Supporting Information

Formal [4+1] Cyclization of (Thio/Imido)Hydrazides and Ethyl 3,3,3-Trifluoropropanoate: Unified Synthesis of 1,3,4-Oxadiazoles, 1,3,4-Thiadiazoles and 1,2,4-Triazoles

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List of Contents

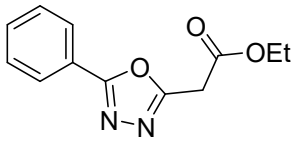
1. General Information

All the reactions were carried out using oven-dried glassware. All the substrates and solvents for the synthesis of compounds were purchased from commercial source (Aladdin, Alfa, Macklin) and used as received without any further purification. All the hydrazides,[1] thiohydrazides[2] and imidohydrazides[3] were synthesized using earlier reported methods. Thin layer chromatography was performed on plates (GF254) supplied by Yantai Chemicals (China) and visualization was accomplished using UV-light, iodine stains or potassium permanganate solution. Silica gel (200-300 mesh) supplied by Tsingdao Haiyang Chemicals (China) was used for column chromatography purification with a hexane−ethyl acetate mixture as eluent. All ^{1}H, ^{13}C and ^{19}F NMR spectra were recorded in $CDCl_3$ or DMSO-d_6 at RT on Bruker spectrometers (400 MHz, 500 MHz, 600 MHz). Chemical shifts were reported in parts per million (ppm), and the residual solvent peak was used as an internal reference: proton ($CDCl_3$: δ 7.26, DMSO-d_6: δ 2.50), carbon ($CDCl_3$: δ 77.16, DMSO-d_6: δ 39.52) or tetramethylsilane (TMS δ 0.00) was used as a reference. Multiplicity was indicated as follows: s (singlet), d (doublet), t (triplet), q (quartet), m (multiplet), dd (doublet of doublet), dtd (doublet of triplet of doublets), ddq (doublet of doublets of quartets), sext (sextet), brs (broad singlet). Coupling constants were reported in Hertz (Hz). High-resolution mass spectra (HRMS) were recorded by ESI-HRMS on a Q-TOF (time-of-flight) mass spectrometer.

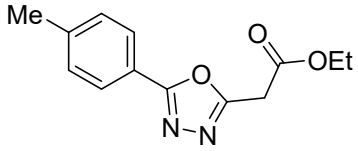
2. Experimental Procedure

(A) General Procedure for the Synthesis of 1,3,4-oxadiazoles.

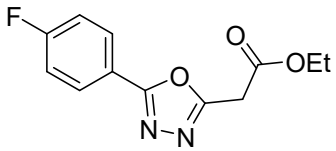
To a 15 mL sealed tube was added 1 (0.50 mmol), Ethyl 3, 3, 3-trifluoropropionate (0.55 mmol), Na_2CO_3 (0.75 mmol) and EtOH (5 mL). The resulting mixture was heated at 80 ^{o}C for the indicated time until the complete consumption of starting material as monitored by TLC or GC-MS analysis. After cooling, the reaction was diluted with EA and the organic phase was washed successively with water (3×25 mL) and brine (3×25 mL), dried over anhydrous Na_2SO_4, and filtered. The filtrate was concentrated in vacuo and the crude residue was purified by silica gel column chromatography (EA/Hexane) to afford desired product.



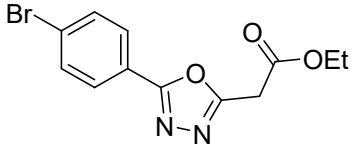
*Ethyl 2-(5-phenyl-1,3,4-oxadiazol-2-yl)acetate (**2a**)*. 110 mg, 95% yield; white solid; R_f = 0.36 (EA-Hexane = 1:4, *V:V*); m.p. 70-72 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.08–8.00 (m, 2H), 7.59–7.45 (m, 3H), 4.24 (q, *J* = 7.1 Hz, 2H), 4.03 (s, 2H), 1.29 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$) δ 166.4, 165.8, 160.4, 132.0, 129.2, 127.1, 123.8, 62.3, 32.2, 14.2; HRMS (ESI-TOF) *m/z* calcd for $C_{12}H_{12}N_2NaO_3$ $[M+Na]^+$: 255.0740, found: 255.0732.



*Ethyl 2-(5-(p-tolyl)-1,3,4-oxadiazol-2-yl)acetate (**2b**)*. 106 mg, 86% yield; white solid; R_f = 0.32 (EA-Hexane = 1:3, *V:V*); m.p. 46-48 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.93 (d, *J* = 7.8 Hz, 2H), 7.30 (d, *J* = 7.8 Hz, 2H), 4.24 (q, *J* = 7.1 Hz, 2H), 4.02 (s, 2H), 2.42 (s, 3H), 1.28 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$) δ 166.5, 165.9, 160.2, 142.5, 129.9, 127.0, 121.0, 62.2, 32.2, 21.7, 14.2; HRMS (ESI-TOF) *m/z* calcd for $C_{13}H_{14}N_2NaO_3$ $[M+Na]^+$: 269.0897 , found: 269.0890.

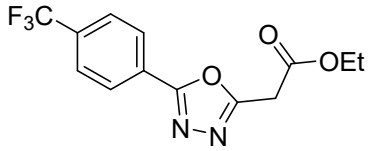


*Ethyl 2-(5-(4-fluorophenyl)-1,3,4-thiadiazol-2-yl) acetate (**2c**)*. 114 mg, 91% yield; white solid; R_f = 0.39 (EA-Hexane = 1:3, *V:V*); m.p. 86-88 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.08–8.00 (m, 2H), 7.22–7.14 (m, 2H), 4.24 (q, *J* = 7.1 Hz, 2H), 4.02 (s, 2H), 1.28 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$) δ 166.4, 164.9 (d, *J* = 253.0 Hz), 164.9, 160.4, 129.4 (d, *J* = 9.0 Hz), 120.1 (d, *J* = 3.2 Hz), 116.5 (d, *J* = 22.3 Hz), 62.3, 32.1, 14.2; ^{19}F{^{1}H} NMR (376 MHz, $CDCl_3$) δ -106.70; HRMS (ESI-TOF) *m/z* calcd for $C_{12}H_{11}FN_2NaO_3$ $[M+Na]^+$: 273.0646 , found: 273.0650.

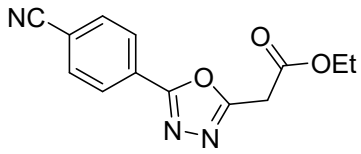


*Ethyl 2-(5-(4-bromophenyl)-1,3,4-thiadiazol-2-yl)acetate (**2d**)*. 135 mg, 87% yield; white solid; R_f = 0.24 (EA-Hexane = 1:3, *V:V*); m.p. 66-68 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.89 (d, *J* = 8.3 Hz, 2H), 7.63 (d, *J* = 8.3 Hz, 2H), 4.23 (q, *J* = 7.1 Hz, 2H), 4.01 (s, 2H), 1.27 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (125

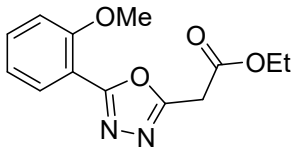
MHz, $CDCl_3$) δ 166.3, 165.0, 160.6, 132.5, 128.4, 126.6, 122.7, 62.3, 32.1, 14.2; HRMS (ESI-TOF) *m/z* calcd for $C_{12}H_{11}BrN_2NaO_3$ $[M+Na]^+$: 332.9845, found: 332.9840.



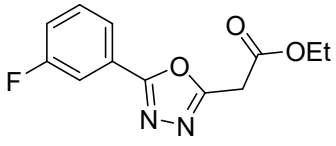
*Ethyl 2-(5-(4-(trifluoromethyl)phenyl)-1,3,4-oxadiazol-2-yl) acetate (**2e**)*. 119 mg, 79% yield; white solid; R_f = 0.37 (EA-Hexane = 1:3, *V:V*); m.p. 59-60 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.18 (d, *J* = 8.2 Hz, 2H), 7.77 (d, *J* = 8.2 Hz, 2H), 4.25 (q, *J* = 7.1 Hz, 2H), 4.06 (s, 2H), 1.29 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$) δ 166.2, 164.6, 161.1, 133.6 (q, *J* = 32.9 Hz), 127.4, 127.1 (d, *J* = 1.4 Hz), 126.3 (q, *J* = 3.8 Hz), 123.7 (q, *J* = 272.6 Hz), 62.4, 32.2, 14.2; ^{19}F{^{1}H} NMR (376 MHz, $CDCl_3$) δ -63.16; HRMS (ESI-TOF) *m/z* calcd for $C_{13}H_{11}F_3N_2NaO_3$ $[M+Na]^+$: 323.0614 , found: 323.0610.



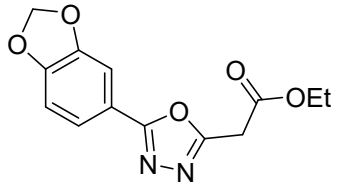
*Ethyl 2-(5-(4-cyanophenyl)-1,3,4-oxadiazol-2-yl)acetate (**2f**)*. 89 mg, 69% yield; white solid; R_f = 0.25 (EA-Hexane = 1:3, *V:V*); m.p. 119-120 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.17 (d, *J* = 8.3 Hz, 2H), 7.81 (d, *J* = 8.3 Hz, 2H), 4.25 (q, *J* = 7.1 Hz, 2H), 4.06 (s, 2H), 1.30 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$) δ 166.1, 164.3, 161.3, 133.0, 127.7, 127.6, 117.9, 115.5, 62.4, 32.2, 14.2; HRMS (ESI-TOF) *m/z* calcd for $C_{13}H_{11}N_3NaO_3$ $[M+Na]^+$: 280.0693 , found: 280.0699.



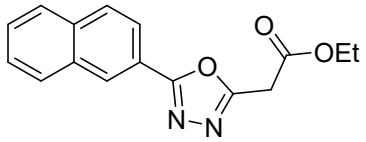
*Ethyl 2-(5-(2-methoxyphenyl)-1,3,4-oxadiazol-2-yl)acetate (**2g**)*. 111 mg, 85% yield; yellowish liquid; R_f = 0.32 (EA-Hexane = 1:1, *V:V*); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.90 (dd, *J* = 7.8, 1.8 Hz, 1H), 7.49 (t, *J* = 7.8 Hz, 1H), 7.09–7.00 (m, 2H), 4.22 (q, *J* = 7.1 Hz, 2H), 4.02 (s, 2H), 3.95 (s, 3H), 1.27 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$) δ166.5, 164.4, 160.1, 158.0, 133.3, 130.6, 120.8, 113.0, 112.1, 62.1, 56.1, 32.2, 14.2; HRMS (ESI-TOF) *m/z* calcd for $C_{13}H_{14}N_2NaO_4$ $[M+Na]^+$: 285.0846 , found: 285.0855.



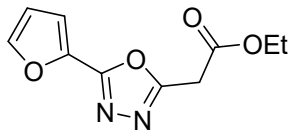
*Ethyl 2-(5-(3-fluorophenyl)-1,3,4-oxadiazol-2-yl)acetate (**2h**)*. 110 mg, 88% yield; white solid; R_f = 0.41 (EA-Hexane = 1:3, *V:V*); m.p. 73-75 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.85 (d, *J* = 7.8 Hz, 1H), 7.78–7.71 (m, 1H), 7.53–7.46 (m, 1H), 7.26–7.22 (m, 1H), 4.25 (q, *J* = 7.1 Hz, 2H), 4.03 (s, 2H), 1.30 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$) δ 166.3, 164.8 (d, *J* = 3.5 Hz), 163.0 (d, *J* = 247.9 Hz), 160.8, 131.1 (d, *J* = 8.1 Hz), 125.7 (d, *J* = 8.7 Hz), 122.9 (d, *J* = 3.2 Hz), 119.1 (d, *J* = 21.1 Hz), 114.2 (d, *J* = 24.5 Hz), 62.4, 32.2, 14.2; ^{19}F{^{1}H} NMR (376 MHz, $CDCl_3$) δ -111.07; HRMS (ESI-TOF) *m/z* calcd for $C_{12}H_{11}FN_2NaO_3$ $[M+Na]^+$: 273.0646 , found: 273.0650.



*Ethyl 2-(5-(benzo[d][1,3]dioxol-5-yl)-1,3,4-oxadiazol-2-yl) acetate (**2i**)*. 123 mg, 89% yield; white solid; R_f = 0.27 (EA-Hexane = 1:3, *V:V*); m.p. 69-71 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.56 (d, *J* = 8.1 Hz, 1H), 7.46 (s, 1H), 6.88 (d, *J* = 8.1 Hz, 1H), 6.03 (s, 2H), 4.22 (q, *J* = 7.1 Hz, 2H), 3.98 (s, 2H), 1.27 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$) δ 166.4, 165.5, 160.0, 150.8, 148.4, 122.1, 117.6, 108.9, 107.1, 102.0, 62.2, 32.1, 14.1; HRMS (ESI-TOF) *m/z* calcd for $C_{13}H_{12}N_2NaO_5$ $[M+Na]^+$: 299.0638, found: 299.0631.

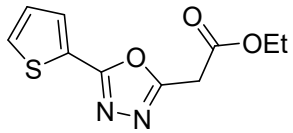


*Ethyl 2-(5-(naphthalen-2-yl)-1,3,4-oxadiazol-2-yl)acetate (**2j**)*. 117 mg, 83% yield; pink solid; R_f = 0.45 (EA-Hexane = 1:3, *V:V*); m.p. 81-83 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.54 (s, 1H), 8.12 (dd, *J* = 8.6, 1.5 Hz, 1H), 7.97–7.91 (m, 2H), 7.88 (d, *J* = 7.6 Hz, 1H), 7.61–7.52 (m, 2H), 4.27 (q, *J* = 7.1 Hz, 2H), 4.07 (s, 2H), 1.30 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$) δ 166.5, 166.0, 160.5, 134.9, 132.9, 129.2, 129.0, 128.2, 128.1, 127.6, 127.2, 123.3, 121.0, 62.3, 32.2, 14.2; HRMS (ESI-TOF) *m/z* calcd for $C_{16}H_{14}N_2NaO_3$ $[M+Na]^+$: 305.0897 , found: 305.0900.

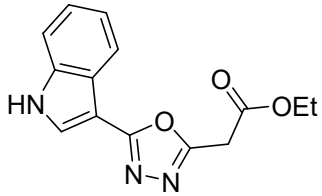


*Ethyl 2-(5-(furan-2-yl)-1,3,4-oxadiazol-2-yl)acetate (**2k**)*. 104 mg, 94% yield; colorless liquid; R_f = 0.26 (EA-Hexane = 1:3, *V:V*); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.56 (d, *J* = 1.1 Hz, 1H), 7.11–7.02 (m, 1H),

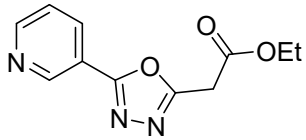
6.54–6.46 (m, 1H), 4.14 (q, *J* = 7.1 Hz, 2H), 3.94 (s, 2H), 1.18 (t, *J* = 7.1 Hz, 3H); $^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$) δ 166.1, 159.6, 158.3, 145.7, 139.1, 114.2, 112.1, 62.0, 31.7, 13.9; HRMS (ESI-TOF) *m/z* calcd for $C_{10}H_{10}N_2NaO_4$ $[M+Na]^+$: 245.0533 , found: 245.0530.



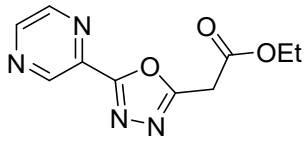
*Ethyl 2-(5-(thiophen-2-yl)-1,3,4-oxadiazol-2-yl)acetate (**2l**)*. 116 mg, 97% yield; yellowish liquid; R_f = 0.23 (EA-Hexane = 1:3, *V:V*); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.71 (d, *J* = 3.6 Hz, 1H), 7.52 (d, *J* = 5.0 Hz, 1H), 7.12 (t, *J* = 4.3 Hz, 1H), 4.20 (q, *J* = 7.1 Hz, 2H), 3.98 (s, 2H), 1.25 (t, *J* = 7.1 Hz, 3H); $^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$) δ 166.2, 161.9, 159.8, 130.4, 130.0, 128.2, 124.9, 62.2, 32.0, 14.1; HRMS (ESI-TOF) *m/z* calcd for $C_{10}H_{10}N_2NaO_3S$ $[M+Na]^+$: 261.0304 , found: 261.0312.



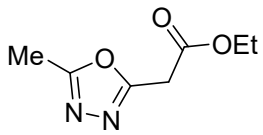
*Ethyl 2-(5-(1H-indol-3-yl)-1,3,4-oxadiazol-2-yl)acetate (**2m**)*. 109 mg, 80% yield; white solid; R_f = 0.37 (EA-Hexane = 1:1, *V:V*); m.p. 90-92 °C; ^{1}H NMR (600 MHz, DMSO-d_6) δ 12.05 (s, 1H), 8.17 (d, *J* = 2.9 Hz, 1H), 8.09 (d, *J* = 7.2 Hz, 1H), 7.57–7.50 (m, 1H), 7.25 (dtd, *J* = 17.9, 7.2, 1.2 Hz, 2H), 4.25 (s, 2H), 4.17 (q, *J* = 7.1 Hz, 2H), 1.21 (t, *J* = 7.1 Hz, 3H); $^{13}C\{^{1}H\}$ NMR (150 MHz, DMSO-d_6) δ 167.3, 162.5, 158.7, 136.5, 128.2, 124.1, 123.0, 121.3, 120.2, 112.5, 99.3, 61.4, 31.4, 14.0; HRMS (ESI-TOF) *m/z* calcd for $C_{14}H_{13}N_3NaO_3$ $[M+Na]^+$: 294.0849 , found: 594.0853.



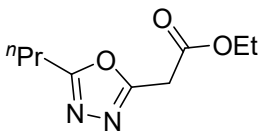
*Ethyl 2-(5-(pyridin-3-yl)-1,3,4-oxadiazol-2-yl)acetate (**2n**)*. 105 mg, 90% yield; white solid; R_f = 0.29 (EA-Hexane = 1:1, *V:V*); m.p. 79-81 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 9.25 (s, 1H), 8.76 (d, *J* = 4.2 Hz, 1H), 8.33 (d, *J* = 7.5 Hz, 1H), 7.45 (t, *J* = 7.5 Hz, 1H), 4.24 (q, *J* = 7.1 Hz, 2H), 4.05 (s, 2H), 1.28 (t, *J* = 7.1 Hz, 3H); $^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$) δ 166.2, 163.7, 161.0, 152.7, 148.0, 134.3, 123.9, 120.3, 62.3, 32.1, 14.2; HRMS (ESI-TOF) *m/z* calcd for $C_{11}H_{11}N_3NaO_3$ $[M+Na]^+$: 256.0693 , found: 256.0699.



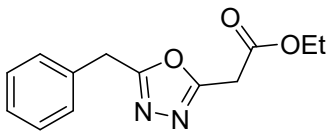
*Ethyl 2-(5-(pyrazin-2-yl)-1,3,4-oxadiazol-2-yl)acetate (**2o**)*. 109 mg, 93% yield; yellowish liquid; R_f = 0.41 (EA-Hexane = 1:1, *V:V*); ^{1}H NMR (500 MHz, $CDCl_3$) δ 9.44 (d, *J* = 1.3 Hz, 1H), 8.73 (d, *J* = 2.5 Hz, 1H), 8.72–8.70 (m, 1H), 4.21 (q, *J* = 7.1 Hz, 2H), 4.07 (s, 2H), 1.25 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$) δ 165.9, 163.1, 162.0, 146.8, 144.7, 144.3, 139.5, 62.4, 32.1, 14.1; HRMS (ESI-TOF) *m/z* calcd for $C_{10}H_{10}N_4NaO_3$ $[M+Na]^+$: 257.0645, found: 257.0650.



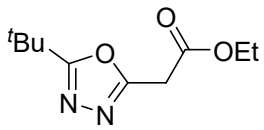
*Ethyl 2-(5-methyl-1,3,4-oxadiazol-2-yl)acetate(**2p**)*. 78 mg, 92% yield; colorless liquid; R_f = 0.38 (EA-Hexane = 1:2, *V:V*); ^{1}H NMR (600 MHz, $CDCl_3$) δ 4.17 (q, *J* = 7.1 Hz, 2H), 3.87 (s, 2H), 2.49 (s, 3H), 1.23 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$) δ 166.5, 164.7, 160.6, 62.1, 31.9, 14.1, 11.0; HRMS (ESI-TOF) *m/z* calcd for $C_7H_{10}N_2NaO_3$ $[M+Na]^+$: 193.0584, found: 193.0589.



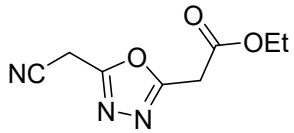
*Ethyl 2-(5-propyl-1,3,4-oxadiazol-2-yl)acetate (**2q**)*. 93 mg, 94% yield; colorless liquid; R_f = 0.32 (EA-Hexane = 1:3, *V:V*); ^{1}H NMR (500 MHz, $CDCl_3$) δ 4.18 (q, *J* = 7.1 Hz, 2H), 3.88 (s, 2H), 2.79 (t, *J* = 7.4 Hz, 2H), 1.78 (sext, *J* = 7.4 Hz, 2H), 1.23 (t, *J* = 7.1 Hz, 3H), 0.98 (t, *J* = 7.4 Hz, 3H); ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$) δ 167.8, 166.4, 160.3, 61.9, 31.8, 27.1, 19.9, 14.0, 13.4; HRMS (ESI-TOF) *m/z* calcd for $C_9H_{14}N_2NaO_3$ $[M+Na]^+$: 221.0897 , found: 221.0890.



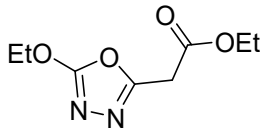
*Ethyl 2-(5-benzyl-1,3,4-oxadiazol-2-yl)acetate (**2r**)*. 106 mg, 86% yield; white solid; R_f = 0.25 (EA-Hexane = 1:3, *V:V*); m.p. 81-83 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.35–7.24 (m, 5H), 4.19 (s, 2H), 4.16 (q, *J* = 7.1 Hz, 2H), 3.88 (s, 2H), 1.20 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$) δ 166.4, 166.3, 161.0, 133.8, 129.0, 128.8, 127.6, 62.1, 32.0, 31.8, 14.0; HRMS (ESI-TOF) *m/z* calcd for $C_{13}H_{14}N_2NaO_3$ $[M+Na]^+$: 269.0897 , found: 269.0893.



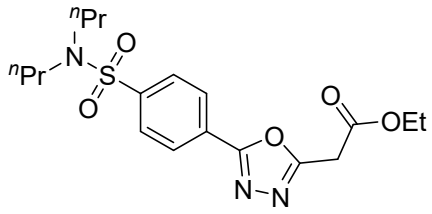
*Ethyl 2-(5-(tert-butyl)-1,3,4-oxadiazol-2-yl)acetate (**2s**)*. 87 mg, 82% yield; colorless liquid; R_f = 0.38 (EA-Hexane = 1:3, *V:V*); ^{1}H NMR (500 MHz, $CDCl_3$) δ 4.20 (q, *J* = 7.1 Hz, 2H), 3.91 (s, 2H), 1.40 (s, 9H), 1.25 (t, *J* = 7.1 Hz, 3H); $^{13}C\{^1H\}$ NMR (125 MHz, $CDCl_3$) δ 174.3, 166.5, 160.4, 62.0, 32.5, 32.1, 28.1, 14.1; HRMS (ESI-TOF) *m/z* calcd for $C_{10}H_{16}N_2NaO_3$ $[M+Na]^+$: 235.1053 , found: 235.1045.



*Ethyl 2-(5-(cyanomethyl)-1,3,4-oxadiazol-2-yl)acetate (**2t**)*. 71 mg, 73% yield; white solid; R_f = 0.24 (EA-Hexane = 1:2, *V:V*); m.p. 84-87 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 4.23 (q, *J* = 7.1 Hz, 2H), 4.07 (s, 2H), 3.98 (s, 2H), 1.28 (t, *J* = 7.1 Hz, 3H); $^{13}C\{^1H\}$ NMR (125 MHz, $CDCl_3$) δ 165.9, 162.3, 158.0, 112.1, 62.5, 31.9, 16.0, 14.1; HRMS (ESI-TOF) *m/z* calcd for $C_8H_9N_3NaO_3$ $[M+Na]^+$: 218.0536 , found: 218.0530.

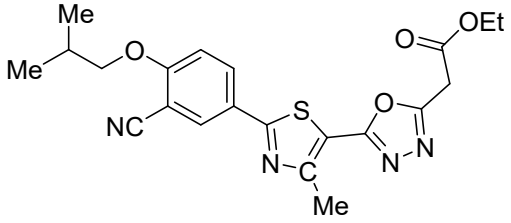


*Ethyl 2-(5-ethoxy-1,3,4-oxadiazol-2-yl)acetate (**2u**)*. 85 mg, 85% yield; colorless liquid; R_f= 0.24 (EA-Hexane = 1:3, V:V); ^{1}H NMR (500 MHz, $CDCl_3$) δ 4.51 (q, J = 7.1 Hz, 2H), 4.18 (q, J = 7.1 Hz, 2H), 3.77 (s, 2H), 1.44 (t, J = 7.1 Hz, 3H), 1.24 (t, J = 7.1 Hz, 3H); $^{13}C\{^1H\}$ NMR (125 MHz, $CDCl_3$) δ 166.3, 166.2, 156.0, 69.1, 61.9, 32.2, 14.1, 14.0; HRMS (ESI-TOF) m/z calcd for $C_8H_{12}N_2NaO_4$ $[M+Na]^+$: 223.0689, found: 223.0693.

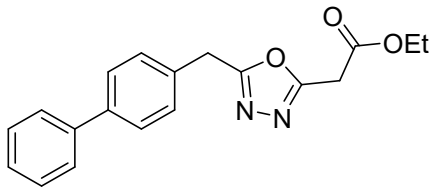


*Ethyl2-(5-(4-(N,N-dipropylsulfamoyl)phenyl)-1,3,4-Oxadiazol -2-yl)acetate (**2v**)*. 134 mg, 68% yield; white solid; R_f = 0.46 (EA-Hexane = 1:2, *V:V*); m.p. 87-90 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.16 (d, *J* = 8.1 Hz, 2H), 7.91 (d, *J* = 8.1 Hz, 2H), 4.23 (q, *J* = 7.1 Hz, 2H), 4.04 (s, 2H), 3.16–3.04 (m, 4H), 1.53 (sext, *J* = 7.4 Hz, 4H), 1.27 (t, *J* = 7.1 Hz, 3H), 0.84 (t, *J* = 7.4 Hz, 6H); $^{13}C\{^1H\}$ NMR (125 MHz, $CDCl_3$)

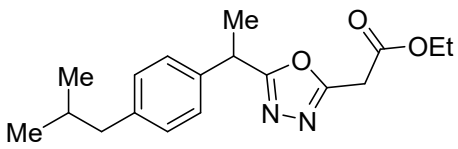
δ 166.2, 164.5, 161.1, 143.4, 127.8, 127.6, 127.1, 62.3, 49.9, 32.1, 22.0, 14.1, 11.2; HRMS (ESI-TOF) *m/z* calcd for $C_{18}H_{25}N_3NaO_5S$ $[M+Na]^+$: 418.1407, found: 418.1412.



*Ethyl 2-(5-(2-(3-cyano-4-isobutoxyphenyl)-4-methylthiazol -5-yl)-1,3,4-oxadiazol-2-yl) acetate (**2w**)*. 128 mg, 60% yield; white solid; R_f = 0.24 (EA-Hexane = 1:3, *V:V*); m.p. 143-145 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.16 (s, 1H), 8.07 (d, *J* = 8.7 Hz, 1H), 7.02 (d, *J* = 8.7 Hz, 1H), 4.25 (q, *J* = 7.1 Hz, 2H), 4.03 (s, 2H), 3.90 (d, *J* = 6.4 Hz, 2H), 2.81 (s, 3H), 2.27 – 2.13 (m, 1H), 1.30 (t, *J* = 7.1 Hz, 3H), 1.08 (d, *J* = 6.7 Hz, 6H); ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$) δ 166.6, 166.1, 162.6, 160.7, 160.0, 157.4, 132.6, 132.1, 125.8, 115.4, 114.3, 112.9, 103.2, 75.9, 62.3, 32.0, 28.3, 19.1, 17.6, 14.2; HRMS (ESI-TOF) *m/z* calcd for $C_{21}H_{22}N_4NaO_4S$ $[M+Na]^+$: 449.1254, found: 449.1244.

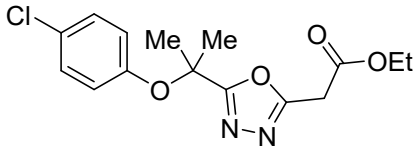


*Ethyl 2-(5-([1,1'-biphenyl]-4-ylmethyl)-1,3,4-oxadiazol-2-yl) acetat (**2x**)*. 140 mg, 87% yield; white solid; R_f = 0.32 (EA-Hexane = 1:3, *V:V*); m.p. 74-76 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.56 (d, *J* = 7.5 Hz, 4H), 7.46–7.41 (m, 2H), 7.40–7.31 (m, 3H), 4.25 (s, 2H), 4.19 (q, *J* = 7.0 Hz, 2H), 3.91 (s, 2H), 1.23 (t, *J* = 7.0 Hz, 3H); ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$) δ166.4, 166.4, 161.1, 140.7, 140.6, 132.8, 129.3, 128.9, 127.7, 127.6, 127.2, 62.1, 32.1, 31.6, 14.1; HRMS (ESI-TOF) *m/z* calcd for $C_{19}H_{18}N_2NaO_3$ $[M+Na]^+$: 345.1210, found: 345.1202.



*Ethyl 2-(5-(1-(4-isobutylphenyl)ethyl)-1,3,4-oxadiazol-2-yl) acetate (**2y**)*. 130 mg, 82% yield; colorless liquid; R_f = 0.43 (EA-Hexane = 1:3, *V:V*); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.16 (d, *J* = 7.9 Hz, 2H), 7.08 (d, *J* = 7.9 Hz, 2H), 4.31 (q, *J* = 7.1 Hz, 1H), 4.15 (q, *J* = 7.1 Hz, 2H), 3.92–3.81 (m, 2H), 2.42 (d, *J* = 7.2 Hz, 2H), 1.87 – 1.77 (m, 1H), 1.73 (d, *J* = 7.1 Hz, 3H), 1.18 (t, *J* = 7.1 Hz, 3H), 0.87 (d, *J* = 6.5 Hz, 6H); ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$) δ 170.0, 166.3, 160.7, 141.0, 137.5, 129.6, 127.0, 62.0, 45.0,

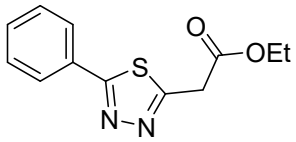
37.1, 32.0, 30.2, 22.4, 19.5, 14.0; HRMS (ESI-TOF) *m/z* calcd for $C_{18}H_{24}N_2NaO_3$ $[M+Na]^+$: 339.1679, found: 339.1686.



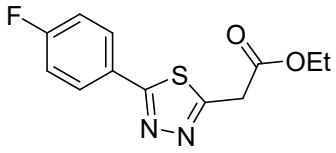
*Ethyl 2-(5-(2-(4-chlorophenoxy)propan-2-yl)-1,3,4-oxadiaz- ol-2-yl)acetate (**2z**)*. 138 mg, 85% yield; colorless liquid; R_f = 0.31 (EA-Hexane = 1:3, *V:V*); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.15 (d, *J* = 8.6 Hz, 2H), 6.67 (d, *J* = 8.6 Hz, 2H), 4.20 (q, *J* = 7.1 Hz, 2H), 3.98 (s, 2H), 1.79 (s, 6H), 1.24 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$) δ 169.2, 166.2, 161.5, 153.2, 129.5, 129.2, 123.0, 75.6, 62.3, 32.1, 26.0, 14.1; HRMS (ESI-TOF) *m/z* calcd for $C_{15}H_{17}ClN_2NaO_4$ $[M+Na]^+$: 347.0769, found: 347.0777.

(B) General Procedure for the Synthesis of 1,3,4-Thiadiazole Compounds.

To a 15 mL sealed tube was added **3** (0.50 mmol), Ethyl 3, 3, 3-trifluoropropionate (0.55 mmol), Na_2CO_3 (0.75 mmol) and EtOH (5 mL). The resulting mixture was heated at 80 °C for the indicated time until the complete consumption of starting material as monitored by TLC or GC-MS analysis. After cooling, the reaction was diluted with EA and organic phase was washed successively with water (3×25 mL) and brine (3×25 mL), dried over anhydrous Na_2SO_4, and filtered. The filtrate was concentrated in vacuo and purified by silica gel column chromatography (EA/Hexane) to afford desired product.

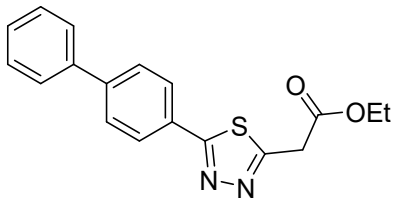


*Ethyl 2-(5-phenyl-1,3,4-thiadiazol-2-yl)acetate (**4a**)*. 110 mg, 89% yield; yellow solid; R_f = 0.31 (EA-Hexane = 1:5, *V:V*); m.p. 88-90 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.00–7.88 (m, 2H), 7.53–7.44 (m, 3H), 4.26 (q, *J* = 7.1 Hz, 2H), 4.22 (s, 2H), 1.31 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$) δ 170.1, 168.6 161.6, 131.2, 130.2, 129.3, 128.0, 62.2, 36.1, 14.2; HRMS (ESI-TOF) *m/z* calcd for $C_{12}H_{12}N_2NaO_2S$ $[M+Na]^+$: 271.0512, found: 271.0517.

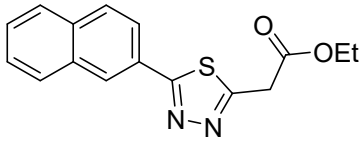


*Ethyl 2-(5-(4-fluorophenyl)-1,3,4-thiadiazol-2-yl)acetate (**4b**)*. 83 mg, 62% yield; yellow solid; R_f = 0.38

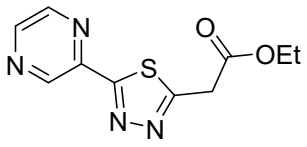
(EA-Hexane = 1:5, *V:V*); m.p. 86-88 °C;^{1}H NMR (500 MHz, $CDCl_3$) δ 7.98–7.92 (m, 2H), 7.19–7.14 (m, 2H), 4.26 (q, *J* = 7.1 Hz, 2H), 4.21 (s, 2H), 1.32 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$) δ 168.9, 168.5, 164.5 (d, *J* = 252.3 Hz), 161.6, 130.0 (d, *J* = 9.1 Hz), 126.5 (d, *J* = 3.3 Hz), 116.5 (d, *J* = 22.2 Hz), 62.2, 36.1, 14.2; ^{19}F{^{1}H} NMR (376 MHz, $CDCl_3$) δ -108.44; HRMS (ESI-TOF) *m/z* calcd for $C_{12}H_{11}FN_2NaO_2S$ $[M+Na]^+$: 289.0417, found: 289.0424.



Ethyl 2-(5-([1,1'-biphenyl]-4-yl)-1,3,4-thiadiazol-2-yl)acet-ate ***(4c)***. 117 mg, 72% yield; yellow solid; R_f = 0.31 (EA-Hexane = 1:5, *V:V*); m.p. 75-77 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.04 (d, *J* = 8.3 Hz, 2H), 7.71 (d, *J* = 8.3 Hz, 2H), 7.65–7.62 (m, 2H), 7.47 (t, *J* = 7.6 Hz, 2H), 7.39 (t, *J* = 7.3 Hz, 1H), 4.28 (q, *J* = 7.1 Hz, 2H), 4.23 (s, 2H), 1.33 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$) δ 169.8, 168.6, 161.5, 144.0, 140.0, 129.1, 129.1, 128.4, 128.2, 127.9, 127.2, 62.2, 36.1, 14.2; HRMS (ESI-TOF) *m/z* calcd for $C_{18}H_{16}N_2NaO_2S$ $[M+Na]^+$:347.0825, found: 347.0817.

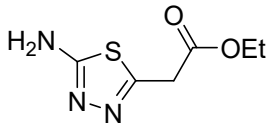


Ethyl 2-(5-(naphthalen-2-yl)-1,3,4-thiadiazol-2-yl)acetate ***(4d)***. 128 mg, 86% yield; yellow solid; R_f = 0.41 (EA-Hexane = 1:5, *V:V*); m.p. 65-67 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.42 (s, 1H), 8.09 (dd, *J* = 8.3, 1.8 Hz, 1H), 7.95–7.90 (m, 2H), 7.89–7.84 (m, 1H), 7.60–7.50 (m, 2H), 4.28 (q, *J* = 7.1 Hz, 2H), 4.24 (s, 2H), 1.33 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$) δ 170.3, 168.6, 161.6, 134.7, 133.2, 129.2, 128.8, 128.3, 128.0, 127.8, 127.6, 127.1, 124.6, 62.2, 36.2, 14.2; HRMS (ESI-TOF) *m/z* calcd for $C_{16}H_{14}N_2NaO_2S$ $[M+Na]^+$: 321.0668, found: 321.0678.

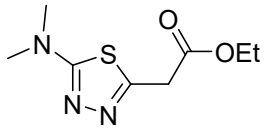


Ethyl 2-(5-(pyrazin-2-yl)-1,3,4-thiadiazol-2-yl)acetate ***(4e)***. 88 mg, 70% yield; yellow solid; R_f = 0.23 (EA-Hexane = 1:4, *V:V*); m.p. 69-71 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 9.56 (s, 1H), 8.64 (d, *J* = 26.1 Hz, 2H), 4.27 (q, *J* = 7.1 Hz, 2H), 4.24 (s, 2H), 1.31 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$) δ 169.3, 168.2, 164.4, 146.1, 145.0, 144.4, 142.6, 62.2, 36.2, 14.2; HRMS (ESI-TOF) *m/z* calcd

for $C_{10}H_{10}N_4NaO_2S$ $[M+Na]^+$: 273.0417, found: 273.0410.



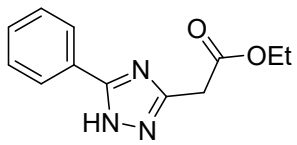
*Ethyl 2-(5-amino-1,3,4-thiadiazol-2-yl)acetate (**4f**).* 57 mg, 61% yield; yellow solid; R_f = 0.18 (EA-Hexane = 1:1, *V:V*); m.p. 138-140 °C; ^{1}H NMR (500 MHz, DMSO-d_6) δ 7.11 (s, 2H), 4.12 (q, J = 7.1 Hz, 2H), 3.96 (s, 2H), 1.20 (t, J = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (125 MHz, DMSO-d_6) δ 169.5, 168.8, 150.3, 60.9, 35.4, 14.0; HRMS (ESI-TOF) *m/z* calcd for $C_6H_9N_3NaO_2S$ $[M+Na]^+$: 210.0308, found: 210.0315.



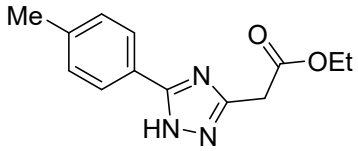
*Ethyl2-(5-(dimethylamino)-1,3,4-thiadiazol-2-yl)acetate(**4g**).* 88 mg, 82% yield; yellow liquid; R_f = 0.21 (EA-Hexane = 1:1, *V:V*); ^{1}H NMR (500 MHz, $CDCl_3$) δ 4.15 (q, J = 7.1 Hz, 2H), 3.90 (s, 2H), 3.08 (s, 6H), 1.23 (t, J = 7.1 Hz, 3H). ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$) δ 173.0, 168.9, 150.7, 61.6, 41.4, 36.2, 14.1.; HRMS (ESI-TOF) *m/z* calcd for $C_8H_{13}N_3NaO_2S$ $[M+Na]^+$: 238.0621, found: 238.0617.

(C) **General Procedure for the Synthesis of 1,2,4-Triazole Compounds.**

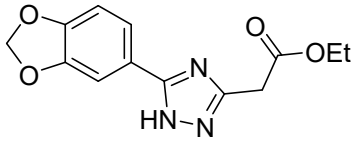
To a 15 mL sealed tube was added **5** (0.50 mmol), Ethyl 3, 3, 3-trifluoropropionate (0.55 mmol), Na_2CO_3 (0.75 mmol) and EtOH (5 mL). The resulting mixture was heated at 80 °C for the indicated time until the complete consumption of starting material as monitored by TLC or GC-MS analysis. After cooling, the reaction was diluted with EA and organic phase was washed successively with water (3×25 mL) and brine (3×25 mL), dried over anhydrous Na_2SO_4, and filtered. The filtrate was concentrated in vacuo and purified by silica gel column chromatography (EA/Hexane) to afford desired product.



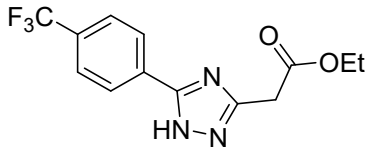
*Ethyl 2-(5-phenyl-1H-1,2,4-triazol-3-yl)acetate (**6a**).* 65 mg, 56% yield; yellow liquid; R_f = 0.30 (EA-Hexane = 2:3, *V:V*); ^{1}H NMR (500 MHz, $CDCl_3$) δ 12.64 (brs, 1H), 8.01–7.93 (m, 2H), 7.40–7.33 (m, 3H), 4.21 (q, J = 7.1 Hz, 2H), 3.97 (s, 2H), 1.27 (t, J = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$) δ 169.7, 160.1, 153.2, 129.8, 129.4, 128.8, 126.5, 62.0, 33.3, 14.2; HRMS (ESI-TOF) *m/z* calcd for $C_{12}H_{13}N_3NaO_2$ $[M+Na]^+$: 254.0900, found: 254.0905.



