Electronic Supplementary Material (ESI) for New Journal of Chemistry.

Supporting Information

A Practical Flow Synthesis of Hydrazine Derivatives from Alcohols

Jie Ding, [a] Ye Yang, [a] Mingzhen Xue, [a] Xukai Gong, [a] Hu Cai*[a] and Wentao Xu*[a]

[a] *School of Chemistry and Chemical Engineering, Nanchang University, Nanchang, Jiangxi 330031, China. Email: caihu@ncu.edu.cn; wtxu@ncu.edu.cn*

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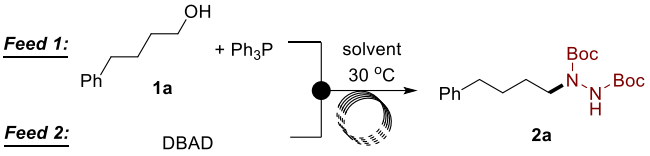
1. General information

All the reactions were conducted under air conditions unless otherwise noted. All solvents were obtained from commercial suppliers and used without further purification. Reagents were purchased from Energy Chemical, Adamas-beta, and etc. Flash column chromatographic purification of products was accomplished using forced-flow chromatography on Silica Gel (300-400 mesh).

^{1}H NMR, ^{13}C NMR and ^{19}F NMR spectra were recorded on a 400 MHz spectrometer in $CDCl_3$ (δH = 0.0 ppm, δC = 77.02 ppm as standard). Data for ^{1}H NMR are reported as follows: chemical shift (ppm, scale), multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet, br = broad), coupling constant (Hz), and integration. Data for ^{13}C NMR are reported in terms of chemical shift (ppm, scale), multiplicity, and coupling constant (Hz). High-resolution mass spectra were obtained by ESI on a TOF mass analyzer.

2. Optimization of the deoxygenative hydrazination

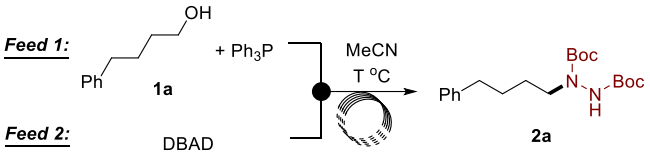
2.1 Table S1. Investigation of reaction solvent.



Entry	Solvent	Yield of **2a** (%) [b]
1	THF	56
2	DMF	46
3	CH_3CN	85
4	DCE	79
5	DMSO	Trace
6	Acetone	32

[a] Continuous flow conditions: Feed 1: alcohol (**1a**, 2 mmol, 0.1 M), Ph_3P (3 mmol, 1.5 equiv), solvent (10.0 mL); feed 2: DBAD (0.3 mmol, 1.5 equiv, 0.15 M), solvent (10.0 mL), 30 °C, 7 mL reactor volume, 1.1 * 1.5 mm, t_R = 42 min. [b] Isolated yields in 1.0 mmol scale.

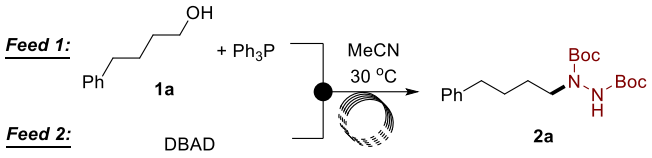
2.2 Table S2. The exploration of reaction temperature.



Entry	T (℃)	Yield of **2a** (%) [b]
1	10	57
2	30	85
3	50	82

[a] Continuous flow conditions: Feed 1: alcohol (**1a**, 2 mmol, 0.1 M), Ph_3P (3 mmol, 1.5 equiv), solvent (10.0 mL); feed 2: DBAD (0.3 mmol, 1.5 equiv, 0.15 M), solvent (10.0 mL), T ºC, 7 mL reactor volume, 1.1 * 1.5 mm, t_R = 42 min. [b] Isolated yields in 1.0 mmol scale.

2.3 Table S3. Investigation of flow rate.

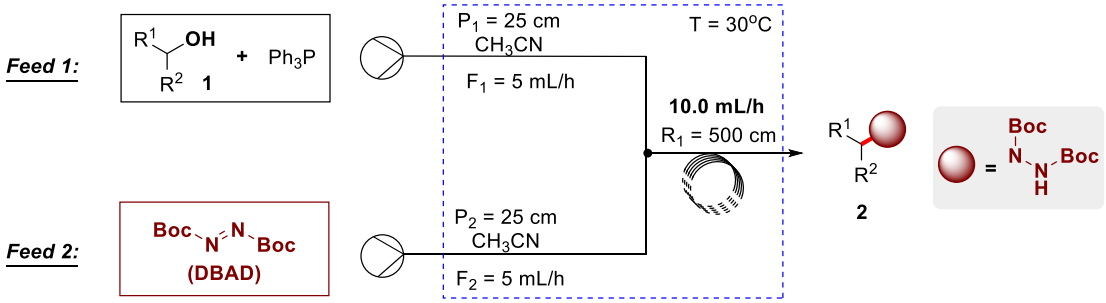


Entry	flow rate (mL/h)	t_R (min)	Yield of **2a** (%) [b]
1	40	10.5	46
2	20	21	52
3	10	42	85

[a] Continuous flow conditions: Feed 1: alcohol (**1a**, 2 mmol, 0.1 M), Ph_3P (3 mmol, 1.5 equiv), MeCN (10.0 mL); feed 2: DBAD (0.3 mmol, 1.5 equiv, 0.15 M), MeCN (10.0 mL), T ºC, 7 mL reactor volume, 1.1 * 1.5 mm. [b] Isolated yields in 1.0 mmol scale.

3. General procedure

3.1 General procedure for deoxygenative hydrazination of alcohols.



There are two 10 ml syringes. One was filled with alcohol (2.0 mmol) and PPh_3 (786.9 mg, 3 mmol) in MeCN (10.0 mL). Another was filled with DBAD (690.9 mg, 3 mmol) in MeCN (10.0 mL). Next, the syringes were placed into the syringe driver, and the advancing speed of the device was set at 5.0 mL/h, and the infusion mode was set to single infusion. The tubing (1.1 x 1.5 mm, 5 m, volume = 7.0 mL) was placed into a water bath at 30 ℃. Thus, the reaction mixture was at the speed of 10.0 mL/h at 30 ℃. After approximately 0.3 h of equilibration, 10.0 mL of the product solution was collected. The organic layers were concentrated under vacuo. The product was purified by flash column chromatography on silica gel (petroleum ether: ethyl acetate). In addition, 100.0 mL of the product solution was collected for the gram-reaction.

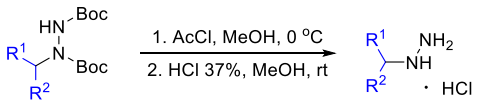
Figure S1. Reaction set-up

3.2 General procedure for the synthesis of pharmacologically active compounds on gram-scale

(1) Synthesis of hydrazine derivatives

According to the general procedure, the reaction mixture of octan-2-ol was collected 200.0 mL, the reaction mixture of 2-phenylethan-1-ol was collected 100.0 mL, and the reaction mixture of 4-(benzo[d][1,3]dioxol-5-yl)butan-2-ol was collected 100.0 mL. The finished mixture was concentrated under vacuo and purified by flash column chromatography on silica gel. The responding hydrazine derivative was afforded and used in next steps.

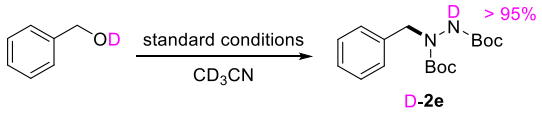
(2) The deprotection of hydrazine derivatives to hydrazinium hydrochloride



The obtained hydrazine derivative was dissolved in MeOH (50.0 mL) and cooled down to 0 ºC. Then acetyl chloride (9.54 g for octan-2-ol, 4.77 g for 2-phenylethan-1-ol and 4-(benzo[d][1,3]dioxol-5-yl)butan-2-ol) was slowly added dropwise. Then the mixture was stirred for 2.5 min. Subsequently, 40 mL HCl in MeOH (37%, 200 μL/mL) was added (20 mL for 4-(benzo[d][1,3]dioxol-5-yl)butan-2-ol). The reaction was stirred at room temperature for 2.0 h. The solvent was removed under reduced pressure, then further dried using vacuum drying chamber, to afford the corresponding hydrazine hydrochloride **5a-c**.

4. Investigation of the reaction mechanism

4.1 The deuterium-labeled experiments



D-**2e**

In order to clarify the origination of the hydrogen atom from hydrazination products **2**, the deuterium-labeled experiments were conducted. We speculate that the hydrogen atom of products originates from alcohols. Benzyl alcohol-OD (**1e**-D) was prepared according to the previous reference (*J. Org. Chem.* 2019, **84**, 11676). When benzyl alcohol-OD was used under the standard conditions in CD_3CN, the peak of ^1H spectrum at 2.16 ppm disappeared and D-**2e** was afforded (Figure S2). It suggests that the hydrogen atom might originate from benzyl alcohol. Next, benzyl alcohol-OD and **2e** were stirred for 12 h in CD_3CN. It is found that there is no deuterium exchange between benzyl alcohol-OD and **2e**. Thus, the hydrogen atom of **2e** likely originates from alcohols. Generally, the nucleophile is a relatively acidic compound (pKa $\leq$ 15) in Mitsonobu Reaction. However, the pka value of alcohols is greater than 15 (pKa-**1e** = 27 in DMSO). As shown in Figure S4, the formed intermediate 7 might contribute to the proton transfer, resulting in the oxyphosphonium salt **8** and the hydrazine anion. In addition, **1f** was chosen to examine the possible intermediate. As shown in Figure S5-2, there are three kinds of peaks. A small peak at -115.2 ppm can be assigned to **2f**. The major peak at 117.1 ppm might be assigned to the relatively stable oxyphosphonium salt **8** while the rest peak at -116.54 ppm might be assigned to the unstable intermediate **7**.

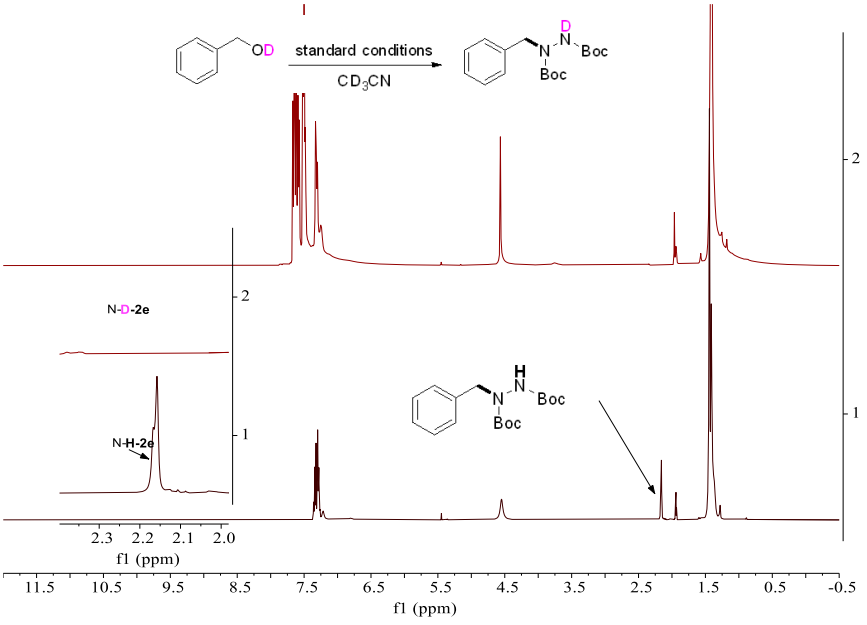


Figure S2. The ^1H spectrum of the reaction mixture and **2e**.

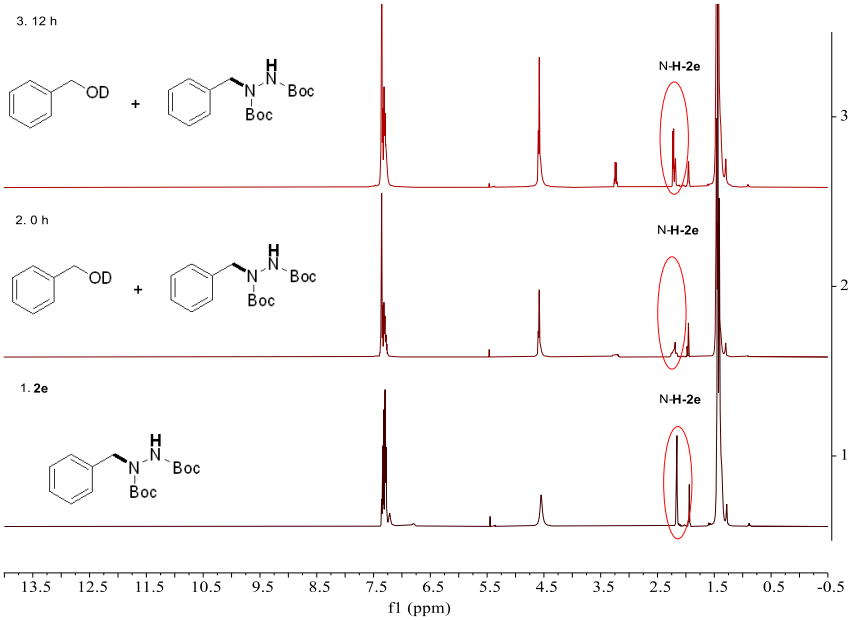


Figure S3. The ^{1}H spectrum of benzyl alcohol-OD and **2e**.

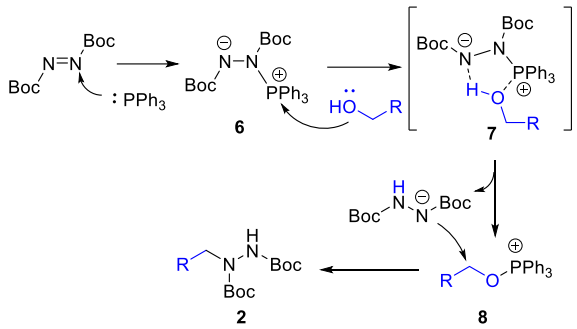


Figure S4. The proposed mechanism.

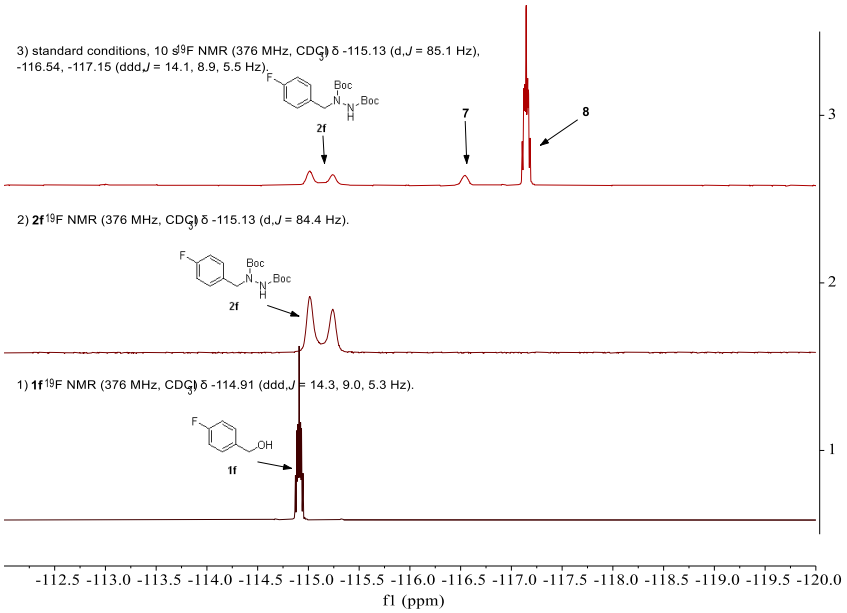
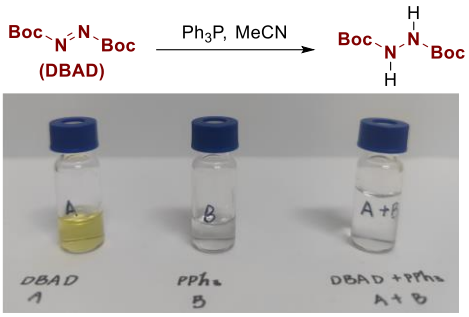


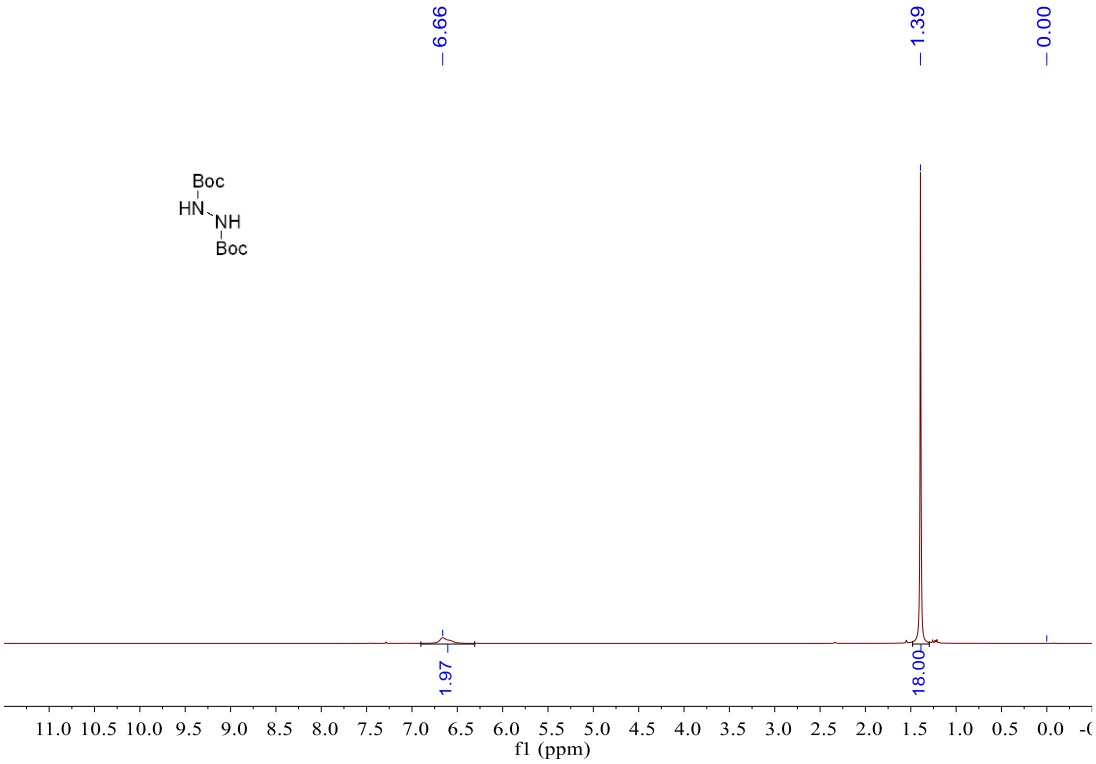
Figure S5. The ^{19}F spectrum of reaction mixture.

4.2 The side reaction

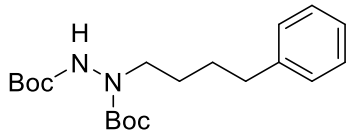


We found that the yellow color of DBAD solution disappeared as soon as DBAD was mixed with Ph_3P. The byproduct di-tert-butyl hydrazine-1,2-dicarboxylate was collected after purification. In batch, the side reaction will compete with the deoxygenative hydrazination, resulting in a lower yield.

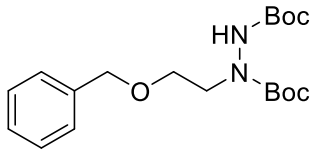
di-tert-butyl hydrazine-1,2-dicarboxylate ^{1}H NMR (400 MHz, Chloroform-*d*) δ 6.66 (s, 2H), 1.39 (s, 18H).



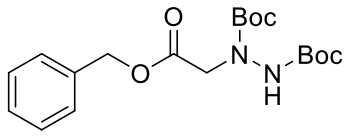
5. Characterization of products



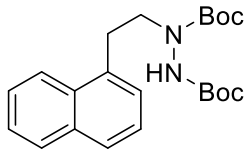
di-tert-butyl 1-(4-phenylbutyl)hydrazine-1,2-dicarboxylate[1] (**2a**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 308.9 mg, 85%, purified by flash chromatography, colorless solid; Rf = 0.5 (petroleum ether/ethylacetate 5:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30 – 7.20 (m, 2H), 7.15 (t, *J* = 7.7 Hz, 3H), 6.29 - 6.08 (br m, 1H), 3.44 (s, 2H), 2.62 (d, *J* = 7.0 Hz, 2H), 1.59 (q, *J* = 4.5 Hz, 4H), 1.45 (dd, *J* = 8.2, 5.1 Hz, 18H).



di-tert-butyl 1-(2-(benzyloxy)ethyl)hydrazine-1,2-dicarboxylate (**2b**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 246.1 mg, 67%, purified by flash chromatography, colorless solid; Rf = 0.5 (petroleum ether/ethylacetate 5:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33 (d, *J* = 4.5 Hz, 4H), 7.28 (t, *J* = 3.9 Hz, 1H), 6.54 – 6.35 (br m, 1H), 4.49 (s, 2H), 3.52 (t, *J* = 5.8 Hz, 2H), 1.88 (p, *J* = 6.5 Hz, 2H), 1.45 (s, 18H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 155.2, 155.2, 138.1, 138.1, 128.3, 127.6, 81.0, 81.0, 72.7, 67.3, 48.7, 28.1. HRMS m/z (ESI) calcd for $C_{19}H_{30}N_2NaO_5^+$ $(M + Na)^+$ 389.2047; found:389.2050.

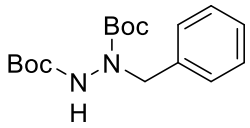


di-tert-butyl 1-(2-(benzyloxy)-2-oxoethyl)hydrazine-1,2-dicarboxylate (**2c**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 258.5 mg, 68%, purified by flash chromatography, white solid; Rf = 0.5 (petroleum ether/ethylacetate 5:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.46 – 7.27 (m, 5H), 6.69 (br s, 1H), 5.18 (d, *J* = 6.5 Hz, 2H), 4.28 (d, *J* = 35.2 Hz, 2H), 1.46 (s, 18H), ^{13}C NMR (101 MHz, $CDCl_3$) δ 169.7, 155.1, 154.5, 135.2, 128.6, 128.4, 128.2, 81.9, 81.4, 67.0, 51.0, 28.1, 28.0.

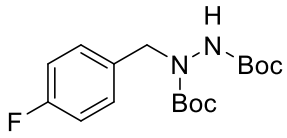


di-tert-butyl 1-(2-(naphthalen-1-yl)ethyl)hydrazine-1,2-dicarboxylate (**2d**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 266.5 mg, 69%, purified by flash chromatography, white solid; Rf = 0.5 (petroleum ether/ethylacetate 5:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.11 (s, 1H), 7.78 (dd, *J* = 47.5, 7.5 Hz, 2H), 7.48 (dd, J = 16.8, 8.9 Hz, 2H), 7.42 – 7.27 (m, 2H), 6.52 – 6.37 (br m, 1H), 3.82 (s, 2H), 3.37 (s,

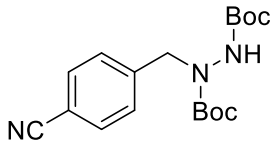
2H), 1.48 (s, 18H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 155.0, 155.0, 135.0, 133.8, 132.0, 128.8, 127.1, 126.8, 126.0, 125.5, 123.6, 81.3, 81.1, 51.0, 31.7, 28.2. HRMS m/z (ESI) calcd for $C_{22}H_{31}N_2O_4^+$ $(M + H)^+$ 387.2278, found: 387.2274



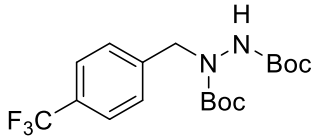
di-tert-butyl 1-benzylhydrazine-1,2-dicarboxylate[2] (**2e**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 257.6 mg, 80%, purified by flash chromatography, white solid; Rf = 0.5 (petroleum ether/ethylacetate 5:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.31 (dt, *J* = 14.2, 7.0 Hz, 5H), 6.28 – 6.05 (br m, 1H), 4.64 (s, 2H), 1.48 (s, 9H), 1.44 (s, 9H).



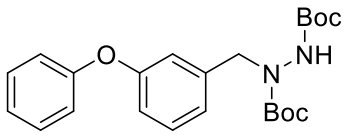
di-tert-butyl 1-(4-fluorobenzyl)hydrazine-1,2-dicarboxylate[3] (**2f**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 248.6 mg, 73%, purified by flash chromatography, white solid; Rf = 0.4 (petroleum ether/ethylacetate 5:1); ^{1}H NMR (400 MHz, DMSO-d6) δ 9.13 (s, 1H), 7.31 (s, 2H), 7.14 (d, *J* = 8.0 Hz, 2H), 4.43 (s, 2H), 1.40 (d, *J* = 12.7 Hz, 18H).



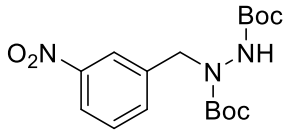
di-tert-butyl 1-(4-cyanobenzyl)hydrazine-1,2-dicarboxylate[3] (**2g**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 253.3 mg, 73%, purified by flash chromatography, white solid; Rf = 0.4 (petroleum ether/ethylacetate 5:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.62 (d, *J* = 7.9 Hz, 2H), 7.44 (d, *J* = 7.9 Hz, 2H), 6.56 (br s, 1H), 4.68 (s, 2H), 1.48 – 1.43 (m, 18H).



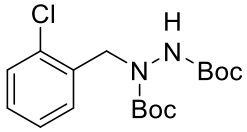
di-tert-butyl 1-(4-(trifluoromethyl)benzyl)hydrazine-1,2-dicarboxylate[3] (**2h**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 281.0 mg, 72%, purified by flash chromatography, white solid; Rf = 0.4 (petroleum ether/ethylacetate 5:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.64 – 7.38 (m, 4H), 6.35 – 6.24 (br m, 1H), 4.68 (s, 2H), 1.46 (d, *J* = 15.4 Hz, 18H).



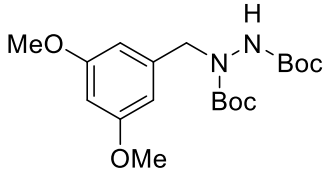
di-tert-butyl 1-(3-phenoxybenzyl)hydrazine-1,2-dicarboxylate (**2i**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 302.3 mg, 73%, purified by flash chromatography, white waxy semi-solid; Rf = 0.5 (petroleum ether/ethylacetate 5:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.49 – 7.13 (m, 3H), 7.12 – 6.71 (m, 6H), 6.34 – 6.18 (br m, 1H), 4.54 (s, 2H), 1.45 (s, 9H), 1.39 (s, 9H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 157.4, 156.9, 155.0, 139.2, 129.7, 129.4, 123.3, 122.7, 118.9, 118.2, 117.7, 110.0, 81.3, 81.3, 52.6, 28.1, 28.1. HRMS m/z (ESI) calcd for $C_{23}H_{31}N_2O_5^+$ $(M + H)^+$ 415.2227, found: 415.2225.



di-tert-butyl 1-(3-nitrobenzyl)hydrazine-1,2-dicarboxylate (**2j**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 312.1 mg, 85%, purified by flash chromatography, light yellow solid; Rf = 0.4 (petroleum ether/ethylacetate 5:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.71 – 7.30 (m, 4H), 6.28 – 6.09 (br m, 1H), 4.68 (s, 2H), 1.48 (s, 9H), 1.45 (s, 9H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 155.4, 155.0, 148.2, 139.4, 134.6, 129.4, 123.0, 122.5, 81.9, 81.5, 50.5, 28.1, 28.0. HRMS m/z (ESI) calcd for $C_{17}H_{25}N_3NaO_6^+$ $(M + Na)^+$ 390.1636, found: 390.1637.

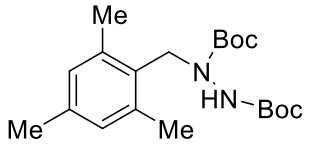


di-tert-butyl 1-(2-chlorobenzyl)hydrazine-1,2-dicarboxylate[4] (**2k**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 270.9 mg, 76%, purified by flash chromatography, off-white solid; Rf = 0.5 (petroleum ether/ethylacetate 5:1); ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.21 (s, 1H), 7.42 (d, *J* = 5.0 Hz, 2H), 7.30 (dd, *J* = 9.6, 5.2 Hz, 2H), 4.60 (s, 2H), 1.40 (s, 18H).

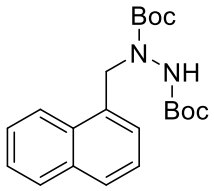


di-tert-butyl 1-(3,5-dimethoxybenzyl)hydrazine-1,2-dicarboxylate (**2l**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 309.7 mg, 81%, purified by flash chromatography, off-white solid; Rf = 0.5 (petroleum ether/ethylacetate 5:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.43 (s, 2H), 6.39 – 6.36 (m, 1H), 6.14 (s, 1H), 4.58 (s, 2H), 3.77 (s, 6H), 1.49 (s, 9H), 1.45 (s, 9H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 160.8, 155.7, 155.1, 139.5,

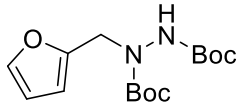
106.1, 99.3, 81.2, 81.1, 55.2, 52.9, 28.1, 28.1. HRMS m/z (ESI) calcd for $C_{19}H_{31}N_2O_6^+$ $(M + H)^+$ 383.2177, found: 383.2170.



