

Supporting Information

Molecular iodine-mediated synthesis of thiocarbamates from isocyanides, thiols and water under metal-free conditions

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1. General information

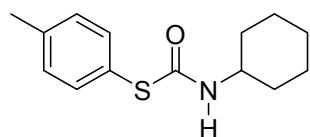
Commercially available reagents were purchased from commercial suppliers and used without further purification. Reactions were monitored by thin layer chromatography (TLC) using silicycle pre-coated silica gel plates. Flash column chromatography was performed over silicycle silica gel (200-300 mesh). ¹H NMR and ¹³C NMR spectra were recorded on 400 MHz NMR plus spectrometer using residue solvent peaks as internal standards. High resolution mass spectra were obtained using GCT-TOF instrument with ESI source.

2. General procedure for the synthesis of compound 3

In a pressure tube was consecutively placed thiol **1** (0.1 mmol), isocyanide **2** (0.22 mmol), I₂ (0.2 mmol) and DMSO/H₂O (10:1, 0.5 mL), then the mixtures were heated to 70 °C. The progress of the reaction was monitored by TLC. The reaction typically took 8 h. Upon completion, the reaction was cooled to room temperature, then water (5mL) was added to the reaction mixture, it was extracted with CH₂Cl₂ (5 mL x 3) 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 to obtain thiocarbamate **3**.

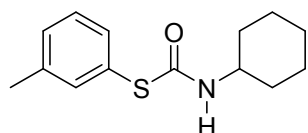
3. The Characterization of Products

S-(*p*-tolyl) cyclohexylcarbamothioate (**3aa**)¹



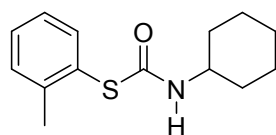
White solid (46.3 mg, 93 %); ¹H NMR (400 MHz, CDCl₃) δ 7.36 (d, *J* = 8.1 Hz, 2H), 7.14 (d, *J* = 7.5 Hz, 2H), 5.14 (br s, 1H), 3.64 (br s, 1H), 2.30 (s, 3H), 1.80 (d, *J* = 12.1 Hz, 2H), 1.65 – 1.47 (m, 3H), 1.31 – 1.15 (m, 2H), 1.13 – 0.90 (m, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 165.5, 139.9, 135.4, 130.3, 125.4, 50.4, 32.8, 25.4, 24.6, 21.3.

S-(*m*-tolyl) cyclohexylcarbamothioate (**3ba**)



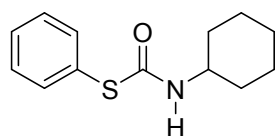
Yellow solid (43.2 mg, 87 %); ^1H NMR (400 MHz, CDCl_3) δ 7.40 – 7.32 (m, 2H), 7.32 – 7.25 (m, 1H), 7.22 (d, $J = 7.5$ Hz, 1H), 5.27 (br s, 1H), 3.73 (br s, 1H), 2.37 (s, 3H), 1.96 – 1.83 (m, 2H), 1.67 – 1.50 (m, 3H), 1.37 – 1.24 (m, 2H), 1.13 – 0.96 (m, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 165.2, 139.3, 135.9, 132.4, 130.4, 129.2, 128.6, 50.5, 32.8, 25.4, 24.6, 21.3. HRMS (ESI) calcd for $\text{C}_{14}\text{H}_{19}\text{NOS}$ $[\text{M} + \text{H}]^+$: 250.1260, found: 250.1256.

S-(*o*-tolyl) cyclohexylcarbamothioate (3ca)



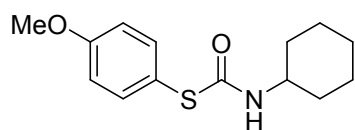
White solid (44.3 mg, 89 %); ^1H NMR (400 MHz, CDCl_3) δ 7.55 (d, $J = 7.6$ Hz, 1H), 7.38 – 7.27 (m, 2H), 7.21 – 7.25 (m, 1H), 5.17 (br s, 1H), 3.72 (br s, 1H), 2.46 (s, 3H), 1.92 – 1.79 (m, 2H), 1.64 – 1.49 (m, 3H), 1.39 – 1.21 (m, 3H), 1.14 – 1.01 (m, 2H). ^{13}C NMR (100 MHz, CDCl_3) δ 164.8, 142.8, 136.9, 131.0, 130.4, 128.4, 127.0, 50.3, 32.9, 25.4, 24.5, 21.1. HRMS (ESI) calcd for $\text{C}_{14}\text{H}_{19}\text{NOS}$ $[\text{M} + \text{H}]^+$: 250.1260, found: 250.1264.

S-phenyl cyclohexylcarbamothioate (3da)²



White solid (42.3 mg, 90 %); ^1H NMR (400 MHz, CDCl_3) δ 7.55 (dd, $J = 6.8, 3.2$ Hz, 2H), 7.44 – 7.35 (m, 3H), 5.34 (br s, 1H), 3.73 (br s, 1H), 1.96 – 1.80 (m, 2H), 1.69 – 1.50 (m, 3H), 1.35 – 1.23 (m, 2H), 1.15 – 0.97 (m, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 164.9, 135.4, 129.5, 129.4, 128.9, 50.5, 32.8, 25.4, 24.6.

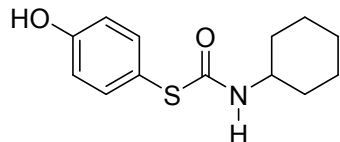
S-(4-methoxyphenyl) cyclohexylcarbamothioate (3ea)



White solid (49.7 mg, 94 %); ^1H NMR (400 MHz, CDCl_3) δ 7.46 (d, $J = 8.4$ Hz, 2H), 6.92 (d, $J = 8.6$ Hz, 2H), 5.23 (br s, 1H), 3.82 (s, 3H), 3.71 (br s, 1H), 1.93 – 1.79 (m, 2H), 1.65 – 1.51 (m, 3H), 1.35 – 1.24 (m, 2H), 1.17 – 1.01 (m, 3H). ^{13}C NMR (100

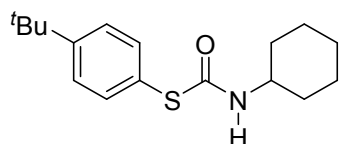
MHz, CDCl₃) δ 165.9, 160.9, 137.2, 132.7, 115.1, 55.4, 50.4, 32.9, 25.4, 24.6. HRMS (ESI) calcd for C₁₄H₁₉NO₂S [M + H]⁺: 266.1209, found: 266.1208.

S-(4-hydroxyphenyl) cyclohexylcarbamothioate (3fa)



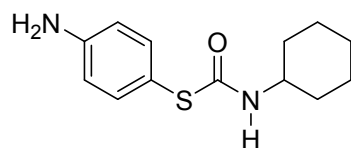
White solid (41.2 mg, 82%); ¹H NMR (400 MHz, CDCl₃) δ 7.31 (d, *J* = 8.2 Hz, 2H), 6.71 (d, *J* = 8.2 Hz, 2H), 5.40 (br s, 1H), 3.74 (br s, 1H), 1.96 – 1.84 (m, 2H), 1.71 – 1.52 (m, 3H), 1.37 – 1.32 (m, 2H), 1.13 – 0.91 (m, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 167.8, 158.2, 137.4, 117.5, 117.0, 50.7, 32.9, 25.3, 24.6. HRMS (ESI) calcd for C₁₃H₁₇NO₂S [M + H]⁺: 252.1053, found: 252.1050.

S-(4-(*tert*-butyl)phenyl)cyclohexylcarbamothioate (3ga)



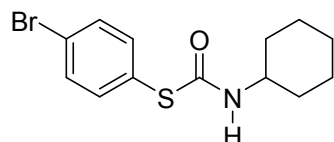
White solid (47.8 mg, 82%); ¹H NMR (400 MHz, CDCl₃) δ 7.55 – 7.37 (m, 4H), 5.24 (br s, 1H), 3.73 (br s, 1H), 1.97 – 1.78 (m, 2H), 1.62 – 1.50 (m, 3H), 1.37 – 1.28 (m, 11H), 1.16 – 1.05 (m, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 165.4, 152.9, 135.2, 126.5, 125.4, 50.4, 34.8, 32.8, 31.2, 25.4, 24.5. HRMS (ESI) calcd for C₁₇H₂₅NO₂S [M + H]⁺: 292.1730, found: 292.1724.

S-(4-aminophenyl)cyclohexylcarbamothioate (3ha)



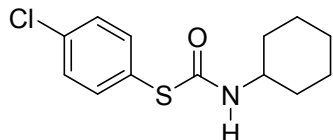
Yellow solid (40.5 mg, 81 %); ¹H NMR (400 MHz, CDCl₃) δ 7.31 (d, *J* = 8.8, 2H), 6.67 (d, *J* = 8.4, 2H), 5.21 (br s, 1H), 3.93 (s, 2H), 3.70 (br s, 1H), 1.83 (d, *J* = 12.7 Hz, 2H), 1.60 – 1.51 (m, 2H), 1.34 – 1.27 (m, 3H), 1.14 – 0.96 (m, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 166.9, 148.3, 137.2, 116.1, 115.8, 50.1, 32.8, 25.4, 24.5. HRMS (ESI) calcd for C₁₃H₁₈N₂OS [M + H]⁺: 251.1213, found: 251.1208.

S-(4-bromophenyl)cyclohexylcarbamothioate (3ia)³



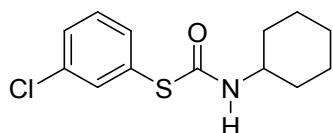
White solid (48.4 mg, 85%); ^1H NMR (400 MHz, CDCl_3) δ 7.52 (d, $J = 8.0$ Hz, 2H), 7.39 (d, $J = 8.2$ Hz, 2H), 5.25 (br s, 1H), 3.73 (br s, 1H), 2.00 – 1.85 (m, 2H), 1.64 (d, $J = 8.0$ Hz, 3H), 1.29 – 1.11 (m, 5H). ^{13}C NMR (100 MHz, CDCl_3) δ 163.8, 136.7, 132.4, 129.4, 124.0, 50.8, 32.9, 25.4, 24.7.

***S*-(4-chlorophenyl)cyclohexylcarbamothioate (3ja)¹**



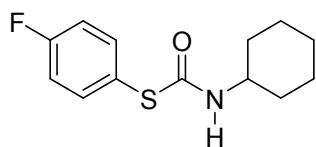
White solid (43.1 mg, 80%); ^1H NMR (400 MHz, CDCl_3) δ 7.48 – 7.43 (m, 2H), 7.38 – 7.33 (m, 2H), 5.27 (br s, 1H), 3.73 (br s, 1H), 1.98 – 1.86 (m, 2H), 1.70 – 1.59 (m, 3H), 1.37 – 1.26 (m, 2H), 1.15 – 1.02 (m, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 164.1, 136.5, 135.8, 129.4, 127.2, 50.8, 32.9, 25.3, 24.7.

***S*-(3-chlorophenyl) cyclohexylcarbamothioate (3ka)**



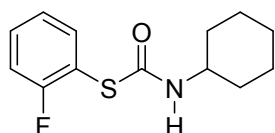
White solid (53.2 mg, 90%); ^1H NMR (400 MHz, CDCl_3) δ 7.54 (d, $J = 2.1$ Hz, 1H), 7.42 (d, $J = 7.4$ Hz, 1H), 7.39 – 7.29 (m, 2H), 5.28 (br s, 1H), 3.73 (br s, 1H), 2.00 – 1.87 (m, 2H), 1.74 – 1.61 (m, 3H), 1.36 – 1.29 (m, 2H), 1.21 – 1.10 (m, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 163.6, 134.8, 134.6, 133.2, 130.5, 130.1, 129.5, 50.9, 32.9, 25.4, 24.7. HRMS (ESI) calcd for $\text{C}_{13}\text{H}_{16}\text{ClNOS}$ [$\text{M} + \text{H}$]⁺: 270.0714, found: 270.0716.

***S*-(4-fluorophenyl) cyclohexylcarbamothioate (3la)³**



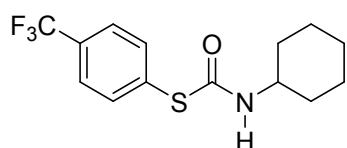
White solid (39.5 mg, 78%); ^1H NMR (400 MHz, CDCl_3) δ 7.51 (dd, $J = 8.7, 5.4$ Hz, 2H), 7.09 (t, $J = 8.6$ Hz, 2H), 5.29 (br s, 1H), 3.72 (br s, 1H), 1.99 – 1.81 (m, 2H), 1.73 – 1.56 (m, 3H), 1.37 – 1.26 (m, 2H), 1.18 – 1.07 (m, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 164.7 (d, $J = 16.0$ Hz), 162.3, 137.5 (d, $J = 8.4$ Hz), 124.1, 116.5 (d, $J = 22.0$ Hz), 50.7, 32.9, 25.4, 24.7. ^{19}F NMR (376 MHz, CDCl_3) δ -111.07 (s).

***S*-(2-fluorophenyl) cyclohexylcarbamothioate (3ma)**



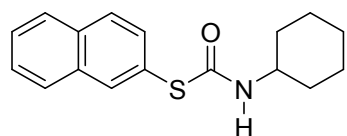
White solid (37.4 mg, 78%); ^1H NMR (400 MHz, CDCl_3) δ 7.41 (m, 2H), 7.24 – 6.95 (m, 2H), 5.36 (br s, 1H), 3.67 (br s, 1H), 1.85 (d, $J = 12.4$ Hz, 2H), 1.58 (dd, $J = 27.2, 16.0$ Hz, 3H), 1.34 – 1.21 (m, 2H), 1.12 – 1.03 (m, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 163.8, 162.9, 161.2, 137.6, 132.0 (d, $J = 8.4$ Hz), 124.6 (d, $J = 4.0$ Hz), 116.2 (d, $J = 27.2$ Hz), 51.0, 32.8, 25.34, 24.7. ^{19}F NMR (376 MHz, CDCl_3): δ -105.7 (s). HRMS (ESI) calcd for $\text{C}_{13}\text{H}_{16}\text{FNOS}$ $[\text{M} + \text{H}]^+$: 254.1009, found: 254.1003.

S-(4-(trifluoromethyl)phenyl)cyclohexylcarbamothioate (3na)



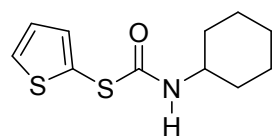
White solid (42.4 mg, 70%); ^1H NMR (400 MHz, CDCl_3) δ 7.68 – 7.59 (m, 4H), 5.36 (br s, 1H), 3.74 (br s, 1H), 2.01 – 1.88 (m, 2H), 1.74 – 1.59 (m, 3H), 1.38 – 1.28 (m, 2H), 1.24 – 1.12 (m, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 163.1, 135.0, 133.5, 131.1 (q, $J = 34.2$ Hz), 126.4 (q, $J = 3.6$ Hz), 125.7 (q, $J = 276.4$ Hz), 51.09, 32.96, 25.33, 24.69. ^{19}F NMR (376 MHz, CDCl_3): δ -82.8 (s). HRMS (ESI) calcd for $\text{C}_{14}\text{H}_{16}\text{F}_3\text{NOS}$ $[\text{M} + \text{H}]^+$: 304.0977, found: 304.0971.

S-(naphthalen-2-yl)cyclohexylcarbamothioate (3oa)



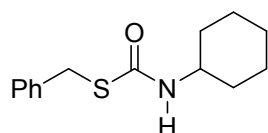
White solid (49.1 mg, 86%); ^1H NMR (400 MHz, CDCl_3) δ 8.08 (d, $J = 1.6$ Hz, 1H), 7.87 – 7.72 (m, 3H), 7.62 – 7.49 (m, 3H), 5.27 (br s, 1H), 3.75 (br s, 1H), 1.99 – 1.84 (m, 2H), 1.65 (s, 2H), 1.37 – 1.24 (m, 3H), 1.17 – 1.02 (m, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 164.9, 135.2, 133.6, 133.3, 131.6, 129.1, 128.0, 127.8, 127.3, 126.7, 126.1, 50.6, 32.9, 25.3, 24.6. HRMS (ESI) calcd for $\text{C}_{17}\text{H}_{19}\text{NOS}$ $[\text{M} + \text{H}]^+$: 286.1260, found: 286.1265.

S-(thiophen-2-yl)cyclohexylcarbamothioate (3pa)



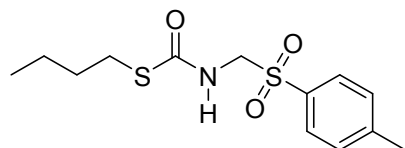
White solid (39.5 mg, 82%); ^1H NMR (400 MHz, CDCl_3) δ 7.50 (d, $J = 5.2$ Hz, 1H), 7.22 (d, $J = 3.6$ Hz, 1H), 7.04 (dd, $J = 5.2, 3.6$ Hz, 1H), 5.30 (br s, 1H), 3.66 (br s, 1H), 1.79 (dd, $J = 12.4, 4.8$ Hz, 2H), 1.55 – 1.43 (m, 3H), 1.29 – 1.16 (m, 2H), 1.19 – 0.98 (m, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 164.6, 137.3, 132.9, 128.3, 126.8, 50.5, 32.7, 25.3, 24.4. HRMS (ESI) calcd for $\text{C}_{11}\text{H}_{15}\text{NOS}_2$ [$\text{M} + \text{H}$] $^+$: 242.0668, found: 242.0664.

S-benzyl cyclohexylcarbamothioate (3ra)



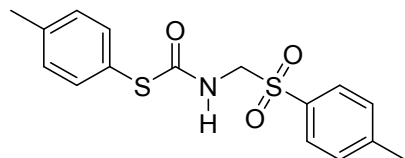
White solid (42.3 mg, 85%); ^1H NMR (400 MHz, CDCl_3) δ 7.43 – 7.21 (m, 5H), 5.26 (br s, 1H), 4.15 (s, 2H), 3.77 (br s, 1H), 2.05 – 1.87 (m, 2H), 1.77 – 1.63 (m, 3H), 1.40 – 1.12 (m, 5H). ^{13}C NMR (100 MHz, CDCl_3) δ 165.6, 138.5, 128.8, 128.6, 127.1, 50.7, 34.2, 33.2, 25.4, 24.7. HRMS (ESI) calcd for $\text{C}_{14}\text{H}_{19}\text{NOS}$ [$\text{M} + \text{H}$] $^+$: 250.1260, found: 250.1259.