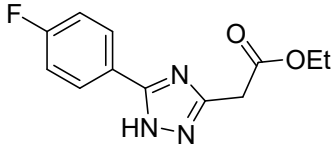
*Ethyl 2-(5-(p-tolyl)-1H-1,2,4-triazol-3-yl)acetate (**6b**)*. 37 mg, 30% yield; yellow liquid; R_f = 0.45 (EA-Hexane = 1:1, *V:V*); ^{1}H NMR (500 MHz, $CDCl_3$) δ 12.79 (brs, 1H), 7.82 (d, *J* = 7.8 Hz, 2H), 7.15 (d, *J* = 7.8 Hz, 2H), 4.19 (q, *J* = 7.1 Hz, 2H), 3.93 (s, 2H), 2.34 (s, 3H), 1.25 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$) δ 169.7, 159.6, 153.8, 139.9, 129.5, 129.2, 126.5, 61.8, 33.5, 21.5, 14.2; HRMS (ESI-TOF) *m/z* calcd for $C_{13}H_{15}N_3NaO_2$ $[M+Na]^+$: 268.1056, found: 268.1050.



*Ethyl 2-(5-(benzo[d][1,3]dioxol-5-yl)-1H-1,2,4-triazol-3-yl) acetate (**6c**)*. 55 mg, 40% yield; yellow solid; R_f = 0.40 (EA-Hexane = 1:1, *V:V*); m.p. 92-94 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 12.35 (brs, 1H), 7.58–7.38 (m, 2H), 6.81 (d, *J* = 7.7 Hz, 1H), 5.98 (s, 2H), 4.23 (q, *J* = 6.9 Hz, 2H), 3.95 (s, 2H), 1.29 (t, *J* = 6.9 Hz, 3H); ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$) δ 169.8, 160.1, 152.7, 149.0, 148.1, 123.8, 120.8, 108.6, 107.0, 101.5, 62.0, 33.3, 14.2; HRMS (ESI-TOF) *m/z* calcd for $C_{13}H_{13}N_3NaO_4$ $[M+Na]^+$: 298.0798, found: 298.0805.

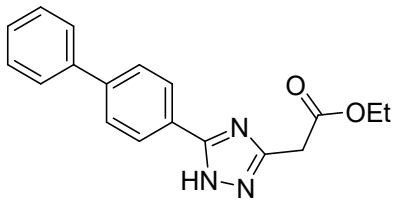


*Ethyl 2-(5-(4-(trifluoromethyl)phenyl)-1H-1,2,4-triazol-3-yl) acetate (**6d**)*. 43 mg, 29% yield; yellow solid; R_f = 0.41 (EA-Hexane = 1:1, *V:V*); m.p. 88-89 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 12.26 (brs, 1H), 8.23–8.09 (m, 2H), 7.67 (d, *J* = 8.1 Hz, 2H), 4.29 (q, *J* = 7.1 Hz, 2H), 4.04 (s, 2H), 1.33 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$) δ 169.6, 160.4, 151.2, 133.9, 131.4 (q, *J* = 33.3 Hz), 126.8, 125.8 (q, *J* = 3.7 Hz), 124.2 (q, *J* = 272.1 Hz), 62.3, 32.8, 14.2; ^{19}F{^{1}H} NMR (376 MHz, $CDCl_3$) δ -62.75; HRMS (ESI-TOF) *m/z* calcd for $C_{13}H_{12}F_3N_3NaO_2$ $[M+Na]^+$: 322.0774, found: 322.0766.



*Ethyl 2-(5-(4-fluorophenyl)-1H-1,2,4-triazol-3-yl)acetate (**6e**)*. 45 mg, 36% yield; yellow solid; R_f = 0.20 (EA-Hexane = 1:2, *V:V*); m.p. 100-102 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 12.56 (brs, 1H), 8.07–7.84 (m,

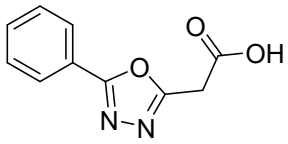
2H), 7.06 (t, *J* = 8.5 Hz, 2H), 4.23 (q, *J* = 7.1 Hz, 2H), 3.97 (s, 2H), 1.28 (t, *J* = 7.1 Hz, 3H); $^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$) δ 169.7, 163.8 (d, *J* = 249.3 Hz), 160.4, 152.2, 128.5 (d, *J* = 8.4 Hz), 126.1, 115.8 (d, *J* = 21.9 Hz), 62.1, 33.1, 14.2; $^{19}F\{^{1}H\}$ NMR (376 MHz, $CDCl_3$) δ -111.39; HRMS (ESI-TOF) *m/z* calcd for $C_{12}H_{12}FN_3NaO_2$ $[M+Na]^+$: 272.0806, found: 272.0812.



Ethyl 2-(5-([1,1'-biphenyl]-4-yl)-1H-1,2,4-triazol-3-yl)acet-ate ***(6f)****.* 66 mg, 43% yield; yellow solid; R_f = 0.39 (EA-Hexane = 1:1, *V:V*); m.p. 106-108 °C; ^{1}H NMR (500 MHz, DMSO-d_6) δ 14.14 (brs, 1H), 8.08 (d, *J* = 8.1 Hz, 2H), 7.80 (d, *J* = 7.4 Hz, 2H), 7.73 (d, *J* = 7.7 Hz, 2H), 7.48 (t, *J* = 7.6 Hz, 2H), 7.39 (t, *J* = 7.3 Hz, 1H), 4.14 (q, *J* = 7.1 Hz, 2H), 3.90 (s, 2H), 1.21 (t, *J* = 7.1 Hz, 3H); $^{13}C\{^{1}H\}$ NMR (125 MHz, DMSO-d_6) δ 168.7, 160.4, 153.9, 140.9, 139.4, 129.0, 127.8, 127.0, 126.6, 126.4, 60.7, 33.4, 14.0; HRMS (ESI-TOF) *m/z* calcd for $C_{18}H_{17}N_3NaO_2$ $[M+Na]^+$: 330.1213, found: 330.1217.

(D) Procedure for the Synthesis of 7.

A solution of KOH (23 mg, 0.39 mmol) in ethanol was added to a solution of **2a** (69 mg, 0.30 mmol) in ethanol, the mixture was stirred at room temperature for 6 h (monitored by TLC). The precipitated solid was filtered and treated with 1N HCl. After acidification, it was filtered again into afford white solid **7**.

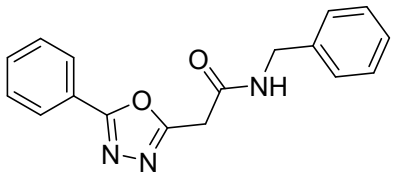


*2-(5-phenyl-1,3,4-thiadiazol-2-yl)acetic acid (****7****).* 50 mg, 81% yield; white solid; R_f = 0.16 (EA-Hexane = 1:1, *V:V*); m.p. 111-112 °C; ^{1}H NMR (500 MHz, DMSO-d_6) δ 8.00–7.95 (m, 2H), 7.63–7.57 (m, 3H), 4.09 (s, 2H); $^{13}C\{^{1}H\}$ NMR (125 MHz, DMSO-d_6) δ 168.5, 164.4, 162.0, 132.0, 129.5, 126.4, 123.3, 32.2; HRMS (ESI-TOF) *m/z* calcd for $C_{10}H_8N_2NaO_3$ $[M+Na]^+$: 227.0427, found:227.0435.

(E) Procedure for the Synthesis of 8.

To a solution of **2a** (69 mg, 0.30 mmol) in toluene (3 mL) was added benzylamine (64 mg, 0.60 mmol) and the resulting mixture was heated to reflux for 8 h. After cooling, the solvent was evaporated under reduced pressure and the residue was purified by column chromatography (EA-Hexane = 1:5) to afford

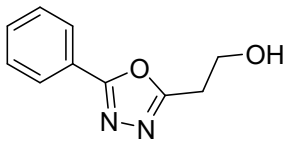
compound **8**.



*N-benzyl-2-(5-phenyl-1,3,4-thiadiazol-2-yl)acetamide (**8**).* 62 mg, 70% yield; white solid; R_f = 0.25 (EA-Hexane = 1:2, *V:V*); m.p. 105-107 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.01 (d, *J* = 7.8 Hz, 2H), 7.57–7.47 (m, 4H), 7.35–7.26 (m, 5H), 4.49 (d, *J* = 5.6 Hz, 2H), 3.96 (s, 2H); ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$) δ 165.4, 164.3, 161.8, 137.7, 132.1, 129.2, 128.8, 127.9, 127.7, 127.1, 123.4, 44.1, 33.5; HRMS (ESI-TOF) *m/z* calcd for $C_{17}H_{15}N_3NaO_2$ $[M+Na]^+$: 316.1056, found:316.1062.

(F) Procedure for the Synthesis of 9.

To a stirred solution of **2a** (69 mg, 0.30 mmol) in 3 mL of tetrahydrofuran/water (5/1) was added $NaBH_4$ (56 mg, 1.50 mmol) at 0 °C and the reaction mixture was slowly warmed to room temperature. Then additional $NaBH_4$ (34 mg, 0.90 mmol) was added and stirred for 3 h at room temperature. After the reaction was carefully quenched with 1N HCl, the reaction mixture concentrated under reduced pressure to give crude product. The crude product was dissolved in EA then washed with brine and the organic layer was dried over anhydrous Na_2SO_4. The organic mixture was concentrated in vacuo and the residue was purified by column chromatography (EA-Hexane = 1:3) to afford **9**.

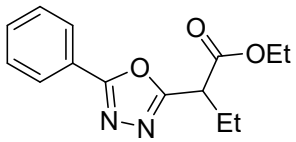


*2-(5-phenyl-1,3,4-thiadiazol-2-yl)ethan-1-ol (**9**).* 47 mg, 83% yield; colorless liquid; R_f = 0.20 (EA-Hexane = 1:2, *V:V*); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.96 (d, *J* = 7.7 Hz, 2H), 7.51–7.41 (m, 3H), 4.11 (t, *J* = 5.8 Hz, 2H), 3.60 (s, 1H), 3.14 (t, *J* = 5.8 Hz, 2H); ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$) δ 165.3, 165.0, 131.8, 129.1, 126.9, 123.8, 58.8, 29.2; HRMS (ESI-TOF) *m/z* calcd for $C_{10}H_{10}N_2NaO_2$ $[M+Na]^+$: 213.0634, found: 213.0630.

(G) Procedure for the Synthesis of 10.

To a solution of **2a** (69 mg, 0.30 mmol) in dry acetonitrile (3 mL) was added K_2CO_3 (124 mg, 0.90 mmol), CH_3CH_2Br (81 mg, 0.75 mmol). The vigorously stirred mixture was heated to 85 °C for 3 h (monitored by TLC). After cooling, the mixture was filtered through a pad of celite. The organic mixture was concentrated in vacuo and the residue was purified by column chromatography (EA-Hexane = 1:5)

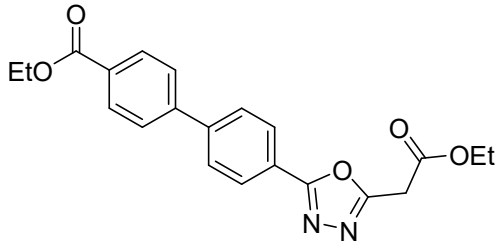
to afford **10**.



*Ethyl 2-(5-phenyl-1,3,4-thiadiazol-2-yl)butanoate (**10**)*. 59 mg, 76% yield; colorless liquid; R_f = 0.42 (EA-Hexane = 1:3, V:V); ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.07–8.00 (m, 2H), 7.54–7.45 (m, 3H), 4.21 (q, J = 7.1 Hz, 2H), 3.98 (t, J = 7.4 Hz, 1H), 2.20 (ddq, J = 33.9, 14.2, 7.4 Hz, 2H), 1.24 (t, J = 7.1 Hz, 3H), 1.03 (t, J = 7.4 Hz, 3H); ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$) δ 169.2, 165.4, 163.8, 131.8, 129.1, 127.0, 123.9, 61.9, 45.2, 23.5, 14.2, 11.9; HRMS (ESI-TOF) m/z calcd for $C_{14}H_{16}N_2NaO_3$ $[M+Na]^+$: 283.1053, found: 283.1057.

(H) Procedure for the Synthesis of 11.

Under N_2 atmosphere, to a solution of **2d** (93 mg, 0.30 mmol) and $Pd(PPh_3)_4$ (17 mg, 0.015 mmol) in dry toluene (5 mL) was added K_2CO_3 (83 mg, 0.60 mmol), 4-ethoxycarbonylphenylboronic acid (116 mg, 0.60 mmol). The vigorously stirred mixture was heated to 90 °C for 5 h (monitored by TLC). After cooling, the mixture was filtered through a pad of celite, the filter cake was washed with EA. The organic mixture was concentrated in vacuo and the residue was purified by column chromatography (EA-Hexane = 1:7) to afford **11**.



*Ethyl 4'-(5-(2-ethoxy-2-oxoethyl)-1,3,4-thiadiazol-2-yl)-[1, 1'-biphenyl]-4-carboxylate (**11**)*. 68 mg, 60% yield; white solid; R_f = 0.26 (EA-Hexane = 1:3, *V:V*); m.p. 87-88 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.13 (d, *J* = 8.0 Hz, 4H), 7.74 (d, *J* = 7.9 Hz, 2H), 7.68 (d, *J* = 7.9 Hz, 2H), 4.40 (q, *J* = 7.1 Hz, 2H), 4.25 (q, *J* = 7.1 Hz, 2H), 4.05 (s, 2H), 1.41 (t, *J* = 7.1 Hz, 3H), 1.29 (t, *J* = 7.1 Hz, 3H); ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$) δ 166.4, 166.4, 165.4, 160.5, 144.0, 143.4, 130.3, 130.2, 128.0, 127.6, 127.2, 123.3, 62.3, 61.2, 32.2, 14.4, 14.2; HRMS (ESI-TOF) *m/z* calcd for $C_{21}H_{20}N_2NaO_5$ $[M+Na]^+$: 403.1264, found:403.1255.

Reference:

1 (a) S. A. Carvalho, L. O. Feitosa, M. Soares, T. E. M. M. Costa, M. G. Henriques, K. Salomão, S. L.

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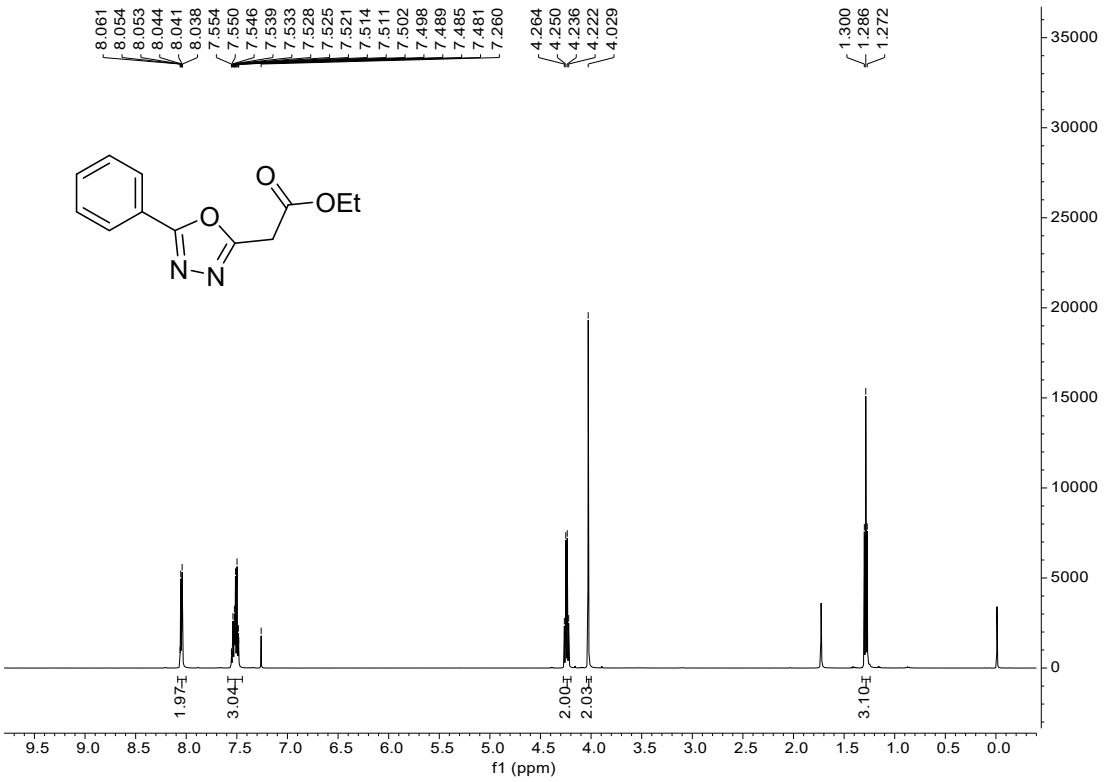
3 (a) N. Lv, Z. Chen, Y. Liu, Z. Liu and Y. Zhang, Synthesis of Functionalized Indenones via Rh-Catalyzed C−H Activation Cascade Reaction, *Org. Lett.*, 2017, **19**, 2588−2591. (b) V. K. Burianova, D. S. Bolotin, A. S. Mikherdov, A. S. Novikov, P. P. Mokolokolo, A. Roodt, V. P. Boyarskiy, D. Dar'in, M. Krasavin, V. V. Suslonov, A. P. Zhdanov, K. Y. Zhizhind and N. T. Kuznetsovd, Mechanism of Generation of *closo*-Decaborato Amidrazones. Intramolecular Non-covalent B–H…π(Ph) Interaction Determines Stabilization of the Configuration Around the Amidrazone C=N Bond, *New J. Chem.*, 2018, **42**, 8693−8703.

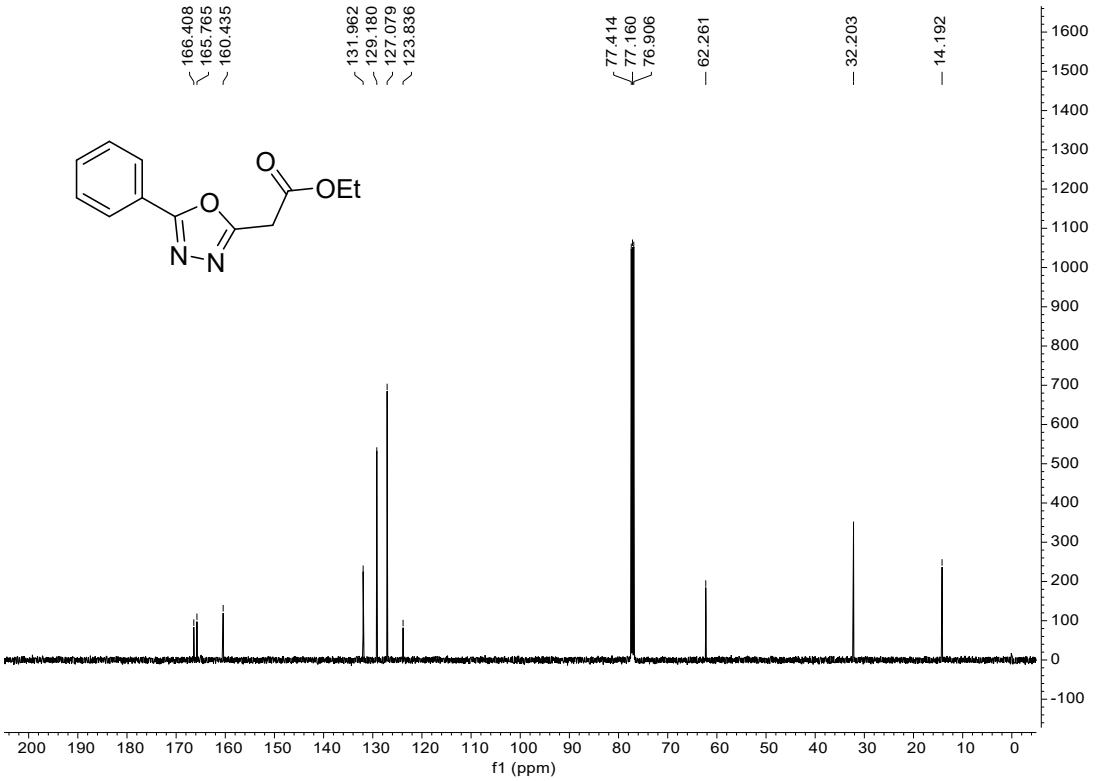
3. NMR Spectra

Ethyl 2-(5-phenyl-1,3,4-oxadiazol-2-yl)acetate (2a)

^{1}H NMR (500 MHz, $CDCl_3$) spectra of **2a**

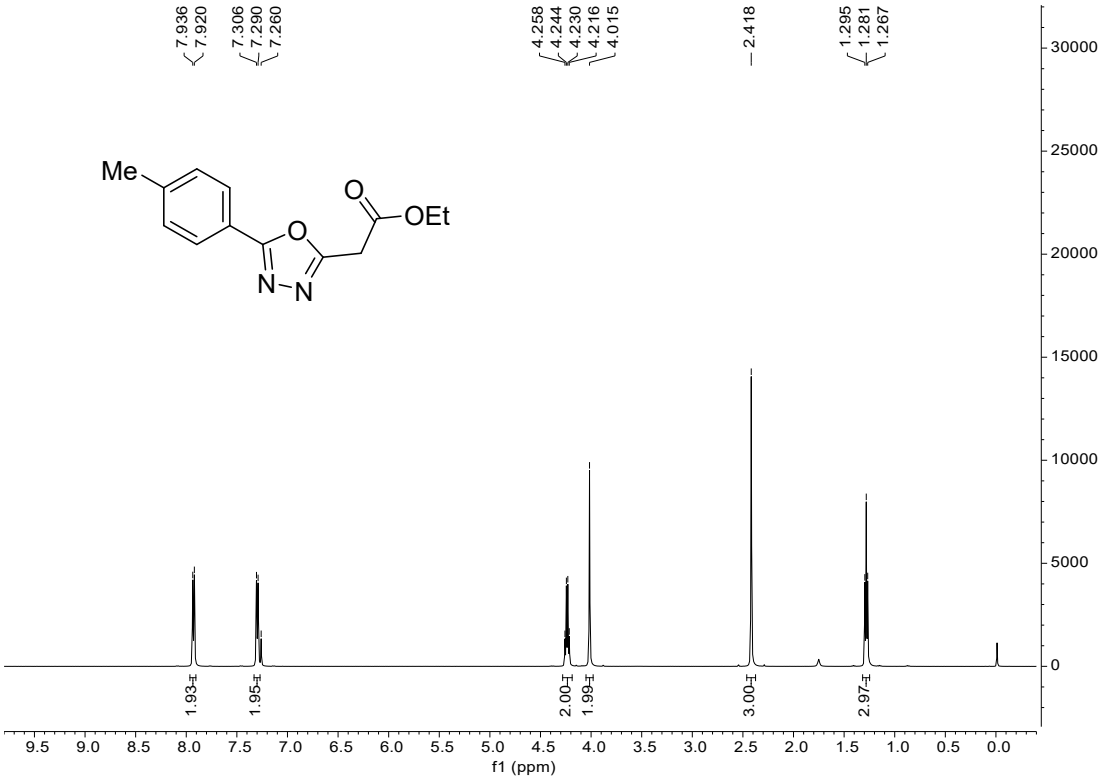


^{13}C NMR (125 MHz, $CDCl_3$) spectra of **2a**

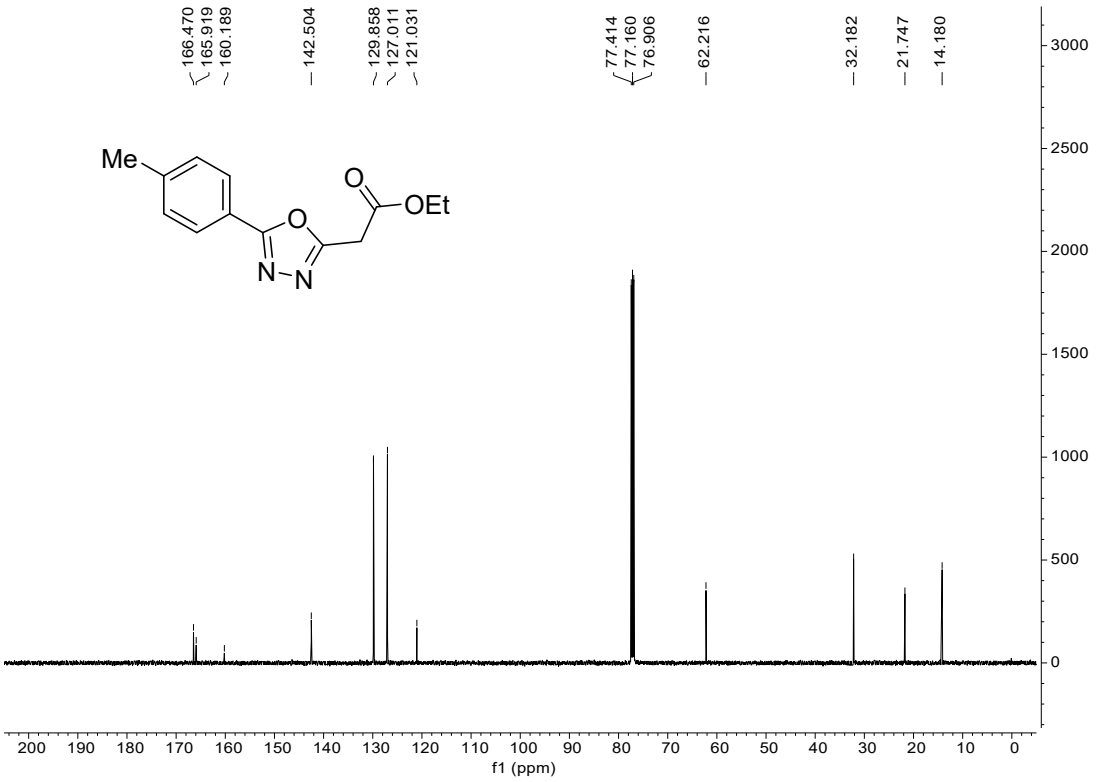


Ethyl 2-(5-(p-tolyl)-1,3,4-oxadiazol-2-yl)acetate (2b)

^{1}H NMR (500 MHz, $CDCl_3$) spectra of **2b**

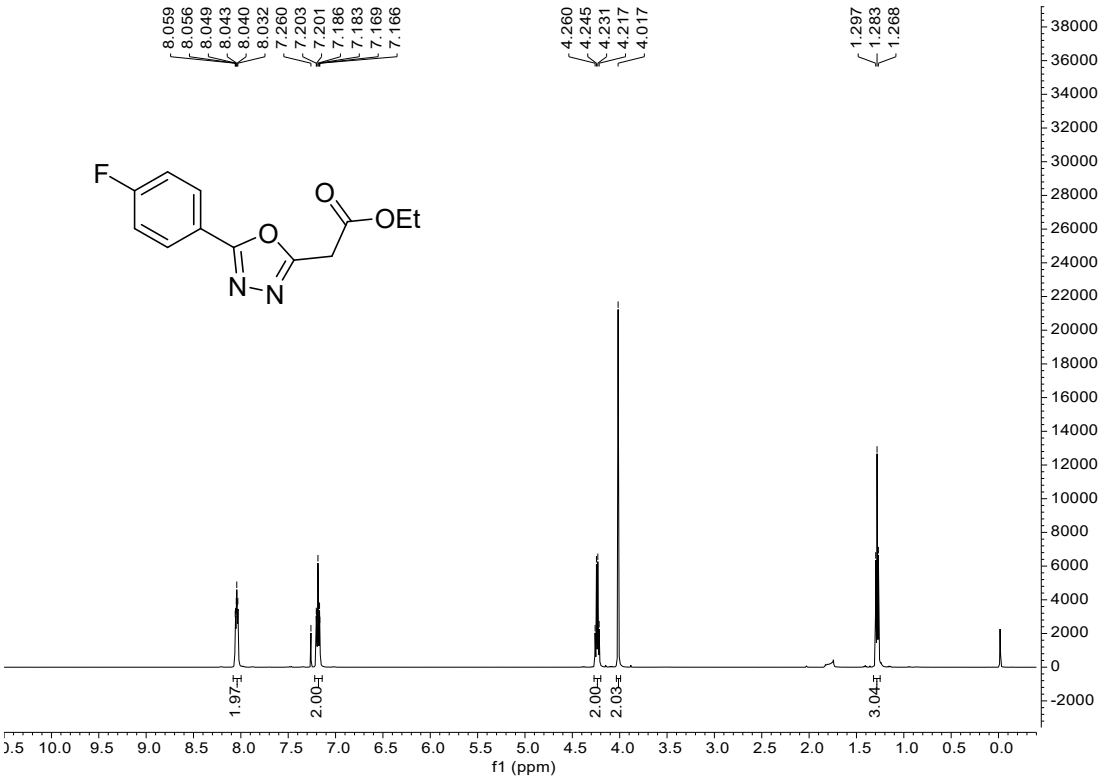


^{13}C NMR (125 MHz, $CDCl_3$) spectra of **2b**

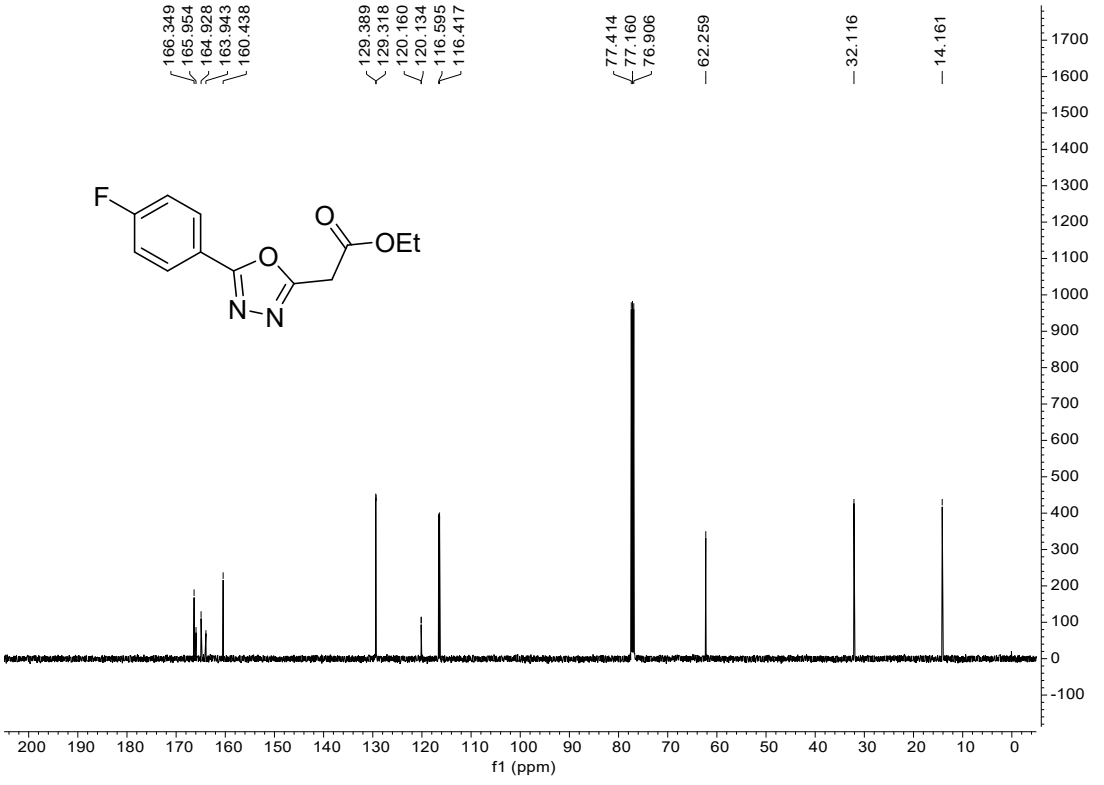


Ethyl 2-(5-(4-fluorophenyl)-1,3,4-thiadiazol-2-yl)acetate (2c)

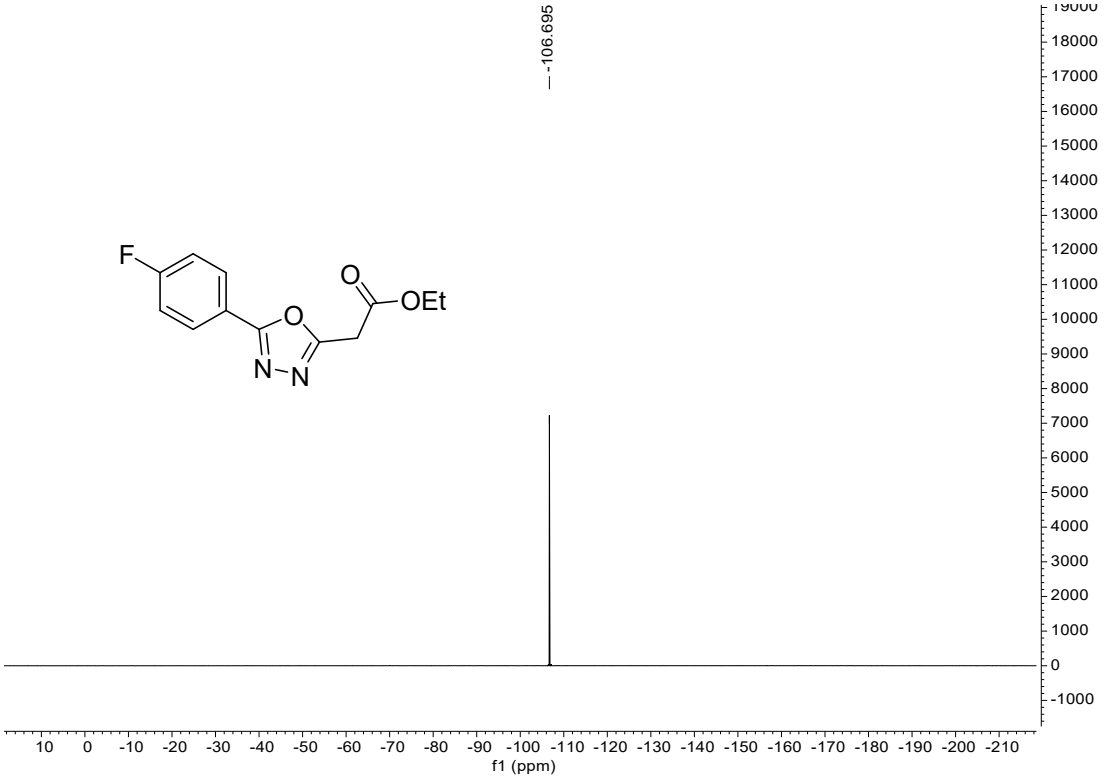
^{1}H NMR (500 MHz, $CDCl_3$) spectra of **2c**



^{13}C NMR (125 MHz, $CDCl_3$) spectra of spectra of **2c**

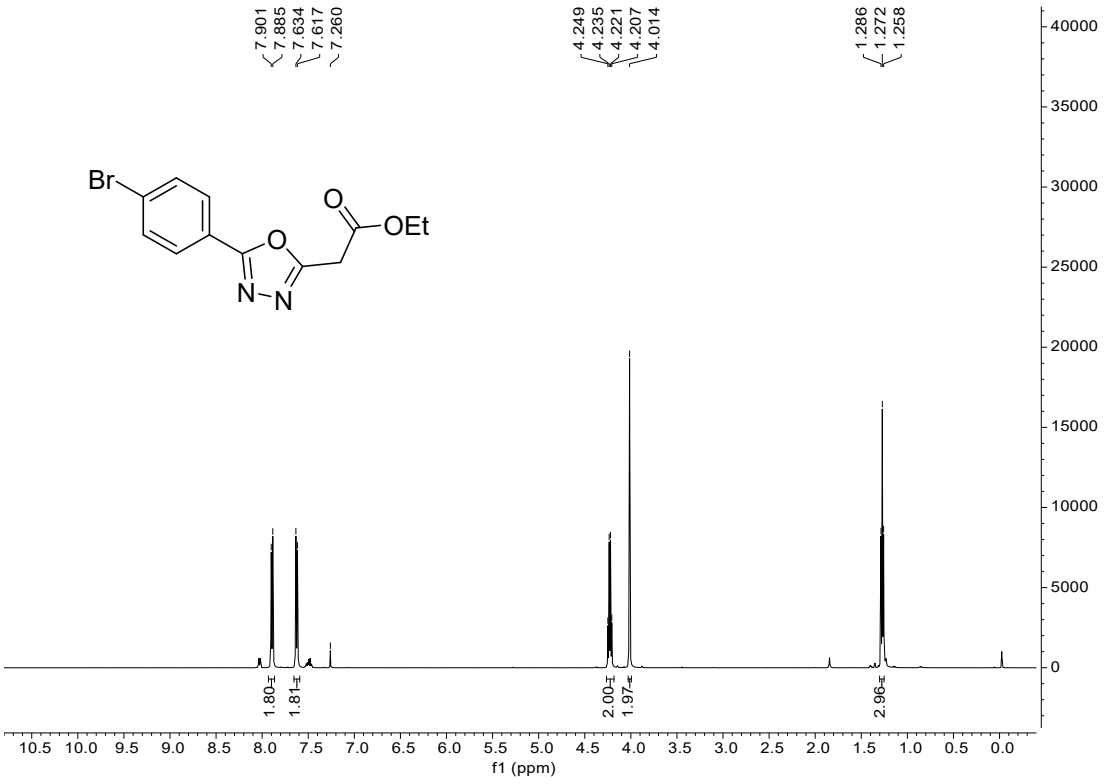


^{19}F NMR (376 MHz, $CDCl_3$) spectra of **2c**

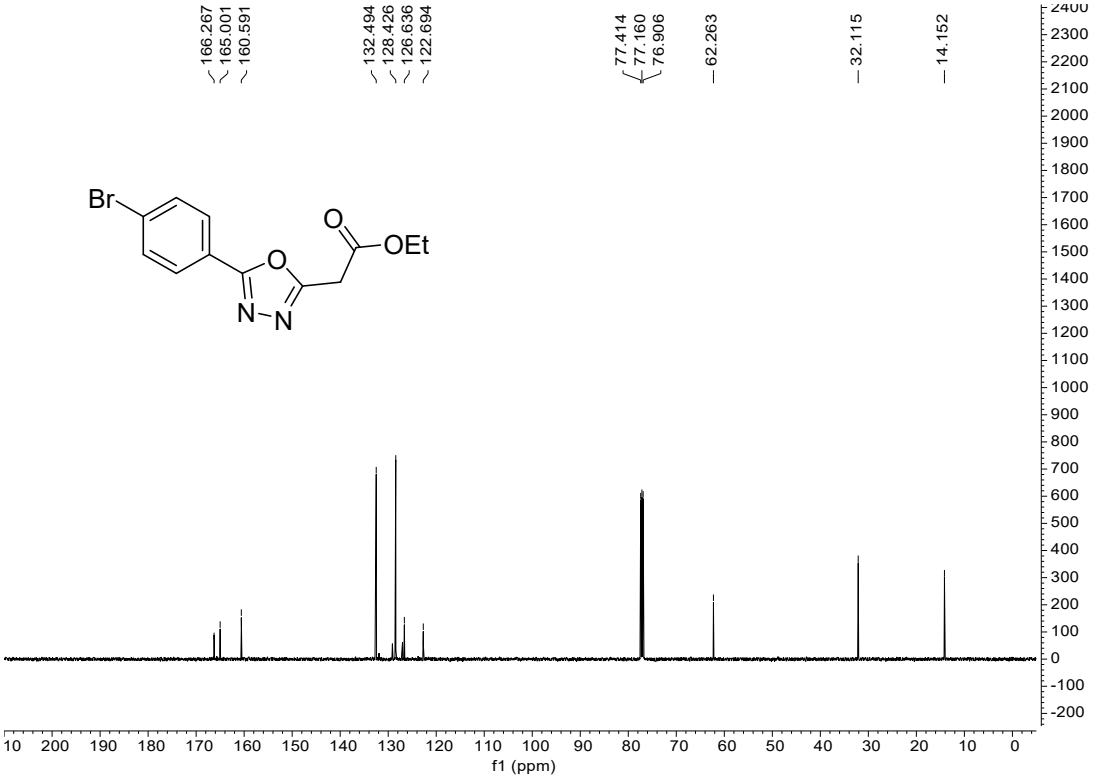


Ethyl 2-(5-(4-bromophenyl)-1,3,4-thiadiazol-2-yl)acetate (2d)