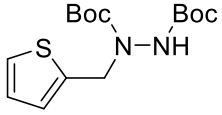
di-tert-butyl 1-(2,4,6-trimethylbenzyl)hydrazine-1,2-dicarboxylate (**2m**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 287.6 mg, 79%, purified by flash chromatography, off-white solid; Rf = 0.5 (petroleum ether/ethylacetate 5:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.84 (s, 2H), 6.07 (s, 1H), 5.10 – 4.35 (m, 2H), 2.27 (d, *J* = 6.8 Hz, 9H), 1.47 (s, 9H), 1.43 (s, 9H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 155.5, 154.8, 138.5, 138.3, 137.2, 137.0, 129.5, 129.0, 80.9, 80.8, 45.3, 28.2, 28.1, 20.9, 19.6. HRMS m/z (ESI) calcd for $C_{20}H_{33}N_2O_4^+$ $(M + H)^+$ 365.2435, found: 365.2438.



di-tert-butyl 1-(naphthalen-1-ylmethyl)hydrazine-1,2-dicarboxylate[3] (**2n**).According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 282.9 mg, 76%, purified by flash chromatography, off-white solid; Rf = 0.5 (petroleum ether/ethylacetate 5:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.17 (d, *J* = 40.9 Hz, 1H), 7.86 (d, *J* = 8.3 Hz, 1H), 7.80 (d, *J* = 8.9 Hz, 1H), 7.50 (p, *J* = 6.6 Hz, 2H), 7.41 (q, *J* = 6.9 Hz, 2H), 6.07 – 5.87 (br m, 1H), 5.07 (d, *J* = 41.9 Hz, 2H), 1.51 (s, 9H), 1.43 (s, 9H).

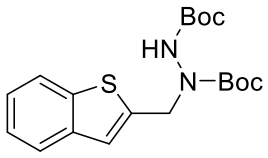


di-tert-butyl 1-(furan-2-ylmethyl)hydrazine-1,2-dicarboxylate (**2o**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 209.1 mg, 67%, purified by flash chromatography, off-white solid; Rf = 0.5 (petroleum ether/ethylacetate 5:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39 – 7.34 (m, 1H), 6.36 (br s, 1H), 6.33 – 6.29 (m, 1H), 6.24 - 6.06 (br m, 1H), 4.61 (s, 2H), 1.48 (s, 9H), 1.45 (s, 9H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 155.0, 154.9, 150.7, 142.3, 110.3, 108.6, 81.3, 81.2, 45.7, 28.2. HRMS m/z (ESI) calcd for $C_{15}H_{25}N_2O_5^+$ $(M + H)^+$ 313.1758, found: 313.1762.

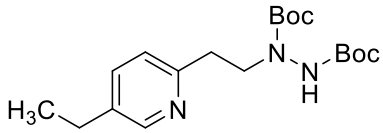


di-tert-butyl 1-(thiophen-2-ylmethyl)hydrazine-1,2-dicarboxylate (**2p**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 236.5 mg, 72%, purified by flash chromatography, off-white solid; Rf = 0.5 (petroleum ether/ethylacetate

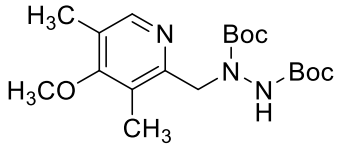
5:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.23 (d, *J* = 37.3 Hz, 1H), 6.92 (d, *J* = 14.9 Hz, 2H), 6.34 - 6.09 (br m, 1H), 4.75 (s, 2H), 1.45 (s, 18H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 154.9, 154.7, 139.4, 126.9, 126.7, 125.5, 81.5, 81.3, 47.6, 28.2, 28.1. HRMS m/z (ESI) calcd for $C_{15}H_{25}N_2O_4S^+$ $(M + H)^+$ 329.1530, found: 329.1530.



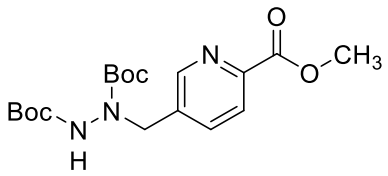
di-tert-butyl 1-(benzo[b]thiophen-2-ylmethyl)hydrazine-1,2-dicarboxylate (**2q**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 332.9 mg, 83%, purified by flash chromatography, white crystalline solid; Rf = 0.5 (petroleum ether/ethylacetate 5:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.51 (d, *J* = 7.5 Hz, 1H), 7.43 (d, *J* = 8.1 Hz, 1H), 7.26 – 7.16 (m, 2H), 6.63 (s, 1H), 6.28 - 6.51 (br m, 1H), 4.77 (s, 2H), 1.49 (s, 9H), 1.45 (s, 9H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 154.9, 154.6, 153.4, 153.4, 128.2, 124.1, 122.7, 120.8, 111.1, 105.3, 81.6, 81.3, 46.4, 28.1. HRMS m/z (ESI) calcd for $C_{19}H_{26}N_2NaO_4S^+$ $(M + Na)^+$ 401.1505, found: 401.1495.



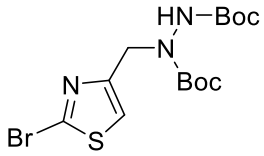
di-tert-butyl 1-(2-(5-ethylpyridin-2-yl)ethyl)hydrazine-1,2-dicarboxylate (**2r**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 255.9 mg, 70%, purified by flash chromatography, white crystalline solid; Rf = 0.4 (petroleum ether/ethylacetate 4:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.35 (s, 1H), 7.50 – 7.37 (m, 1H), 7.14 (s, 1H), 6.52 (br s, 1H), 3.82 (s, 2H), 3.01 (s, 2H), 2.61 (q, *J* = 7.6 Hz, 2H), 1.47 (s, 18H), 1.23 (t, *J* = 7.6 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 156.4, 155.8, 155.1, 148.7, 136.8, 135.9, 122.9, 81.3, 80.8, 49.0, 35.3, 28.2, 28.1, 25.6, 15.3. HRMS m/z (ESI) calcd for $C_{19}H_{32}N_3O_4^+$ $(M + H)^+$ 366.2387, found:366.2401.



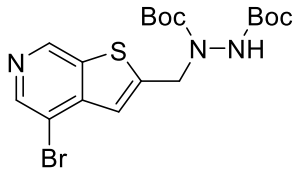
di-tert-butyl 1-((4-methoxy-3,5-dimethylpyridin-2-yl)methyl)hydrazine-1,2-dicarboxylate (**2s**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 259.2 mg, 68%, purified by flash chromatography, colorless solid; Rf = 0.5 (petroleum ether/ethylacetate 3:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.15 (d, *J* = 3.8 Hz, 1H), 7.30-7.17 (br m, 1H), 4.69 (s, 2H), 3.74 (s, 3H), 2.22 (s, 3H), 2.17 (s, 3H), 1.56 – 1.40 (m, 18H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 163.8, 156.1, 154.5, 154.5, 148.7, 124.8, 123.9, 81.0, 80.4, 59.8, 51.9, 28.1, 28.1, 13.0, 10.2. HRMS m/z (ESI) calcd for $C_{19}H_{32}N_3O_5^+$ $(M + H)^+$ 382.2336, found: 382.2335.



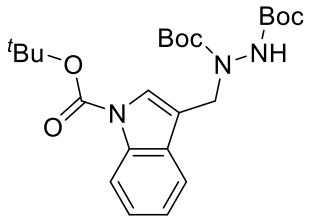
di-tert-butyl 1-((6-(methoxycarbonyl)pyridin-3-yl)methyl)hydrazine-1,2-dicarboxylate (**2t**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 285.9 mg, 75%, purified by flash chromatography, white crystalline solid; Rf = 0.5 (petroleum ether/ethylacetate 3:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.12 (s, 1H), 8.26 (d, *J* = 7.6 Hz, 1H), 7.42 (d, *J* = 7.5 Hz, 1H), 6.99 - 6.72 (br m, 1H), 4.84 (s, 2H), 3.95 (s, 3H), 1.46 (s, 18H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.6, 161.7, 155.5, 154.7, 150.4, 137.6, 124.6, 121.6, 81.6, 81.0, 54.9, 52.3, 28.1, 28.0. HRMS m/z (ESI) calcd for $C_{18}H_{28}N_3O_6^+$ $(M + H)^+$ 382.1973, found: 382.1979.



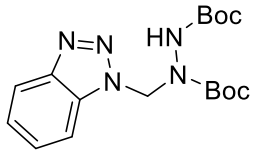
di-tert-butyl 1-((2-bromothiazol-4-yl)methyl)hydrazine-1,2-dicarboxylate (**2u**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 276.9 mg, 68%, purified by flash chromatography, off-white solid; Rf = 0.5 (petroleum ether/ethylacetate 3:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.23 (d, *J* = 32.9 Hz, 1H), 6.8 – 6.57 (br m, 1H), 4.73 (s, 2H), 1.47 (s, 18H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 155.0, 154.7, 152.9, 135.5, 119.9, 81.5, 81.1, 49.4, 28.0, 28.0. HRMS m/z (ESI) calcd for $C_{14}H_{23}BrN3O_4S^+$ $(M + H)^+$ 408.0587, found: 408.0590.



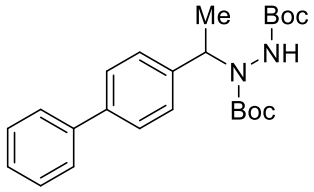
di-tert-butyl 1-((4-bromothieno[2,3-c]pyridin-2-yl)methyl)hydrazine-1,2-dicarboxylate (**2v**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 358.7 mg, 79%, purified by flash chromatography, white solid; Rf = 0.5 (petroleum ether/ethylacetate 3:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.90 (s, 1H), 8.52 (s, 1H), 7.33 (s, 1H), 6.73 – 6.47 (br m, 1H), 4.93 (s, 2H), 1.52 (s, 9H), 1.47 (s, 9H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 154.9, 154.1, 148.8, 144.6, 144.0, 142.5, 136.6, 122.1, 114.2, 82.0, 81.3, 48.8, 28.1. HRMS m/z (ESI) calcd for $C_{18}H_{25}BrN_3O_4S^+$ $(M + H)^+$ 458.0744; found:458.0748.



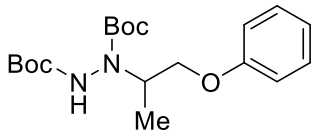
di-tert-butyl 1-((1-(tert-butoxycarbonyl)-1H-indol-3-yl)methyl)hydrazine-1,2-dicarboxylate (**2w**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 341.4 mg, 74%, purified by flash chromatography, off-white solid; Rf = 0.5 (petroleum ether/ethylacetate 3:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.13 (d, *J* = 7.6 Hz, 1H), 7.58 (d, *J* = 29.3 Hz, 2H), 7.32 (t, *J* = 7.7 Hz, 1H), 7.24 (t, *J* = 7.5 Hz, 1H), 6.96 – 6.18 (br m, 1H), 4.77 (s, 2H), 1.67 (s, 9H), 1.50 (s, 9H), 1.45 (s, 9H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 155.2, 155.2, 149.6, 135.6, 129.8, 125.3, 124.5, 122.7, 119.5, 115.2, 83.8, 81.3, 81.3, 43.7, 28.2, 28.2. HRMS m/z (ESI) calcd for $C_{24}H_{36}N_3O_6^+$ $(M + H)^+$ 462.2599, found: 462.2592.



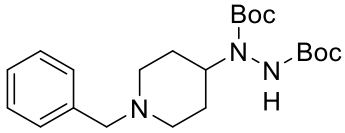
di-tert-butyl 1-((1H-benzo[d][1,2,3]triazol-1-yl)methyl)hydrazine-1,2-dicarboxylate (**2x**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 284.2 mg, 78%, purified by flash chromatography, off-white solid; Rf = 0.5 (petroleum ether/ethylacetate 2:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93 (d, *J* = 68.6 Hz, 1H), 7.50 (t, *J* = 10.4 Hz, 1H), 7.43 – 7.26 (m, 1H), 6.92 – 6.67 (m, 1H), 6.51 (br s, 1H), 6.24 (s, 2H), 1.48 (s, 9H), 1.46 (s, 9H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 155.8, 154.5, 145.9, 132.6, 127.7, 124.1, 119.5, 110.5, 81.6, 81.2, 60.6, 28.0, 27.9. HRMS m/z (ESI) calcd for $C_{17}H_{26}N_5O_4^+$ $(M + H)^+$ 364.1979, found: 364.1984.



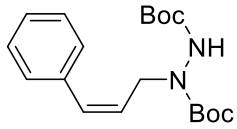
di-tert-butyl 1-(1-([1,1'-biphenyl]-4-yl)ethyl)hydrazine-1,2-dicarboxylate (**2y**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 280.2 mg, 68%, purified by flash chromatography, off-white solid; Rf = 0.5 (petroleum ether/ethylacetate 5:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.56 (t, *J* = 8.2 Hz, 4H), 7.47 – 7.37 (m, 4H), 7.34 (t, *J* = 7.3 Hz, 1H), 6.09 – 6.01 (br m, 1H), 5.65 – 5.54 (m, 1H), 1.57 (d, *J* = 6.6 Hz, 3H), 1.47 (s, 18H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 155.4, 154.9, 140.8, 140.4, 140.3, 128.7, 127.6, 127.2, 127.1, 127.0, 81.3, 80.9, 54.4, 29.7, 28.3, 28.2. HRMS m/z (ESI) calcd for $C_{24}H_{33}N_2O_4^+$ $(M + H)^+$ 413.2435, found: 413.2447.



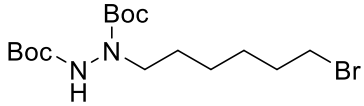
di-tert-butyl 1-(1-phenoxypropan-2-yl)hydrazine-1,2-dicarboxylate (**2z**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 261.2 mg, 71%, purified by flash chromatography, off-white solid; Rf = 0.5 (petroleum ether/ethylacetate 5:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.28 – 7.23 (m, 2H), 6.94 (t, *J* = 7.4 Hz, 1H), 6.88 (d, *J* = 7.6 Hz, 2H), 6.12 (br s, 1H), 4.61 (d, *J* = 48.6 Hz, 1H), 3.93 (d, *J* = 51.2 Hz, 2H), 1.47 (s, 18H), 1.25 (d, *J* = 6.7 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 158.5, 155.7, 154.7, 129.3, 120.8, 114.5, 81.3, 81.0, 68.6, 51.5, 28.1, 28.1, 14.1. HRMS m/z (ESI) calcd for $C_{19}H_{30}N_2NaO_5^+$ $(M + Na)^+$ 389.2047, found: 389.2055.



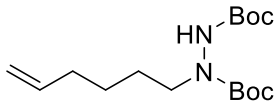
di-tert-butyl 1-(1-benzylpiperidin-4-yl)hydrazine-1,2-dicarboxylate (**2ab**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 284.3 mg, 70%, purified by flash chromatography, off-white solid; Rf = 0.5 (petroleum ether/ethylacetate 3:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30 (d, *J* = 4.2 Hz, 4H), 7.24 (dd, *J* = 9.0, 4.4 Hz, 1H), 6.09 – 5.83 (br m, *J* = 104.6 Hz, 1H), 4.04 (s, 1H), 3.48 (s, 2H), 2.93 (d, *J* = 11.0 Hz, 2H), 2.03 (t, *J* = 12.7 Hz, 2H), 1.87 – 1.60 (m, 4H), 1.46 (s, 18H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 156.2, 155.6, 138.3, 129.2, 128.2, 127.0, 81.1, 80.8, 63.1, 54.4, 52.9, 29.2, 28.2, 28.2. HRMS m/z (ESI) calcd for $C_{22}H_{36}N_3O_4^+$ $(M + H)^+$ 406.2700, found: 406.2713.



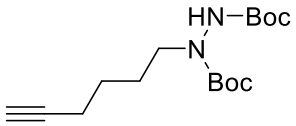
di-tert-butyl (Z)-1-(3-phenylallyl)hydrazine-1,2-dicarboxylate (**2ac**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 257.9 mg, 74%, purified by flash chromatography, off-white solid; Rf = 0.5 (petroleum ether/ethylacetate 5:1). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 – 7.33 (m, 2H), 7.30 (dt, *J* = 9.7, 4.6 Hz, 2H), 7.26 – 7.19 (m, 1H), 6.52 (d, *J* = 4.3 Hz, 1H), 6.48 (d, *J* = 4.4 Hz, 1H), 6.29 – 6.14 (m, 1H), 4.22 (s, 2H), 1.49 (d, *J* = 4.9 Hz, 9H), 1.45 (d, *J* = 4.8 Hz, 9H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 155.3, 155.2, 136.6, 133.0, 128.5, 127.6, 126.4, 124.4, 81.2, 81.1, 51.8, 28.2, 28.1. HRMS m/z (ESI) calcd for $C_{19}H_{28}N_2NaO_4^+$ $(M + Na)^+$ 371.1941, found: 371.1950.



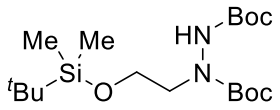
di-tert-butyl 1-(6-bromohexyl)hydrazine-1,2-dicarboxylate (**2ad**)**.** According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 272.1 mg, 69%, purified by flash chromatography, white semi-solid; Rf = 0.7 (petroleum ether/ethylacetate 5:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.34 - 6.14 (br m, 1H), 3.40 (t, *J* = 6.8 Hz, 4H), 1.86 (p, *J* = 6.9 Hz, 2H), 1.57 (p, *J* = 7.4 Hz, 2H), 1.47 (m, 20H), 1.32 (dt, *J* = 15.6, 7.6 Hz, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 155.6, 155.4, 81.0, 80.9, 49.2, 33.7, 32.7, 28.2, 28.2, 27.8, 27.3, 25.8. HRMS m/z (ESI) calcd for $C_{16}H_{32}BrN_2O_4^+$ $(M + H)^+$ 395.1540, found: 395.1545.



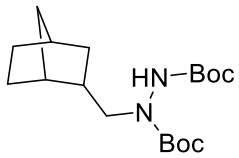
di-tert-butyl 1-(hex-5-en-1-yl)hydrazine-1,2-dicarboxylate (**2ae**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 226.4 mg, 72%, purified by flash chromatography, white semi-solid; Rf = 0.7 (petroleum ether/ethylacetate 5:1). ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.35 (br m, 1H), 5.88 – 5.62 (m, 1H), 5.17 – 4.78 (m, 2H), 3.44 (s, 2H), 2.07 (q, *J* = 7.3 Hz, 2H), 1.57 (p, *J* = 7.3 Hz, 2H), 1.47 (d, *J* = 5.3 Hz, 18H), 1.43 – 1.36 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 155.4, 155.1, 138.5, 114.6, 81.0, 80.8, 49.1, 33.4, 28.2, 28.1, 26.8, 25.9. HRMS m/z (ESI) calcd for $C_{16}H_{30}N_2NaO_4^+$ $(M + Na)^+$ 337.2098, found: 337.2093.



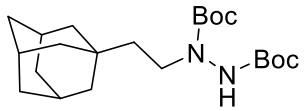
di-tert-butyl 1-(hex-5-yn-1-yl)hydrazine-1,2-dicarboxylate (**2af**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 243.6 mg, 67%, purified by flash chromatography, white semi-solid; Rf = 0.7 (petroleum ether/ethylacetate 5:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.32 – 6.09 (br m, 1H), 3.44 (d, *J* = 16.9 Hz, 2H), 2.30 – 2.16 (m, 2H), 1.95 (t, *J* = 2.5 Hz, 1H), 1.68 (t, *J* = 7.4 Hz, 2H), 1.59 – 1.52 (m, 2H), 1.48 (s, 9H), 1.46 (s, 9H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 157.9, 155.5, 84.2, 81.1, 81.0, 68.5, 48.8, 28.2, 26.6, 25.6, 18.1. HRMS m/z (ESI) calcd for $C_{16}H_{29}N_2O_4^+$ $(M + H)^+$ 313.2122, found: 313.2114.



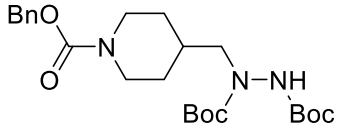
di-tert-butyl 1-(2-((tert-butyldimethylsilyl)oxy)ethyl)hydrazine-1,2-dicarboxylate (**2ag**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 277.1 mg, 71%, purified by flash chromatography, light yellow solid; Rf = 0.7 (petroleum ether/ethylacetate 5:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.47 - 6.17 (br m, 1H), 3.75 (s, 2H), 3.56 (s, 2H), 1.47 (s, 18H), 0.89 (s, 9H), 0.13 – 0.01 (m, 6H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 155.2, 154.8, 81.3, 80.9, 60.7, 51.4, 28.2, 28.1, 25.8, 18.1, -5.4. HRMS m/z (ESI) calcd for $C_{18}H_{42}N_3O_5Si^+$ $(M + NH_4)^+$ 408.2888, found: 408.2893.



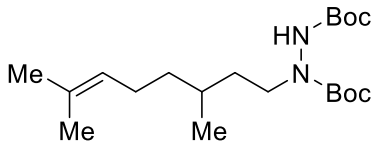
di-tert-butyl 1-(((1R,4S)-bicyclo[2.2.1]heptan-2-yl)methyl)hydrazine-1,2-dicarboxylate (**2ah**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 241.5 mg, 71%, purified by flash chromatography, white semi-solid; Rf = 0.6 (petroleum ether/ethylacetate 5:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.30 – 6.07 (br m, 1H), 3.45 (s, 2H), 2.25 – 2.10 (m, 2H), 1.79 (s, 1H), 1.70 (ddd, *J* = 15.8, 9.4, 3.4 Hz, 1H), 1.60 – 1.52 (m, 2H), 1.47 (d, *J* = 3.7 Hz, 18H), 1.31 (d, *J* = 15.2 Hz, 3H), 1.16 – 1.08 (m, 1H), 0.75 – 0.63 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 155.9, 155.4, 81.3, 80.9, 51.3, 39.8, 38.9, 36.9, 36.5, 34.5, 30.0, 28.2, 22.7. HRMS m/z (ESI) calcd for $C_{18}H_{33}N_2O_4^+$ $(M + H)^+$ 341.2435, found: 341.2435.



di-tert-butyl 1-(2-((3r,5r,7r)-adamantan-1-yl)ethyl)hydrazine-1,2-dicarboxylate (**2ai**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 260.3 mg, 66%, purified by flash chromatography, white solid; Rf = 0.6 (petroleum ether/ethylacetate 5:1). ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.28 – 6.02 (br m, 1H), 3.45 (s, 2H), 1.94 (s, 2H), 1.66 (dt, *J* = 22.5, 11.9 Hz, 8H), 1.50 (s, 5H), 1.47 (d, *J* = 5.4 Hz, 18H), 1.37 – 1.31 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 155.4, 155.2, 80.9, 80.9, 46.0, 42.3, 41.2, 37.1, 31.6, 28.6, 28.2, 28.2. HRMS m/z (ESI) calcd for $C_{22}H_{39}N_2O_4^+$ $(M + H)^+$ 395.2904, found: 395.2905.

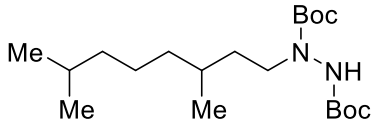


di-tert-butyl 1-((1-((benzyloxy)carbonyl)piperidin-4-yl)methyl)hydrazine-1,2-dicarboxylate (**2aj**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 310.3 mg, 67%, purified by flash chromatography, off-white solid; Rf = 0.5 (petroleum ether/ethylacetate 3:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.35 (d, *J* = 4.1 Hz, 4H), 7.30 (dd, *J* = 8.8, 4.6 Hz, 1H), 6.47 – 6.39 (br m, 1H), 5.12 (s, 2H), 4.13 (dt, *J* = 14.3, 9.3 Hz, 2H), 3.32 (s, 2H), 2.78 (s, 2H), 2.04 (s, 1H), 1.70 (d, *J* = 12.5 Hz, 2H), 1.47 (s, 9H), 1.45 (s, 9H), 1.21 – 1.07 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 155.5, 155.4, 155.2, 136.8, 128.4, 127.8, 127.7, 81.3, 81.0, 66.9, 55.0, 43.8, 34.7, 29.6, 28.1. HRMS m/z (ESI) calcd for $C_{24}H_{38}N_3O_6^+$ $(M + H)^+$ 464.2755, found: 464.2754.

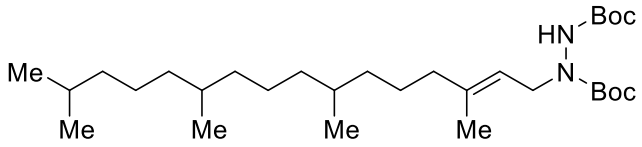


di-tert-butyl 1-(3,7-dimethyloct-6-en-1-yl)hydrazine-1,2-dicarboxylat (**4a**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent;

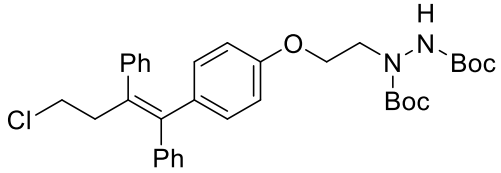
270.5 mg, 73%, purified by flash chromatography, white solid; Rf = 0.6 (petroleum ether/ethylacetate 5:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.31 - 6.10 (br m, 1H), 5.09 (d, *J* = 6.6 Hz, 1H), 3.47 (s, 2H), 1.99 (dp, *J* = 22.1, 7.2, 6.3 Hz, 2H), 1.84 (s, 1H), 1.69 (d, *J* = 4.9 Hz, 3H), 1.60 (s, 2H), 1.49 (d, *J* = 6.5 Hz, 18H), 1.40 – 1.29 (m, 3H), 1.24 – 1.08 (m, 2H), 0.91 (t, *J* = 6.5 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 150.6, 150.3, 126.2, 119.6, 76.1, 75.8, 42.5, 31.9, 29.1, 25.1, 23.2, 23.2, 20.7, 20.4, 14.4, 12.6. HRMS m/z (ESI) calcd for $C_{20}H_{39}N_2O_4^+$ $(M + H)^+$ 371.2904, found: 371.2902.



di-tert-butyl 1-(3,7-dimethyloctyl)hydrazine-1,2-dicarboxylate (**4b**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 271.8 mg, 73%, purified by flash chromatography, off-white solid; Rf = 0.6 (petroleum ether/ethylacetate 5:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.33 - 6.12 (br m, 1H), 3.46 (s, 2H), 1.61 – 1.50 (m, 2H), 1.48 (s, 18H), 1.37 – 1.20 (m, 5H), 1.19 – 1.07 (m, 3H), 0.92 – 0.83 (m, 9H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 155.4, 155.0, 81.0, 80.8, 47.5, 39.2, 37.1, 34.3, 30.5, 28.2 (d, *J* = 3.2 Hz), 27.9, 24.6, 22.7, 22.6, 19.5. HRMS m/z (ESI) calcd for $C_{20}H_{41}N_2O_4^+$ $(M + H)^+$ 373.3061, found: 373.3061.

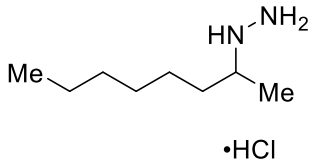


di-tert-butyl (E)-1-(3,7,11,15-tetramethylhexadec-2-en-1-yl)hydrazine-1,2-dicarboxylate (**4c**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 385.6 mg, 76%, purified by flash chromatography, off-white solid; Rf = 0.6 (petroleum ether/ethylacetate 5:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.31 - 6.03 (br m, 1H), 5.23 – 5.11 (m, 1H), 4.05 (s, 2H), 1.95 (p, *J* = 9.0, 8.5 Hz, 2H), 1.61 (s, 3H), 1.44 (s, 18H), 1.39 – 1.30 (m, 4H), 1.28 – 1.18 (m, 8H), 1.16 – 1.09 (m, 3H), 1.08 – 0.97 (m, 4H), 0.83 (t, *J* = 7.2 Hz, 12H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 155.4, 155.0, 140.7, 118.5, 81.2, 80.9, 46.3, 39.9, 39.3, 37.4, 37.3, 37.3, 36.7, 32.8, 32.7, 28.2, 28.2, 27.9, 25.1, 24.8, 24.5, 22.7, 22.6, 19.7, 19.7, 16.0. HRMS m/z (ESI) calcd for $C_{30}H_{59}N_2O4^+$ $(M + H)^+$ 511.4469, found: 511.4470.

