), 8.04 (d, J = 8.8 Hz, 1 H), 7.88 (d, J = 8.4 Hz, 2 H), 7.84 (dd, J_1 = 8.8 Hz, J_2 =

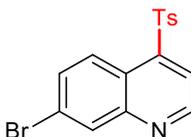
4.0 Hz, 1 H), 7.34 (d, J = 8.0 Hz, 2 H), 2.40 (s, 3 H); ^{13}C NMR (100 MHz, CDCl_3): δ = 150.0, 148.0, 145.5, 144.4, 136.8, 134.0, 132.1, 130.2, 128.1, 126.7, 123.4, 123.2, 121.7, 21.6; HRMS (ESI) m/z calcd. for $\text{C}_{16}\text{H}_{13}\text{BrNO}_2\text{S}[\text{M}+\text{H}]^+$: 361.9845, found 361.9842.

7-chloro-4-tosylquinoline (3la)



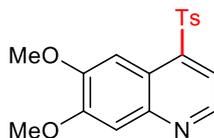
^1H NMR (400 MHz, CDCl_3): δ = 9.09 (d, J = 4.4 Hz, 1 H), 8.62 (d, J = 9.2 Hz, 1 H), 8.17 (d, J = 2.0 Hz, 1 H), 8.10 (d, J = 4.4 Hz, 1 H), 7.86 (d, J = 8.4 Hz, 2 H), 7.59 (dd, J_1 = 8.8 Hz, J_2 = 2.0 Hz, 1 H), 7.31 (d, J = 8.0 Hz, 2 H), 2.38 (s, 3 H); ^{13}C NMR (100 MHz, CDCl_3): δ = 150.8, 149.8, 145.5, 145.4, 136.8, 136.5, 130.2, 129.7, 129.4, 128.0, 125.6, 121.0, 120.5, 21.6; HRMS (ESI) m/z calcd. for $\text{C}_{16}\text{H}_{13}\text{ClNO}_2\text{S}[\text{M}+\text{H}]^+$: 318.0350, found 318.0348.

7-bromo-4-tosylquinoline (3ma)



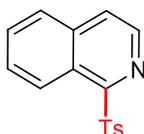
^1H NMR (400 MHz, CDCl_3): δ = 9.09 (d, J = 4.4 Hz, 1 H), 8.55 (d, J = 9.2 Hz, 1 H), 8.37 (d, J = 2.0 Hz, 1 H), 8.12 (d, J = 4.4 Hz, 1 H), 7.86 (d, J = 8.4 Hz, 2 H), 7.73 (dd, J_1 = 9.2 Hz, J_2 = 2.0 Hz, 1 H), 7.32 (d, J = 8.0 Hz, 2 H), 2.39 (s, 3 H); ^{13}C NMR (100 MHz, CDCl_3): δ = 150.8, 150.0, 145.6, 145.4, 136.9, 132.8, 132.2, 130.2, 128.0, 125.6, 124.8, 121.2, 120.8, 21.6; HRMS (ESI) m/z calcd. for $\text{C}_{16}\text{H}_{13}\text{BrNO}_2\text{S}[\text{M}+\text{H}]^+$: 361.9845, found 361.9843.

6,7-dimethoxy-4-tosylquinoline (3na)



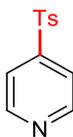
^1H NMR (400 MHz, CDCl_3): δ = 8.88 (d, J = 4.8 Hz, 1 H), 7.99 (d, J = 4.4 Hz, 1 H), 7.87 – 7.84 (m, 3 H), 7.45 (s, 1 H), 7.29 (d, J = 8.0 Hz, 2 H), 4.00 (s, 3 H), 4.00 (s, 3 H), 2.38 (s, 3 H); ^{13}C NMR (100 MHz, CDCl_3): δ = 152.8, 151.1, 147.2, 147.1, 145.0, 142.7, 137.4, 129.9, 127.7, 118.9, 118.2, 108.7, 101.9, 56.2, 56.1, 21.6; HRMS (ESI) m/z calcd. for $\text{C}_{18}\text{H}_{18}\text{NO}_4\text{S}[\text{M}+\text{H}]^+$: 344.0951, found 344.0944.

1-tosylisoquinoline (3oa)¹



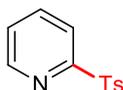
^1H NMR (400 MHz, CDCl_3): $\delta = 9.17 - 9.14$ (m, 1 H), 8.42 (d, $J = 5.6$ Hz, 1 H), 7.98 – 7.96 (m, 2 H), 7.91 – 7.88 (m, 1 H), 7.78 – 7.73 (m, 3 H), 7.35 (d, $J = 8.0$ Hz, 2 H), 2.43 (s, 3 H); ^{13}C NMR (100 MHz, CDCl_3): $\delta = 157.2, 144.7, 140.5, 137.7, 136.0, 131.1, 129.6, 129.2, 127.5, 125.3, 124.9, 124.2, 21.7$.

4-tosylpyridine (3pa)⁸



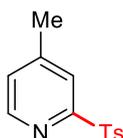
^1H NMR (400 MHz, CDCl_3): $\delta = 8.78$ (d, $J_1 = 4.4$ Hz, $J_2 = 1.6$ Hz, 2 H), 7.82 (d, $J = 8.0$ Hz, 2 H), 7.73 (d, $J_1 = 4.4$ Hz, $J_2 = 2.0$ Hz, 2 H), 7.32 (d, $J = 8.0$ Hz, 2 H), 2.39 (s, 3 H); ^{13}C NMR (100 MHz, CDCl_3): $\delta = 151.0, 150.0, 145.3, 136.5, 130.2, 128.1, 120.4, 21.6$.

2-tosylpyridine (3qa)⁸



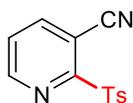
^1H NMR (400 MHz, CDCl_3): $\delta = 8.66$ (d, $J = 4.0$ Hz, 1 H), 8.18 (d, $J = 8.0$ Hz, 1 H), 7.94 – 7.88 (m, 3 H), 7.45 – 7.42 (m, 1 H), 7.32 (d, $J = 8.4$ Hz, 2 H), 2.40 (s, 3 H); ^{13}C NMR (100 MHz, CDCl_3): $\delta = 159.0, 150.4, 144.8, 138.0, 135.9, 129.8, 128.9, 126.7, 122.0, 21.6$.

4-methyl-2-tosylpyridine (3ra)⁸



^1H NMR (400 MHz, CDCl_3): $\delta = 8.50$ (d, $J = 4.8$ Hz, 1 H), 8.01 – 8.00 (m, 1 H), 7.93 (d, $J = 8.8$ Hz, 2 H), 7.32 (d, $J = 8.0$ Hz, 2 H), 7.24 – 7.22 (m, 1 H), 2.45 (s, 3 H), 2.40 (s, 3 H); ^{13}C NMR (100 MHz, CDCl_3): $\delta = 157.9, 149.2, 149.0, 143.7, 135.1, 128.8, 127.9, 126.5, 121.8, 20.7, 20.3$.

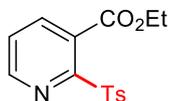
2-tosylnicotinonitrile (3sa)⁸



^1H NMR (400 MHz, CDCl_3): $\delta = 8.84$ (dd, $J_1 = 4.8$ Hz, $J_2 = 1.6$ Hz, 1 H), 8.18 (dd, $J_1 = 8.0$ Hz, $J_2 = 1.6$ Hz, 1 H), 8.02 (d, $J = 8.8$ Hz, 2 H), 7.62 – 7.59 (m, 1 H), 7.38 (d, $J = 8.4$ Hz, 2 H),

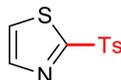
2.44 (s, 3 H); ¹³C NMR (100 MHz, CDCl₃): δ = 160.2, 152.2, 146.1, 143.6, 134.6, 130.1, 129.5, 126.2, 113.9, 108.5, 21.8.

ethyl 2-tosylnicotinate (3ta)



¹H NMR (400 MHz, CDCl₃): δ = 8.65 (dd, *J*₁ = 4.8 Hz, *J*₂ = 1.6 Hz, 1 H), 7.96 (d, *J* = 8.4 Hz, 2 H), 8.02 (dd, *J*₁ = 8.0 Hz, *J*₂ = 1.6 Hz, 1 H), 7.49 – 7.46 (m, 1 H), 7.32 (d, *J* = 8.0 Hz, 2 H), 4.50 (q, *J* = 7.2 Hz, 2 H), 2.41 (s, 3 H), 1.44 (t, *J* = 7.2 Hz, 3 H); ¹³C NMR (100 MHz, CDCl₃): δ = 166.0, 155.6, 150.5, 145.0, 137.3, 135.7, 129.6, 129.6, 129.3, 126.1, 62.9, 21.6, 13.9; HRMS (ESI) *m/z* calcd. for C₁₅H₁₆NO₄S[M+H]⁺: 306.0795, found 306.0798.

2-tosylthiazole (3ua)⁹



¹H NMR (400 MHz, CDCl₃): δ = 7.97 (d, *J* = 8.4 Hz, 2 H), 7.93 (d, *J* = 3.2 Hz, 1 H), 7.65 (d, *J* = 3.2 Hz, 1 H), 7.35 (dd, *J*₁ = 8.8 Hz, *J*₂ = 0.8 Hz, 2 H), 2.42 (s, 3 H); ¹³C NMR (100 MHz, CDCl₃): δ = 167.5, 145.6, 145.2, 135.7, 130.1, 128.7, 125.6, 21.7.

4. References

1. Wang, R.; Zeng, Z.; Chen, C.; Yi, N.; Jiang, J.; Cao, Z.; Deng, W.; Xiang, J., Fast regioselective sulfonylation of pyridine/quinoline N-oxides induced by iodine. *Org. Biomol. Chem.* **2016**, *14* (23), 5317-5321.
2. Sun, K.; Chen, X.-L.; Li, X.; Qu, L.-B.; Bi, W.-Z.; Chen, X.; Ma, H.-L.; Zhang, S.-T.; Han, B.-W.; Zhao, Y.-F.; Li, C.-J., H-phosphonate-mediated sulfonylation of heteroaromatic N-oxides: a mild and metal-free one-pot synthesis of 2-sulfonyl quinolines/pyridines. *Chem. Commun.* **2015**, *51* (60), 12111-12114.
3. Du, B.; Qian, P.; Wang, Y.; Mei, H.; Han, J.; Pan, Y., Cu-Catalyzed Deoxygenative C2-Sulfonylation Reaction of Quinoline N-Oxides with Sodium Sulfinite. *Org. Lett.* **2016**, *18* (16), 4144-4147.
4. Xie, L.-Y.; Li, Y.-J.; Qu, J.; Duan, Y.; Hu, J.; Liu, K.-J.; Cao, Z.; He, W.-M., A base-free, ultrasound accelerated one-pot synthesis of 2-sulfonylquinolines in water. *Green Chemistry* **2017**, *19* (23), 5642-5646.
5. Sumunnee, L.; Buathongjan, C.; Pimpasri, C.; Yotphan, S., Iodine/TBHP-Promoted One-Pot Deoxygenation and Direct 2-Sulfonylation of Quinoline N-Oxides with Sodium Sulfinates: Facile and Regioselective Synthesis of 2-Sulfonylquinolines. *Eur. J. Org. Chem.* **2017**, *2017* (5), 1025-1032.
6. Lee, H.-Y.; Chang, C.-Y.; Su, C.-J.; Huang, H.-L.; Mehndiratta, S.; Chao, Y.-H.; Hsu, C.-M.; Kumar, S.; Sung, T.-Y.; Huang, Y.-Z.; Li, Y.-H.; Yang, C.-R.; Liou, J.-P., 2-(Phenylsulfonyl)quinoline

N-hydroxyacrylamides as potent anticancer agents inhibiting histone deacetylase. *Eur. J. Med. Chem.* **2016**, *122*, 92-101.

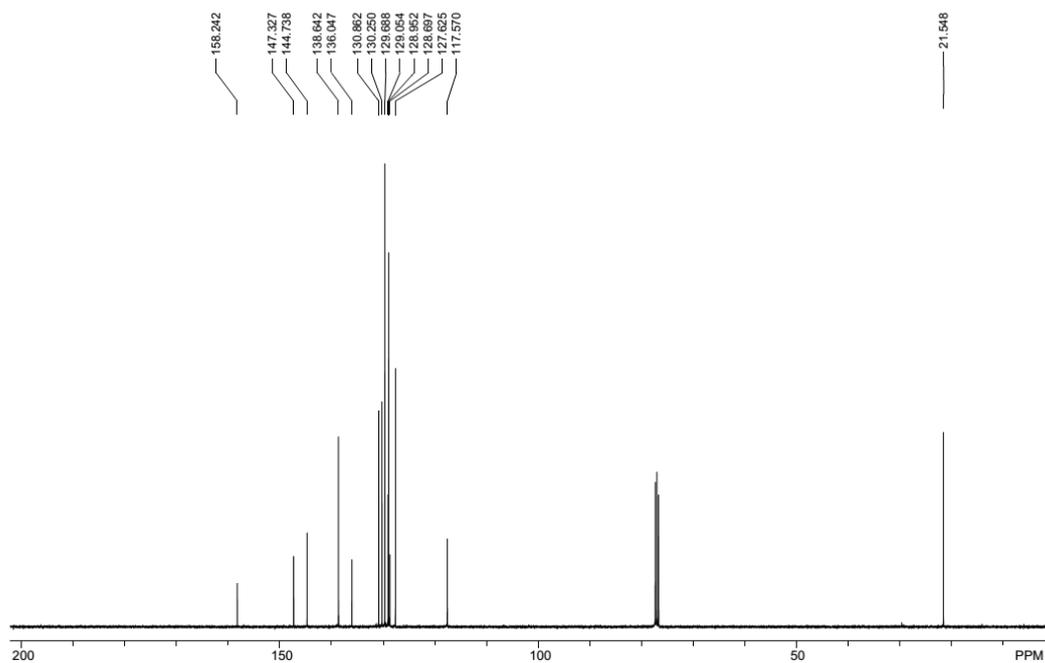
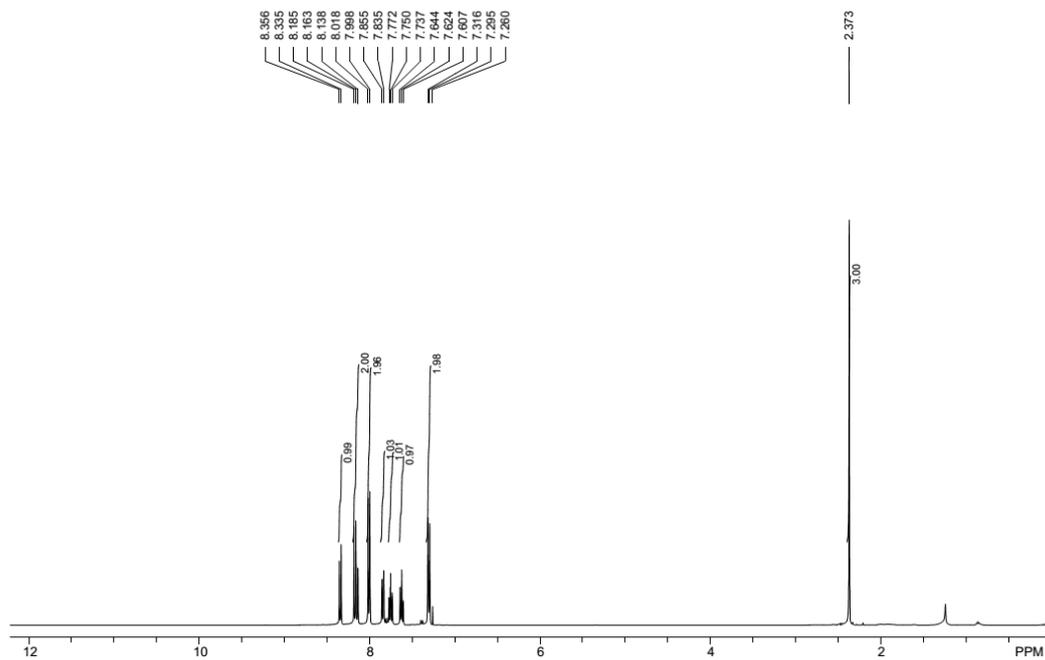
7. Wen - Kai, F.; Kai, S.; Chen, Q.; Xiao - Lan, C.; Ling - Bo, Q.; Wen - Zhu, B.; Yu - Fen, Z., Iodine - Mediated Sulfonylation of Quinoline N - Oxides: a Mild and Metal - Free One - Pot Synthesis of 2 - Sulfonyl Quinolines. *Asian. J. Org. Chem.* **2017**, *6* (5), 492-495.

8. Maloney, K. M.; Kuethe, J. T.; Linn, K., A Practical, One-Pot Synthesis of Sulfonylated Pyridines. *Org. Lett.* **2011**, *13* (1), 102-105.

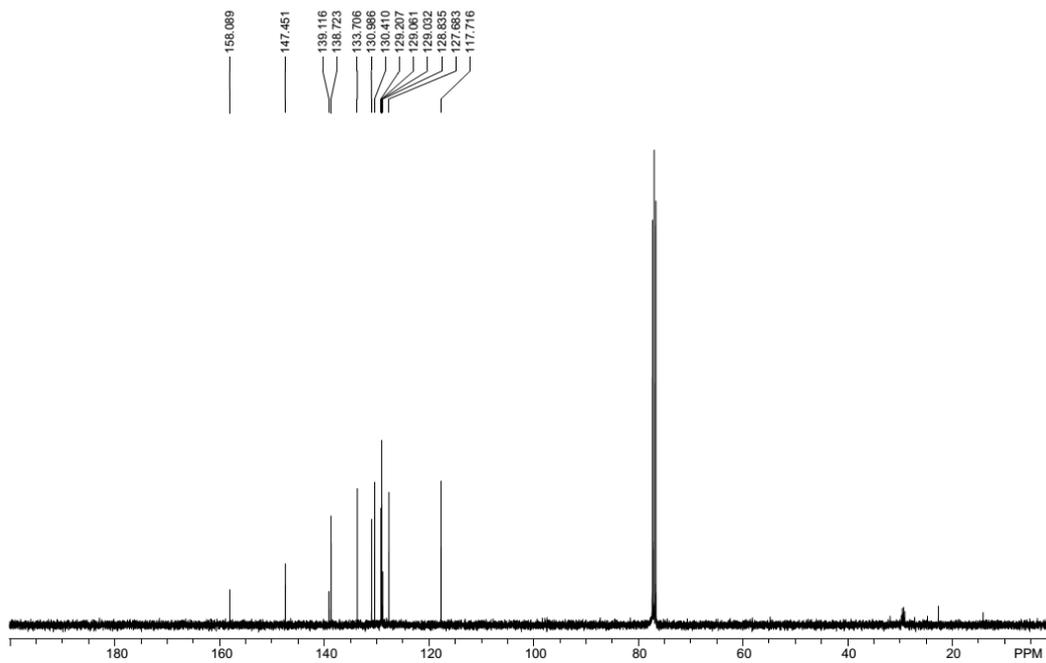
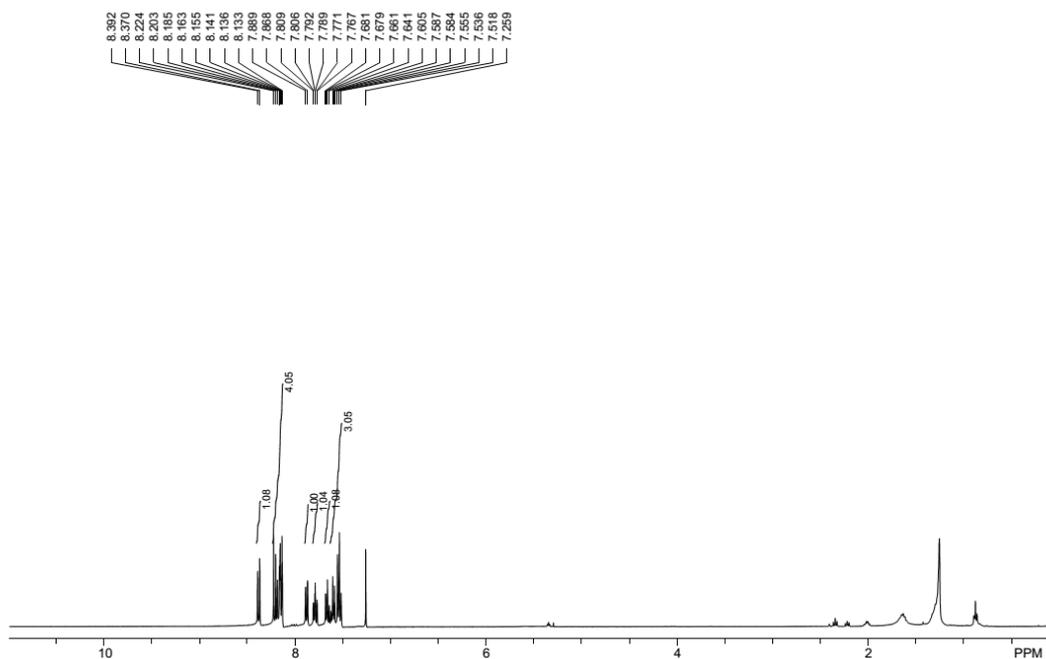
9. Liang, S.; Zhang, R.-Y.; Xi, L.-Y.; Chen, S.-Y.; Yu, X.-Q., Sulfonylation of Five-Membered Heterocycles via an S_NAr Reaction. *J. Org. Chem.* **2013**, *78* (23), 11874-11880.

5. ^1H and ^{13}C NMR spectra of products

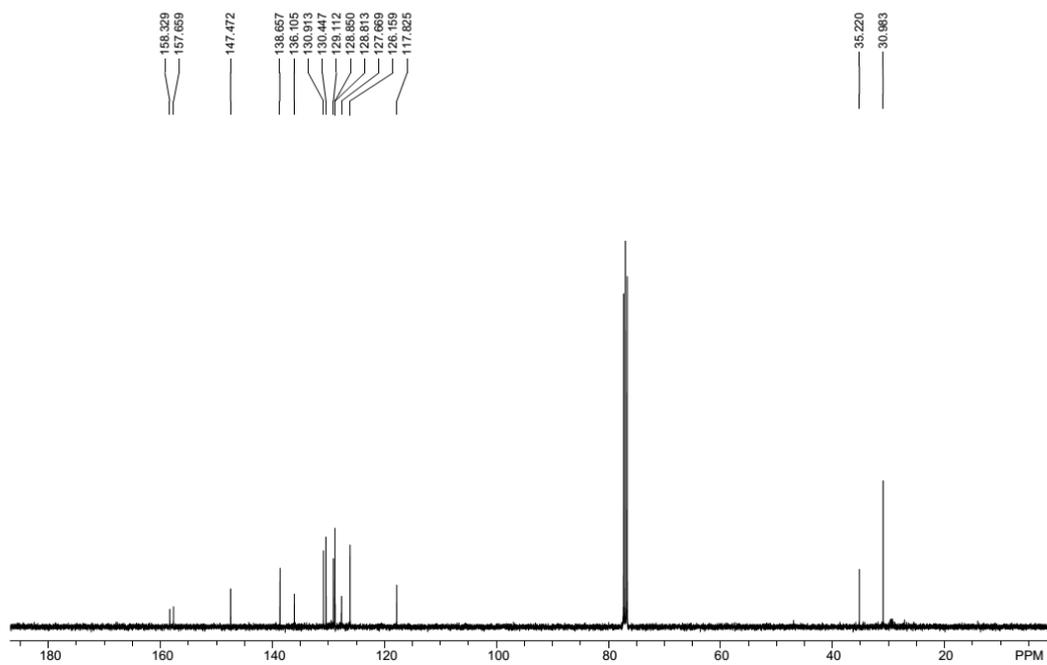
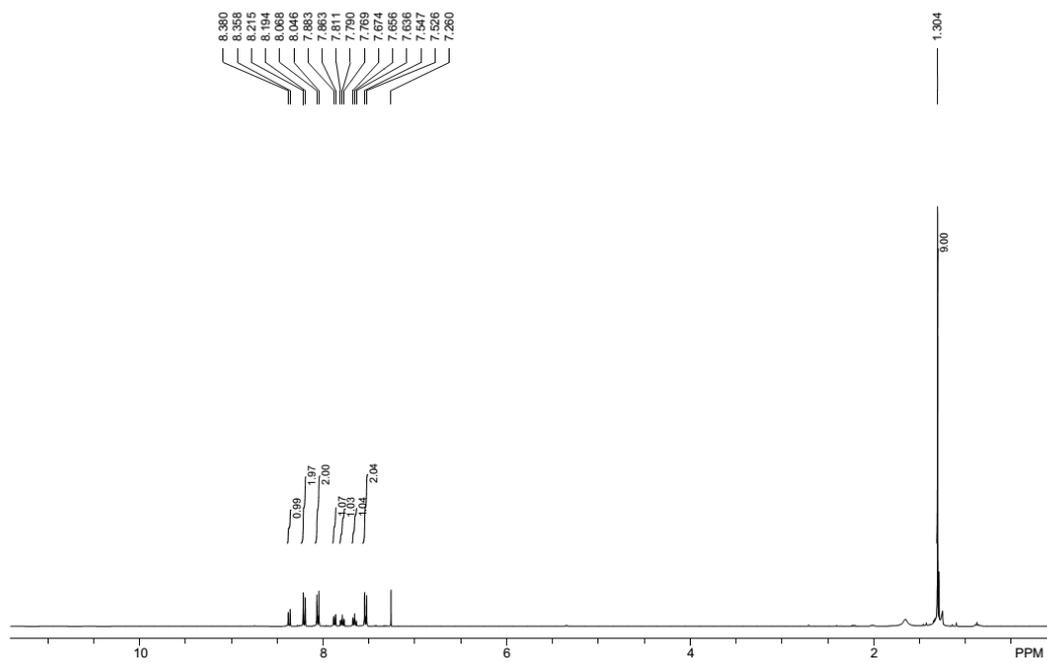
2-tosylquinoline (3aa)