^{1}H NMR (500 MHz, $CDCl_3$) spectra of **2d**

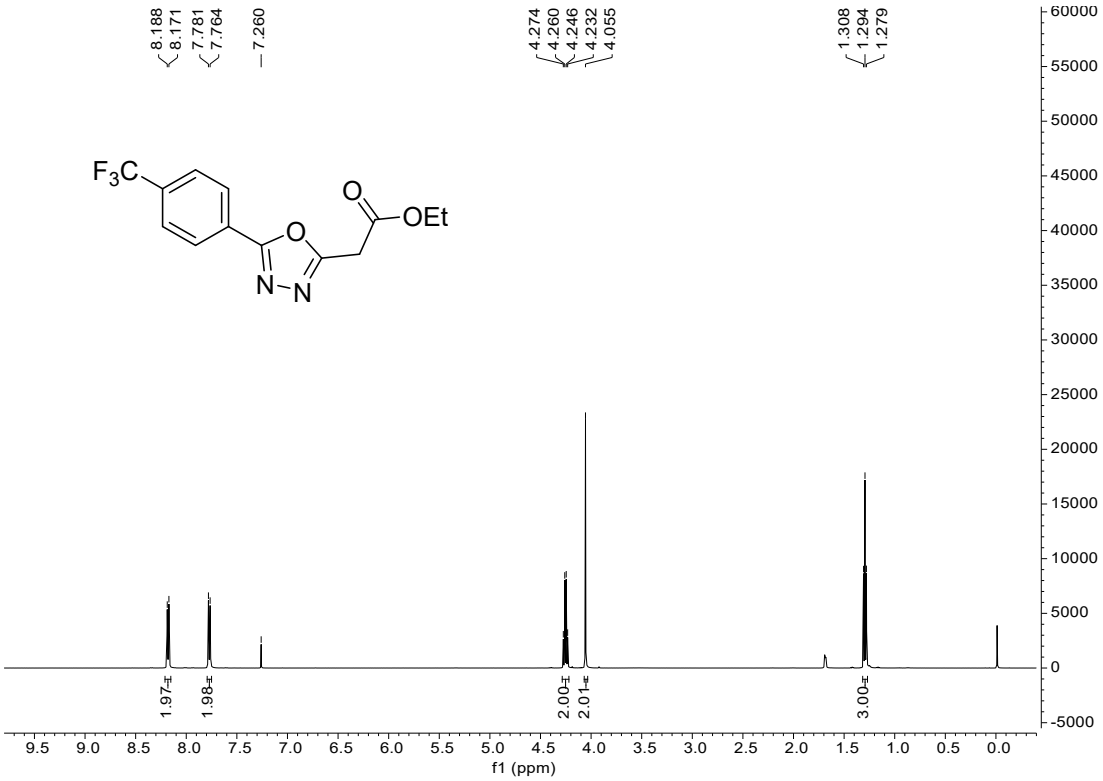


^{13}C NMR (125 MHz, $CDCl_3$) spectra of **2d**

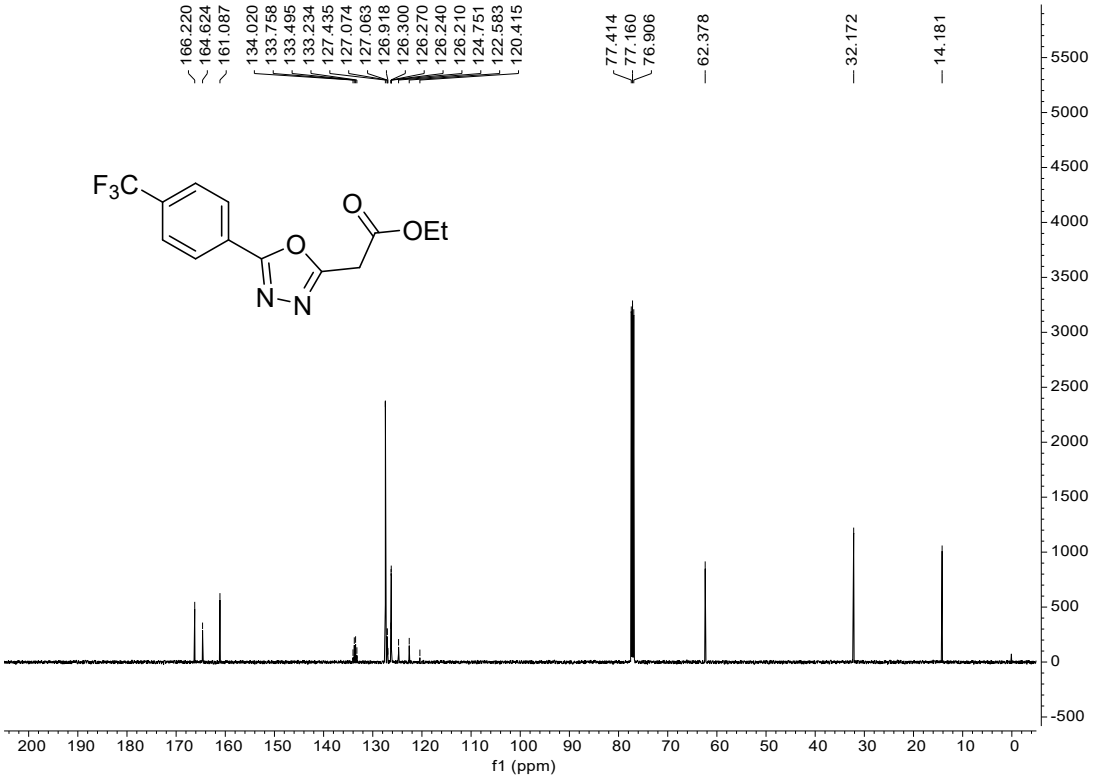


Ethyl 2-(5-(4-(trifluoromethyl)phenyl)-1,3,4-oxadiazol-2-yl)acetate (2e)

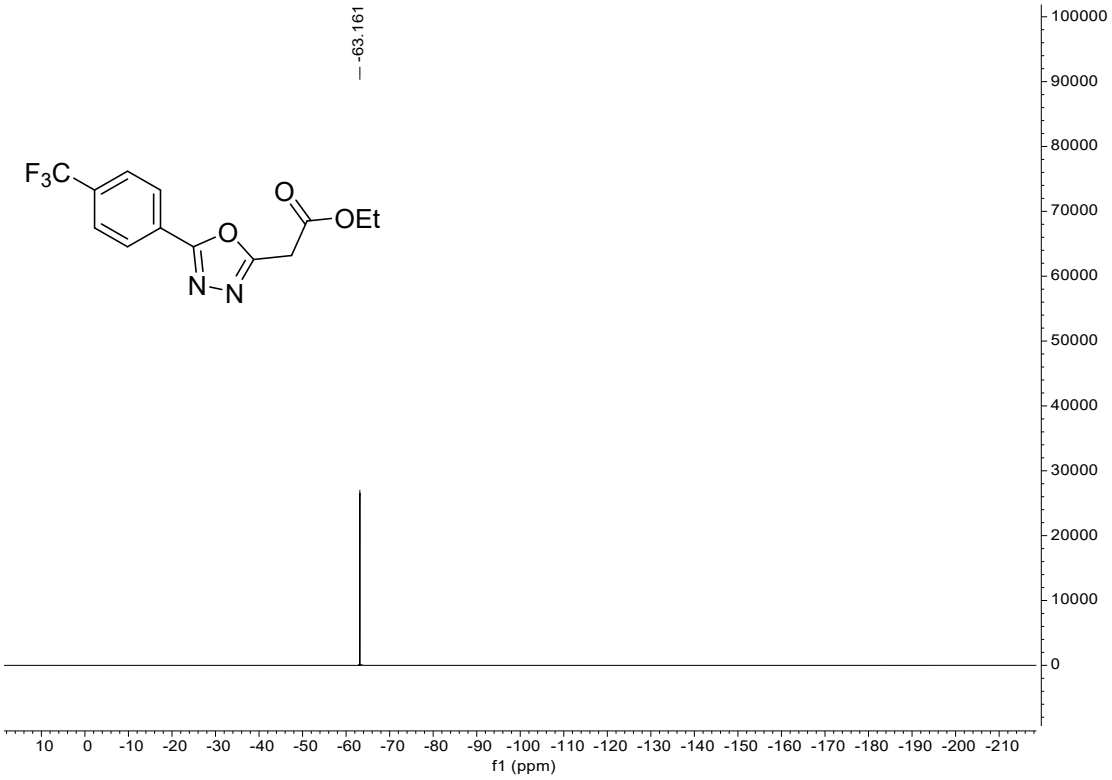
^{1}H NMR (500 MHz, $CDCl_3$) spectra of **2e**



^{13}C NMR (125 MHz, $CDCl_3$) spectra of **2e**

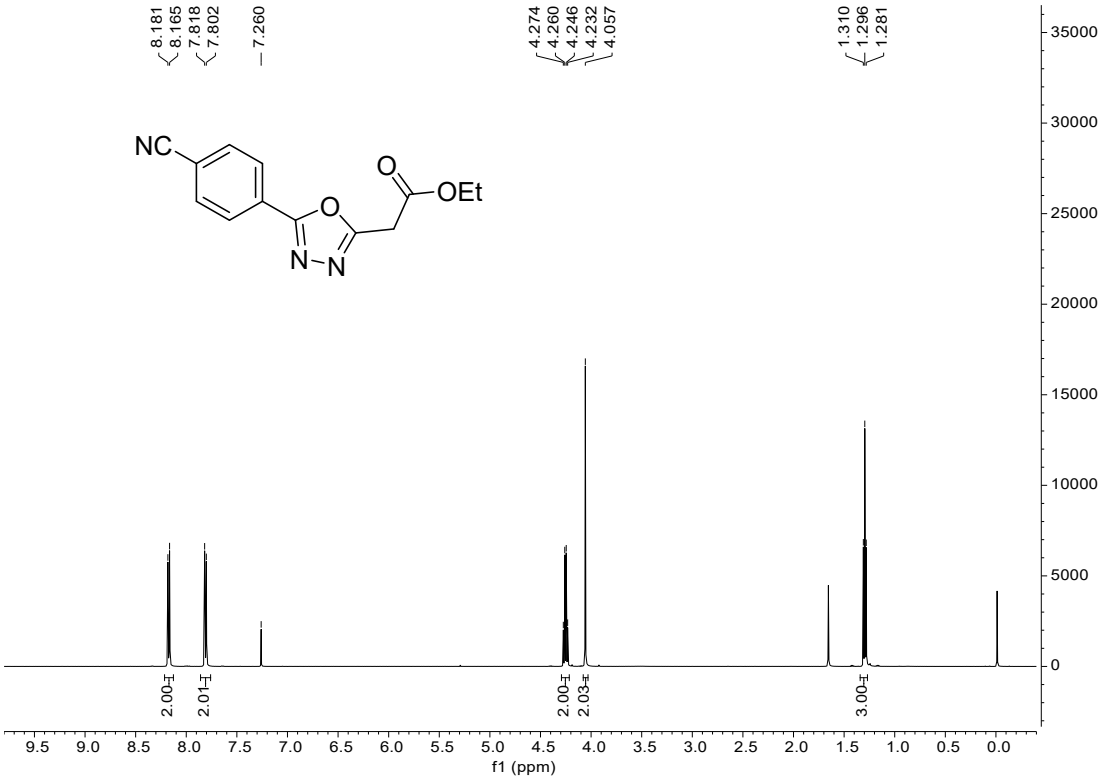


^{19}F NMR (376 MHz, $CDCl_3$) spectra of **2e**

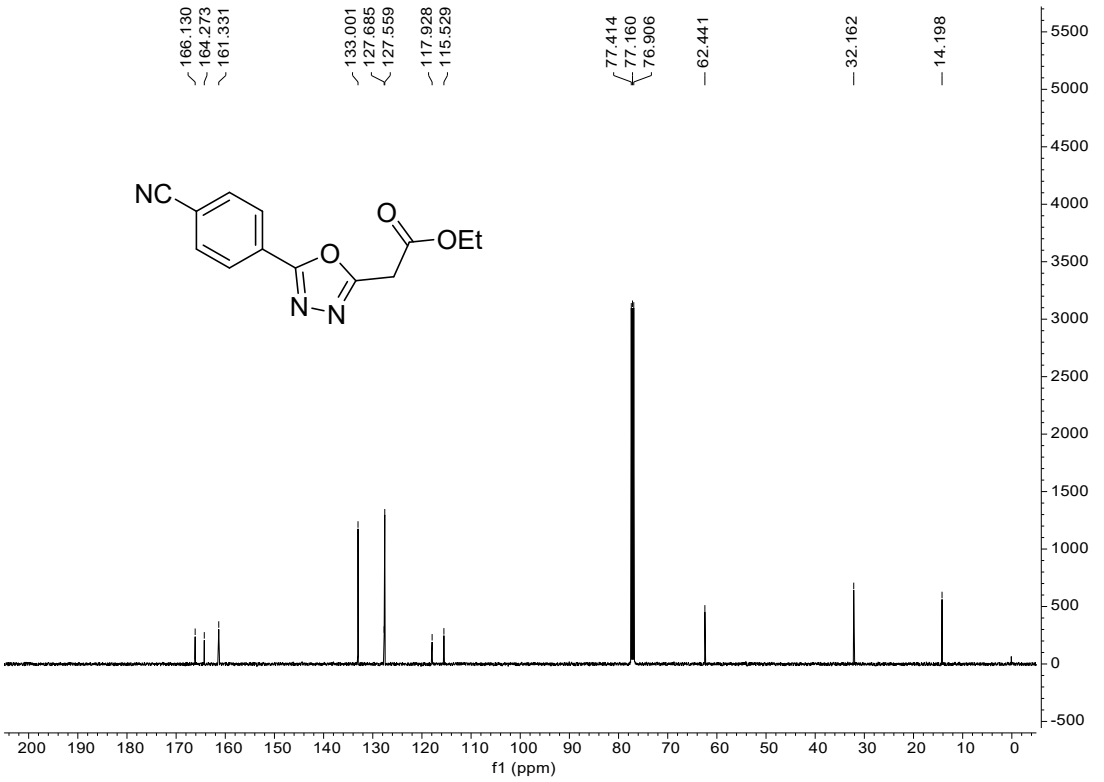


Ethyl 2-(5-(4-cyanophenyl)-1,3,4-oxadiazol-2-yl)acetate (2f)

^{1}H NMR (500 MHz, $CDCl_3$) spectra of **2f**

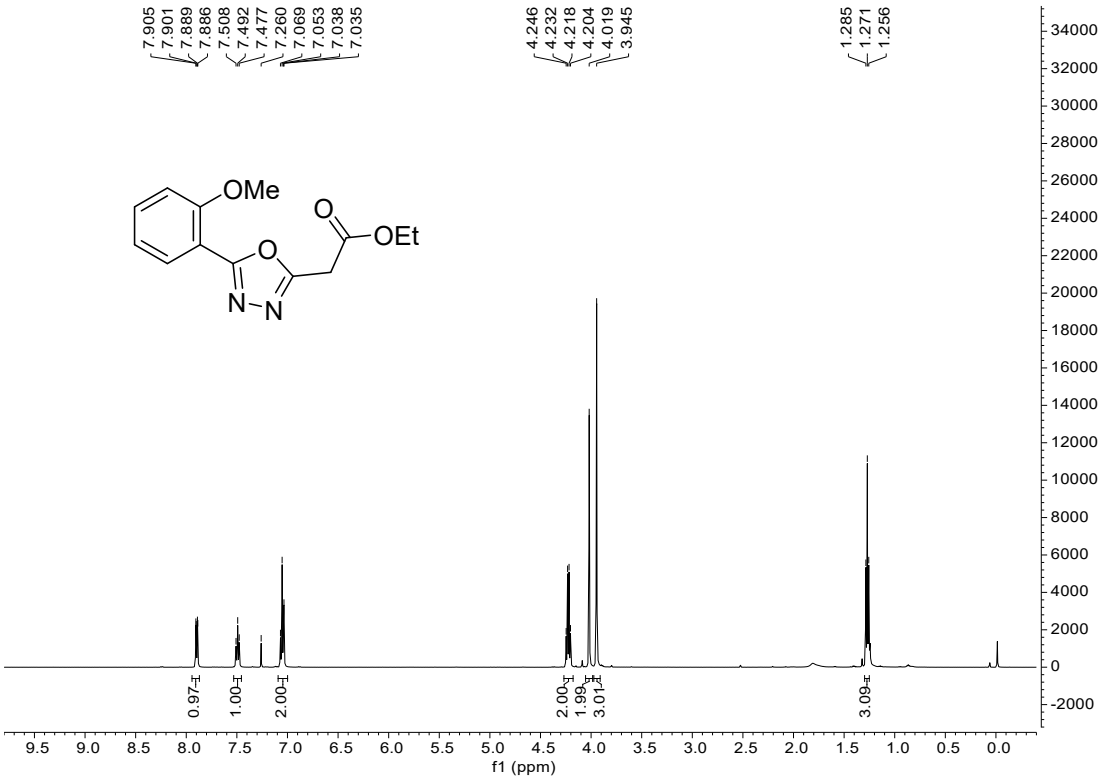


^{13}C NMR (125 MHz, $CDCl_3$) spectra of **2f**

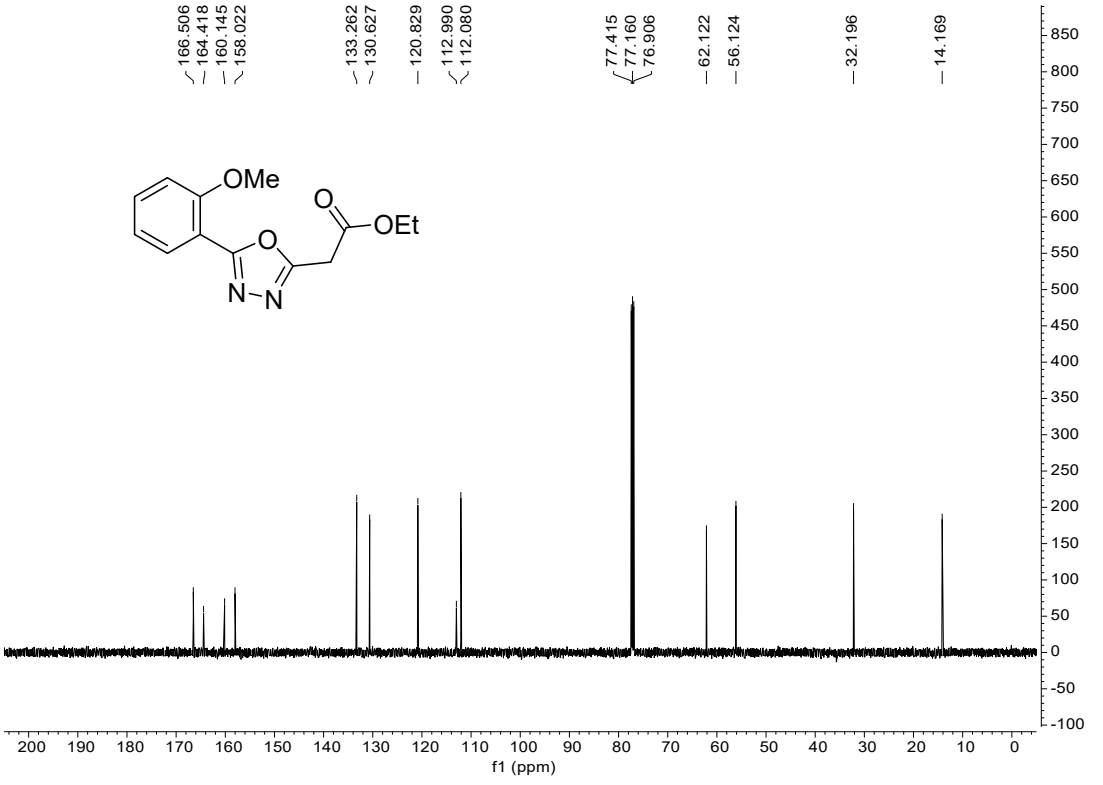


Ethyl 2-(5-(2-methoxyphenyl)-1,3,4-oxadiazol-2-yl)acetate (2g)

^{1}H NMR (500 MHz, $CDCl_3$) spectra of **2g**

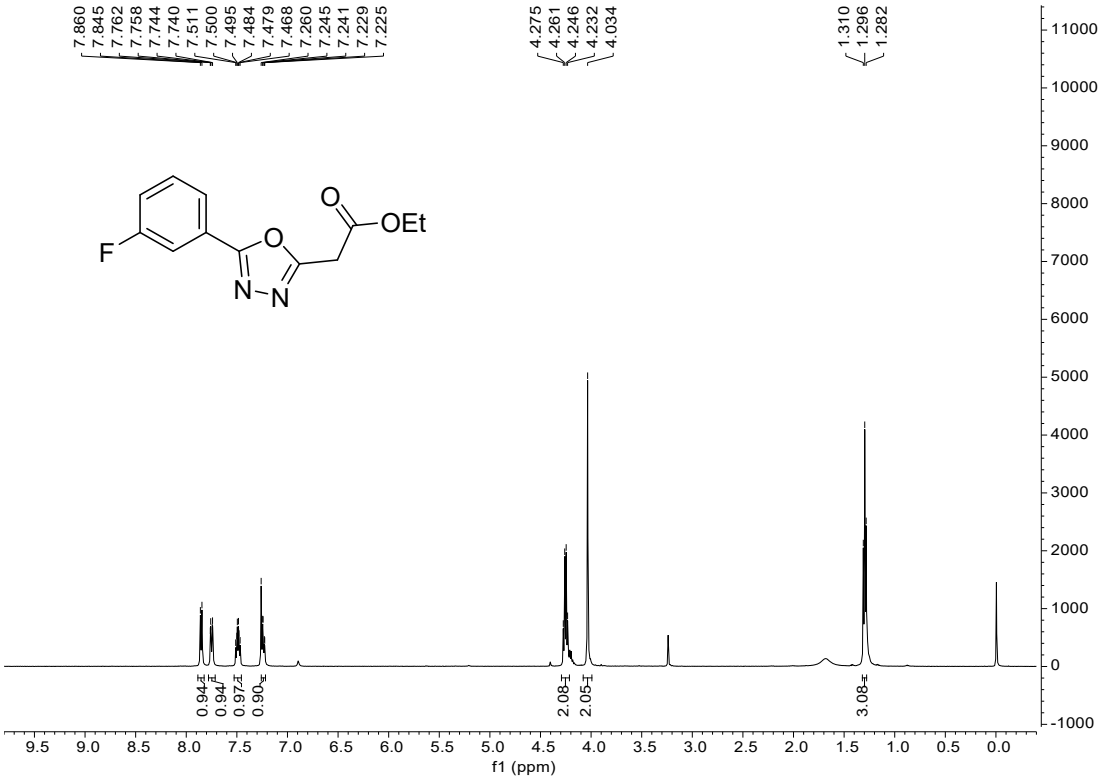


^{13}C NMR (125 MHz, $CDCl_3$) spectra of **2g**

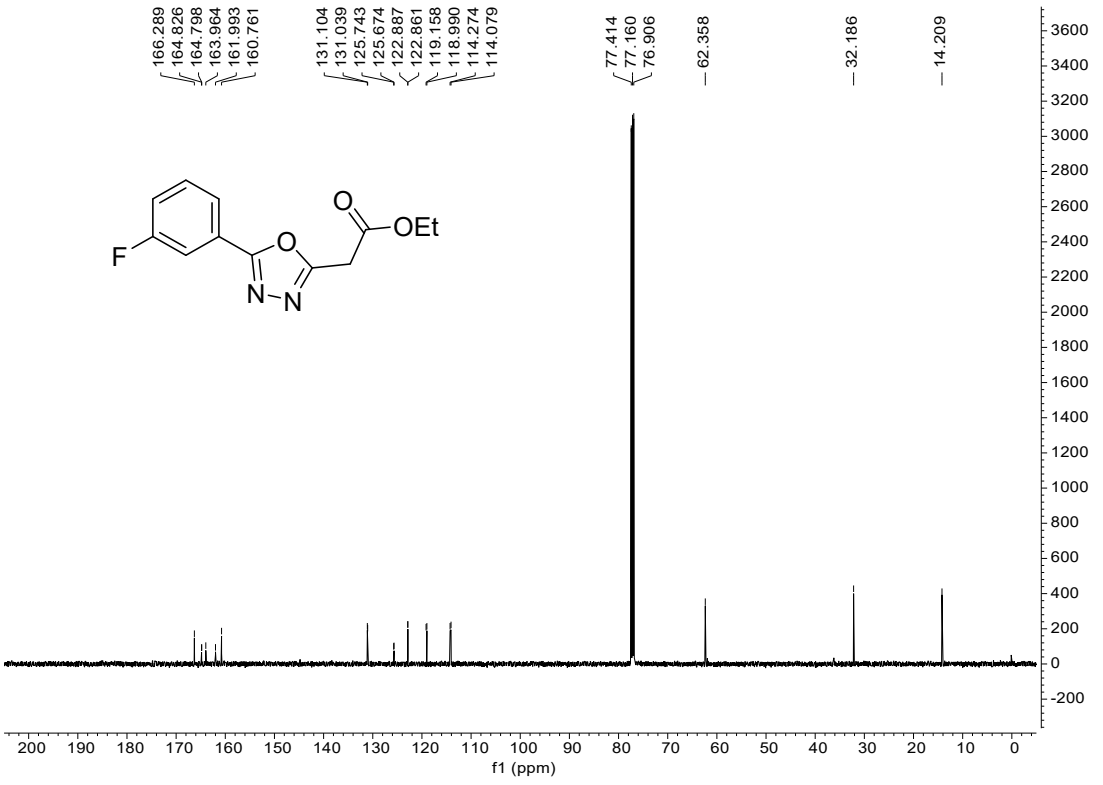


Ethyl 2-(5-(3-fluorophenyl)-1,3,4-oxadiazol-2-yl)acetate (2h)

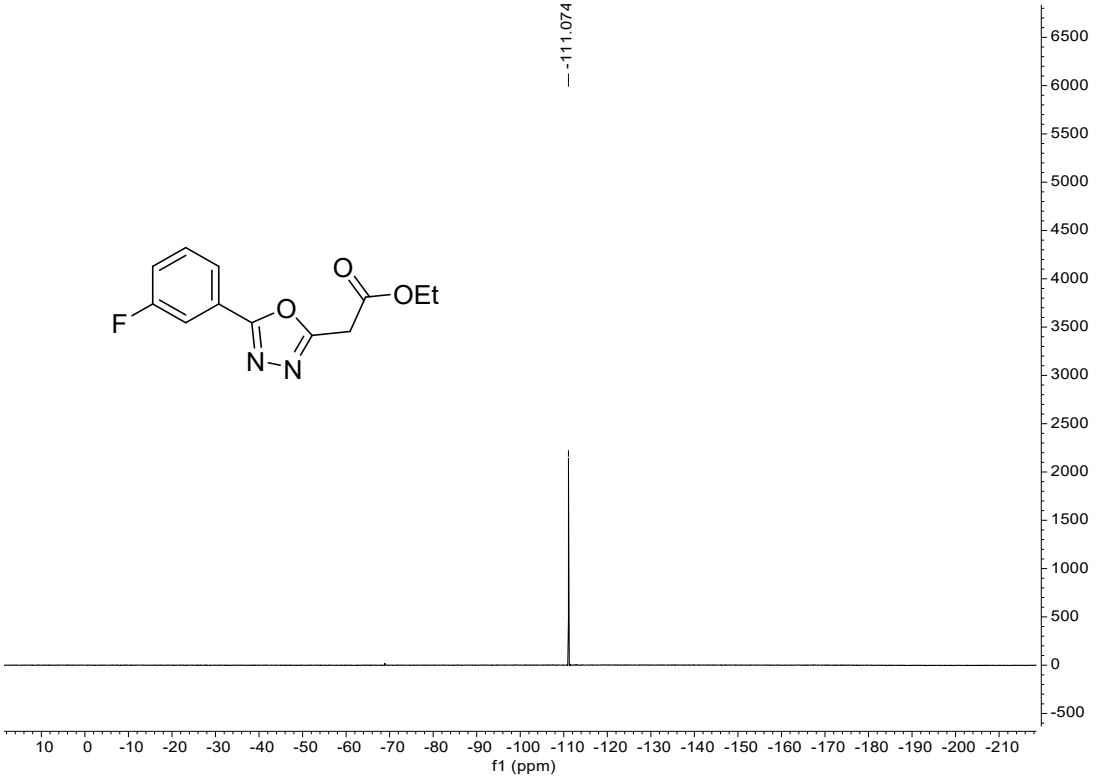
^{1}H NMR (500 MHz, $CDCl_3$) spectra of **2h**



^{13}C NMR (125 MHz, $CDCl_3$) spectra of **2h**

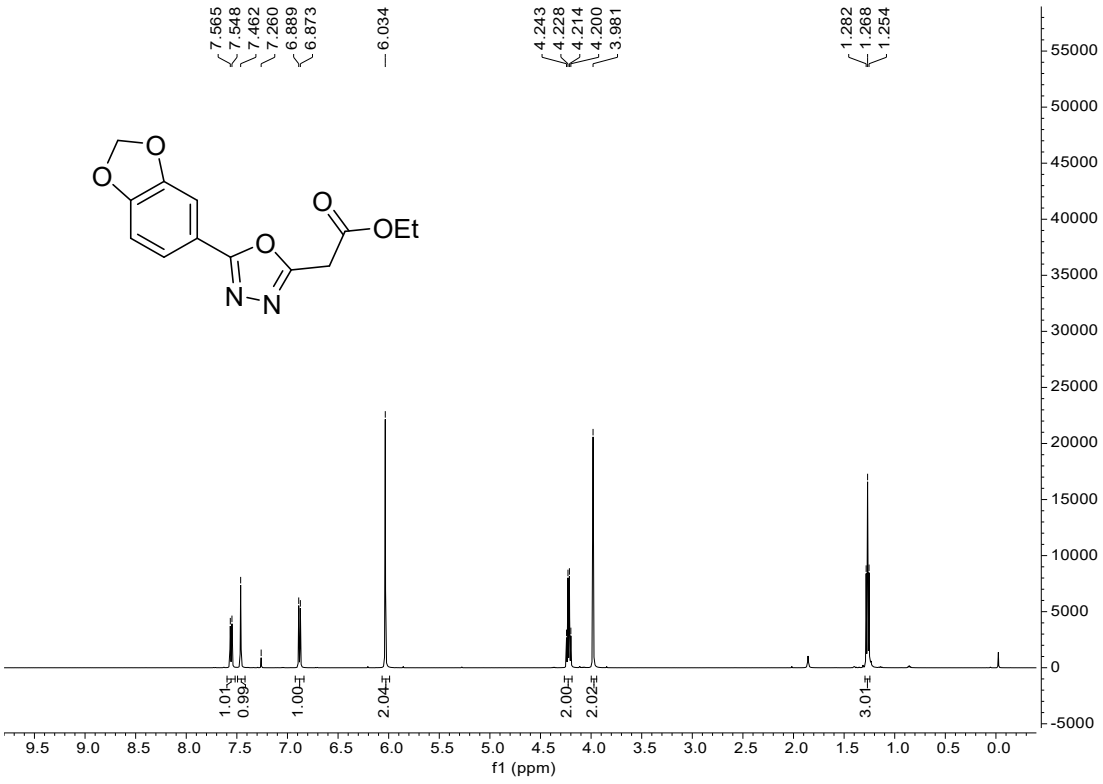


^{19}F NMR (376 MHz, $CDCl_3$) spectra of **2h**

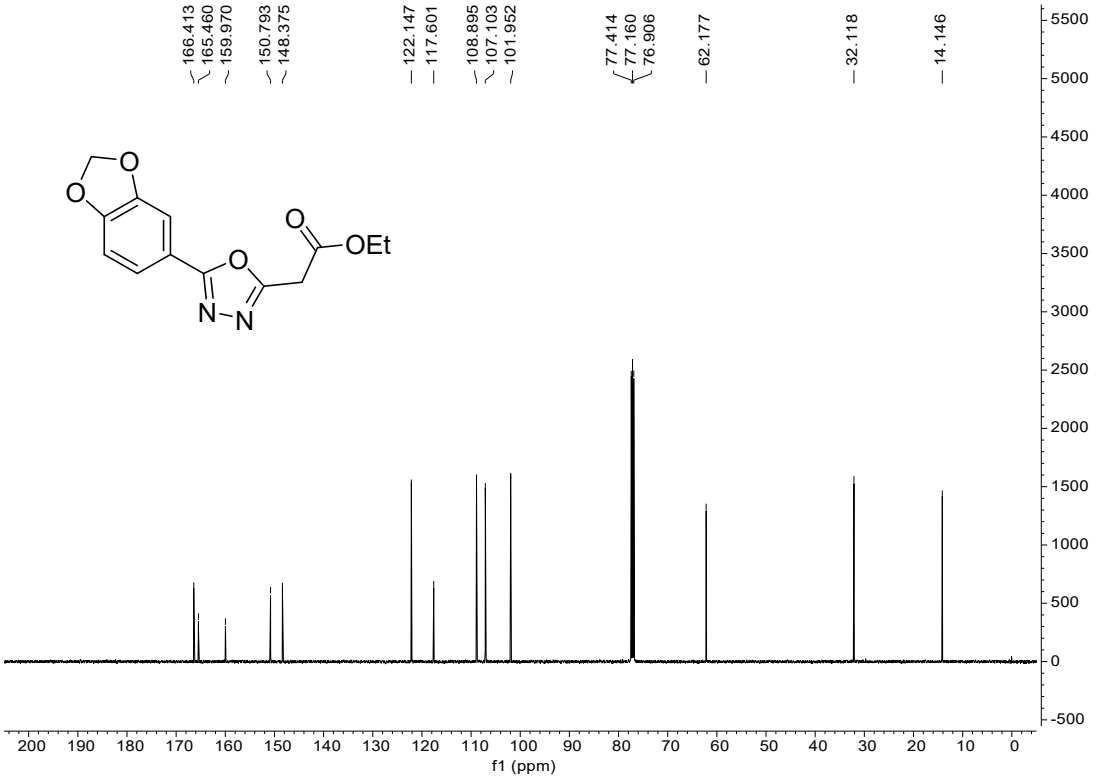


Ethyl 2-(5-(benzo[d][1,3]dioxol-5-yl)-1,3,4-oxadiazol-2-yl)acetate (2i)

^{1}H NMR (500 MHz, $CDCl_3$) spectra of **2i**

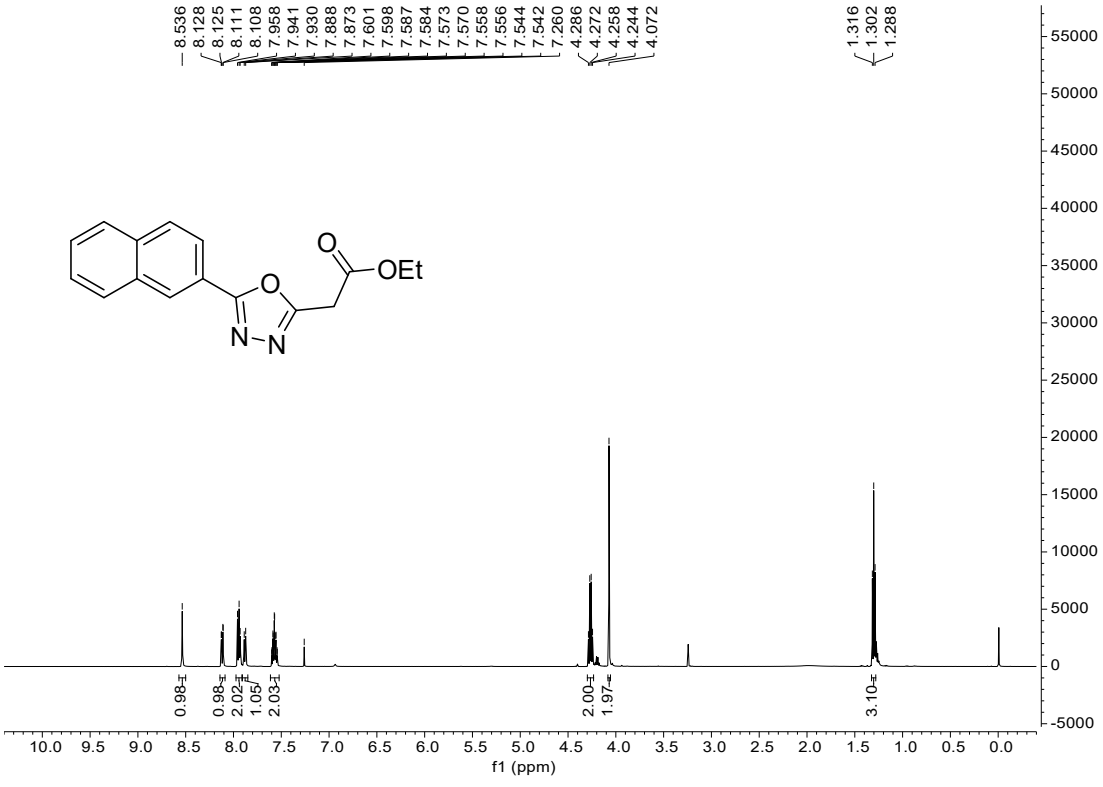


^{13}C NMR (125 MHz, $CDCl_3$) spectra of **2i**

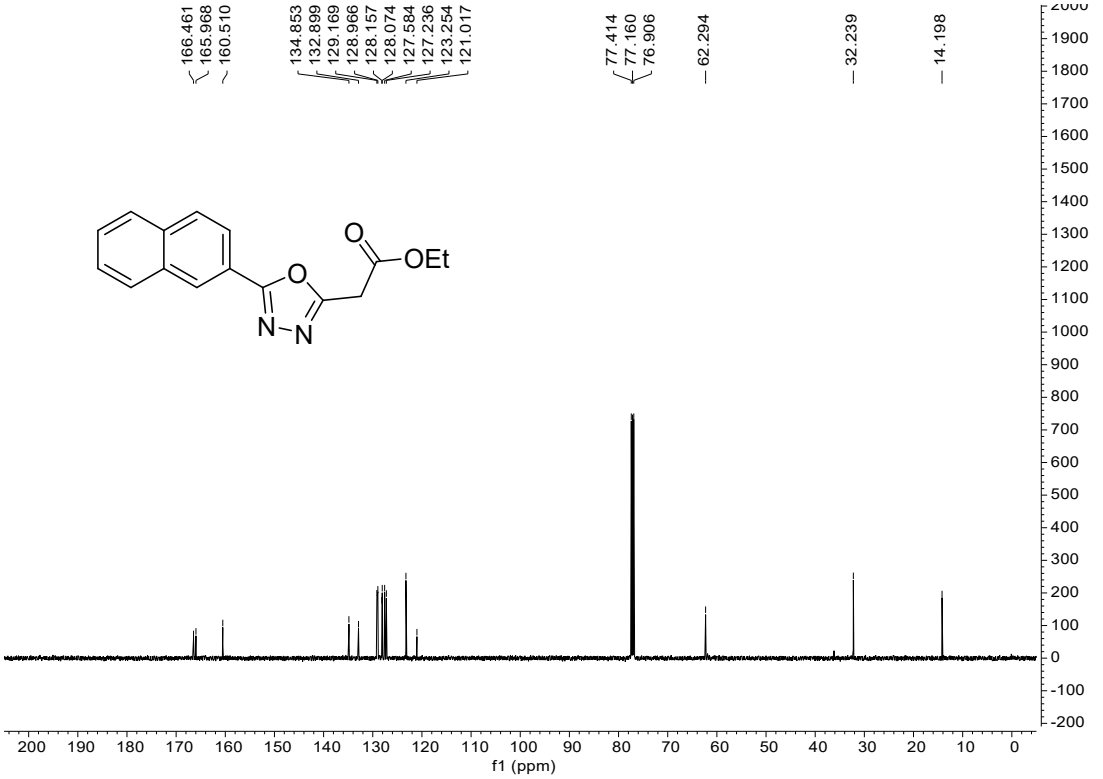


Ethyl 2-(5-(naphthalen-2-yl)-1,3,4-oxadiazol-2-yl)acetate (2j)

^{1}H NMR (500 MHz, $CDCl_3$) spectra of **2j**

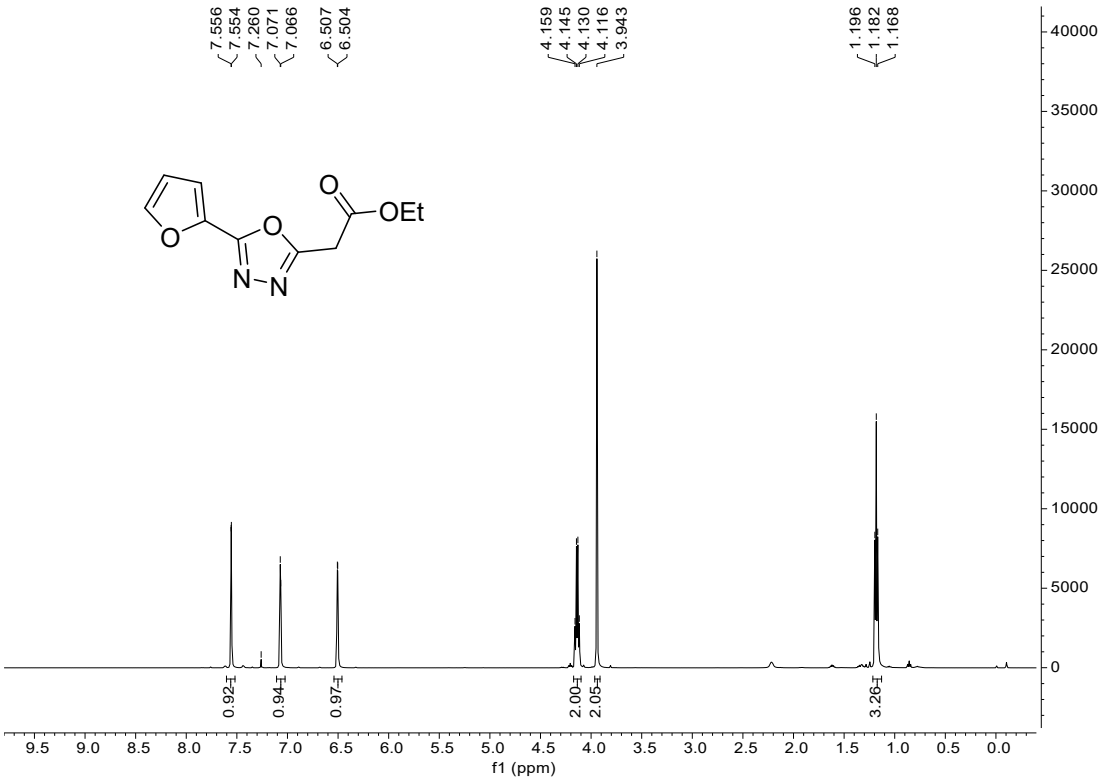


^{13}C NMR (125 MHz, $CDCl_3$) spectra of **2j**

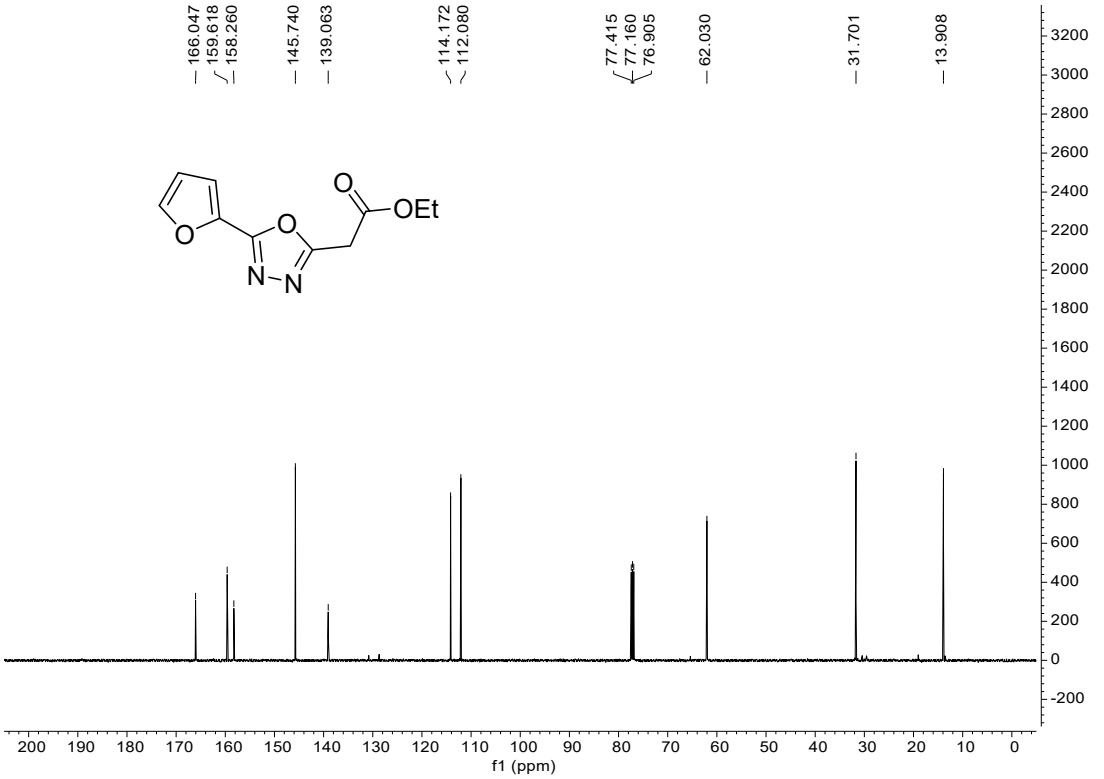


Ethyl 2-(5-(furan-2-yl)-1,3,4-oxadiazol-2-yl)acetate (2k)