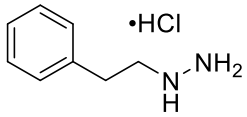


di-tert-butyl(Z)-1-(2-(4-(4-chloro-1,2-diphenylbut-1-en-1-yl)phenoxy)ethyl)hydrazine-1,2-dicarboxylate (**4d**). According to the general procedure in 1.0 mmol scale using 1.5 equiv Ph_3P reagent and 1.5 equiv DBAD reagent; 375.9 mg, 65%, purified by flash chromatography, off-white solid; Rf = 0.5 (petroleum ether/ethylacetate 5:1).^{1}H NMR (400 MHz, $CDCl_3$) δ 7.46 – 7.07 (m, 10H), 6.80 (t, *J* = 11.4 Hz, 2H), 6.54 (d, *J* = 8.5 Hz, 2H), 6.46 – 6.24 (br m, 1H), 3.98 (s, 2H),

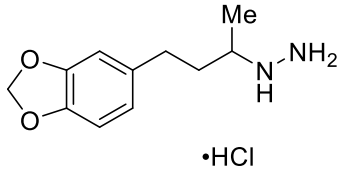
3.77 (s, 2H), 3.42 (tt, *J* = 7.5, 4.6 Hz, 2H), 2.93 (ddt, *J* = 10.1, 7.5, 4.5 Hz, 2H), 1.54 – 1.32 (m, 18H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 156.7, 155.1, 154.9, 142.8, 141.6, 140.8, 135.1, 135.0, 131.7, 129.4, 129.3, 128.3, 128.2, 126.9, 126.5, 113.3, 81.2, 81.1, 64.9, 48.9, 42.8, 38.5, 28.1. HRMS m/z (ESI) calcd for $C_{34}H_{42}ClN_2O_5^+$ $(M + H)^+$ 593.2777, found: 593.2779.



octan-2-ylhydrazine hydrochloride (**5a**). According to the general procedure in 20 mmol scale; 2.56 g, 71%, white solid; ^{1}H NMR (400 MHz, CD_3OD) δ 3.24 – 3.14 (m, 1H), 1.79 (ddt, *J* = 14.5, 10.0, 4.6 Hz, 1H), 1.46 (dd, *J* = 14.7, 9.9 Hz, 1H), 1.41 – 1.31 (m, 8H), 1.29 (d, *J* = 6.6 Hz, 3H), 0.96 – 0.86 (m, 3H). ^{13}C NMR (101 MHz, CD_3OD) δ 58.9, 32.7, 32.7, 30.2, 26.4, 23.6, 15.4, 14.4.



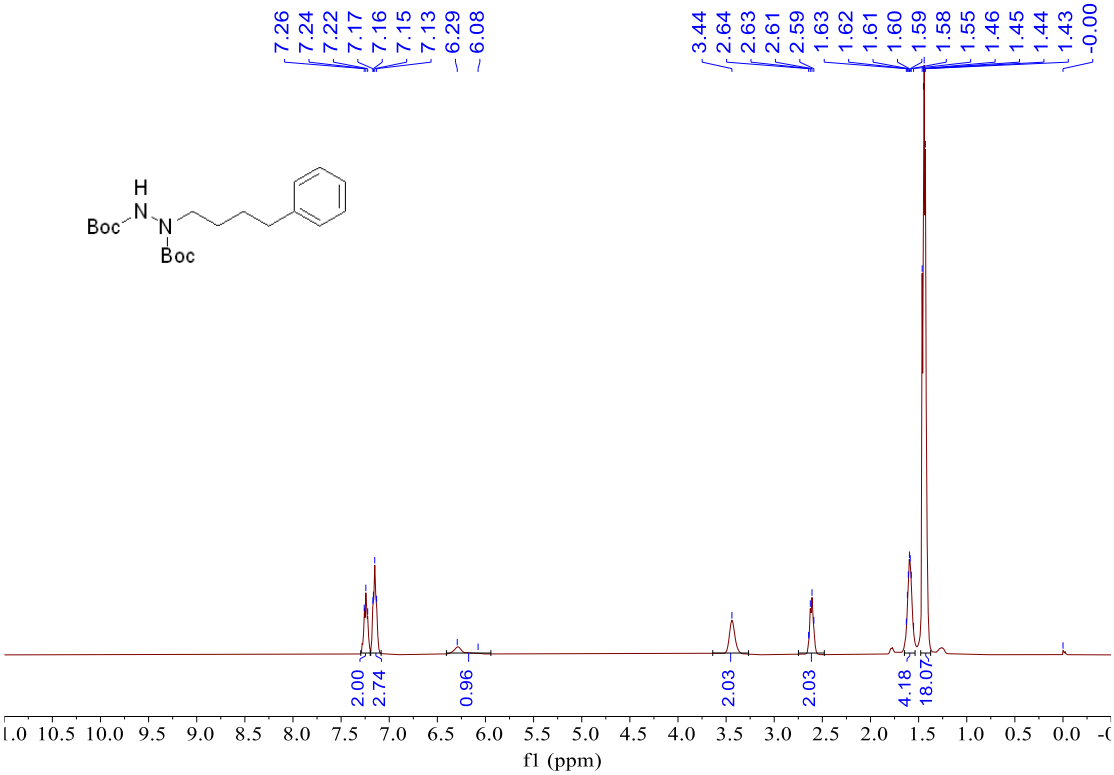
phenethylhydrazine hydrochloride (**5b**). According to the general procedure in 10 mmol scale; 1.08 g, 63%, white solid; ^{1}H NMR (400 MHz, CD_3OD) δ 7.43 – 7.11 (m, 5H), 3.31 (dt, *J* = 3.3, 1.6 Hz, 1H), 3.29 – 3.25 (m, 1H), 2.96 (ddd, *J* = 9.1, 6.8, 1.5 Hz, 2H); ^{13}C NMR (101 MHz, CD_3OD) δ 138.4, 129.9, 129.8, 128.1, 53.6, 32.6.



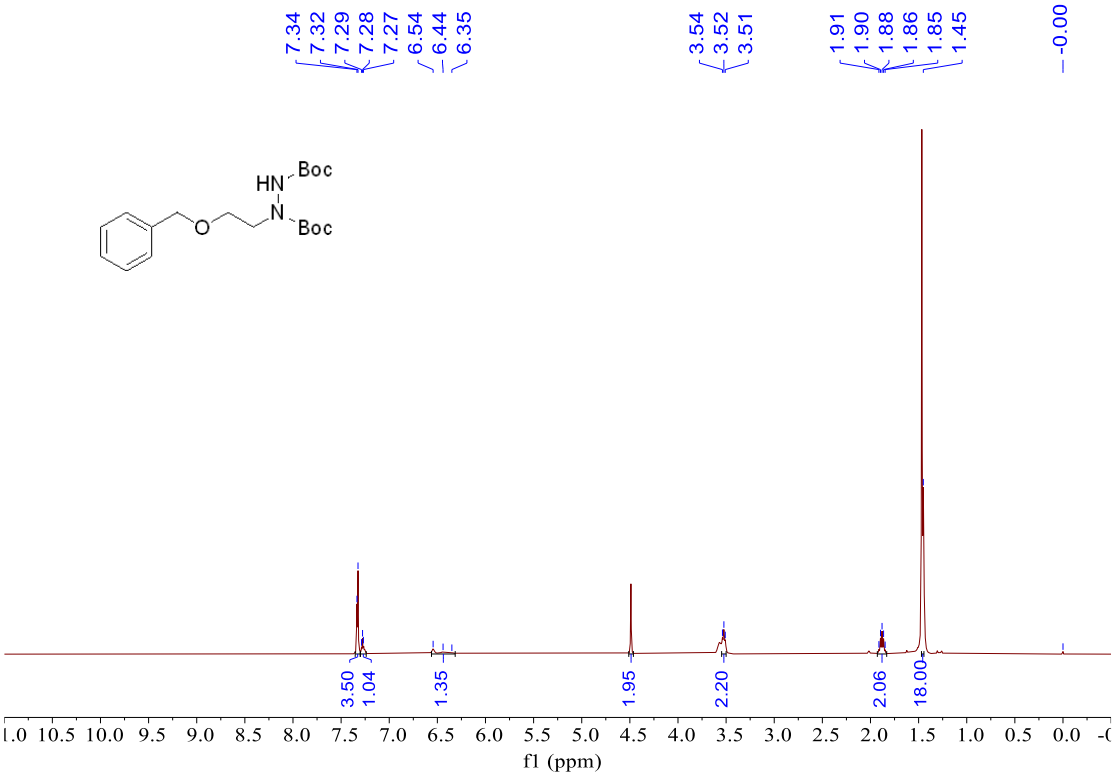
(4-(benzo[d][1,3]dioxol-5-yl)butan-2-yl)hydrazine hydrochloride (**5c**). According to the general procedure in 10 mmol scale; 1.61 g, 66%, white solid. ^{1}H NMR (400 MHz, CD_3OD) δ 6.78 – 6.75 (m, 1H), 6.75 – 6.67 (m, 2H), 5.89 (d, *J* = 2.3 Hz, 2H), 3.29 – 3.17 (m, 1H), 2.76 – 2.65 (m, 1H), 2.64 – 2.55 (m, 1H), 2.16 – 2.06 (m, 1H), 1.82 – 1.68 (m, 1H), 1.36 (d, *J* = 6.6 Hz, 3H); ^{13}C NMR (101 MHz, Methanol-d_4) δ 149.2, 147.4, 135.7, 122.3, 109.7, 109.1, 102.1, 58.2, 34.8, 32.2, 15.4.

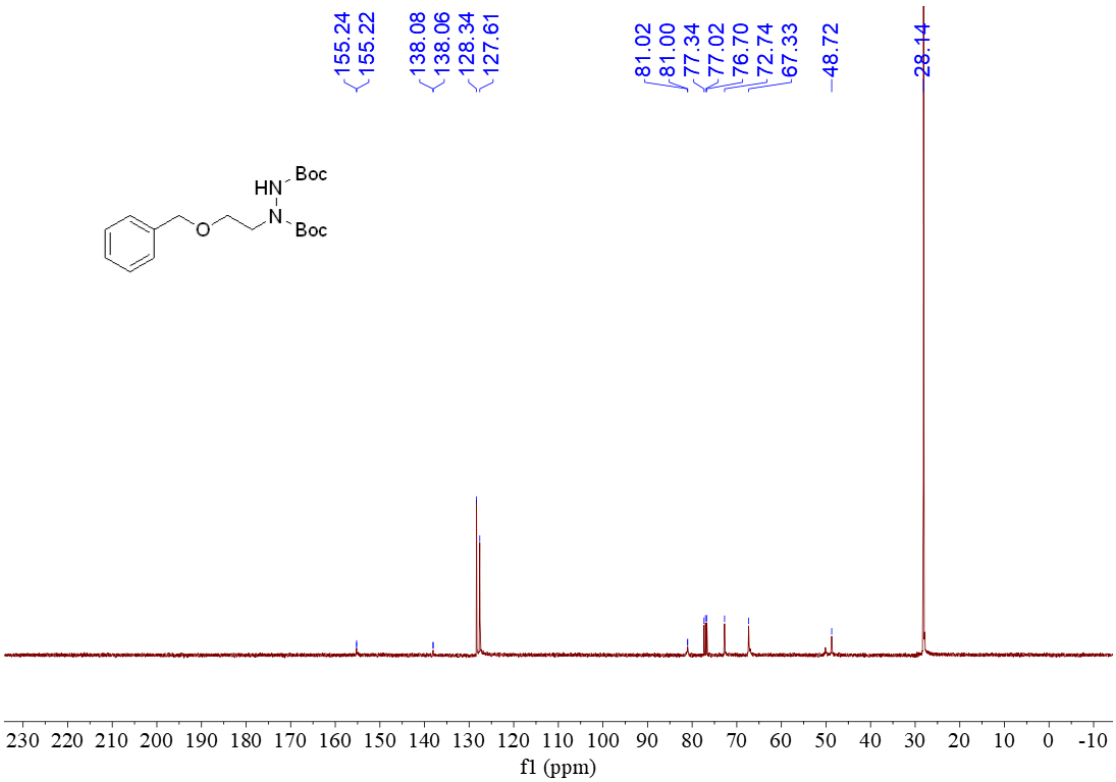
6. NMR spectra of products

di-tert-butyl 1-(4-phenylbutyl)hydrazine-1,2-dicarboxylate (**2a**)

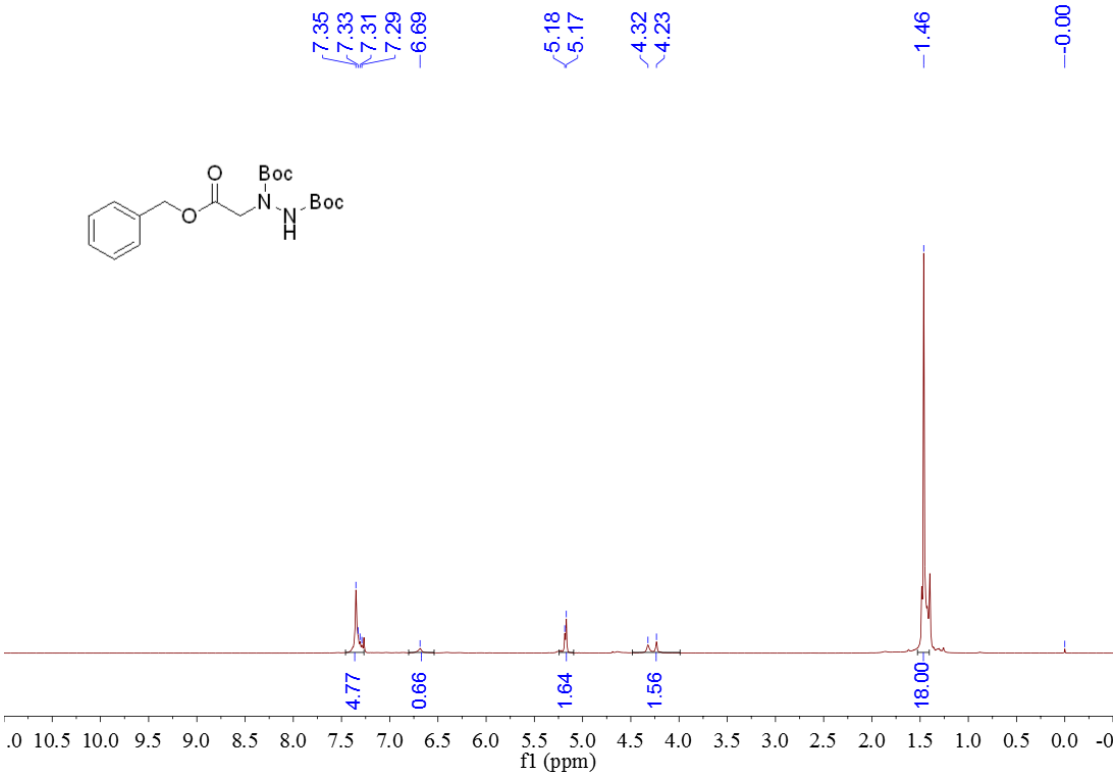


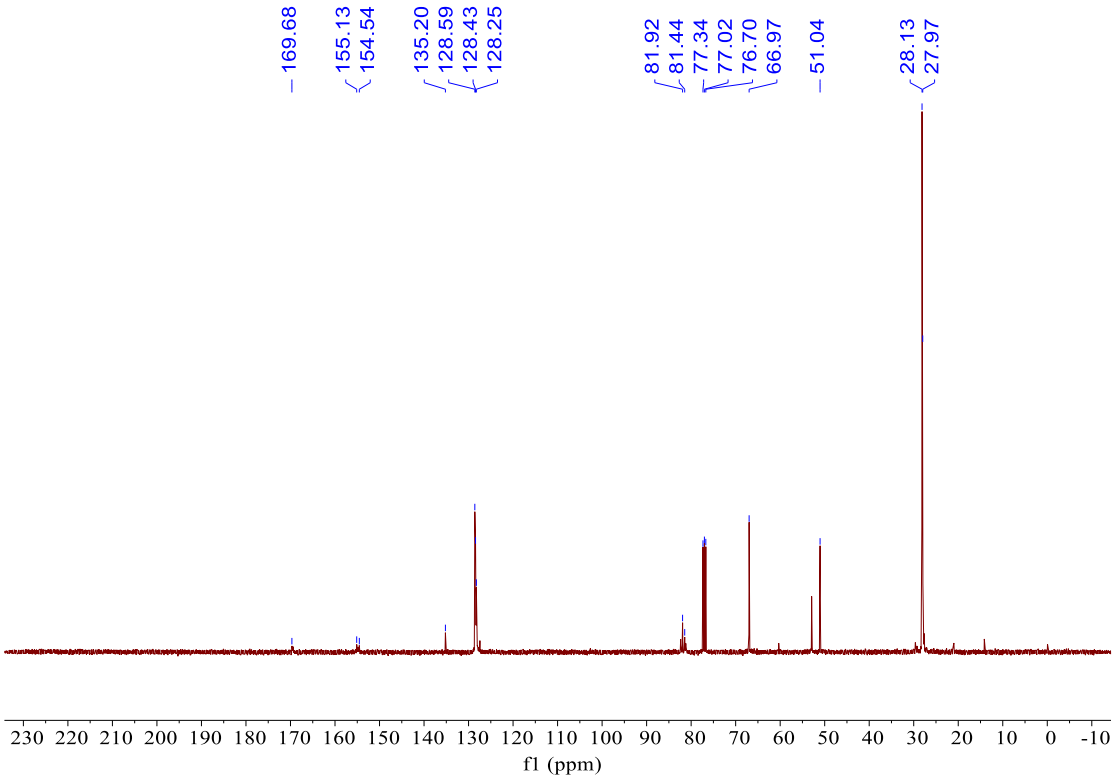
di-tert-butyl 1-(2-(benzyloxy)ethyl)hydrazine-1,2-dicarboxylate (**2b**)



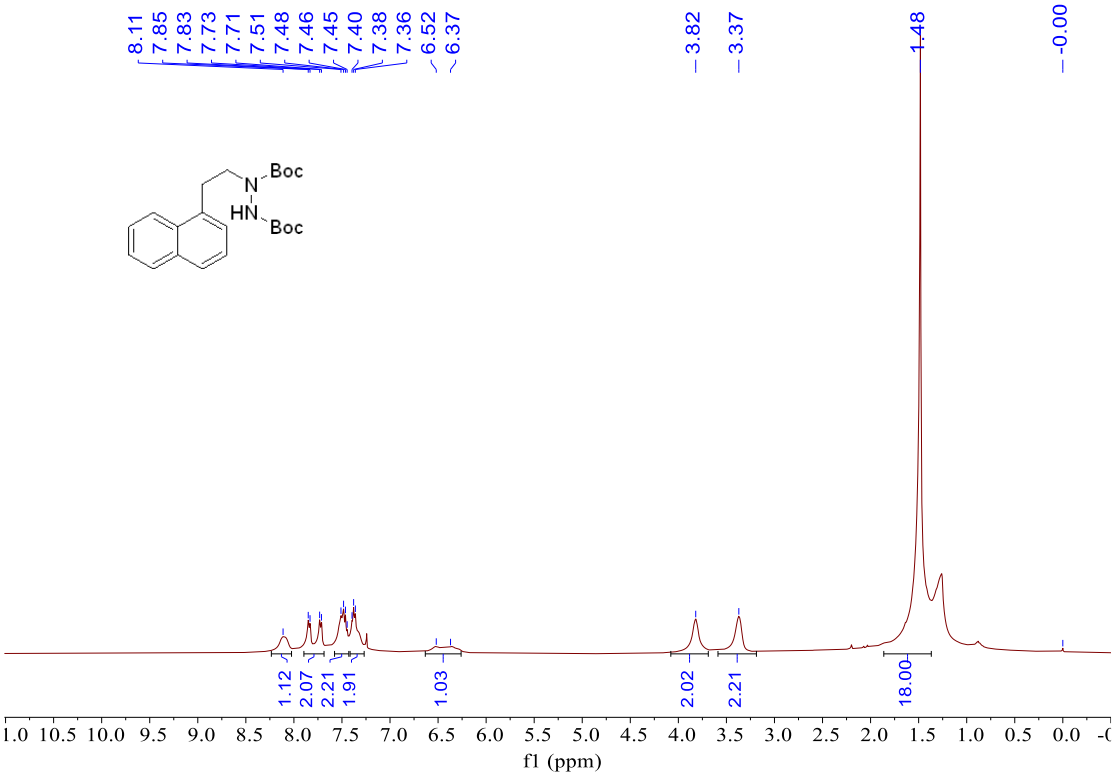


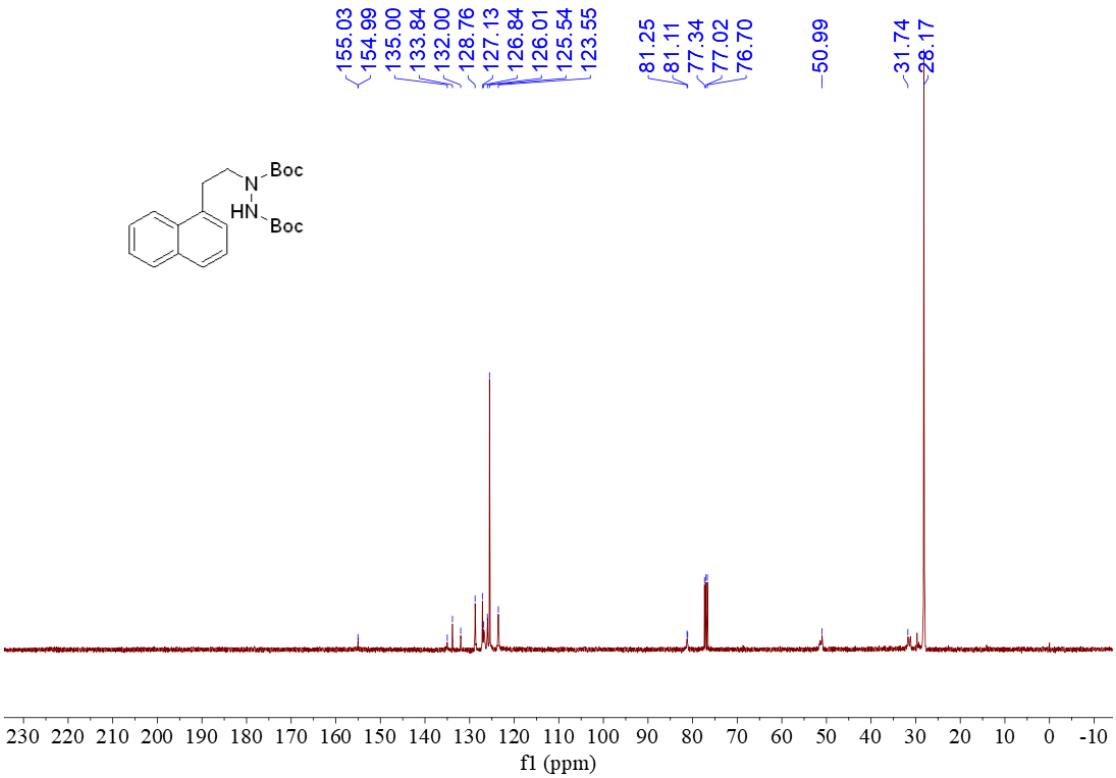
di-tert-butyl 1-(2-(benzyloxy)-2-oxoethyl)hydrazine-1,2-dicarboxylate (**2c**)



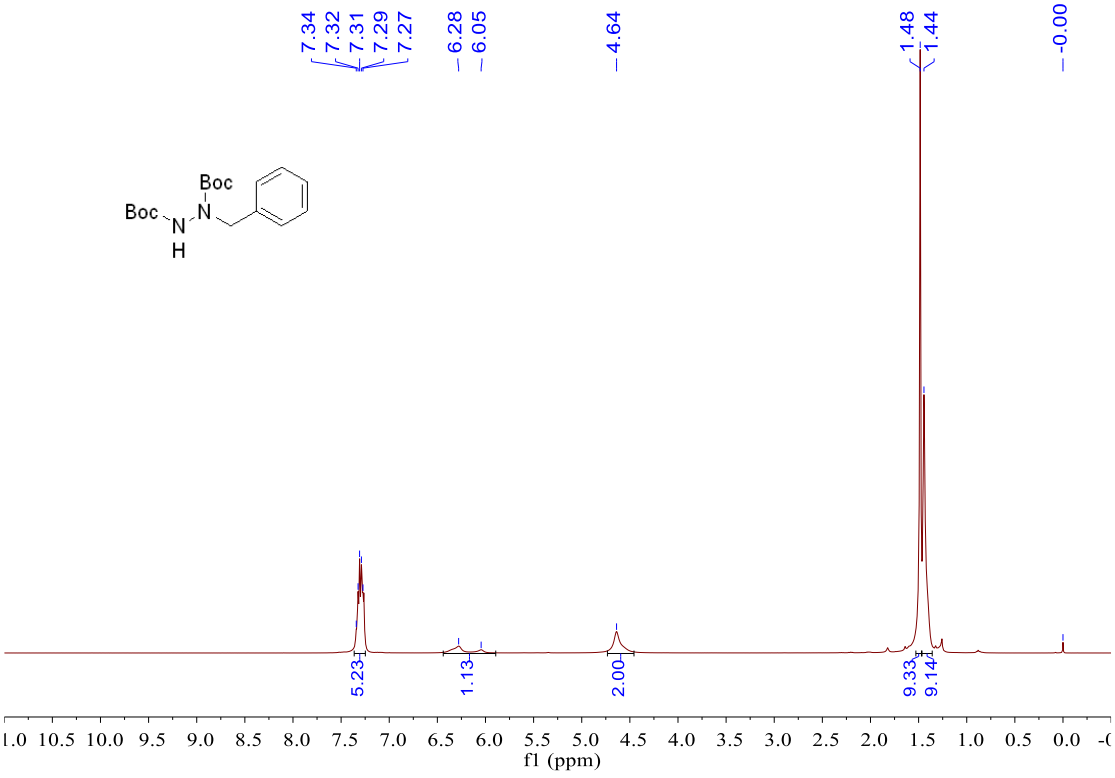


di-tert-butyl 1-(2-(naphthalen-1-yl)ethyl)hydrazine-1,2-dicarboxylate (**2d**)

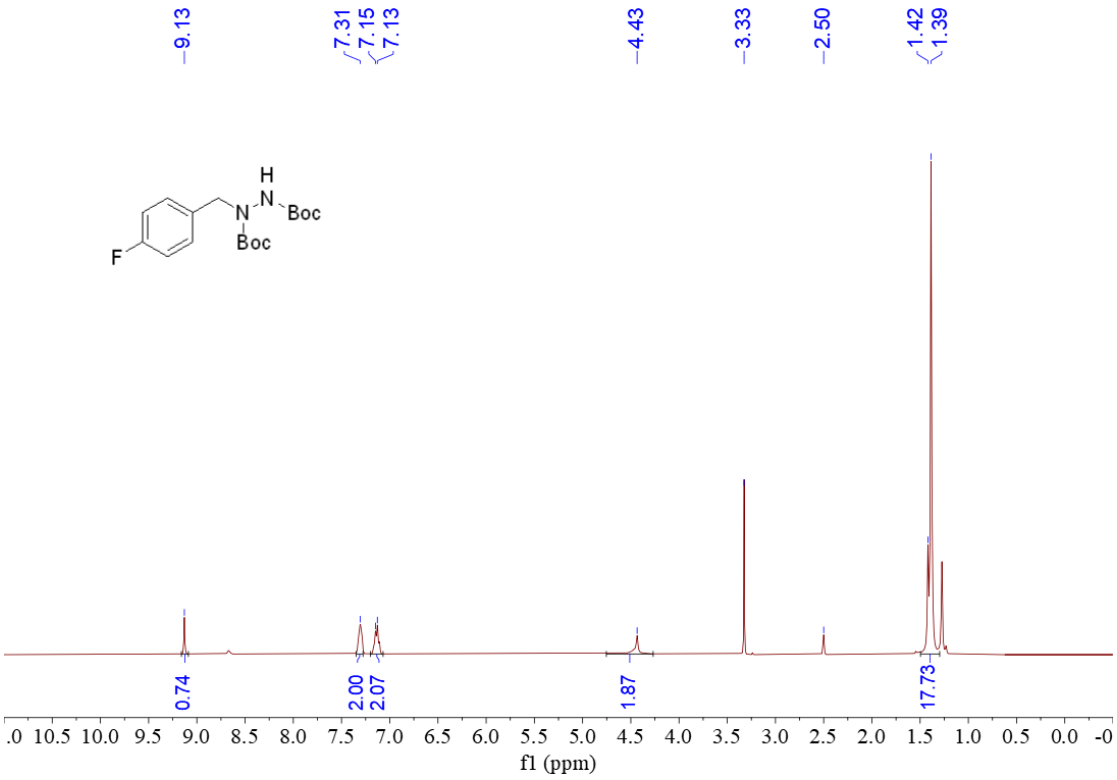




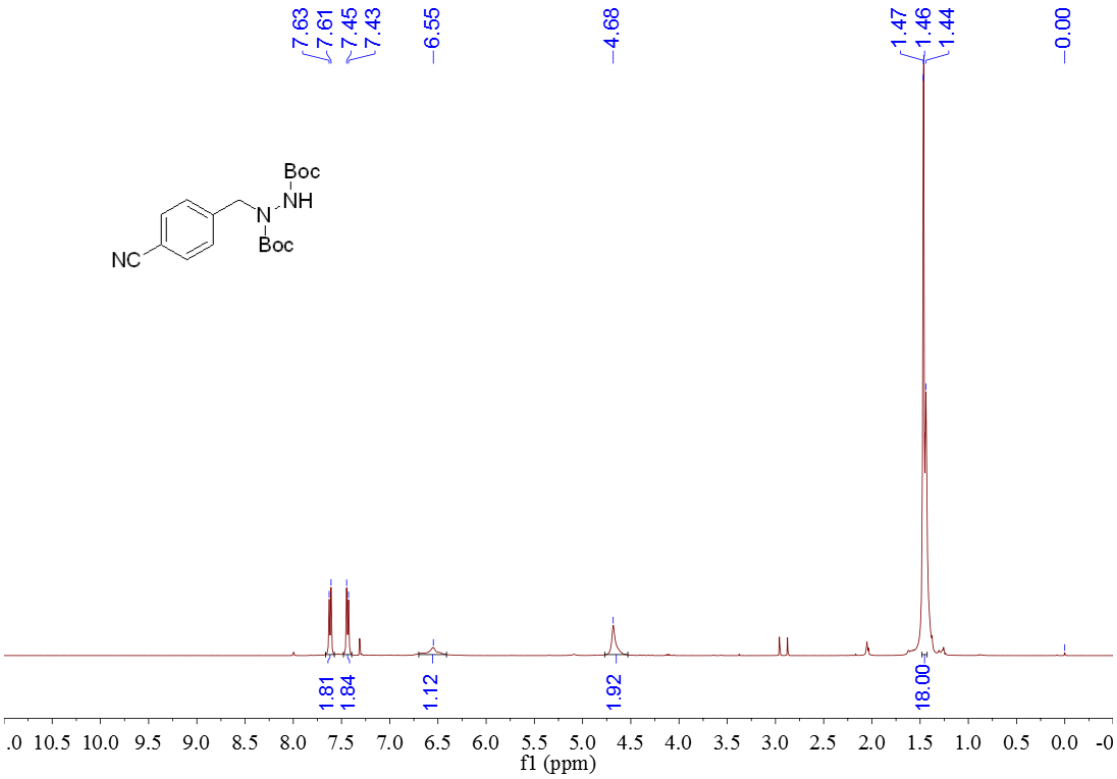
di-tert-butyl 1-benzylhydrazine-1,2-dicarboxylate (**2e**)