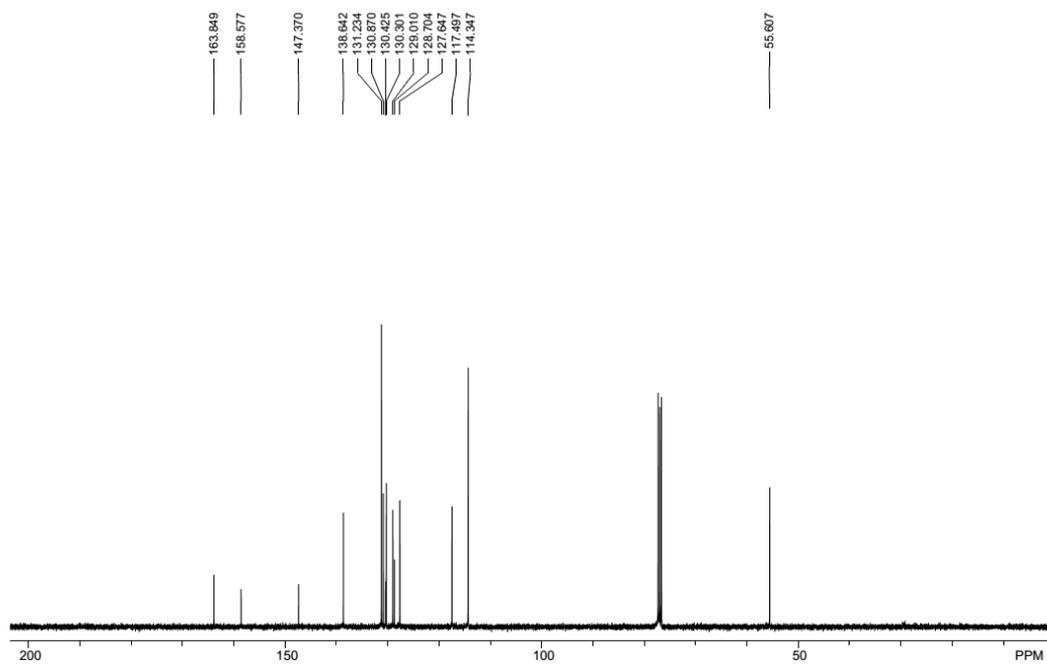
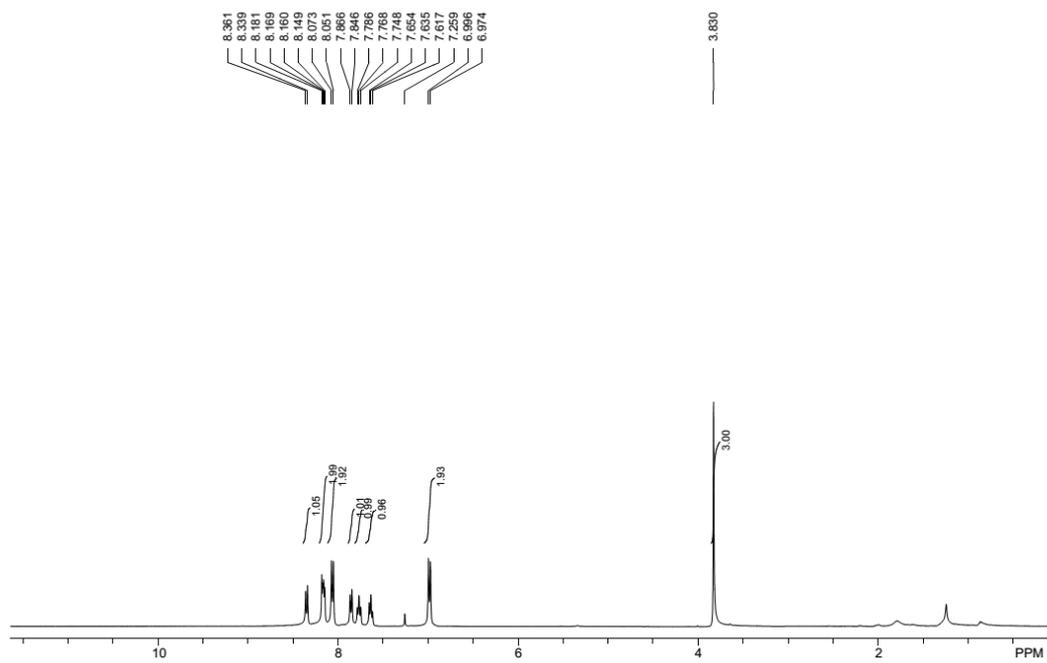
2-(phenylsulfonyl)quinoline (3ab)



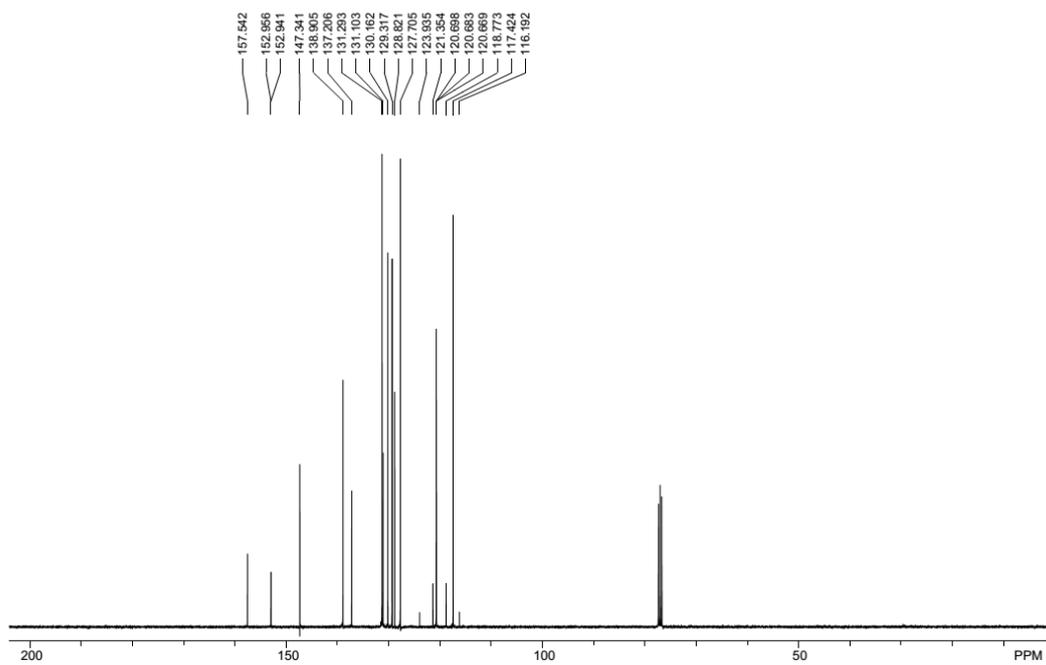
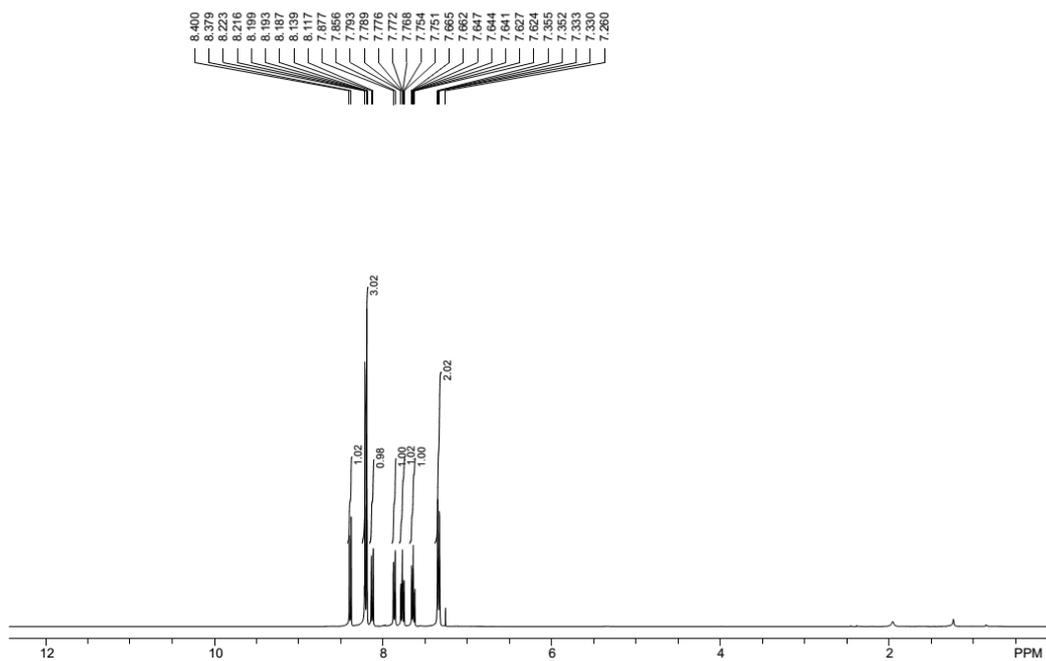
2-((4-(tert-butyl)phenyl)sulfonyl)quinoline (3ac)



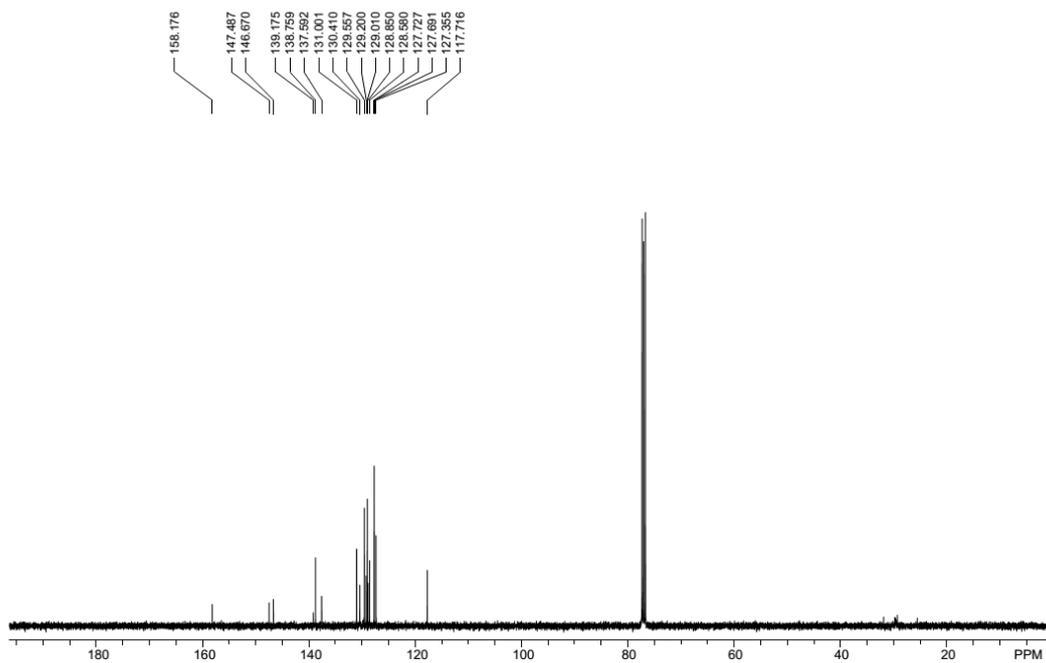
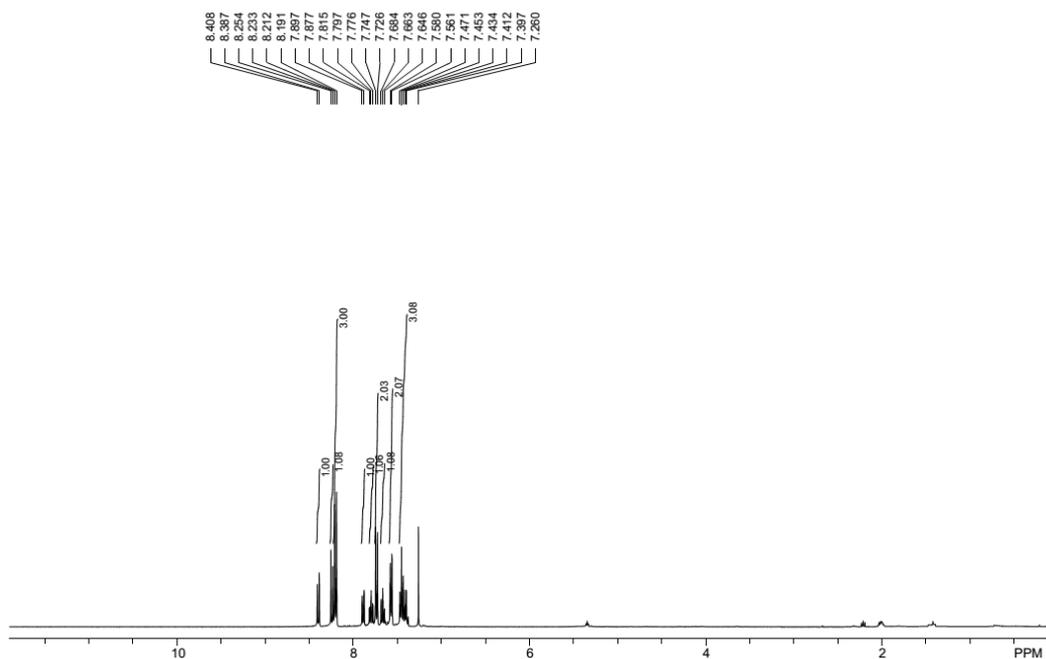
2-((4-methoxyphenyl)sulfonyl)quinoline (3ad)



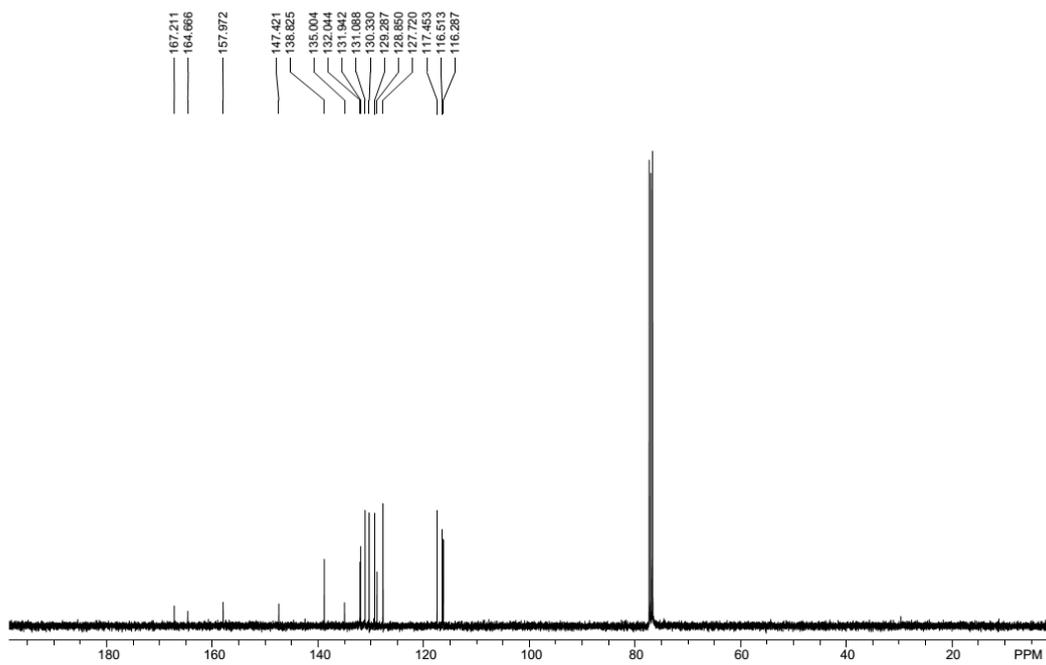
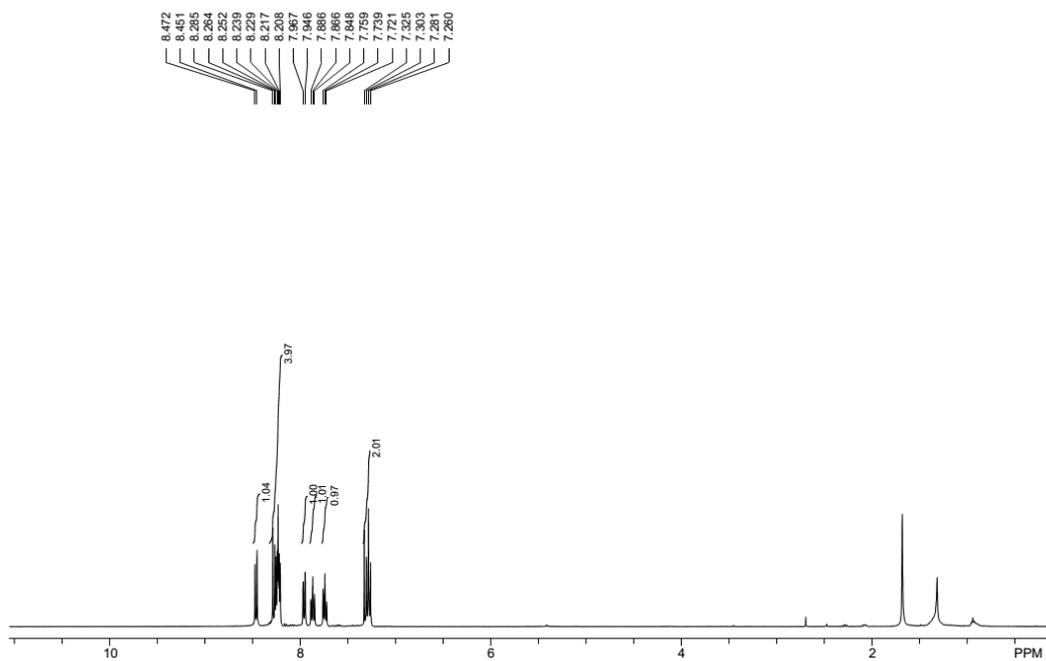
2-((4-(trifluoromethoxy)phenyl)sulfonyl)quinoline (3ae)



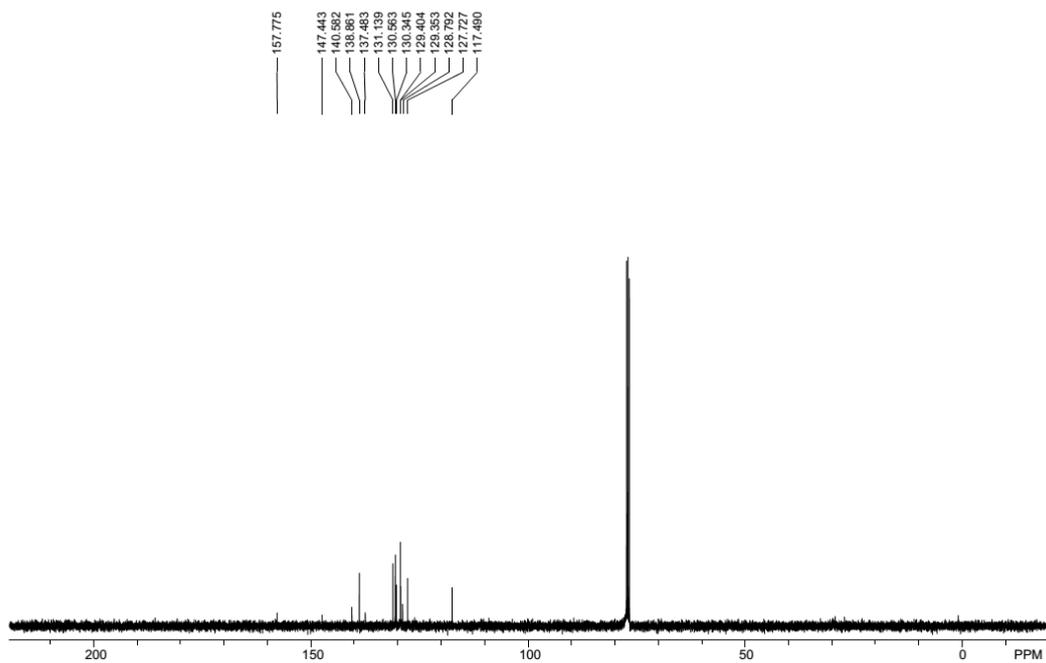
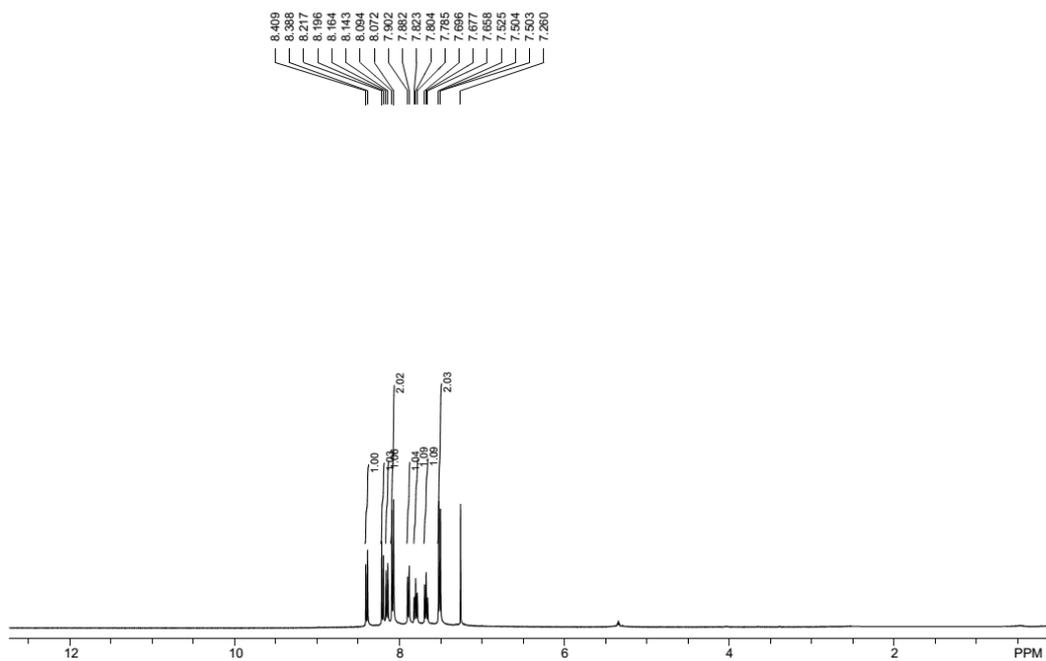
2-([1,1'-biphenyl]-4-ylsulfonyl)quinoline (3af)



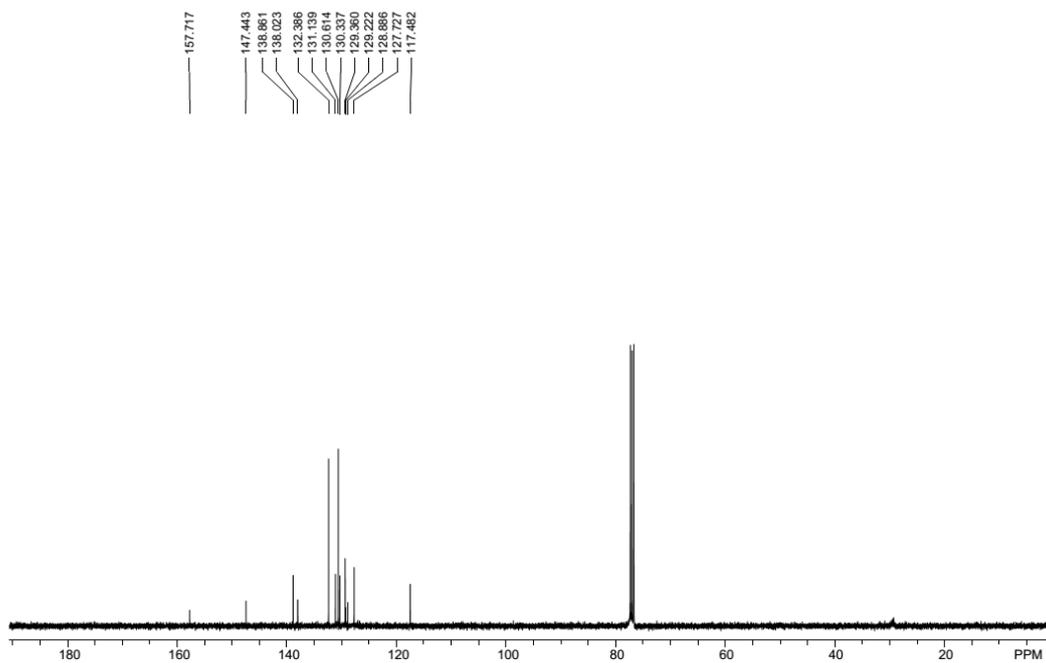
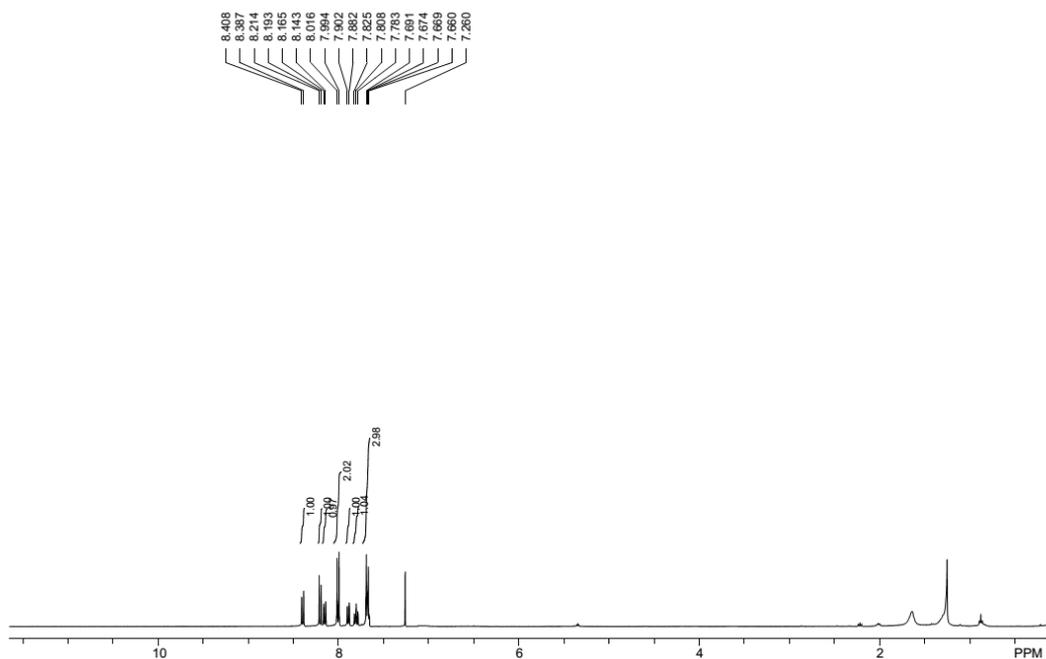
2-((4-fluorophenyl)sulfonyl)quinoline (3ag)