^{1}H NMR (500 MHz, $CDCl_3$) spectra of **2k**

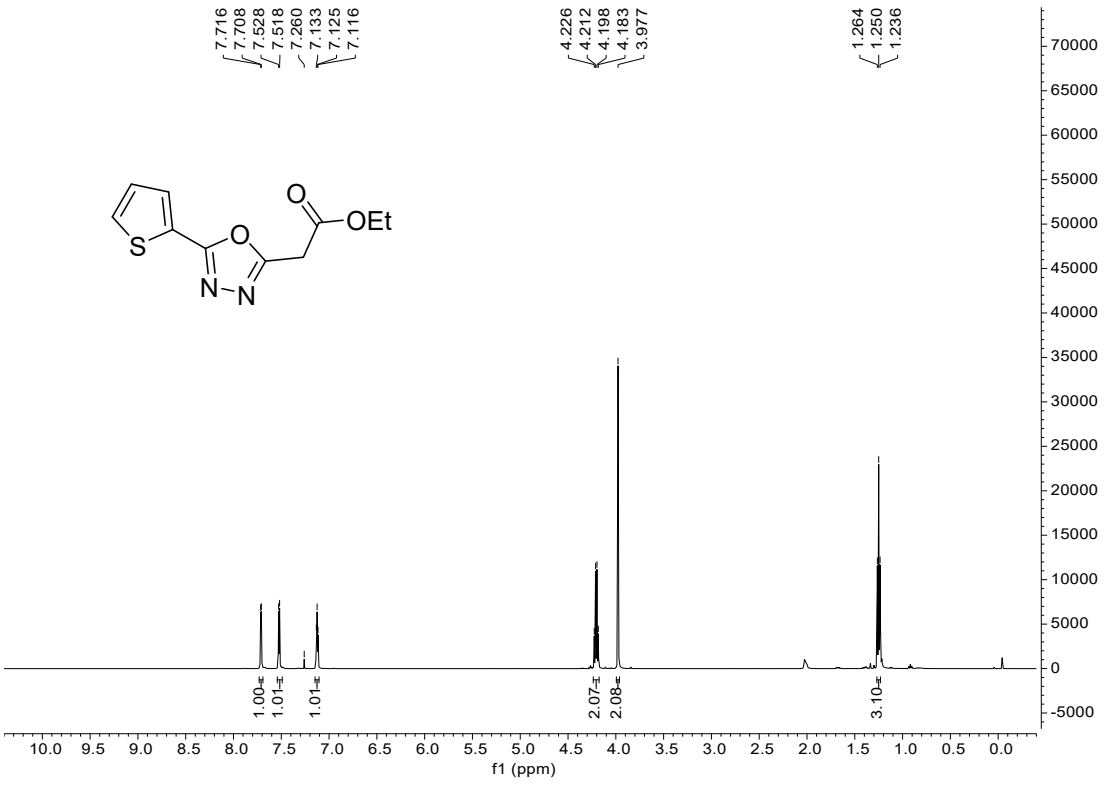


^{13}C NMR (125 MHz, $CDCl_3$) spectra of **2k**

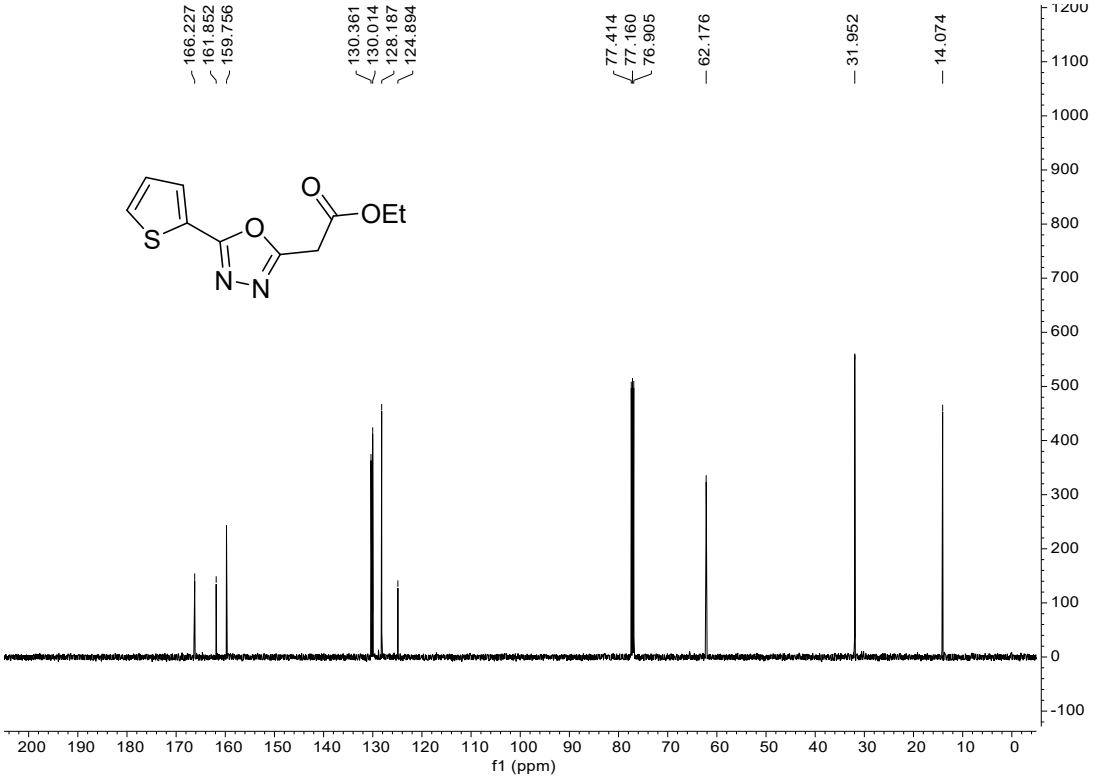


Ethyl 2-(5-(thiophen-2-yl)-1,3,4-oxadiazol-2-yl)acetate (2l)

^{1}H NMR (500 MHz, $CDCl_3$) spectra of **2l**

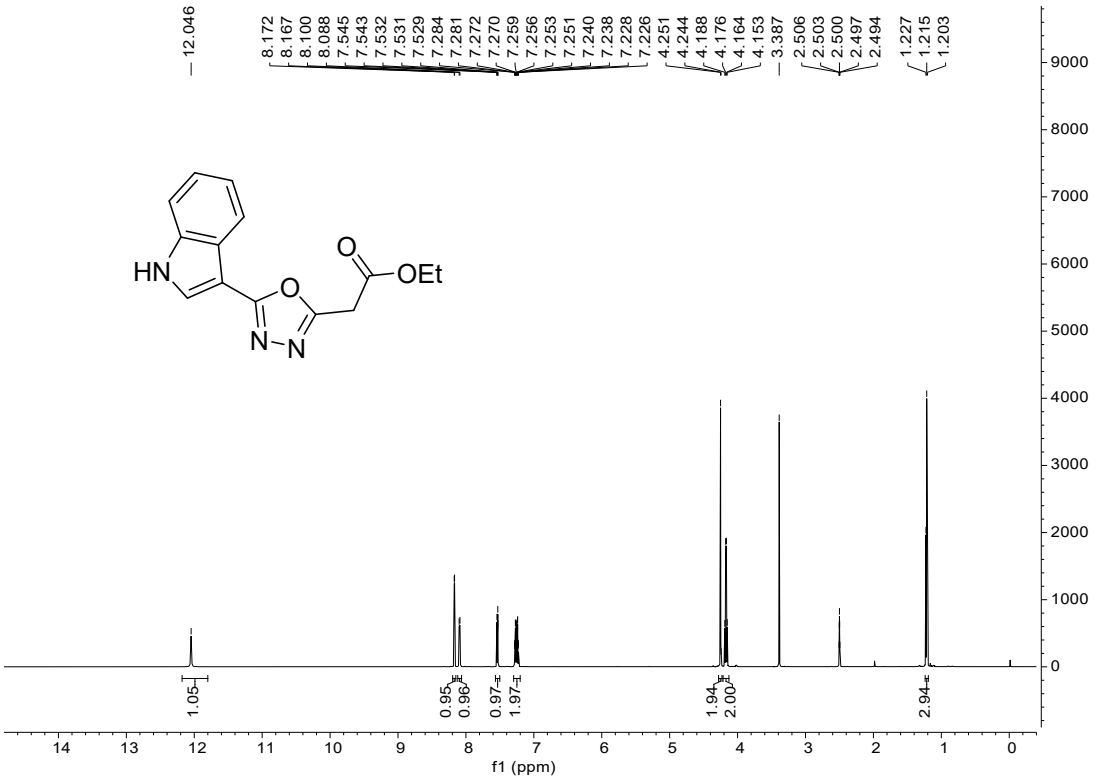


^{13}C NMR (125 MHz, $CDCl_3$) spectra of **2l**

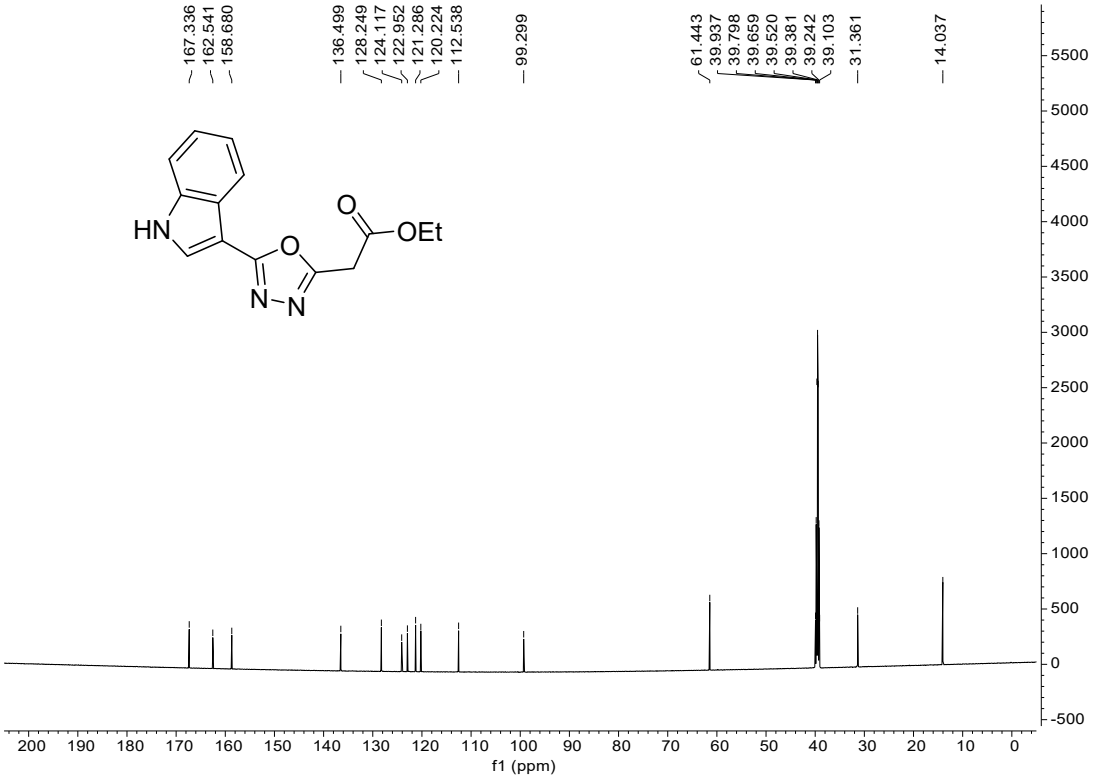


Ethyl 2-(5-(1H-indol-3-yl)-1,3,4-oxadiazol-2-yl)acetate (2m)

^{1}H NMR (600 MHz, DMSO-d_6) spectra of **2m**

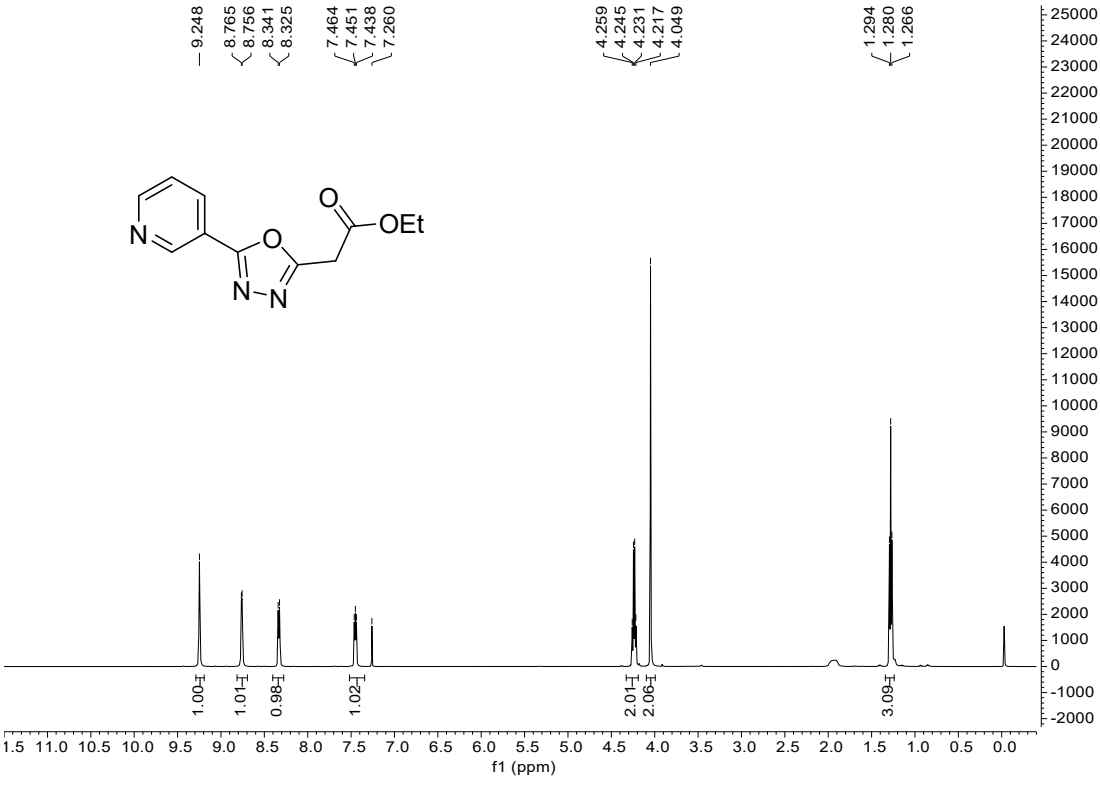


^{13}C NMR (150 MHz, DMSO-d_6) spectra of **2m**

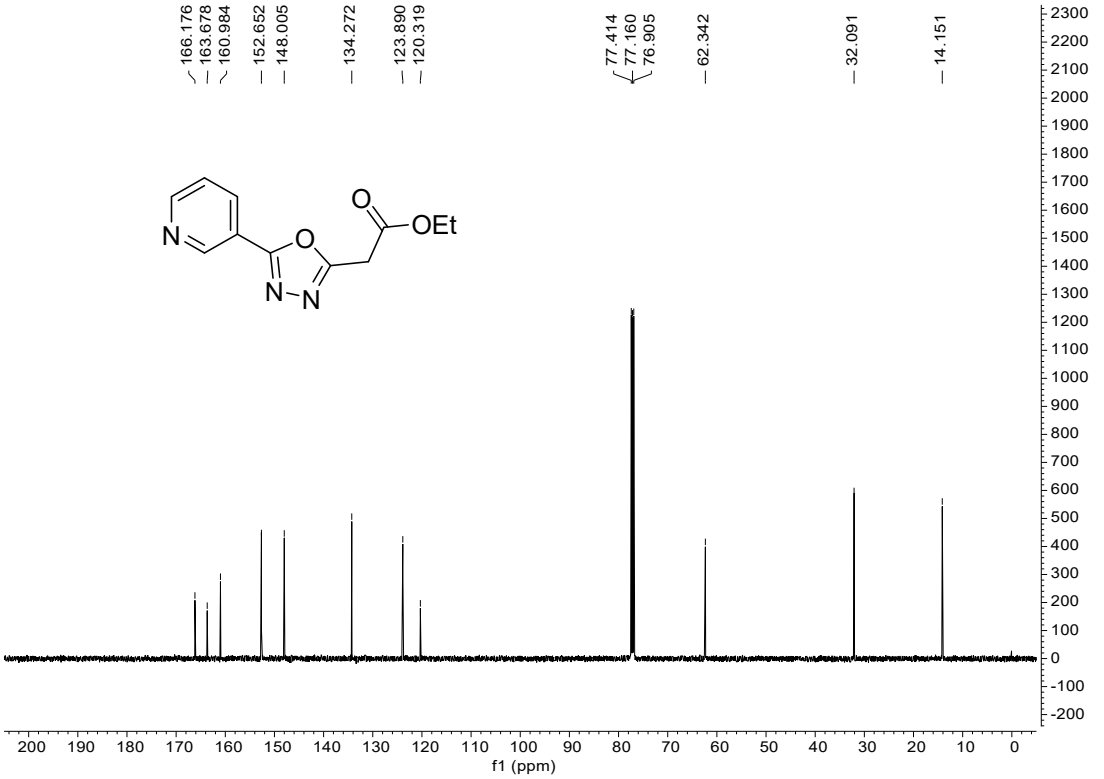


Ethyl 2-(5-(pyridin-3-yl)-1,3,4-oxadiazol-2-yl)acetate (2n)

^{1}H NMR (500 MHz, $CDCl_3$) spectra of **2n**

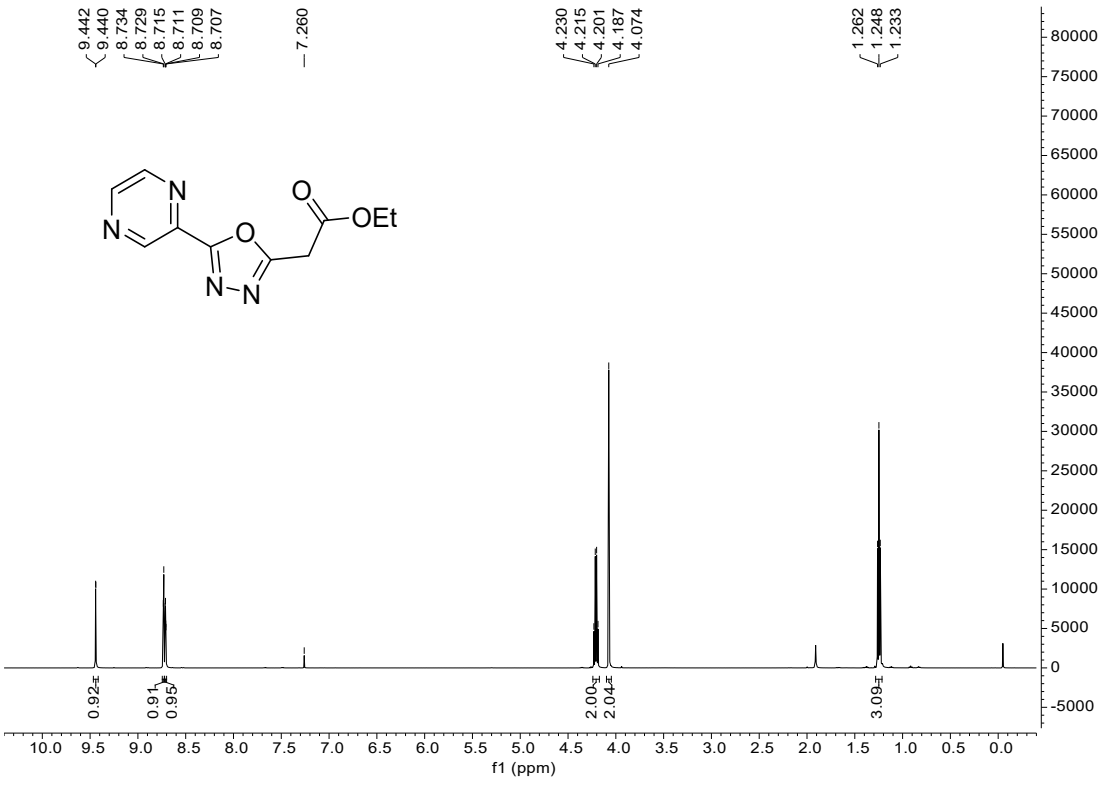


^{13}C NMR (125 MHz, $CDCl_3$) spectra of **2n**

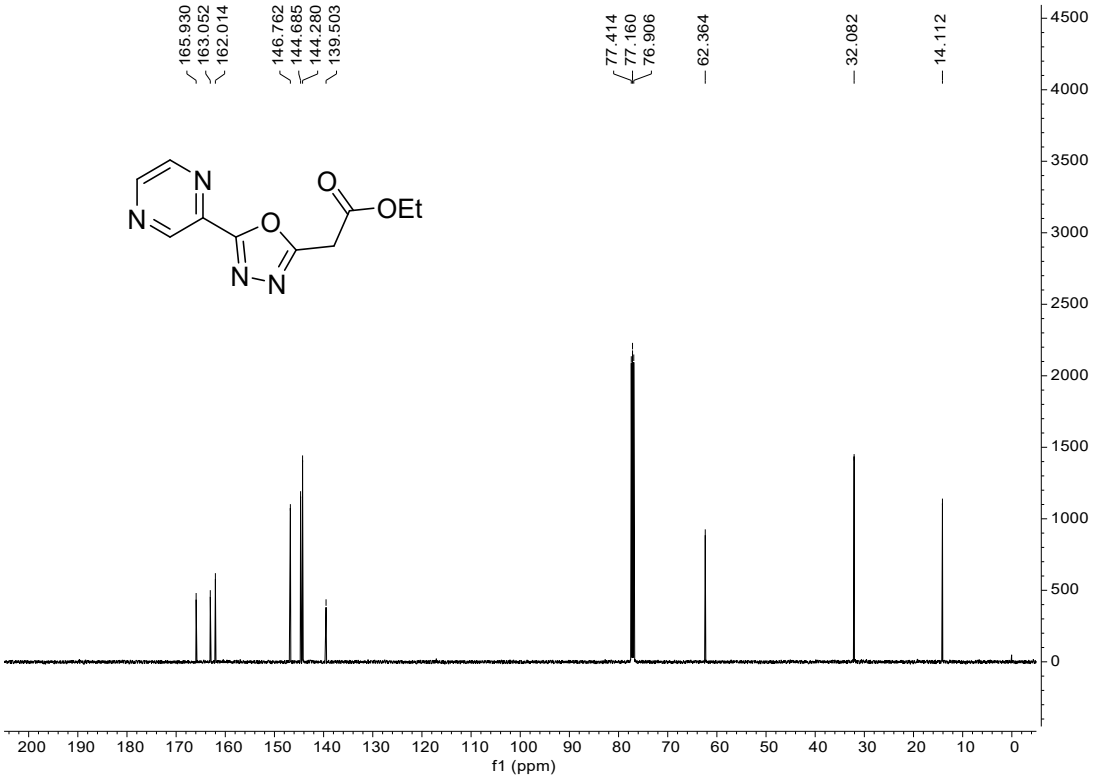


Ethyl 2-(5-(pyrazin-2-yl)-1,3,4-oxadiazol-2-yl)acetate (2o)

^{1}H NMR (500 MHz, $CDCl_3$) spectra of **2o**

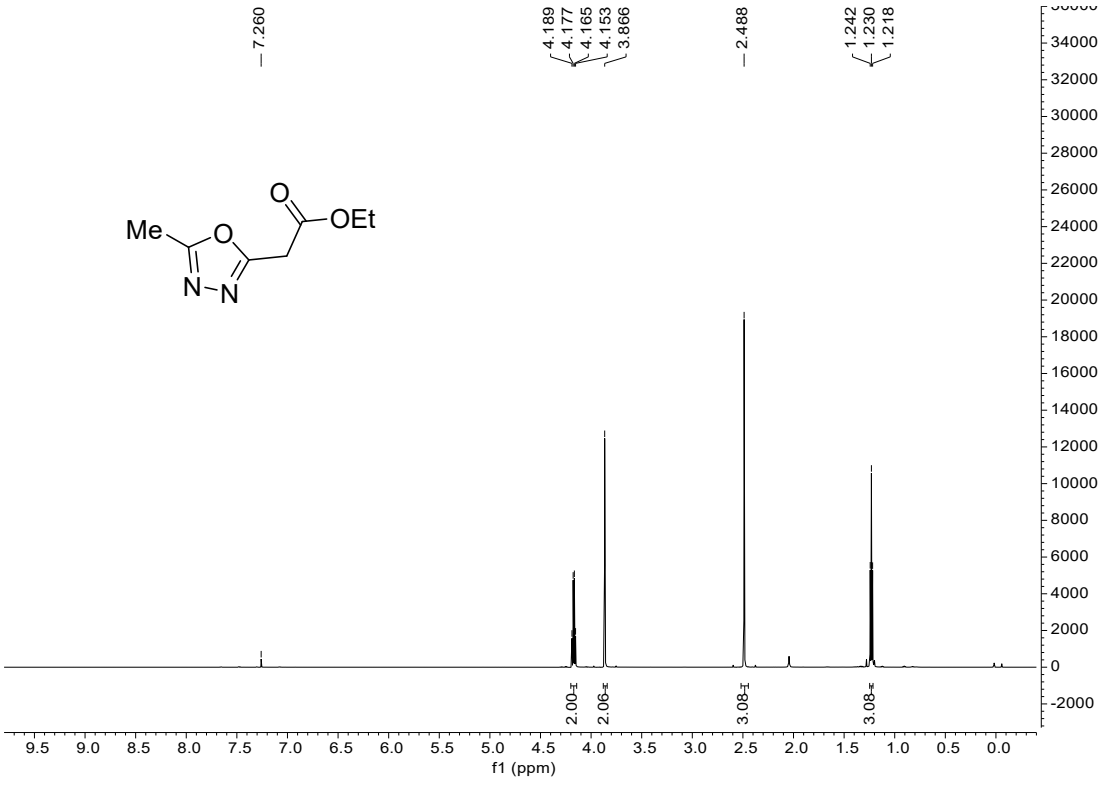


^{13}C NMR (125 MHz, $CDCl_3$) spectra of **2o**

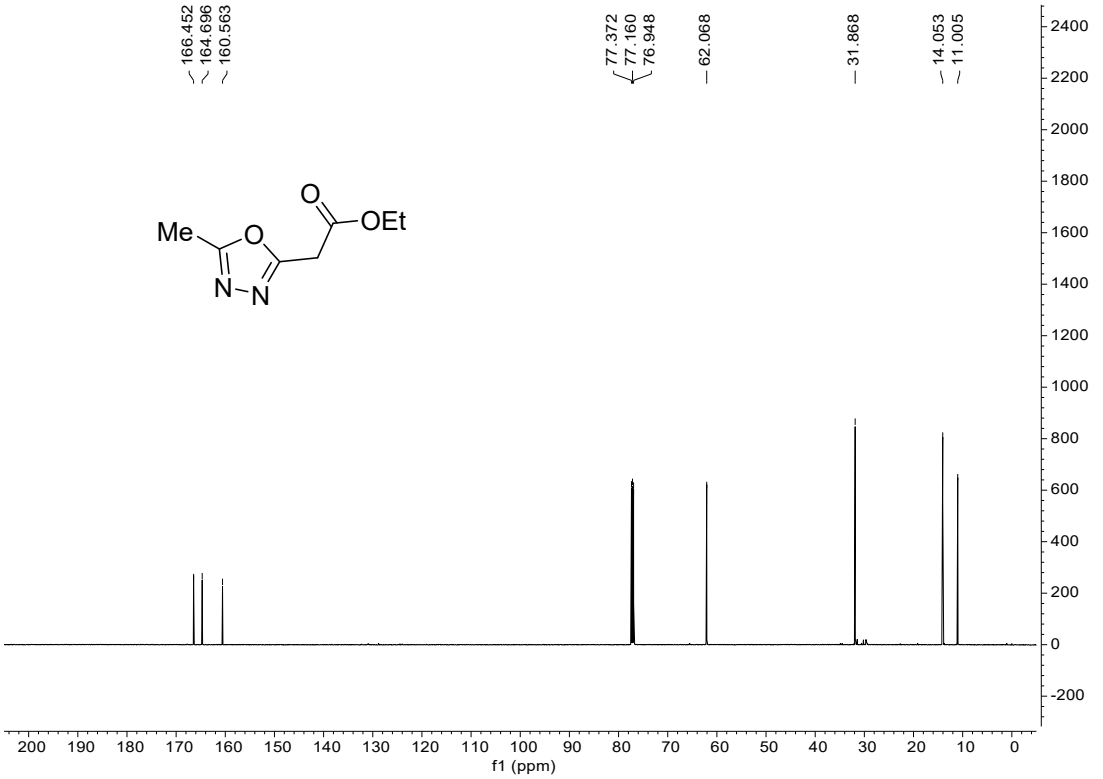


Ethyl 2-(5-methyl-1,3,4-oxadiazol-2-yl)acetate(2p)

^{1}H NMR (600 MHz, $CDCl_3$) spectra of **2p**

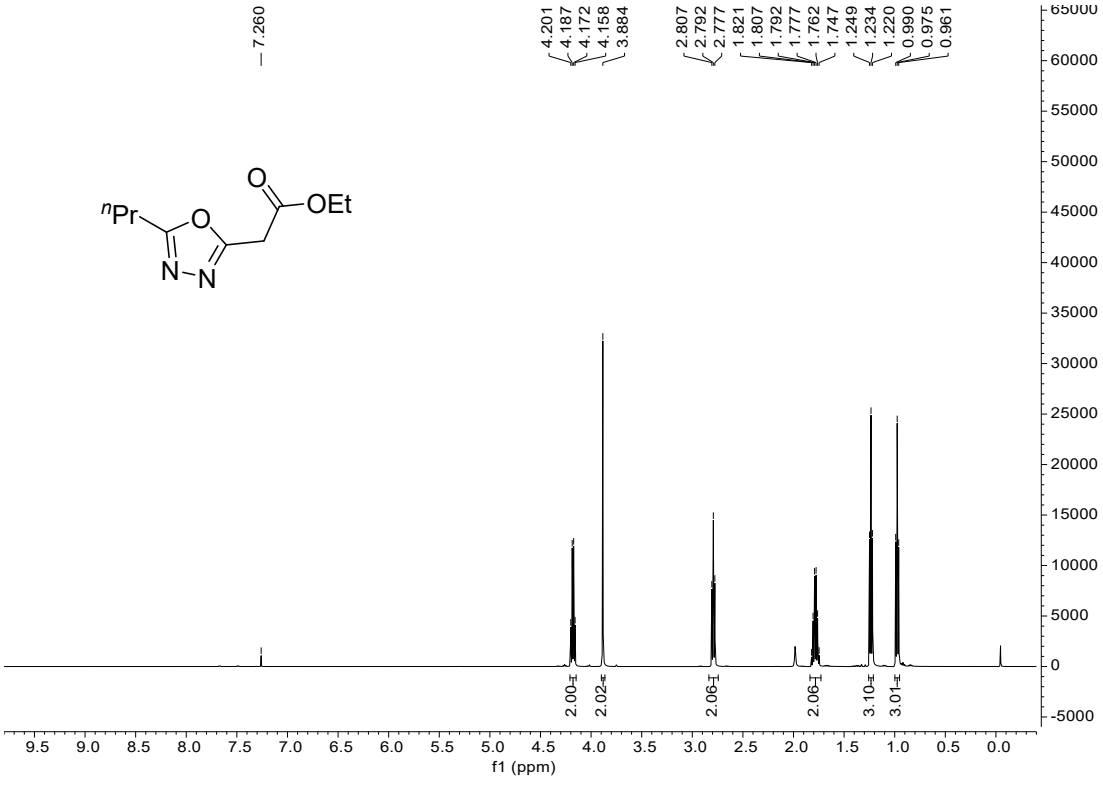


^{13}C NMR (150 MHz, $CDCl_3$) spectra of **2p**

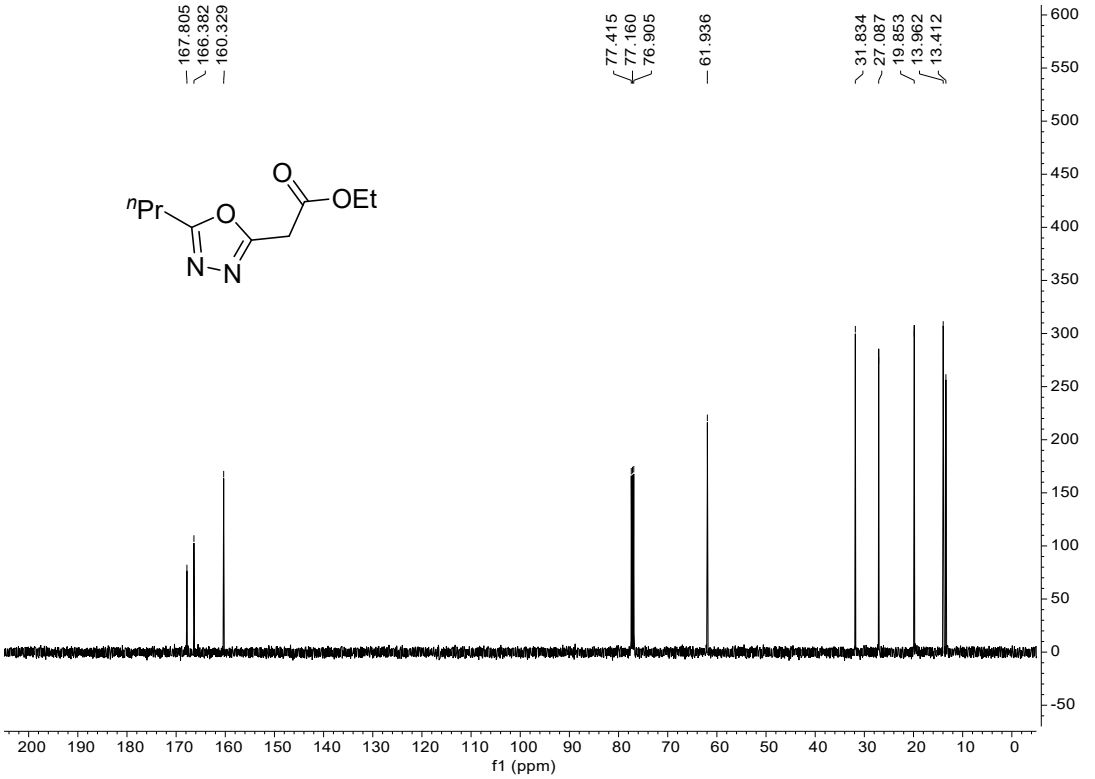


Ethyl 2-(5-propyl-1,3,4-oxadiazol-2-yl)acetate (2q)

^{1}H NMR (500 MHz, $CDCl_3$) spectra of **2q**

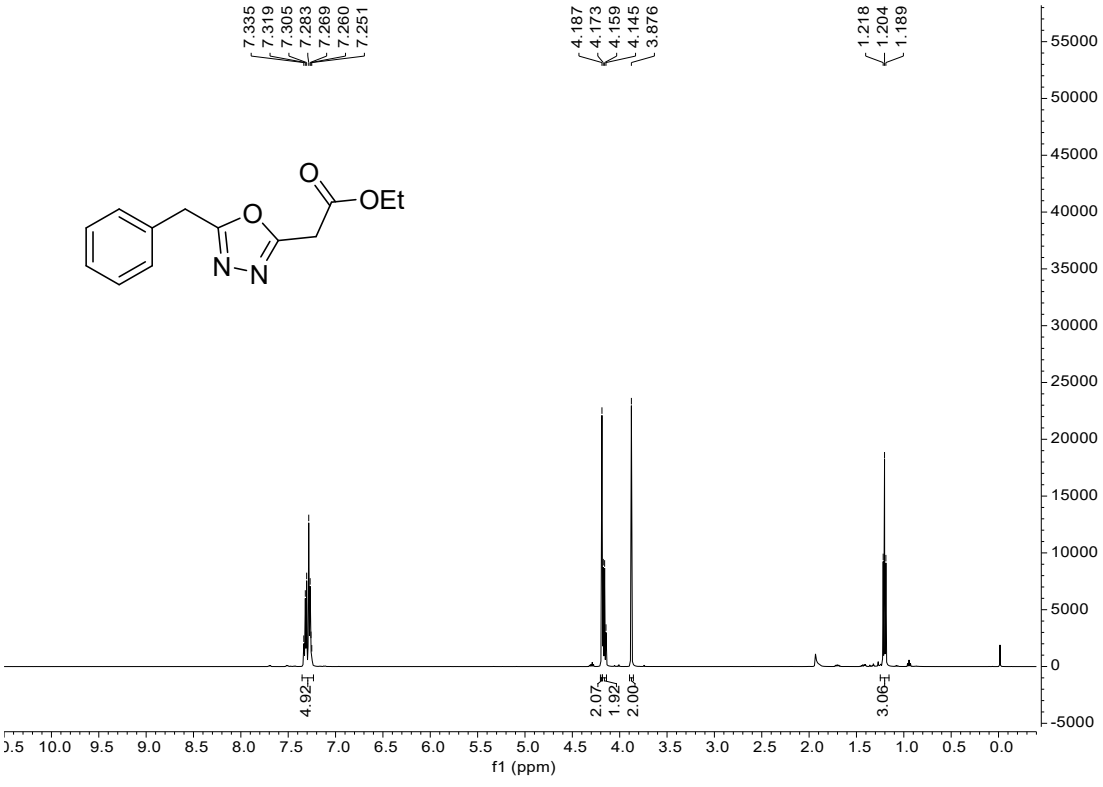


^{13}C NMR (125 MHz, $CDCl_3$) spectra of **2q**

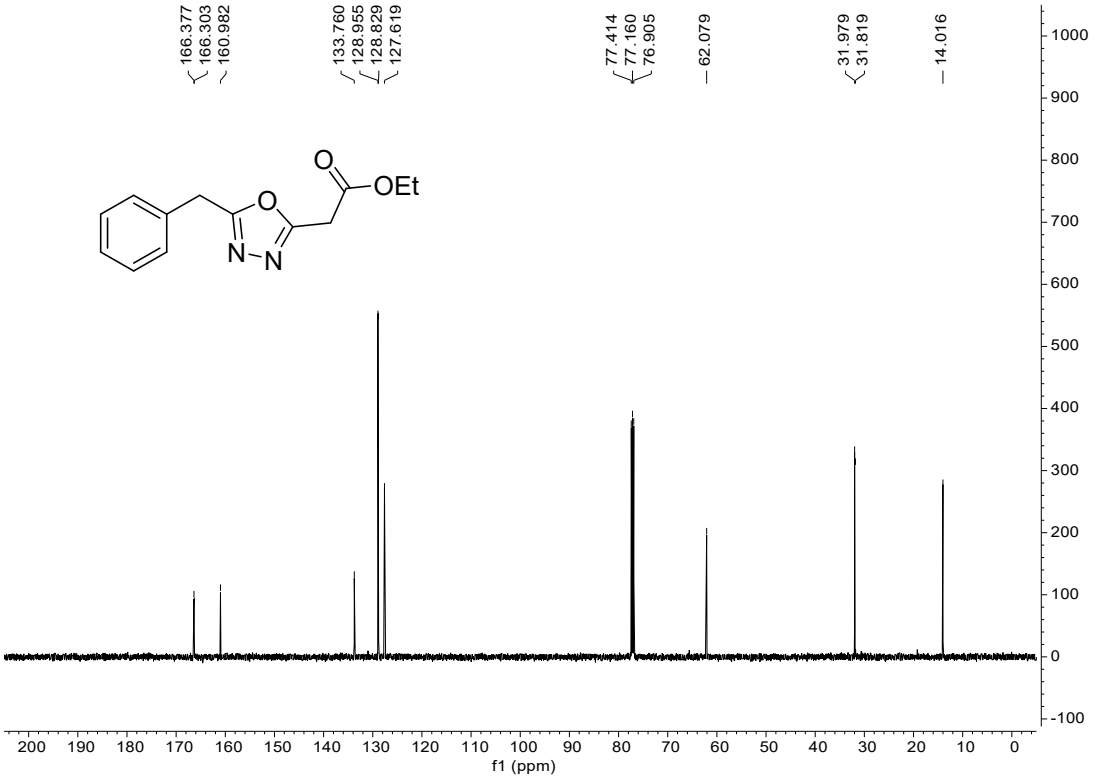


Ethyl 2-(5-benzyl-1,3,4-oxadiazol-2-yl)acetate (2r)