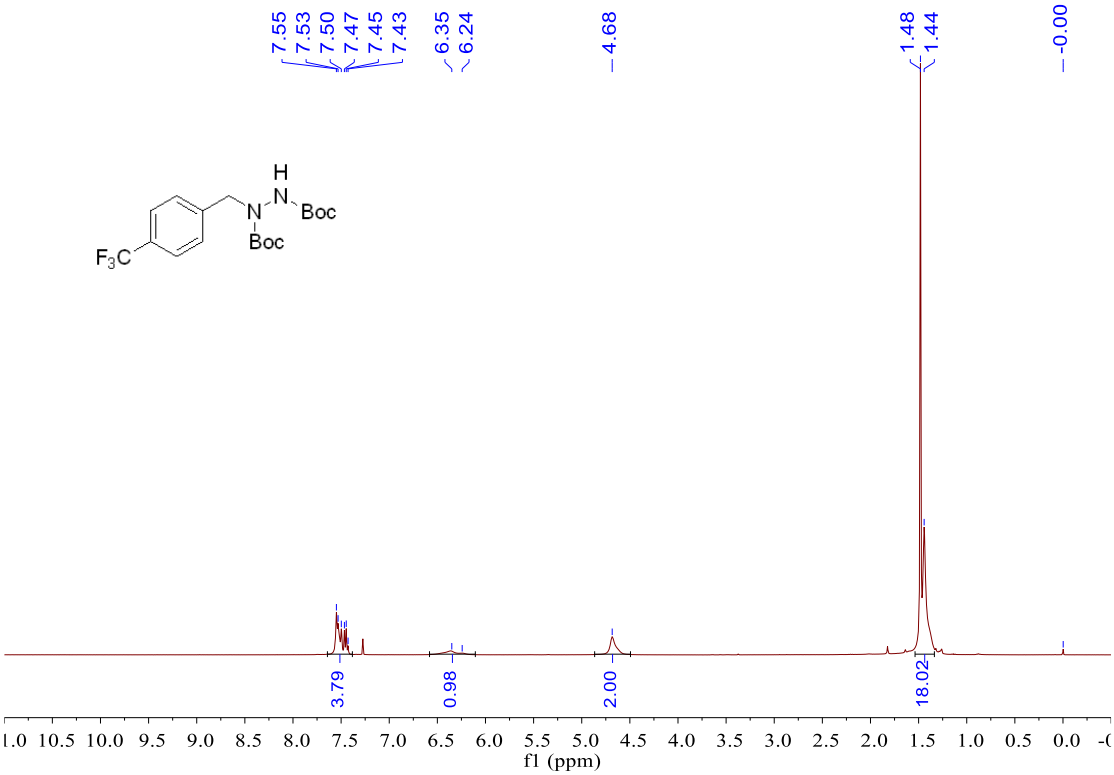
di-tert-butyl 1-(4-fluorobenzyl)hydrazine-1,2-dicarboxylate (**2f**)



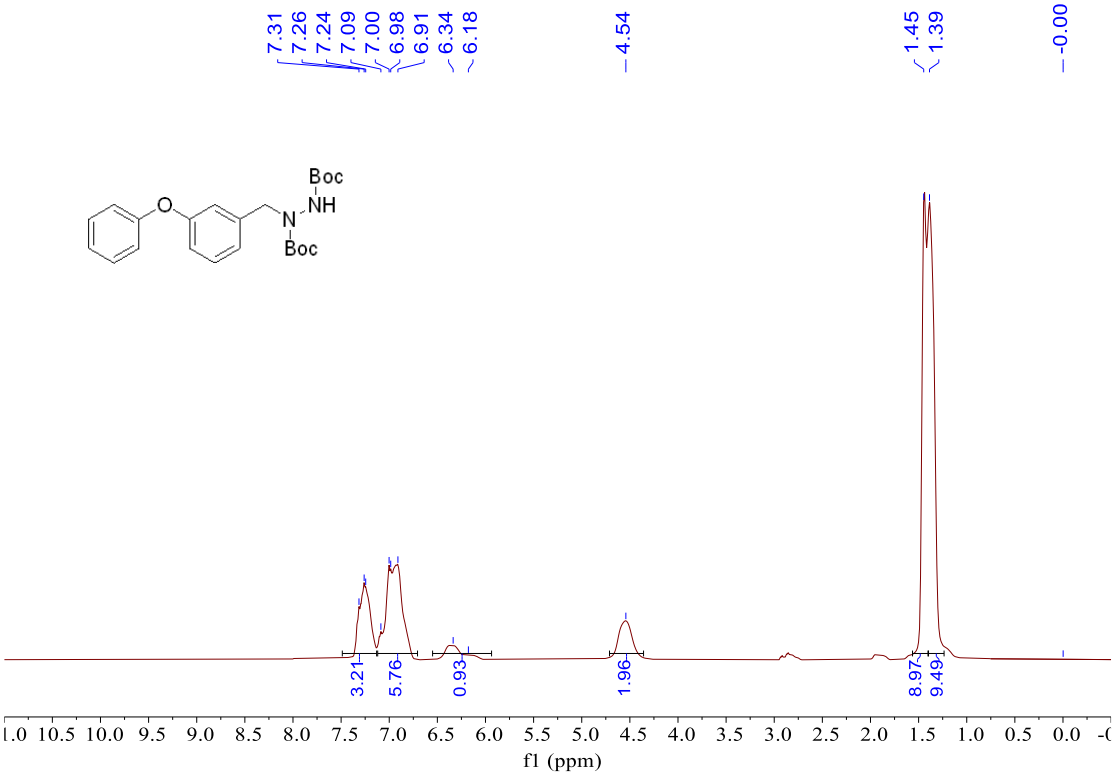
di-tert-butyl 1-(4-cyanobenzyl)hydrazine-1,2-dicarboxylate (**2g**)

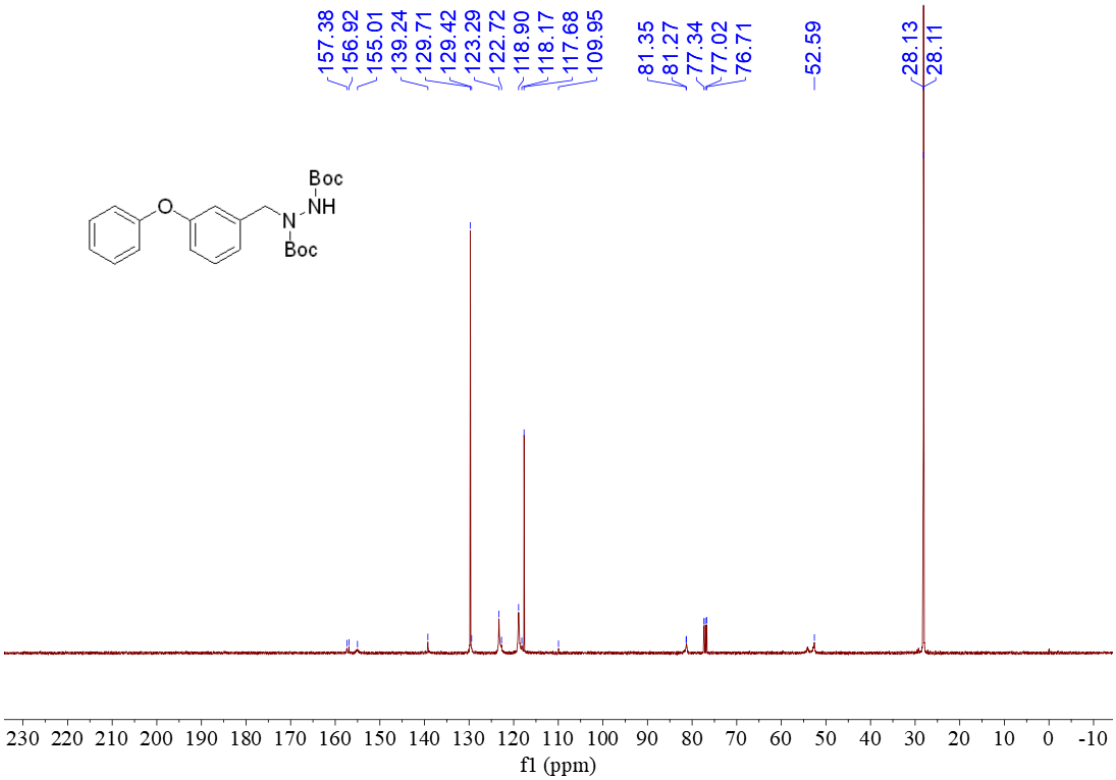


di-tert-butyl 1-(4-(trifluoromethyl)benzyl)hydrazine-1,2-dicarboxylate (**2h**)

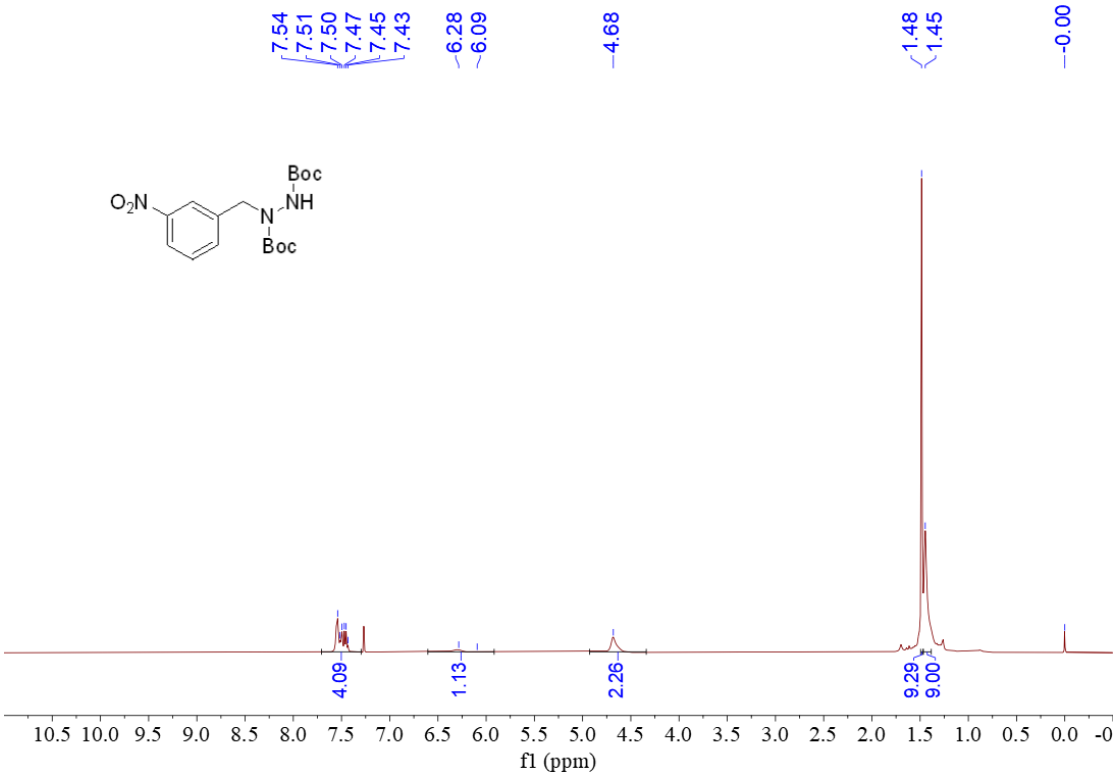


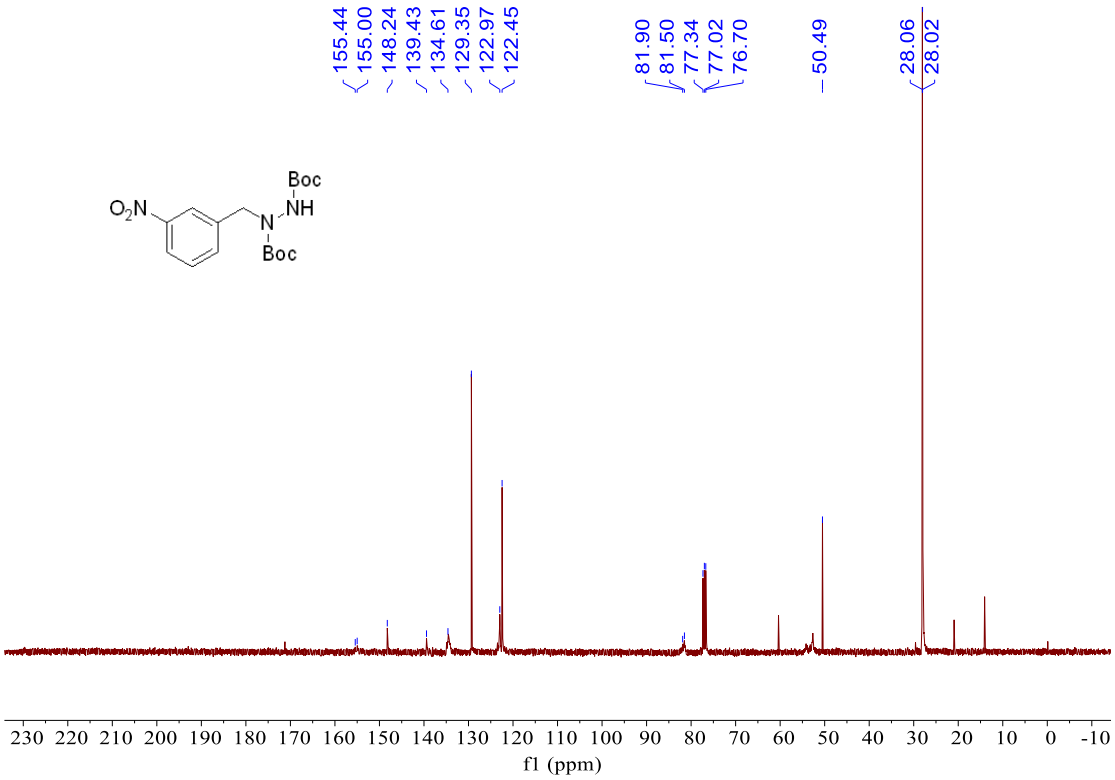
di-tert-butyl 1-(3-phenoxybenzyl)hydrazine-1,2-dicarboxylate (**2i**)



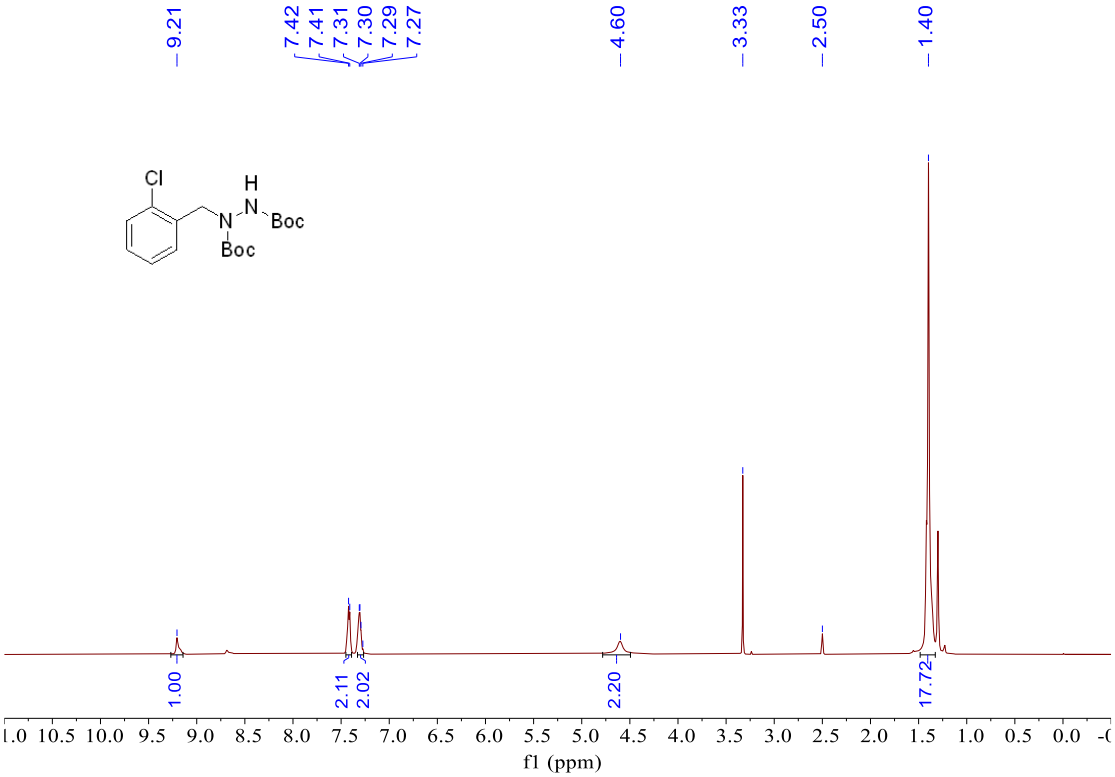


di-tert-butyl 1-(3-nitrobenzyl)hydrazine-1,2-dicarboxylate (**2j**)

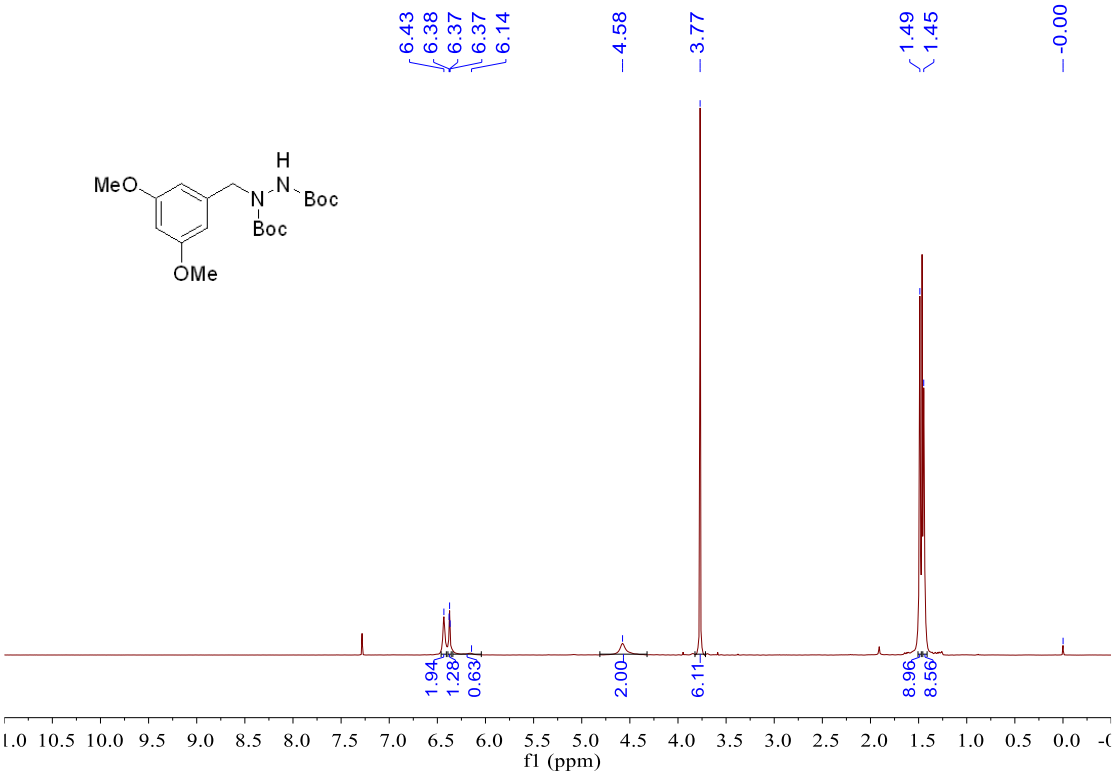


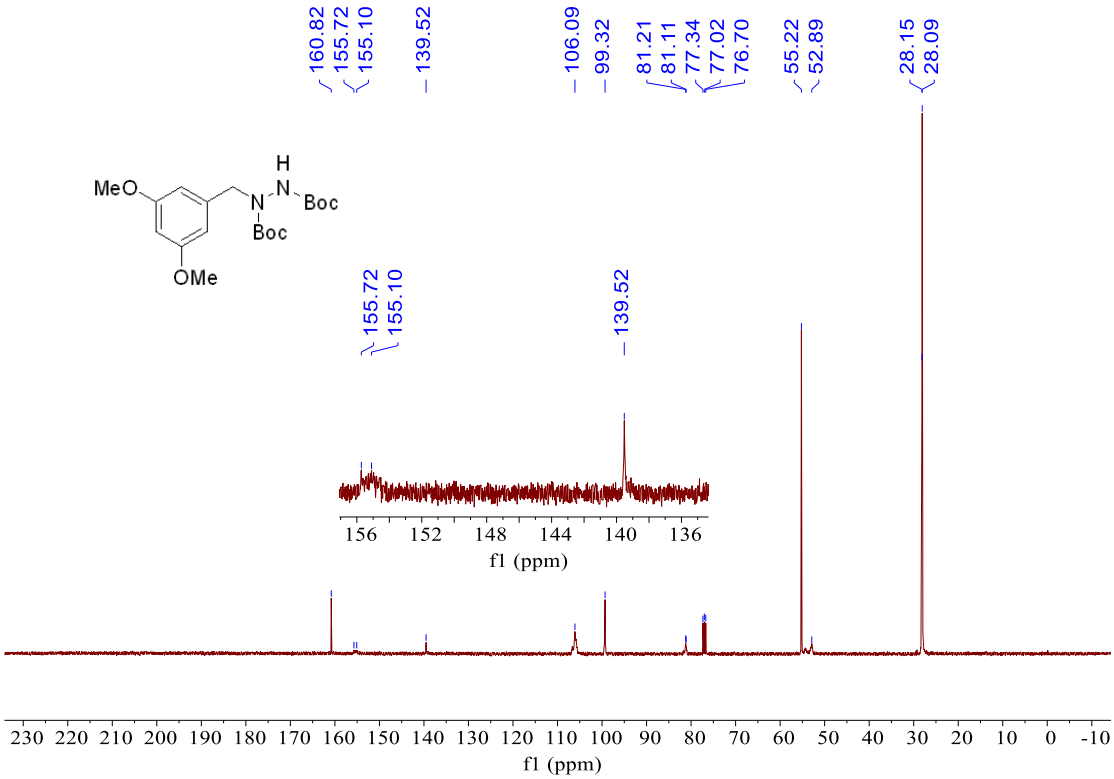


di-tert-butyl 1-(2-chlorobenzyl)hydrazine-1,2-dicarboxylate (**2k**)

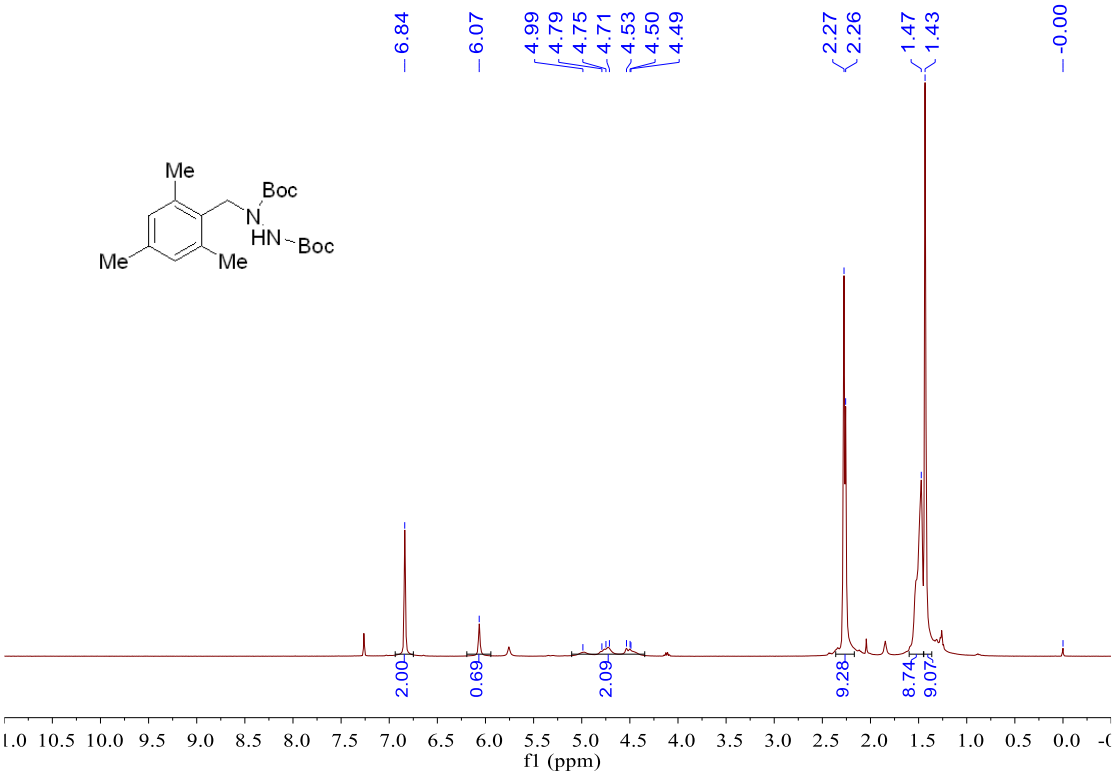


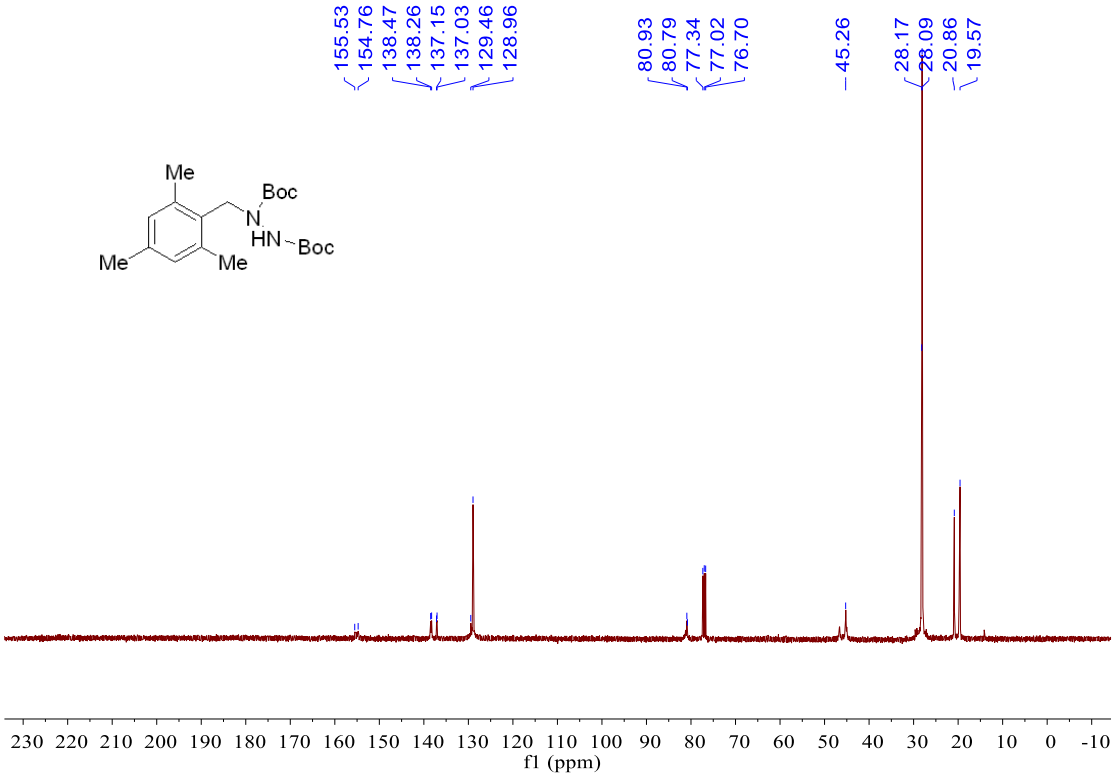
di-tert-butyl 1-(3,5-dimethoxybenzyl)hydrazine-1,2-dicarboxylate (**2l**)