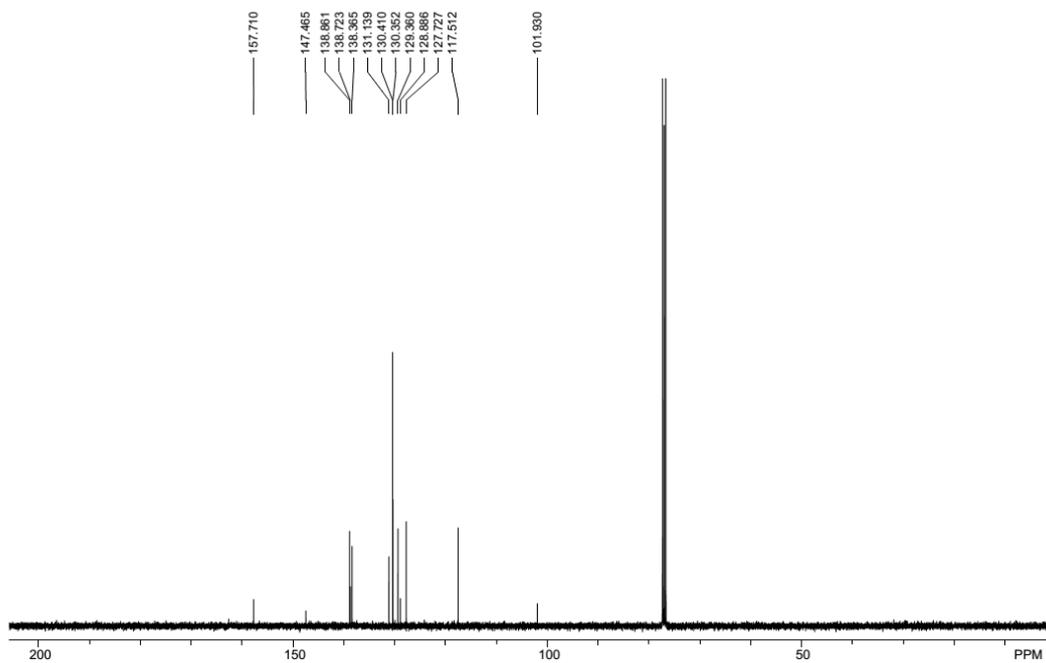
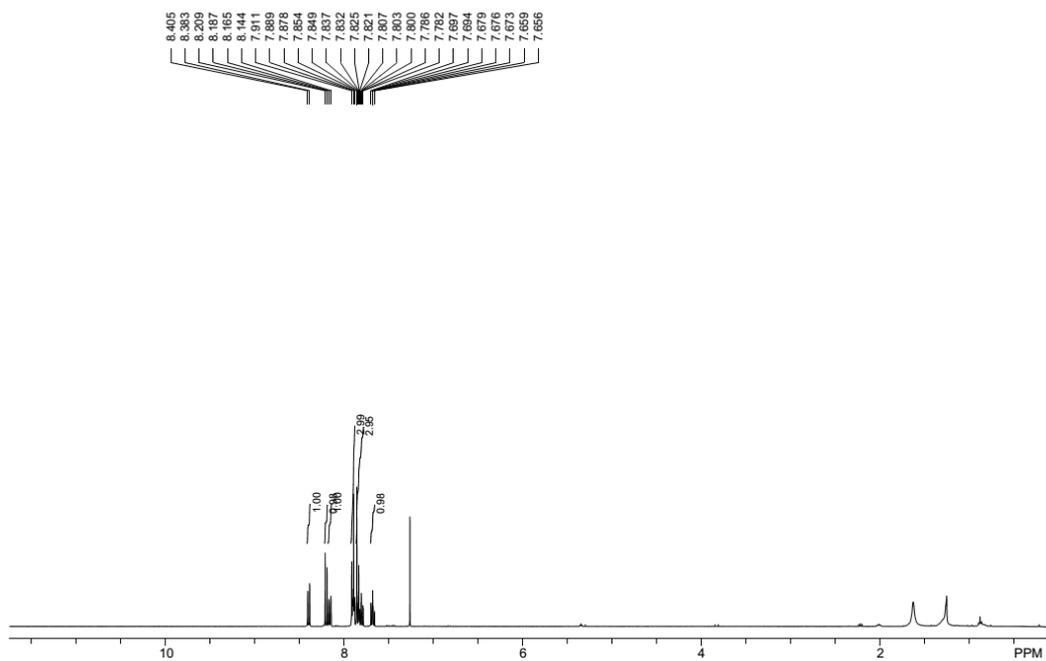
2-((4-chlorophenyl)sulfonyl)quinoline (3ah)



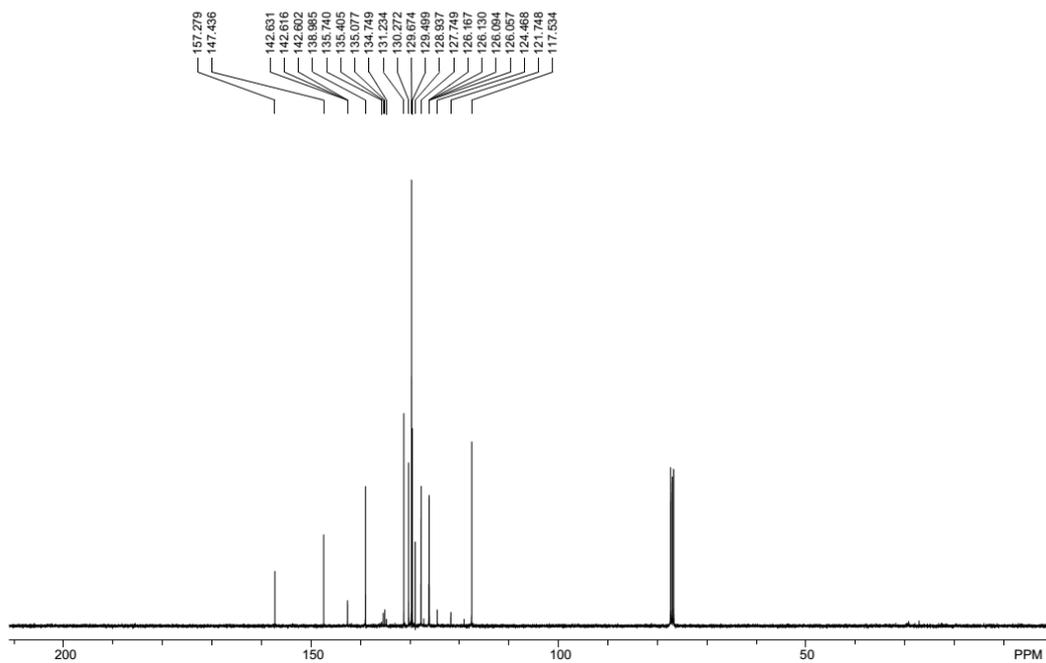
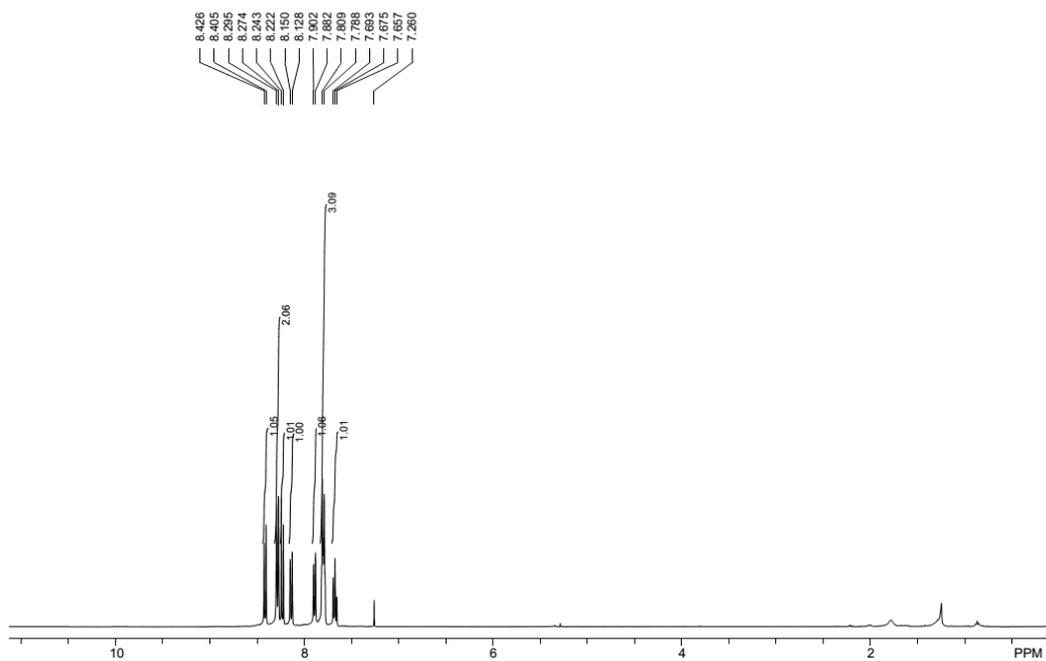
2-((4-bromophenyl)sulfonyl)quinoline (3ai)



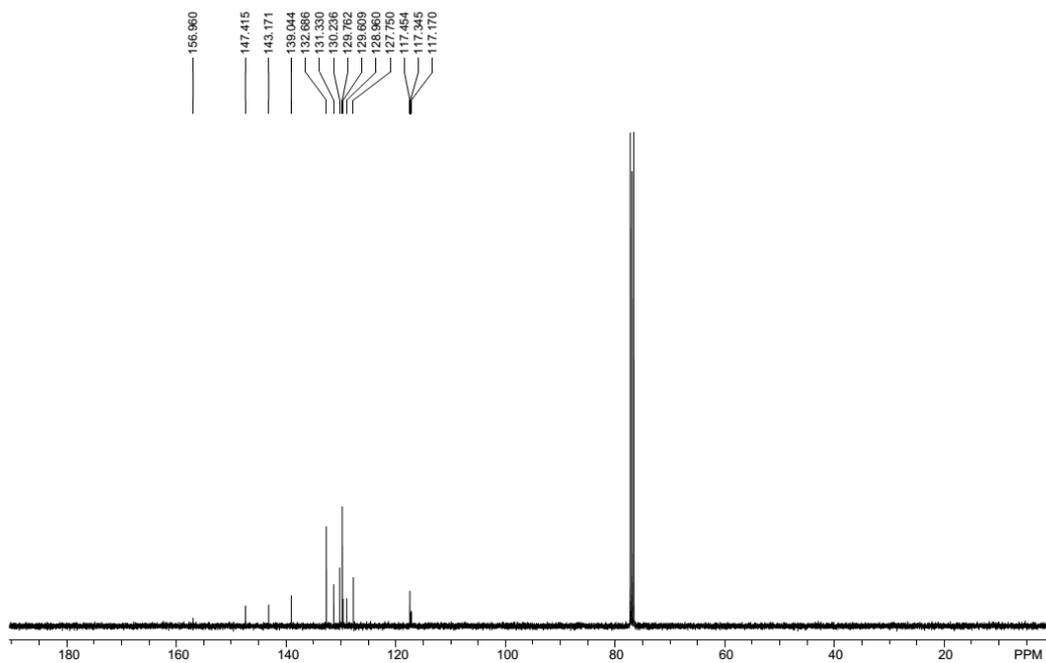
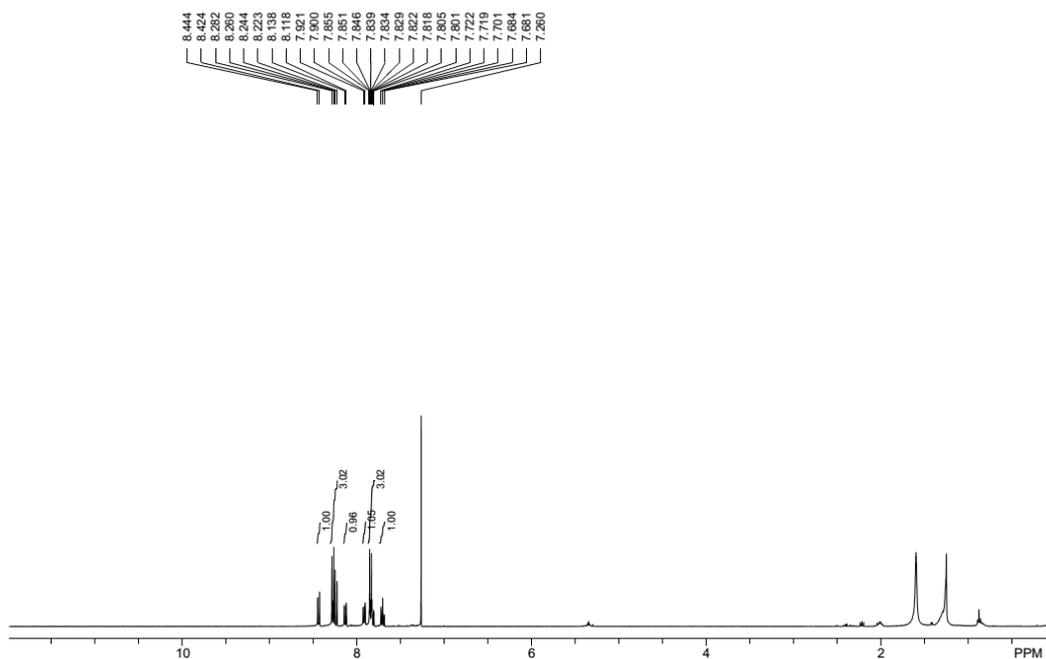
2-((4-iodophenyl)sulfonyl)quinoline (3aj)



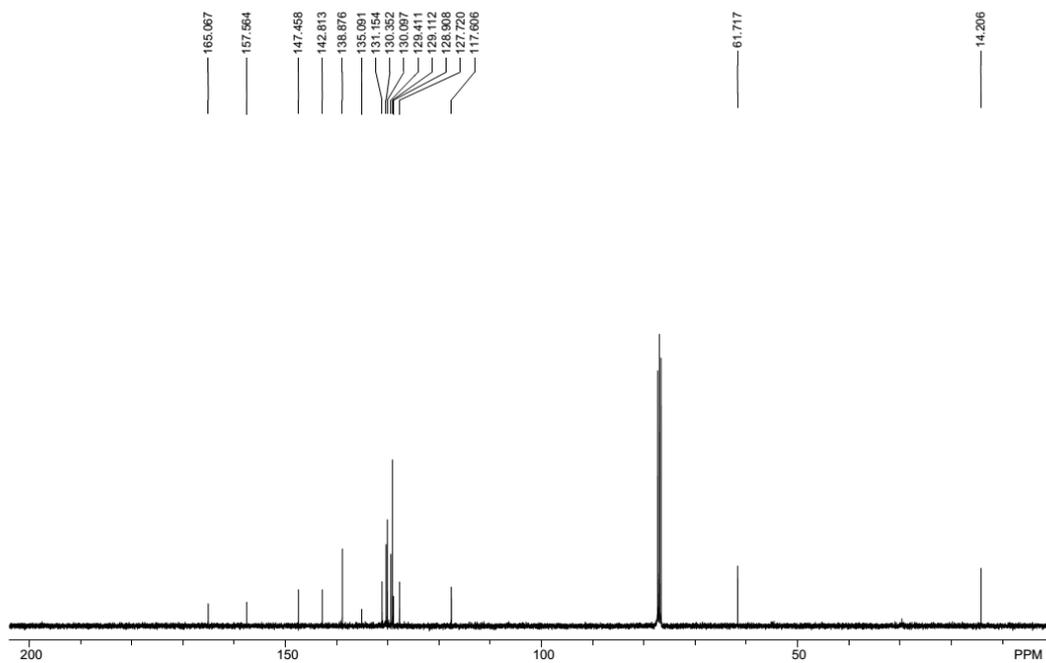
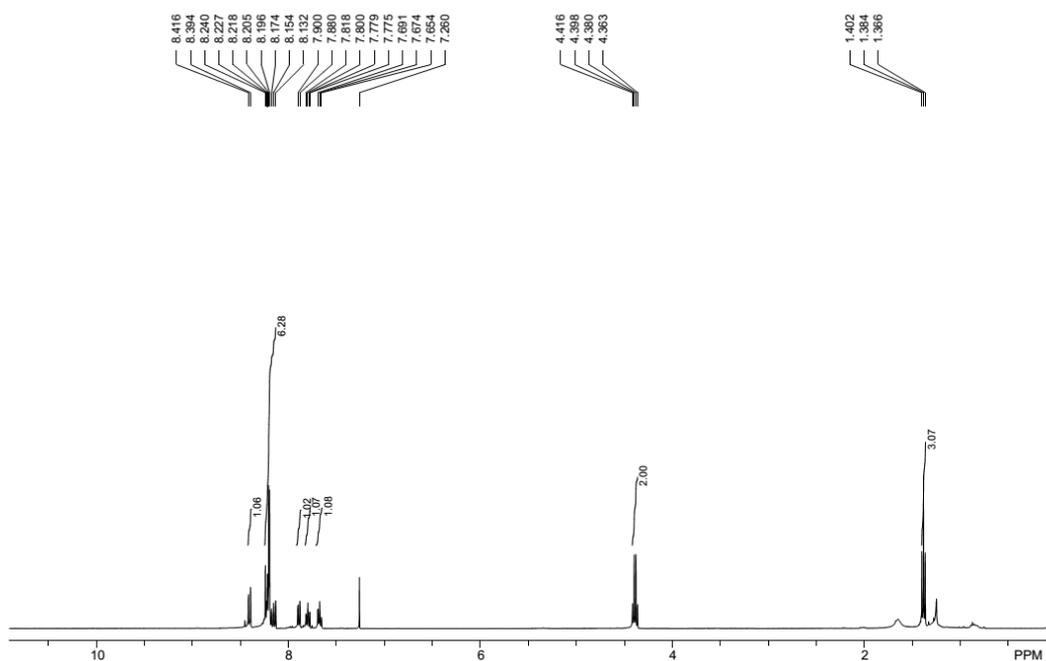
2-((4-(trifluoromethyl)phenyl)sulfonyl)quinoline (3ak)



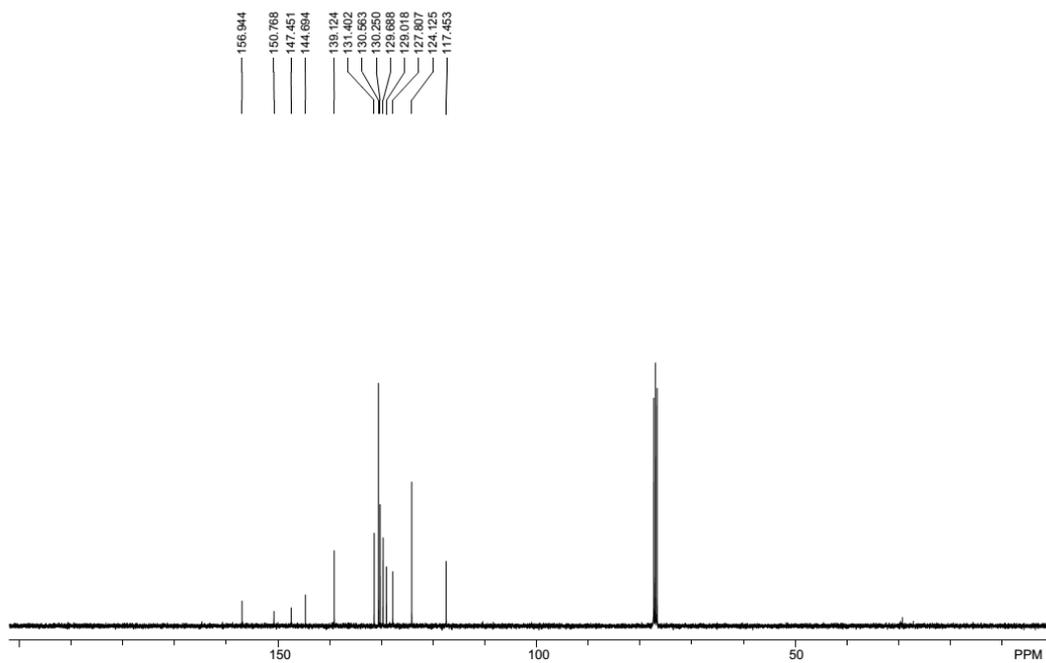
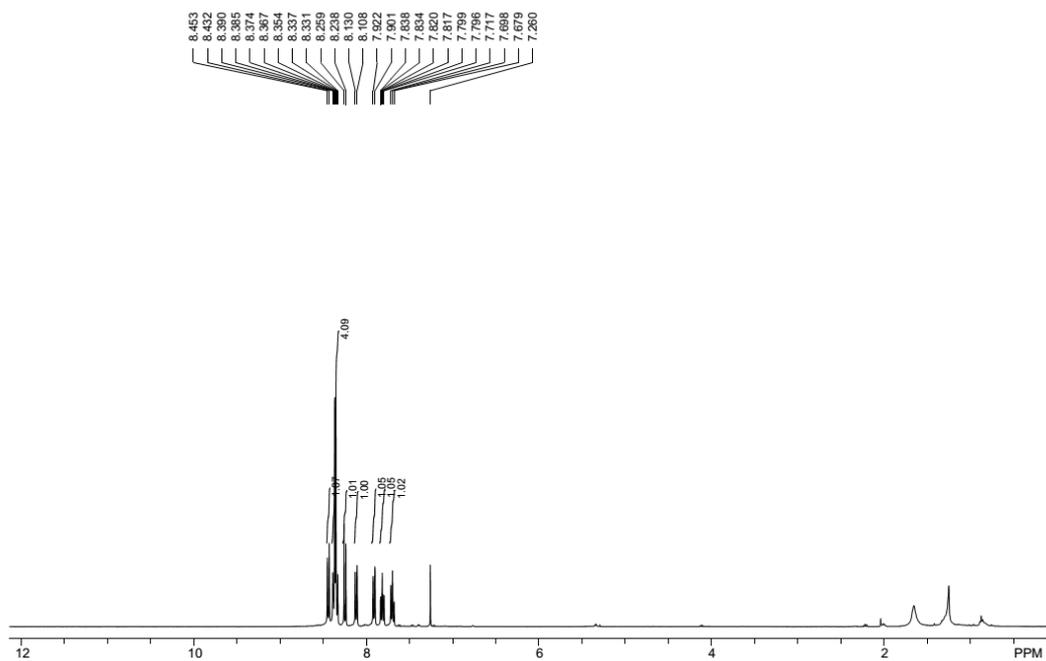
4-(quinolin-2-ylsulfonyl)benzotrile (3a)