^{1}H NMR (500 MHz, $CDCl_3$) spectra of **2r**

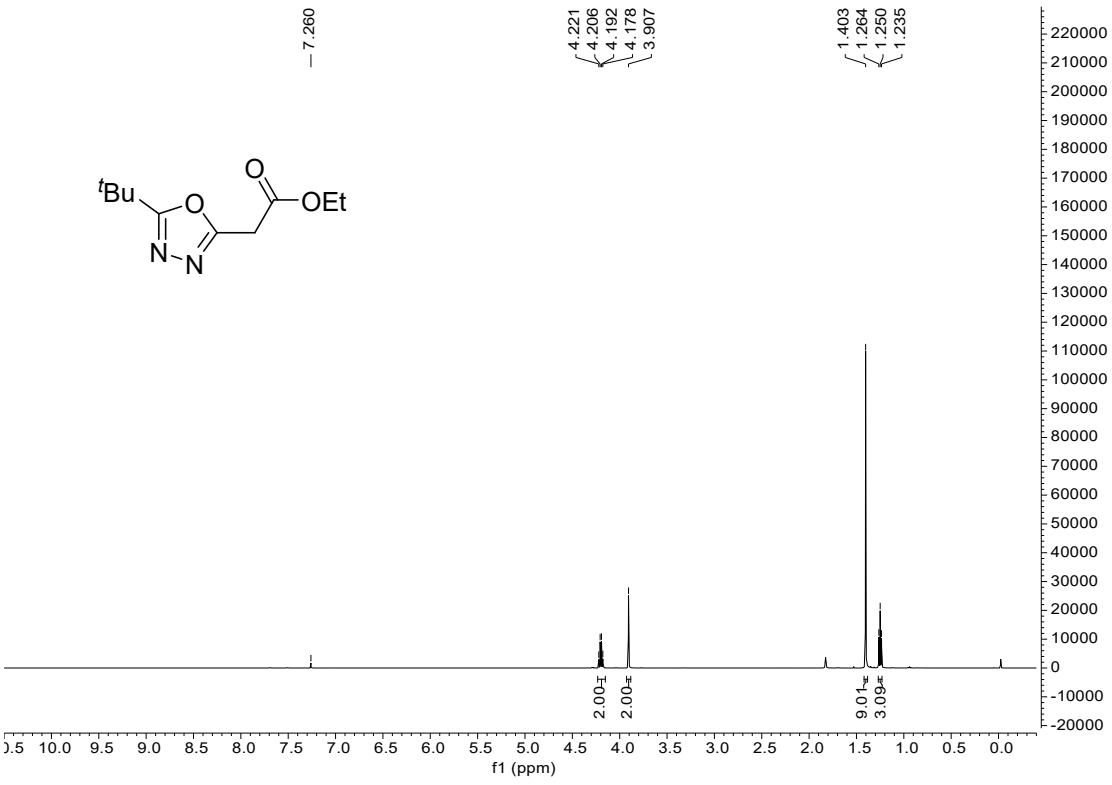


^{13}C NMR (125 MHz, $CDCl_3$) spectra of **2r**

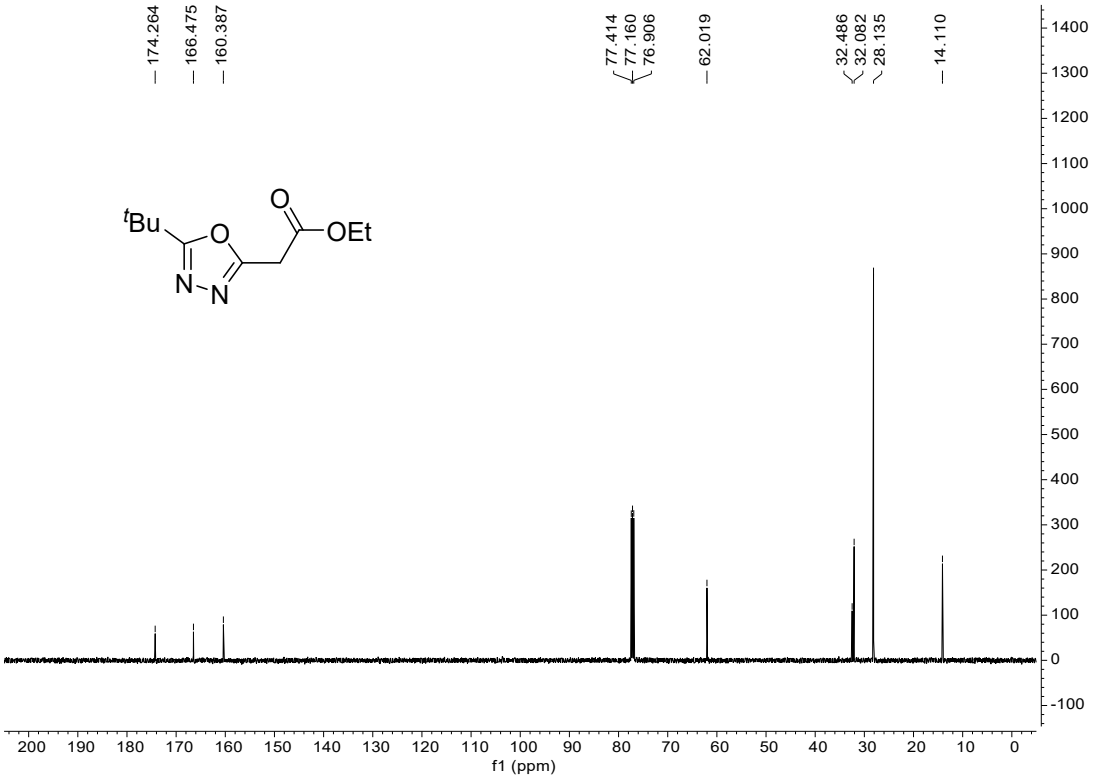


Ethyl 2-(5-(tert-butyl)-1,3,4-oxadiazol-2-yl)acetate (2s)

^{1}H NMR (500 MHz, $CDCl_3$) spectra of **2s**

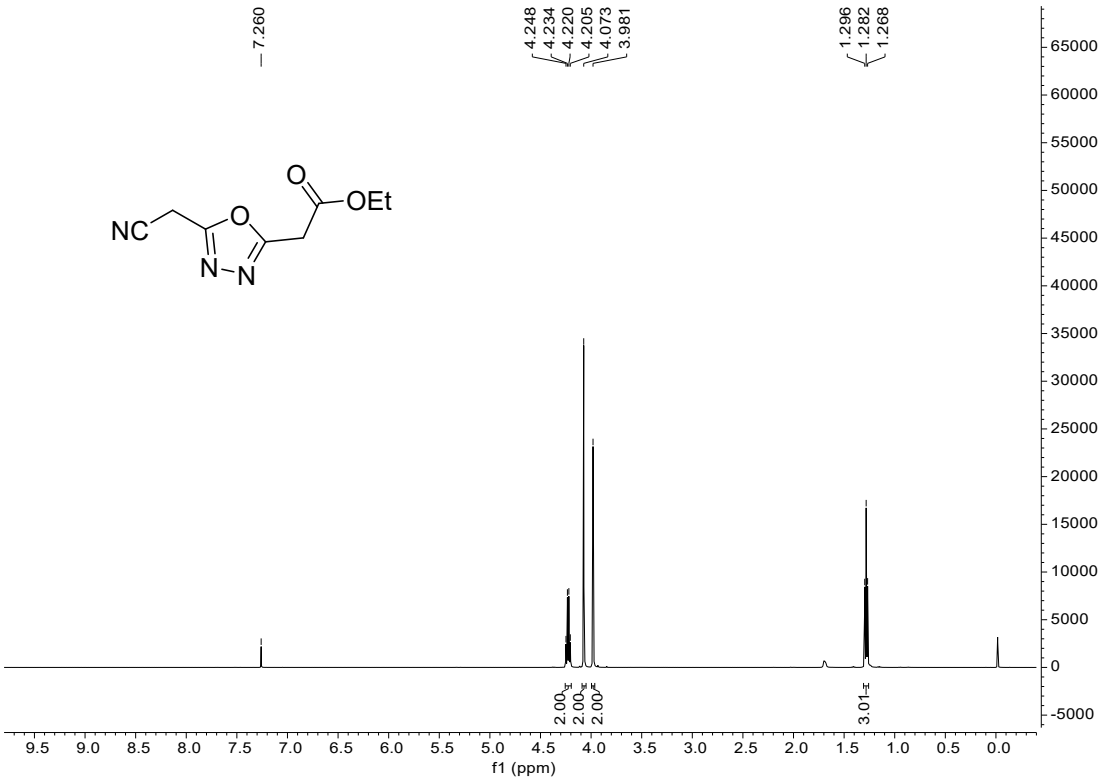


^{13}C NMR (125 MHz, $CDCl_3$) spectra of spectra of **2s**

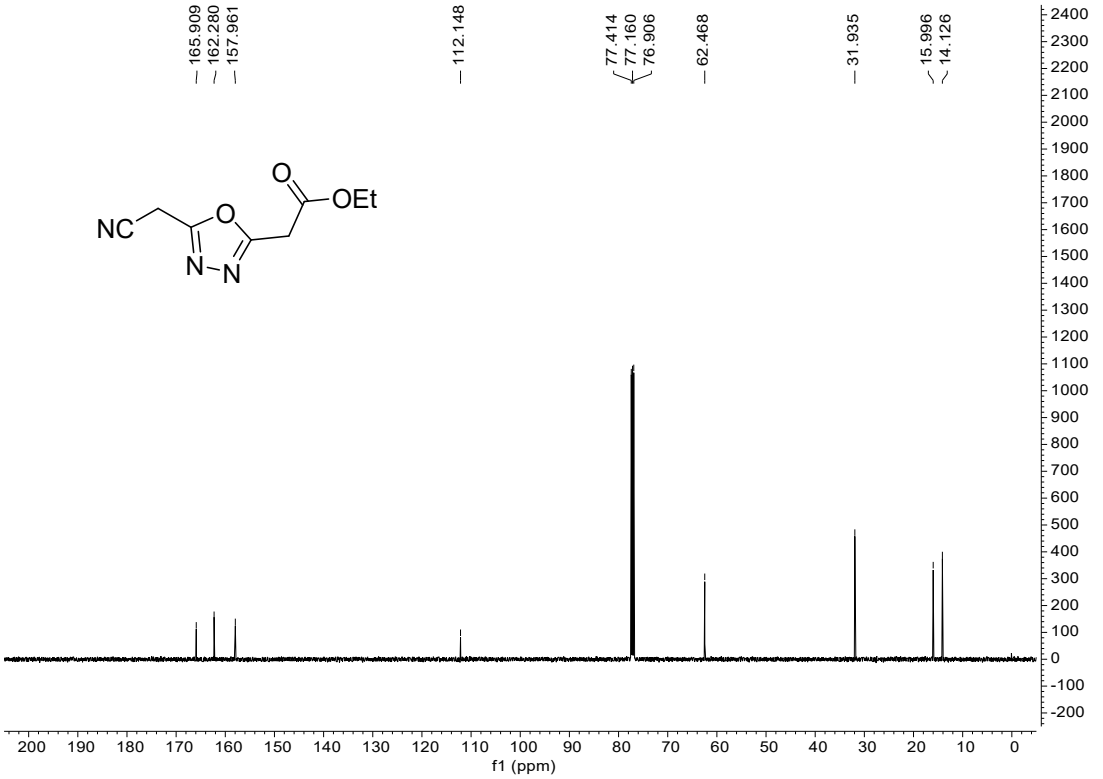


Ethyl 2-(5-(cyanomethyl)-1,3,4-oxadiazol-2-yl)acetate (2t)

^{1}H NMR (500 MHz, $CDCl_3$) spectra of **2t**

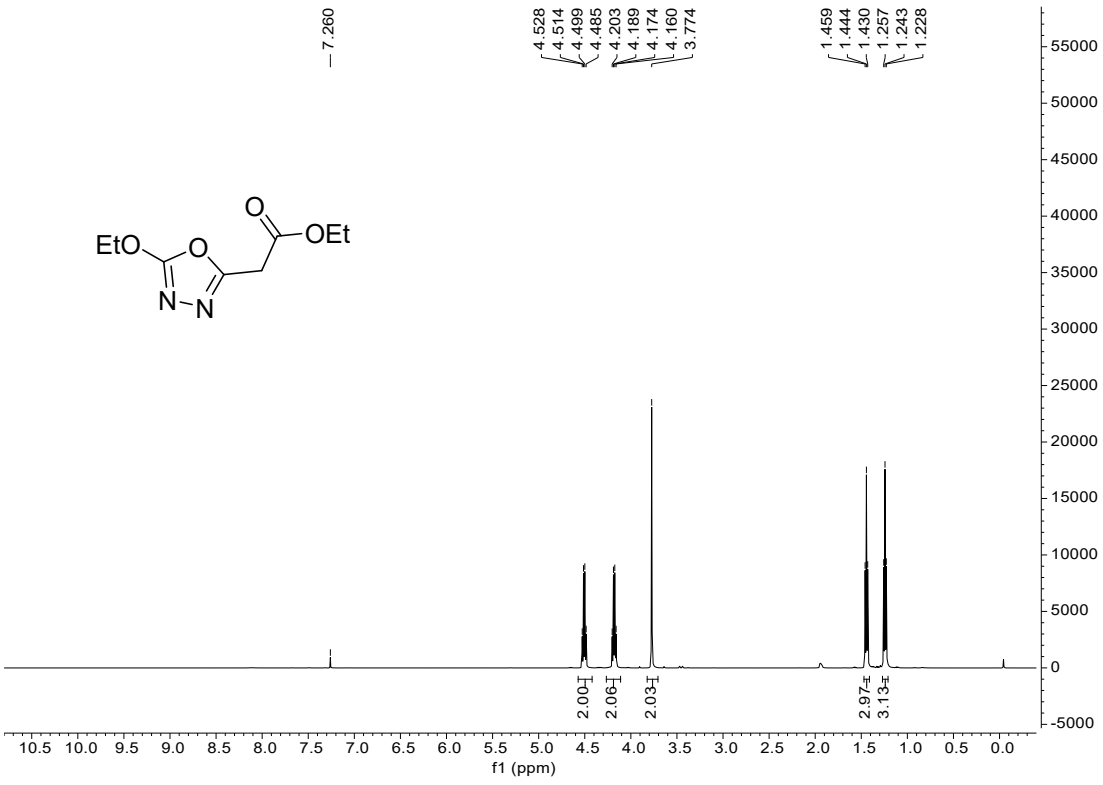


^{13}C NMR (125 MHz, $CDCl_3$) spectra of spectra of **2t**

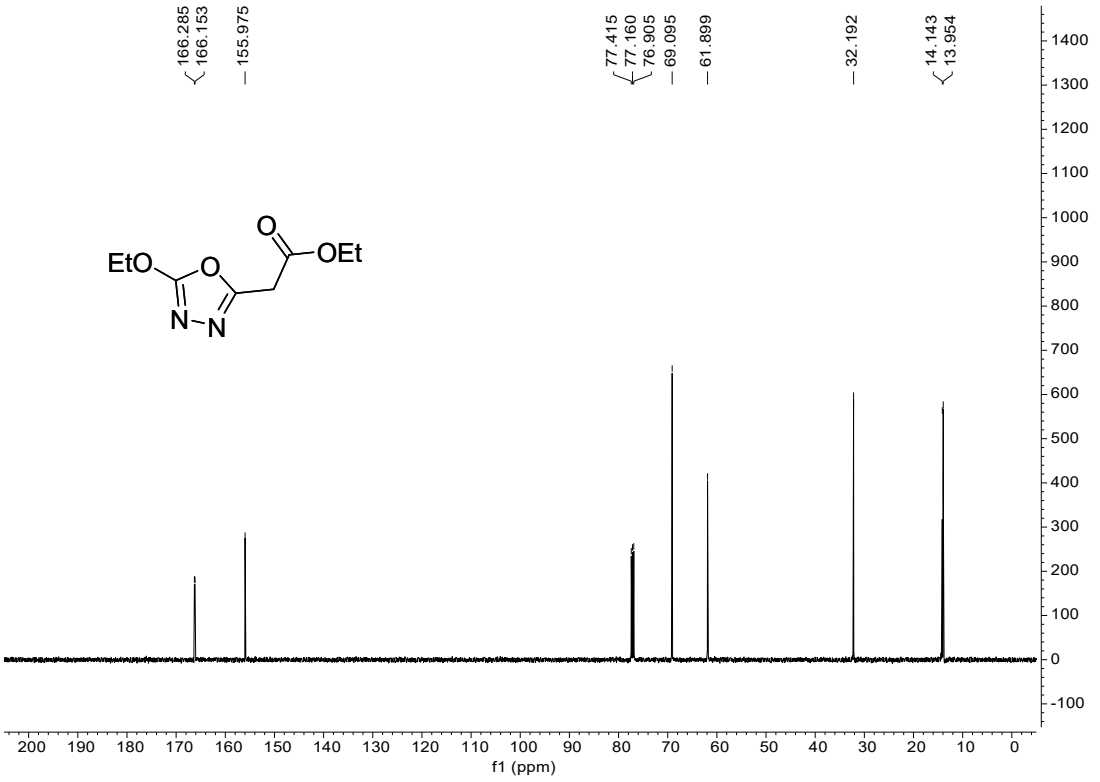


Ethyl 2-(5-ethoxy-1,3,4-oxadiazol-2-yl)acetate (2u)

^{1}H NMR (500 MHz, $CDCl_3$) spectra of **2u**

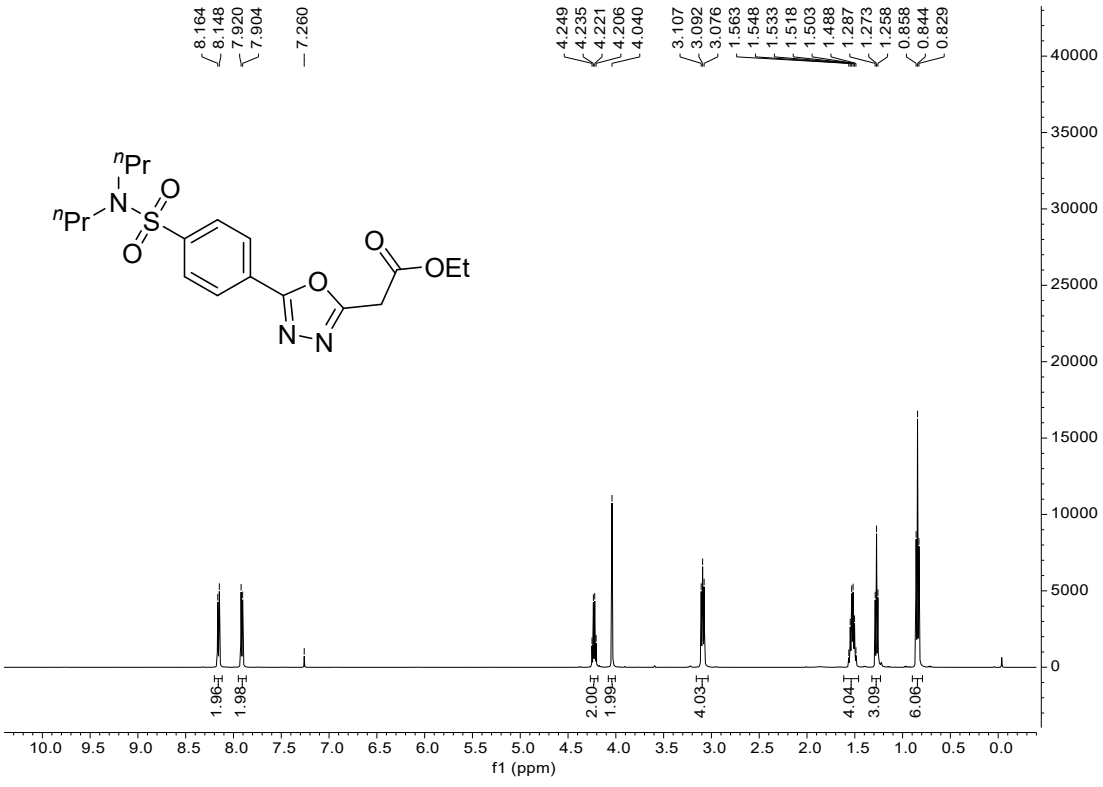


^{13}C NMR (125 MHz, $CDCl_3$) spectra of **2u**

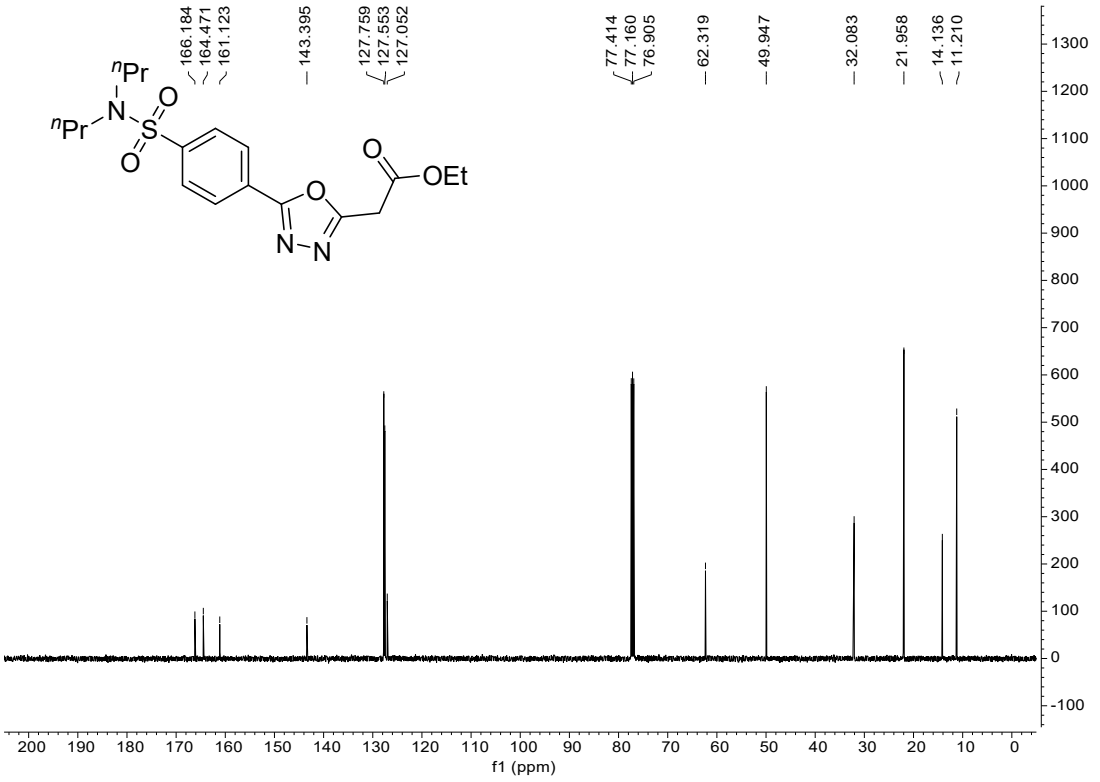


Ethyl 2-(5-(4-(N,N-dipropylsulfamoyl)phenyl)-1,3,4-oxadiazol-2-yl)acetate (2v)

^{1}H NMR (500 MHz, $CDCl_3$) spectra of **2v**

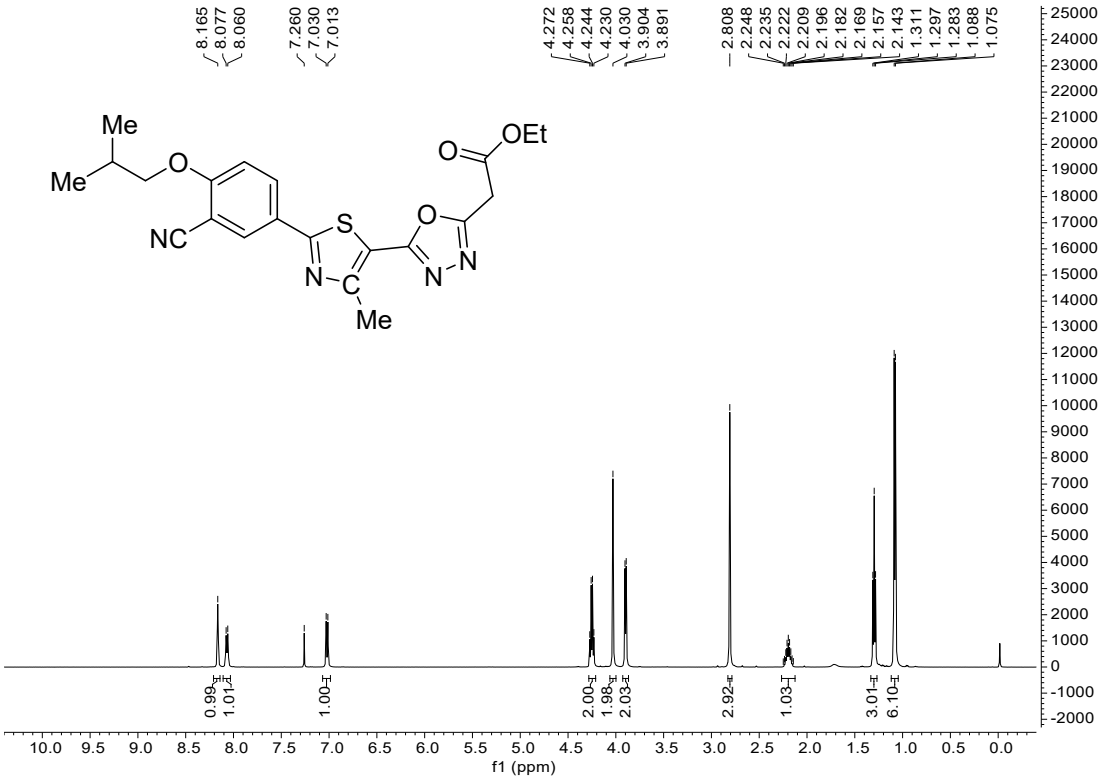


^{13}C NMR (125 MHz, $CDCl_3$) spectra of **2v**

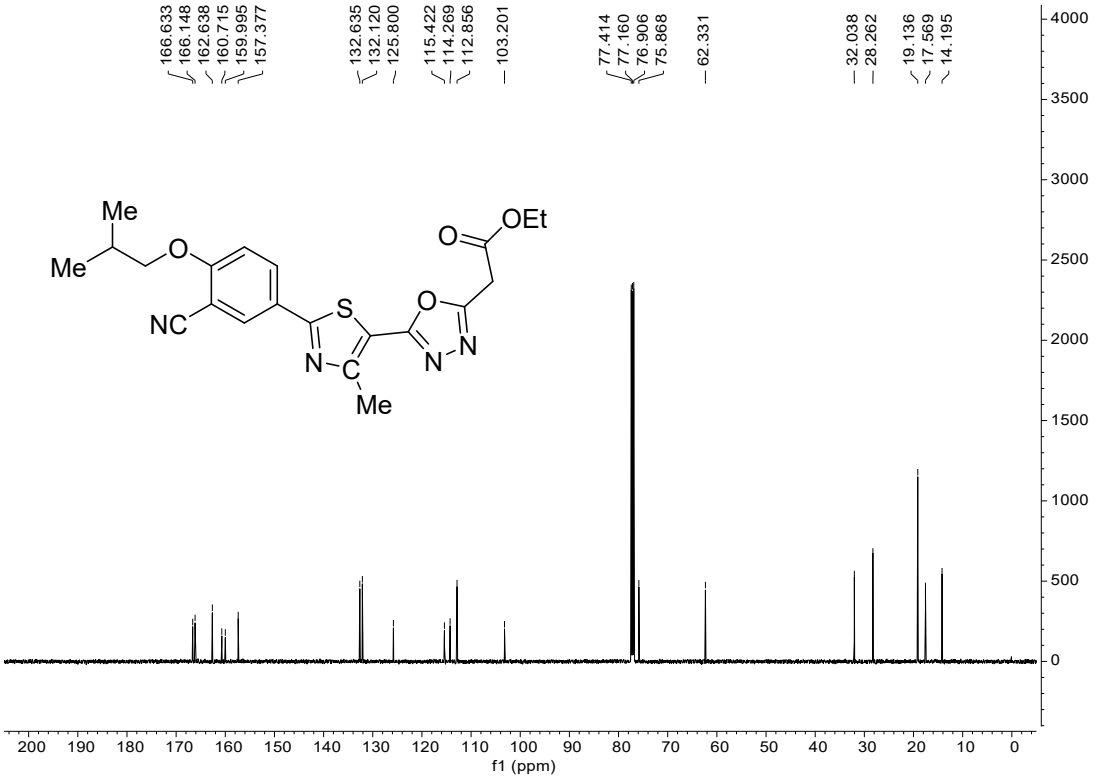


Ethyl 2-(5-(2-(3-cyano-4-isobutoxyphenyl)-4-methylthiazol-5-yl)-1,3,4-oxadiazol-2-yl)acetate (2w)

^{1}H NMR (500 MHz, $CDCl_3$) spectra of **2w**

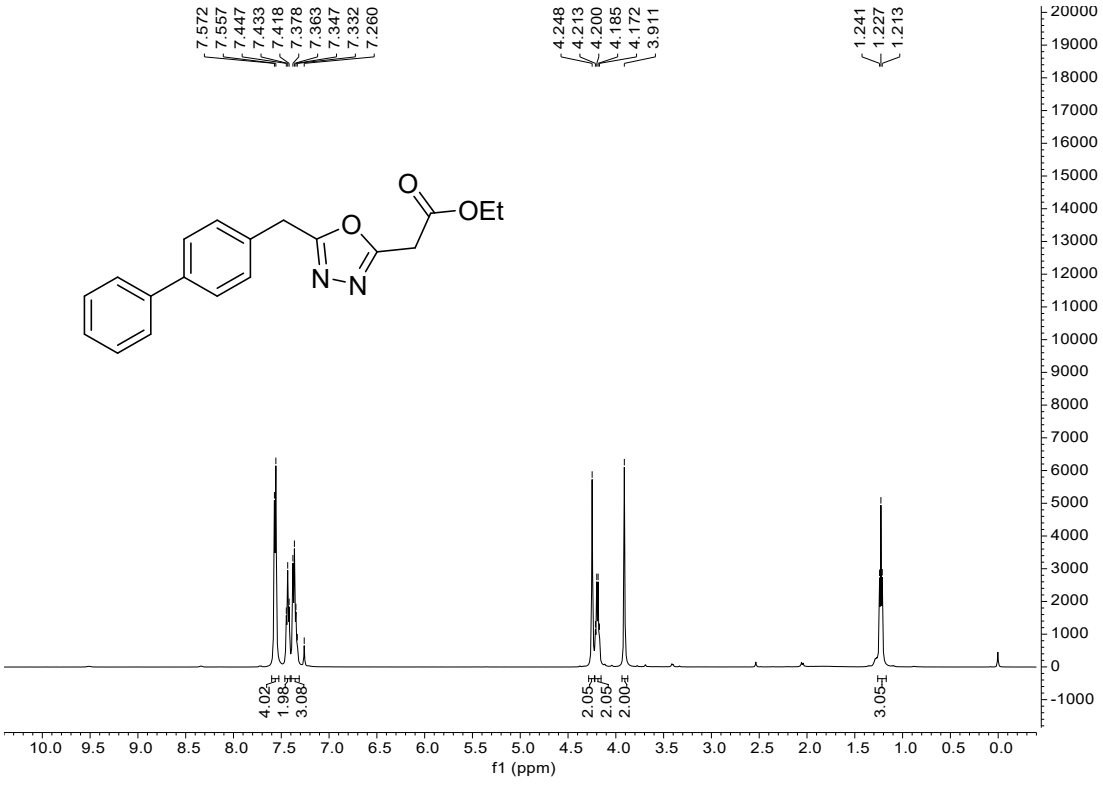


^{13}C NMR (125 MHz, $CDCl_3$) spectra of **2w**

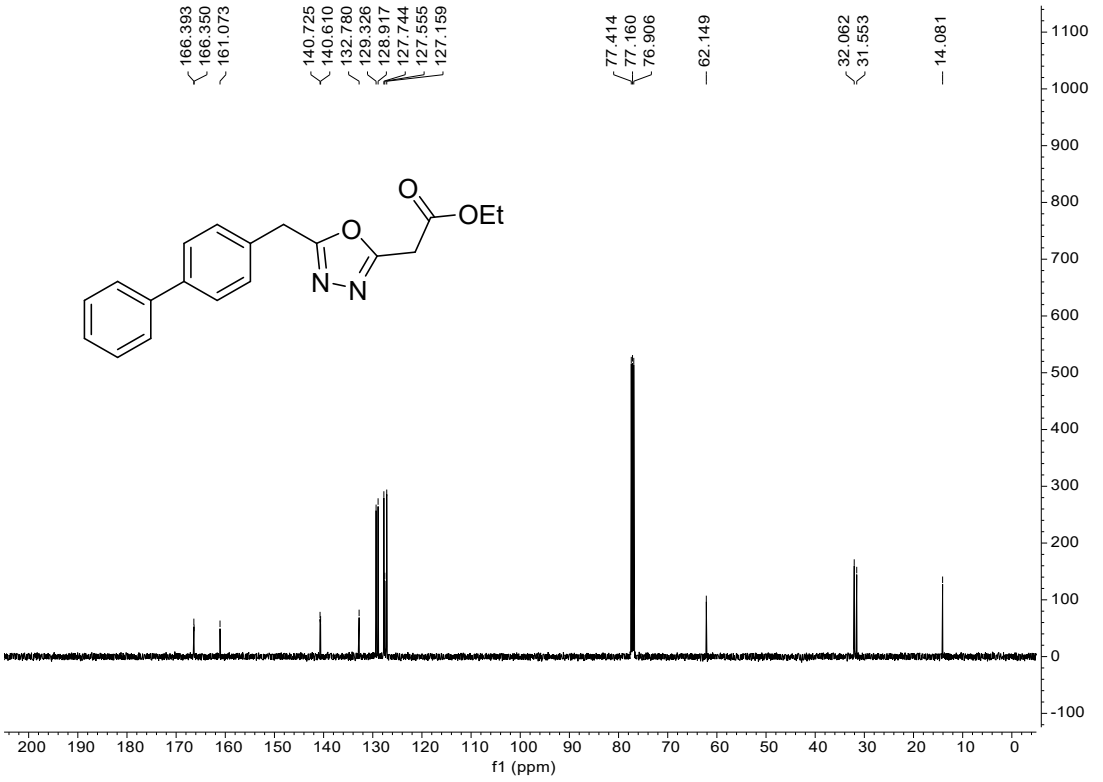


Ethyl 2-(5-([1,1'-biphenyl]-4-ylmethyl)-1,3,4-oxadiazol-2-yl)acetate (2x)

^{1}H NMR (500 MHz, $CDCl_3$) spectra of **2x**

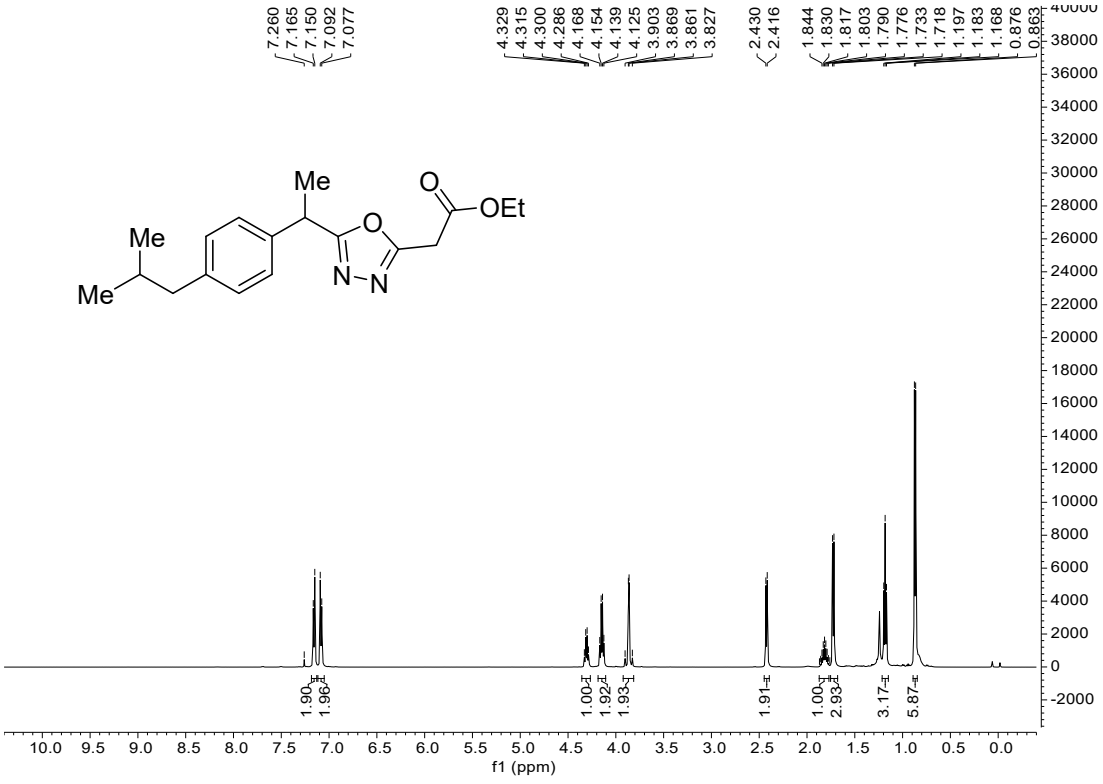


^{13}C NMR (125 MHz, $CDCl_3$) spectra of **2x**

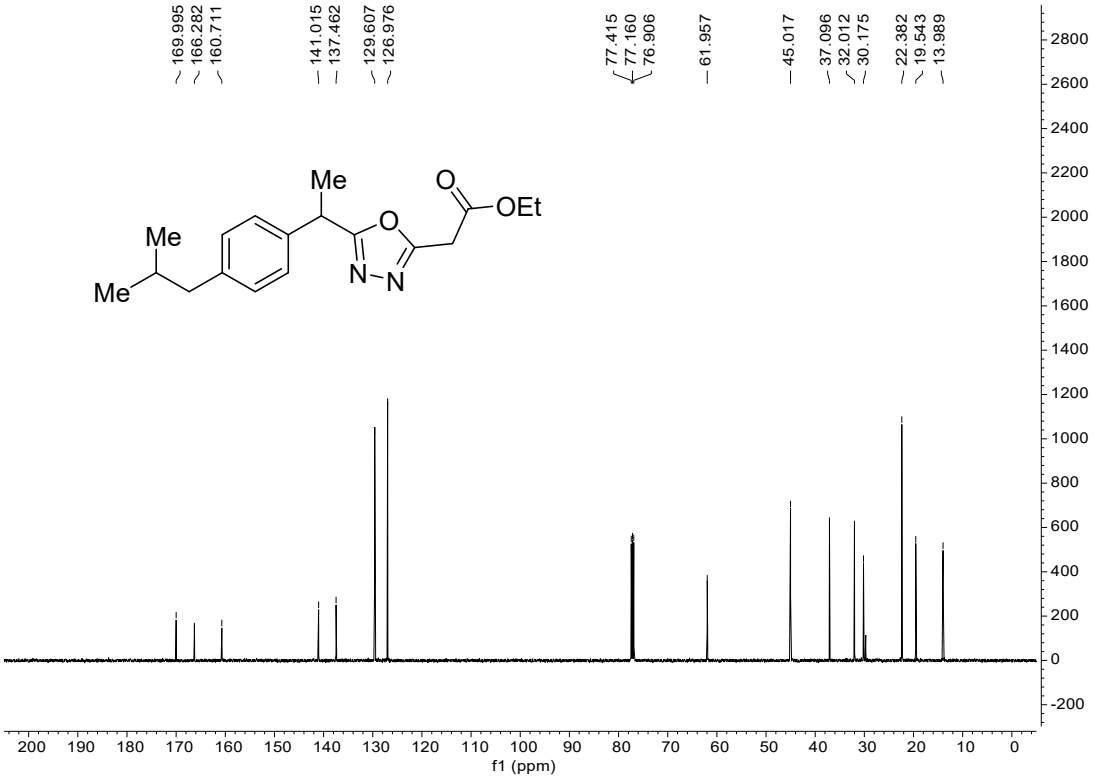


Ethyl 2-(5-(1-(4-isobutylphenyl)ethyl)-1,3,4-oxadiazol-2-yl)acetate (2y)