S-butyl (tosylmethyl)carbamothioate (3sb)



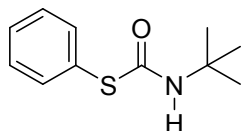
Yellow solid (46.9 mg, 78%); ^1H NMR (400 MHz, CDCl_3) δ 7.78 (d, $J = 8.4$ Hz, 2H), 7.33 (d, $J = 8.0$ Hz, 2H), 6.68 (br s, 1H), 4.67 (d, $J = 6.8$ Hz, 2H), 2.71 (t, $J = 7.2$ Hz, 2H), 2.42 (s, 3H), 1.49 – 1.20 (m, 5H), 0.85 (t, $J = 7.2$ Hz, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 168.1, 145.3, 133.7, 129.9, 129.0, 61.4, 32.2, 29.7, 21.7, 21.6, 13.6. HRMS (ESI) calcd for $\text{C}_{13}\text{H}_{19}\text{NO}_3\text{S}_2$ [$\text{M} + \text{H}$] $^+$: 302.0879, found: 302.0872.

S-phenyl (tosylmethyl)carbamothioate (3db)



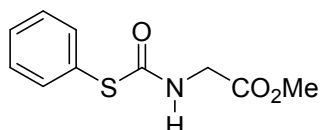
White solid (55.6 mg, 83%); ^1H NMR (400 MHz, CDCl_3) δ 7.77 (d, $J = 8.4$ Hz, 2H), 7.37 (d, $J = 8.0$ Hz, 2H), 7.30 (d, $J = 8.0$ Hz, 2H), 7.22 (d, $J = 8.0$ Hz, 2H), 6.19 (br s, 1H), 4.60 (d, $J = 6.8$ Hz, 2H), 2.46 (s, 3H), 2.38 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 167.1, 145.6, 140.8, 135.4, 133.5, 130.5, 130.1, 128.9, 123.3, 61.2, 21.8, 21.4. HRMS (ESI) calcd for $\text{C}_{16}\text{H}_{17}\text{NO}_3\text{S}_2$ [$\text{M} + \text{H}$] $^+$: 336.0723, found: 336.0716.

S-phenyl tert-butylcarbamothioate (3dc)²



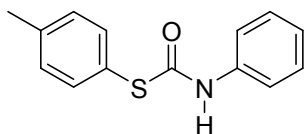
White solid (31.3 mg, 75%); $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 7.87 – 7.42 (m, 3H), 7.33 (d, $J = 3.4$ Hz, 2H), 5.14 (br s, 1H), 1.25 (s, 9H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 164.0, 135.4, 129.3, 129.3, 129.1, 53.5, 28.9.

Methyl ((phenylthio)carbonyl)glycinate (3dd)²



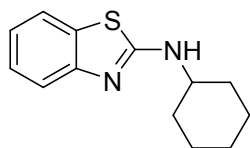
White solid (31.5 mg, 70%); $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 7.75 – 7.54 (m, 2H), 7.46 – 7.42 (m, 3H), 5.91 (s, 1H), 4.04 (d, $J = 5.2$ Hz, 2H), 3.74 (s, 3H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 169.8, 166.9, 135.6, 129.9, 129.6, 127.9, 52.5, 42.5.

S-phenyl phenylcarbamothioate (3de)³



White solid (41.3 mg, 85%); $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 7.47 (d, $J = 8.0$ Hz, 2H), 7.34 (d, $J = 8.0$ Hz, 3H), 7.28 – 7.17 (m, 4H), 7.06 (br s, 1H), 2.35 (s, 3H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 165.2, 140.4, 137.7, 135.7, 130.4, 129.1, 124.6, 124.5, 119.6, 21.4.

N-cyclohexylbenzo[d]thiazol-2-amine (4a)⁴



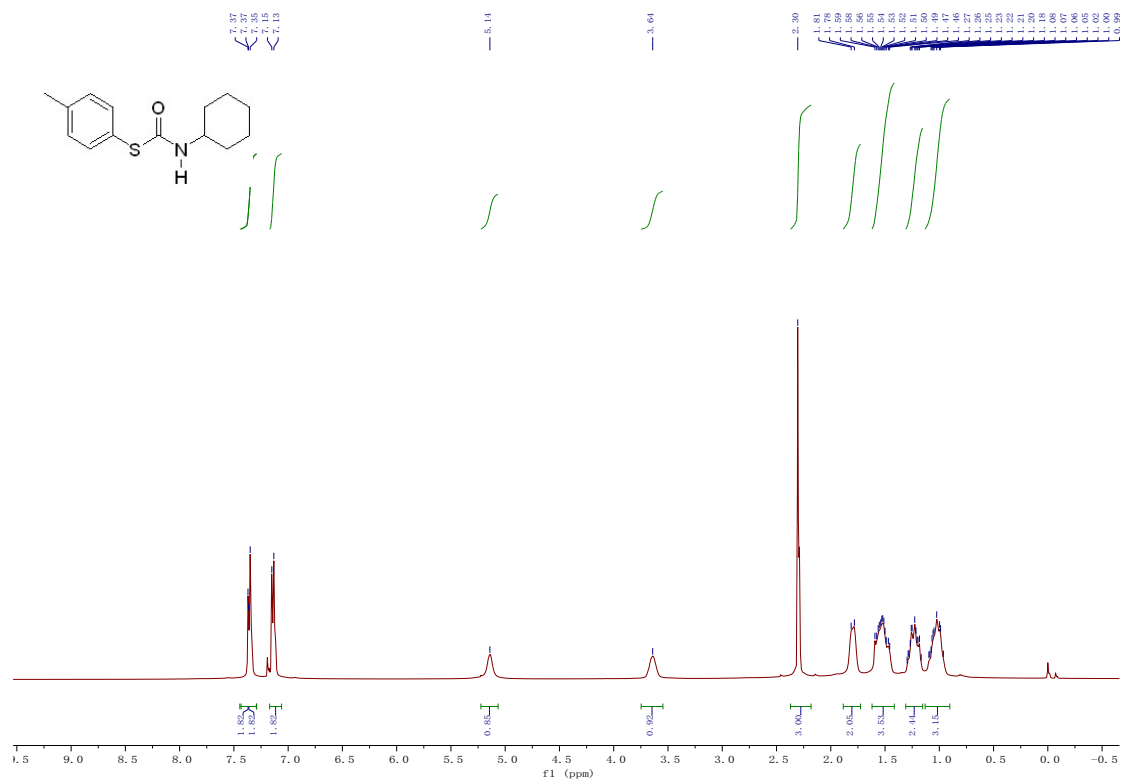
Yellow oil (33.4 mg, 72%); $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 7.54 (dd, $J = 21.2, 8.0$ Hz, 2H), 7.28 (dd, $J = 11.2, 3.6$ Hz, 1H), 7.05 (t, $J = 7.6$ Hz, 1H), 5.76 (s, 1H), 3.53 (t, $J = 9.6$ Hz, 1H), 2.12 (dd, $J = 12.4, 3.2$ Hz, 2H), 1.81 – 1.71 (m, 2H), 1.68 – 1.58 (m, 1H), 1.42 – 1.21 (m, 5H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 166.8, 152.5, 130.3, 125.9, 121.3, 120.8, 118.6, 54.7, 33.3, 25.5, 24.8.

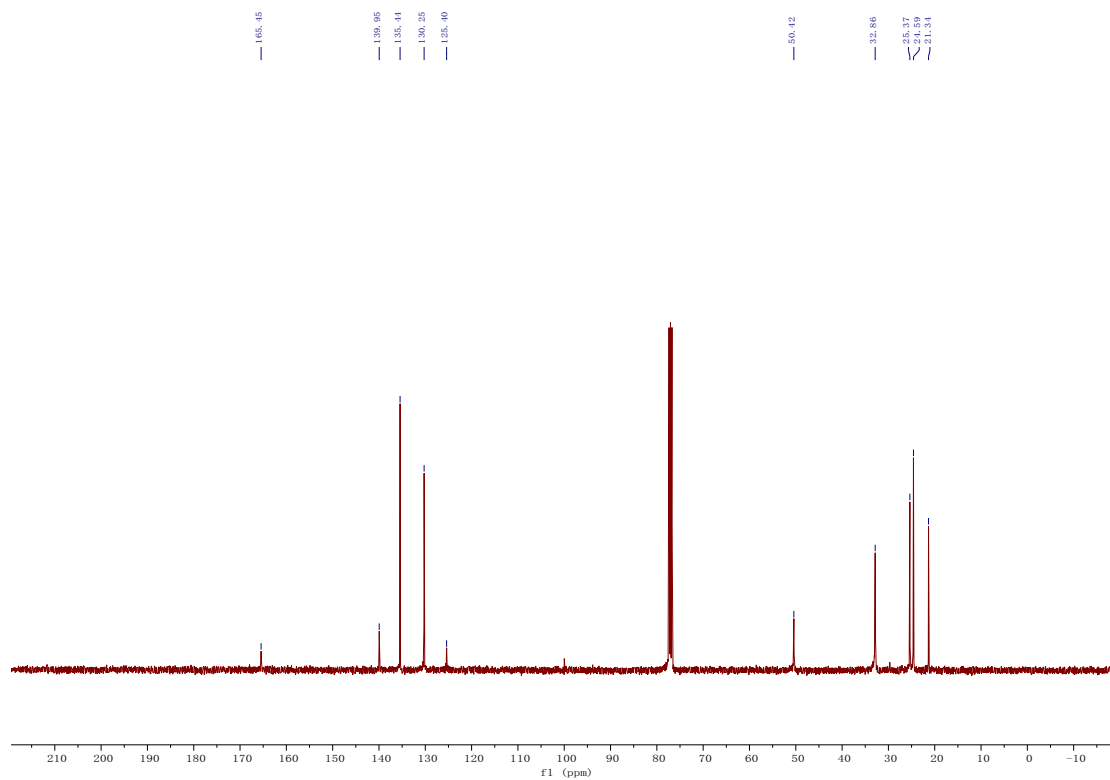
4. References

1. Kim, H.-K.; Lee, A. *Org. Biomol. Chem.*, **2016**, *14*, 7345.
2. Mampuys, P.; Zhu, Y.; Sergeyev, S.; Ruijter, E.; Orru, R. V. A.; Doorslaer, S. V.; Bert U. W. Maes. *Org. Lett.*, **2016**, *18*, 2808.
3. B. Movassagh and M. Soleiman-Beigi, *Monatsh. Chem.*, **2008**, *139*, 137.
4. G. Dumonteil, M.-A. Hiebel, M.-C. Scherrmannb and S. Berteina-Raboin, *RSC Adv.*, **2016**, *6*, 73517.

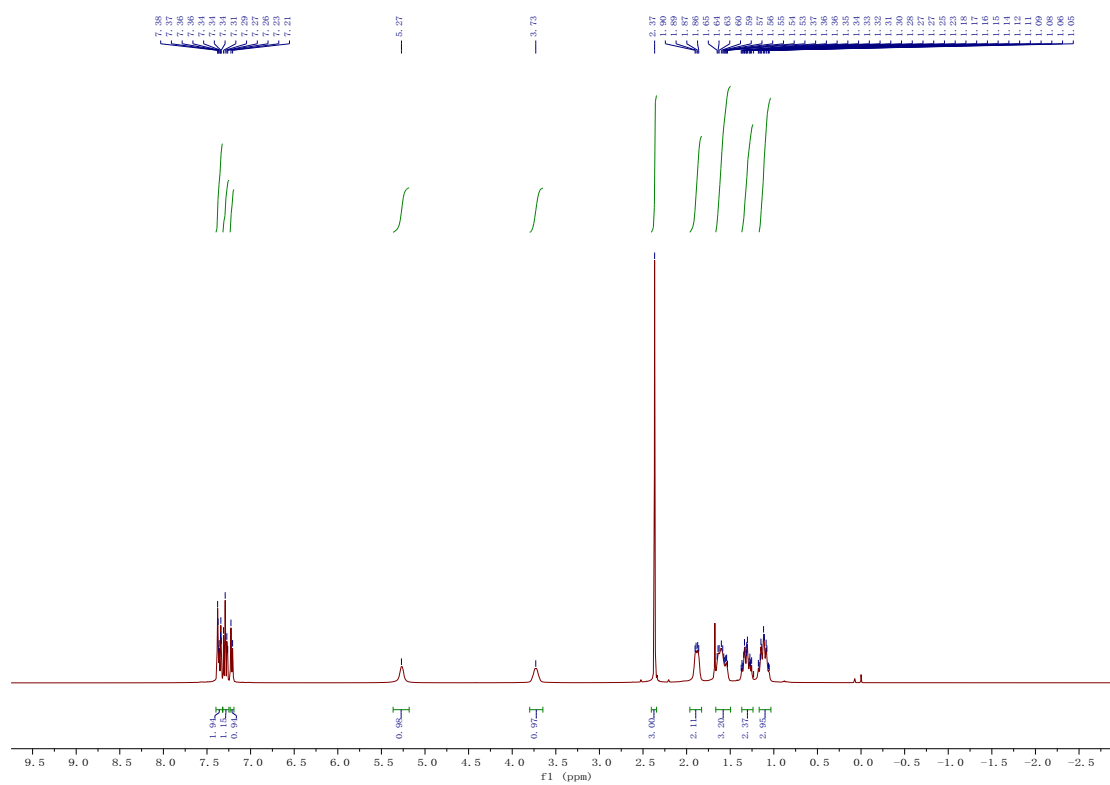
5. ^1H and ^{13}C NMR spectra

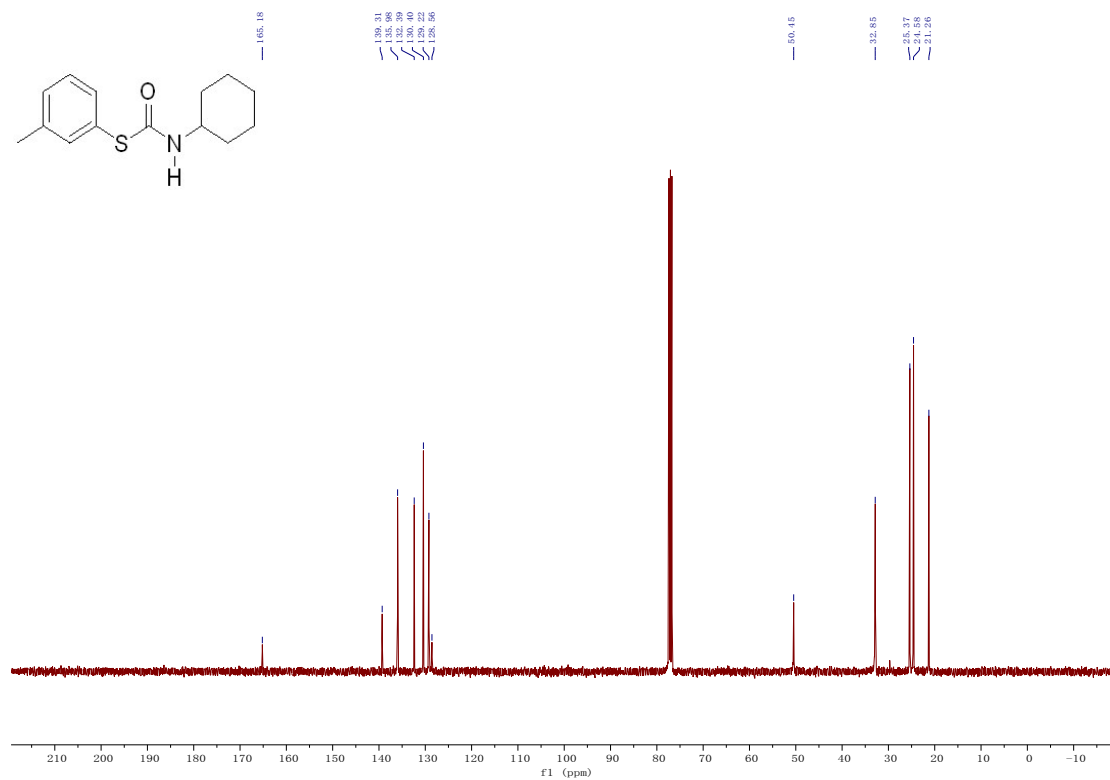
S-(*p*-tolyl) cyclohexylcarbamothioate (3aa)