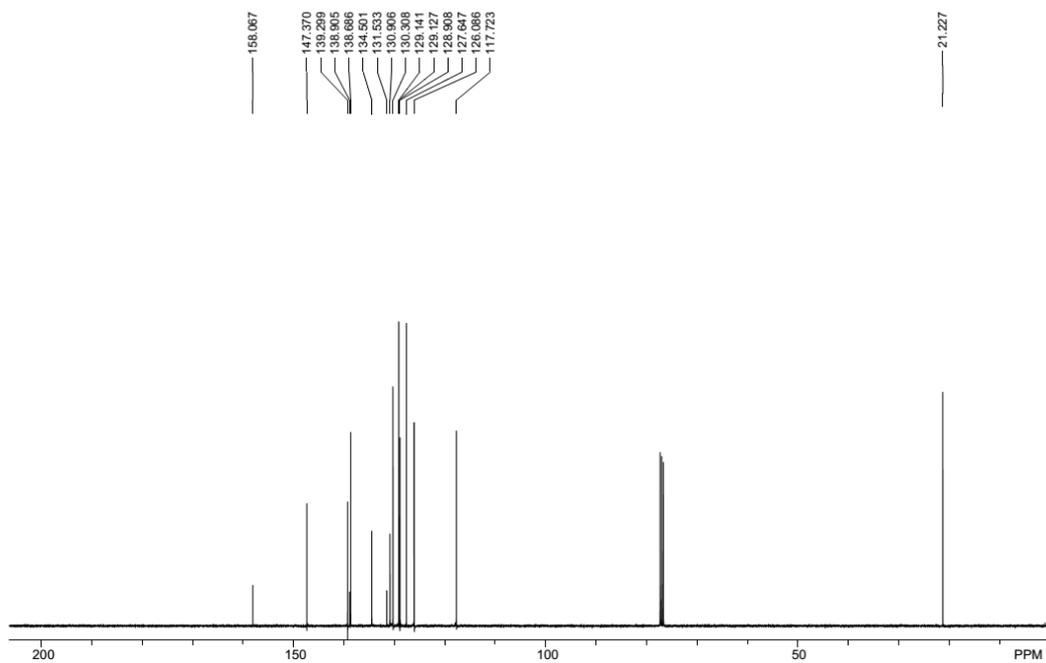
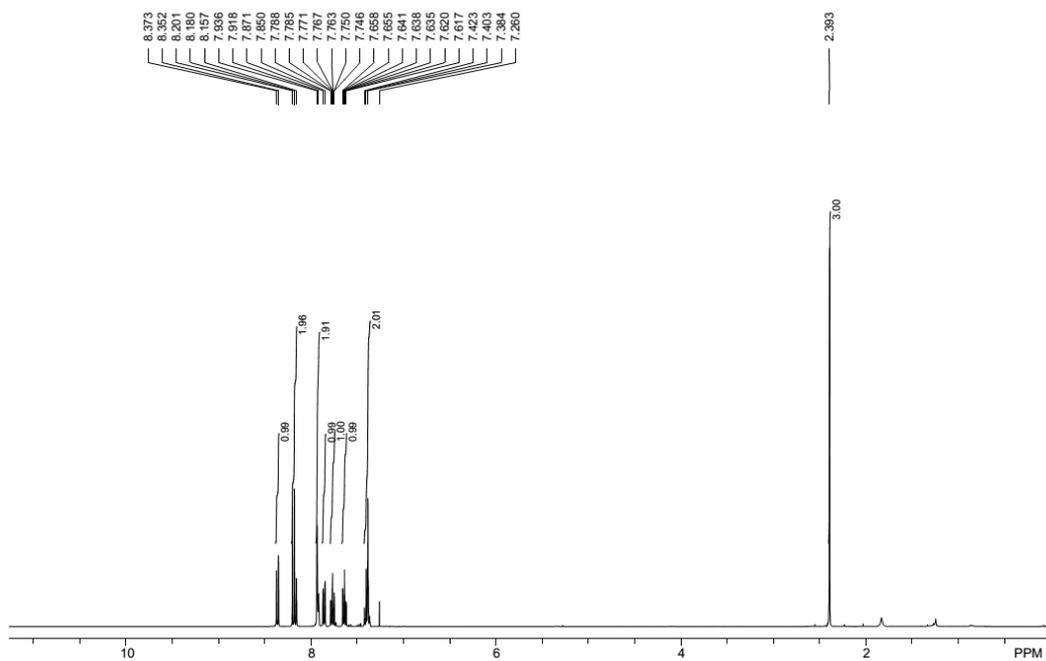
ethyl 4-(quinolin-2-ylsulfonyl)benzoate (3am)



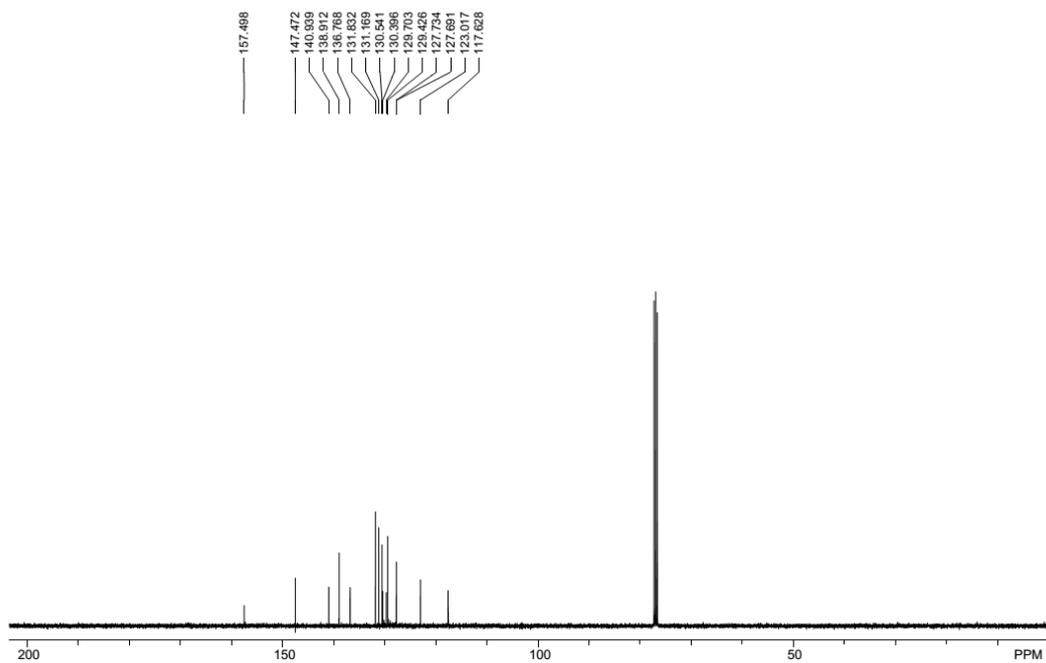
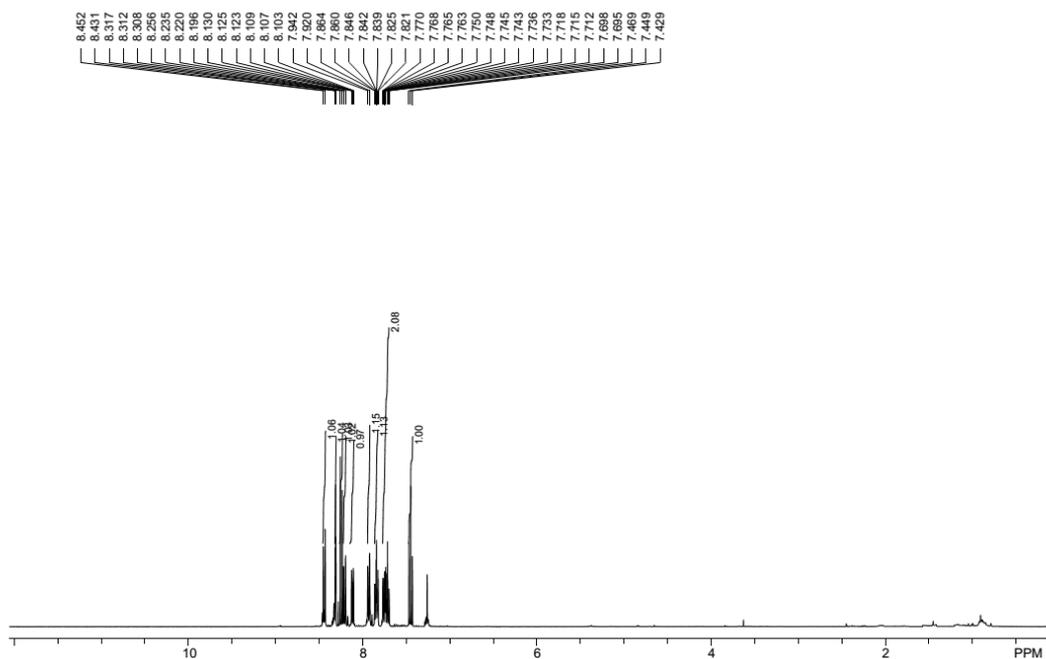
2-((4-nitrophenyl)sulfonyl)quinoline (3an)



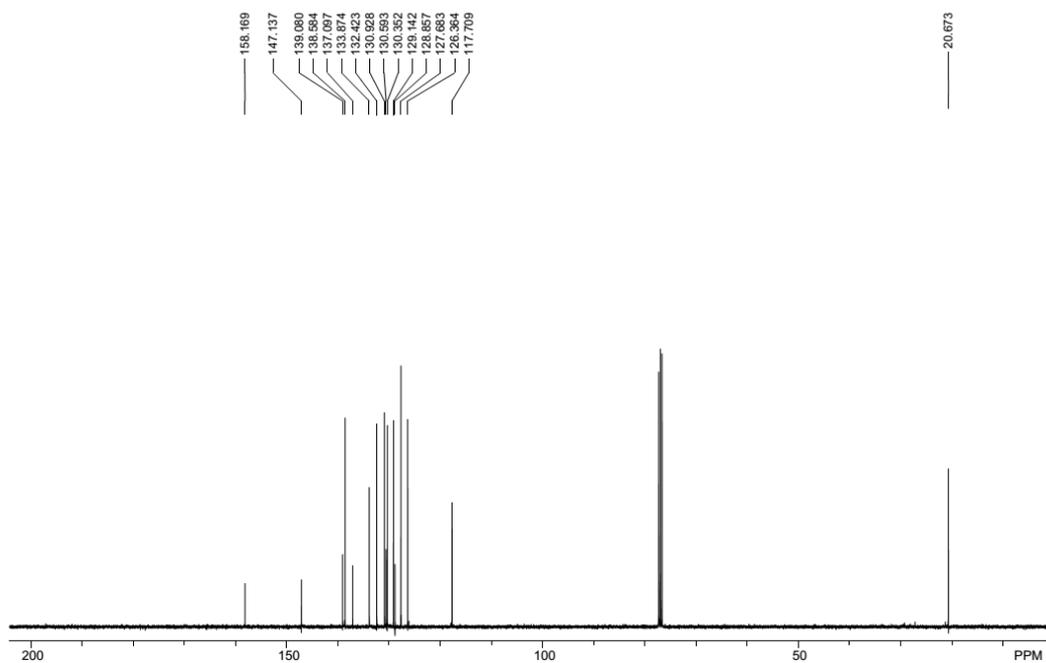
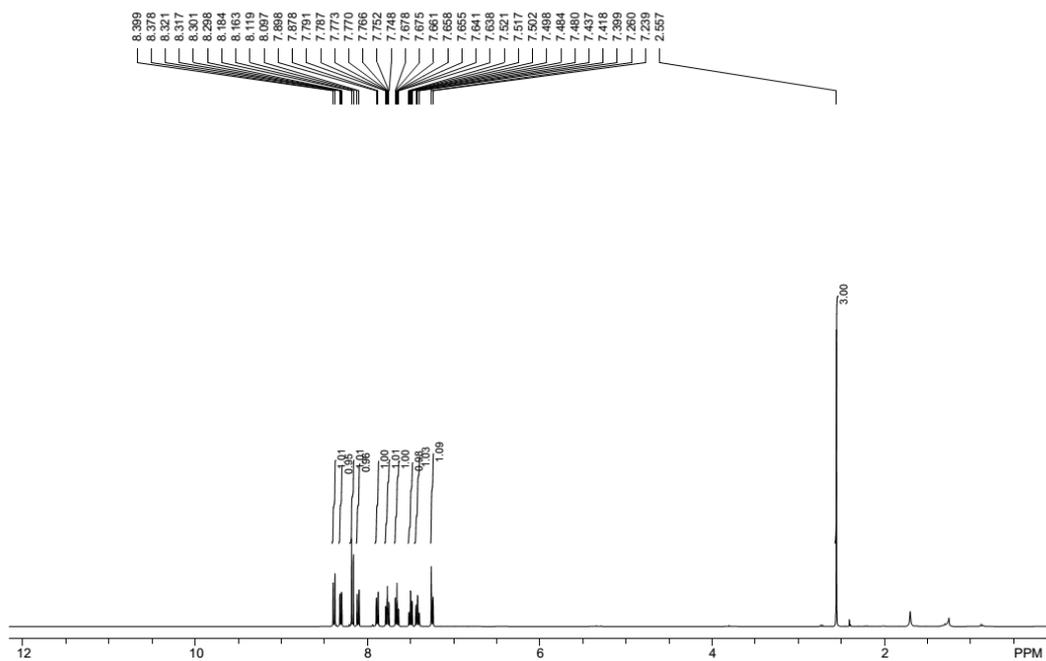
2-(*m*-tolylsulfonyl)quinoline (3ao)



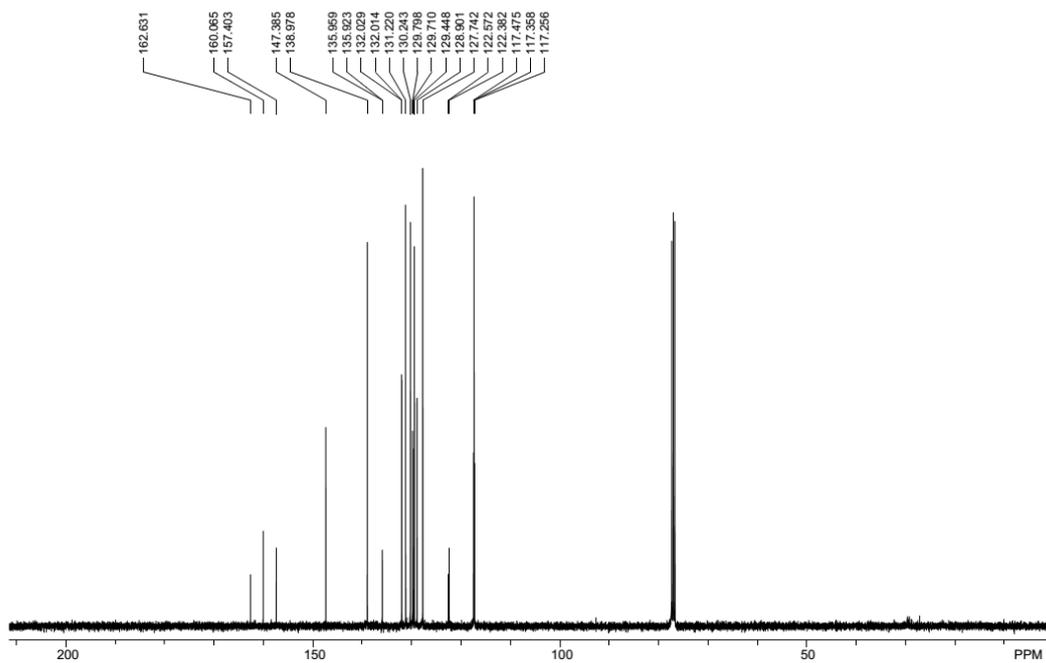
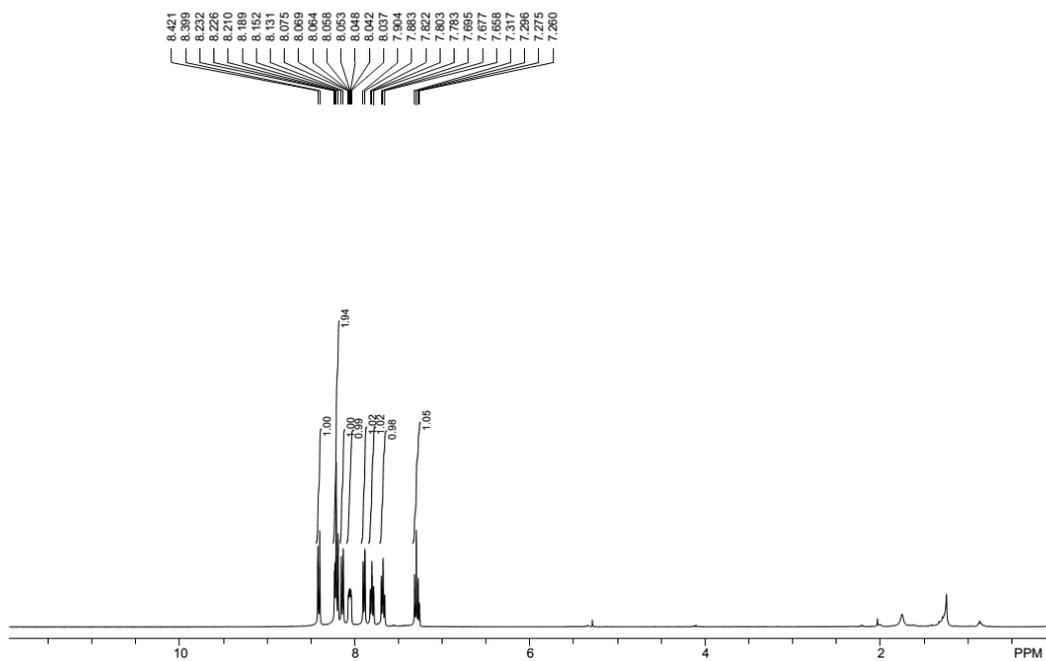
2-((3-bromophenyl)sulfonyl)quinoline (3ap)



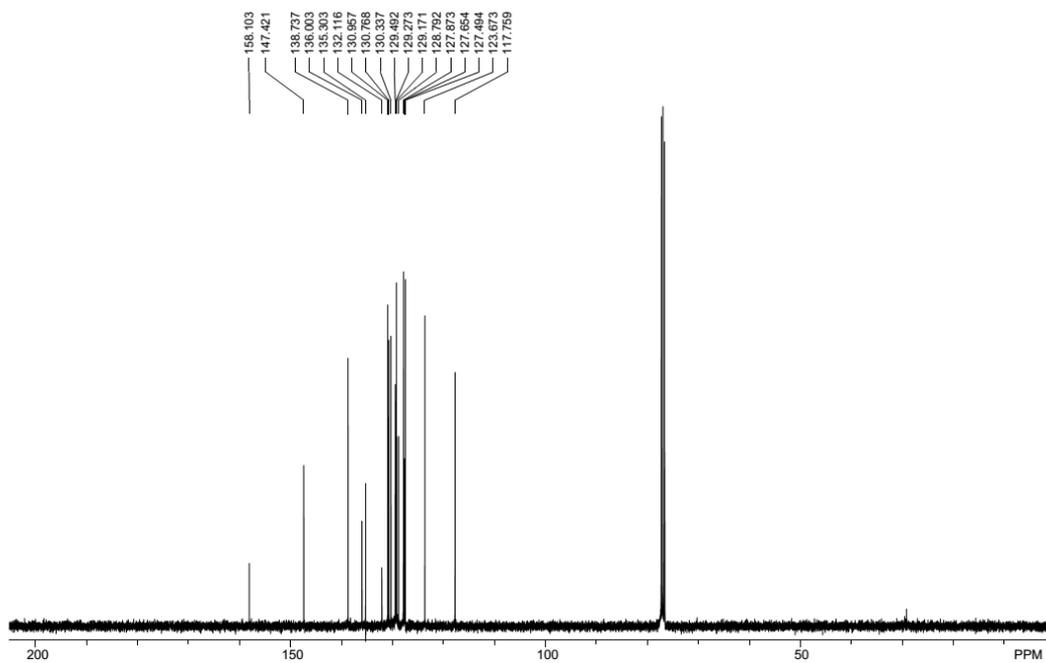
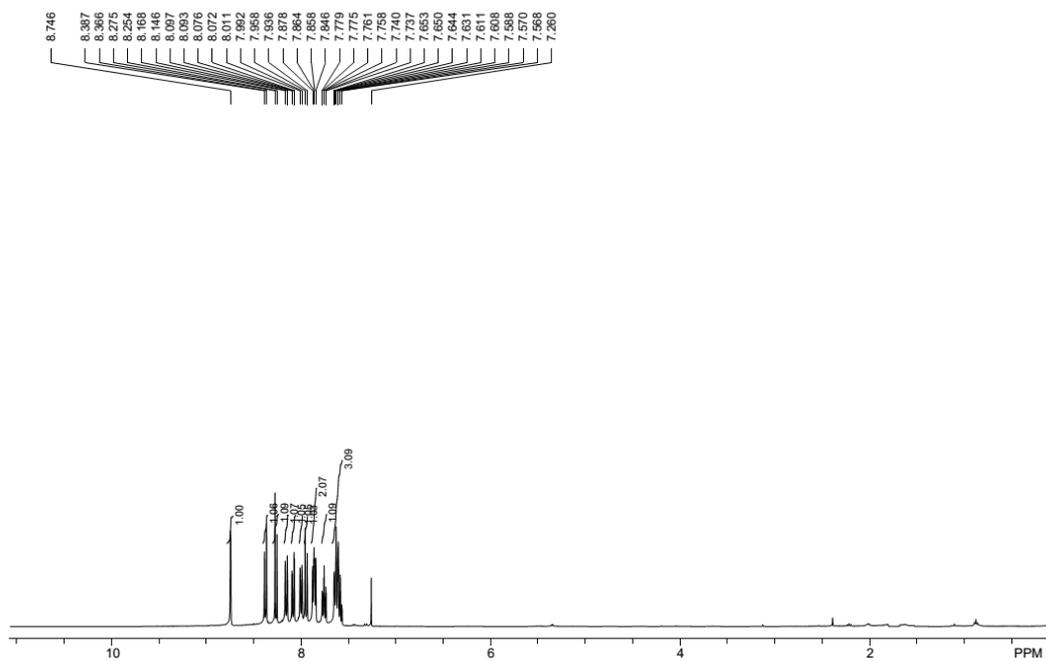
2-(*o*-tolylsulfonyl)quinoline (3aq)



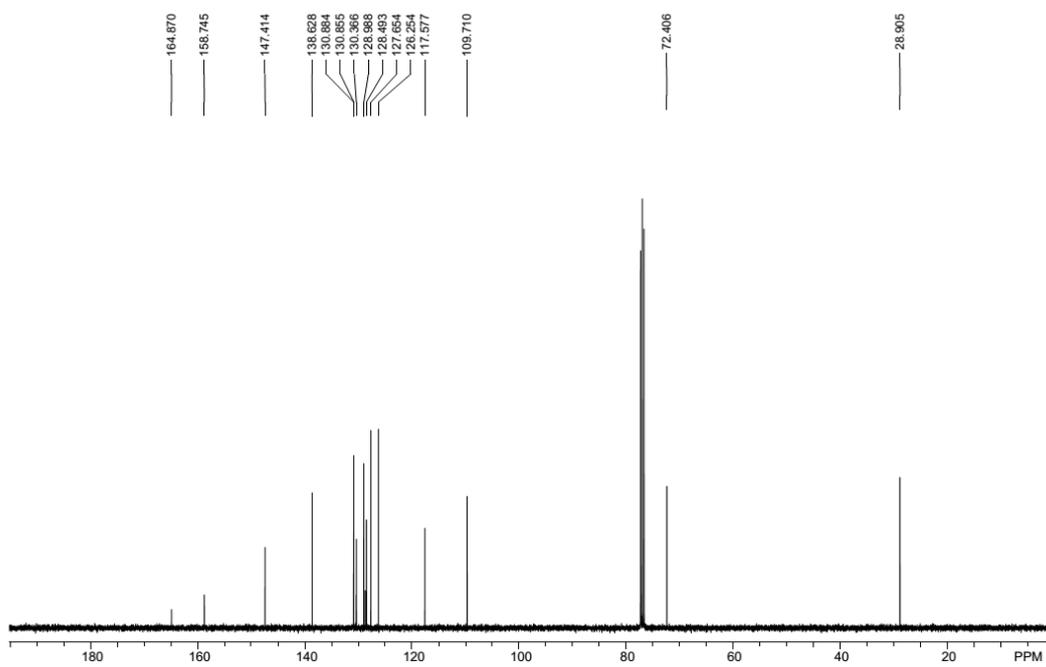
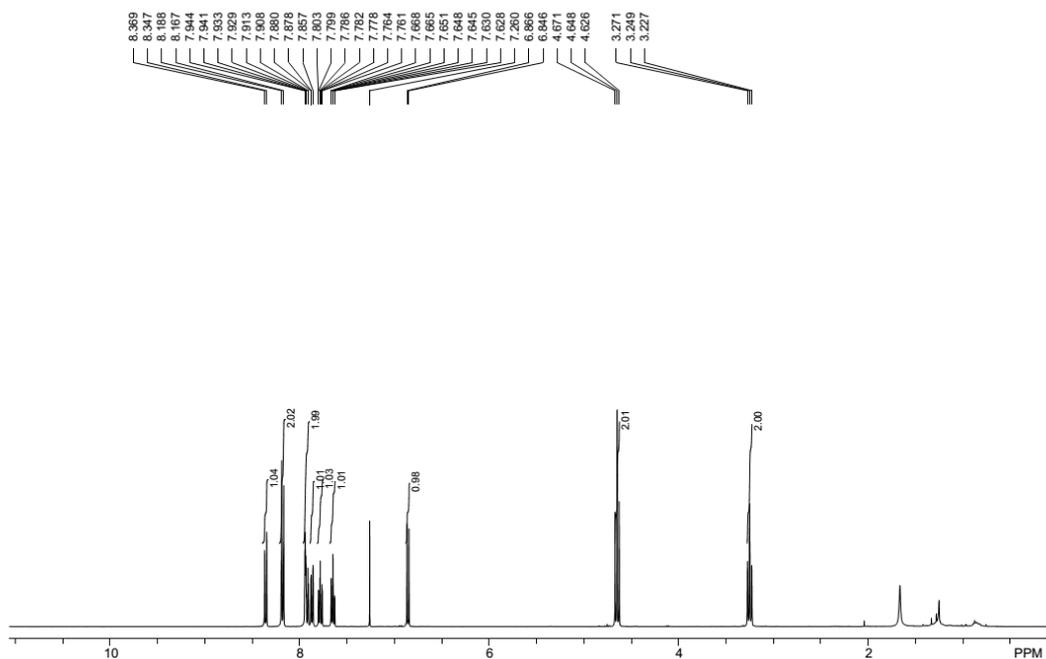
2-((3-chloro-4-fluorophenyl)sulfonyl)quinoline (3as)