^{1}H NMR (500 MHz, $CDCl_3$) spectra of **2y**

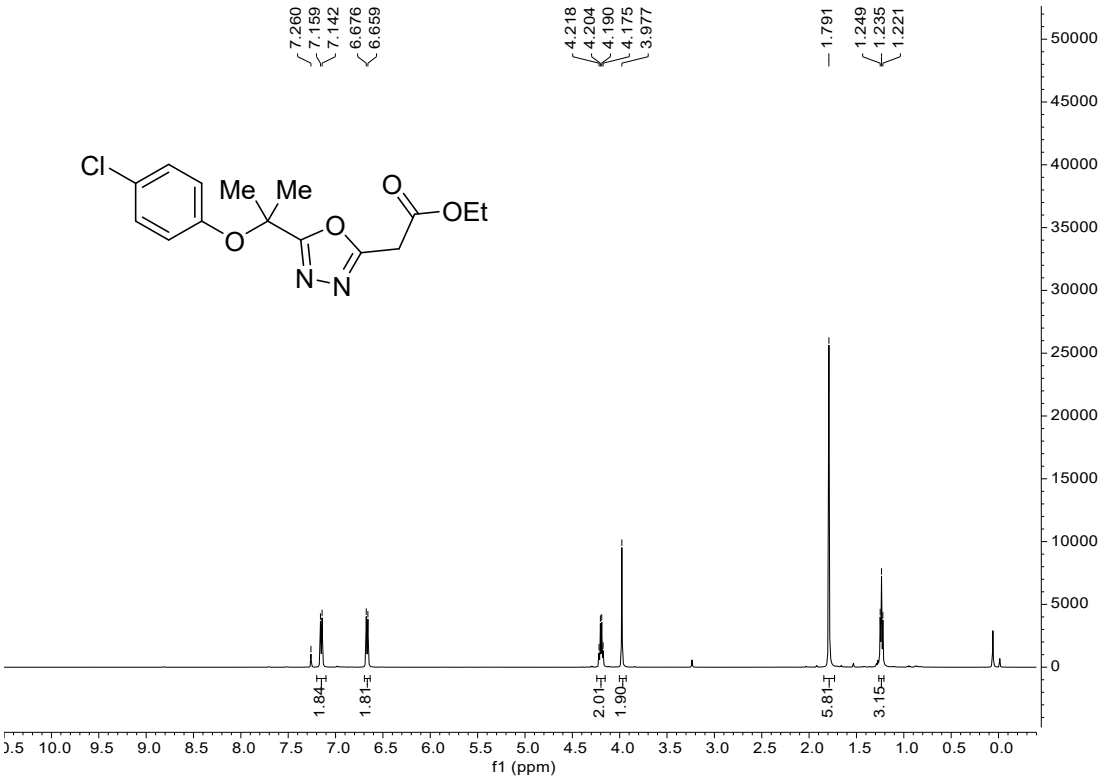


^{13}C NMR (125 MHz, $CDCl_3$) spectra of **2y**

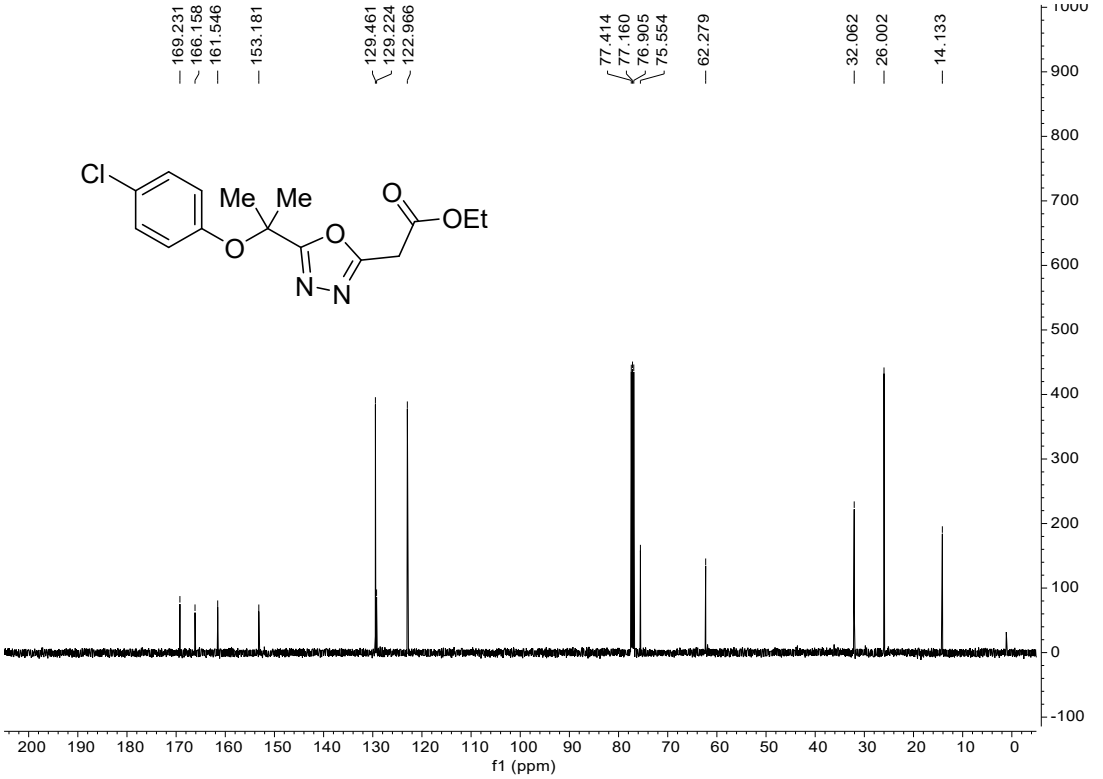


Ethyl 2-(5-(2-(4-chlorophenoxy)propan-2-yl)-1,3,4-oxadiazol-2-yl)acetate (2z)

^{1}H NMR (500 MHz, $CDCl_3$) spectra of **2z**

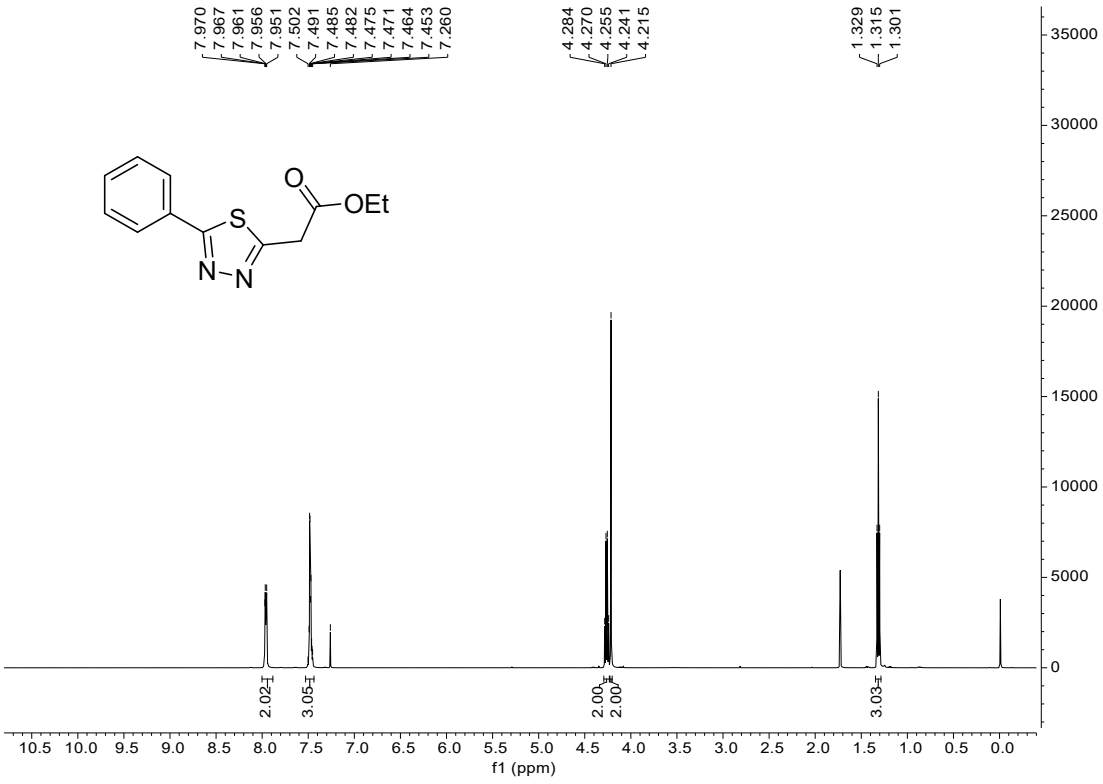


^{13}C NMR (125 MHz, $CDCl_3$) spectra of **2z**

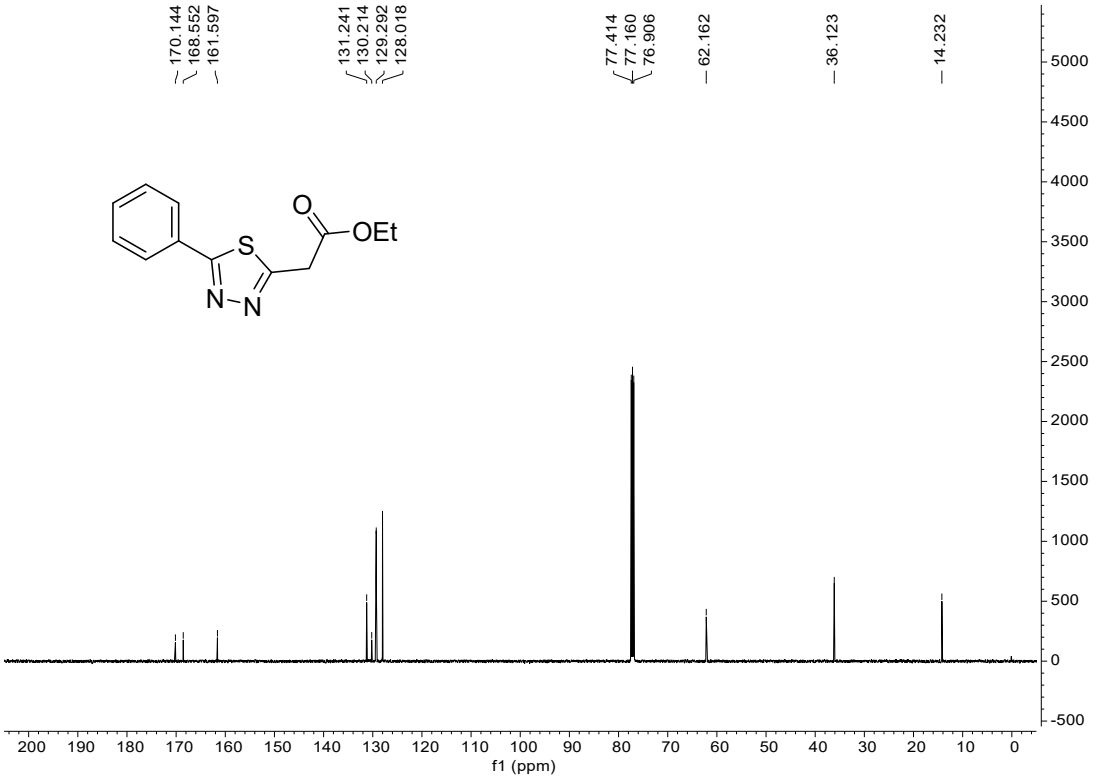


Ethyl 2-(5-phenyl-1,3,4-thiadiazol-2-yl)acetate(4a)

^{1}H NMR (500 MHz, $CDCl_3$) spectra of **4a**

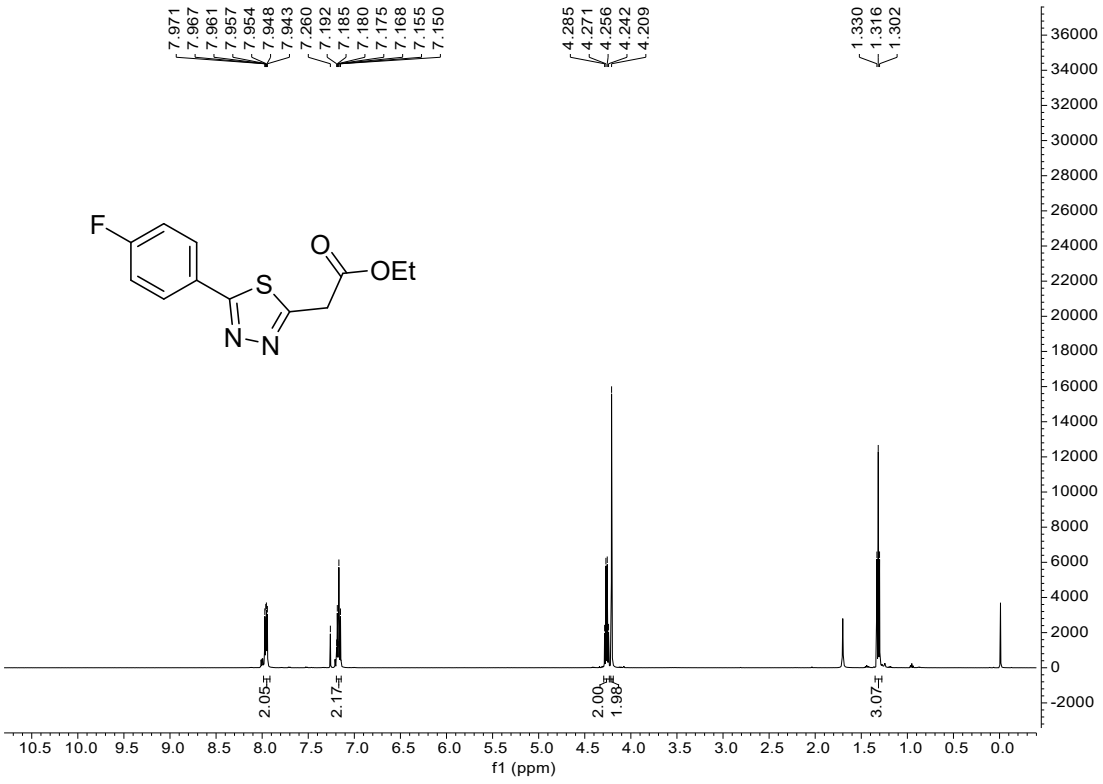


^{13}C NMR (125 MHz, $CDCl_3$) spectra of **4a**

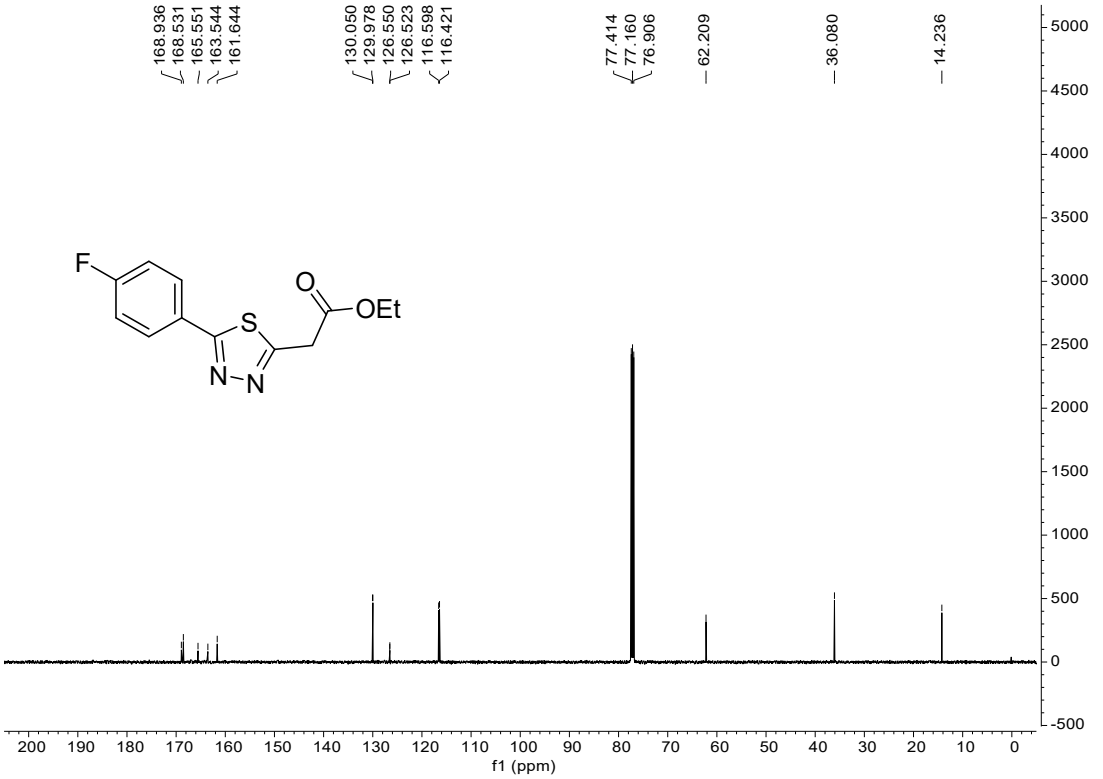


Ethyl 2-(5-(4-fluorophenyl)-1,3,4-thiadiazol-2-yl)acetate(4b)

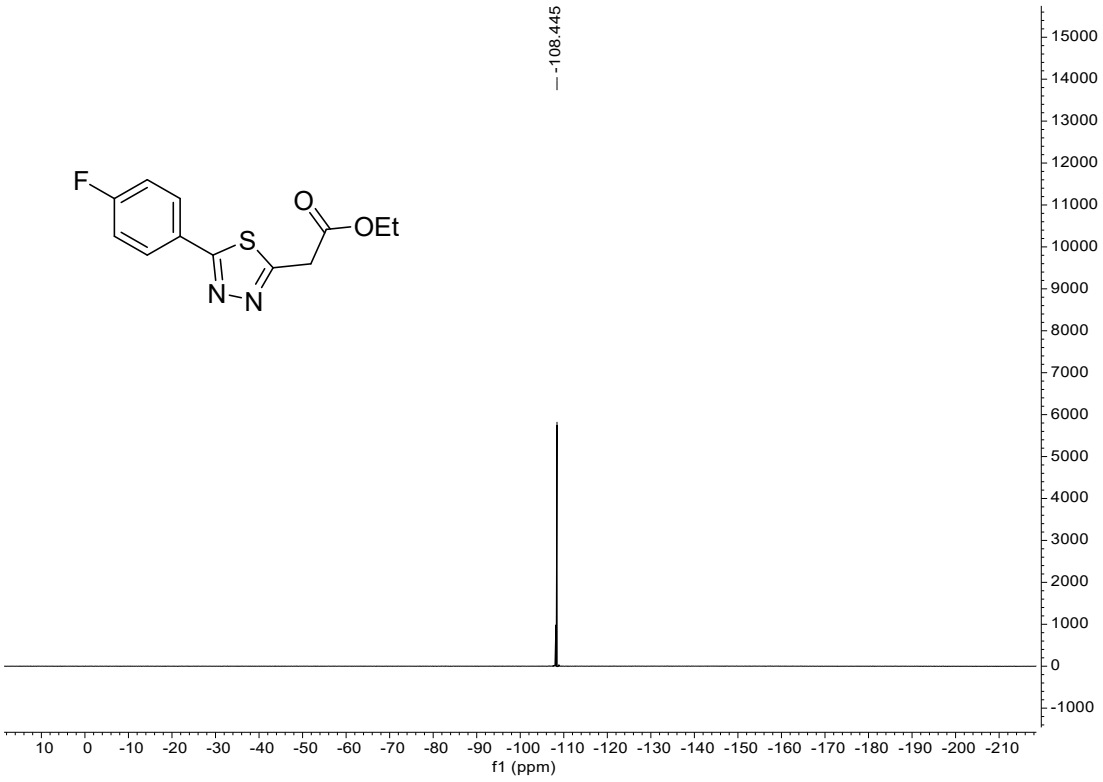
^{1}H NMR (500 MHz, $CDCl_3$) spectra of **4b**



^{13}C NMR (125 MHz, $CDCl_3$) spectra of **4b**

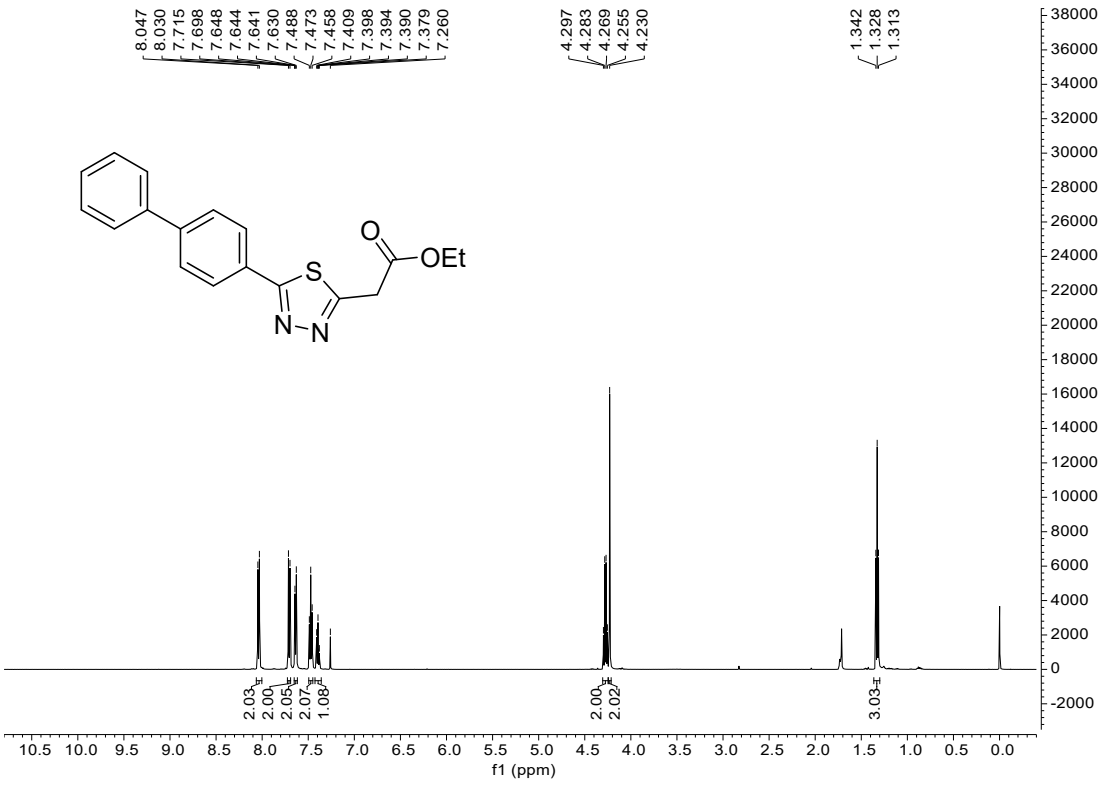


^{19}F NMR (376 MHz, $CDCl_3$) spectra of **4b**

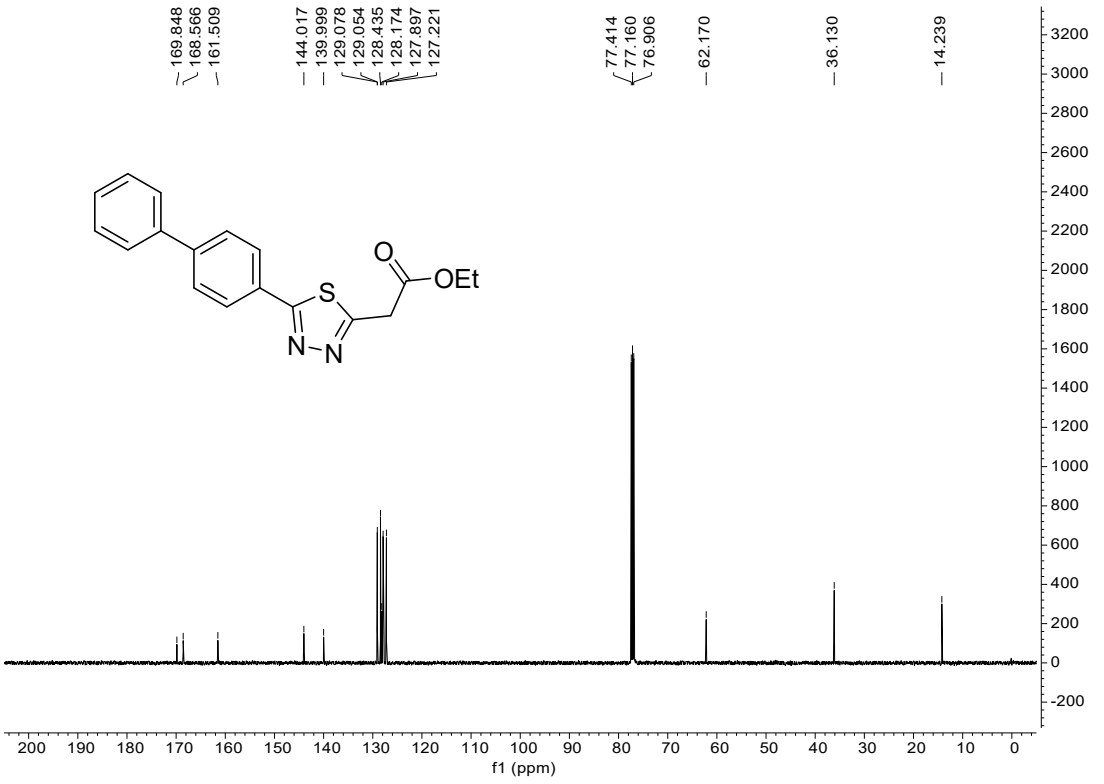


Ethyl 2-(5-([1,1'-biphenyl]-4-yl)-1,3,4-thiadiazol-2-yl)acetate(4c)

^{1}H NMR (500 MHz, $CDCl_3$) spectra of **4c**

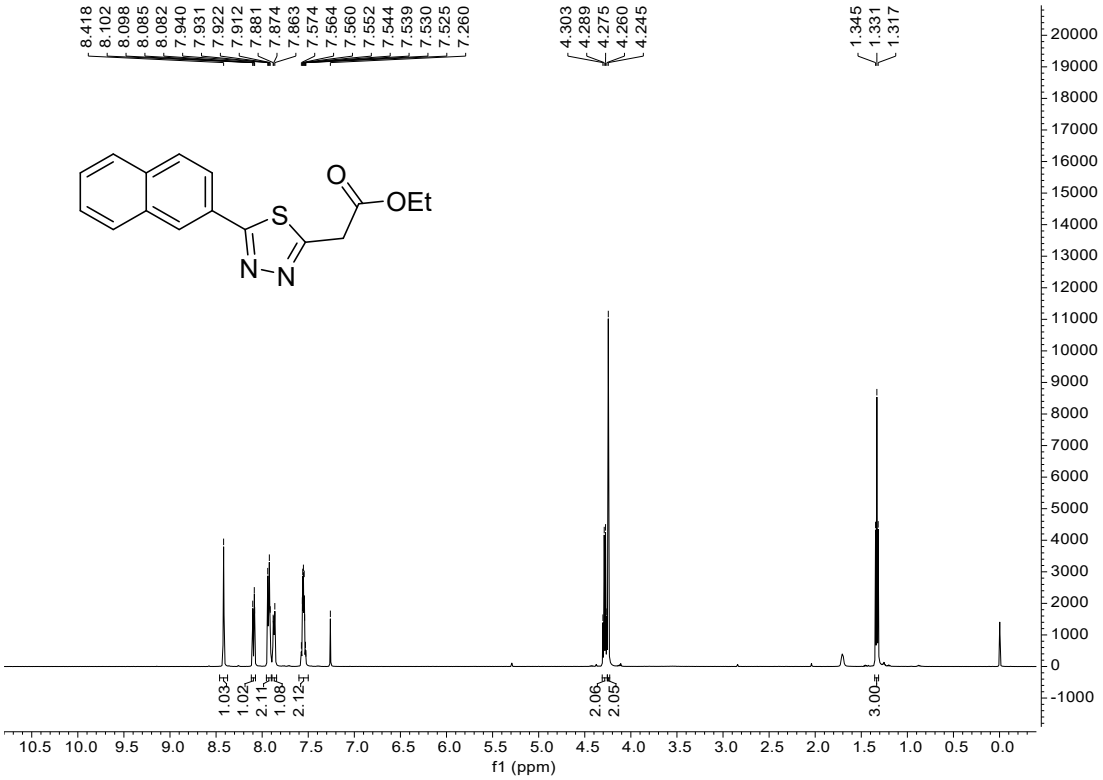


^{13}C NMR (125 MHz, $CDCl_3$) spectra of **4c**

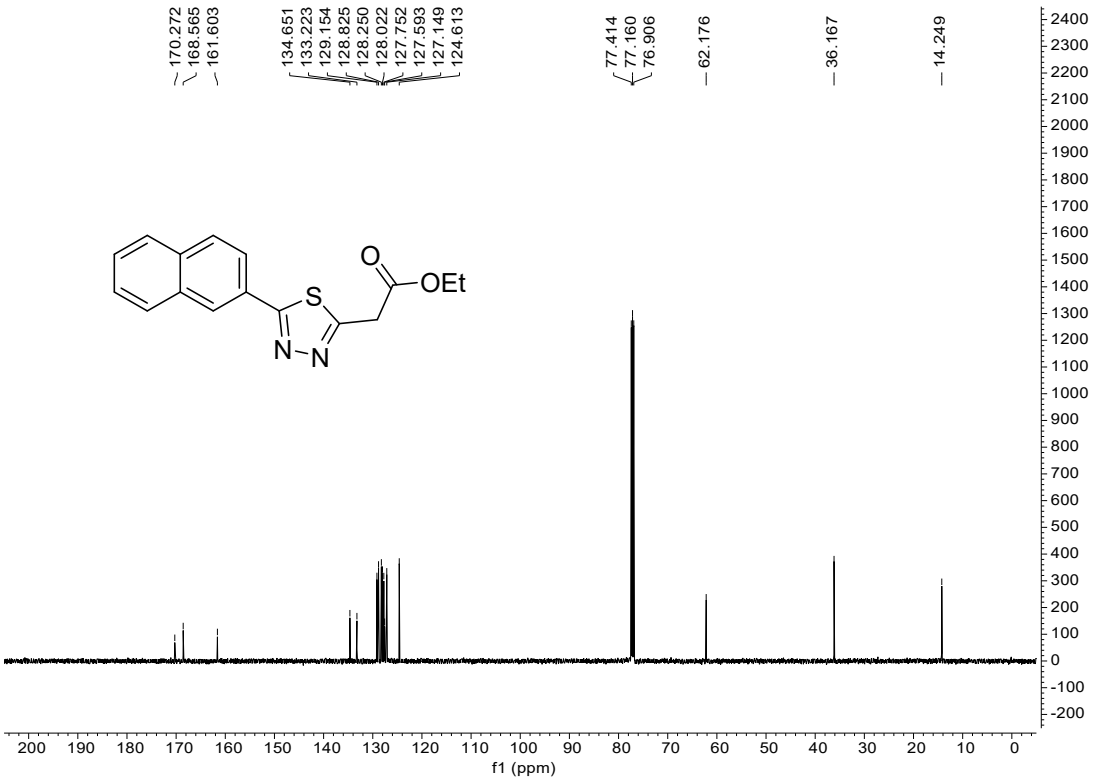


Ethyl 2-(5-(naphthalen-2-yl)-1,3,4-thiadiazol-2-yl)acetate(4d)

^{1}H NMR (500 MHz, $CDCl_3$) spectra of **4d**

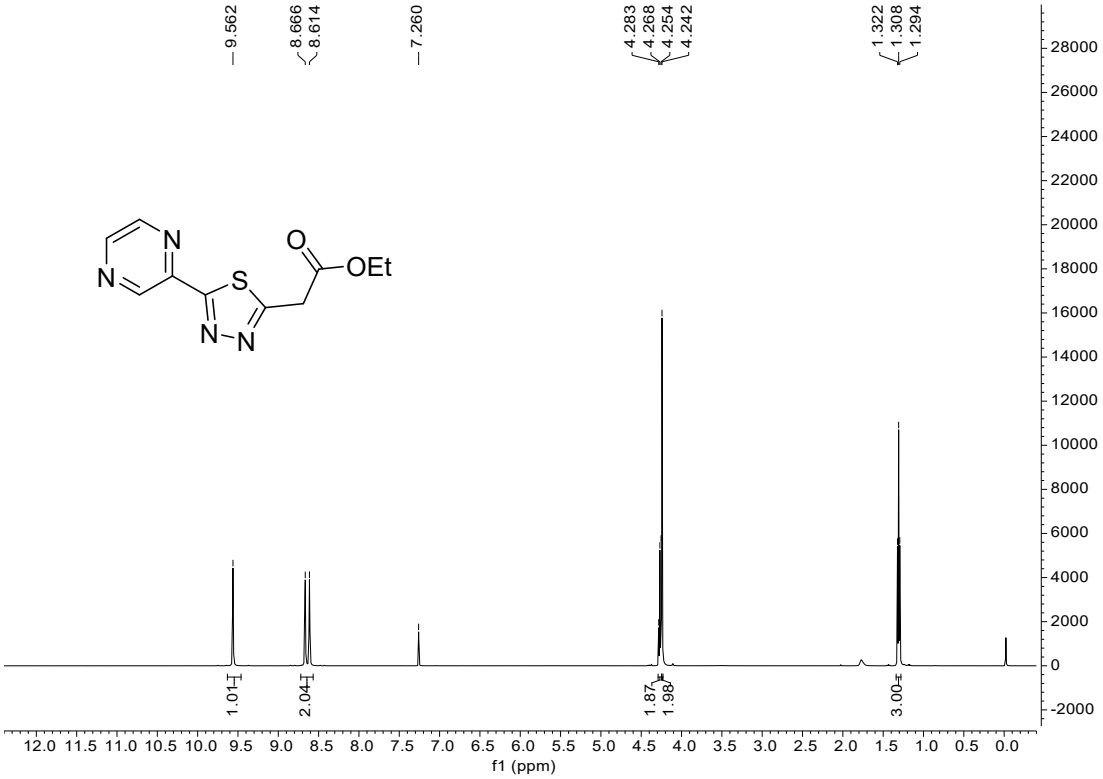


^{13}C NMR (125 MHz, $CDCl_3$) spectra of **4d**

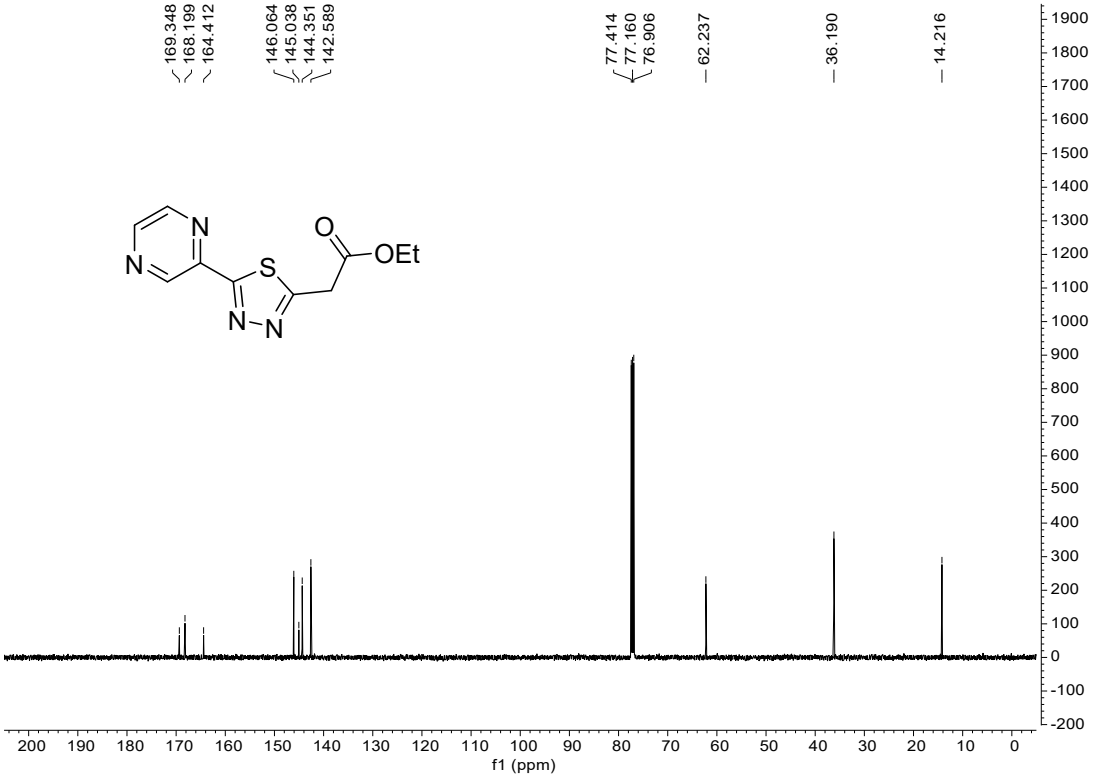


Ethyl 2-(5-(pyrazin-2-yl)-1,3,4-thiadiazol-2-yl)acetate(4e)

^{1}H NMR (500 MHz, $CDCl_3$) spectra of **4e**

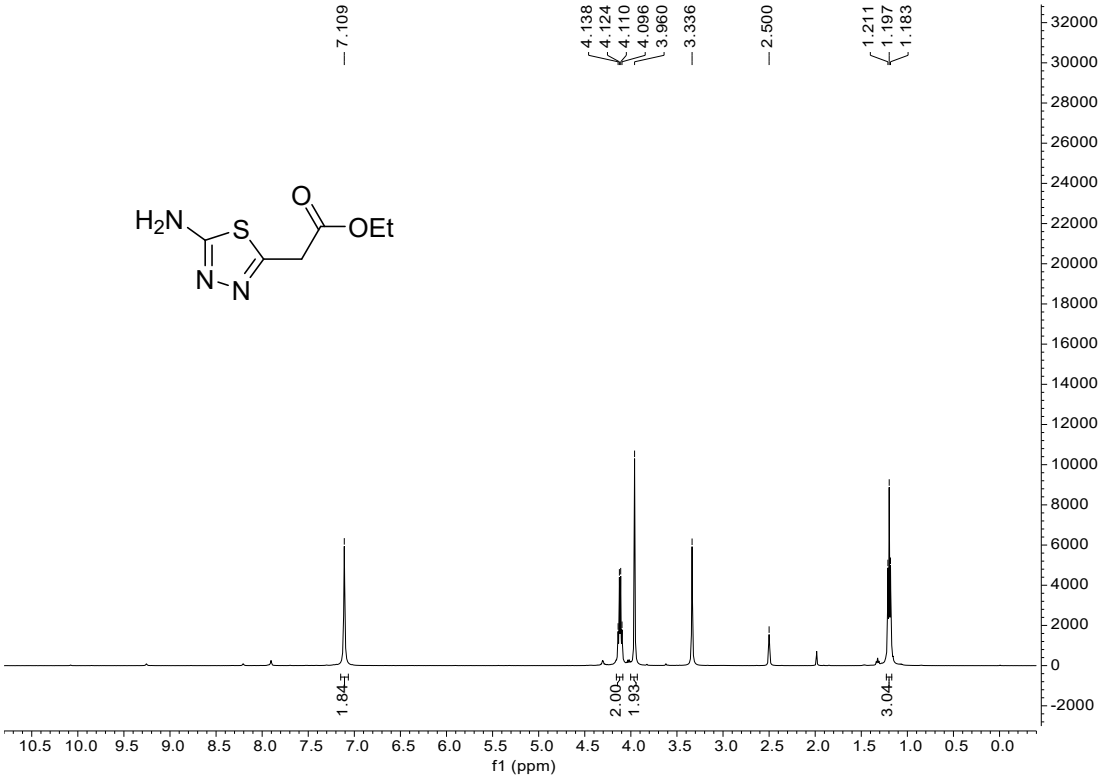


^{13}C NMR (125 MHz, $CDCl_3$) spectra of **4e**

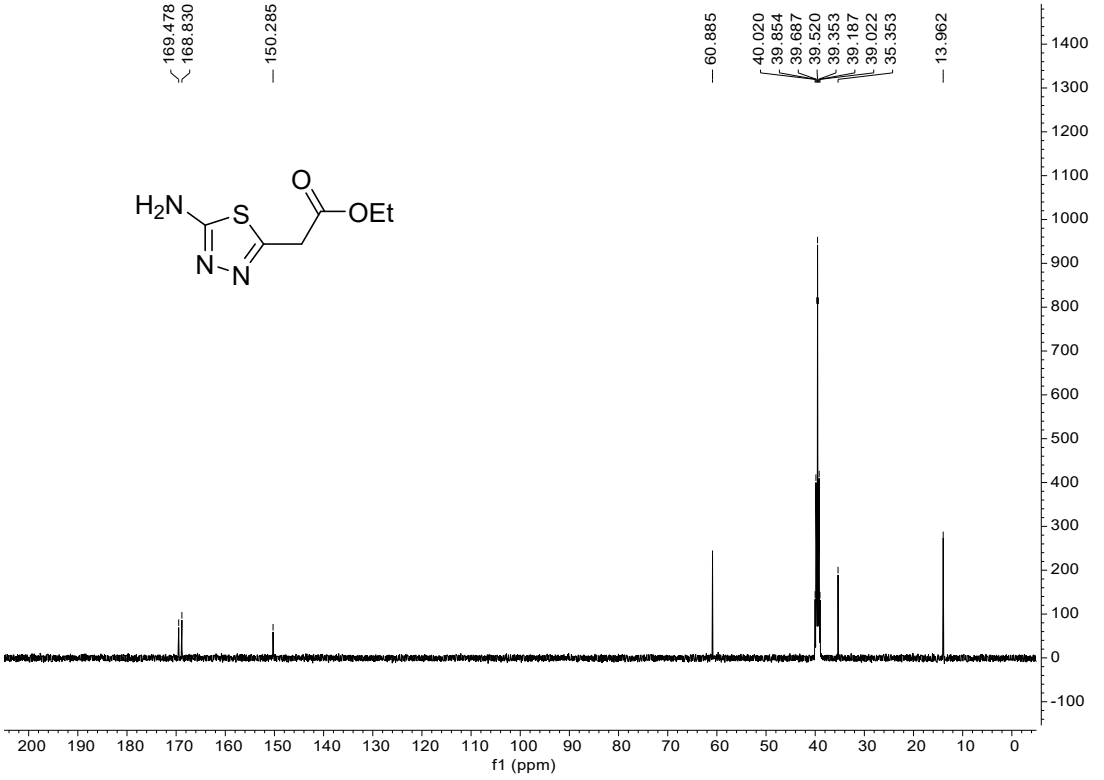


Ethyl 2-(5-amino-1,3,4-thiadiazol-2-yl)acetate (4f)