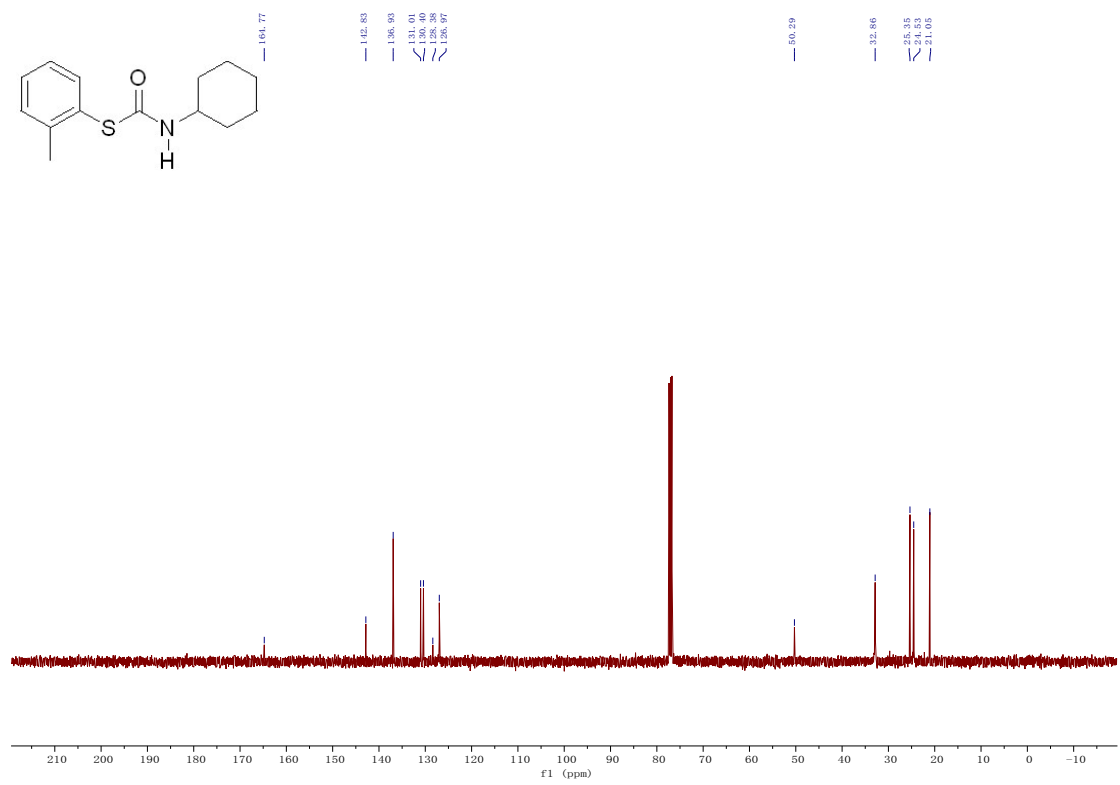
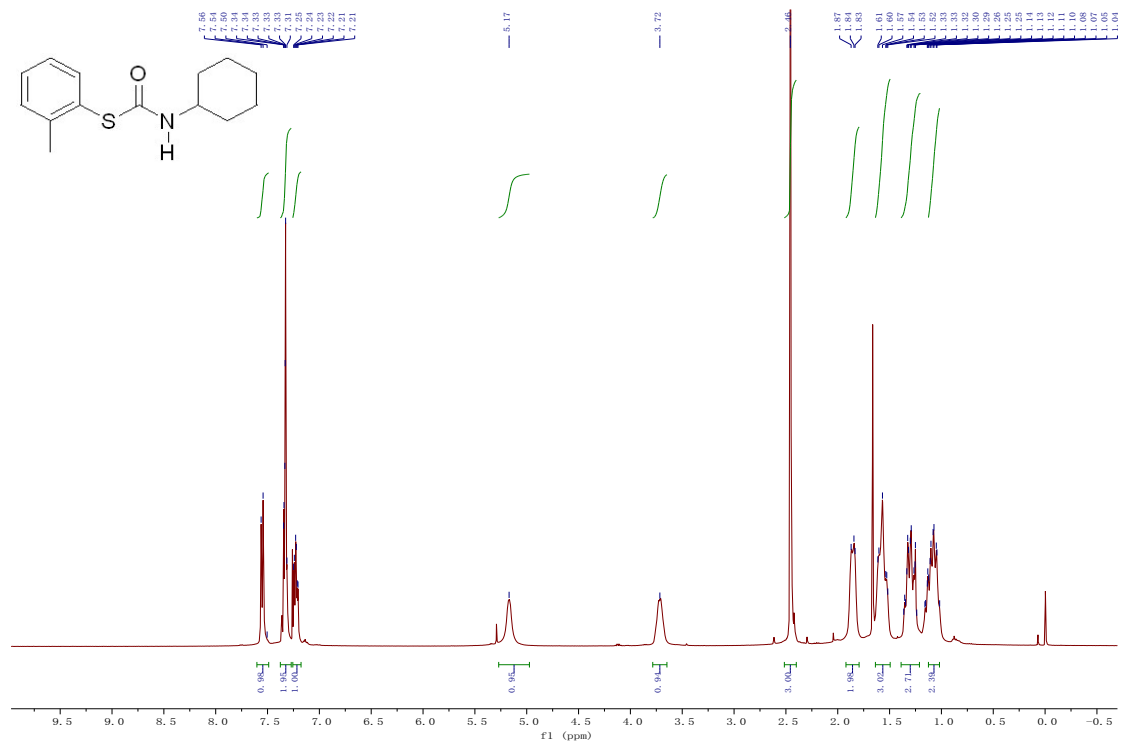


S-(*m*-tolyl) cyclohexylcarbamothioate (3ba)

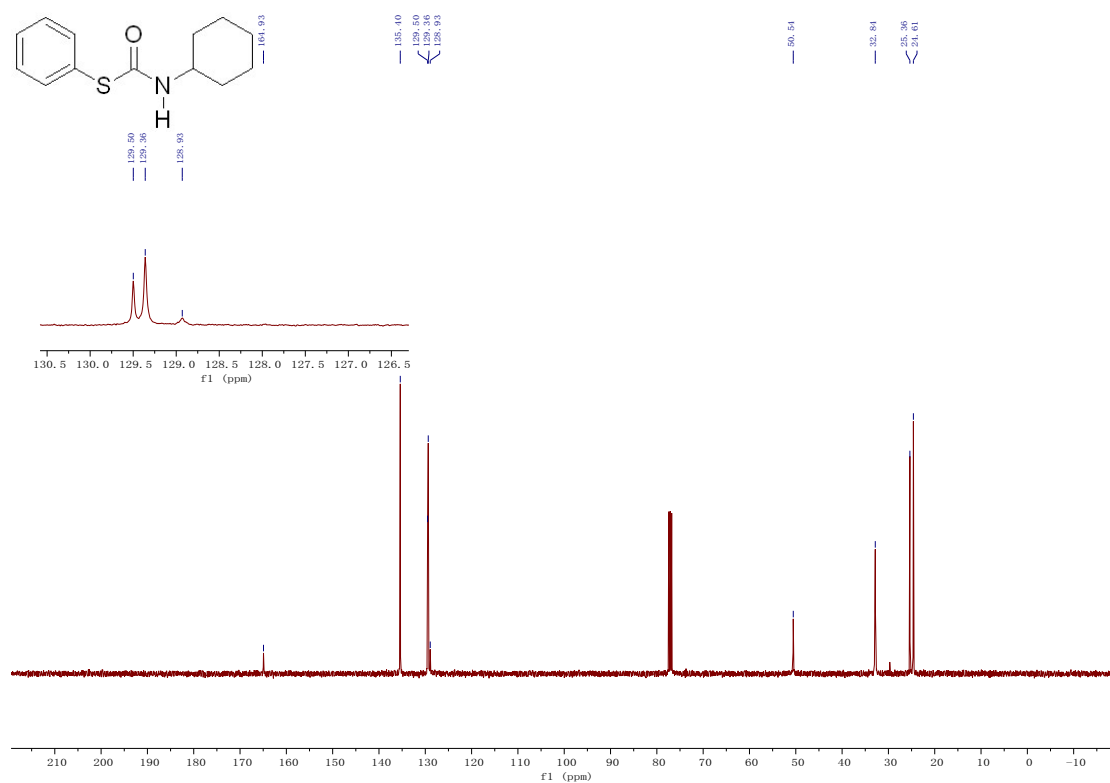
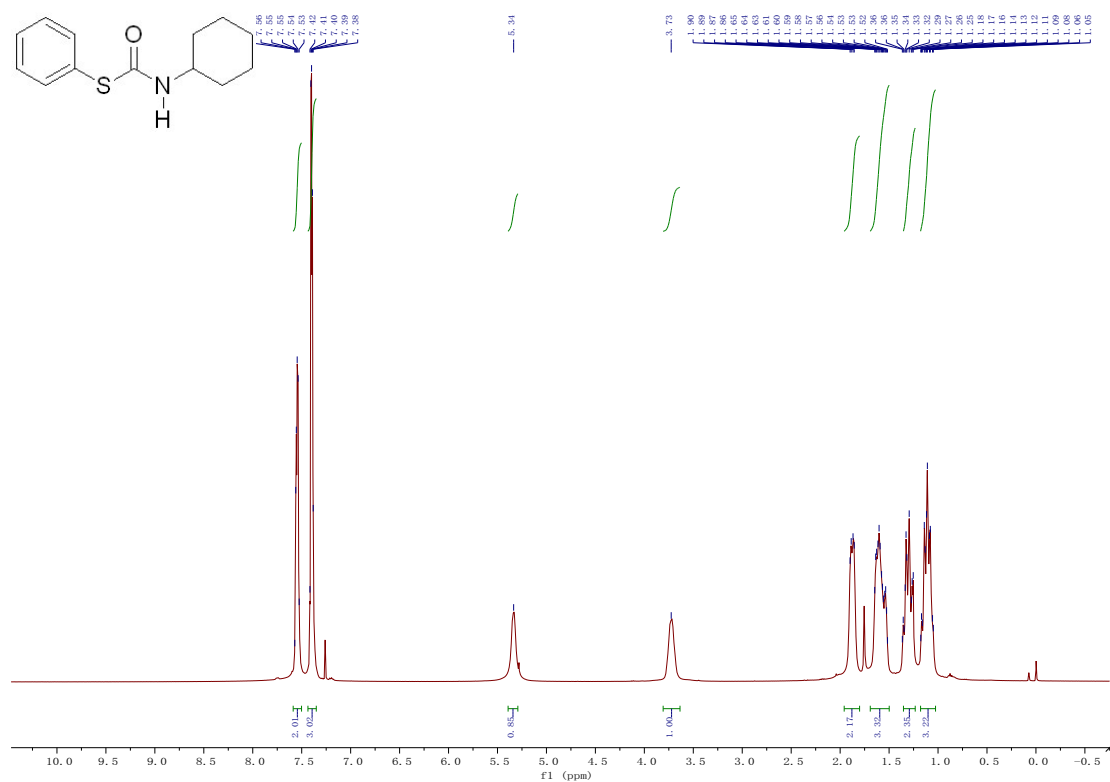




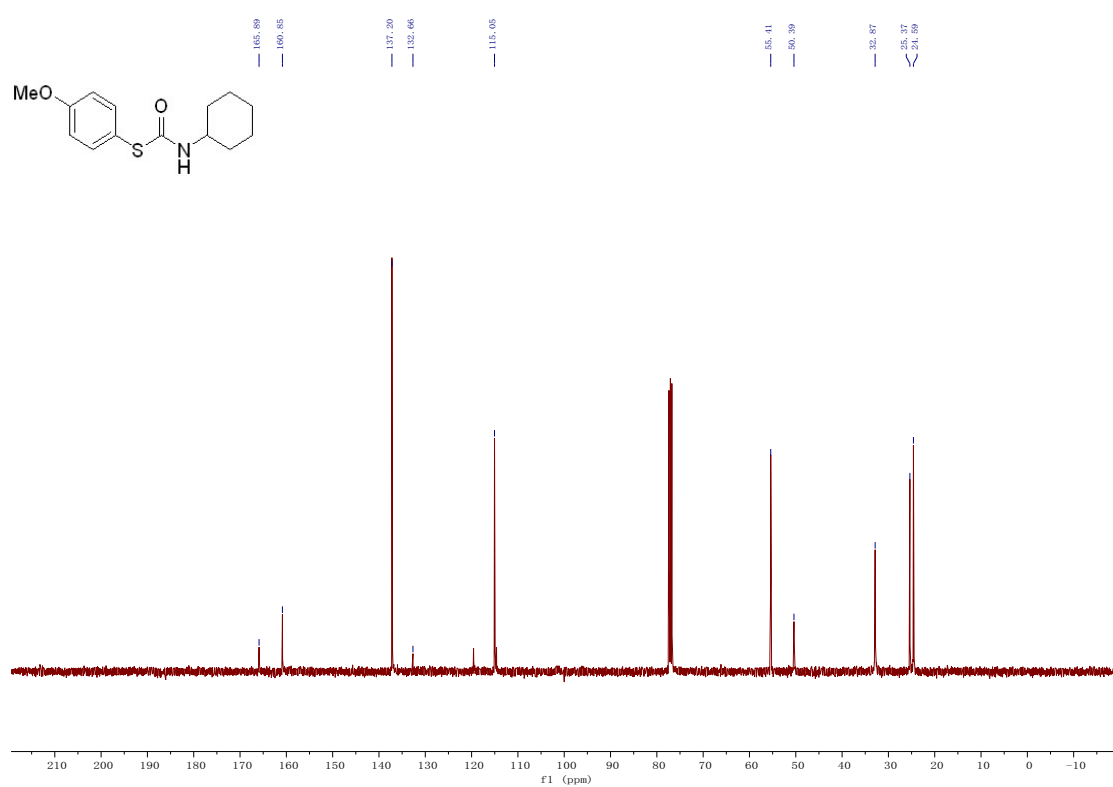
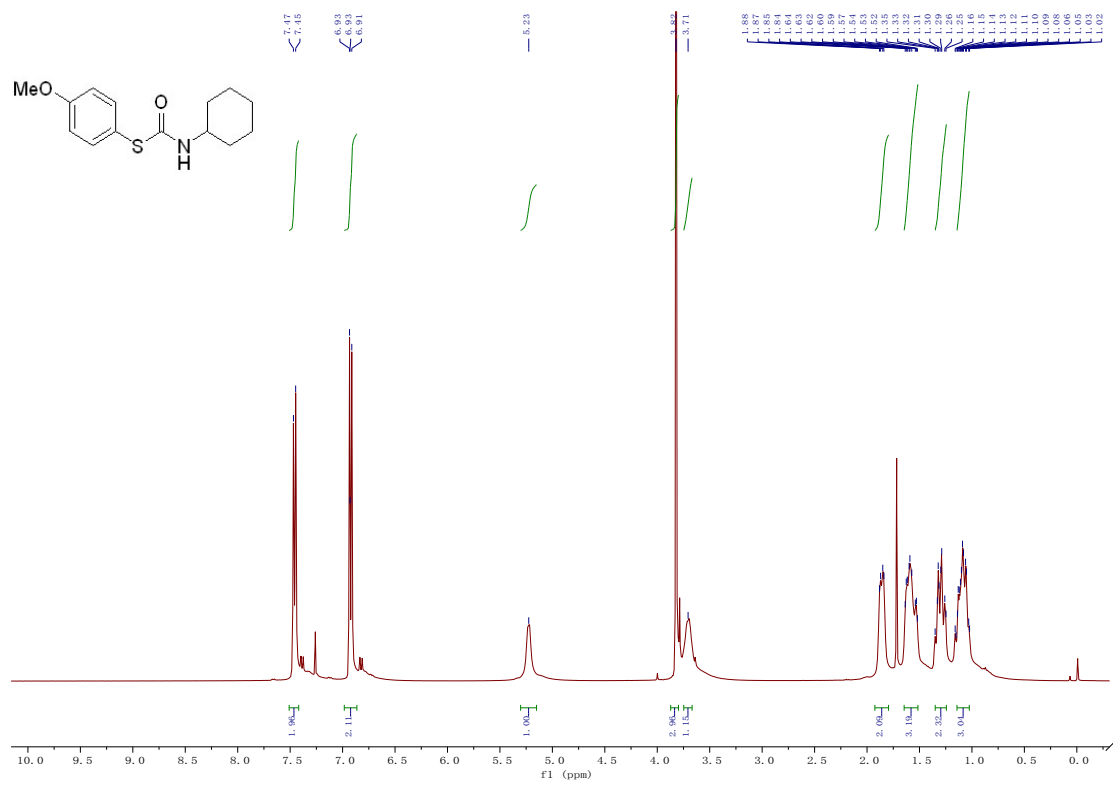
S-(*o*-tolyl) cyclohexylcarbamothioate (3ca)