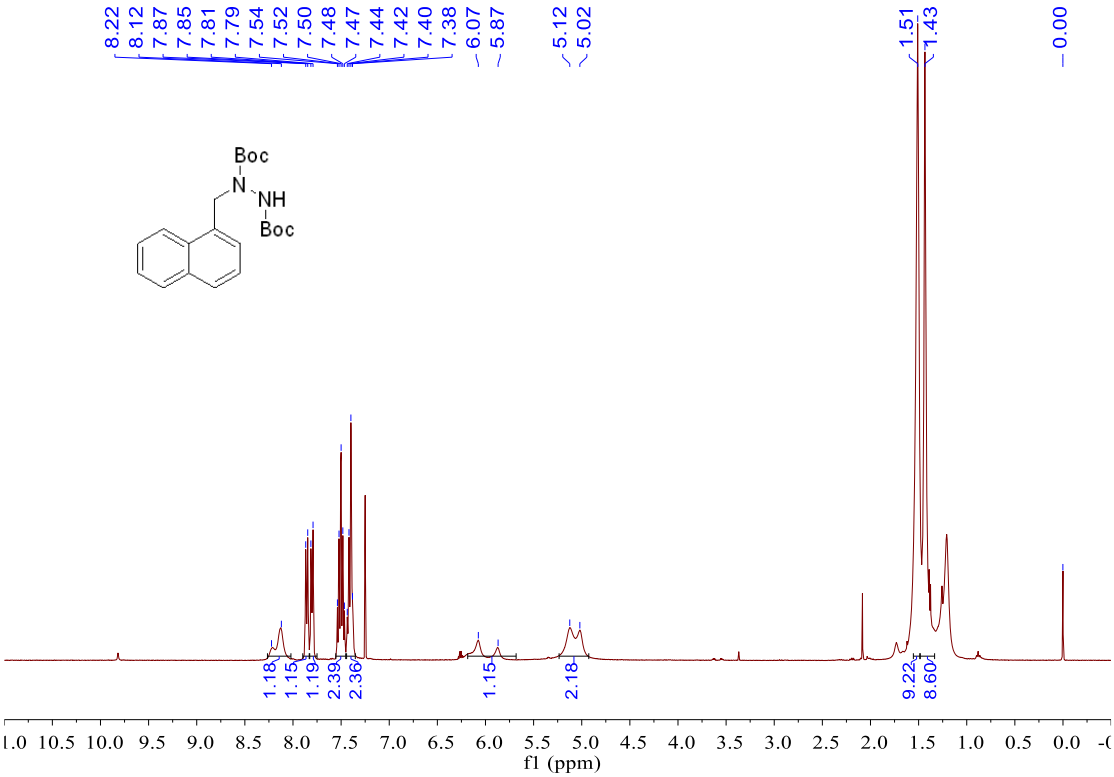


di-tert-butyl 1-(2,4,6-trimethylbenzyl)hydrazine-1,2-dicarboxylate (**2m**)

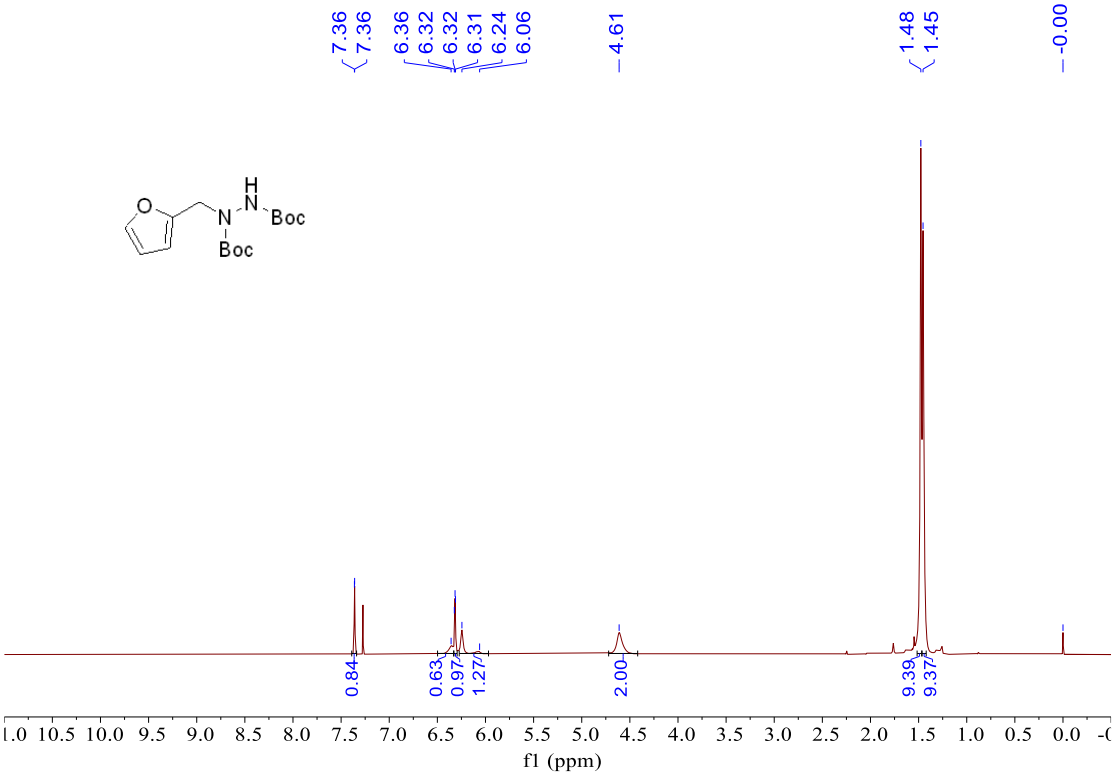


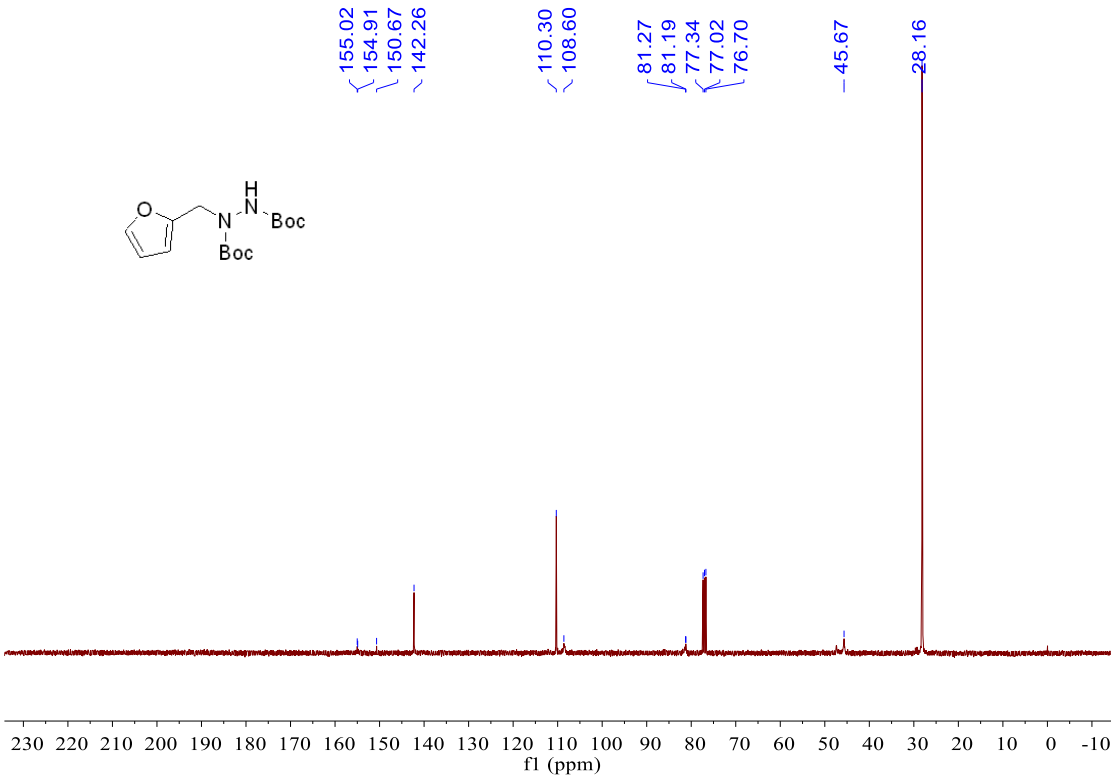


di-tert-butyl 1-(naphthalen-1-ylmethyl)hydrazine-1,2-dicarboxylate (**2n**)

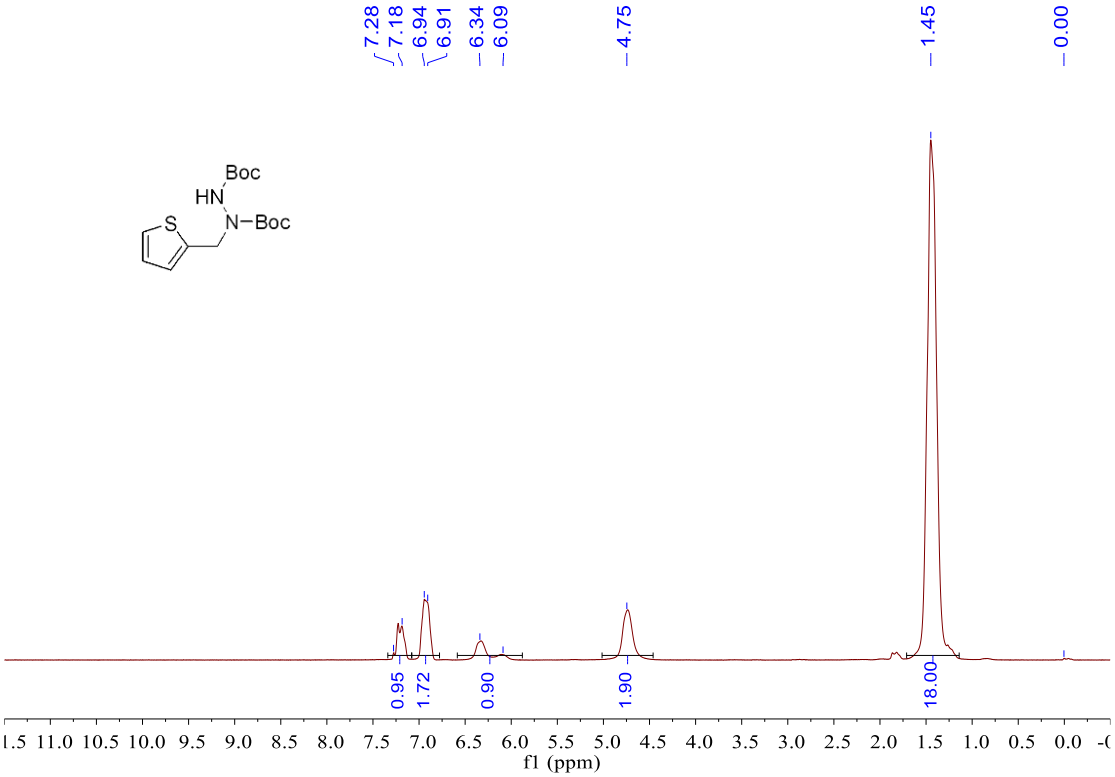


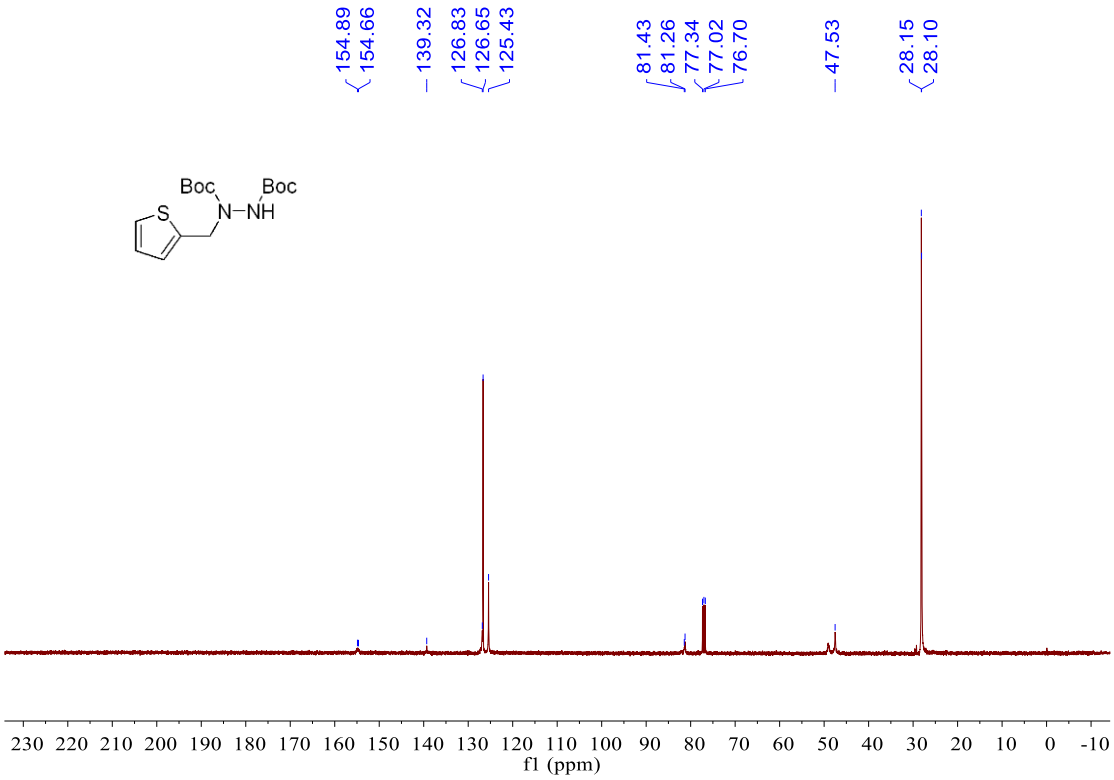
di-tert-butyl 1-(furan-2-ylmethyl)hydrazine-1,2-dicarboxylate (**2o**).



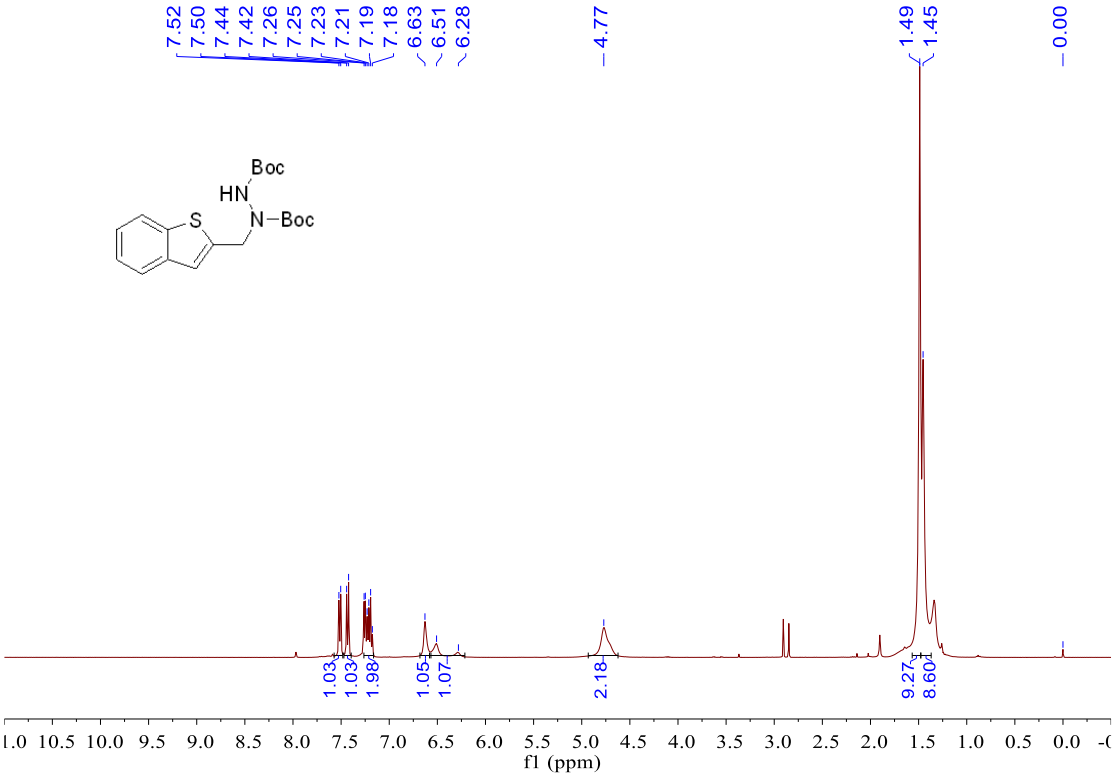


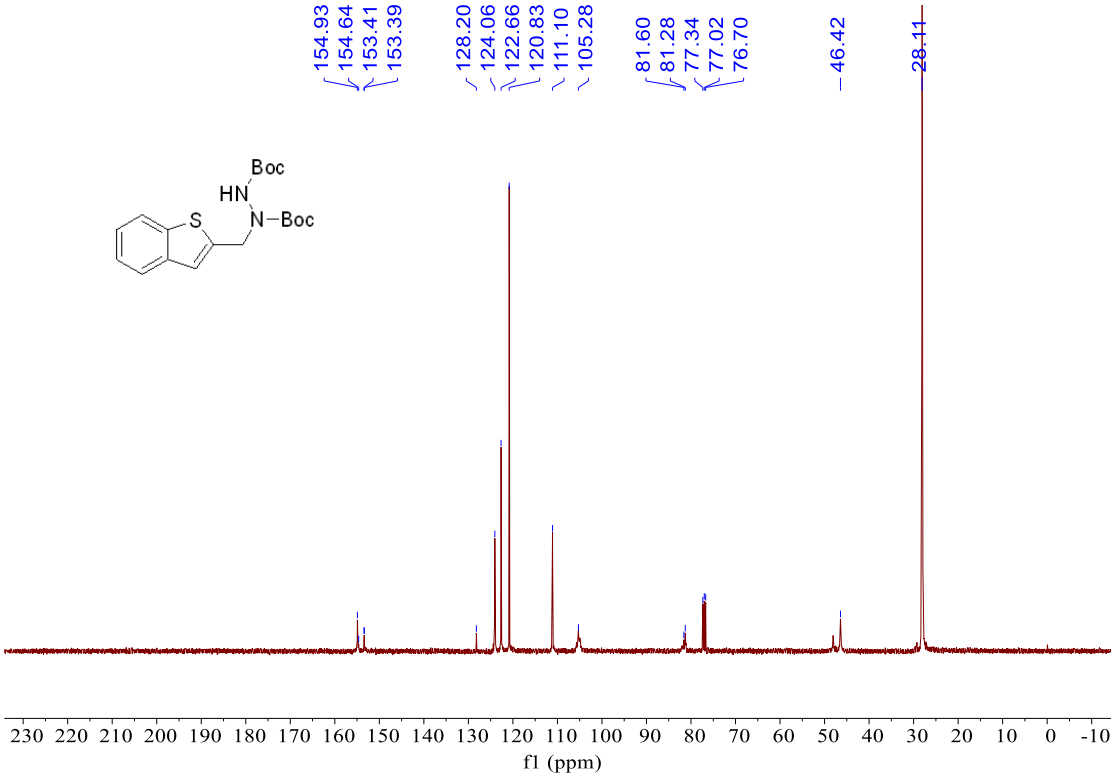
di-tert-butyl 1-(thiophen-2-ylmethyl)hydrazine-1,2-dicarboxylate (**2p**)



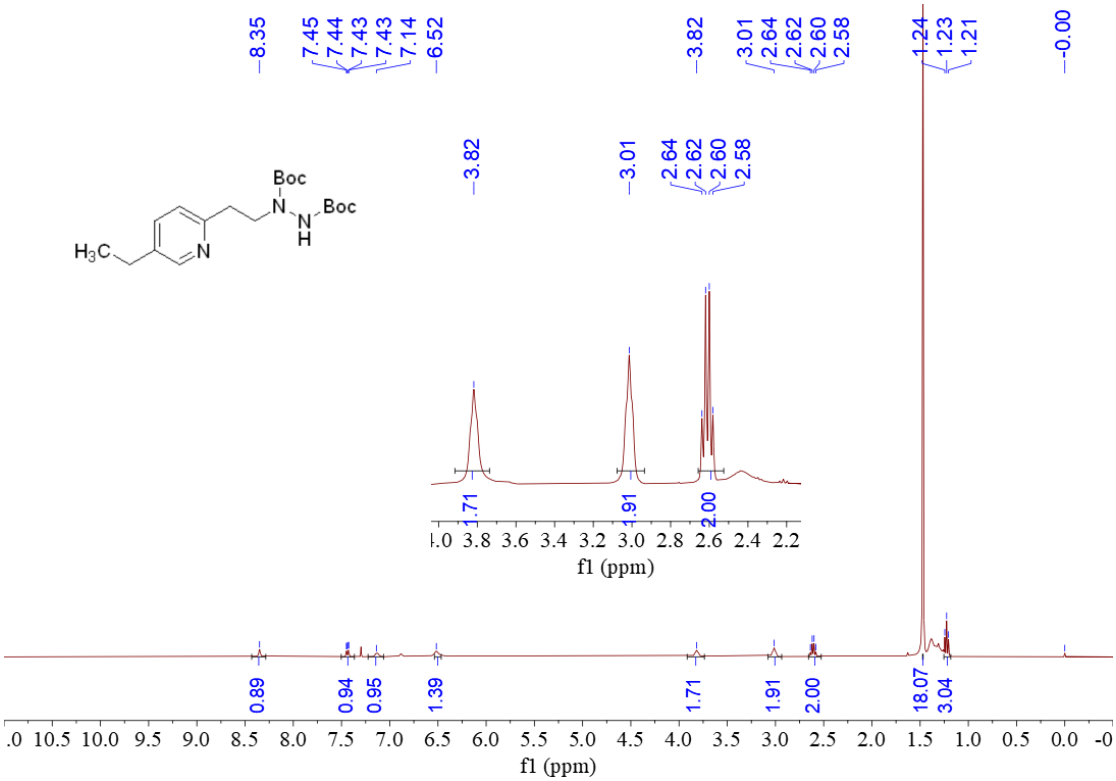


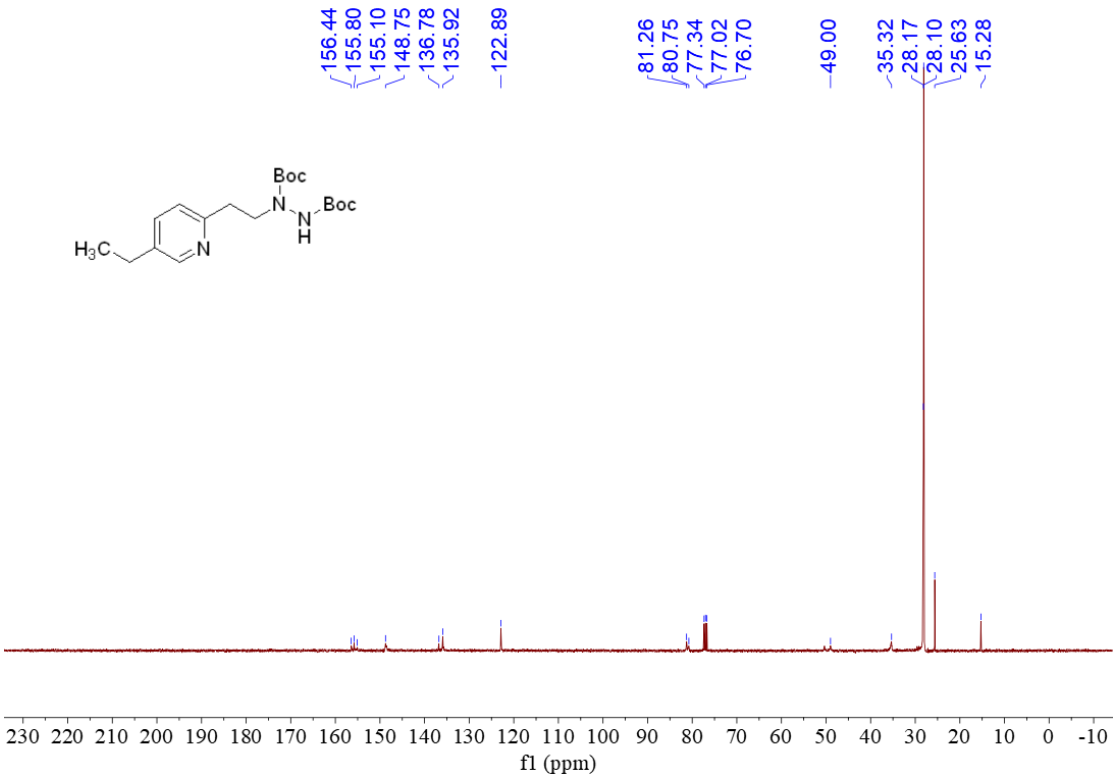
di-tert-butyl 1-(benzo[b]thiophen-2-ylmethyl)hydrazine-1,2-dicarboxylate (**2q**)



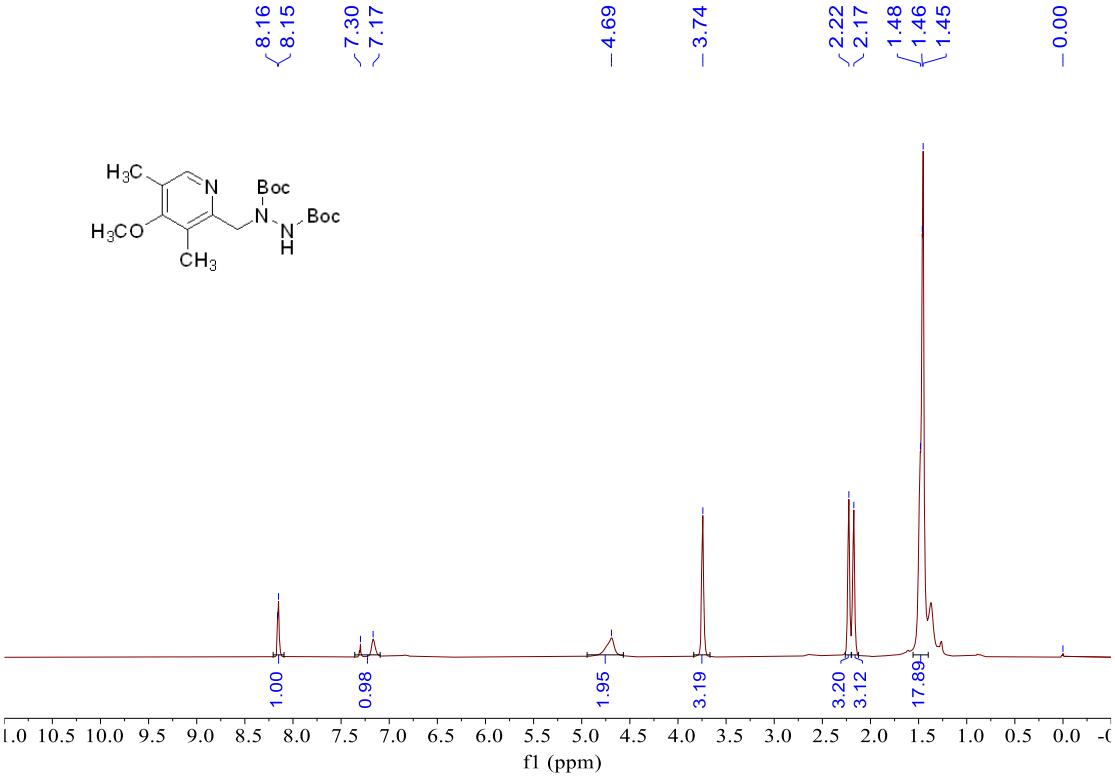


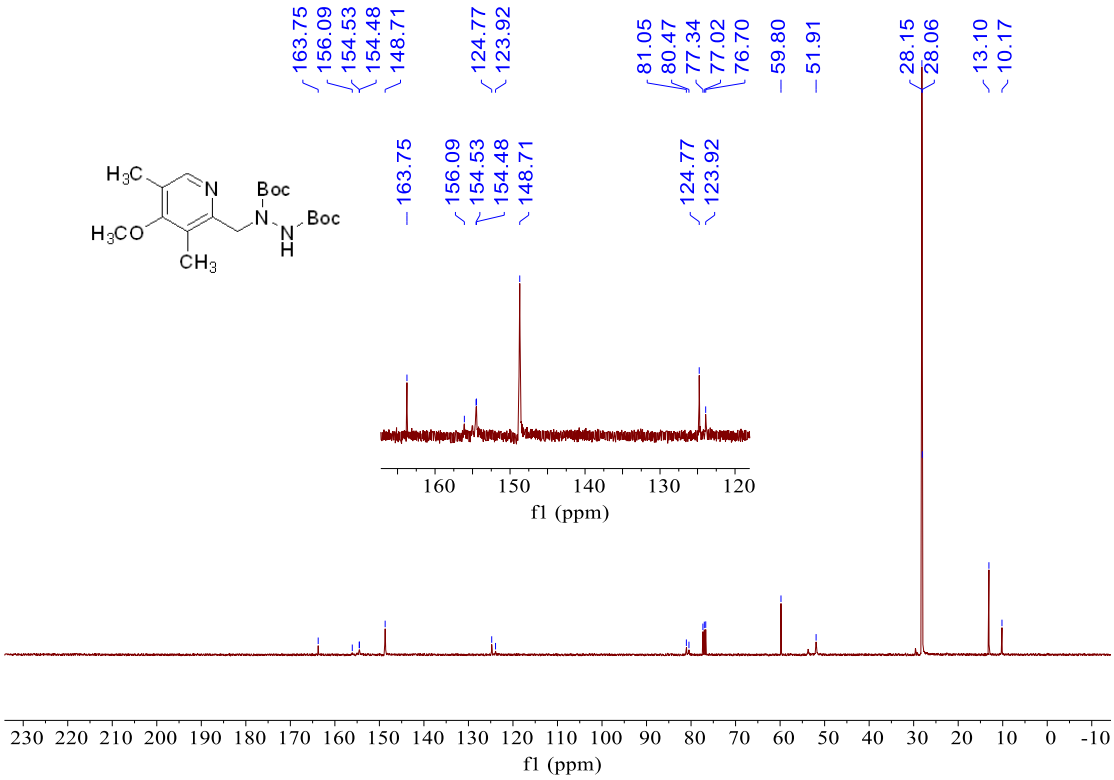
di-tert-butyl 1-(2-(5-ethylpyridin-2-yl)ethyl)hydrazine-1,2-dicarboxylate (**2r**)