^{1}H NMR (500 MHz, DMSO-d_6) spectra of **4f**

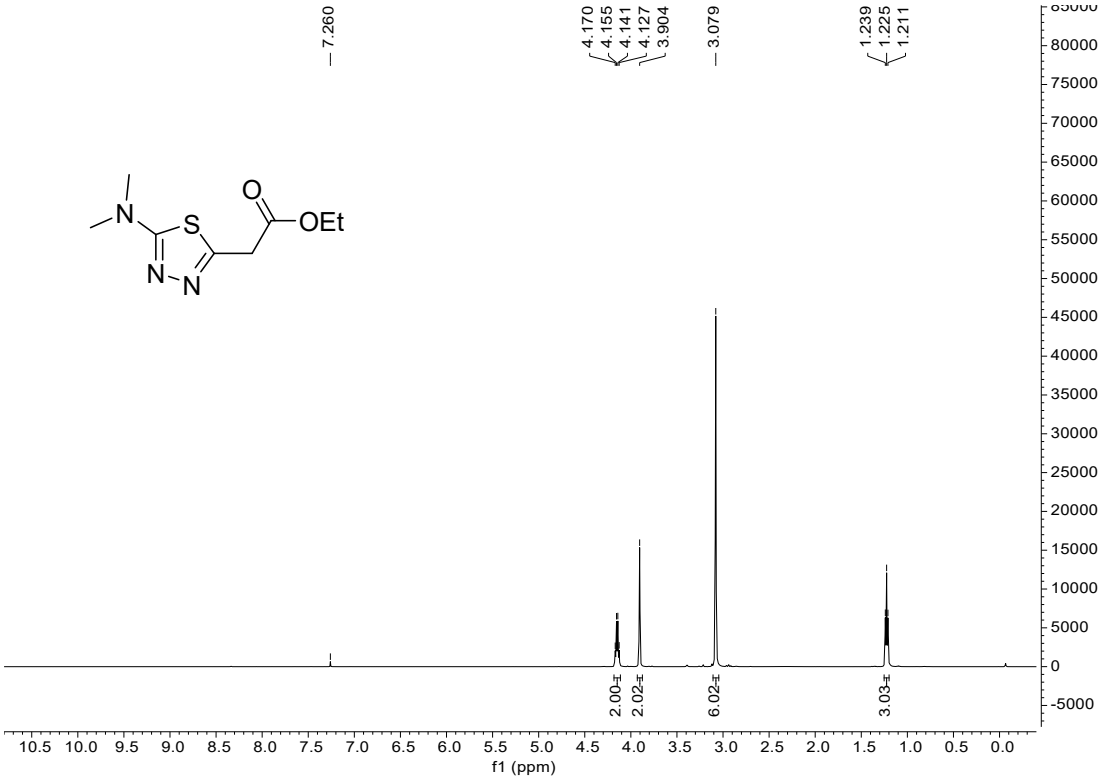


^{13}C NMR (125 MHz, DMSO-d_6) spectra of **4f**

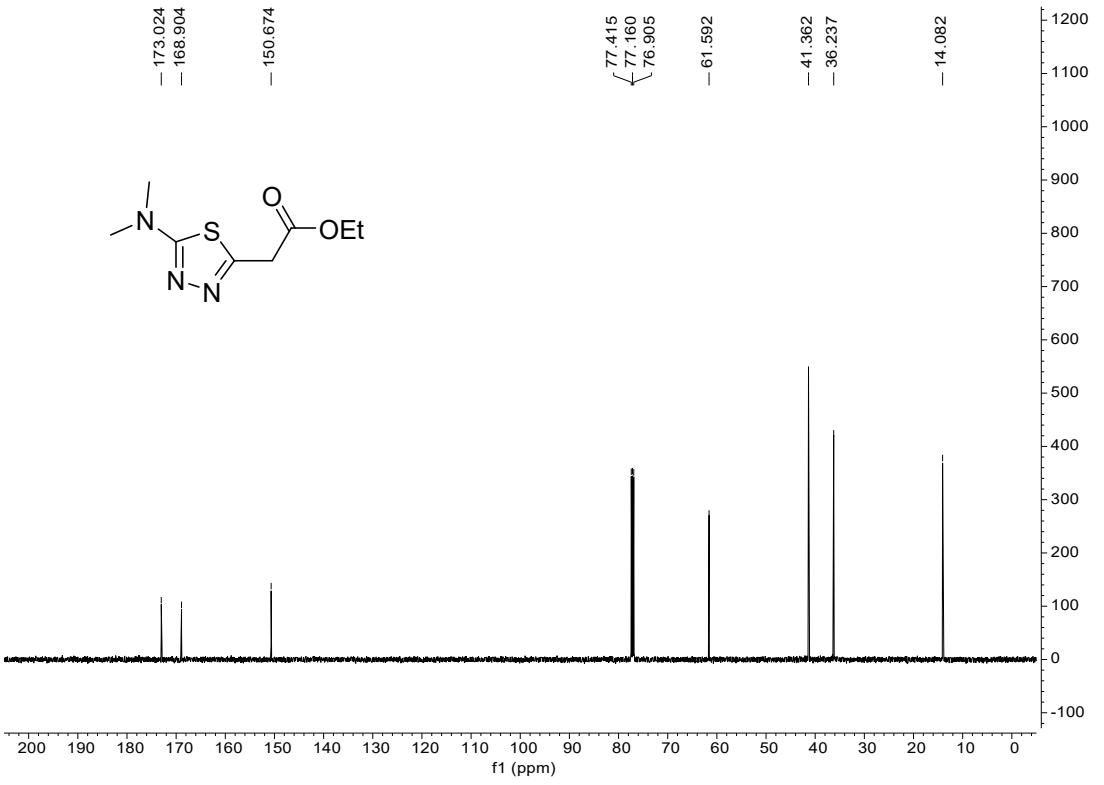


Ethyl 2-(5-(dimethylamino)-1,3,4-thiadiazol-2-yl)acetate(4g)

^{1}H NMR (500 MHz, $CDCl_3$) spectra of **4g**

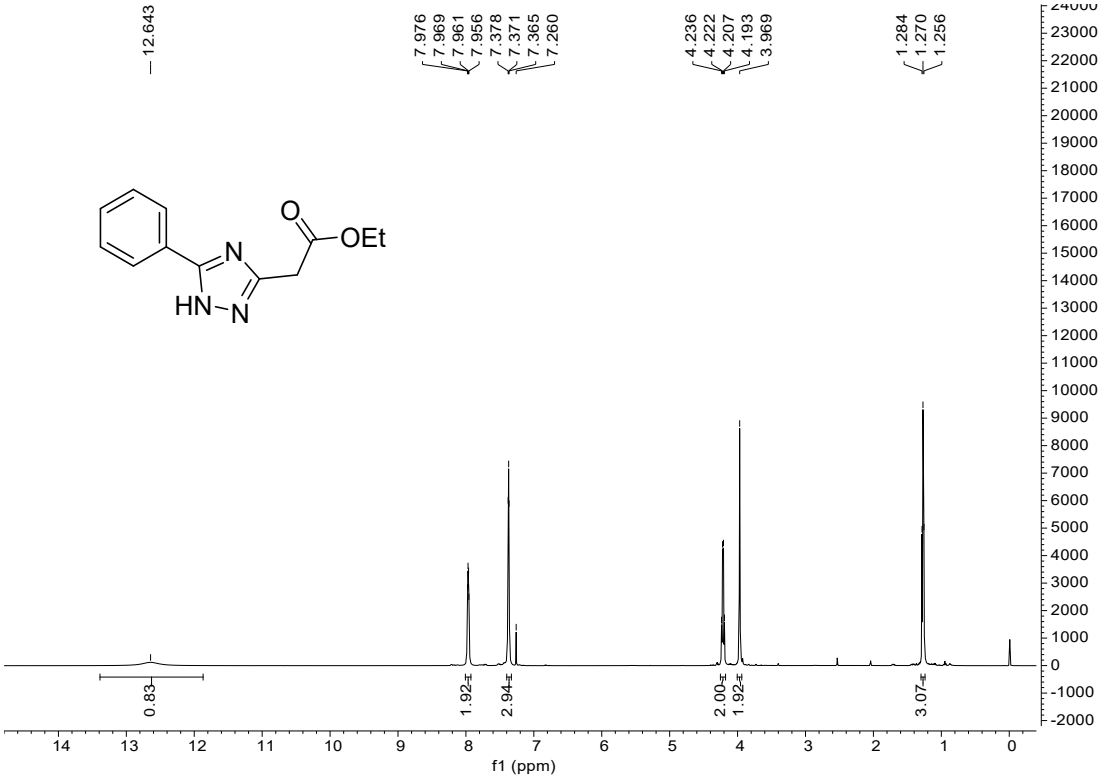


^{13}C NMR (125 MHz, $CDCl_3$) spectra of **4g**

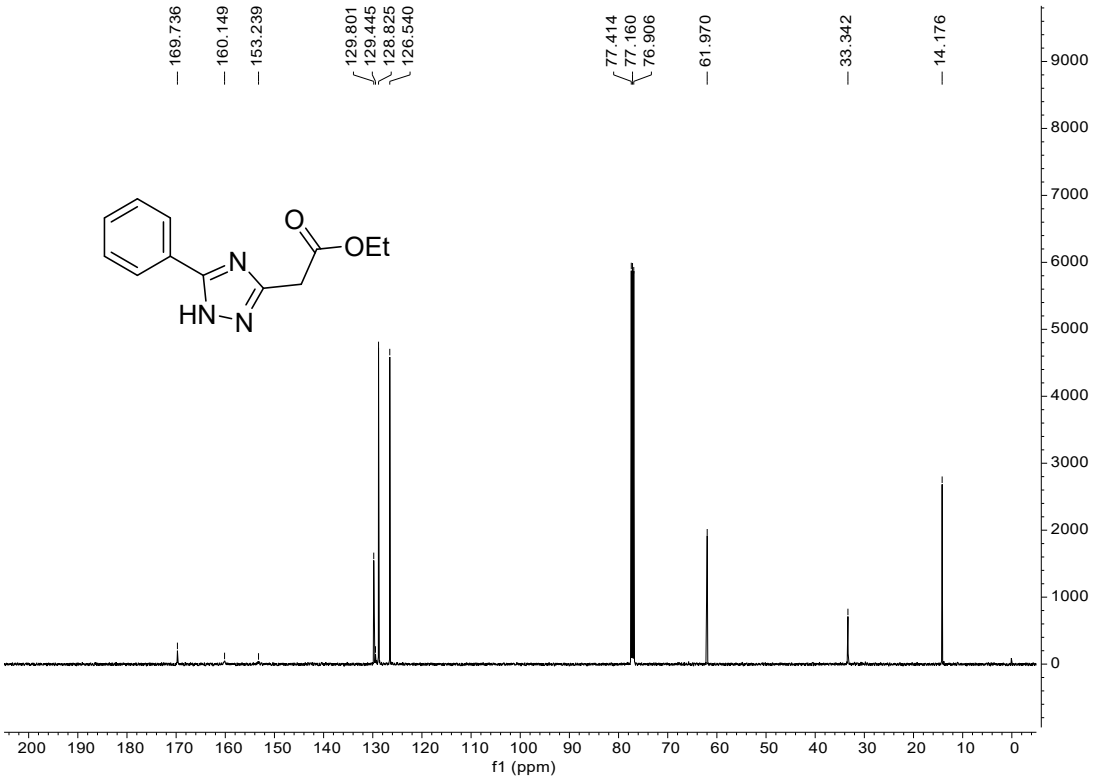


Ethyl 2-(5-phenyl-1H-1,2,4-triazol-3-yl)acetate (6a)

^{1}H NMR (500 MHz, $CDCl_3$) spectra of **6a**

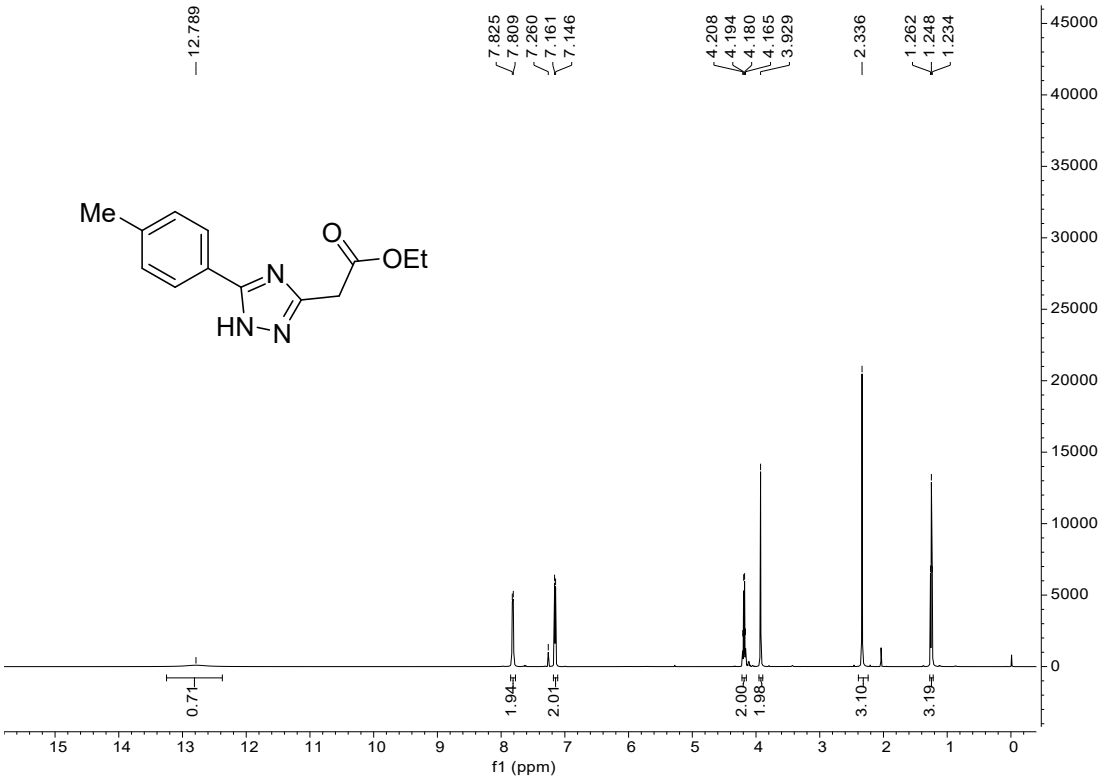


^{13}C NMR (125 MHz, $CDCl_3$) spectra of **6a**

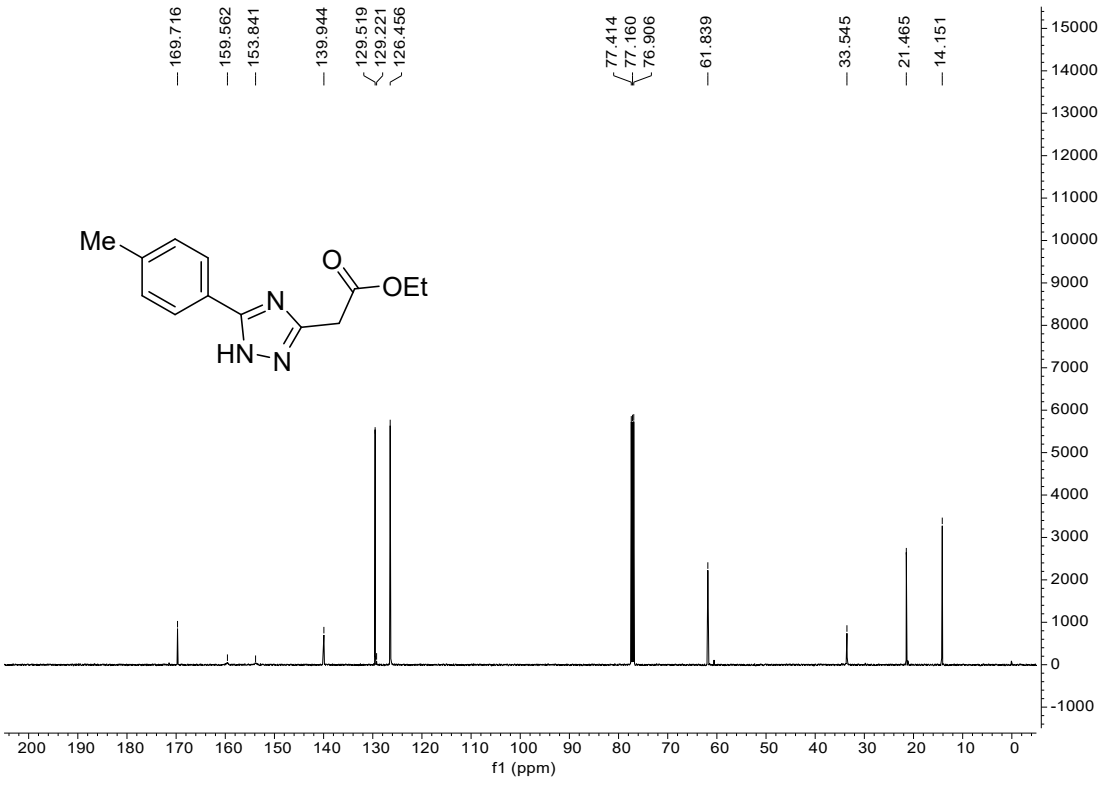


Ethyl 2-(5-(p-tolyl)-1H-1,2,4-triazol-3-yl)acetate (6b)

^{1}H NMR (500 MHz, $CDCl_3$) spectra of **6b**

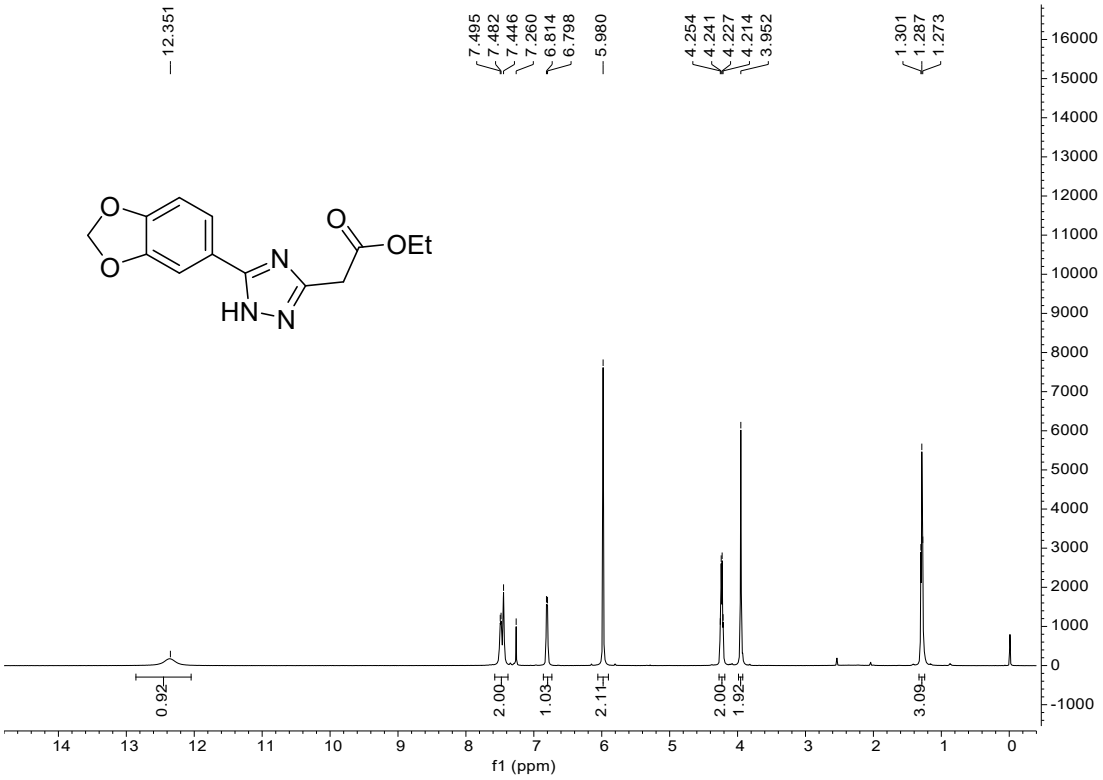


^{13}C NMR (125 MHz, $CDCl_3$) spectra of **6b**

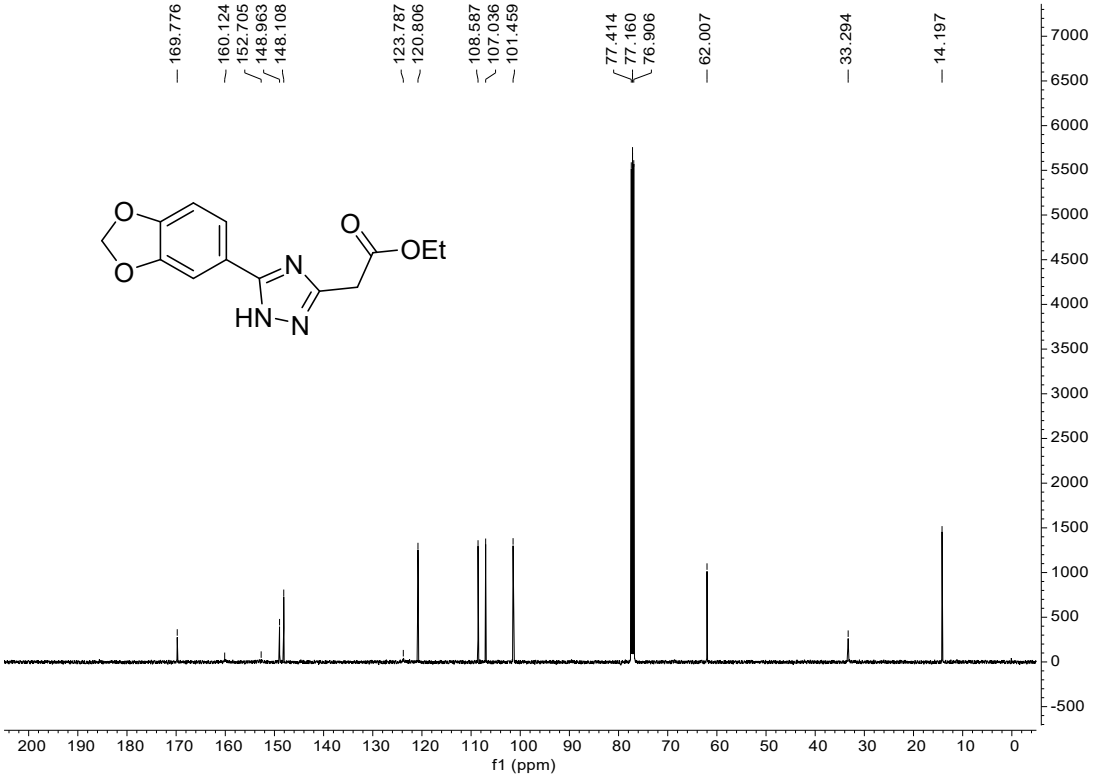


Ethyl 2-(5-(benzo[d][1,3]dioxol-5-yl)-1H-1,2,4-triazol-3-yl)acetate (6c)

^{1}H NMR (500 MHz, $CDCl_3$) spectra of **6c**

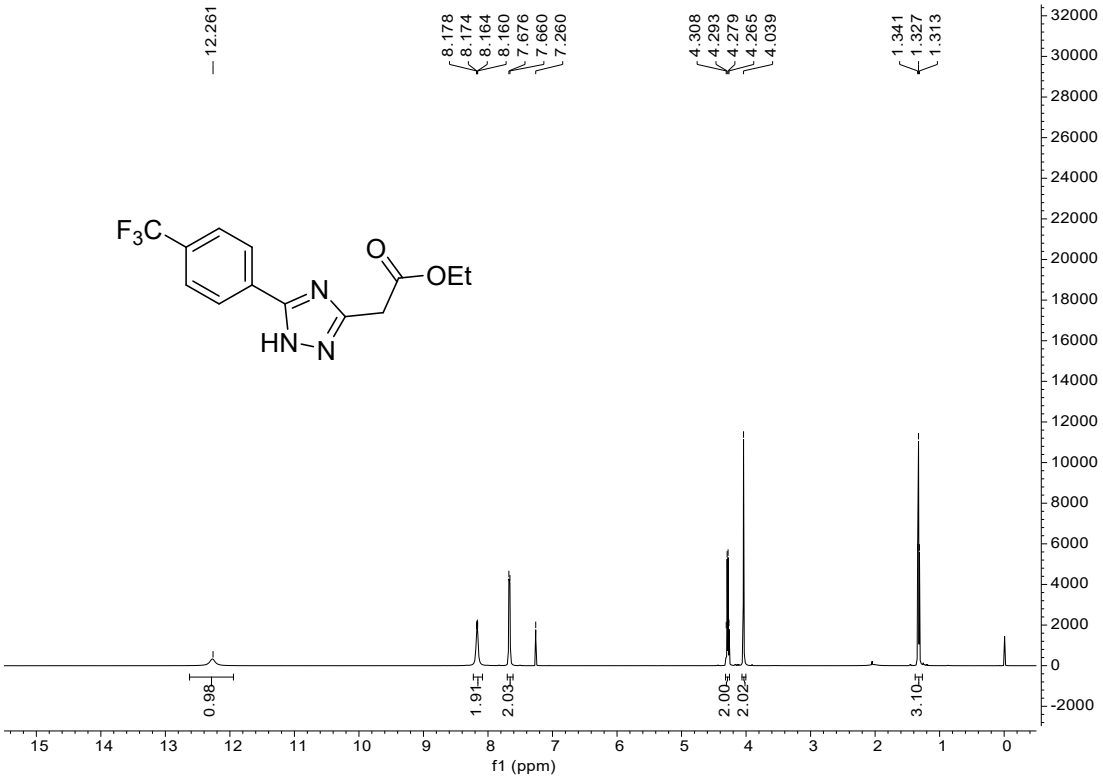


^{13}C NMR (125 MHz, $CDCl_3$) spectra of **6c**

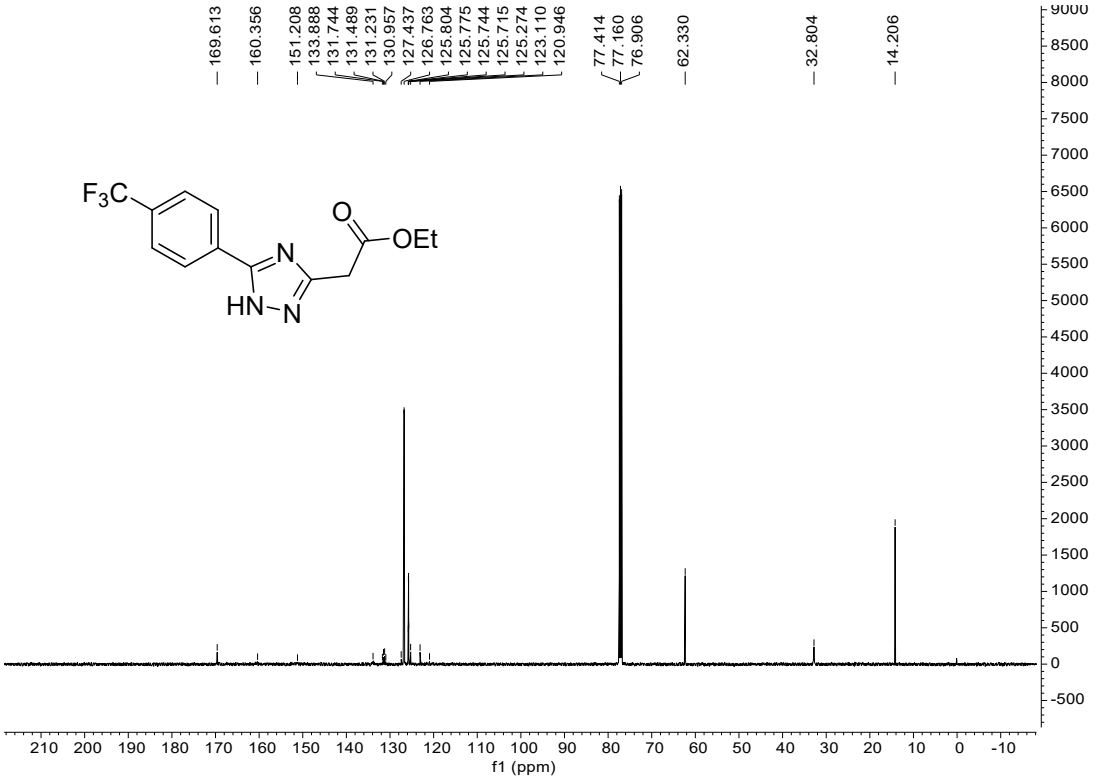


Ethyl 2-(5-(4-(trifluoromethyl)phenyl)-1H-1,2,4-triazol-3-yl)acetate (6d)

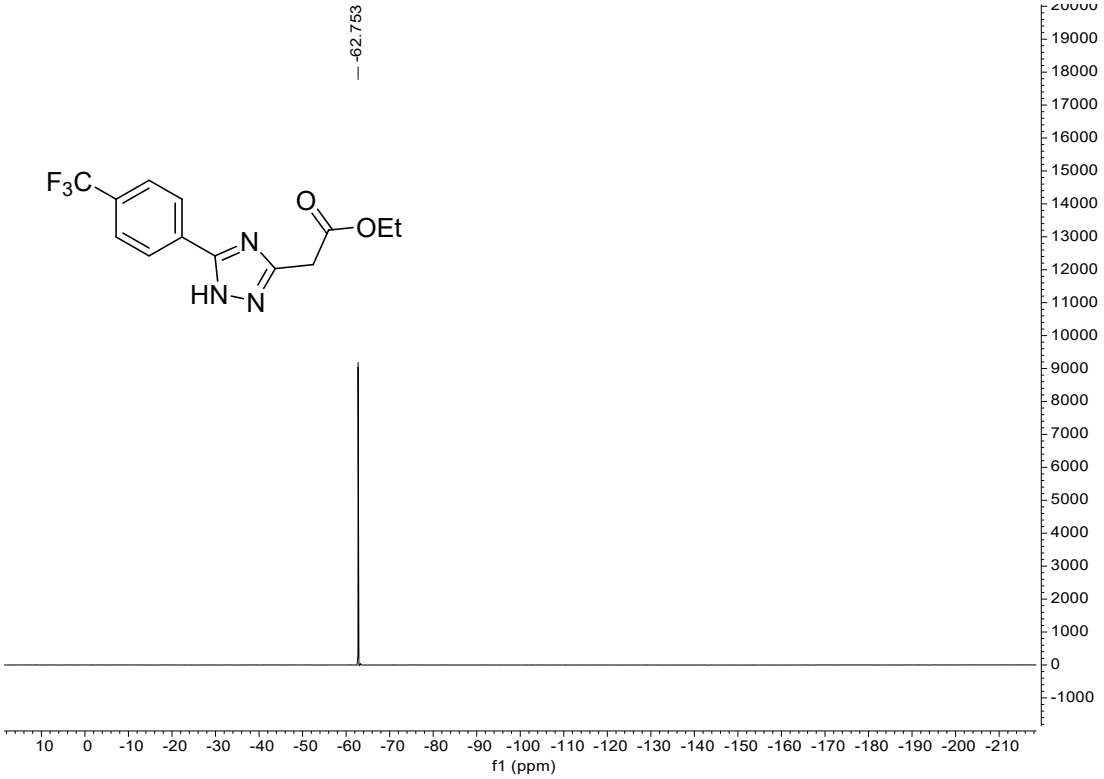
^{1}H NMR (500 MHz, $CDCl_3$) spectra of **6d**



^{13}C NMR (125 MHz, $CDCl_3$) spectra of **6d**

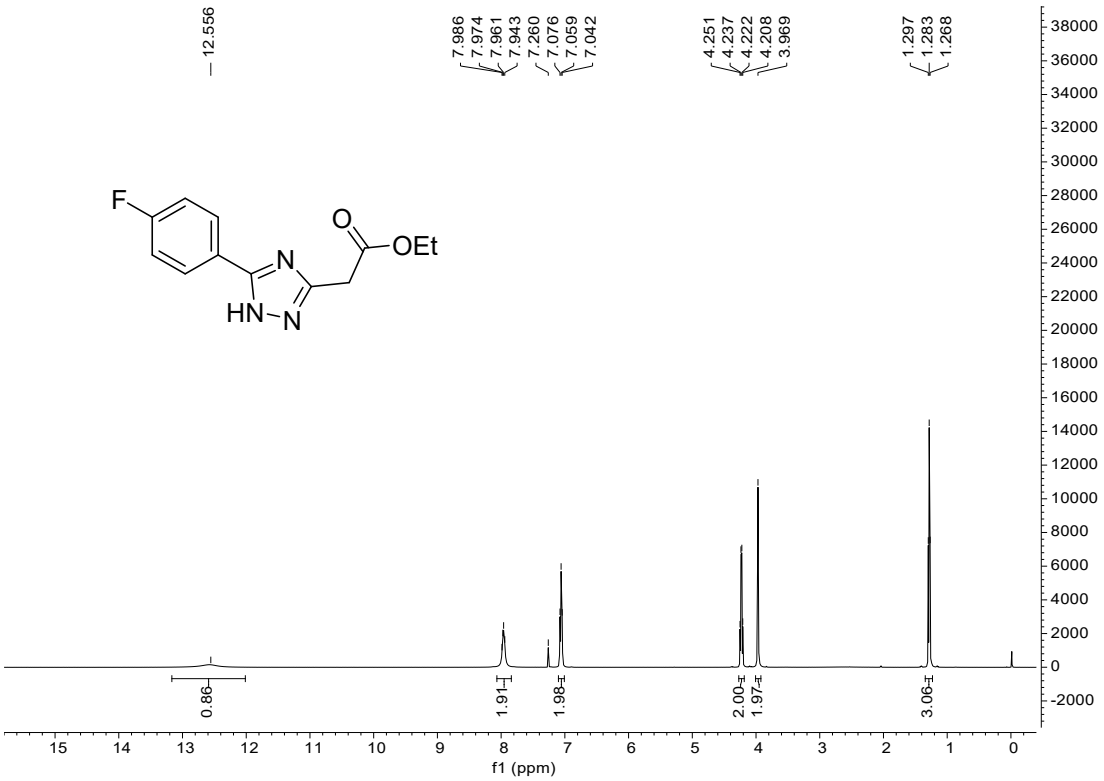


^{19}F NMR (376 MHz, $CDCl_3$) spectra of **6d**

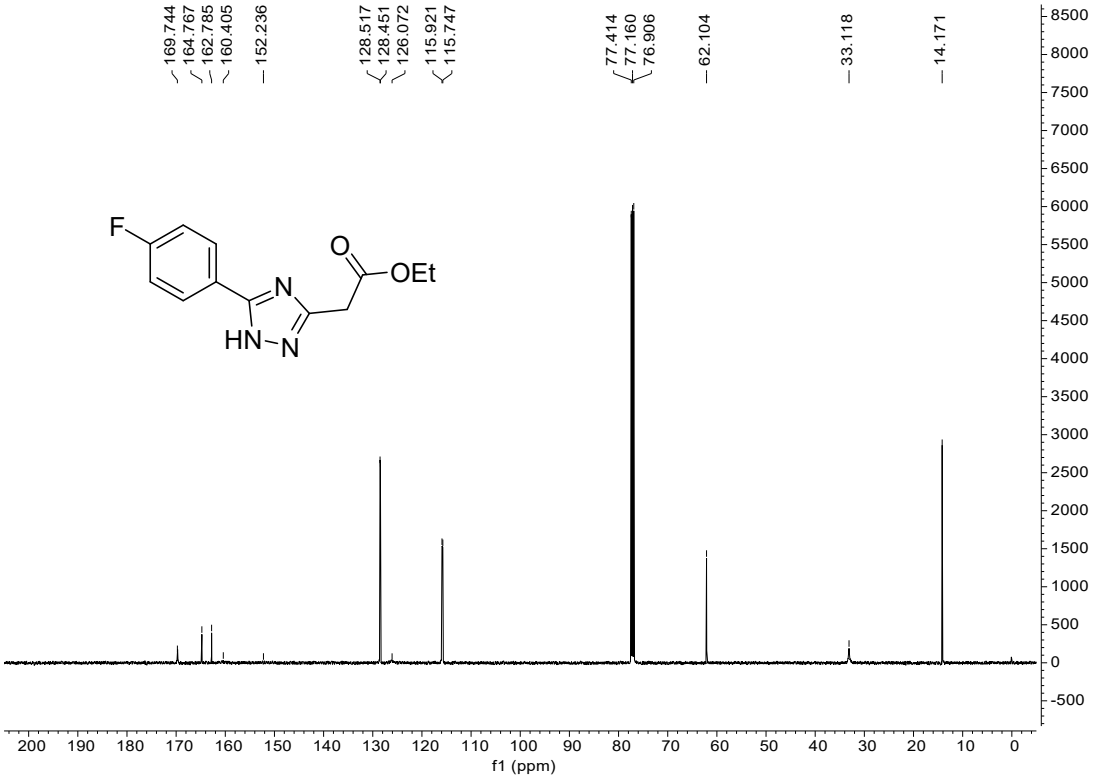


Ethyl 2-(5-(4-fluorophenyl)-1H-1,2,4-triazol-3-yl)acetate (6e)

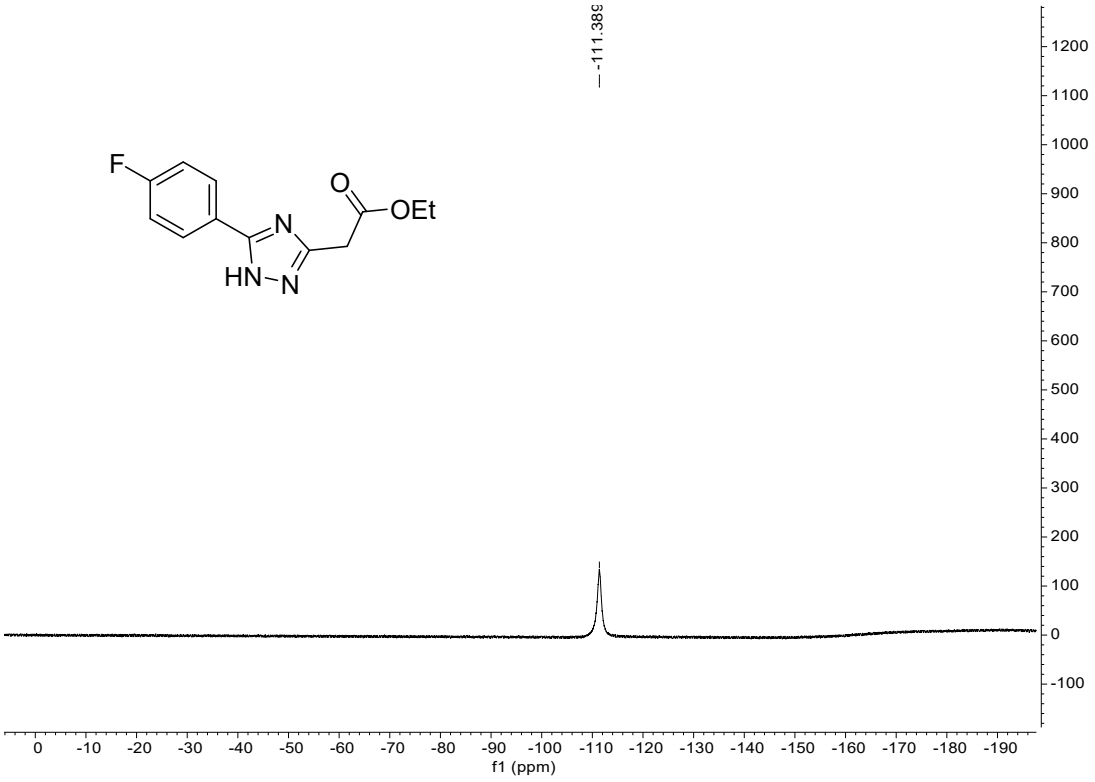
^{1}H NMR (500 MHz, $CDCl_3$) spectra of **6e**