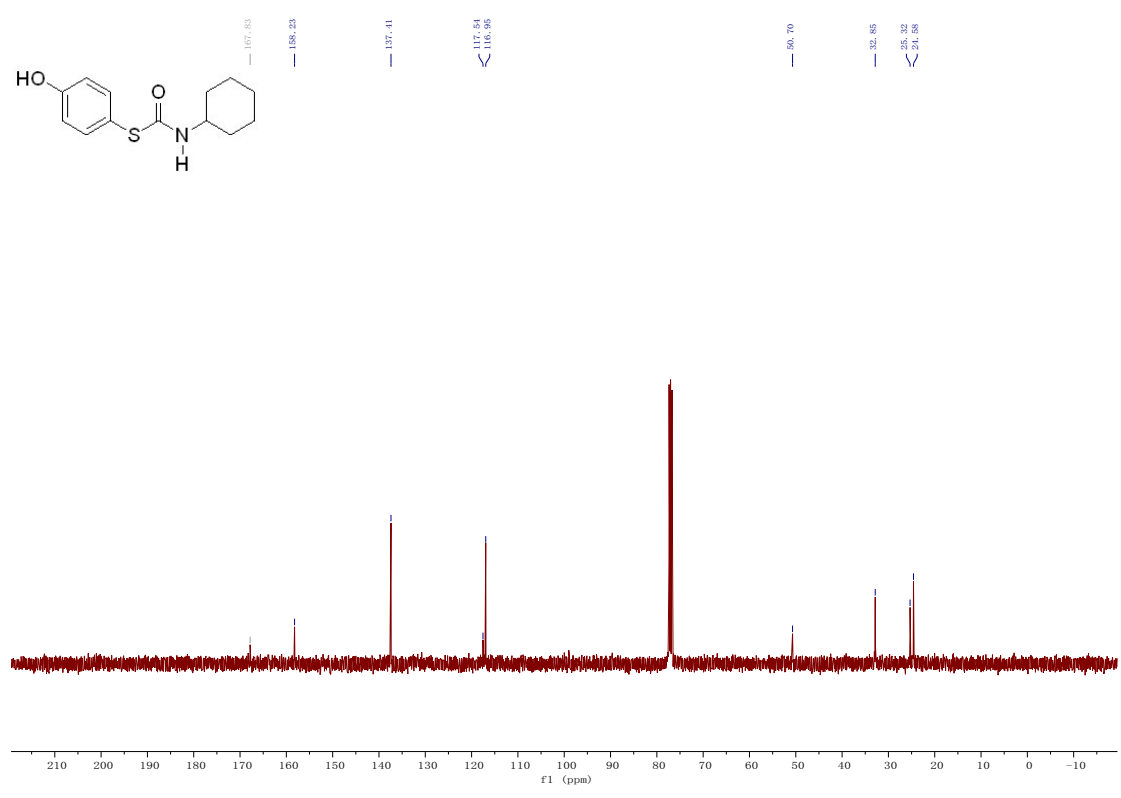
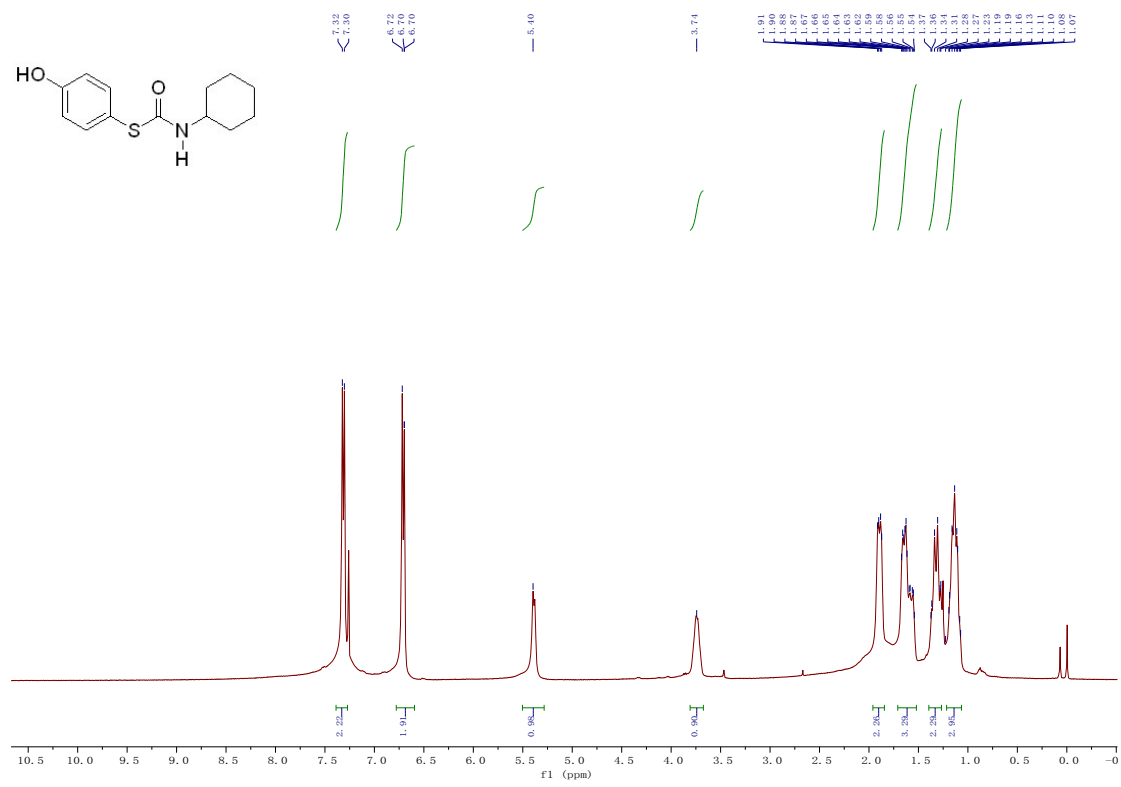
S-phenyl cyclohexylcarbamothioate (3da)



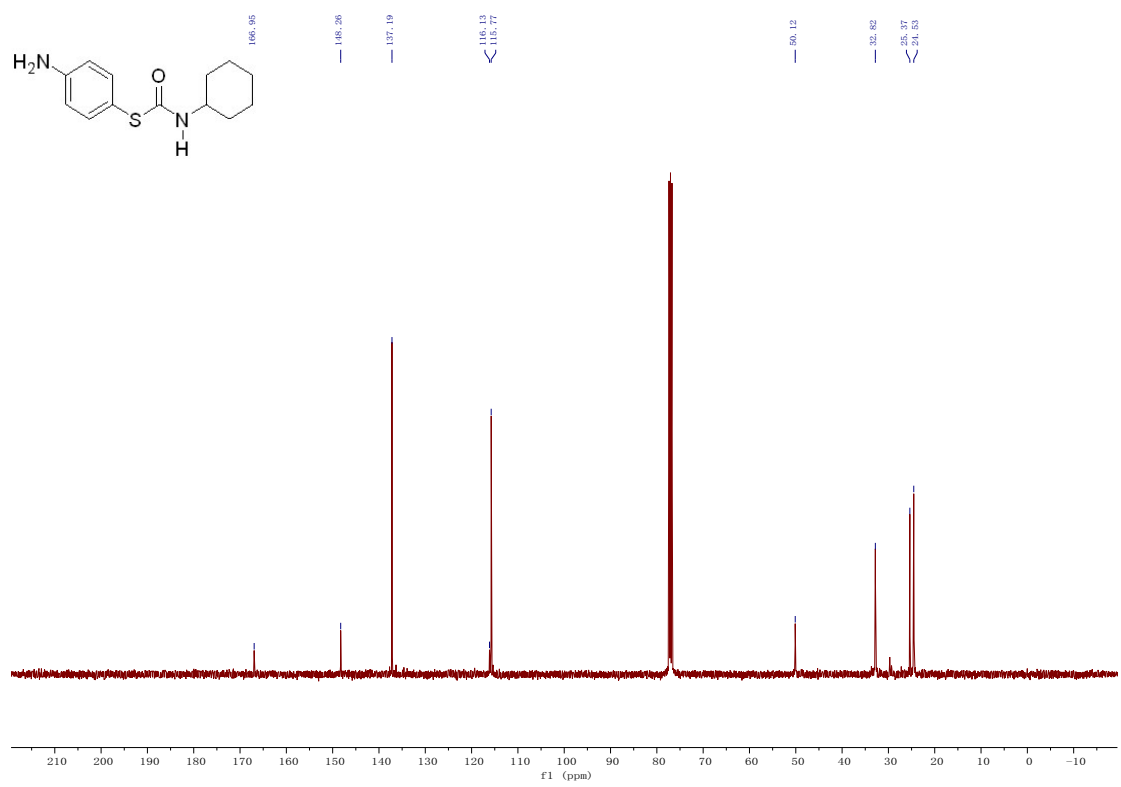
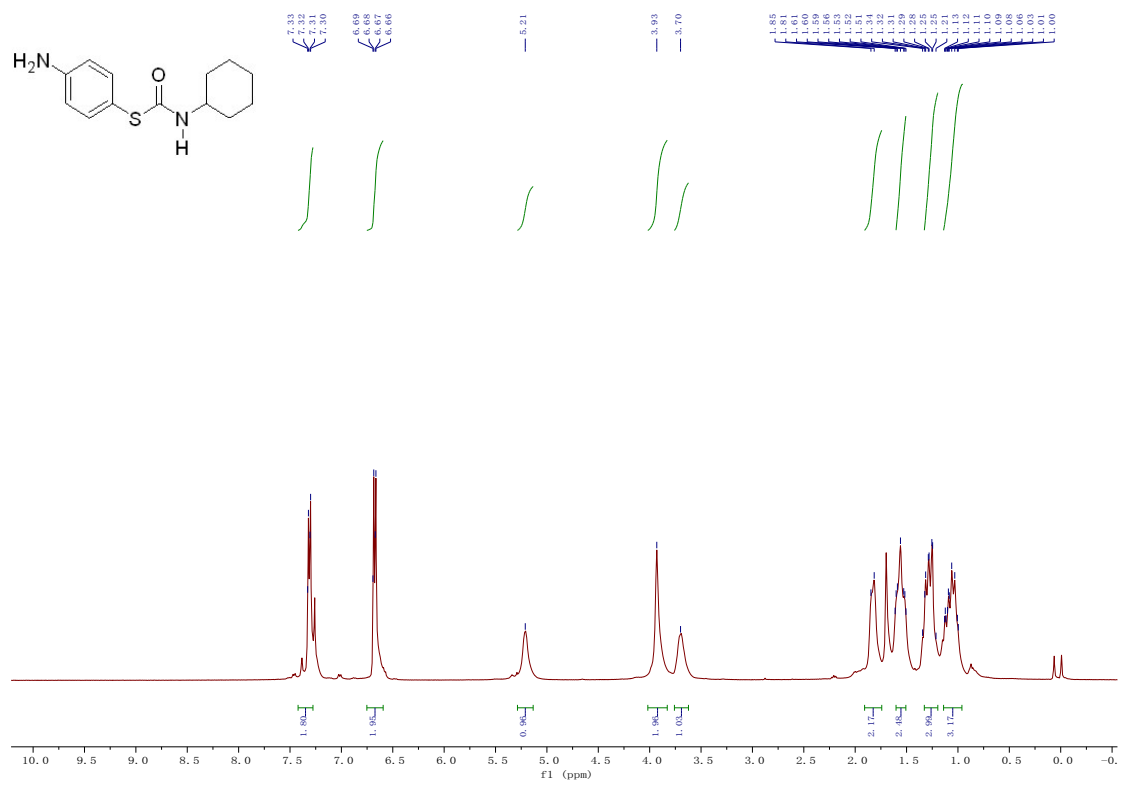
S-(4-methoxyphenyl) cyclohexylcarbamothioate (3ea)



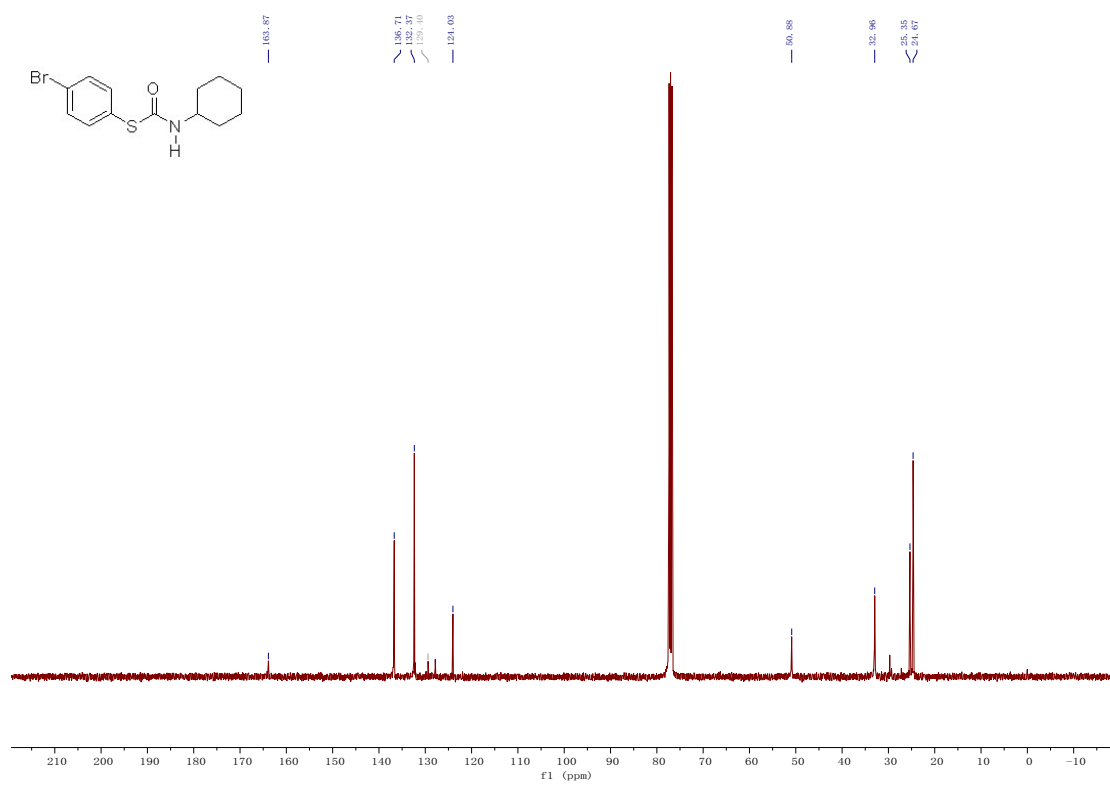
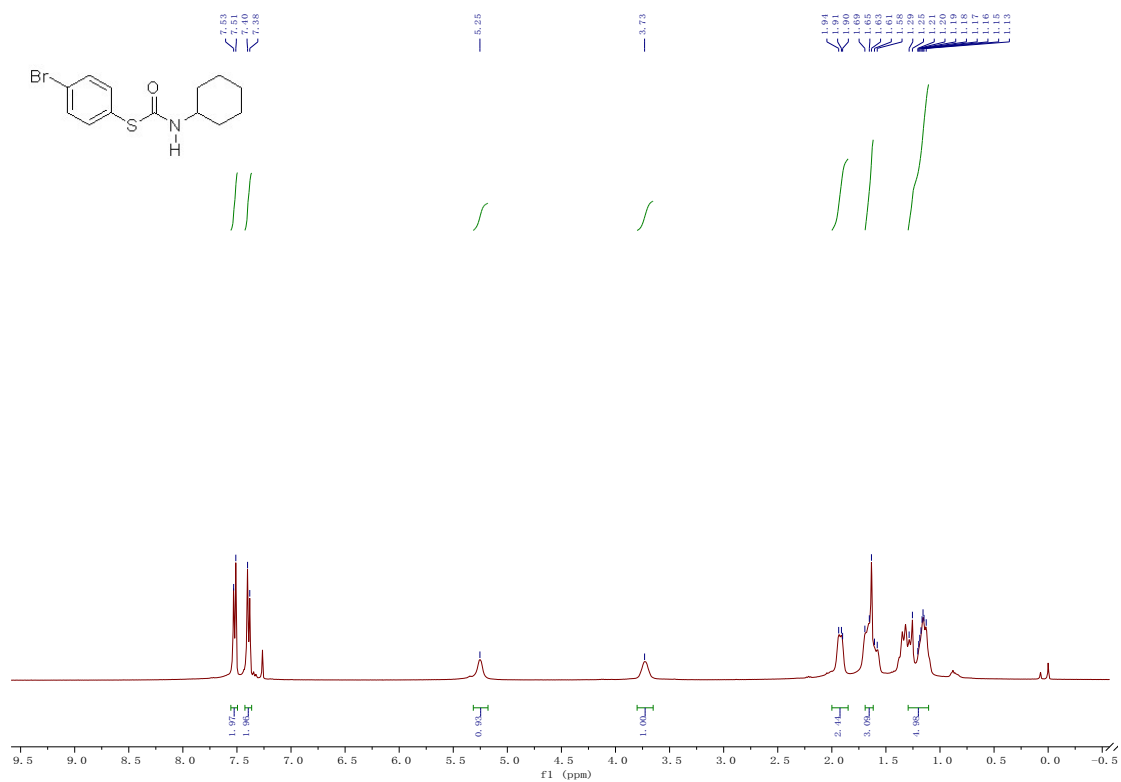
S-(4-hydroxyphenyl) cyclohexylcarbamothioate (3fa)



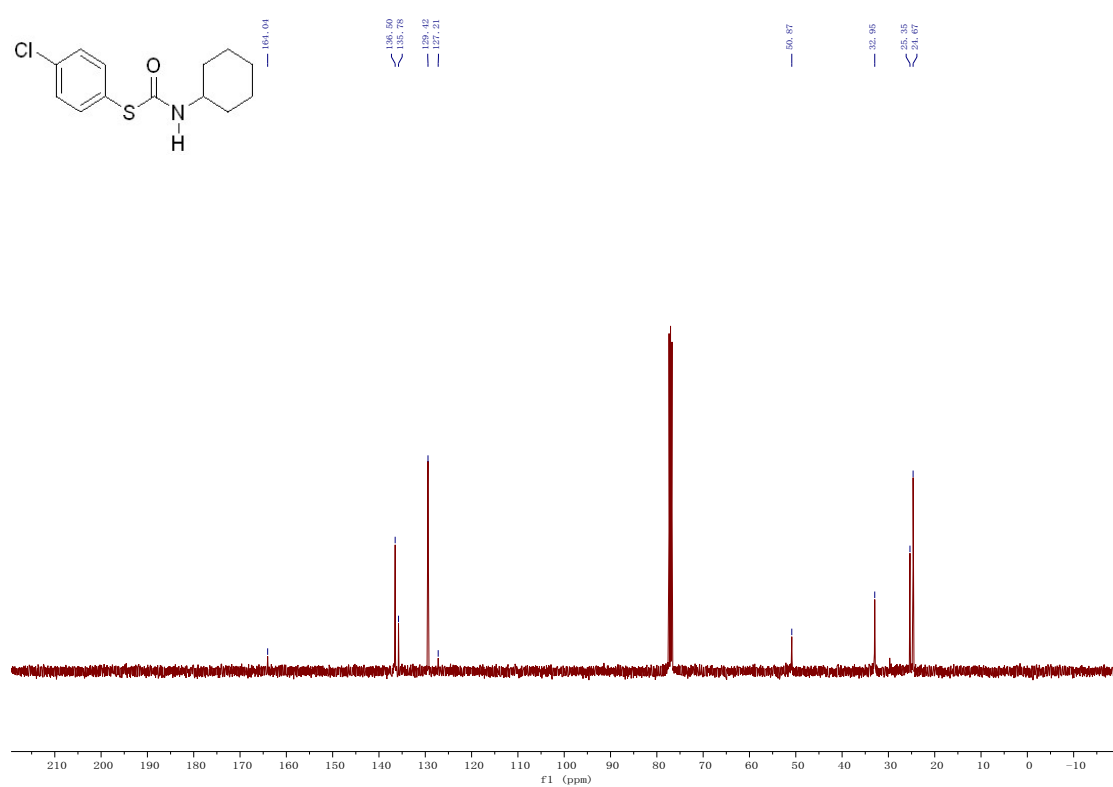
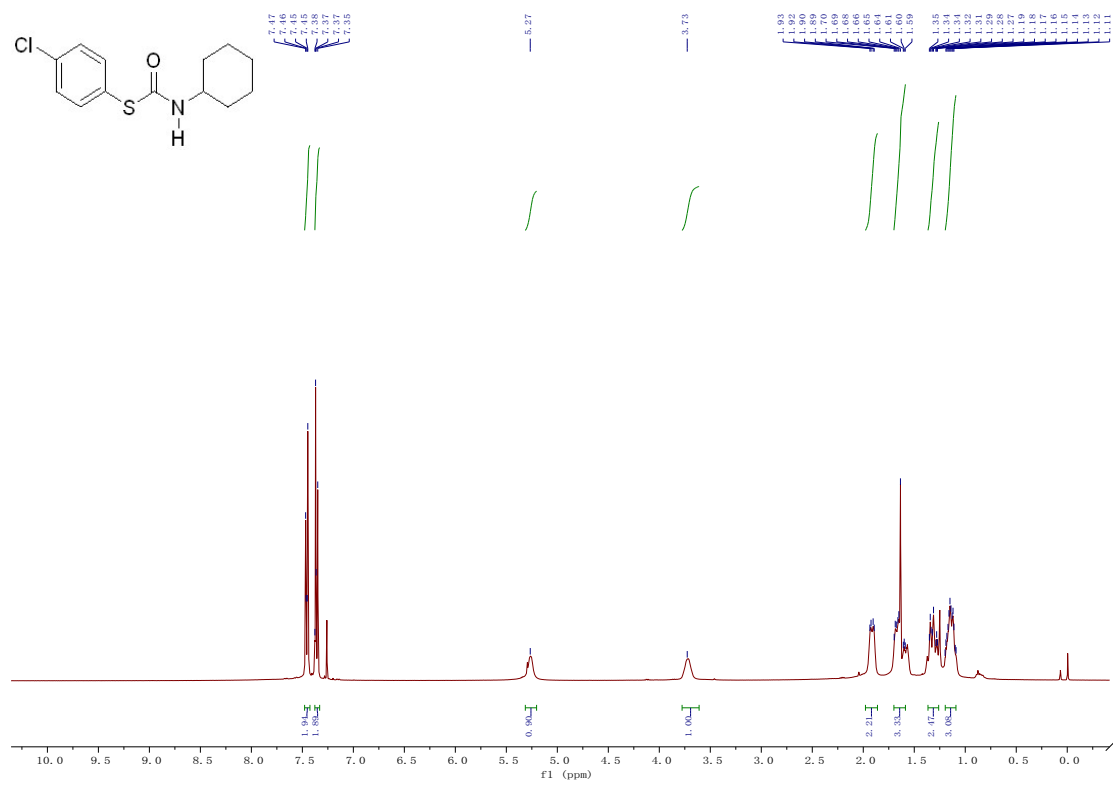
S-(4-(tert-butyl)phenyl) cyclohexylcarbamothioate (3ga)