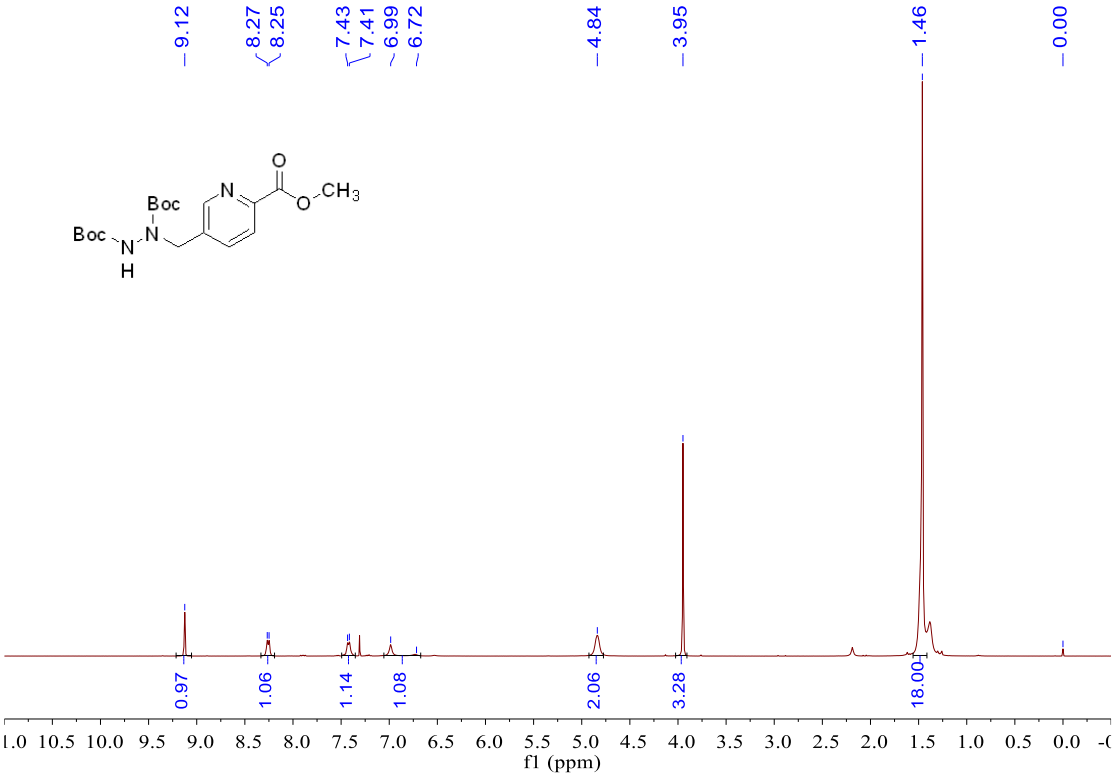


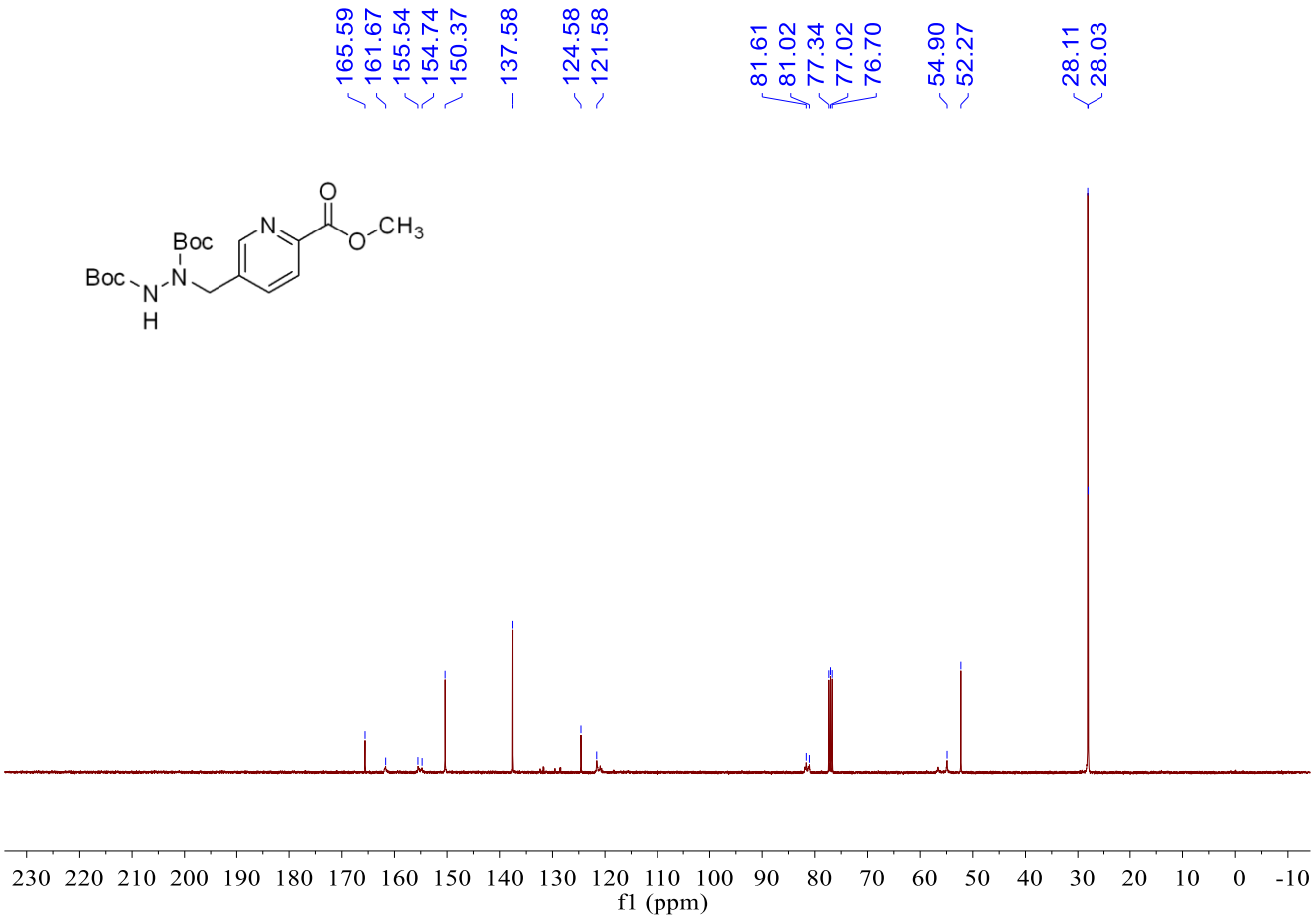
di-tert-butyl 1-((4-methoxy-3,5-dimethylpyridin-2-yl)methyl)hydrazine-1,2-dicarboxylate (**2s**)



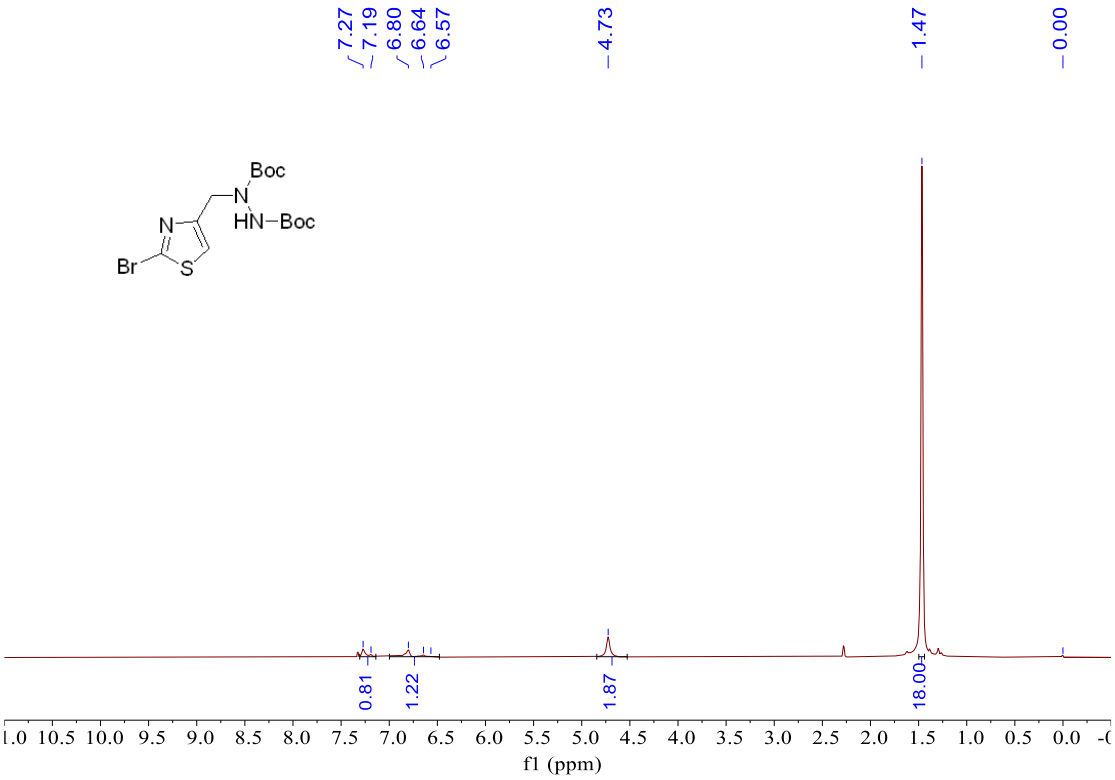


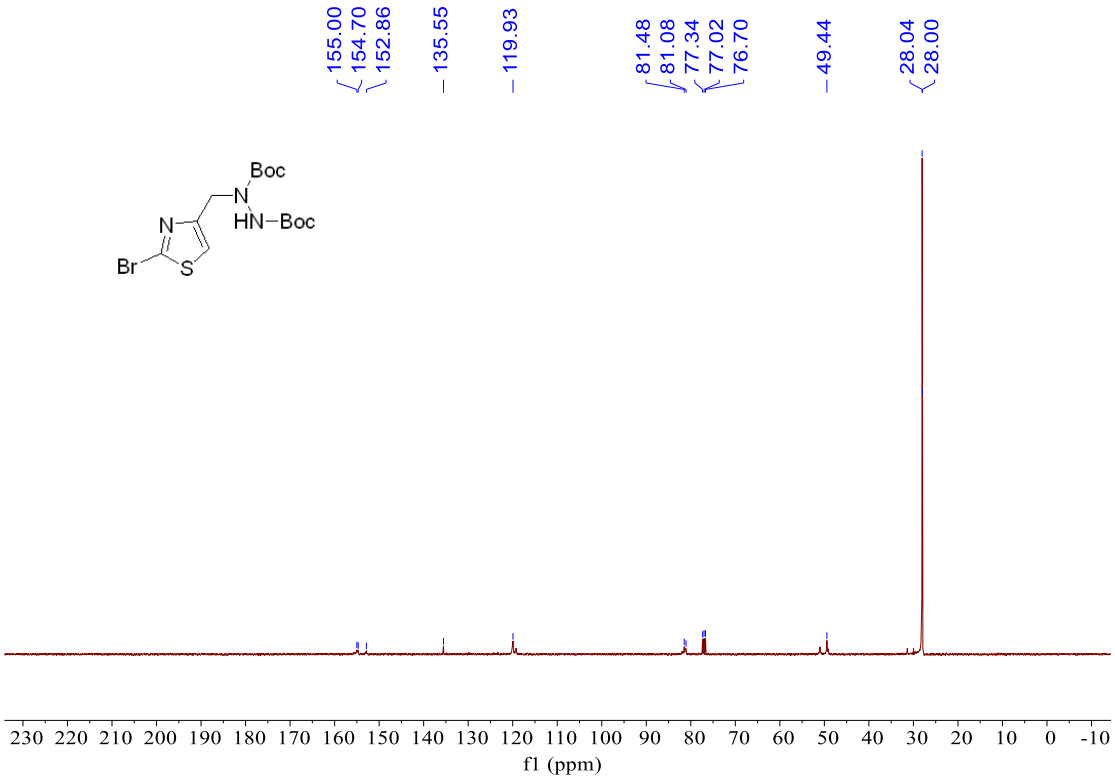
di-tert-butyl 1-((6-(methoxycarbonyl)pyridin-3-yl)methyl)hydrazine-1,2-dicarboxylate (**2t**)



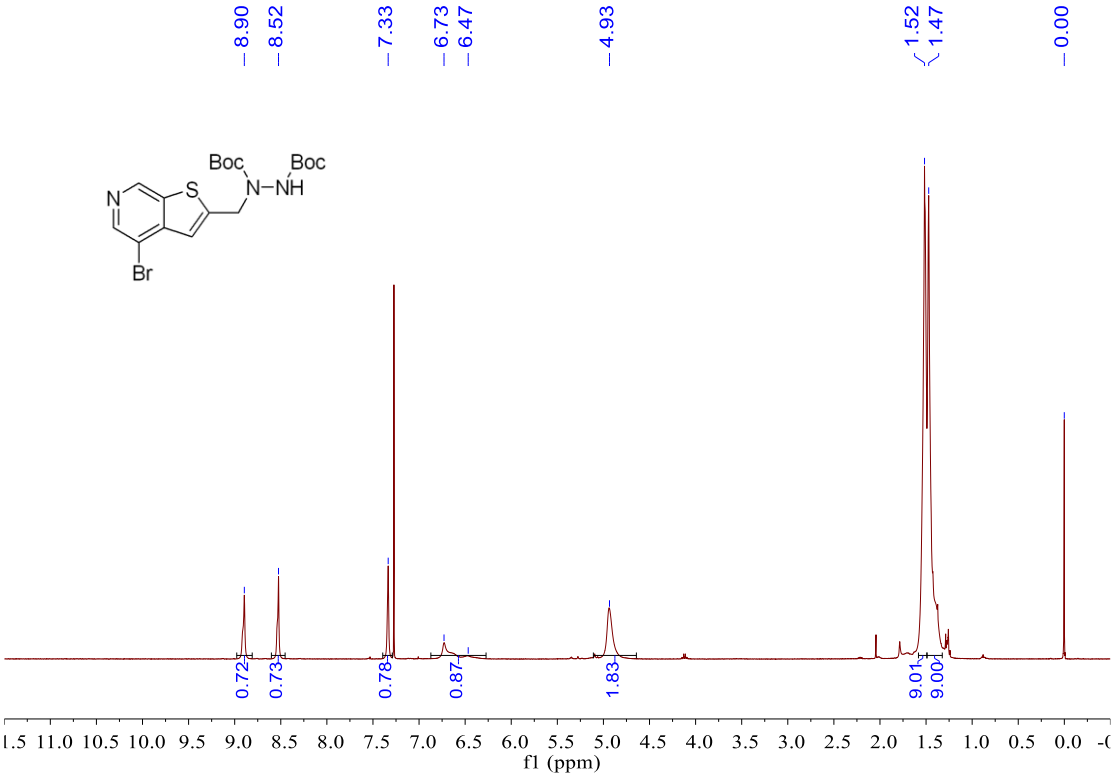


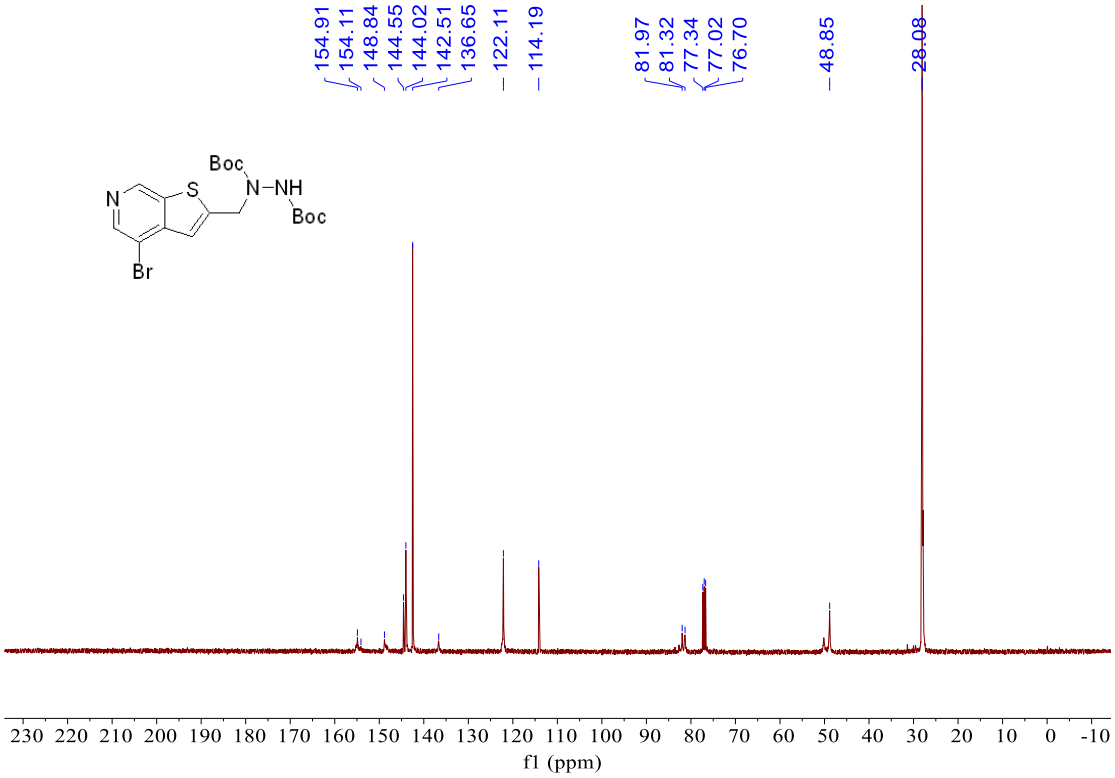
di-tert-butyl 1-((2-bromothiazol-4-yl)methyl)hydrazine-1,2-dicarboxylate (**2u**)



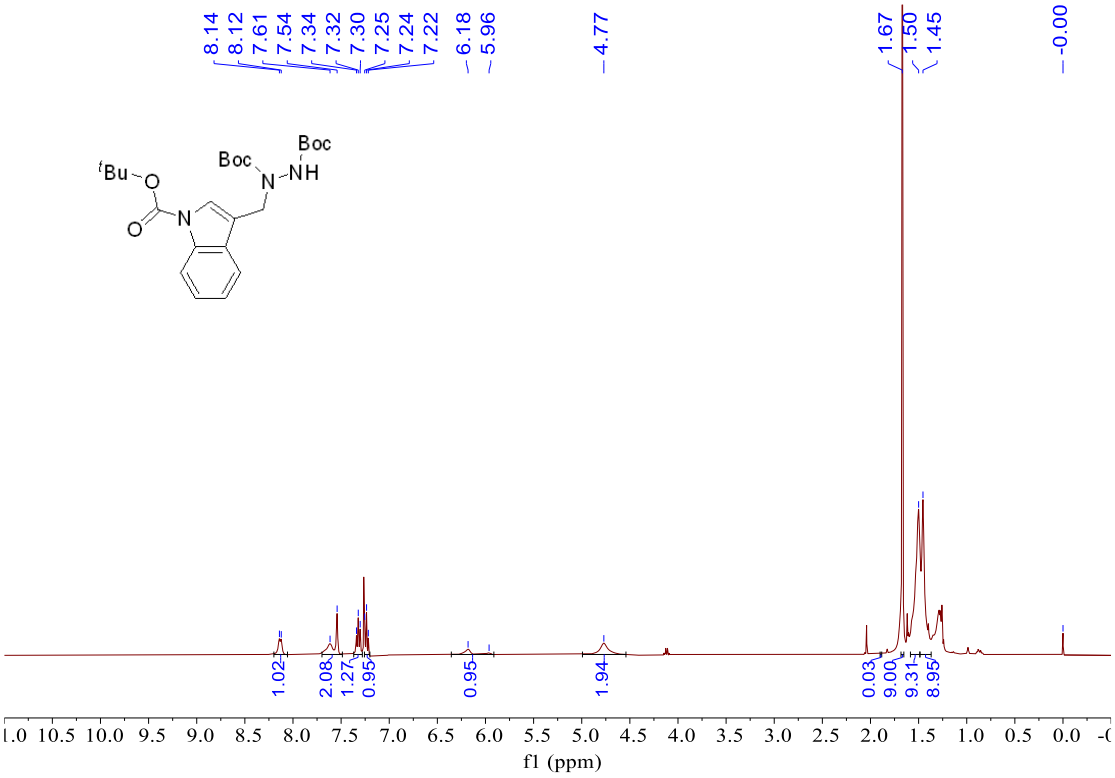


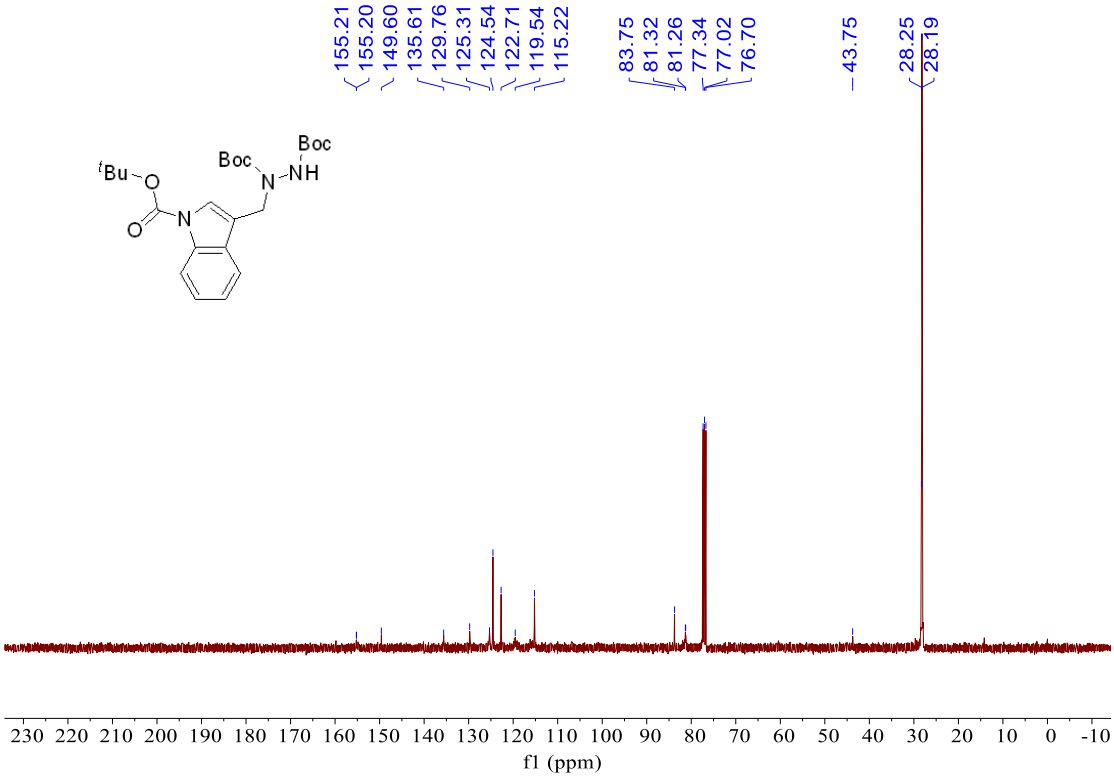
di-tert-butyl 1-((4-bromothieno[2,3-c]pyridin-2-yl)methyl)hydrazine-1,2-dicarboxylate (**2v**)



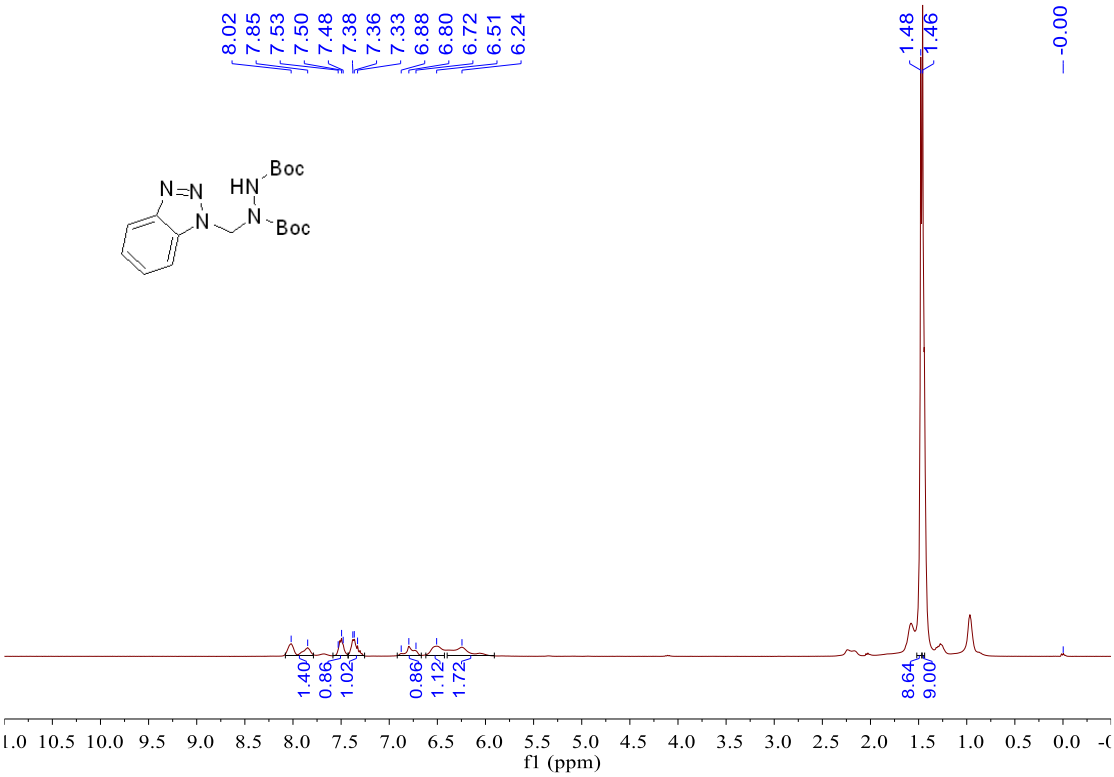


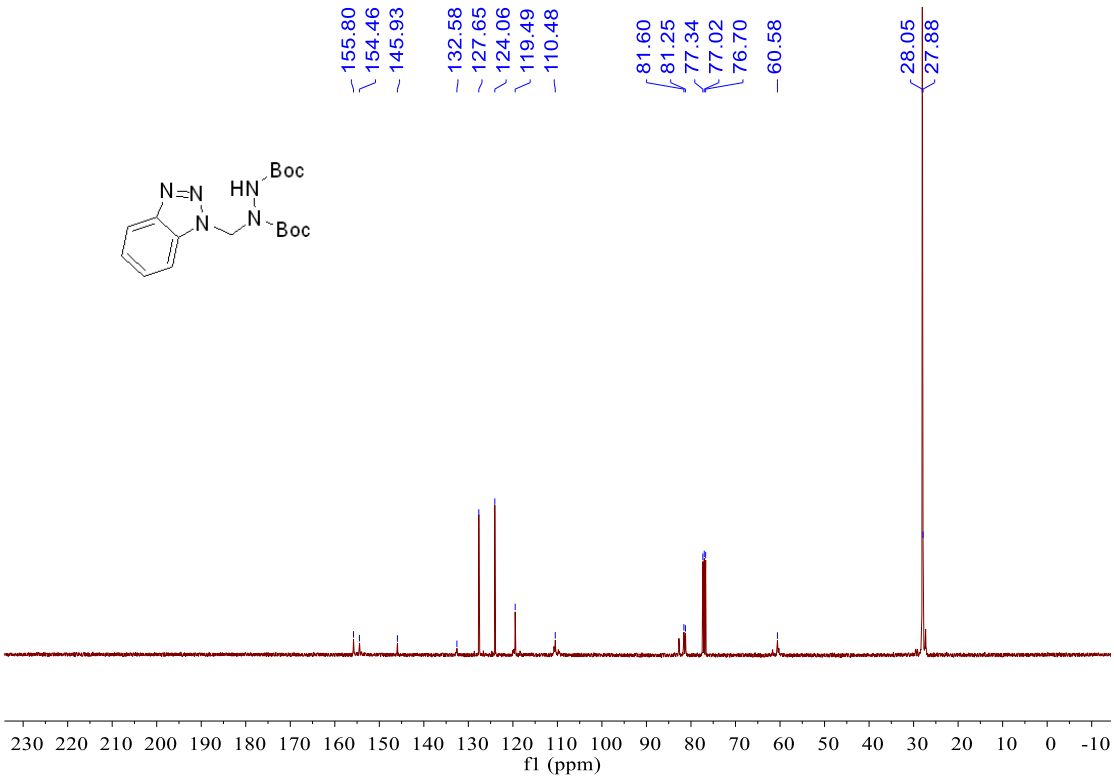
di-tert-butyl 1-((1-(tert-butoxycarbonyl)-1H-indol-3-yl)methyl)hydrazine-1,2-dicarboxylate (**2w**)