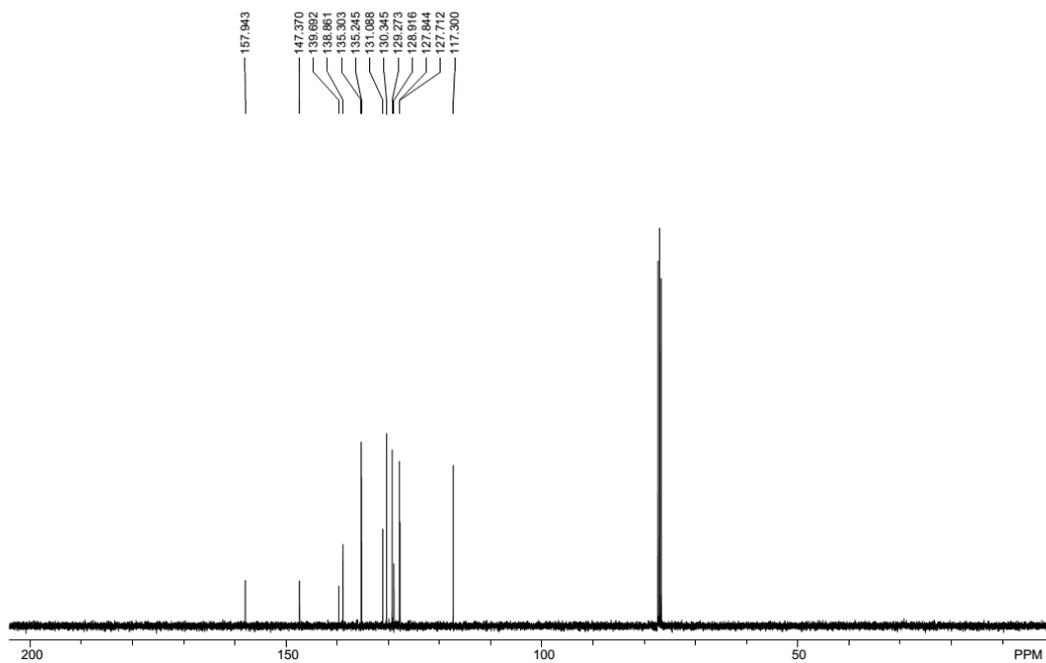
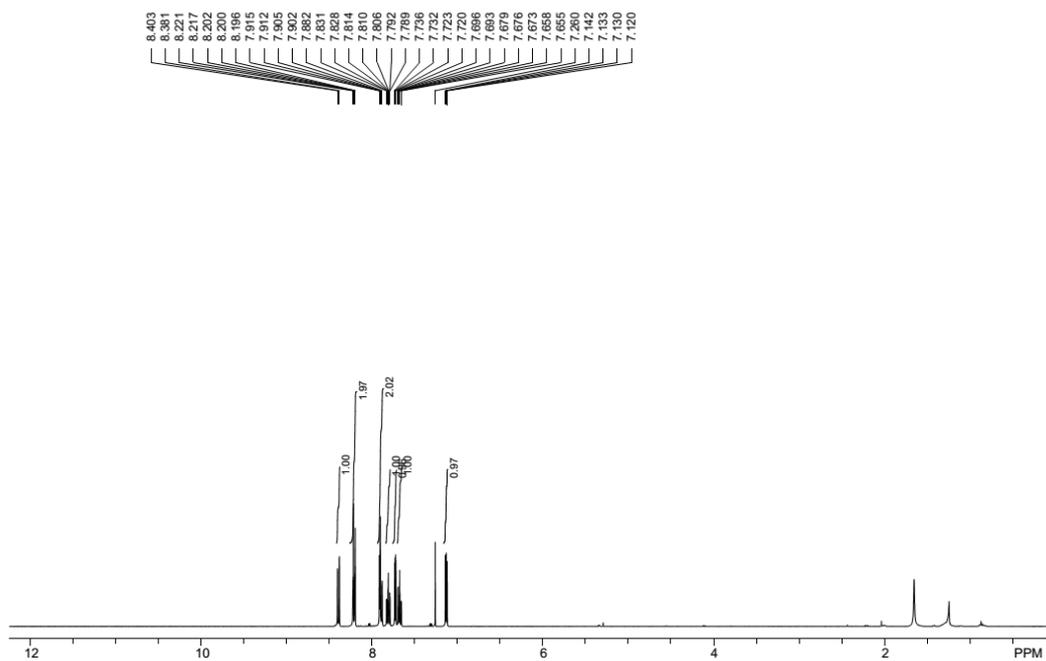
2-(naphthalen-2-ylsulfonyl)quinoline (3at)



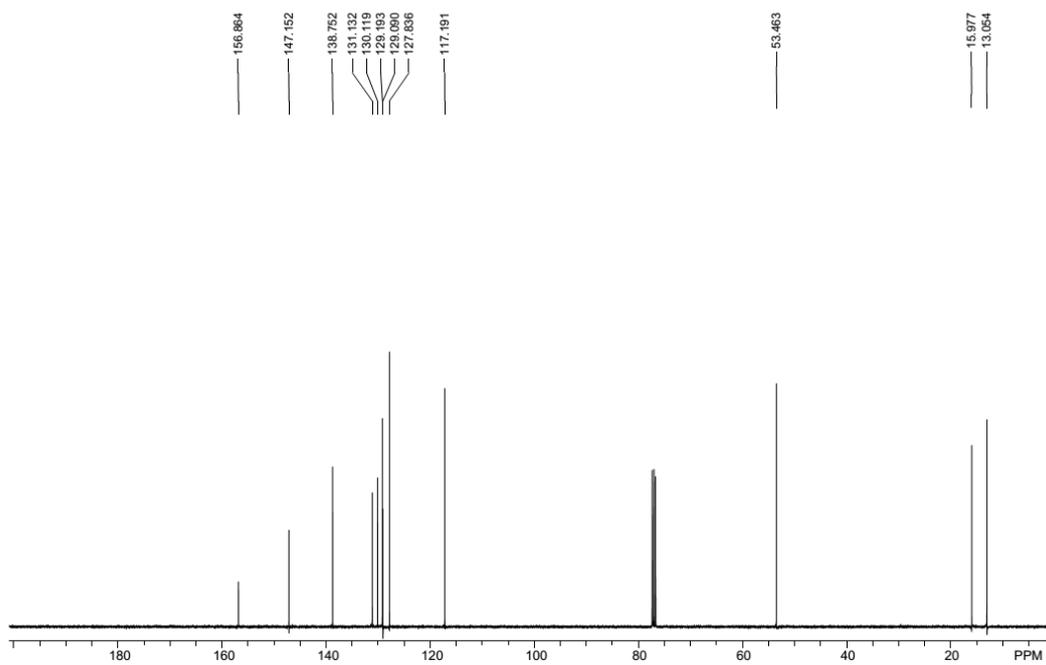
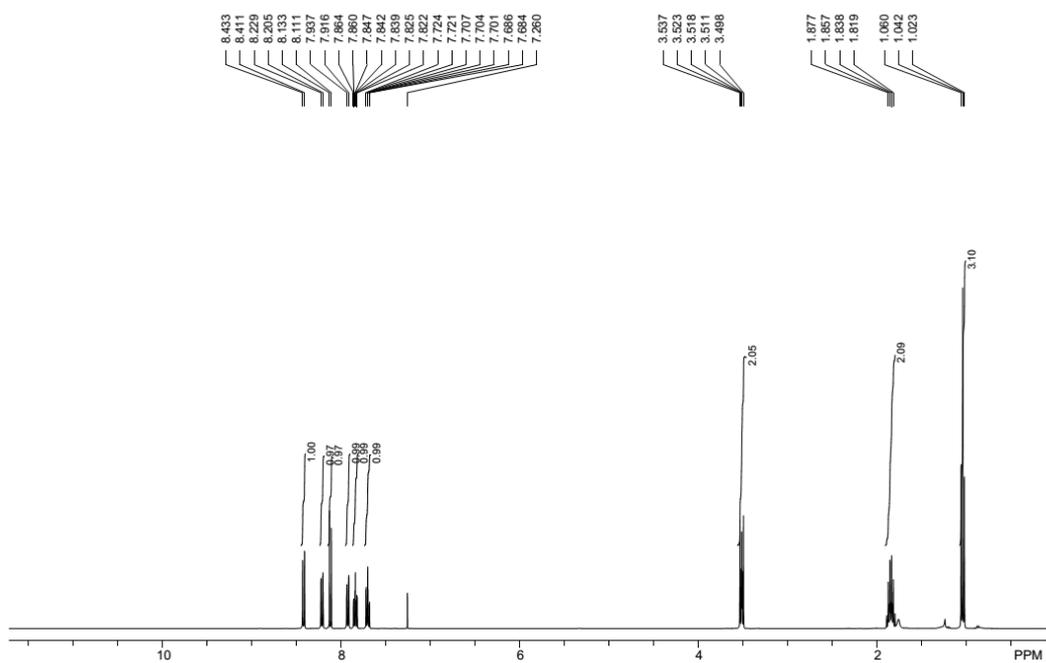
2-((2,3-dihydrobenzofuran-5-yl)sulfonyl)quinoline (3au)



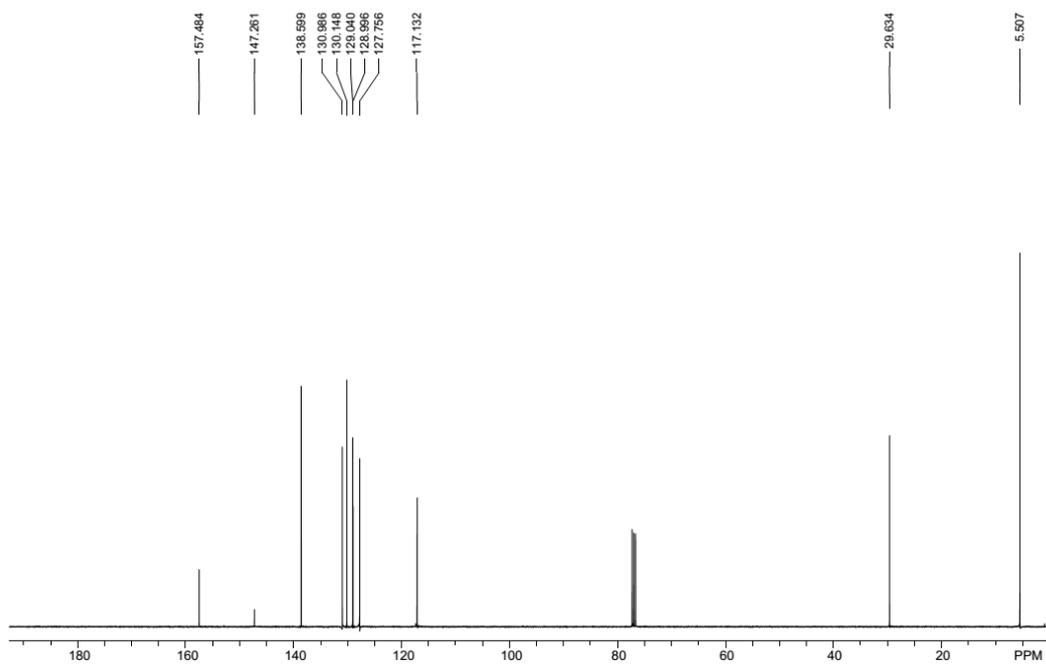
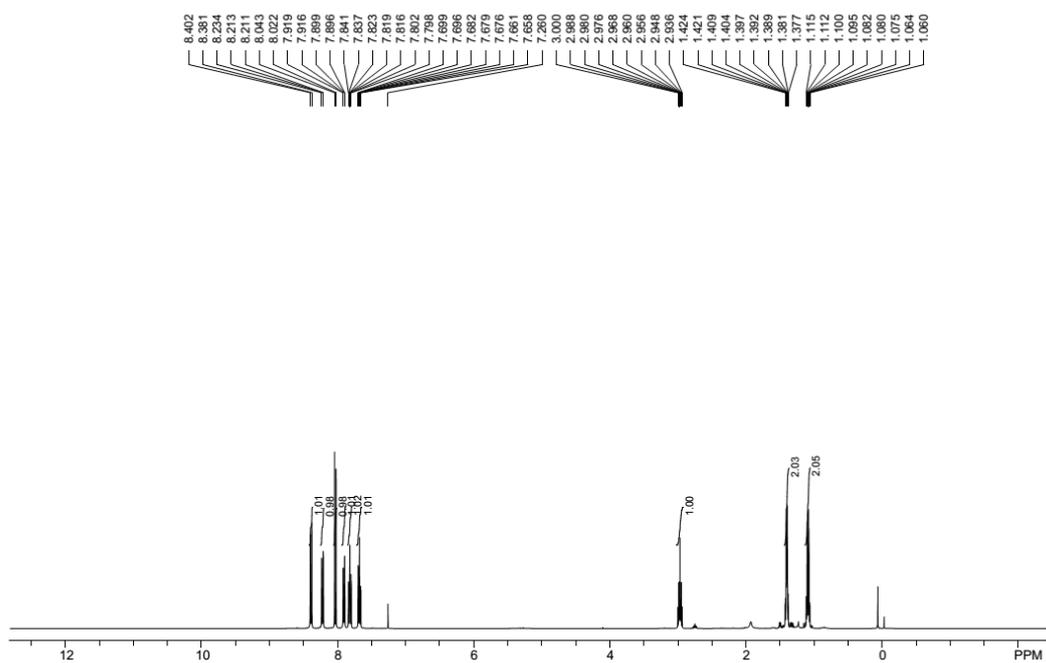
2-(thiophen-2-ylsulfonyl)quinoline (3av)



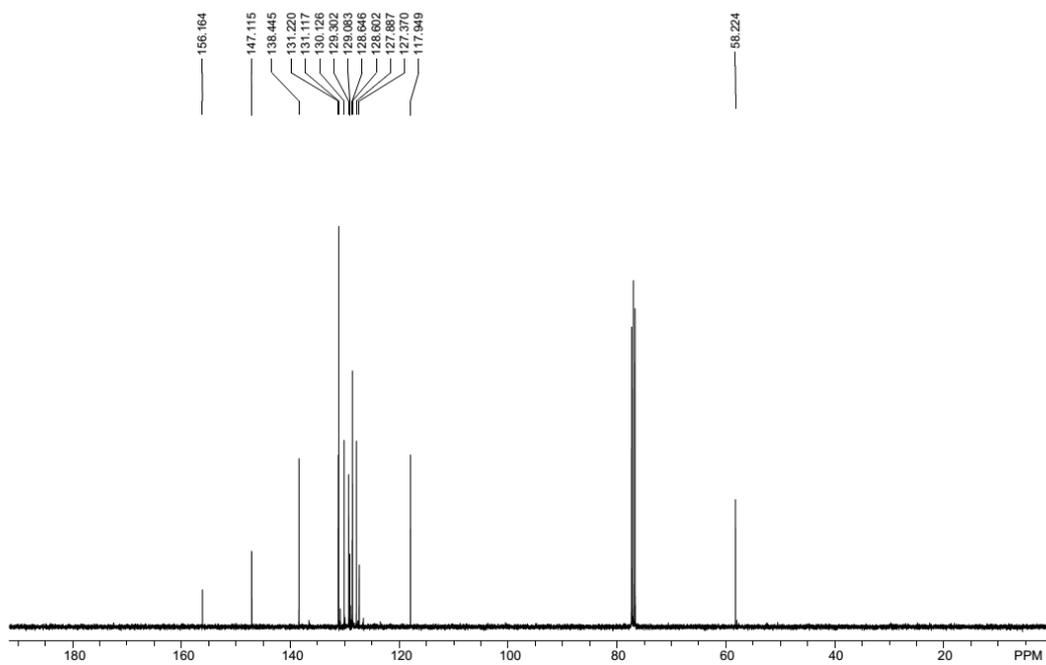
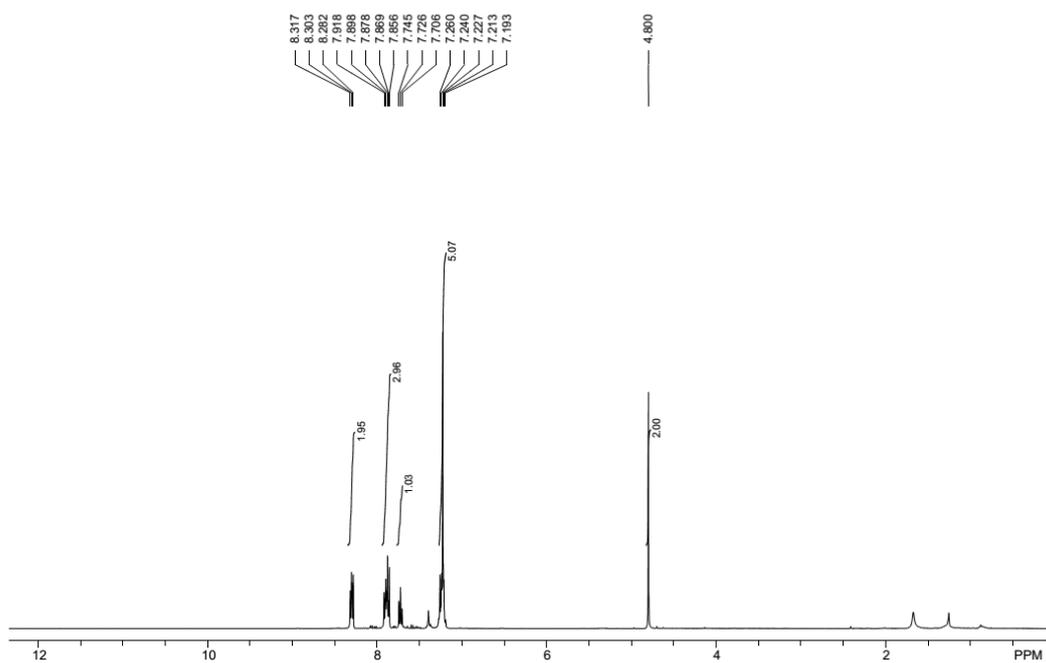
2-(propylsulfonyl)quinoline (3aw)



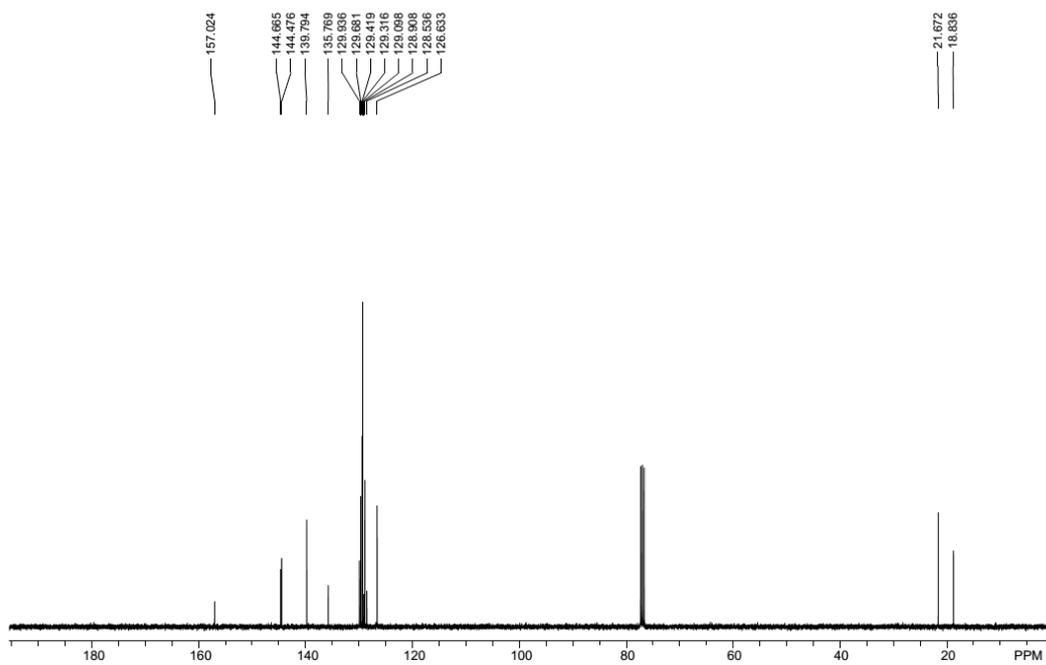
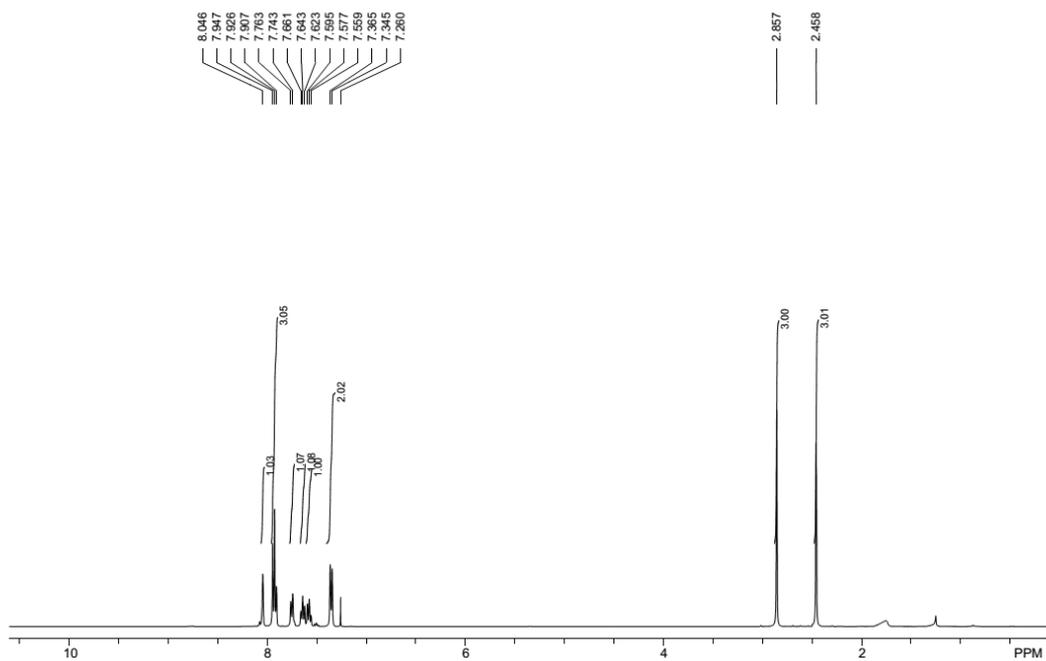
2-(cyclopropylsulfonyl)quinoline (3ax)



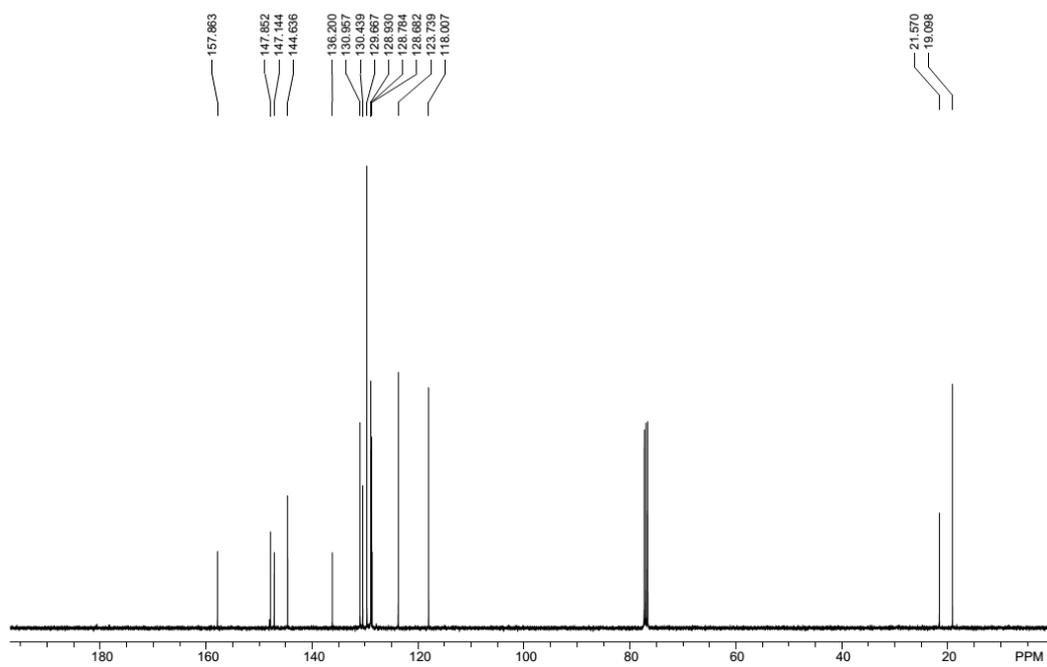
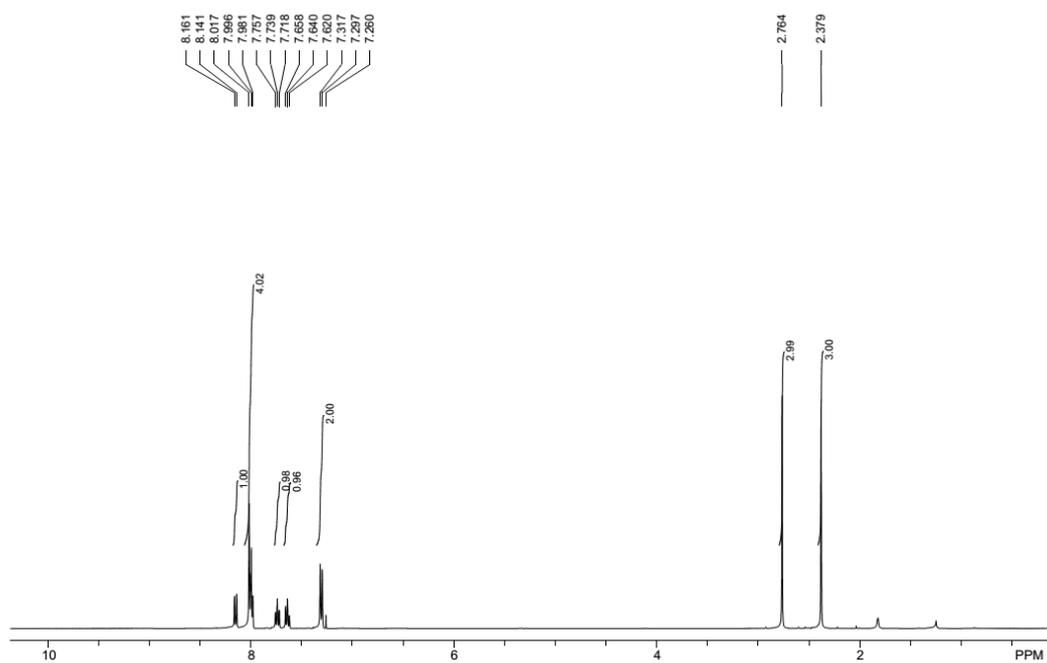
2-(benzylsulfonyl)quinoline (3ay)