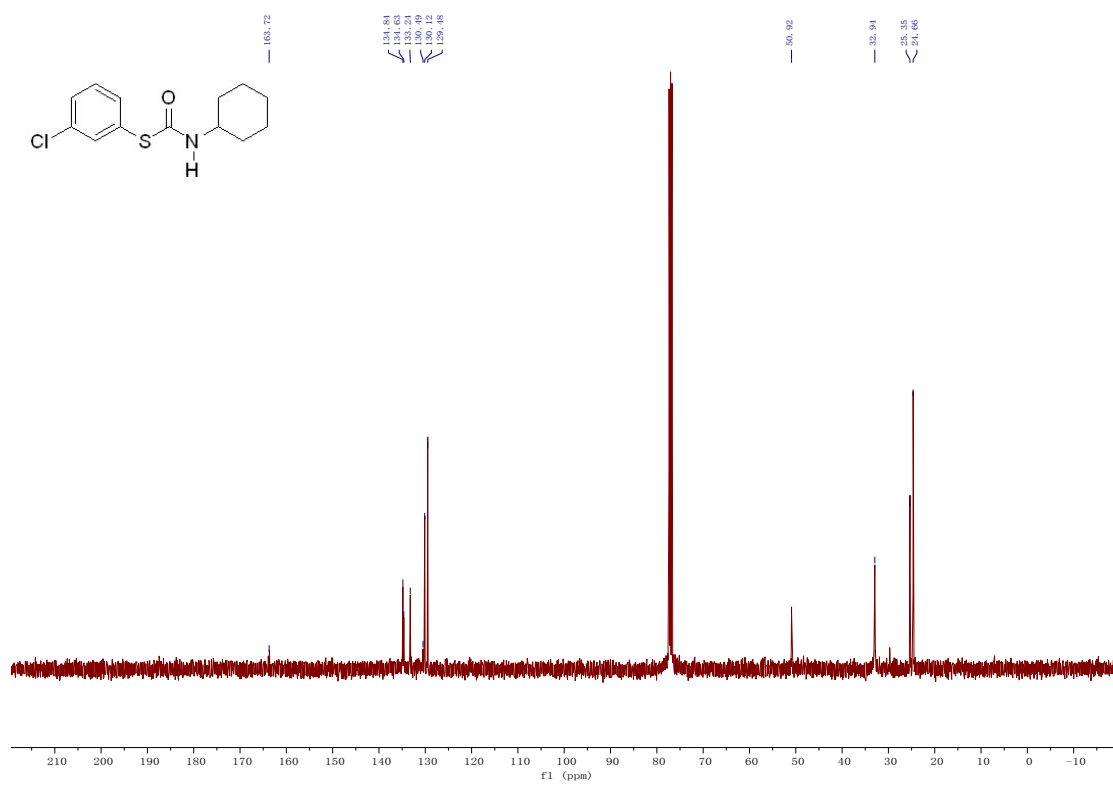
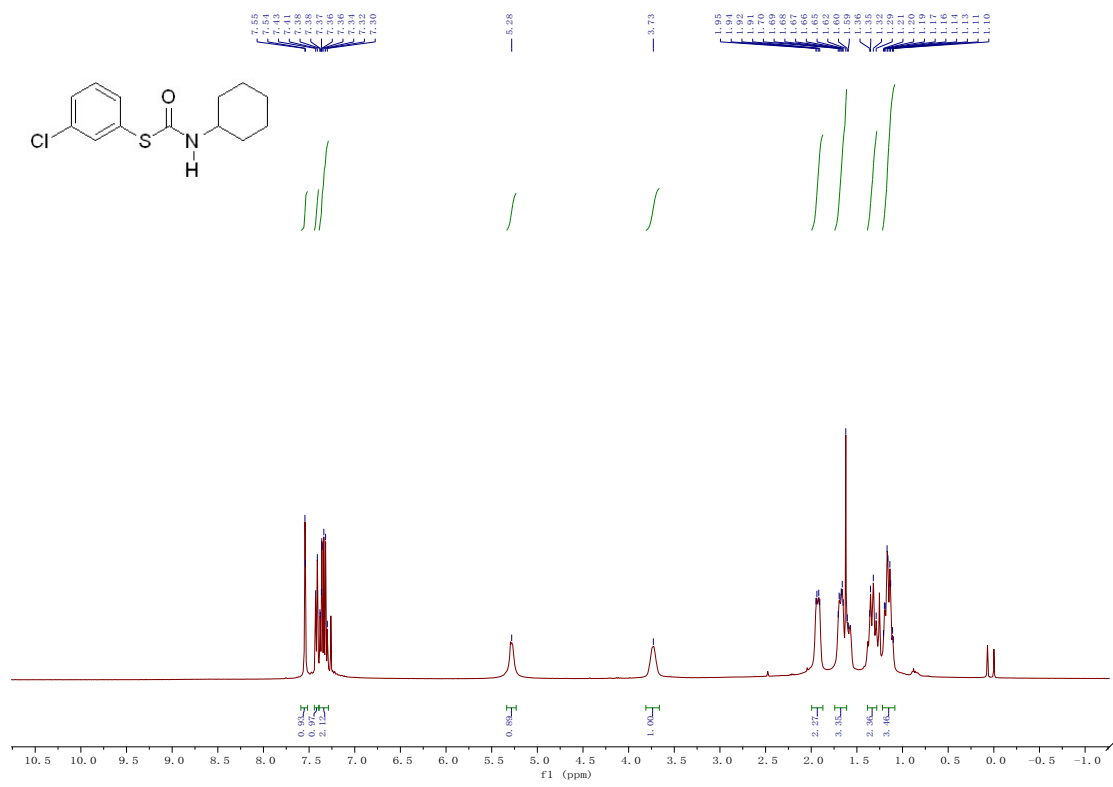
S-(4-bromophenyl) cyclohexylcarbamothioate (3ia)



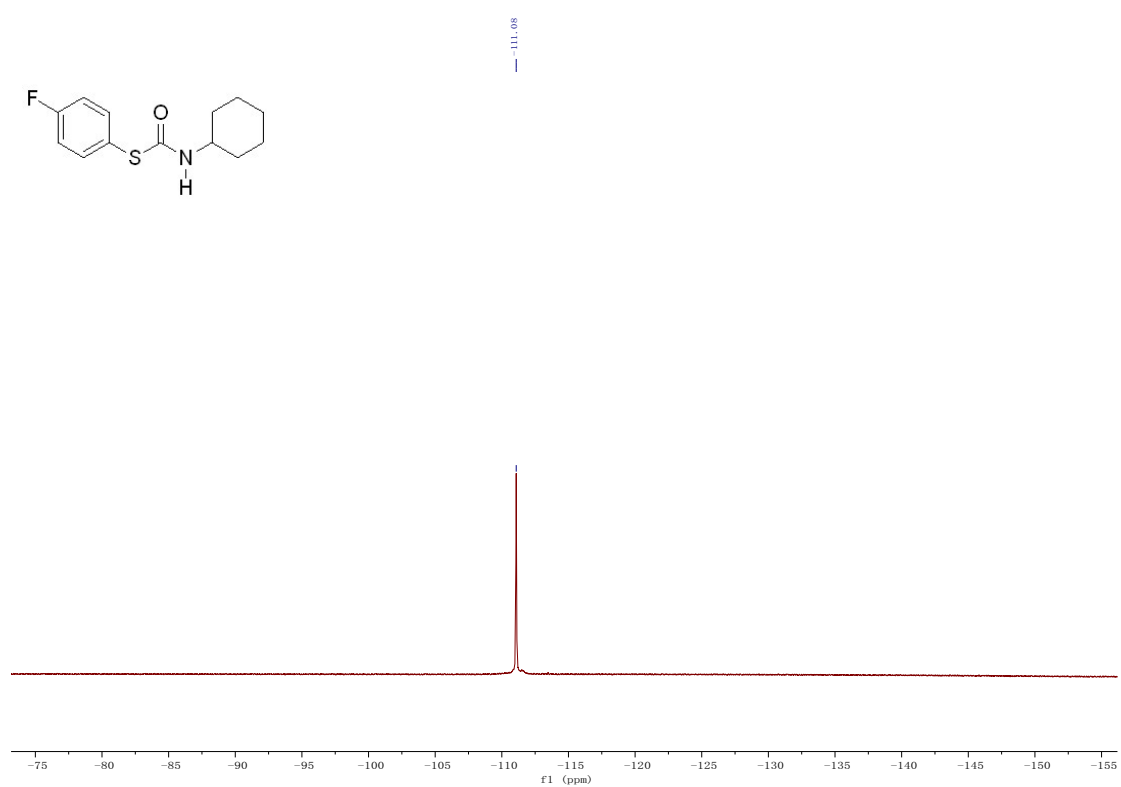
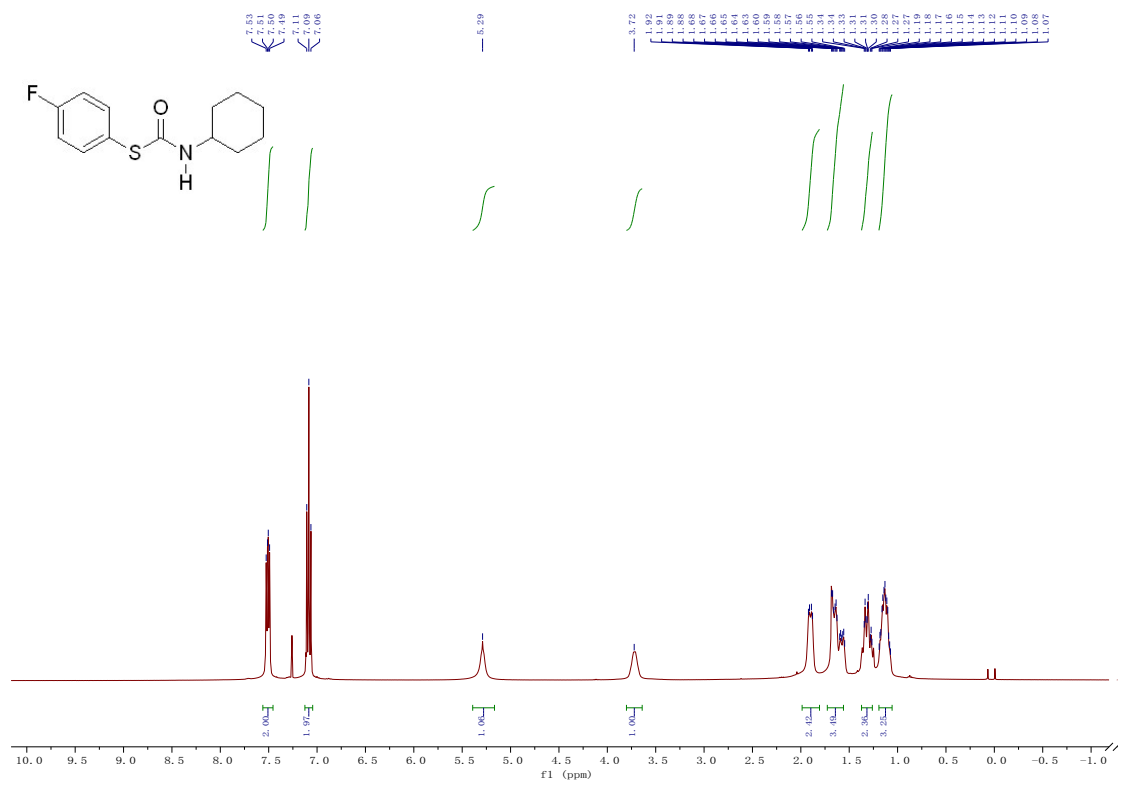
S-(4-chlorophenyl) cyclohexylcarbamothioate (3ja)

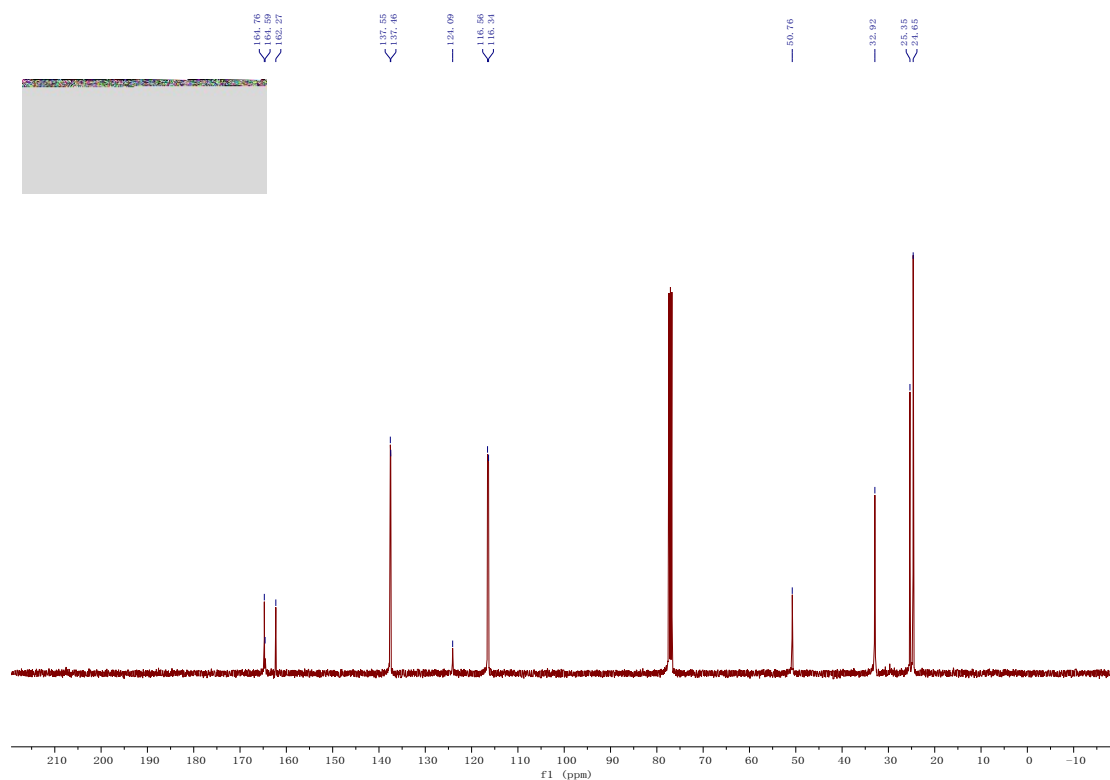


S-(3-chlorophenyl) cyclohexylcarbamothioate (3ka)