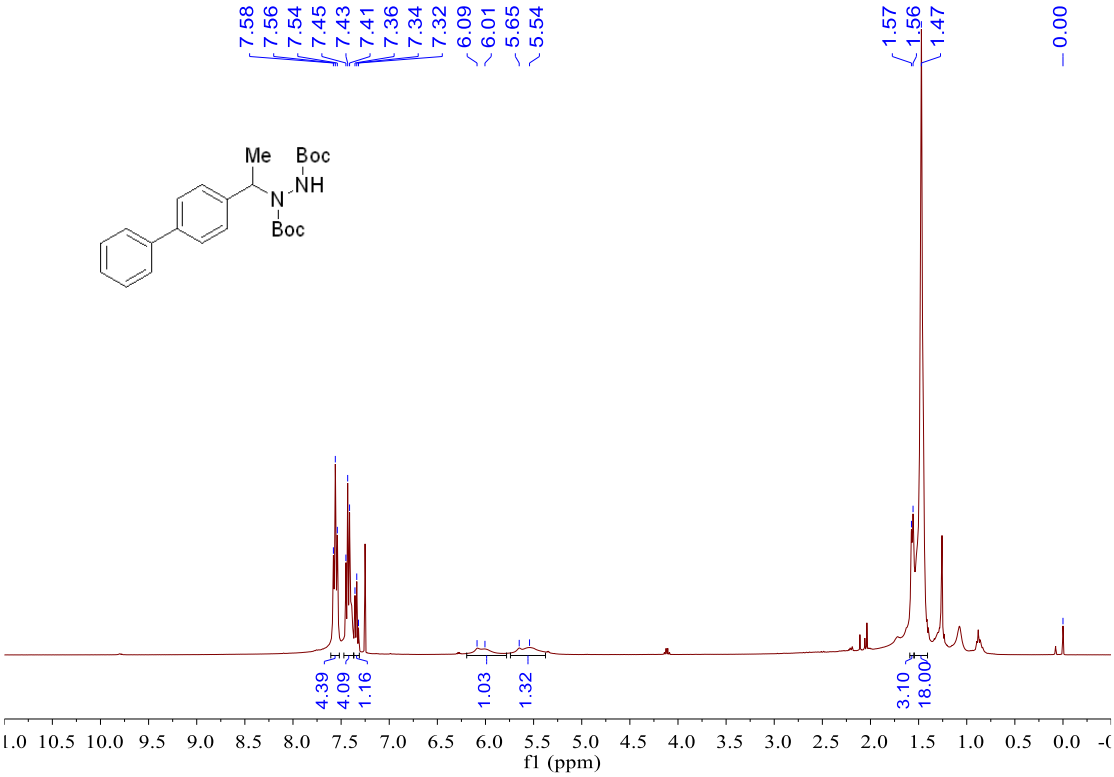


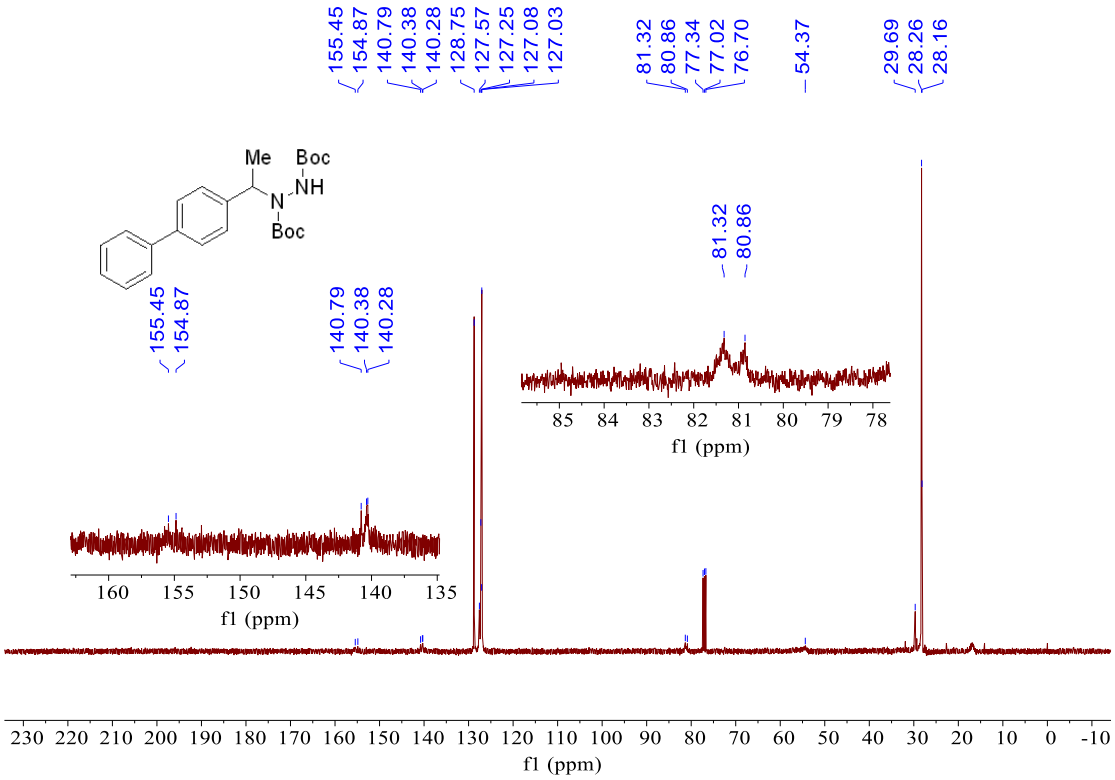
di-tert-butyl 1-((1H-benzo[d][1,2,3]triazol-1-yl)methyl)hydrazine-1,2-dicarboxylate (**2x**)



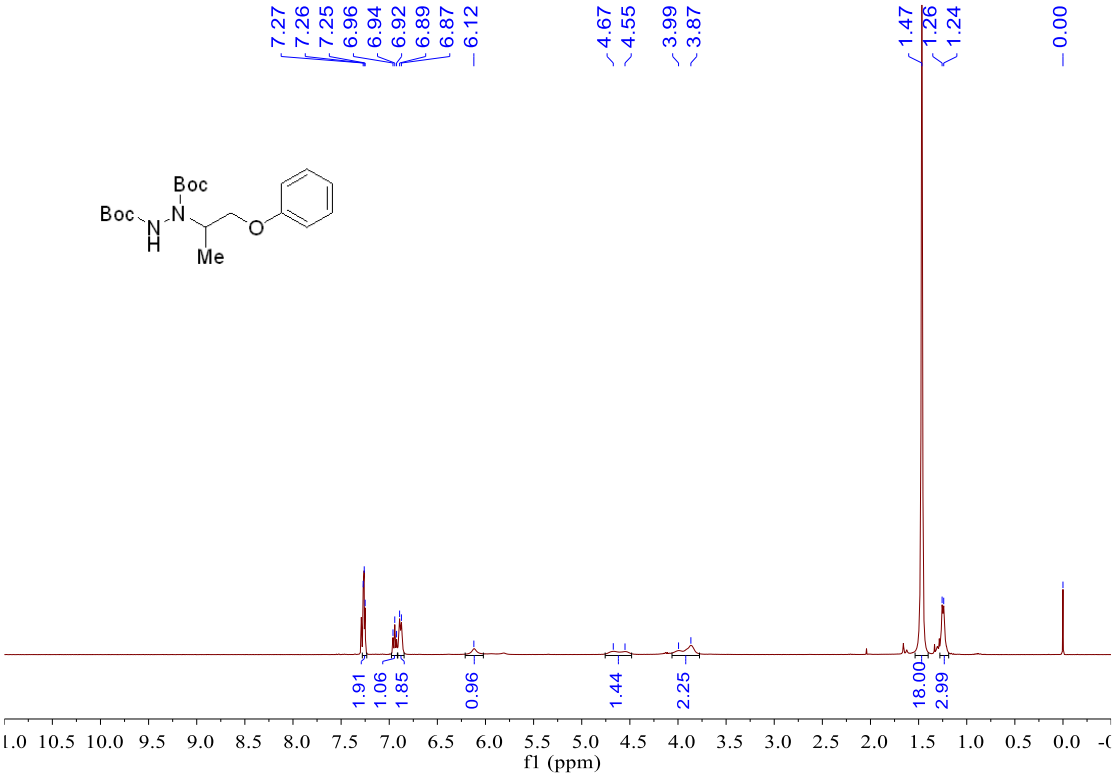


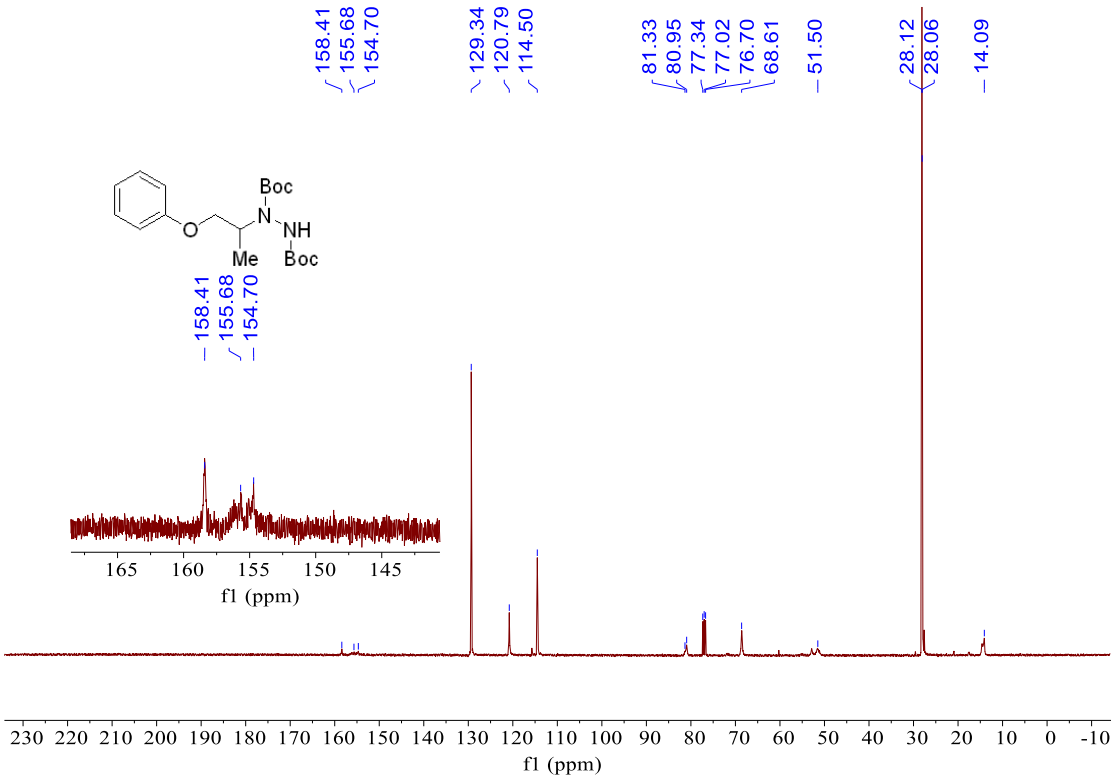
di-tert-butyl 1-(1-([1,1'-biphenyl]-4-yl)ethyl)hydrazine-1,2-dicarboxylate (**2y**)



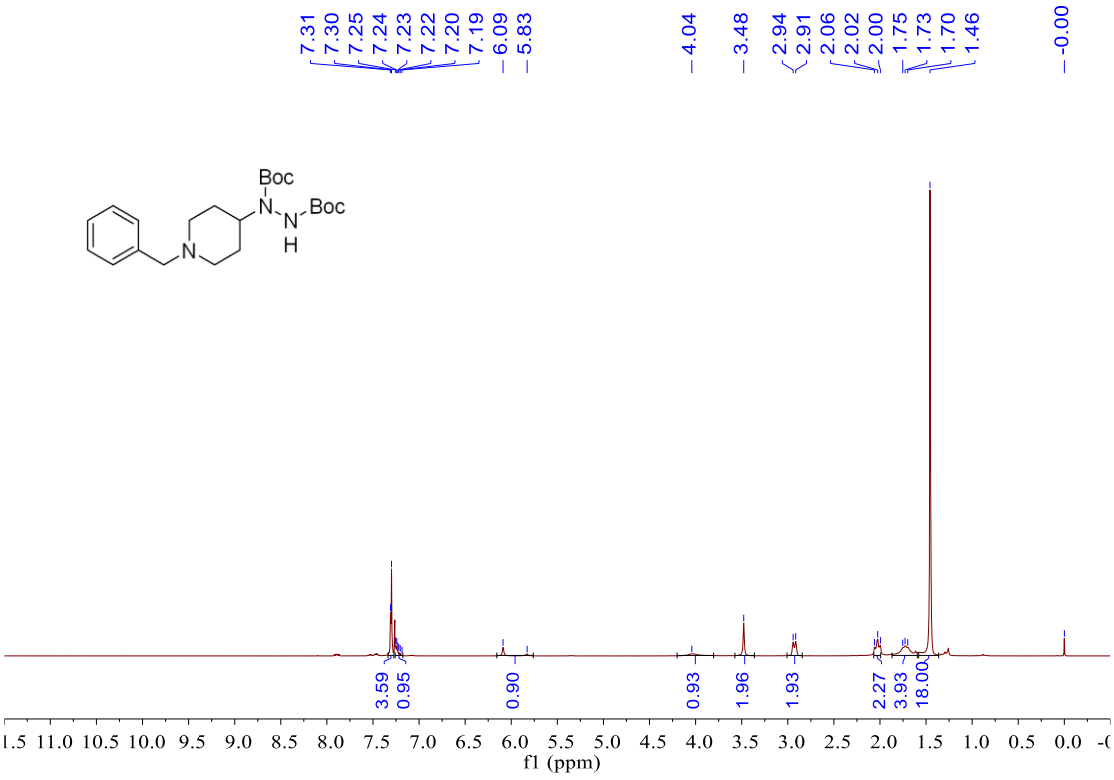


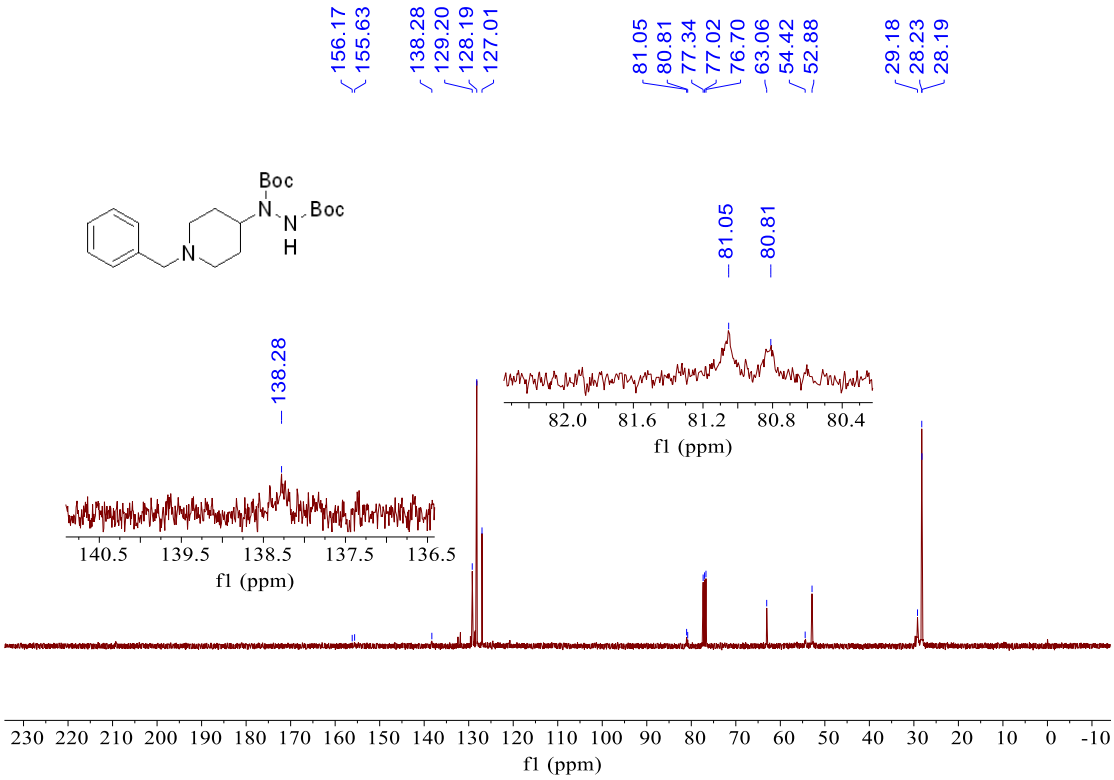
di-tert-butyl 1-(1-phenoxypropan-2-yl)hydrazine-1,2-dicarboxylate (**2z**)



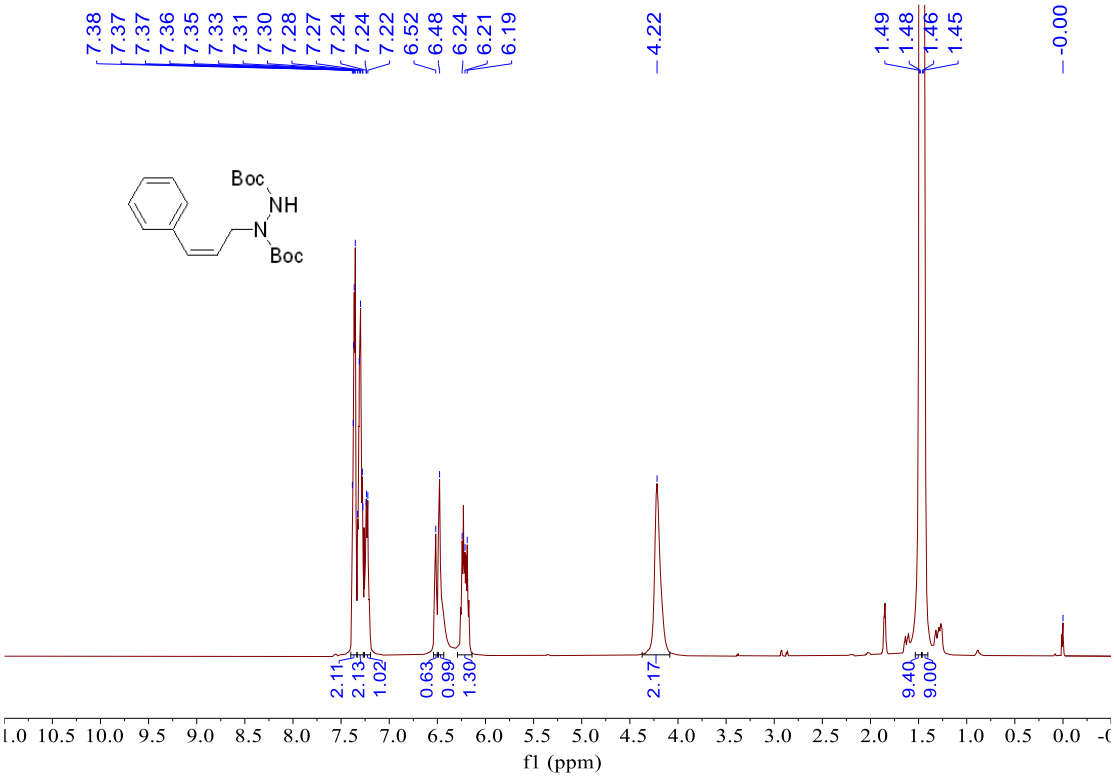


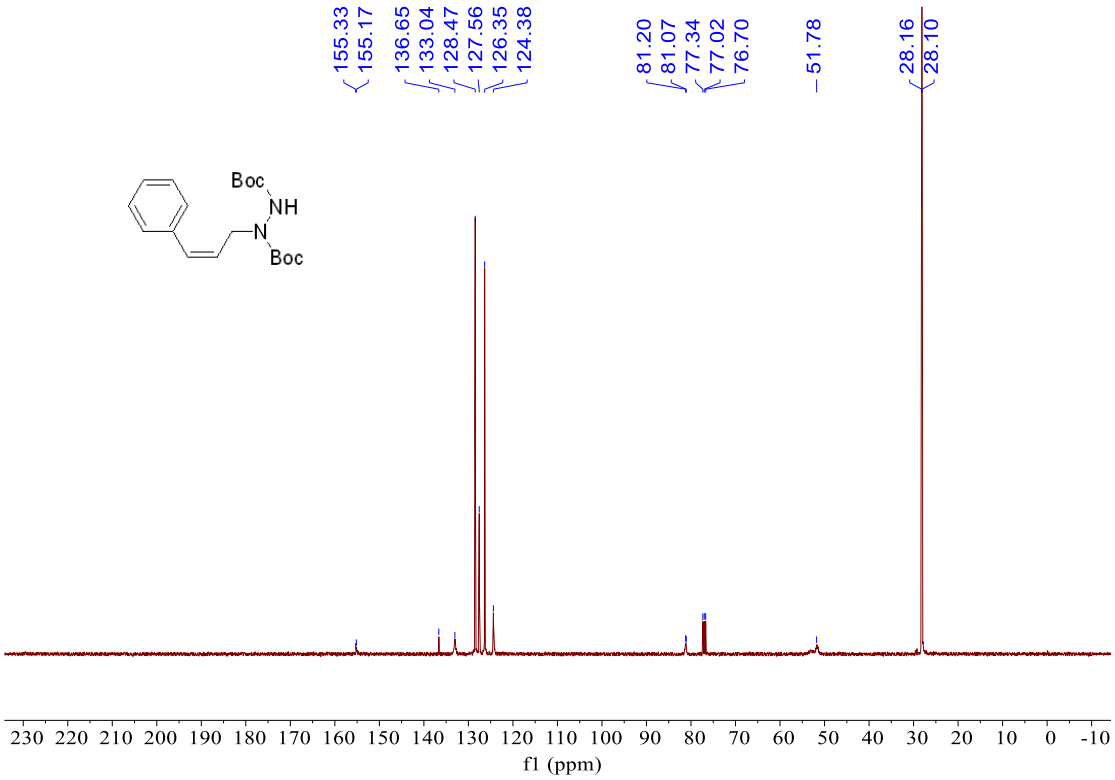
di-tert-butyl 1-(1-benzylpiperidin-4-yl)hydrazine-1,2-dicarboxylate (**2ab**)



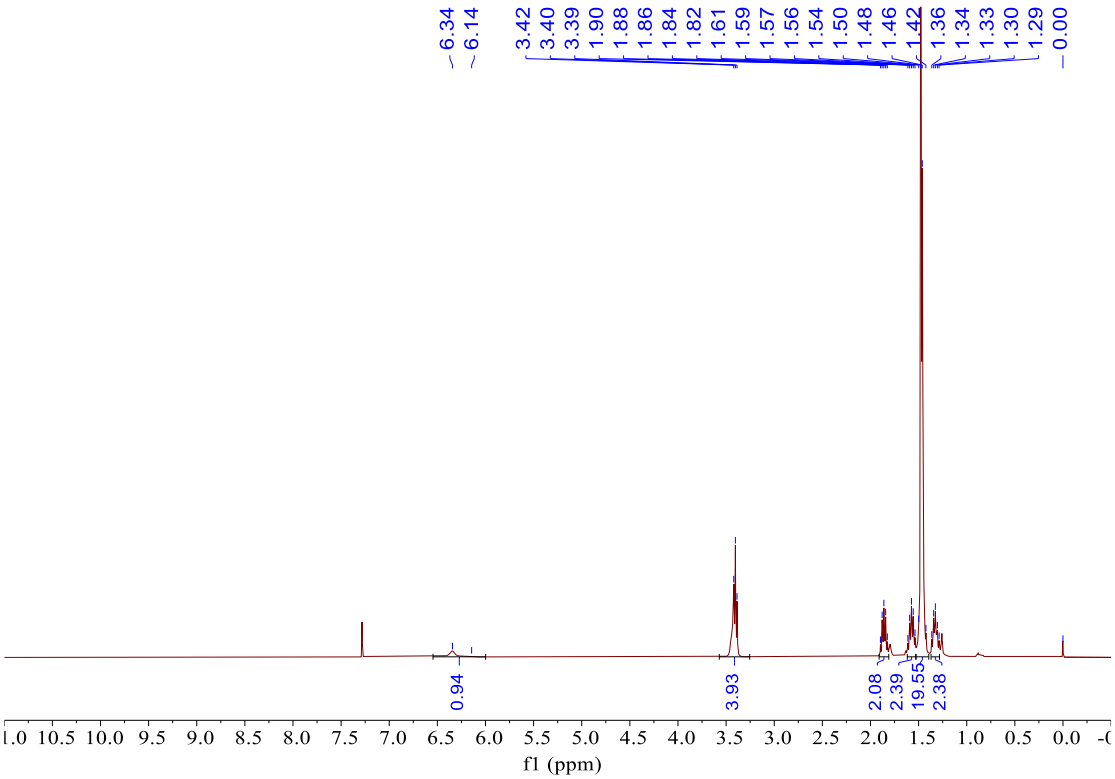


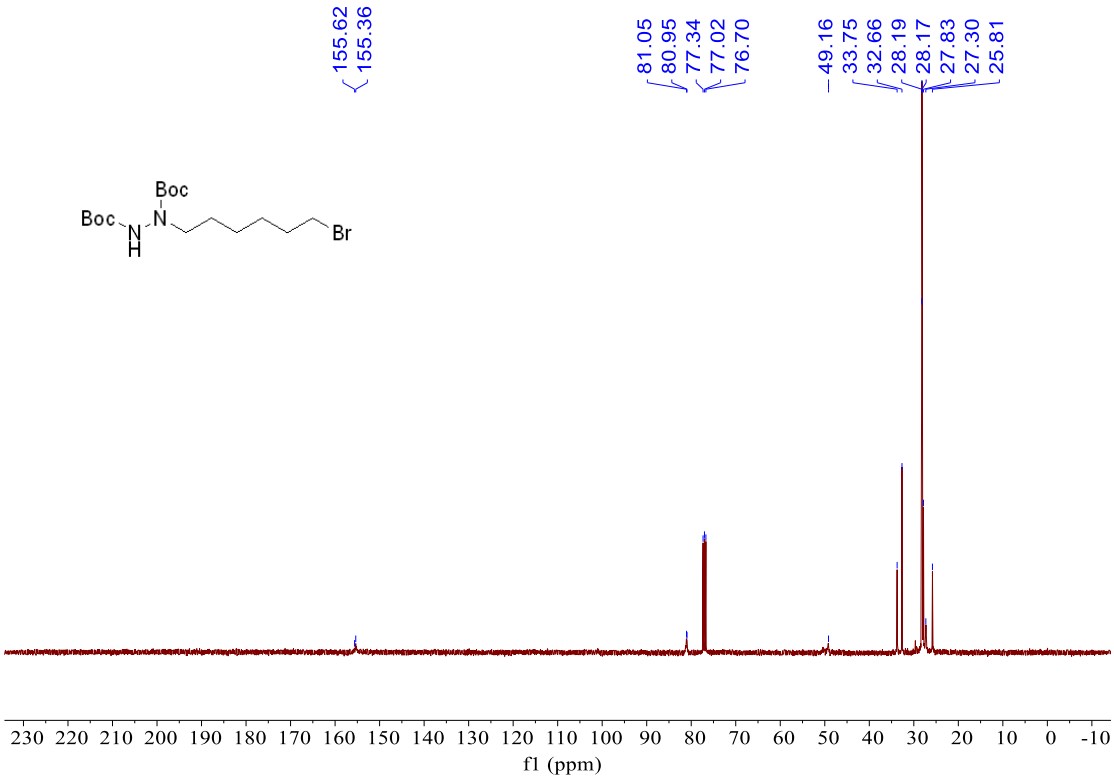
di-tert-butyl (Z)-1-(3-phenylallyl)hydrazine-1,2-dicarboxylate (**2ac**)