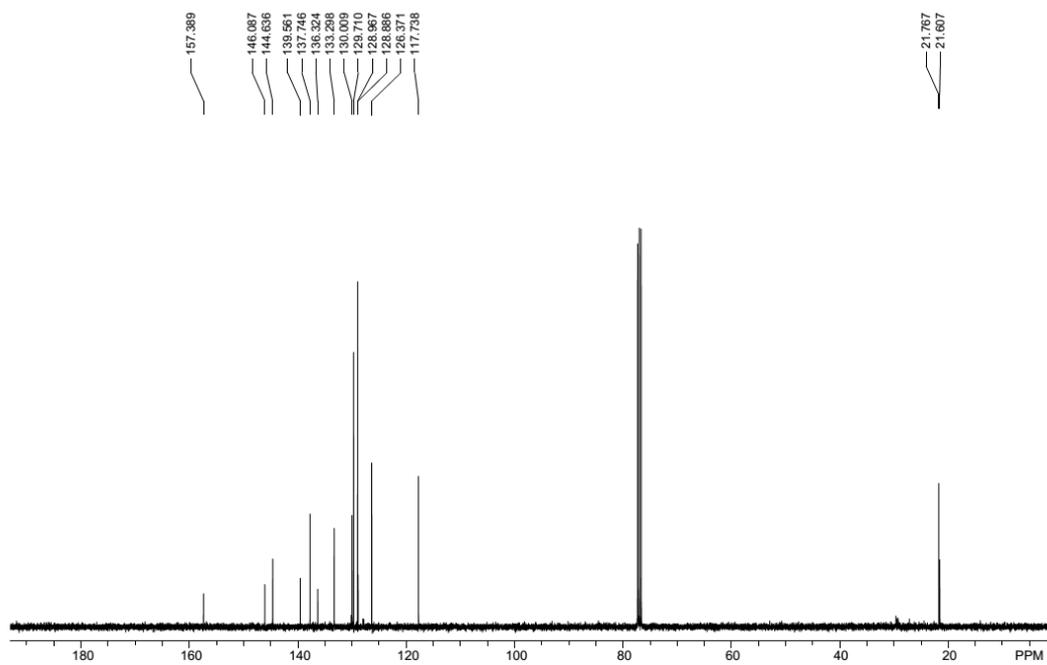
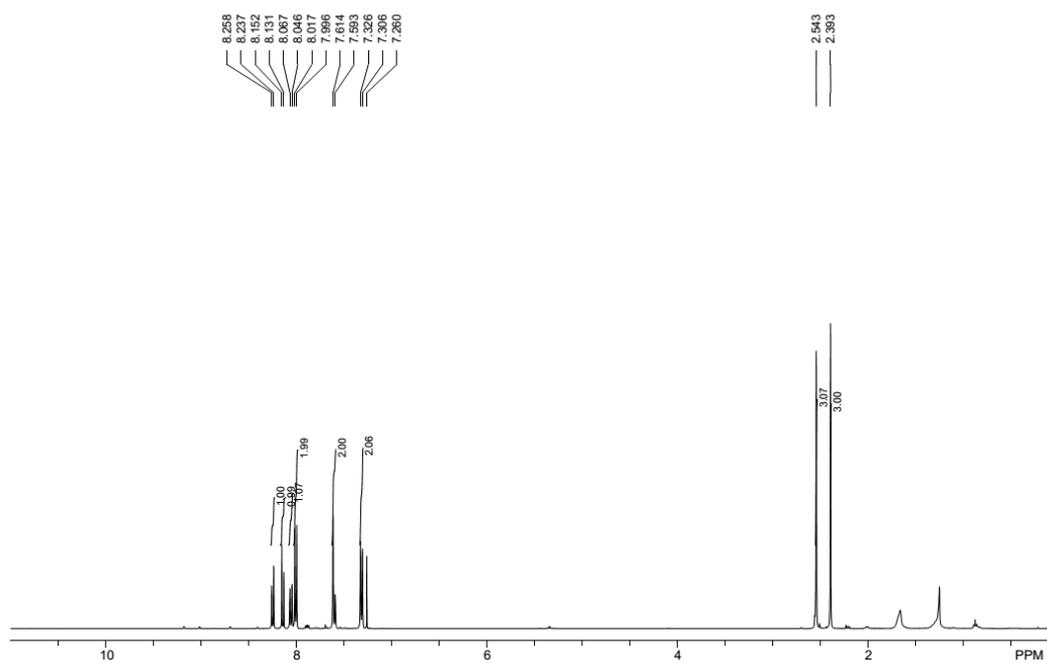
3-methyl-2-tosylquinoline (3ba)



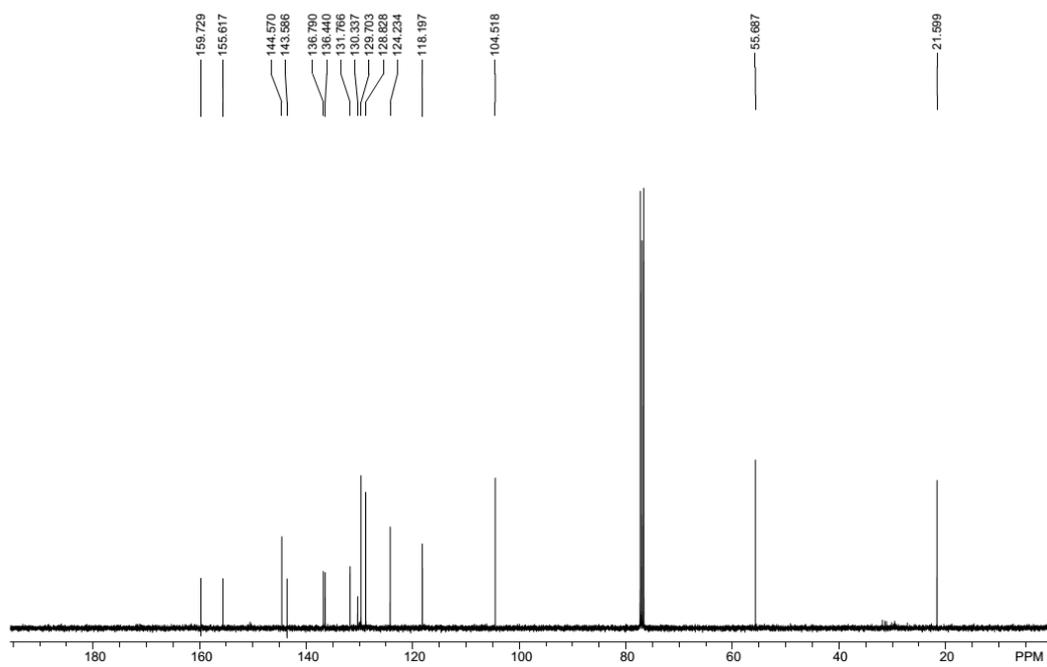
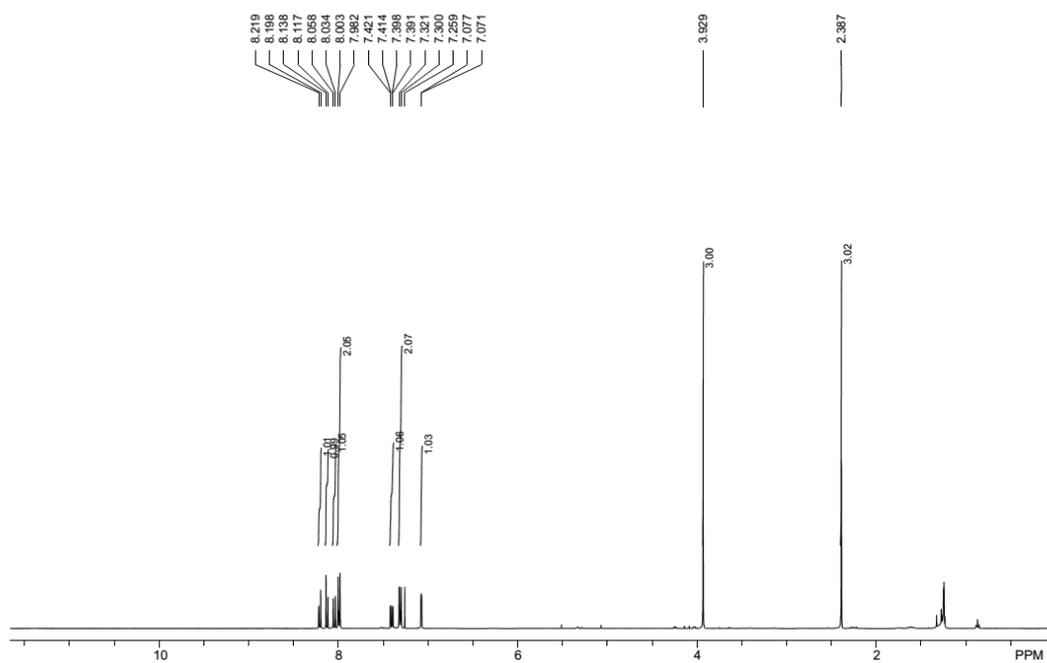
4-methyl-2-tosylquinoline (3ca)



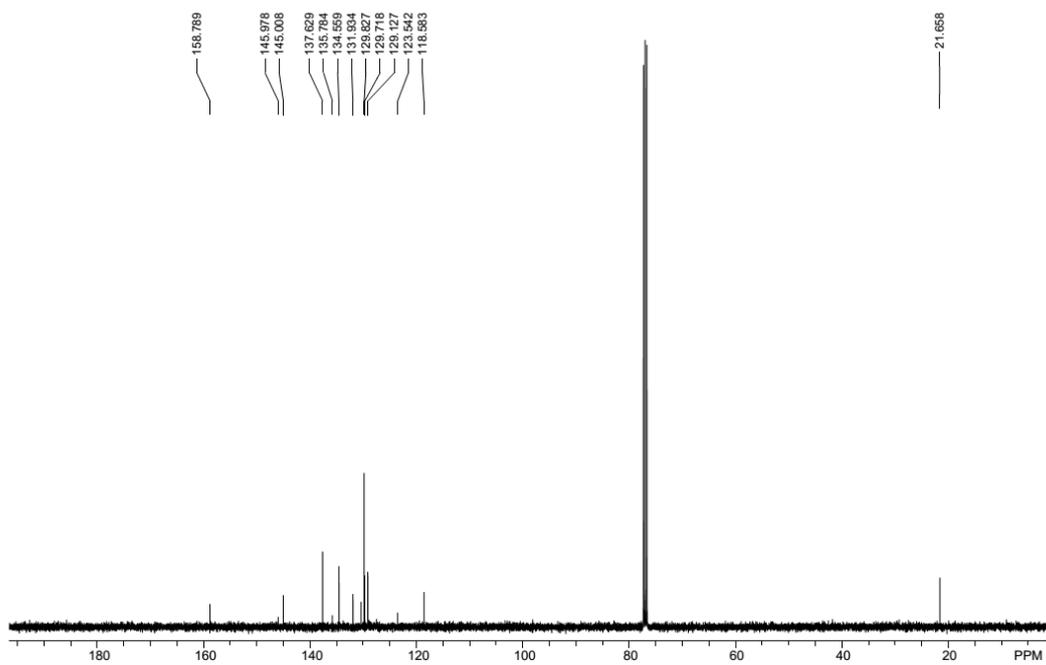
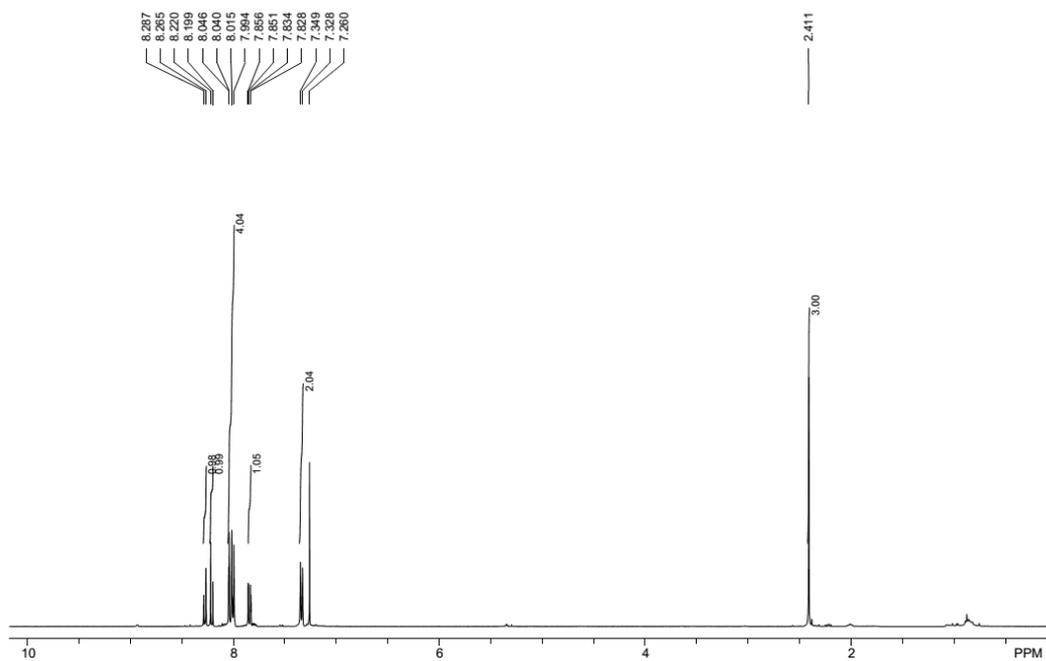
6-methyl-2-tosylquinoline (3ea)



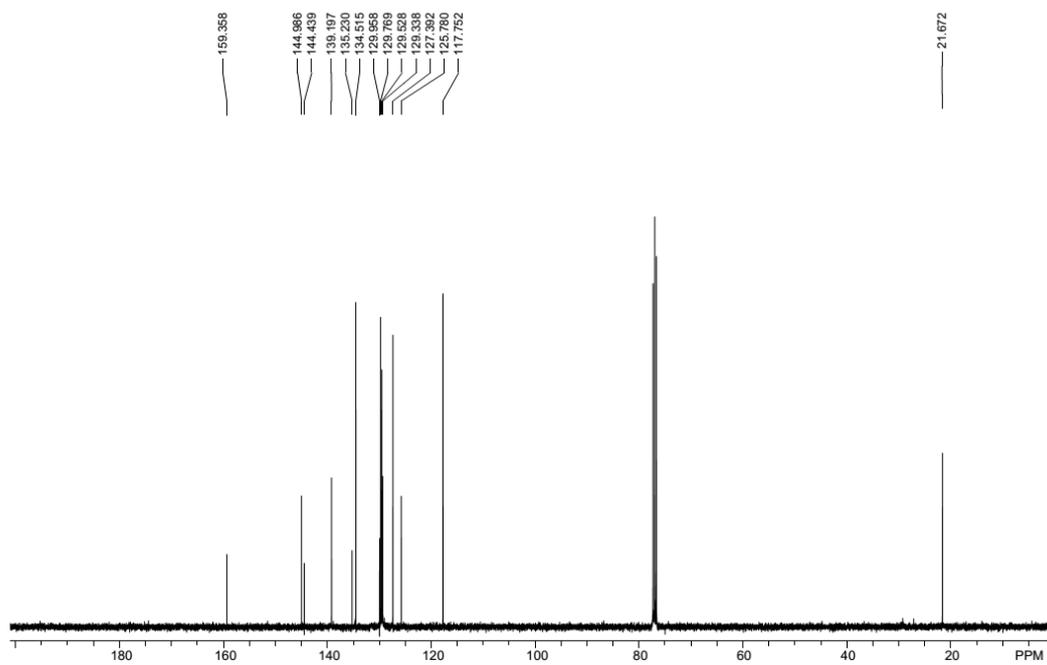
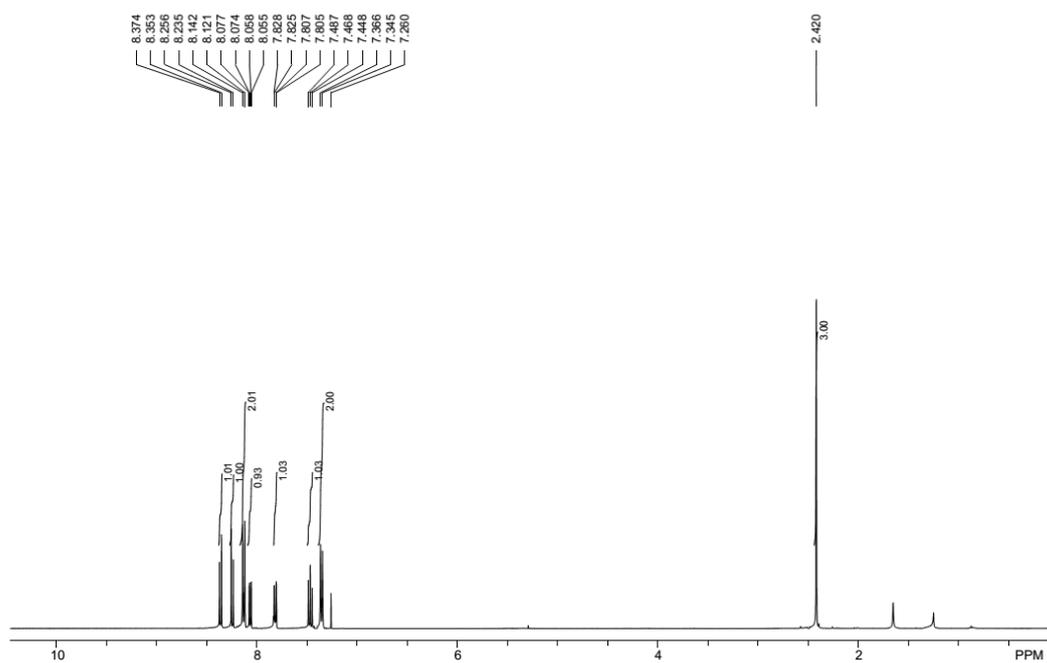
6-methoxy-2-tosylquinoline (3fa)



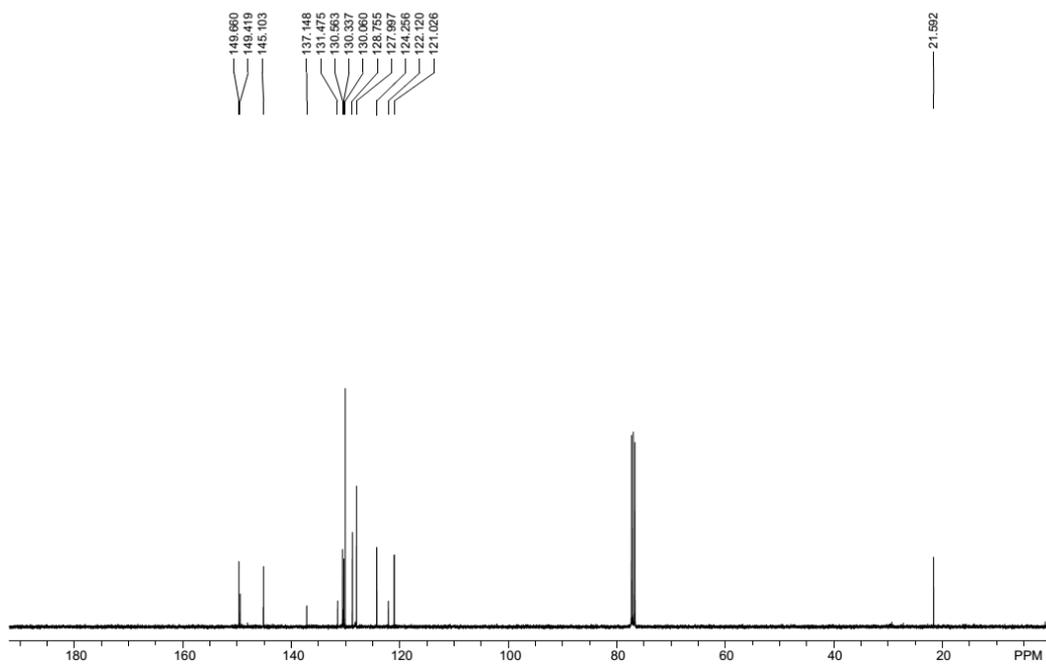
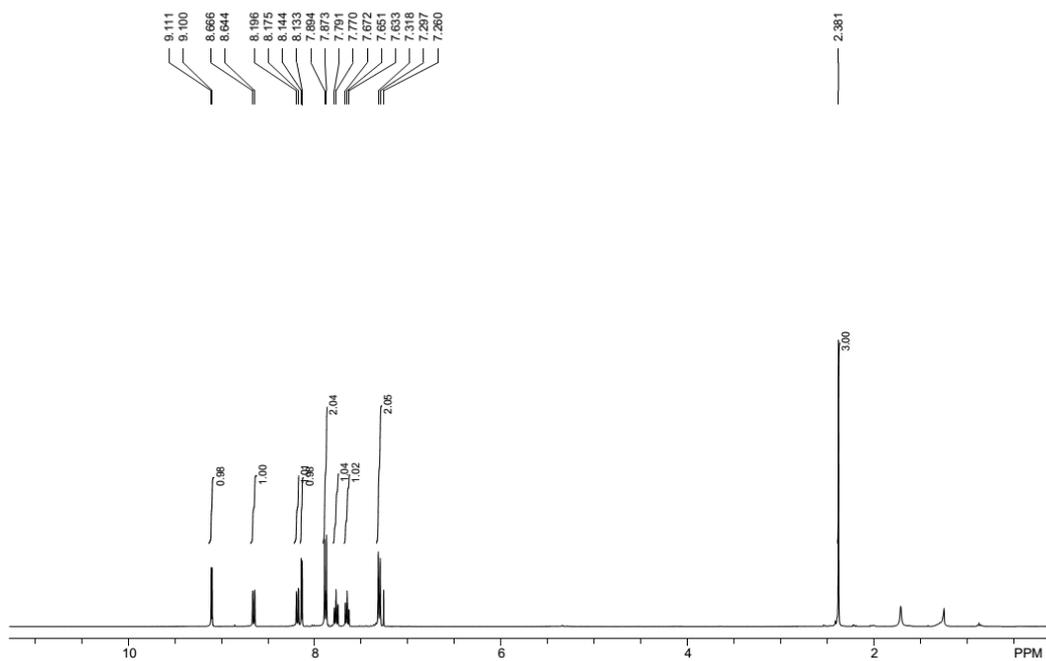
6-bromo-2-tosylquinoline (3ga)



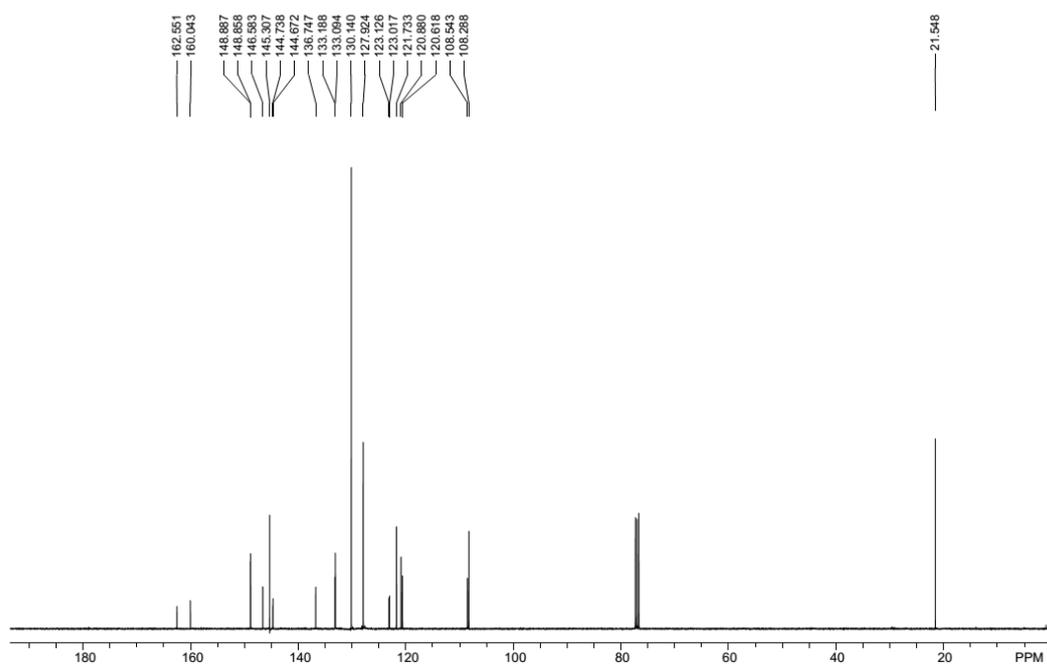
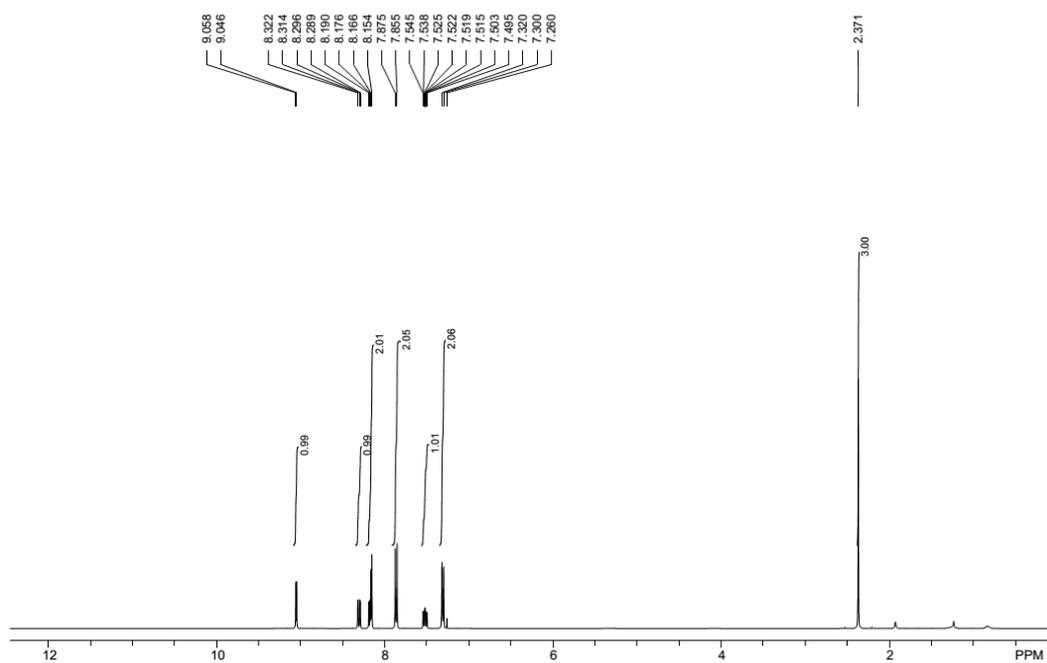
8-bromo-2-tosylquinoline (3ha)