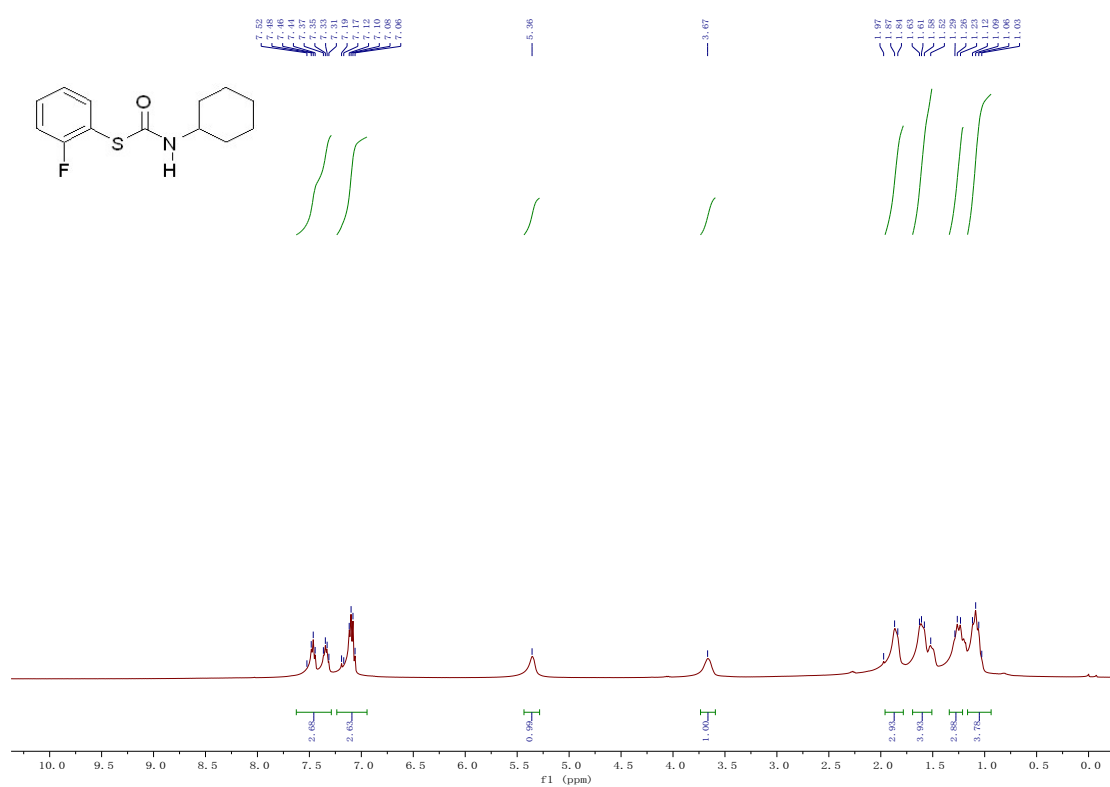


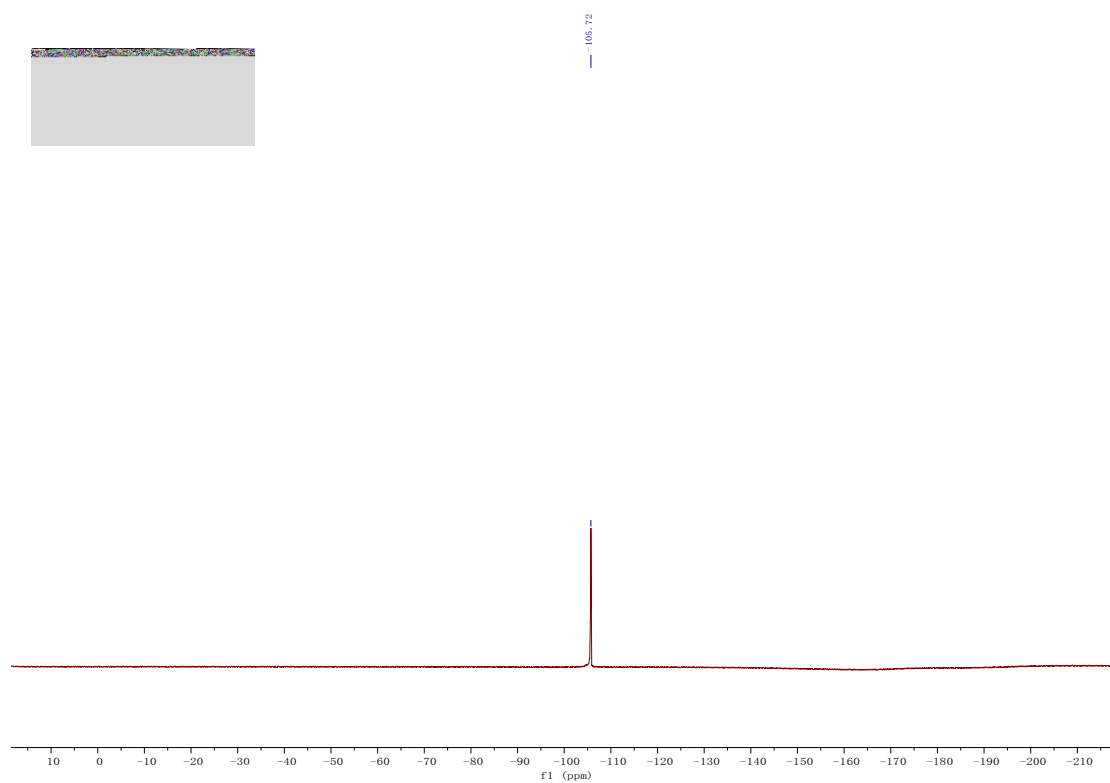
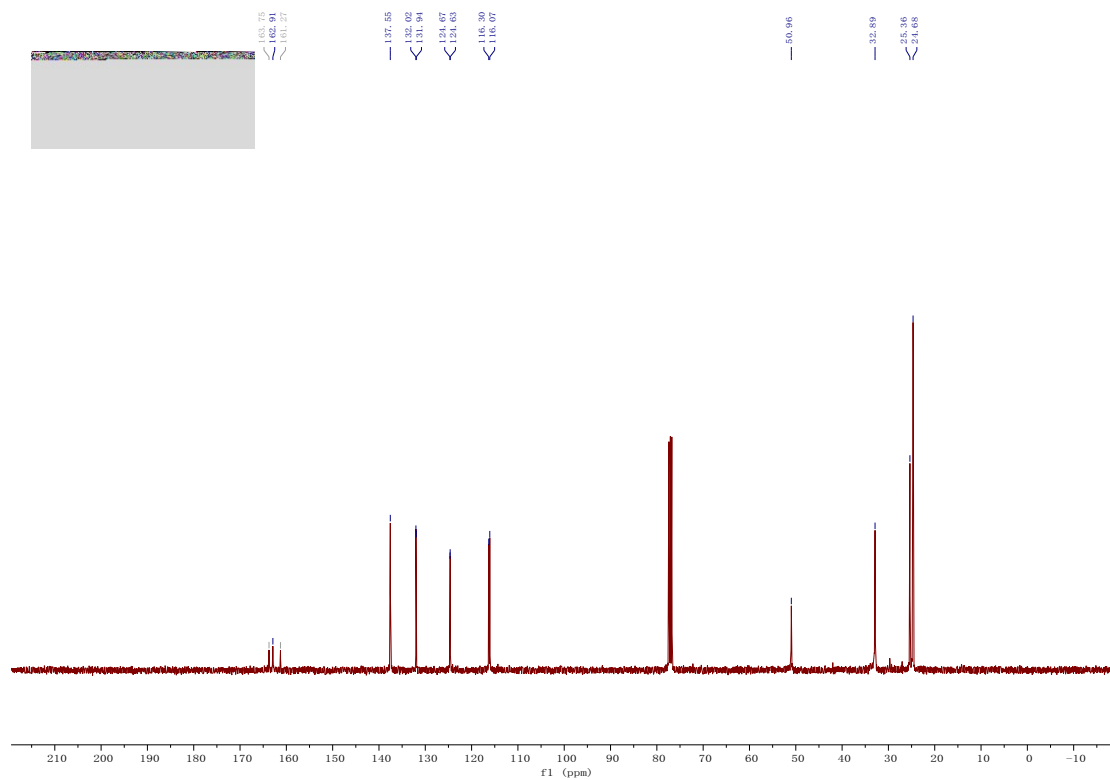
S-(4-fluorophenyl) cyclohexylcarbamothioate (3la)



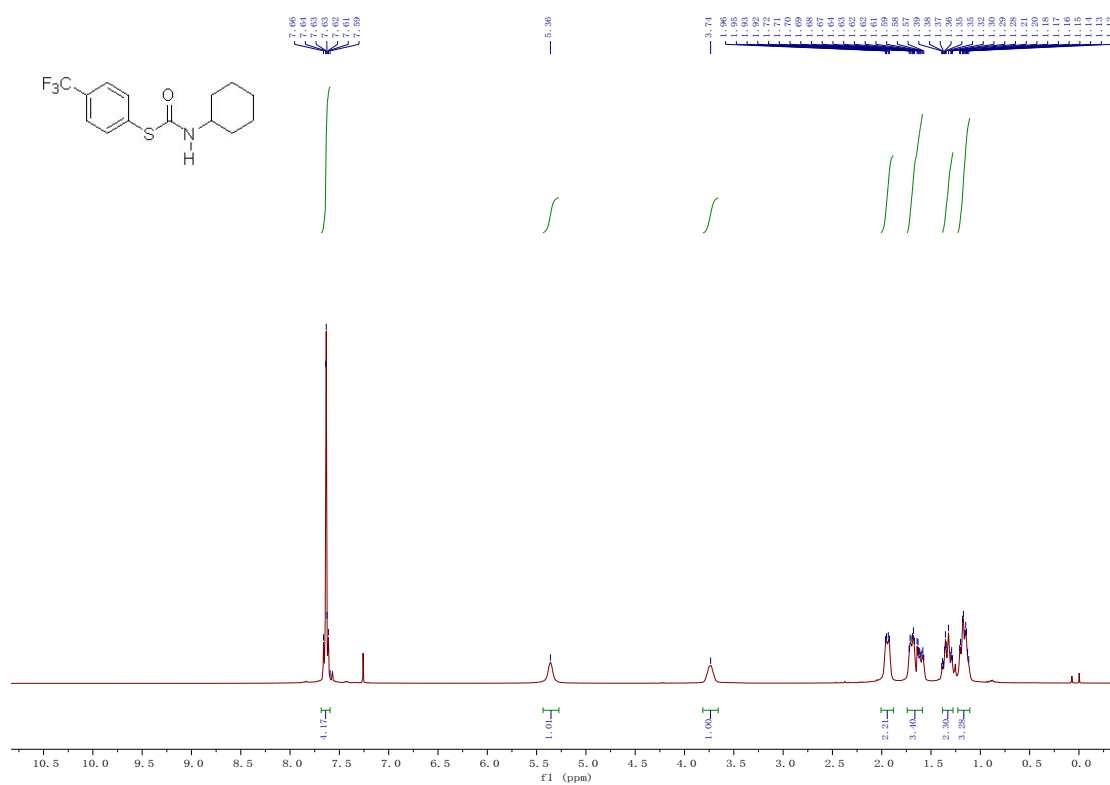
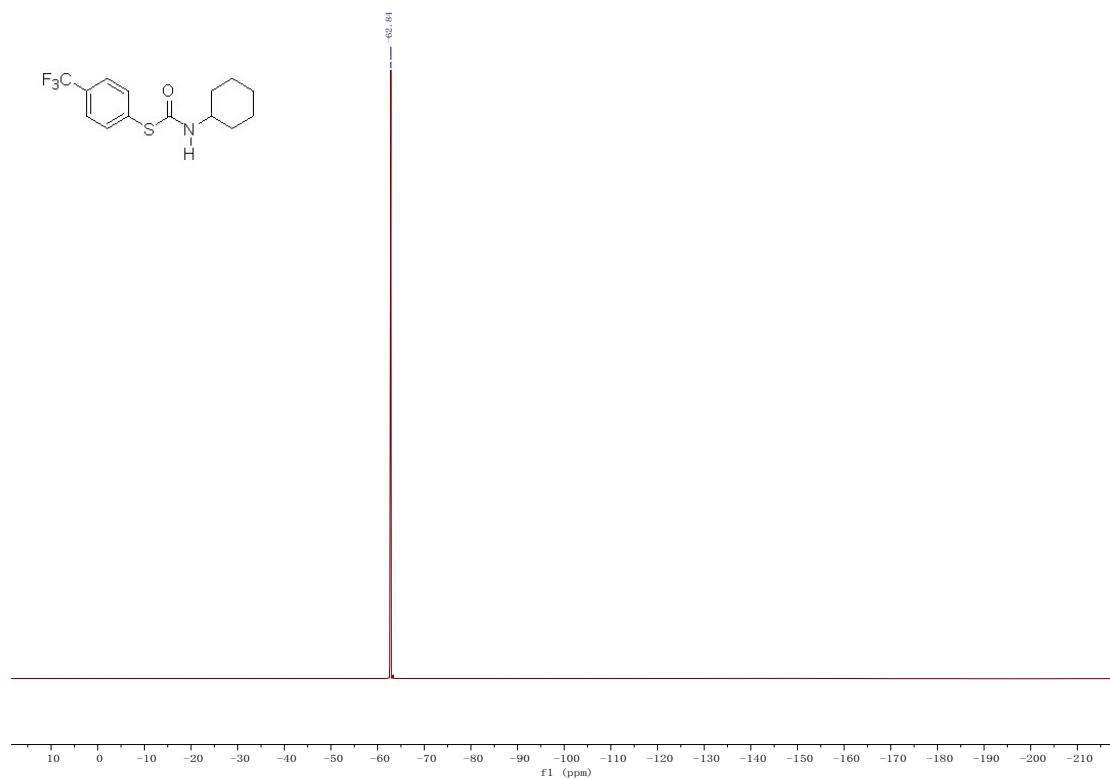


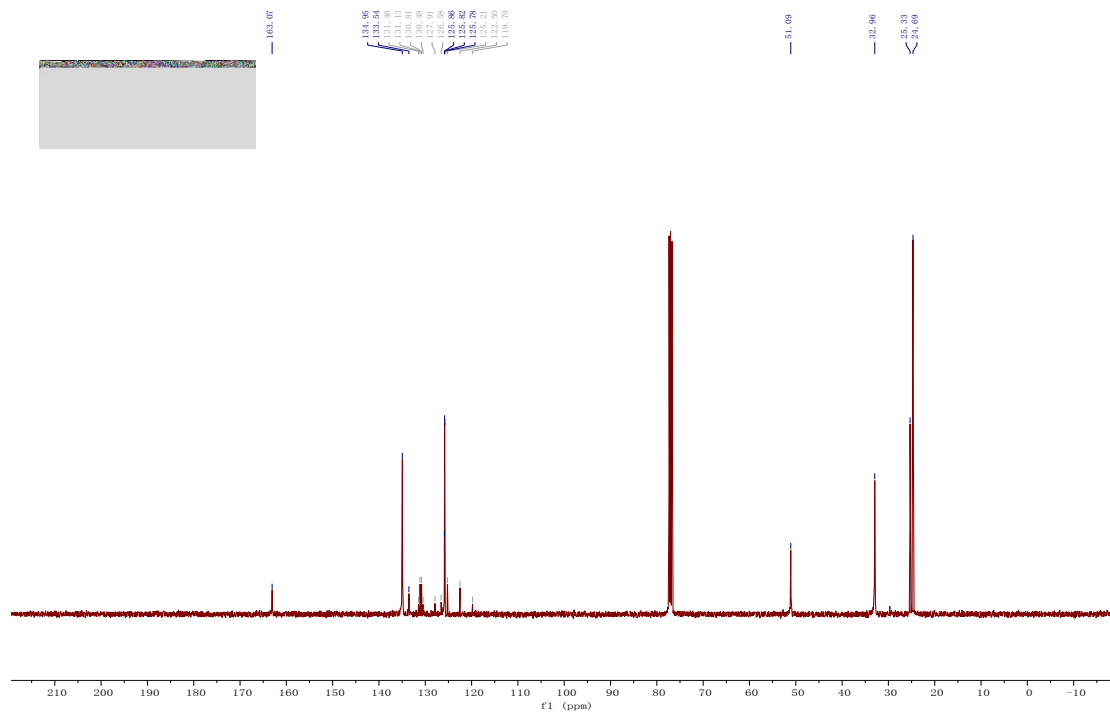
S-(2-fluorophenyl) cyclohexylcarbamothioate (3ma)



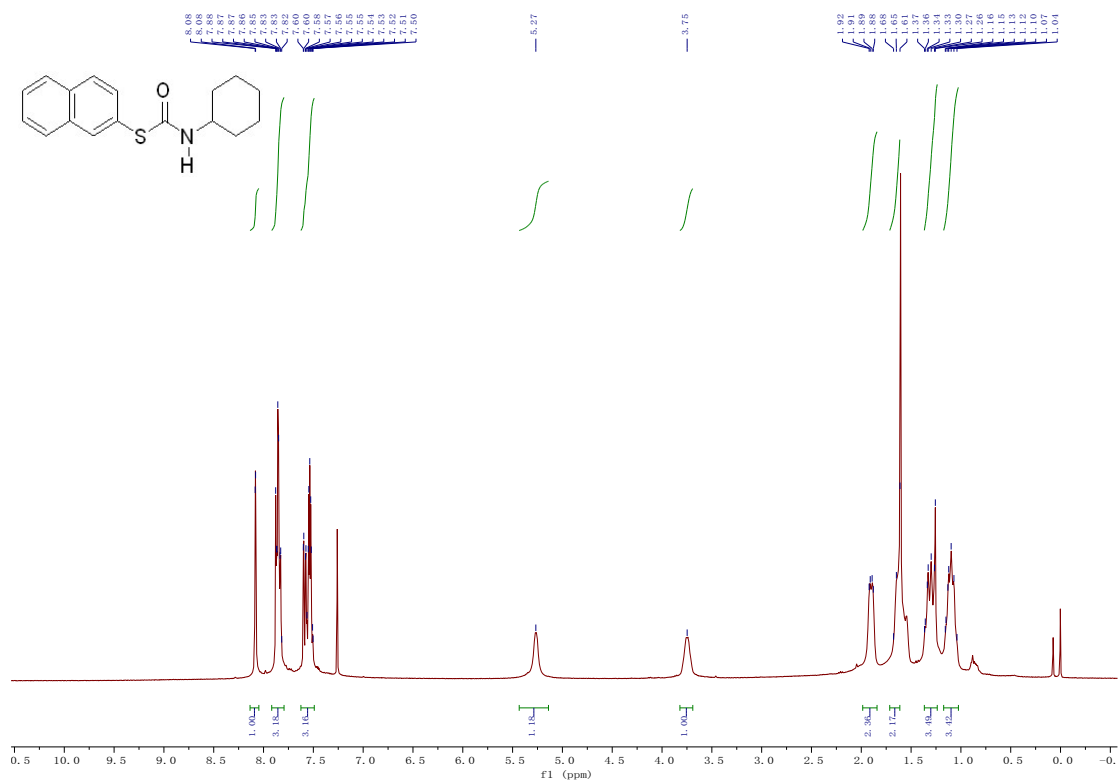


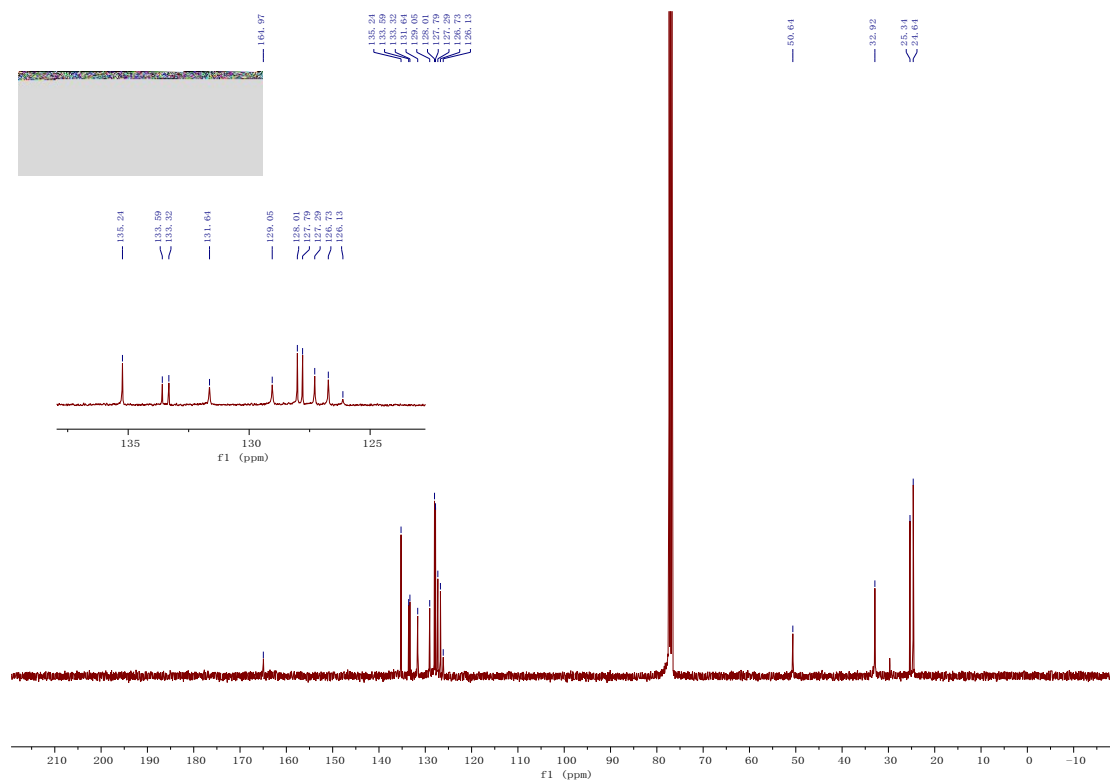
S-(4-(trifluoromethyl)phenyl) cyclohexylcarbamothioate (3na)