^{13}C NMR (125 MHz, $CDCl_3$) spectra of **6e**

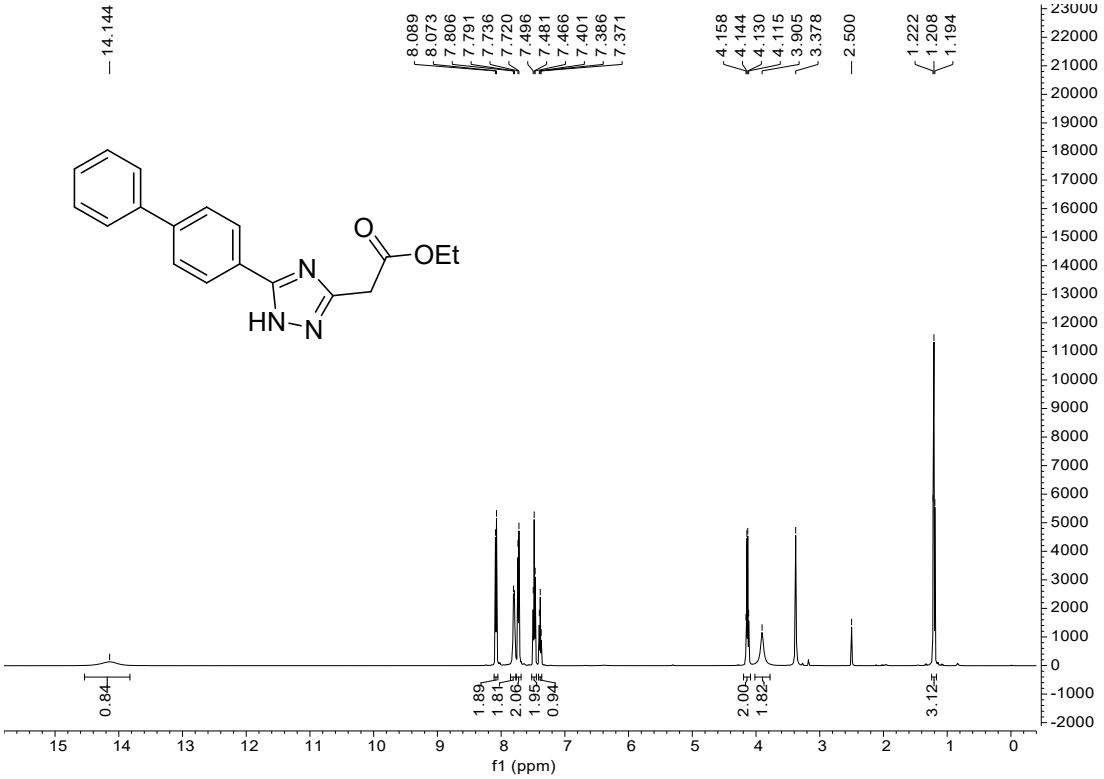


^{19}F NMR (376 MHz, $CDCl_3$) spectra of **6e**

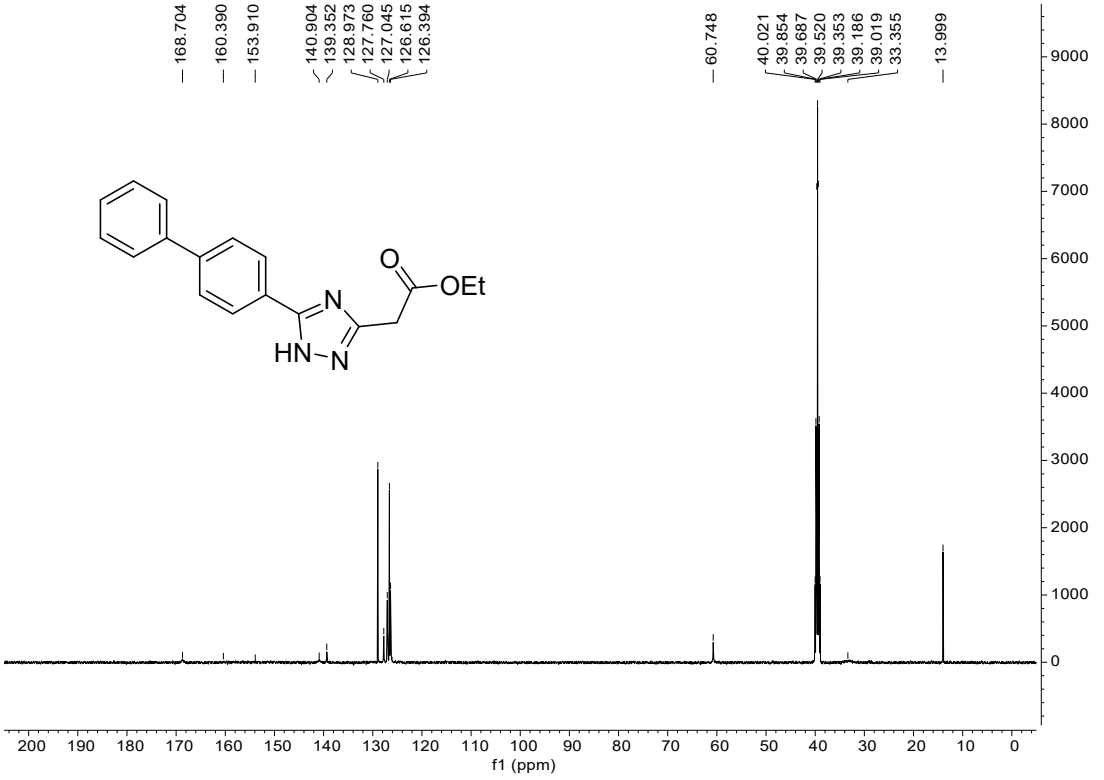


Ethyl 2-(5-([1,1'-biphenyl]-4-yl)-1H-1,2,4-triazol-3-yl)acetate (6f)

^{1}H NMR (500 MHz, DMSO-d_6) spectra of **6f**

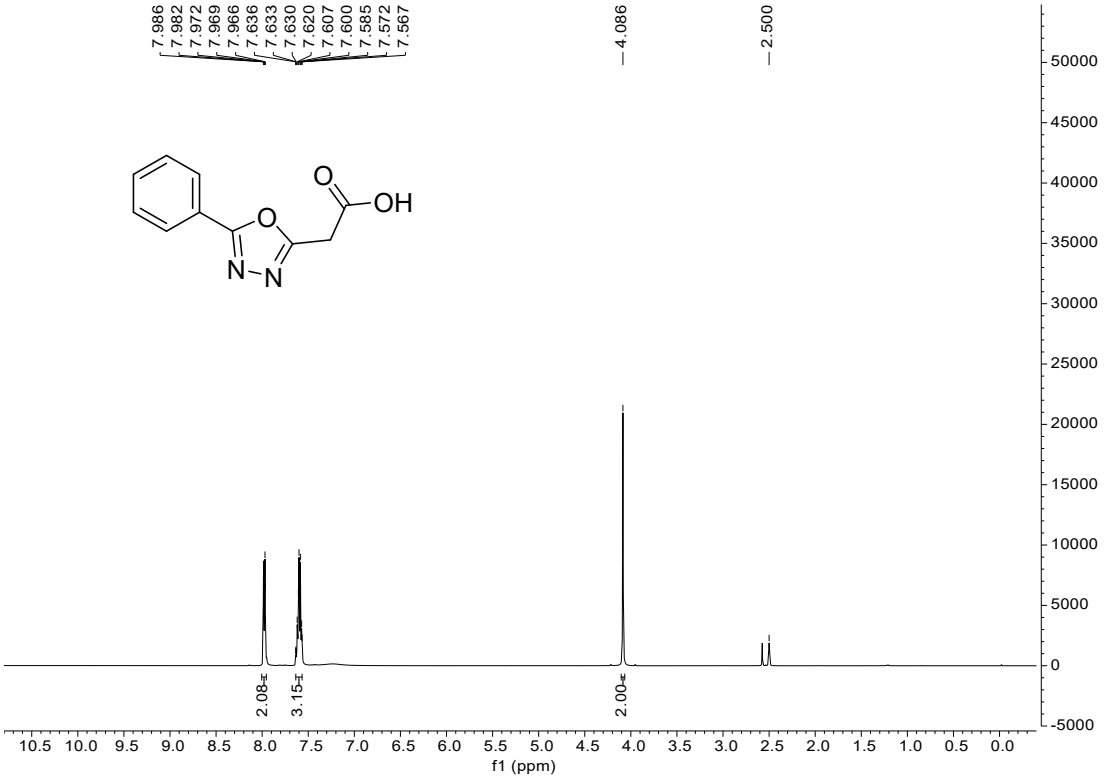


^{13}C NMR (125 MHz, DMSO-d_6) spectra of **6f**

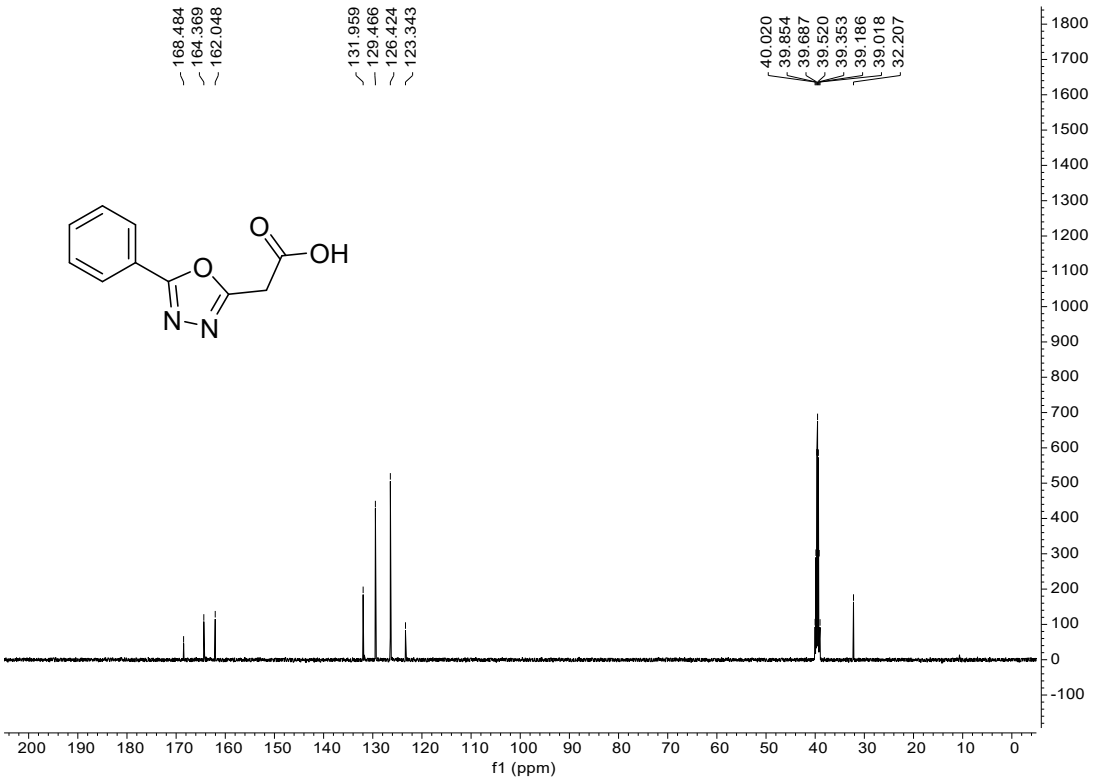


2-(5-phenyl-1,3,4-thiadiazol-2-yl)acetic acid (7)

^{1}H NMR (500 MHz, DMSO-d_6) spectra of **7**

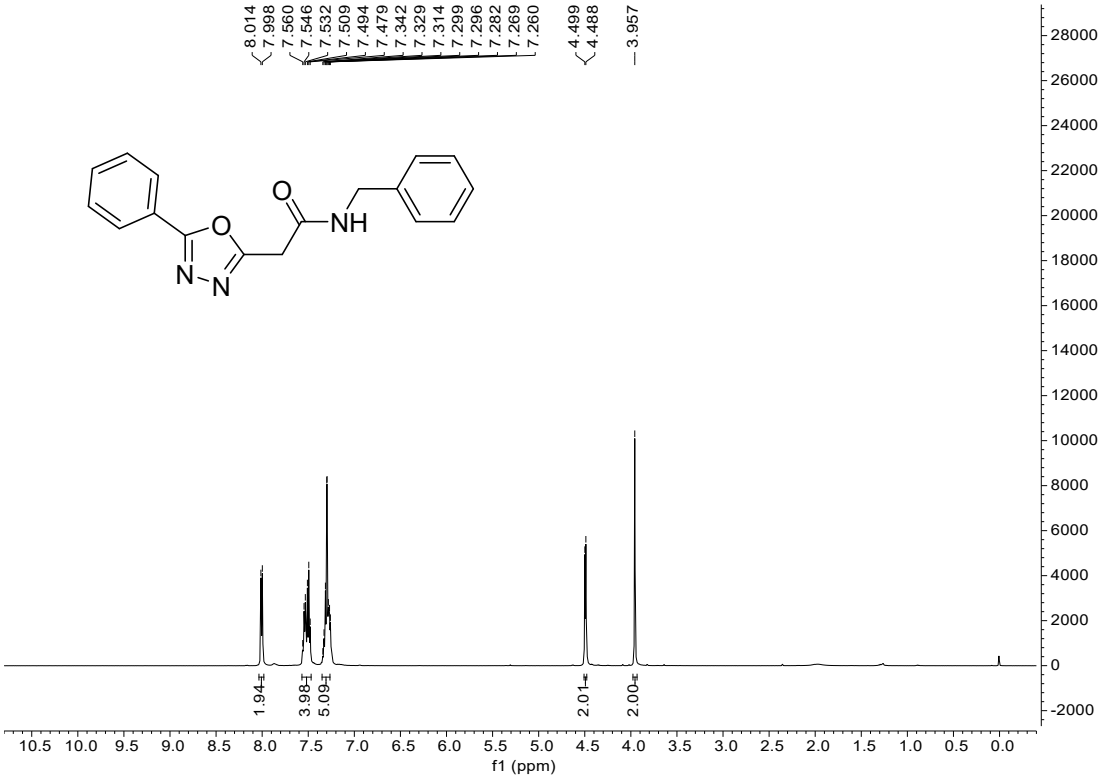


^{13}C NMR (125 MHz, DMSO-d_6) spectra of **7**

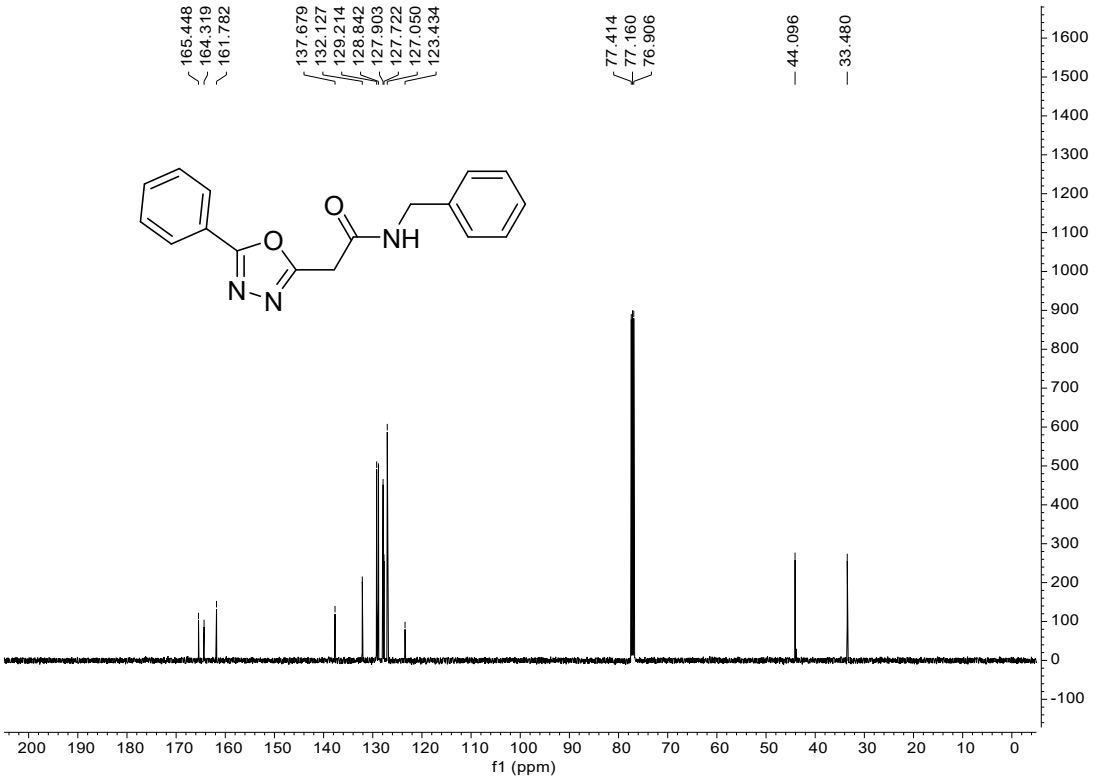


***N*-benzyl-2-(5-phenyl-1,3,4-thiadiazol-2-yl)acetamide (8)**

^{1}H NMR (500 MHz, $CDCl_3$) spectra of **8**

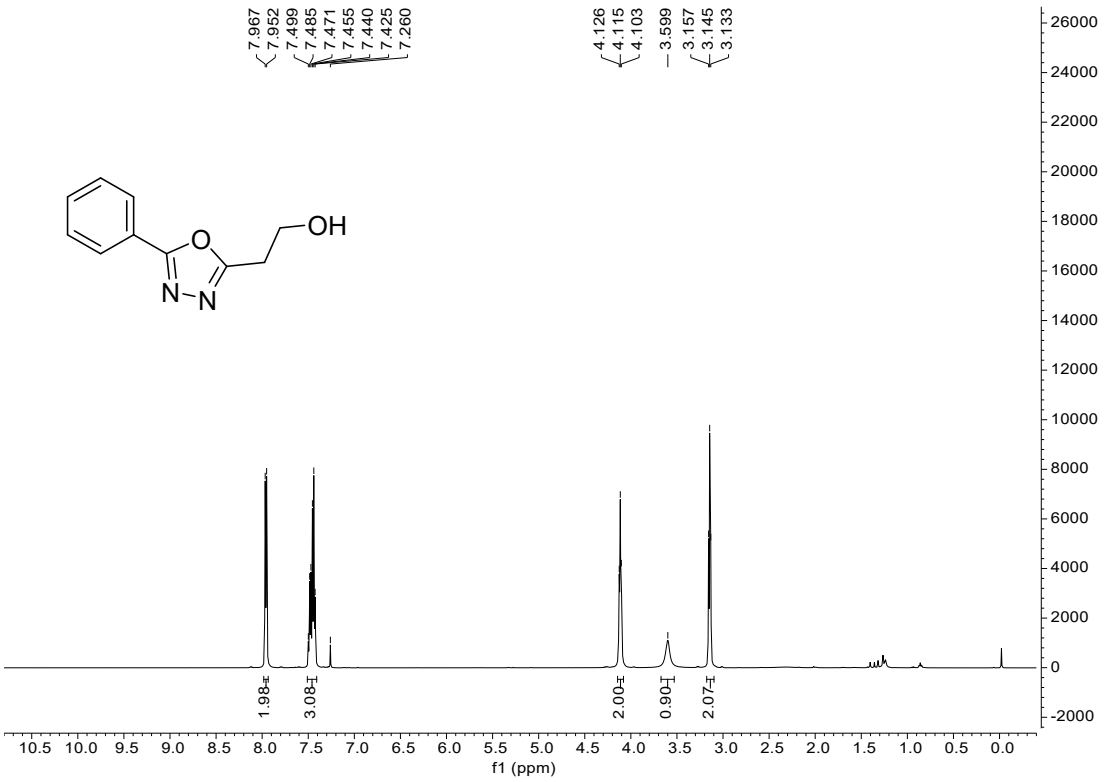


^{13}C NMR (125 MHz, $CDCl_3$) spectra of **8**

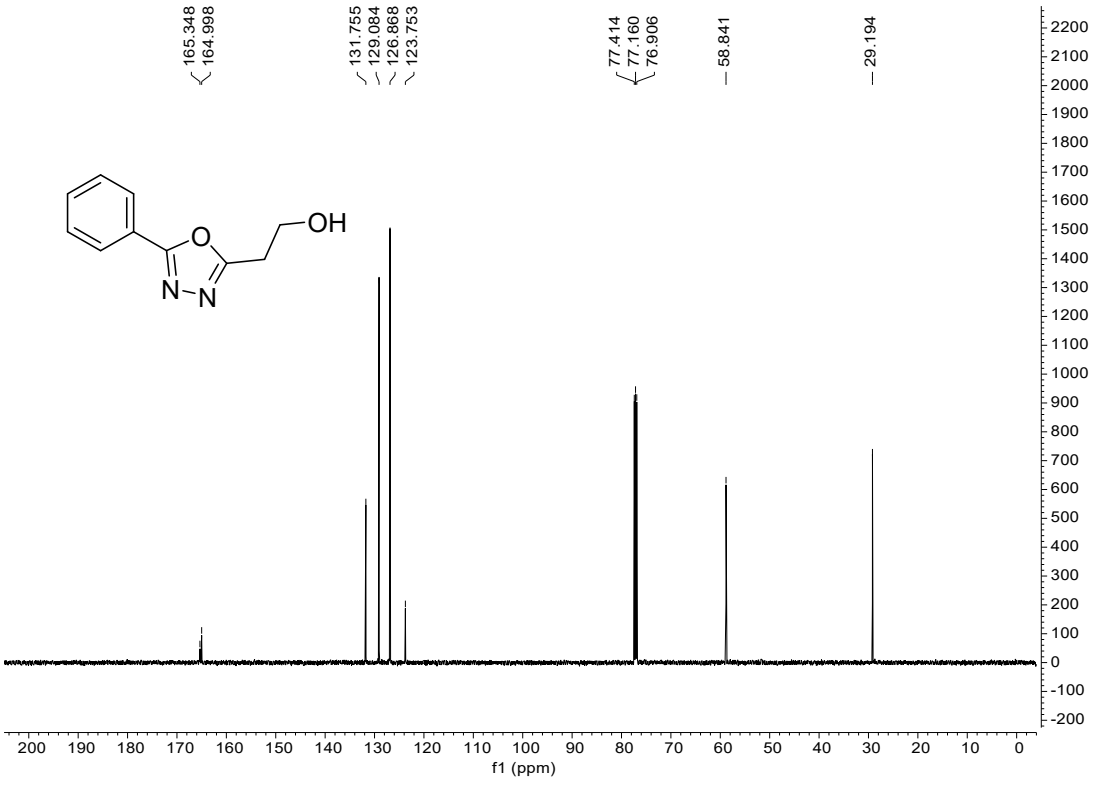


2-(5-phenyl-1,3,4-thiadiazol-2-yl)ethan-1-ol (9)

^{1}H NMR (500 MHz, $CDCl_3$) spectra of **9**

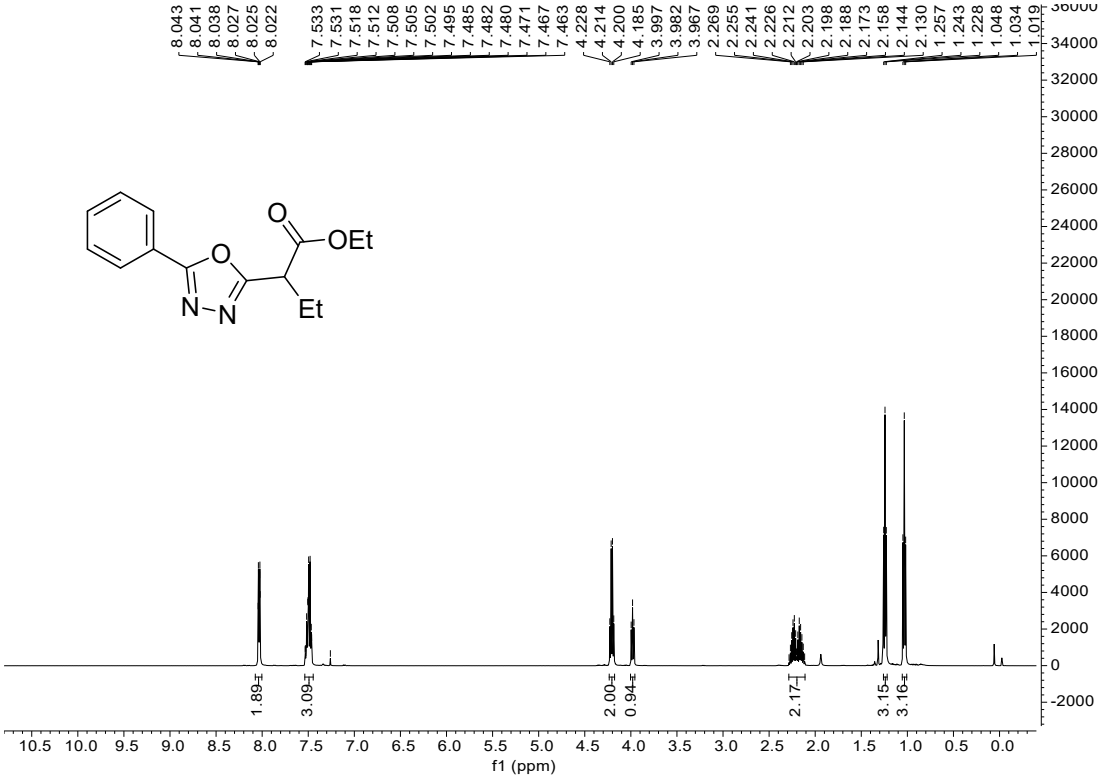


^{13}C NMR (125 MHz, $CDCl_3$) spectra of **9**

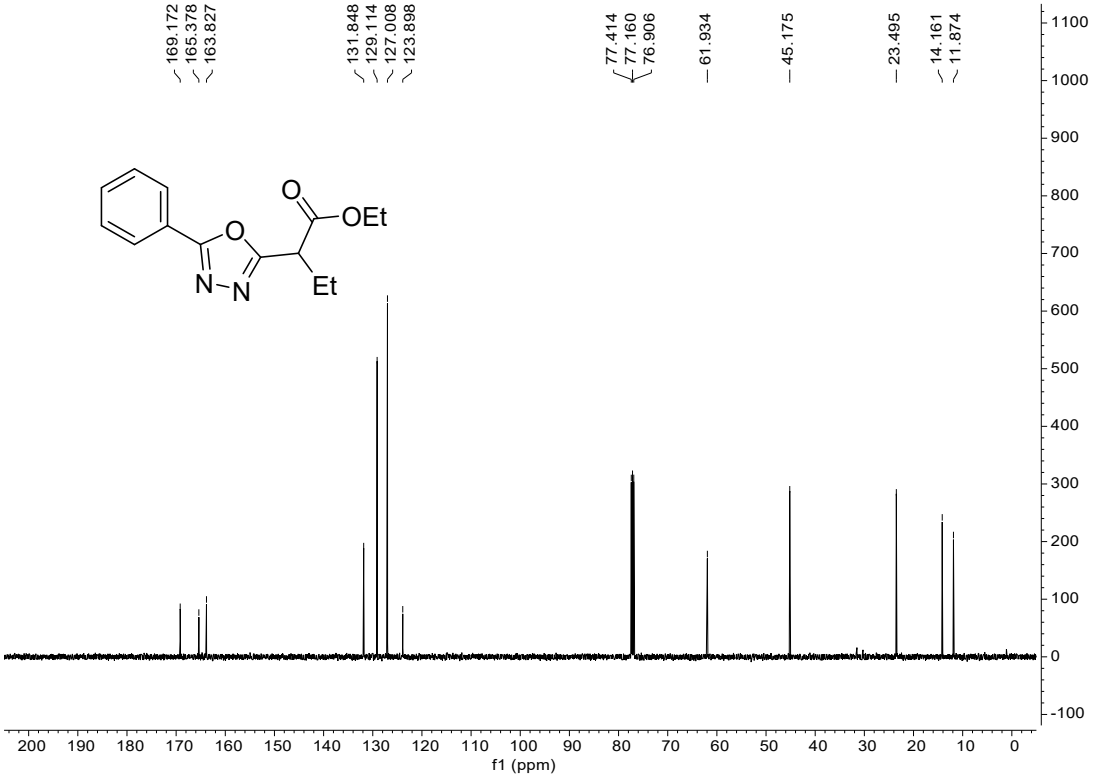


Ethyl 2-(5-phenyl-1,3,4-thiadiazol-2-yl)butanoate (10)

^{1}H NMR (500 MHz, $CDCl_3$) spectra of **10**

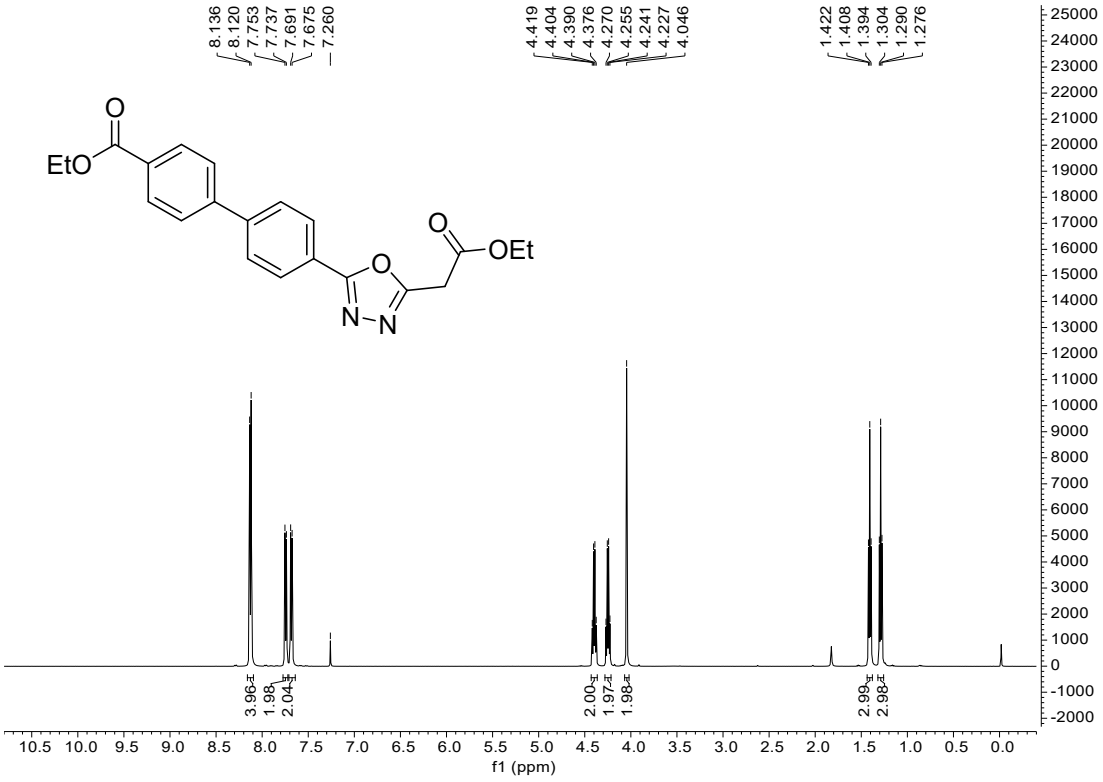


^{13}C NMR (125 MHz, $CDCl_3$) spectra of **10**

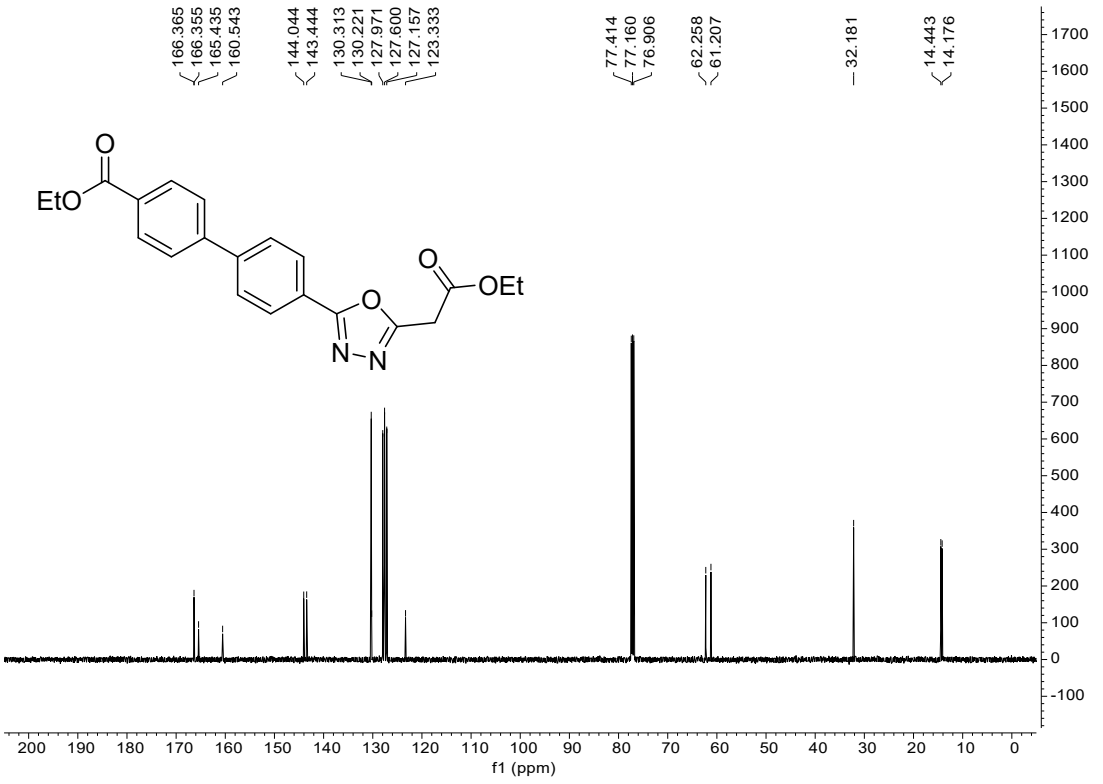


Ethyl 4'-(5-(2-ethoxy-2-oxoethyl)-1,3,4-thiadiazol-2-yl)-[1,1'-biphenyl]-4-carboxylate (11)

^{1}H NMR (500 MHz, $CDCl_3$) spectra of **11**



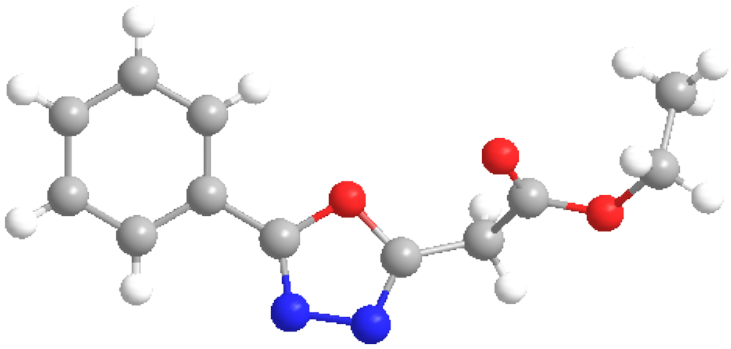
^{13}C NMR (125 MHz, $CDCl_3$) spectra of **11**



4. X-ray structure of 2a (CCDC 2170479)

The structure of **2a** was further determined by single crystal X-ray analysis. (CCDC 2170479) contains the supplementary crystallographic data for this structure. These data can be obtained free of charge from The Cambridge Crystallographic Data Centre).

X-ray structure of product 2a (ellipsoid contour at 50% probability)



Experimental

Single crystals of **2a** ($C_{12}H_{12}N_2O_3$) were grown by slow evaporation in ethyl acetate/ acetonitrile = 2/5 under air atmosphere. A suitable crystal was selected and mounted on a XtaLAB Synergy R, DW system, HyPix diffractometer. The crystal was kept at 100(2) K during data collection. Using Olex2, the structure was solved with the Shelxs structure solution program using Direct Methods.

Crystal structure determination of 2a

Crystal Data for $C_{12}H_{12}N_2O_3$ (M=232.24 g/mol): triclinic, space group P-1 (no. 2), a= 5.6320(5)Å, b= 8.3085(7)Å, c = 12.2276(16)Å, α= 85.953(9)°, β= 80.093(9)°, γ= 75.863(7)°,V= 546.33(10)Å^3, Z= 2, T= 100(2)K, μ(MoKα)= 0.103 mm^{-1}, $Dcalc$ = 1.412 g/cm^3.

Table 1. Crystal data and structure refinement for **2a**

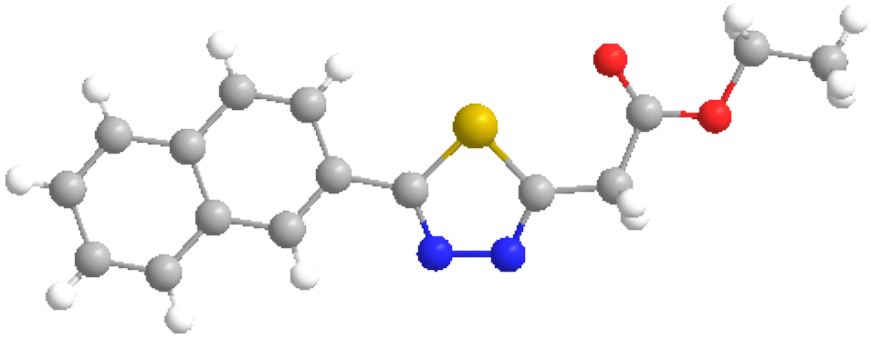
Empirical formula	$C_{12}H_{12}N_2O_3$
Formula weight	232.24
Temperature/K	100(2)
Crystal system	triclinic
Space group	P-1
a/Å	5.6320(5)
b/Å	8.3085(7)
c/Å	12.2276(16)
α/°	85.953(9)
β/°	80.093(9)
γ/°	75.863(7)
Volume/Å^3	546.33(10)

Z	2
ρ_{calc}g/cm^3	1.412
μ/mm^{-1}	0.103
F(000)	244.0
Crystal size/mm^3	0.25 × 0.2 × 0.2
Radiation	MoKα (λ = 0.71073)
2Θ range for data collection/°	6.768 to 59.318
Index ranges	-7 ≤ h ≤ 7, -11 ≤ k ≤ 11, -14 ≤ l ≤ 16
Reflections collected	4184
Independent reflections	2534 [R_{int} = 0.0441, R_{sigma} = 0.0812]
Data/restraints/parameters	2534/0/156
Goodness-of-fit on F^2	1.047
Final R indexes [I>=2σ (I)]	R_1 = 0.0544, wR_2 = 0.1159
Final R indexes [all data]	R_1 = 0.0735, wR_2 = 0.1323
Largest diff. peak/hole / e Å^{-3}	0.26/-0.28

5. X-ray structure of 4d (CCDC 2178538)

The structure of **4d** was further determined by single crystal X-ray analysis. (CCDC 2178538) contains the supplementary crystallographic data for this structure. These data can be obtained free of charge from The Cambridge Crystallographic Data Centre).

X-ray structure of product 4d (ellipsoid contour at 50% probability)



Experimental

Single crystals of **4d** ($C_{16}H_{14}N_2O_2S$) were grown by slow evaporation in ethyl acetate/ acetonitrile = 1/5 under air atmosphere. A suitable crystal was selected and mounted on a XtaLAB Synergy R, DW system, HyPix diffractometer. The crystal was kept at 300 K during data collection. Using Olex2, the structure was solved with the Shelxs structure solution program using Direct Methods.

Crystal structure determination of 4d

Crystal Data for $C_{16}H_{14}N_2O_2S$ (*M* =298.35 g/mol): space group P-1, *a*= 7.7462(4)Å, *b*= 9.2543(4)Å,

c = 10.7494(5)Å, *α*= 106.819(4)°, *β*= 100.376(4)°, *γ*= 93.807(4)°, *V*= 546.33(10)Å^3, *Z*= 2, *T*= 300 K, *Dcalc* = 1.377 g/cm^3.

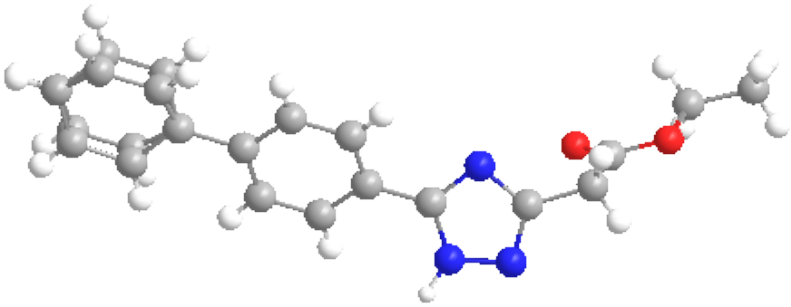
Table 2. Crystal data and structure refinement for **4d**

Bond precision:	C-C = 0.0024 A		Wavelength=0.71073
Cell:	a=7.7462(4)	b=9.2543(4)	c=10.7494(5)
	alpha=106.819(4)	beta=100.376(4)	gamma=93.807(4)
Temperature: 300 K			
	Calculated		Reported
Volume	719.78(6)		719.78(6)
Space group	P -1		P -1
Hall group	-P 1		-P 1
Moiety formula	C16 H14 N2 O2 S		C16 H14 N2 O2 S
Sum formula	C16 H14 N2 O2 S		C16 H14 N2 O2 S
Mr	298.35		298.35
Dx,g cm-3	1.377		1.377
Z	2		2
Mu (mm-1)	0.230		0.230
F000	312.0		312.0
F000'	312.37		
h,k,lmax	11,13,15		10,13,15
Nref	4560		3569
Tmin,Tmax			0.651,1.000
Tmin'			
Correction method= # Reported T Limits: Tmin=0.651 Tmax=1.000			
AbsCorr = MULTI-SCAN			
Data completeness= 0.783		Theta(max)= 30.912	
R(reflections)= 0.0392(2468)			wR2(reflections)= 0.1088(3569)
S = 1.039	Npar= 191		

6. X-ray structure of 6f (CCDC 2178536)

The structure of **6f** was further determined by single crystal X-ray analysis. (CCDC 2178536) contains the supplementary crystallographic data for this structure. These data can be obtained free of charge from The Cambridge Crystallographic Data Centre).

X-ray structure of product 6f (ellipsoid contour at 50% probability)



Experimental

Single crystals of **6f** ($C_{18}H_{17}N_3O_2$) were grown by slow evaporation in ethyl acetate/ acetonitrile = 1/1 under air atmosphere. A suitable crystal was selected and mounted on a XtaLAB Synergy R, DW system, HyPix diffractometer. The crystal was kept at 300 K during data collection. Using Olex2, the structure was solved with the Shelxs structure solution program using Direct Methods.

Crystal structure determination of 6f

Crystal Data for $C_{18}H_{17}N_3O_2$ (*M* =307.34 g/mol): space group P21/c, *a*= 8.4347(6)Å, *b*= 5.1670(3)Å, *c* = 35.992(2)Å, *α*=90°, *β*= 92.243(5)°, *γ*=90°, *V*= 546.33(10)Å^3, *Z*= 4, *T*= 300 K, *Dcalc* = 1.302 g/cm^3.

Table 3. Crystal data and structure refinement for **6f**

Bond precision:	C-C = 0.0021 A		Wavelength=0.71073
Cell:	a=8.4347(6)	b=5.1670(3)	c=35.992(2)
	alpha=90	beta=92.243(5)	gamma=90
Temperature: 300 K			
	Calculated		Reported
Volume	1567.41(17)		1567.41(17)
Space group	P 21/c		P 1 21/c 1
Hall group	-P 2ybc		-P 2ybc
Moiety formula	C18 H17 N3 O2		C18 H17 N3 O2
Sum formula	C18 H17 N3 O2		C18 H17 N3 O2
Mr	307.35		307.34
Dx,g cm-3	1.302		1.302
Z	4		4
Mu (mm-1)	0.087		0.087
F000	648.0		648.0
F000'	648.27		
h,k,lmax	12,7,51		11,6,45
Nref	4880		3975
Tmin,Tmax	0.992,0.996		0.906,1.000
Tmin'	0.987		

Correction method= # Reported T Limits: Tmin=0.906 Tmax=1.000

AbsCorr = MULTI-SCAN

Data completeness= 0.815 Theta(max)= 30.717

R(reflections)= 0.0495(2694) wR2(reflections)= 0.1339(3975)

S = 1.020 Npar= 250