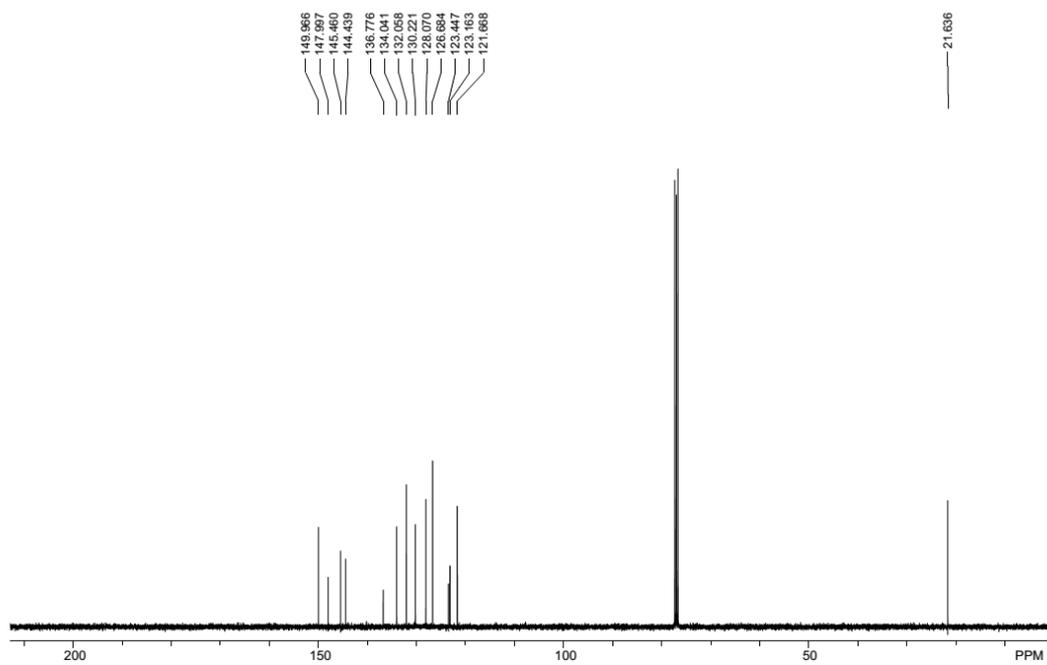
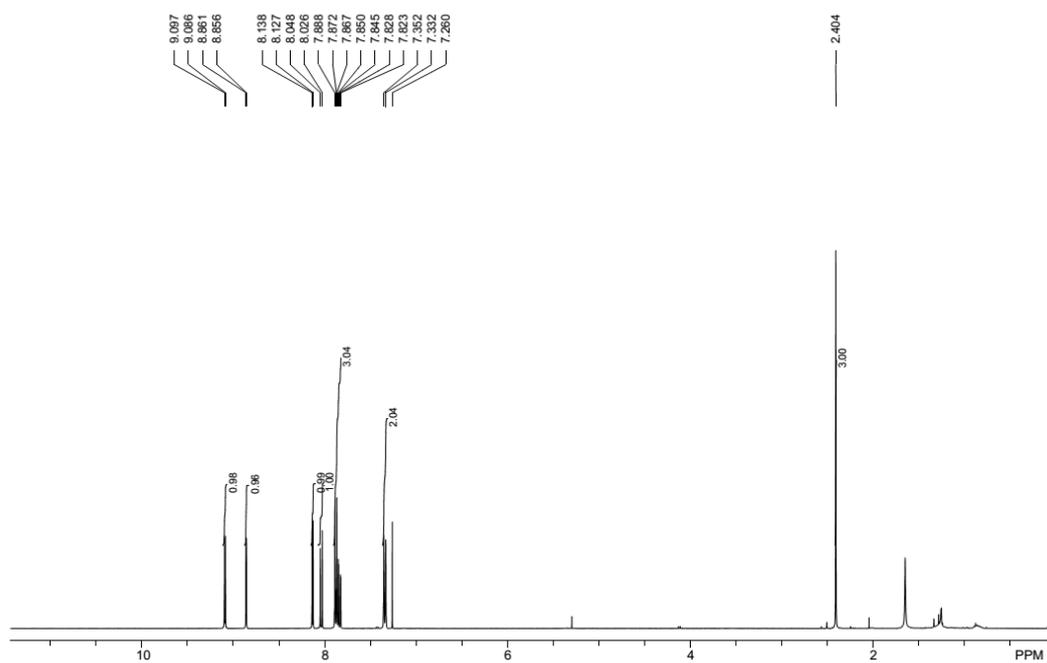
4-tosylquinoline (3ia)



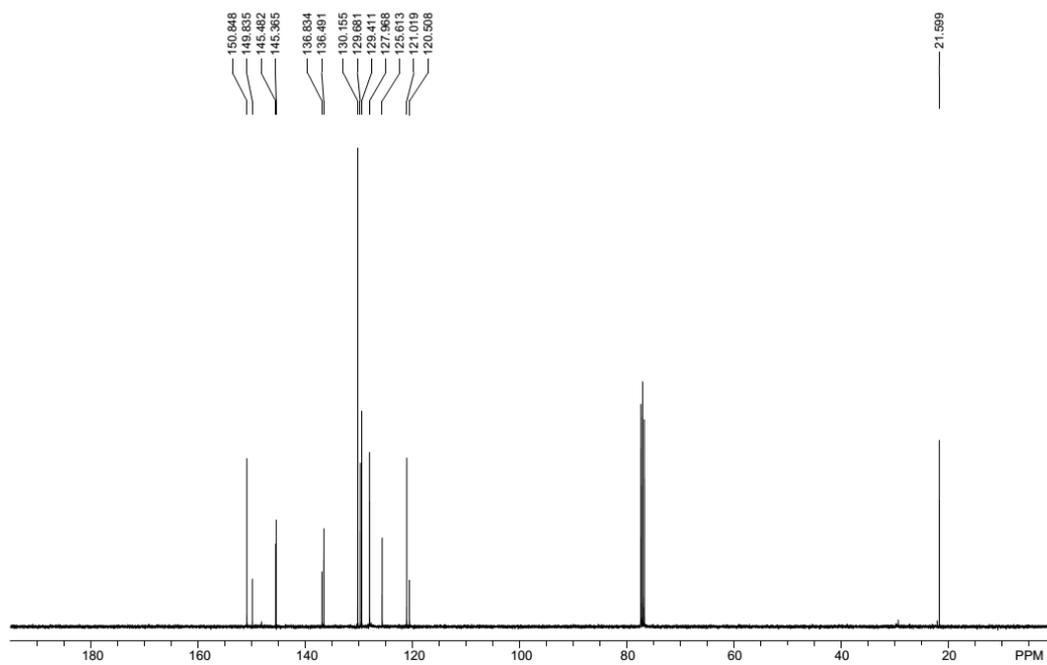
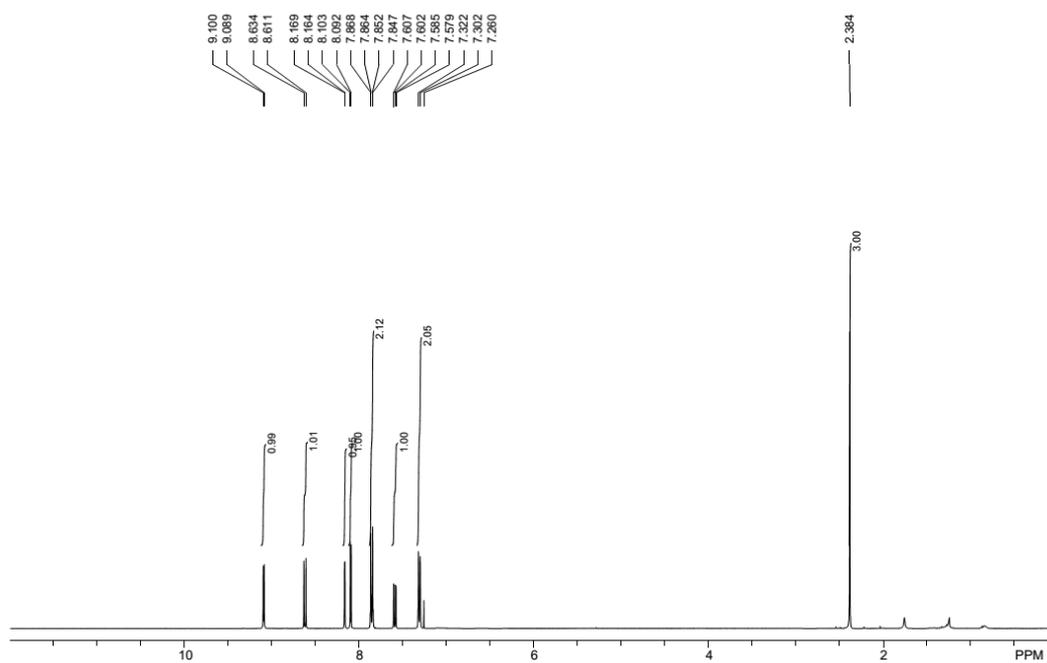
6-fluoro-4-tosylquinoline (3ja)



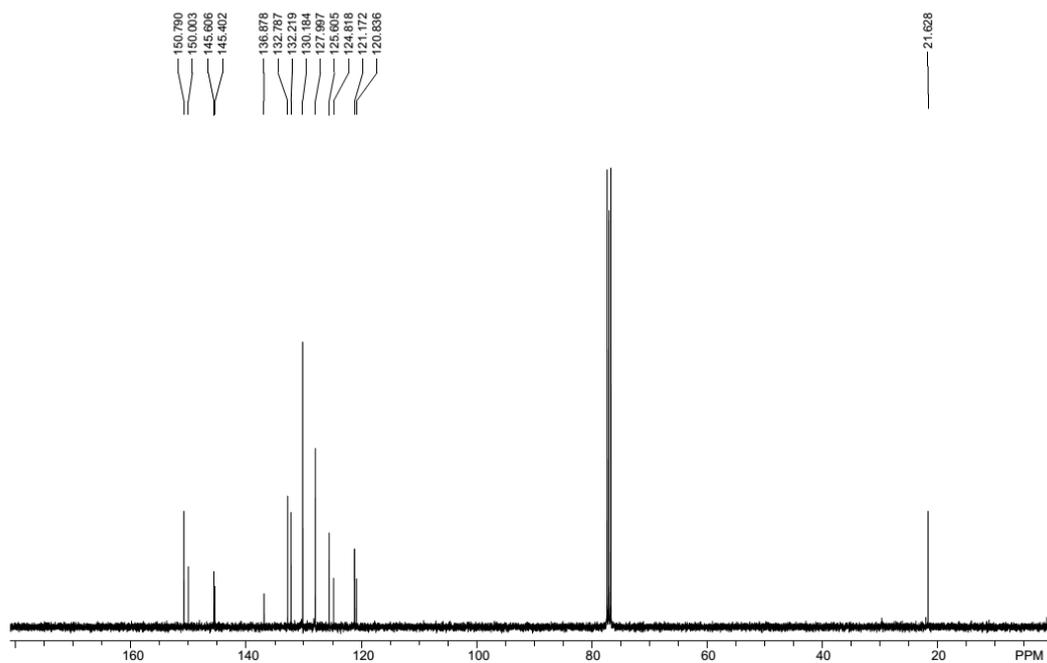
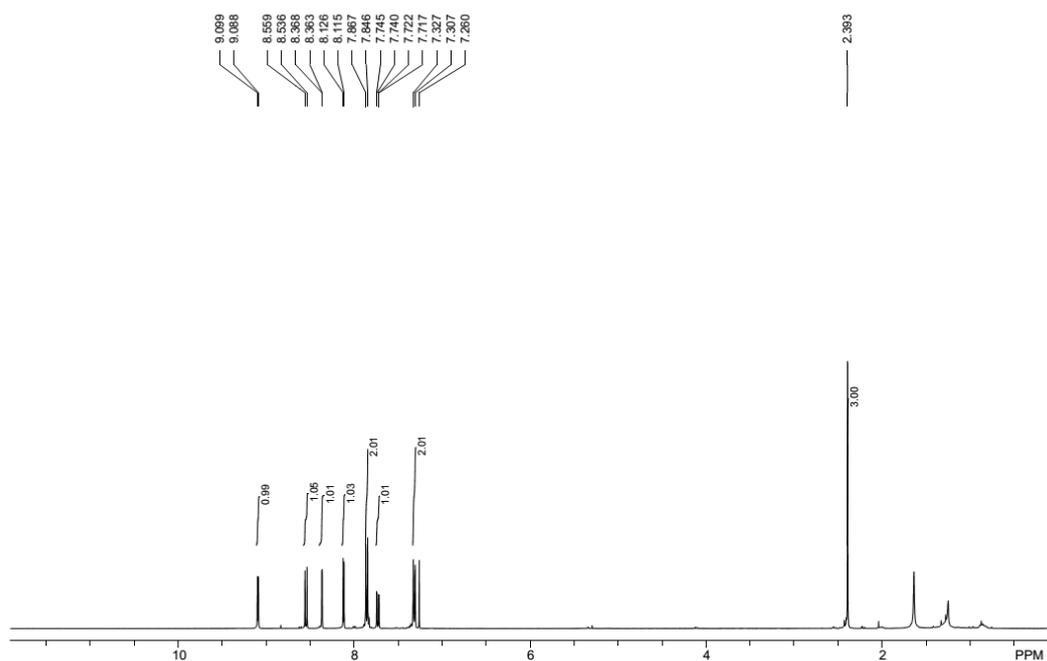
6-bromo-4-tosylquinoline (3ka)



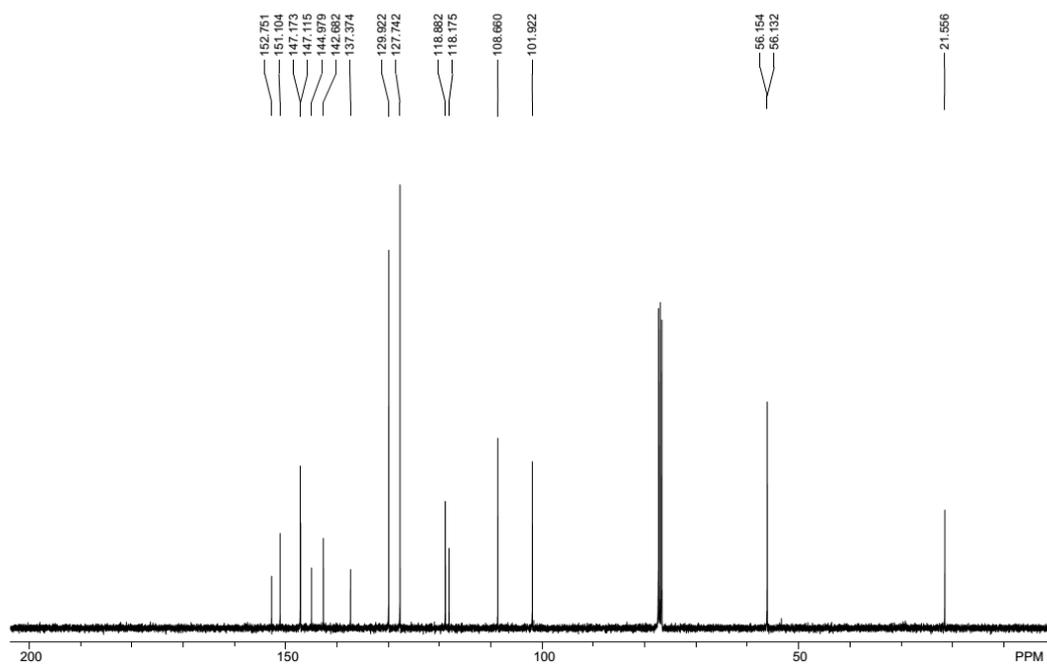
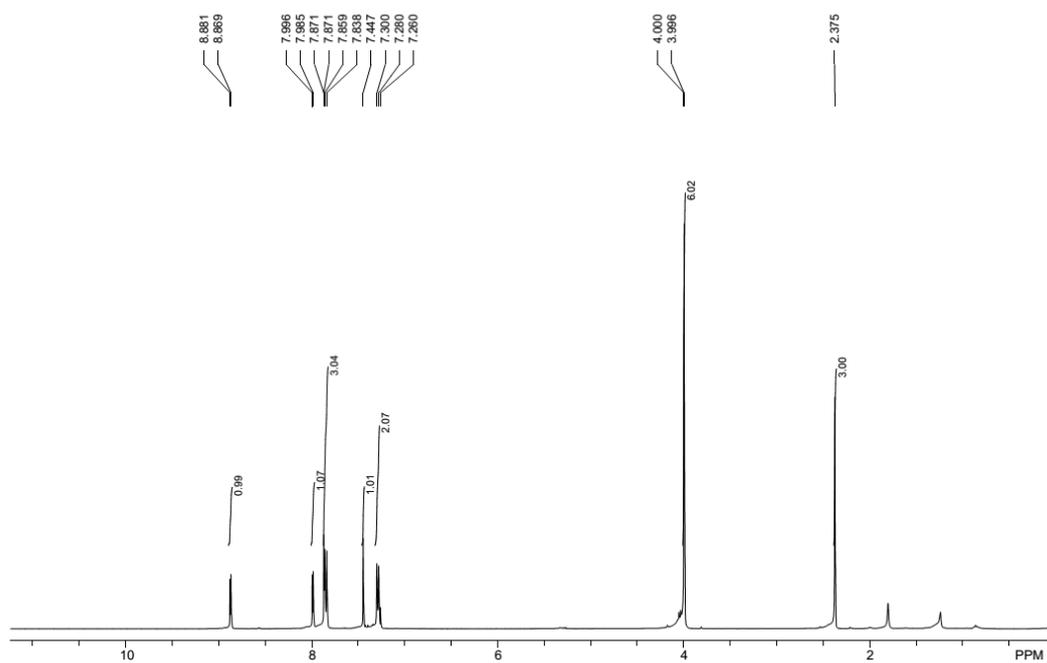
7-chloro-4-tosylquinoline (31a)



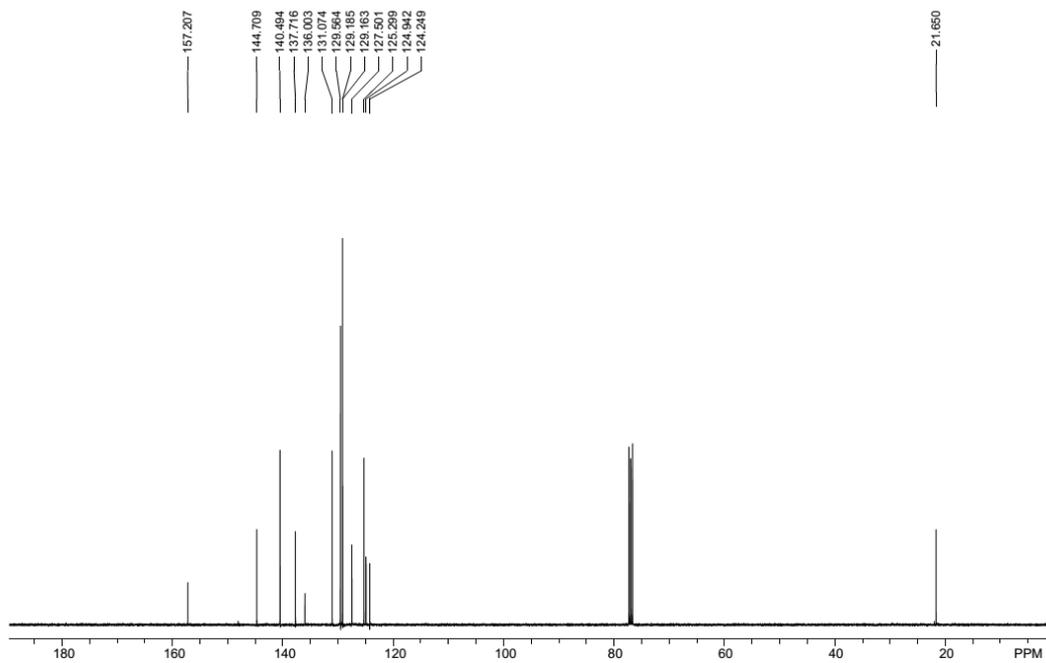
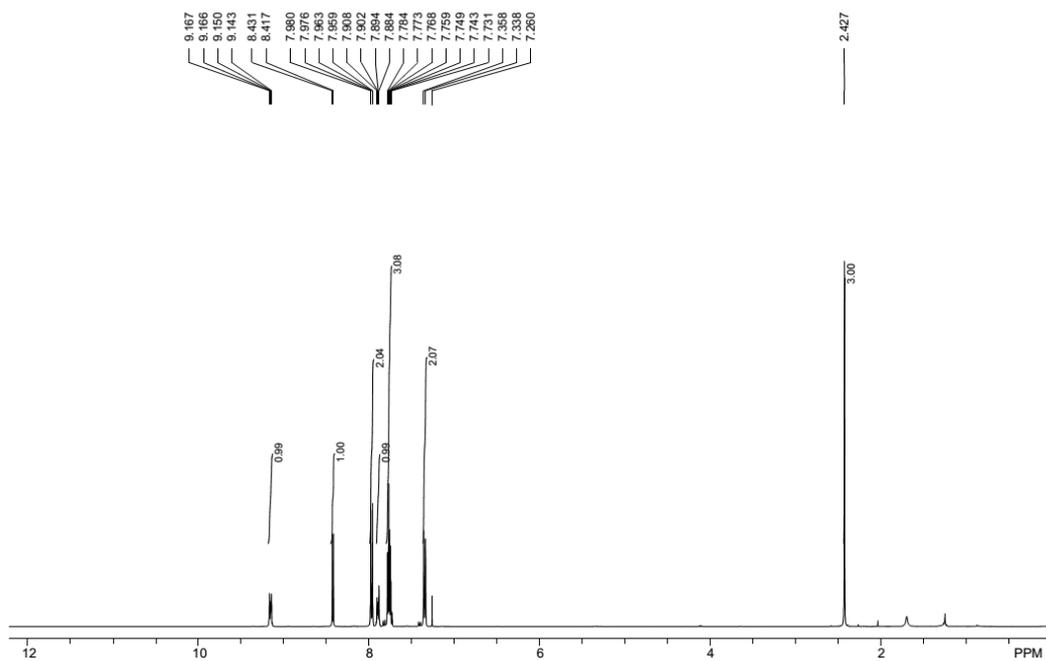
7-bromo-4-tosylquinoline (3ma)