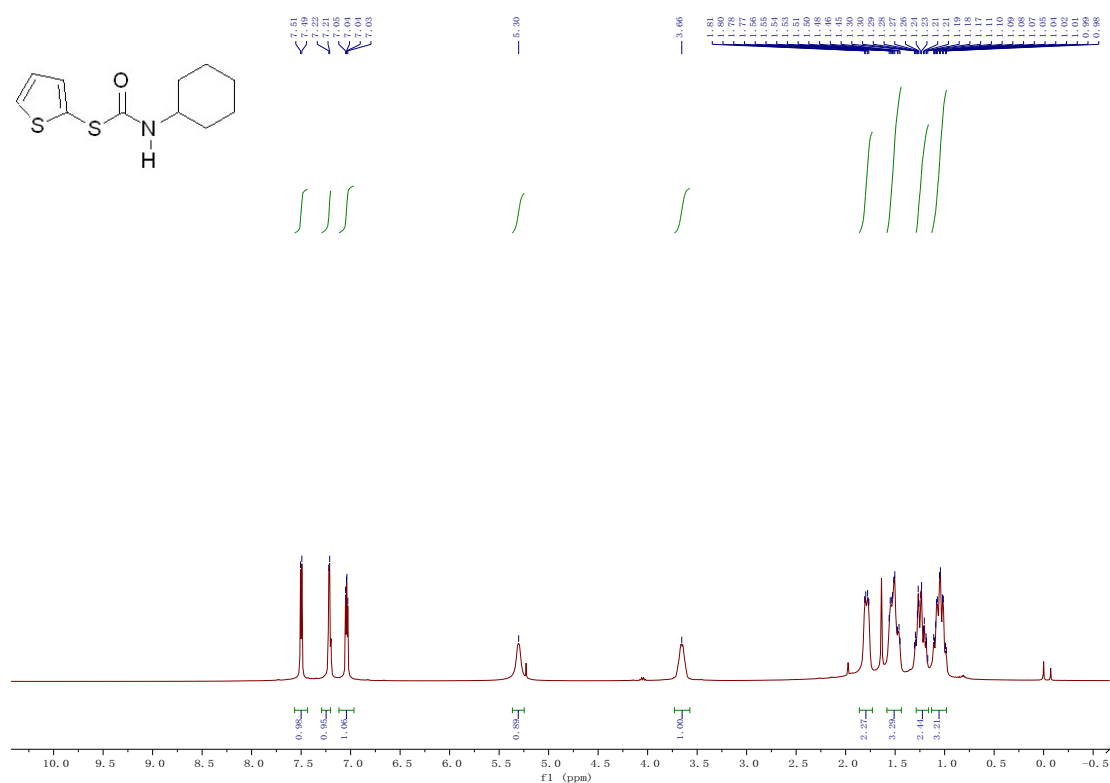


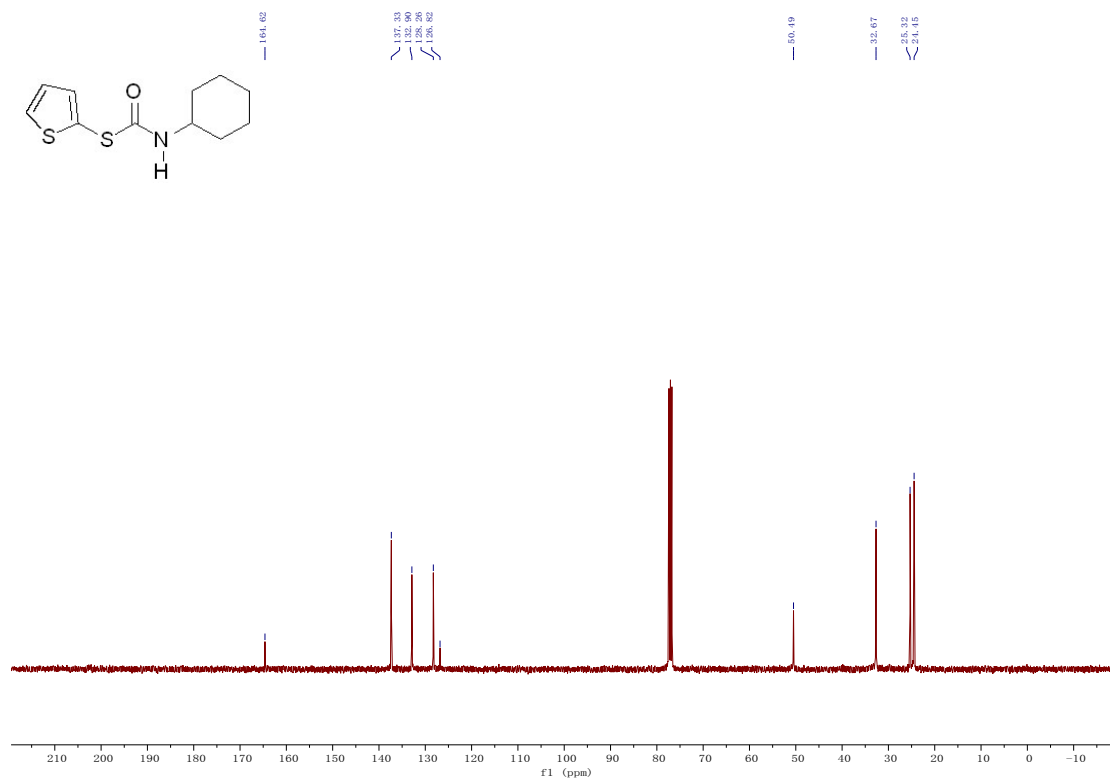
S-(naphthalen-2-yl) cyclohexylcarbamothioate (30a)



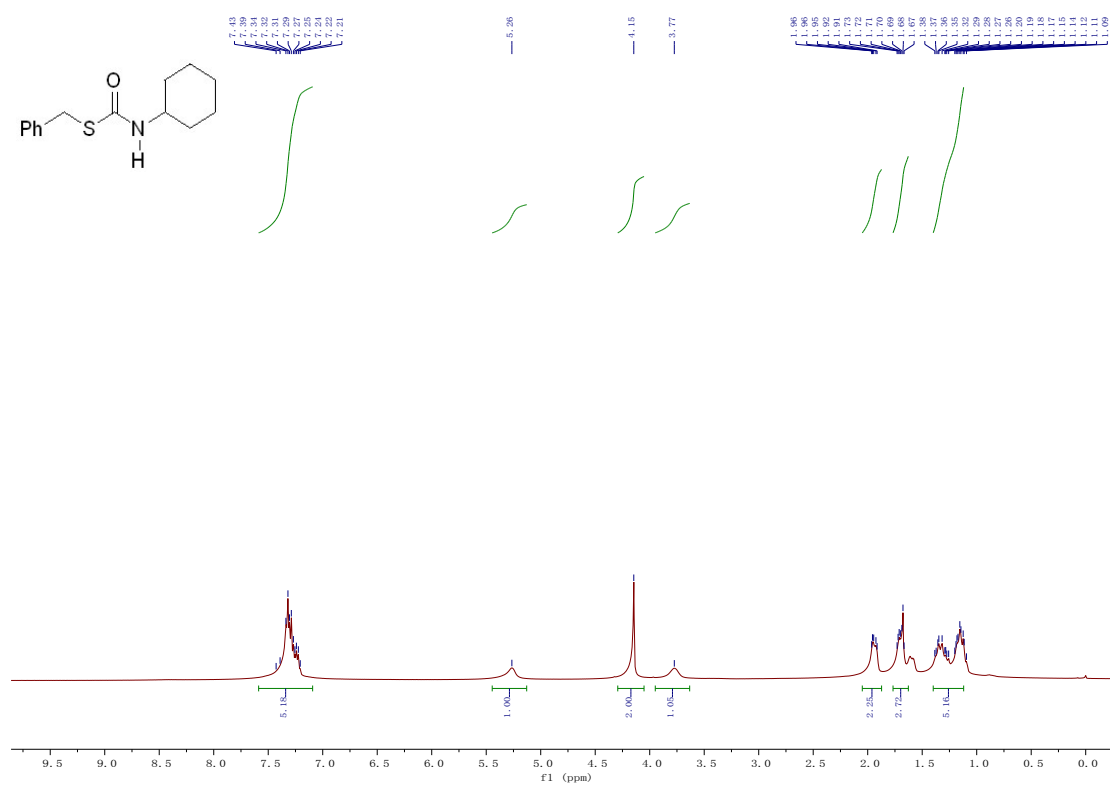


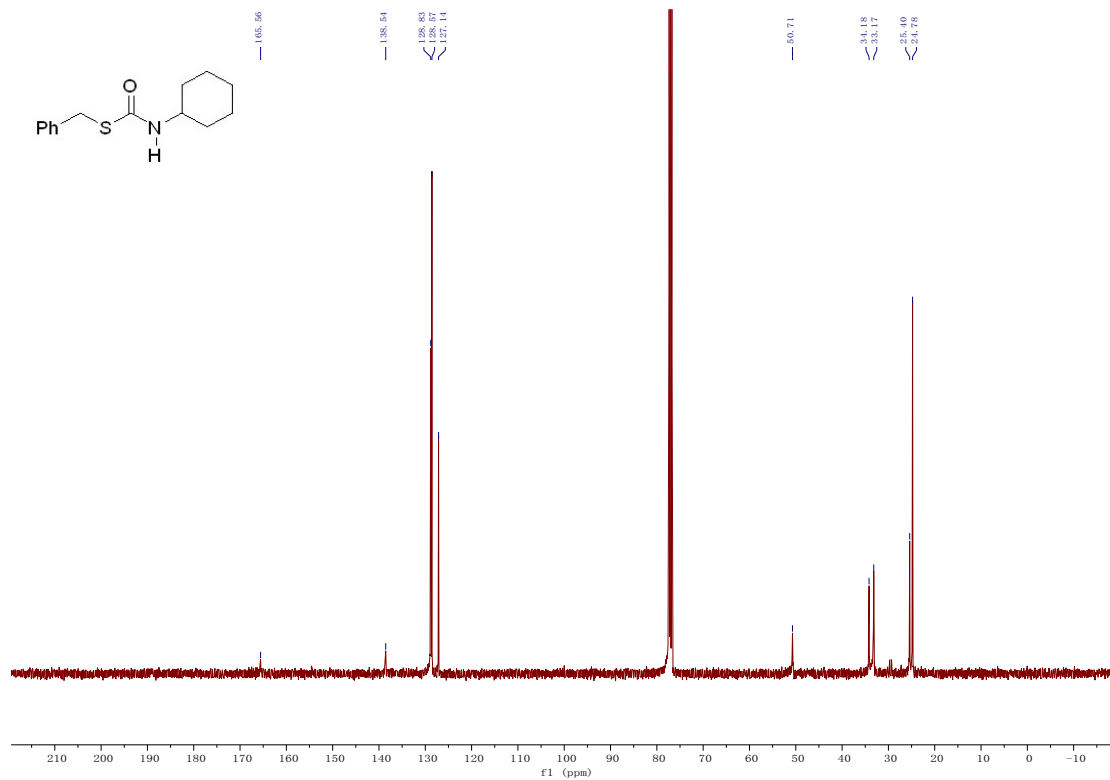
S-(thiophen-2-yl) cyclohexylcarbamothioate (3pa)



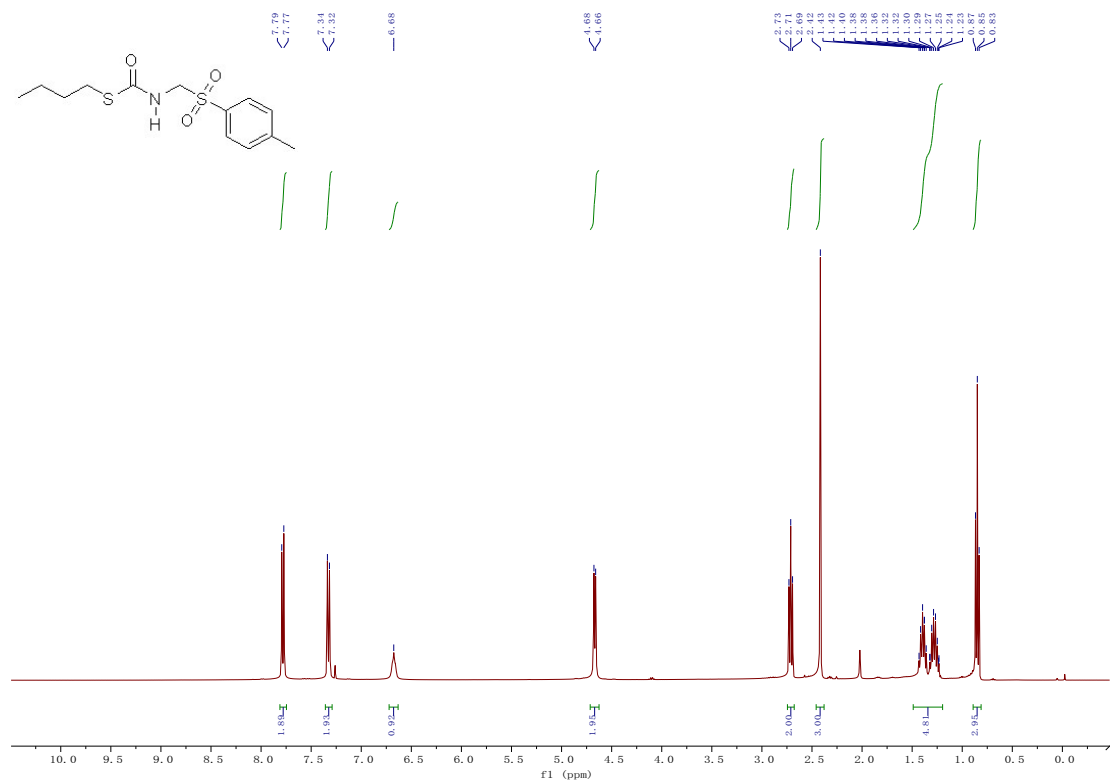


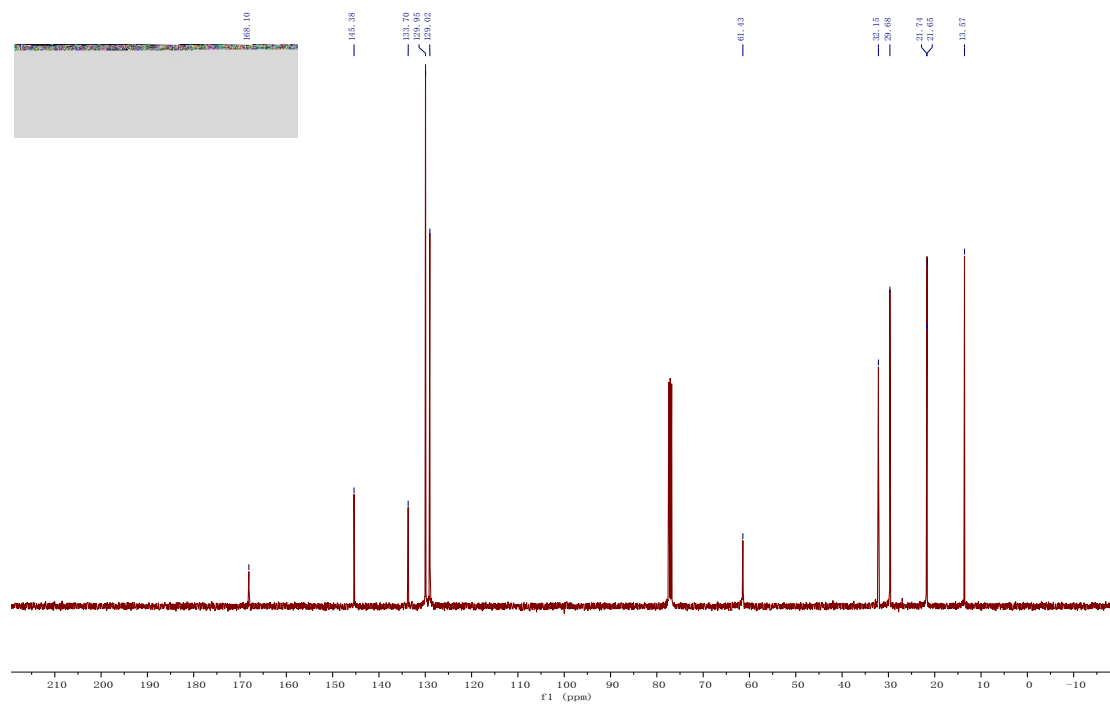
S-benzyl cyclohexylcarbamothioate (3ra)



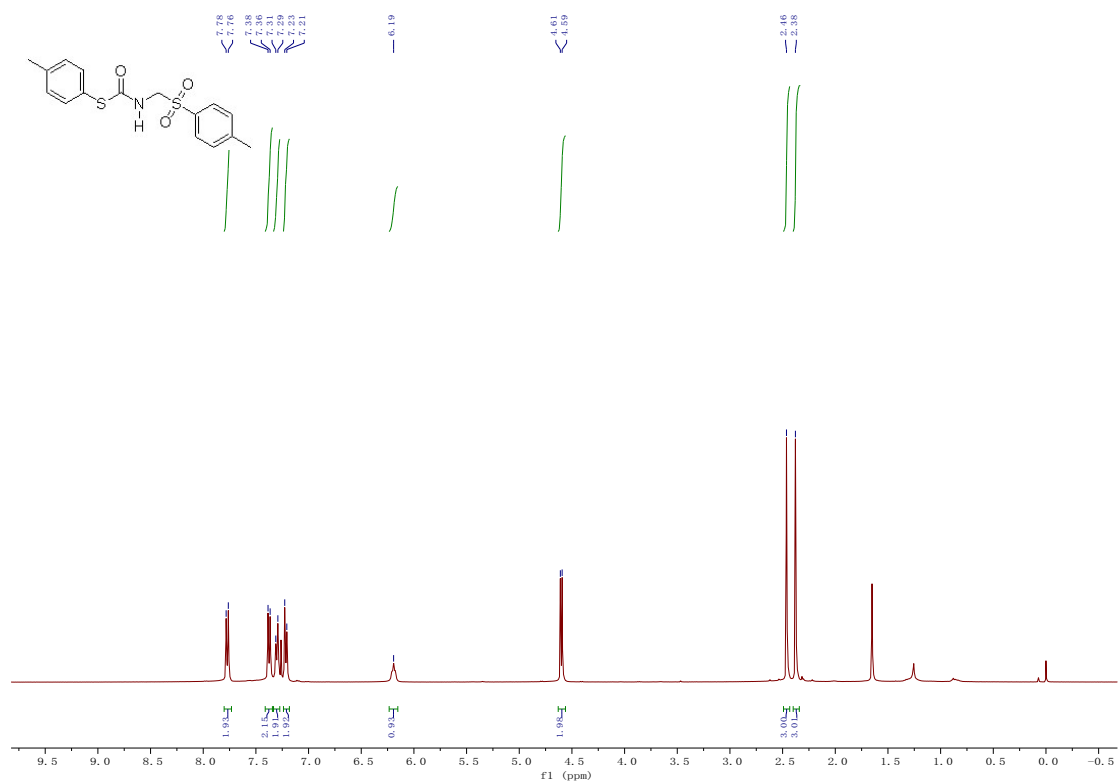


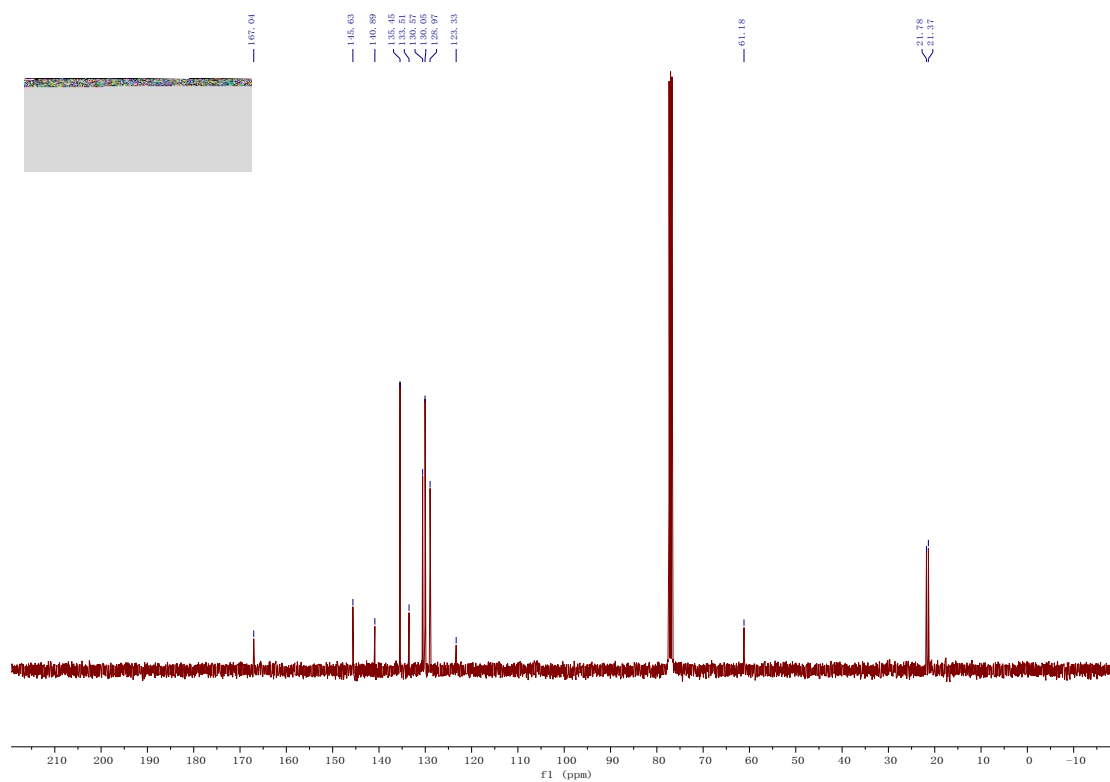
S-butyl (tosylmethyl)carbamothioate (3sb)



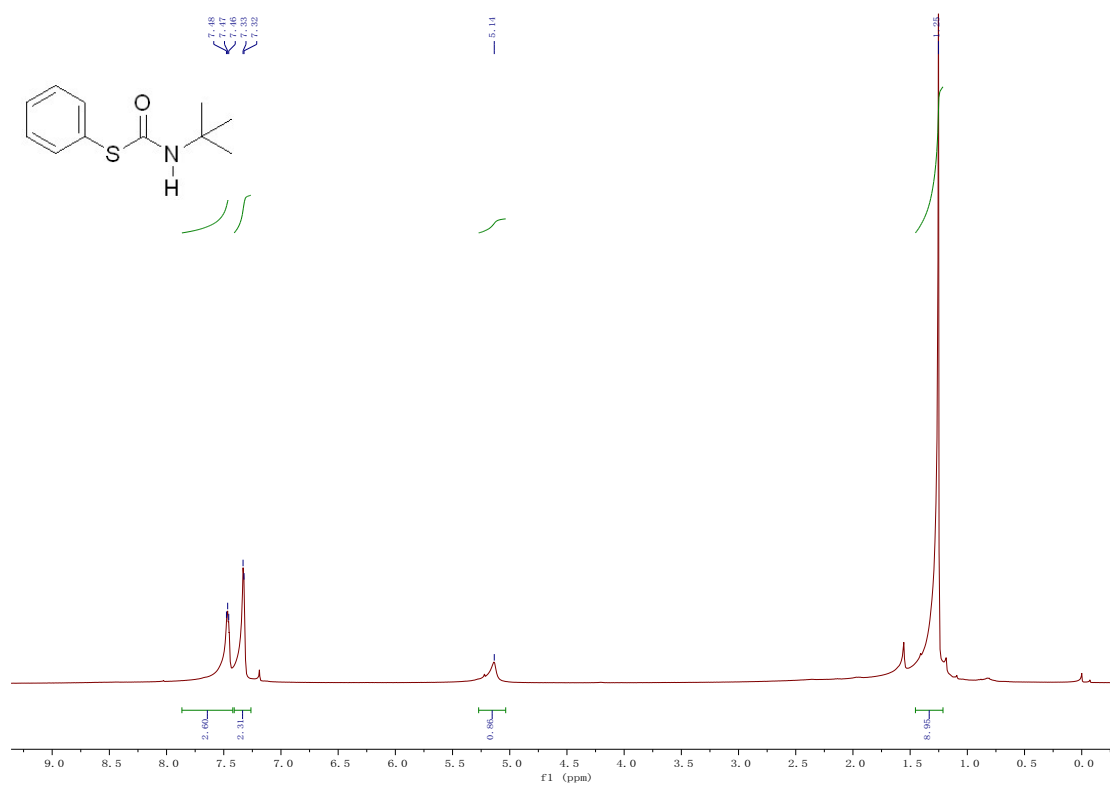


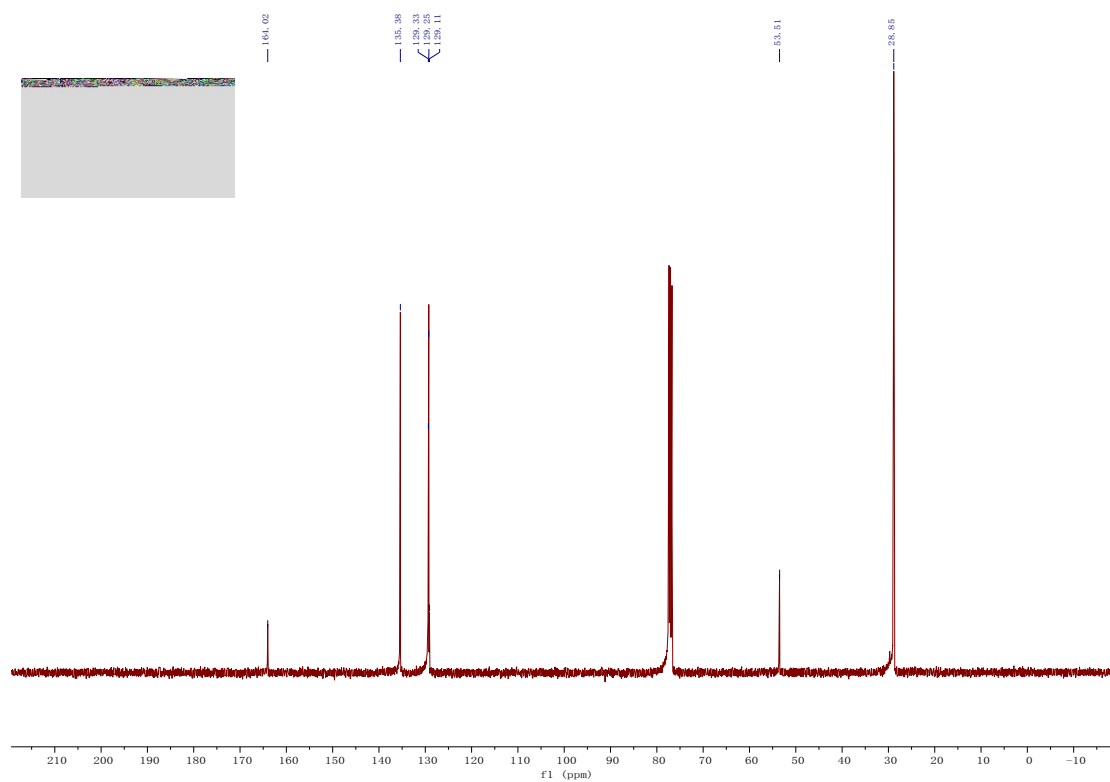
S-phenyl (tosylmethyl)carbamothioate (3db)



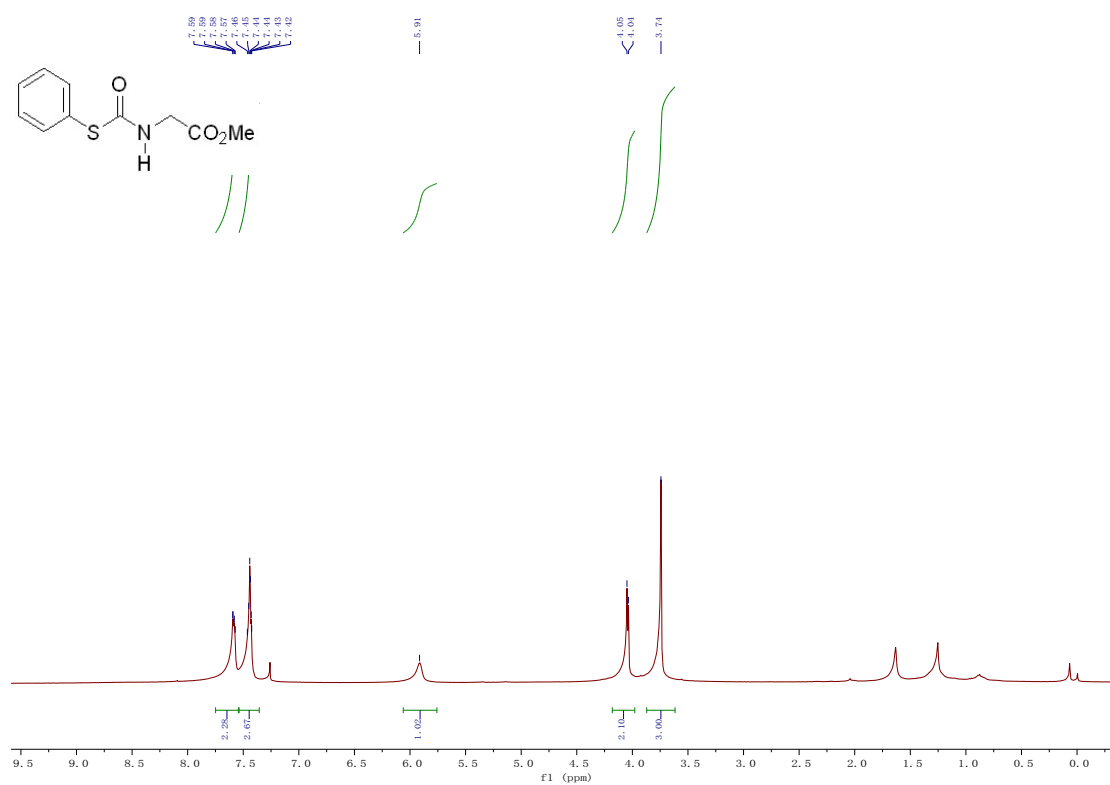


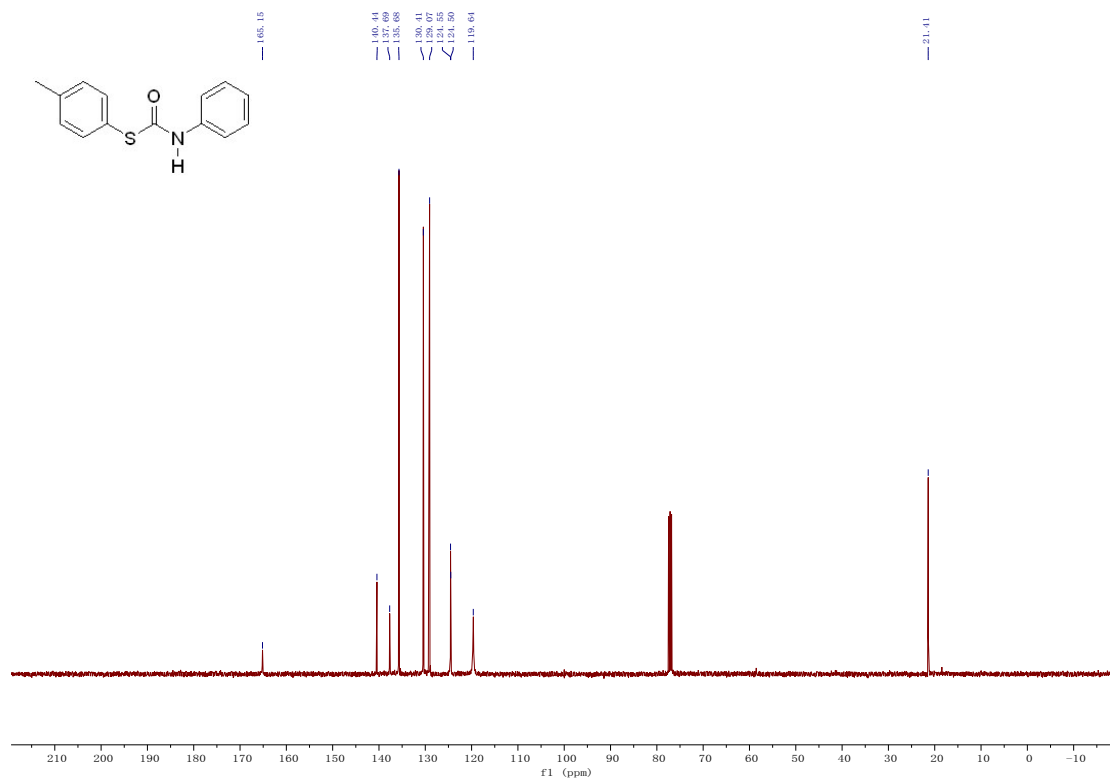
S-phenyl tert-butylcarbamothioate (3dc)





Methyl ((phenylthio)carbonyl)glycinate (3dd)





N-cyclohexylbenzo[d]thiazol-2-amine (4a)