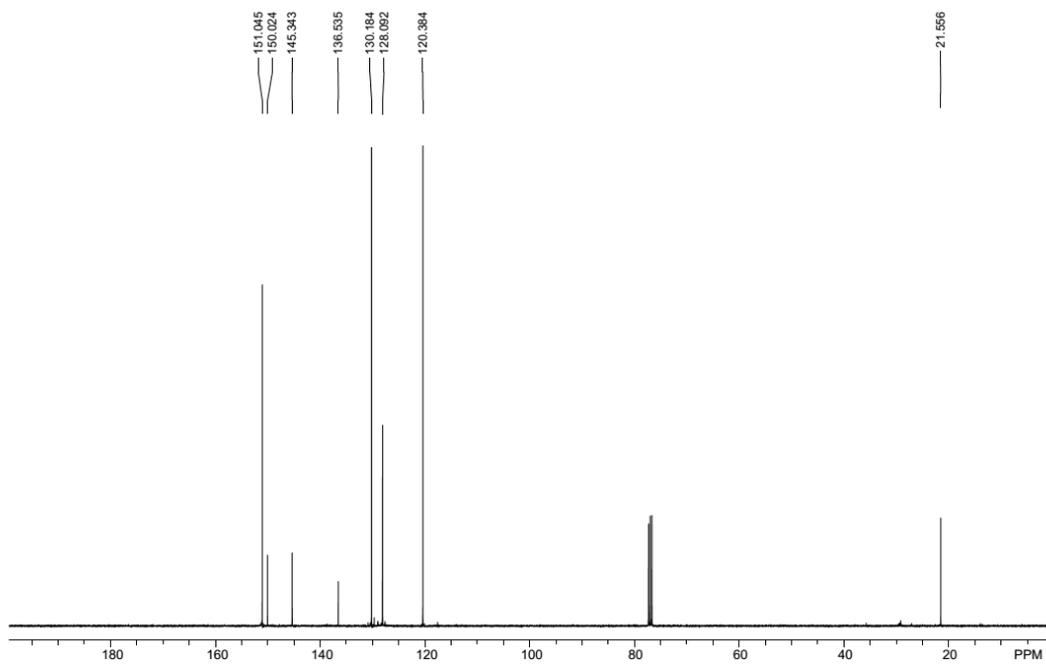
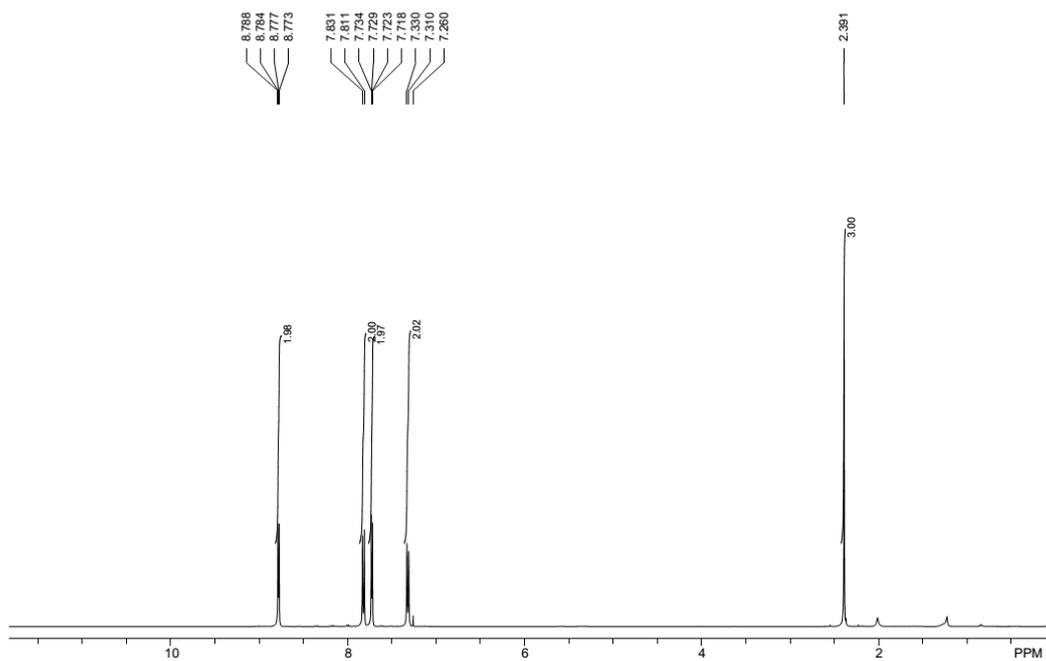
6,7-dimethoxy-4-tosylquinoline (3na)



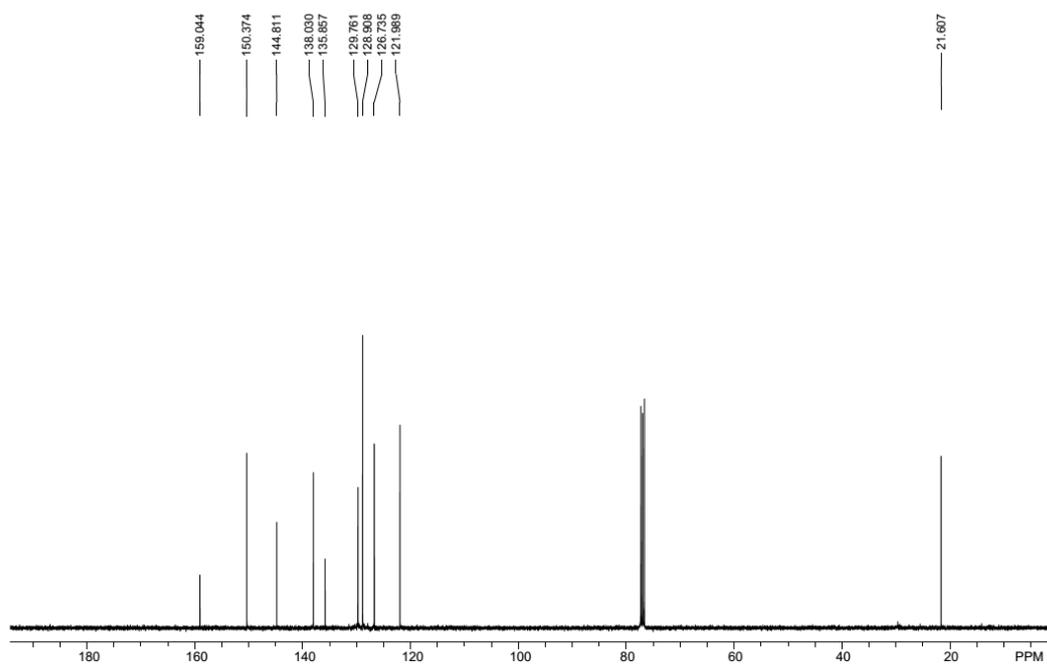
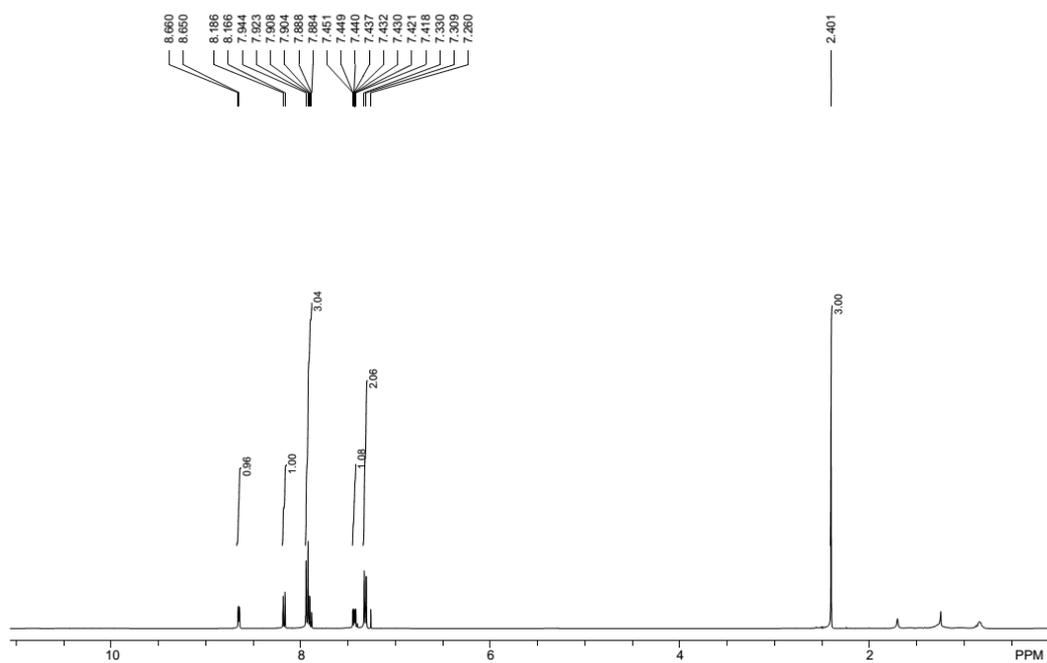
1-tosylisoquinoline (30a)



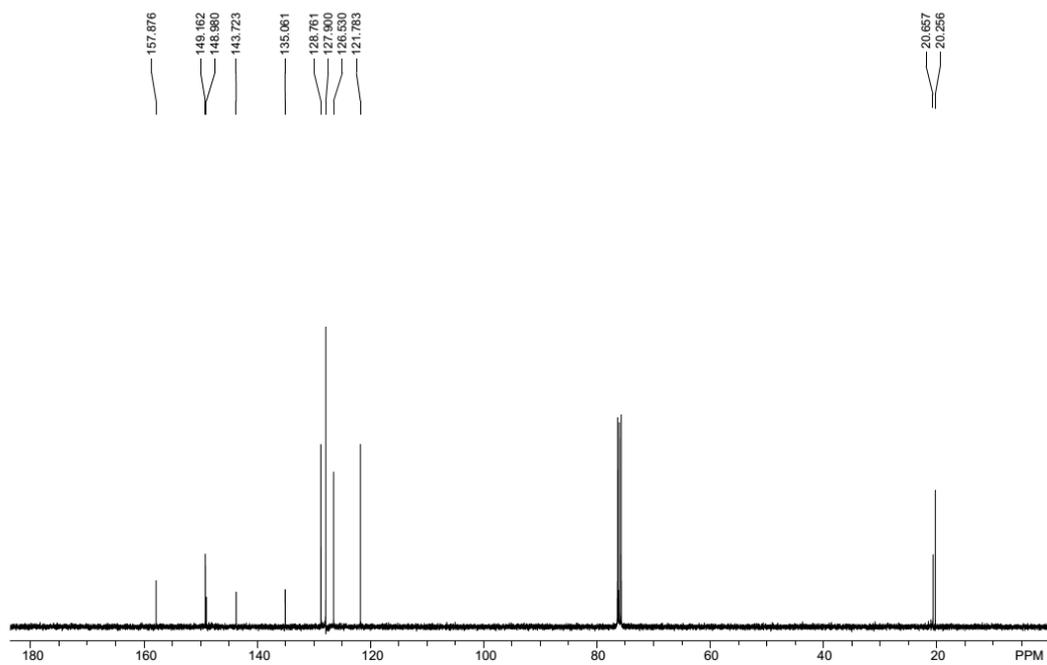
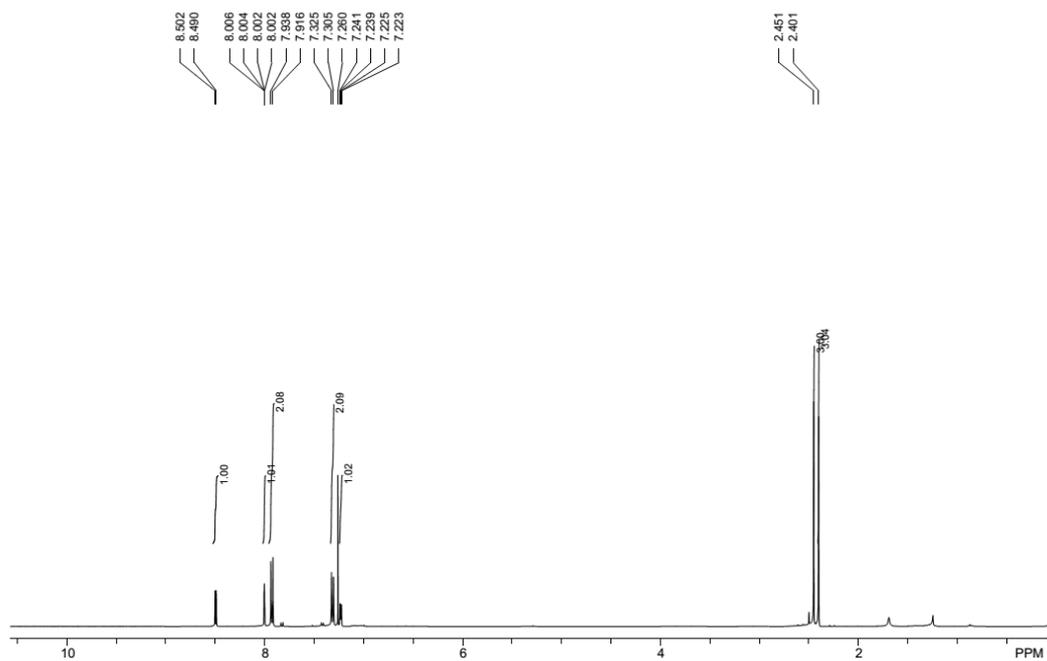
4-tosylpyridine (3pa)



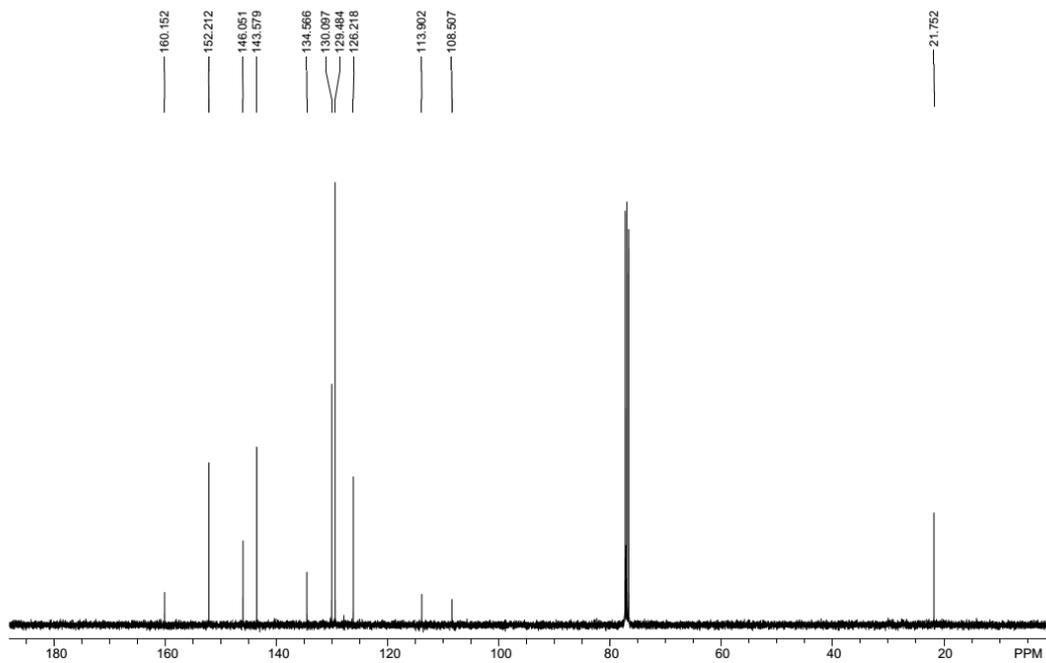
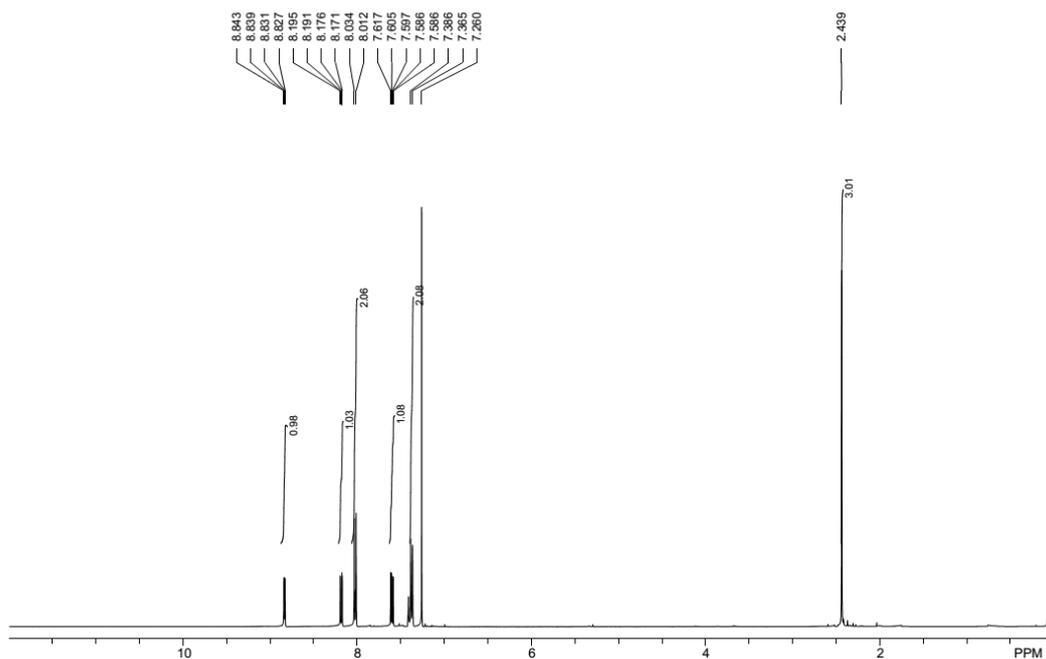
2-tosylpyridine (3qa)



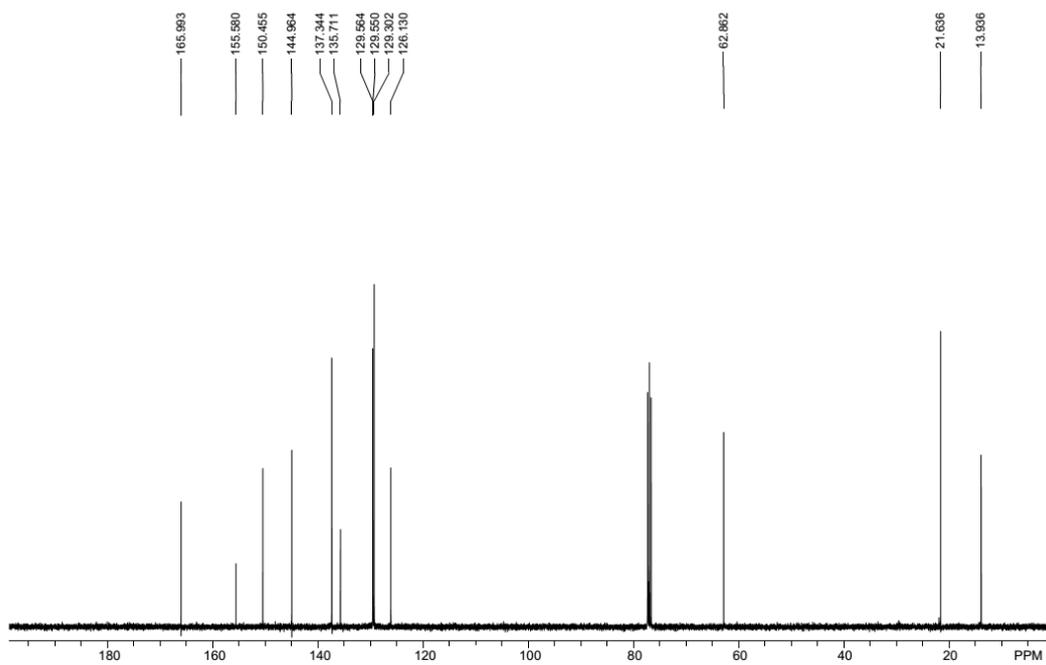
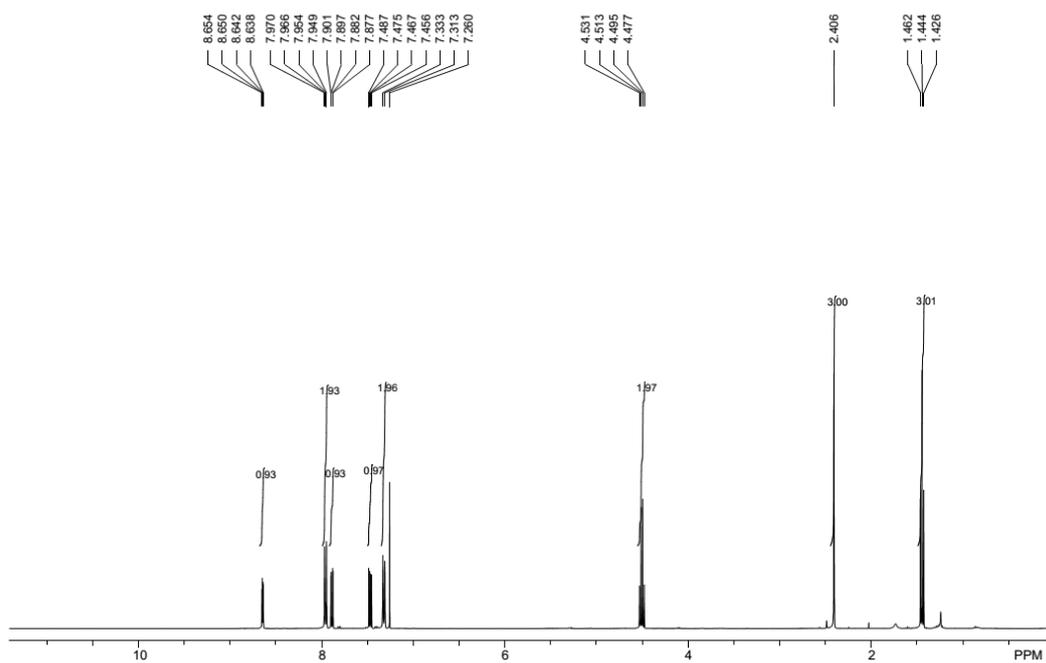
4-methyl-2-tosylpyridine (3ra)



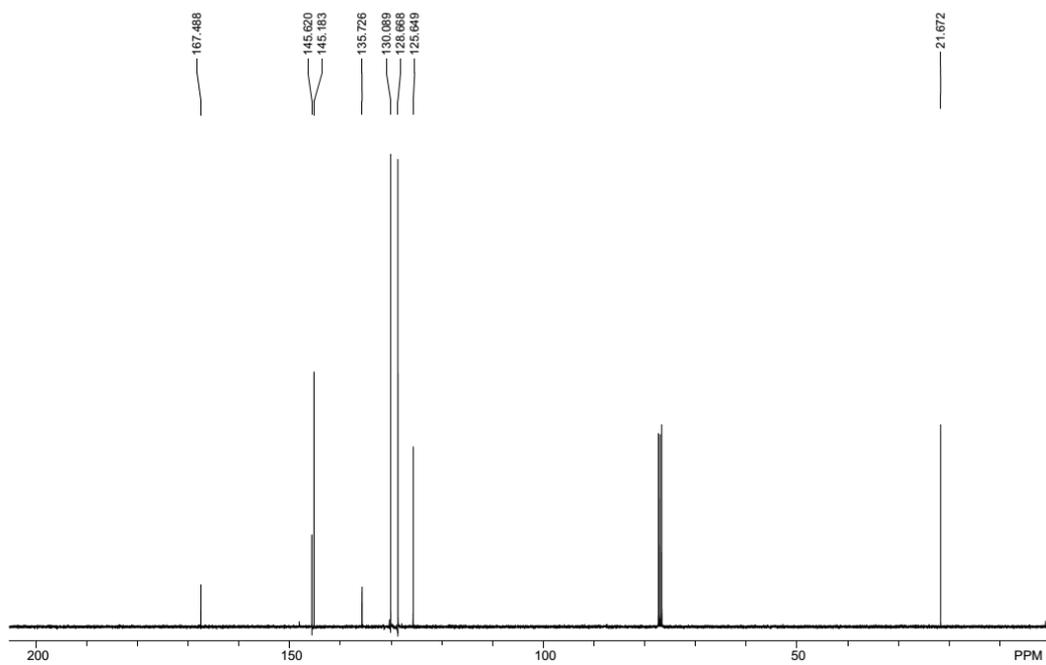
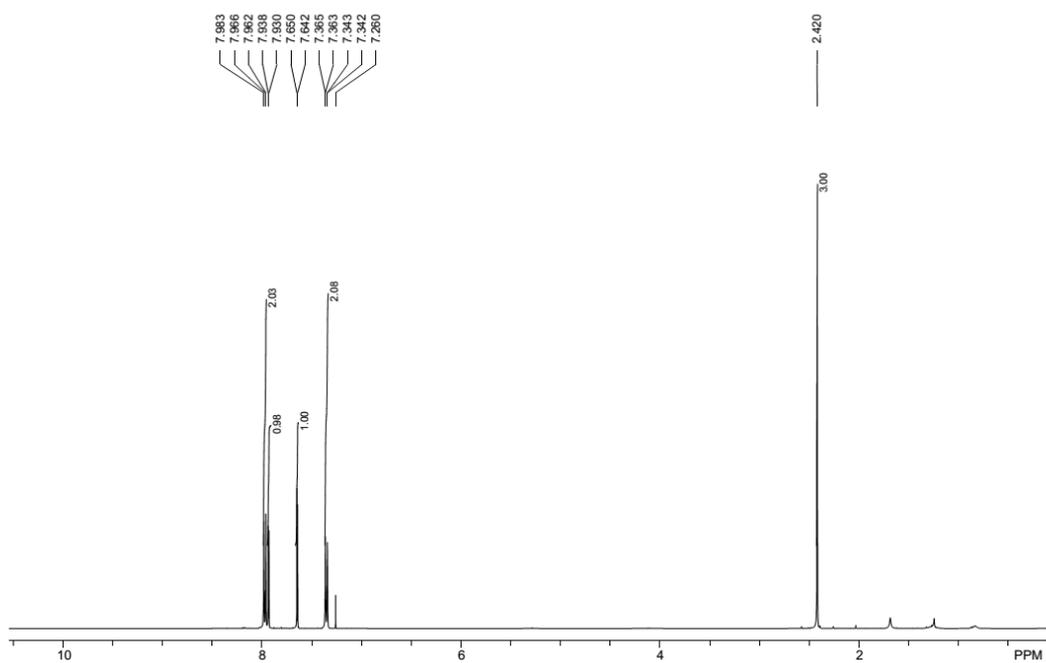
2-tosylnicotinonitrile (3sa)



ethyl 2-tosylnicotinate (3ta)



2-tosylthiazole (3ua)



S-p-tolyl 4-methylbenzenesulfonothioate (4b)