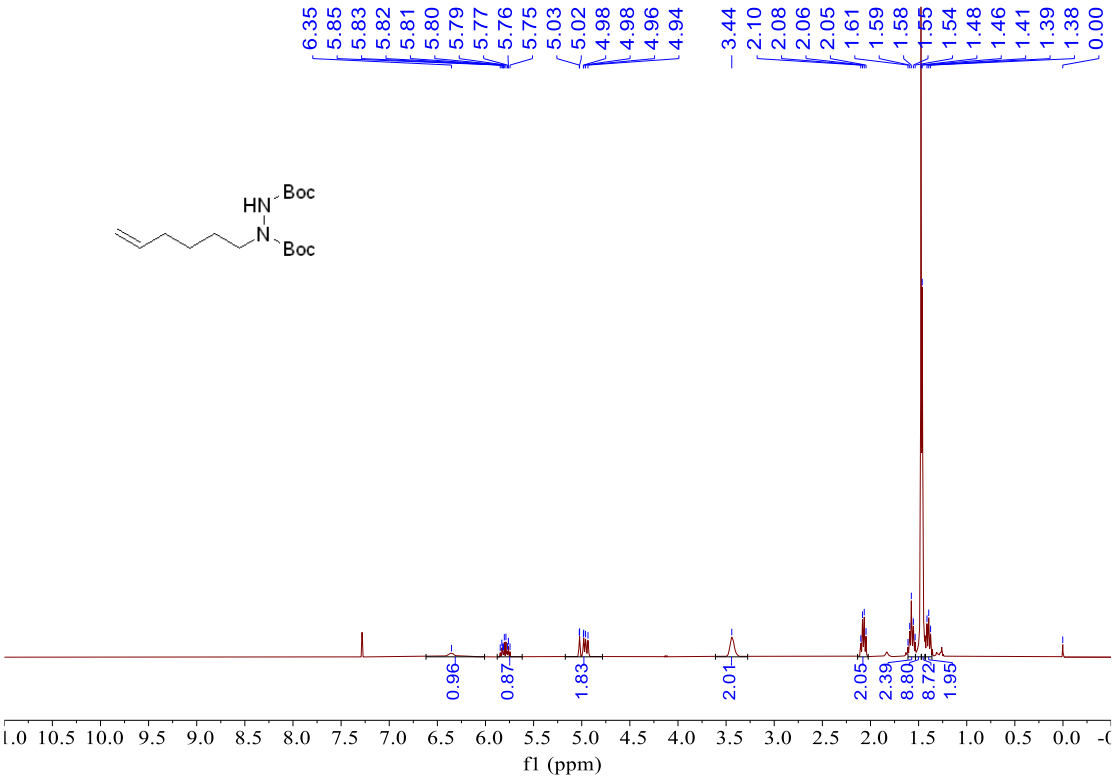


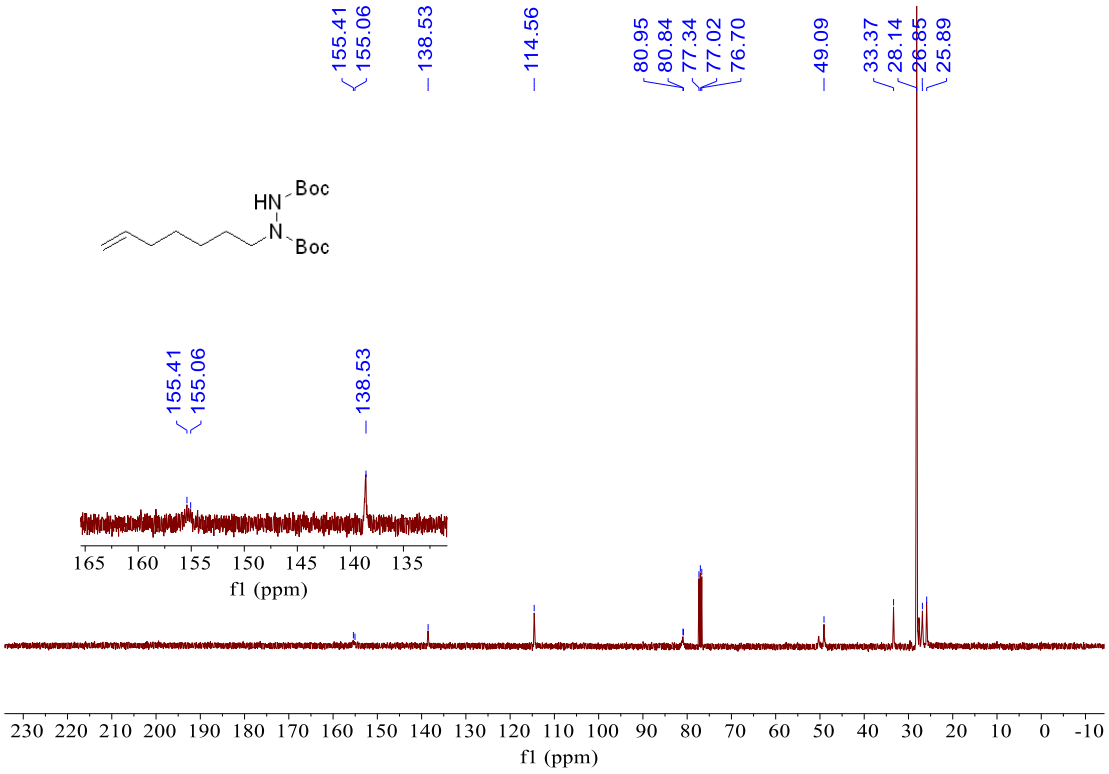
di-tert-butyl 1-(6-bromohexyl)hydrazine-1,2-dicarboxylate (**2ad**)



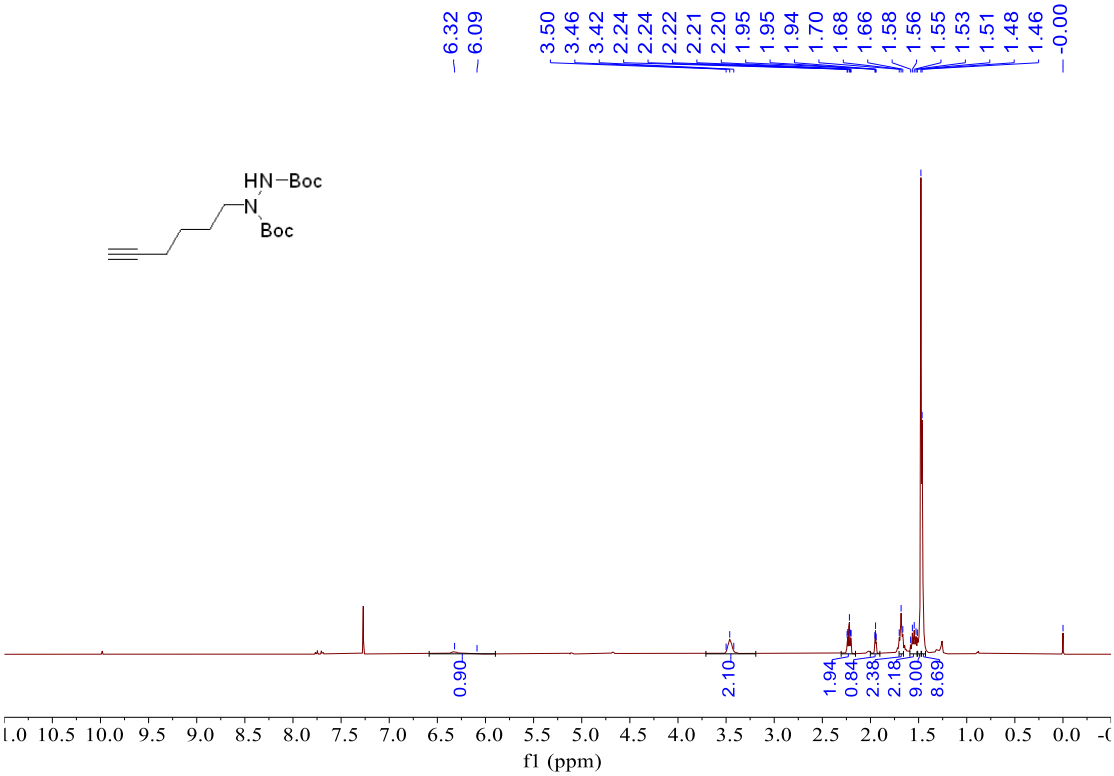


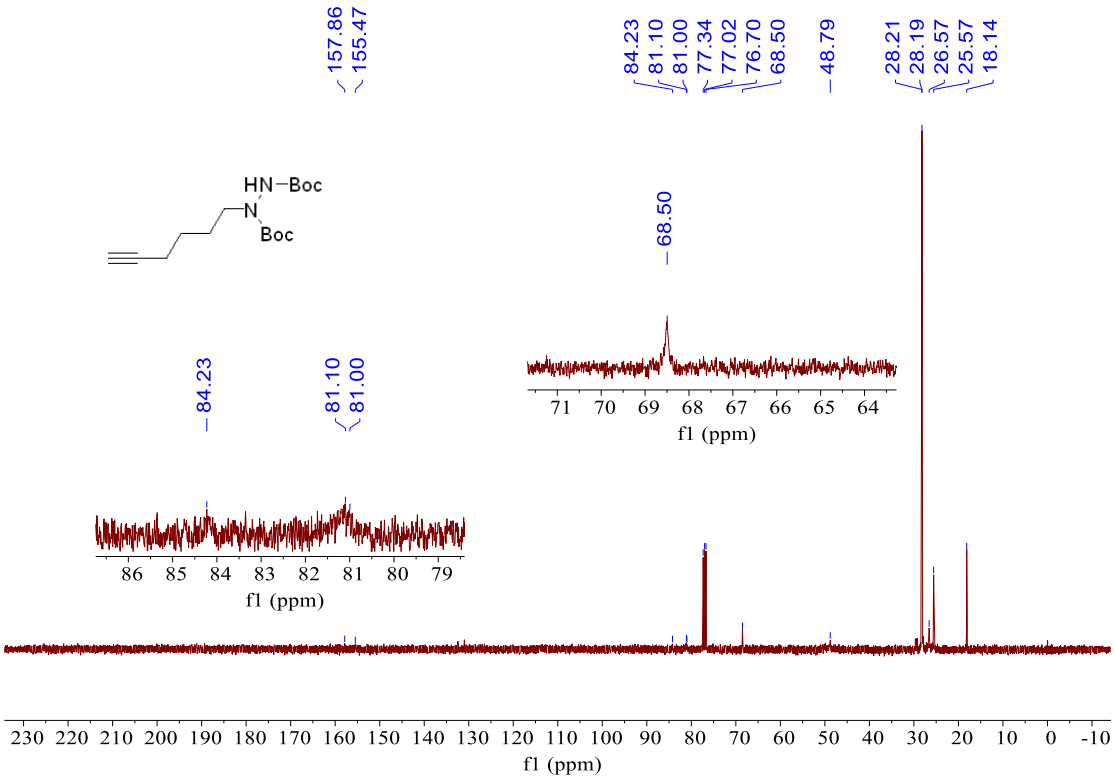
di-tert-butyl 1-(hept-6-en-1-yl)hydrazine-1,2-dicarboxylate (**2ae**)



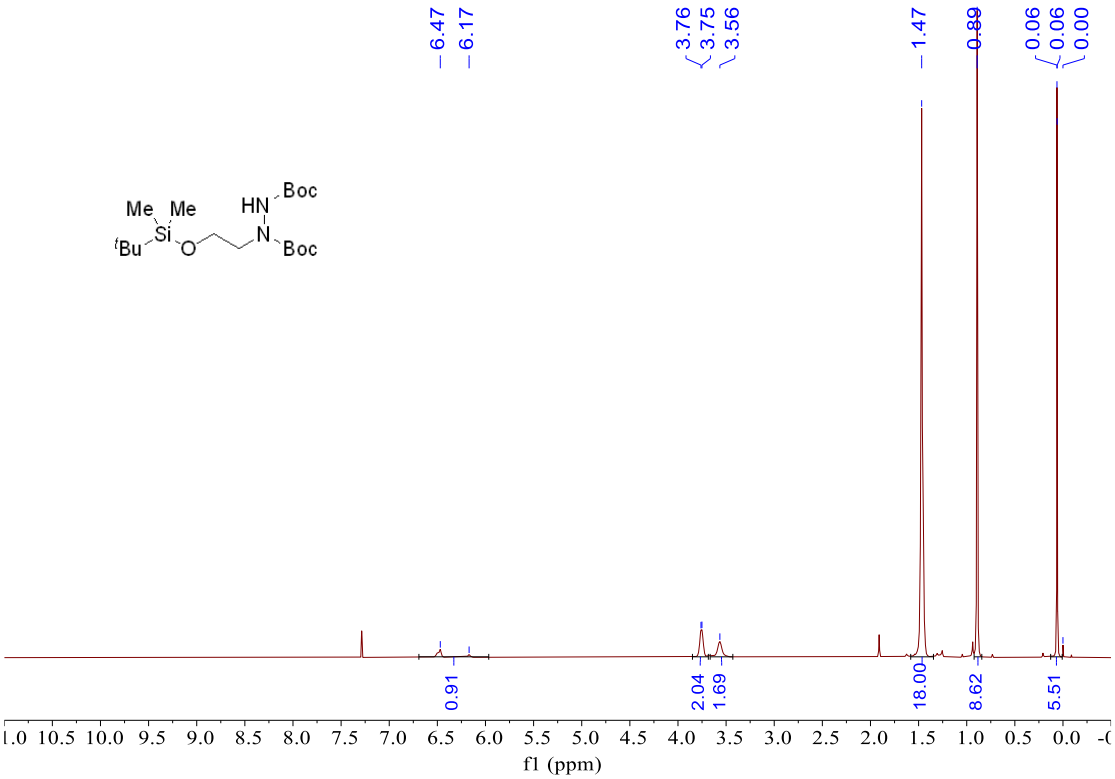


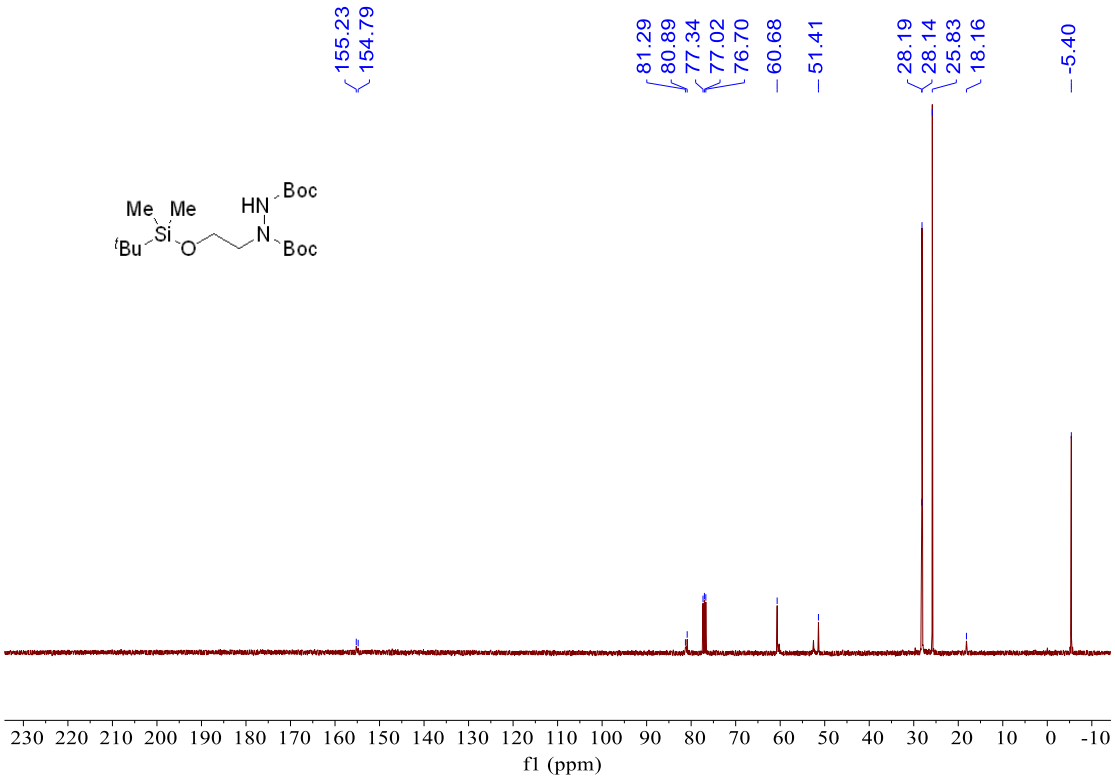
di-tert-butyl 1-(hex-5-yn-1-yl)hydrazine-1,2-dicarboxylate (**2af**)



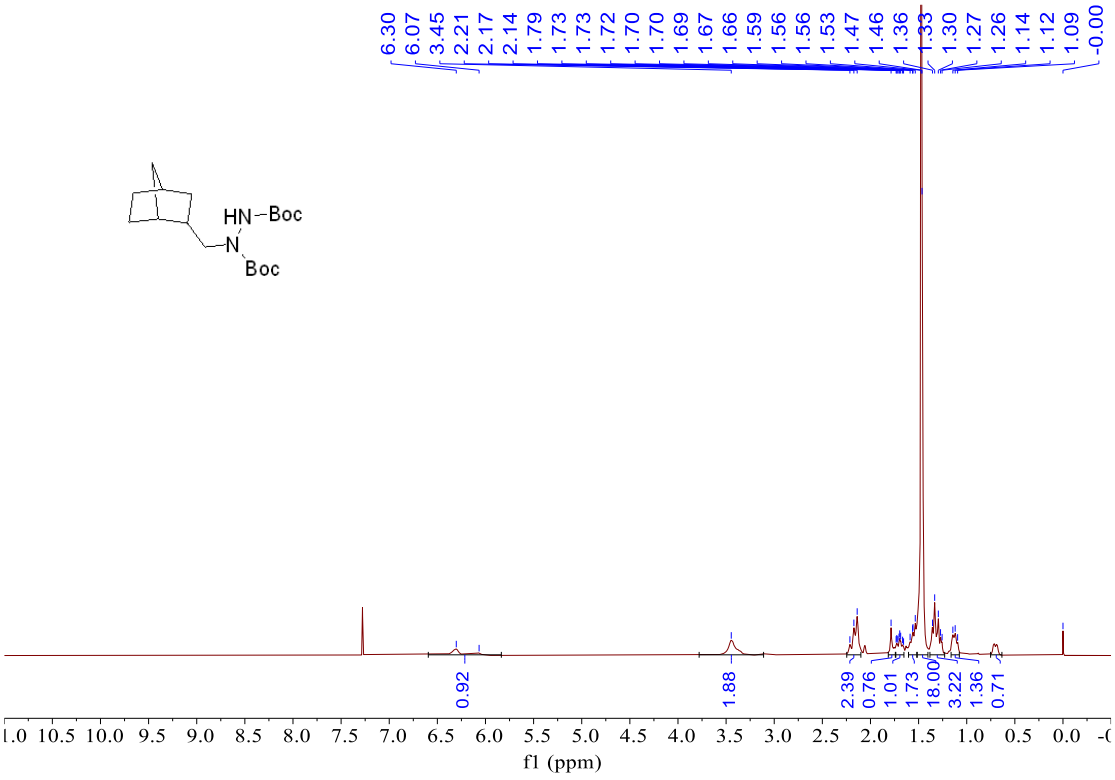


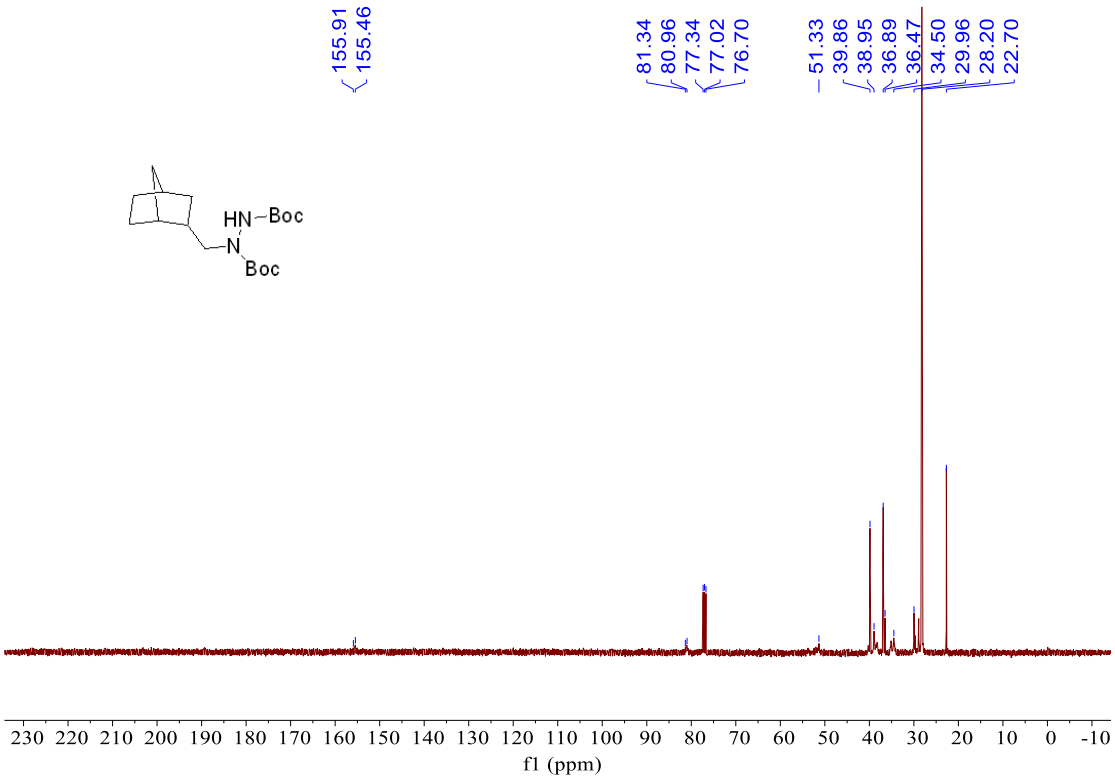
di-tert-butyl 1-(2-((tert-butyldimethylsilyl)oxy)ethyl)hydrazine-1,2-dicarboxylate (**2ag**)



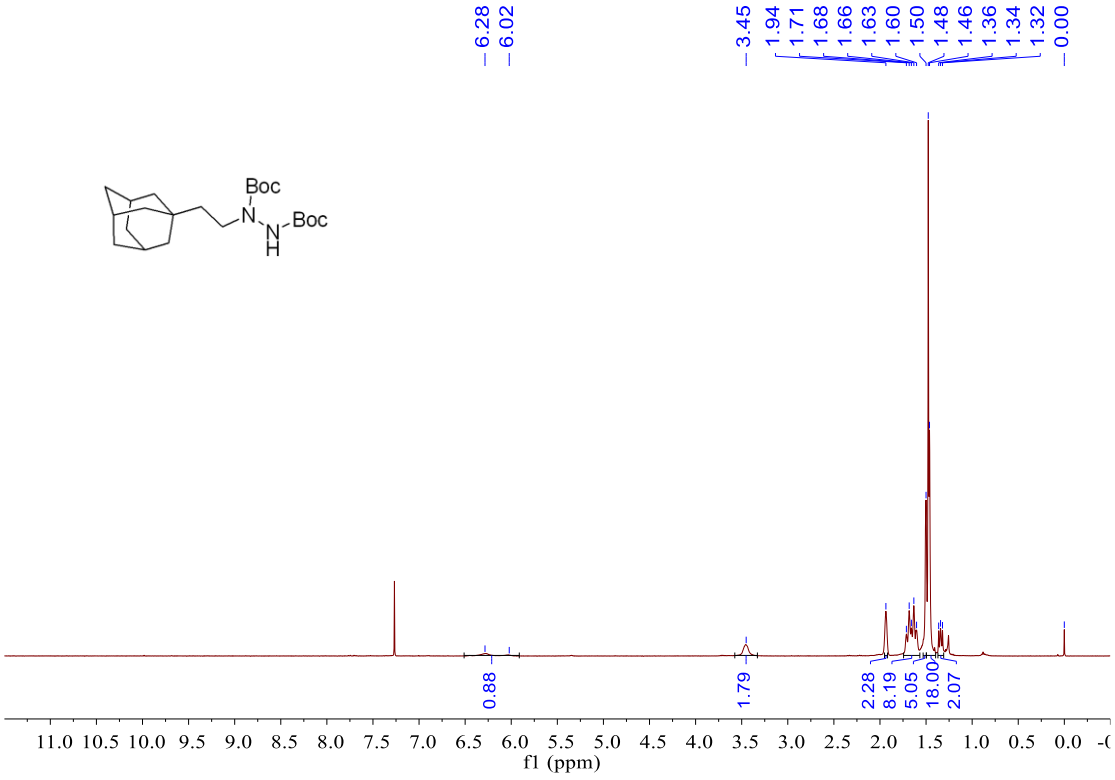


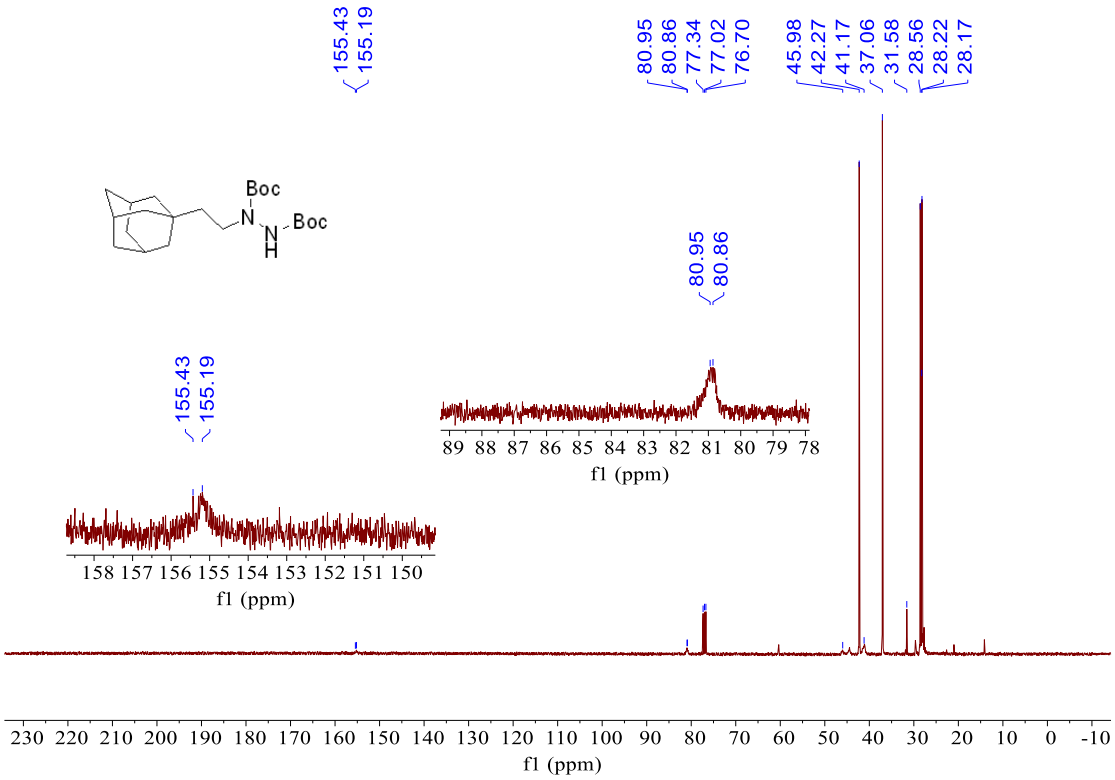
di-tert-butyl 1-(((1R,4S)-bicyclo[2.2.1]heptan-2-yl)methyl)hydrazine-1,2-dicarboxylate (**2ah**)



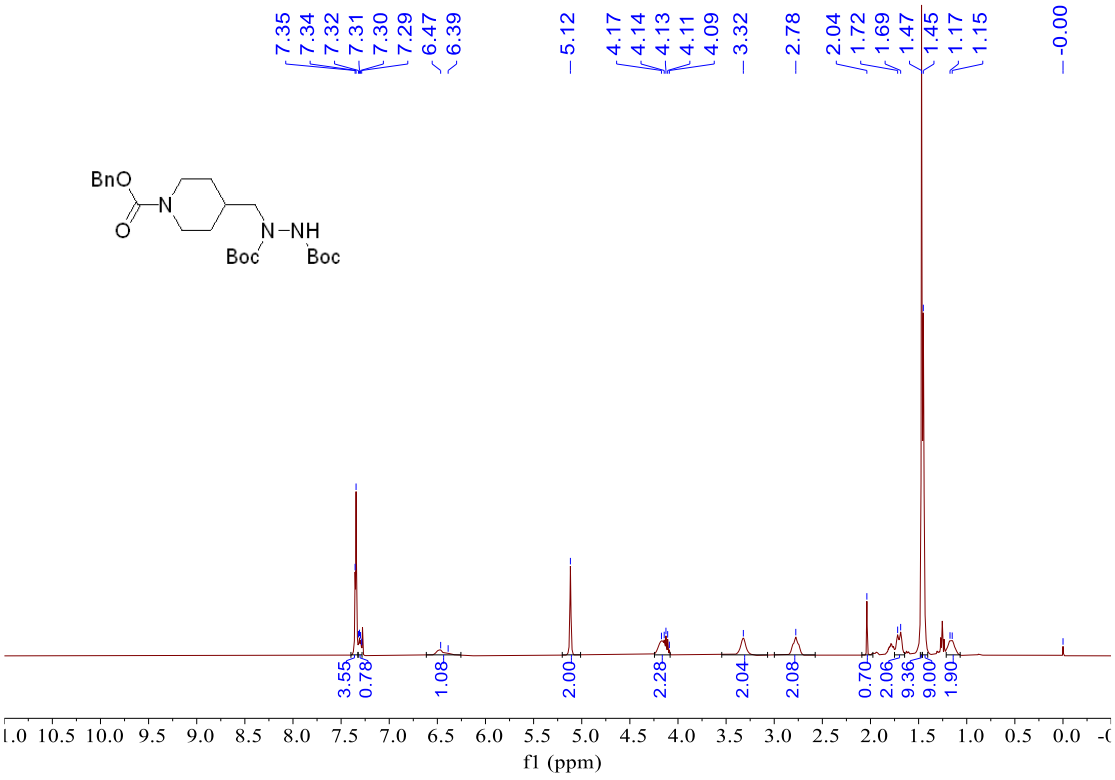


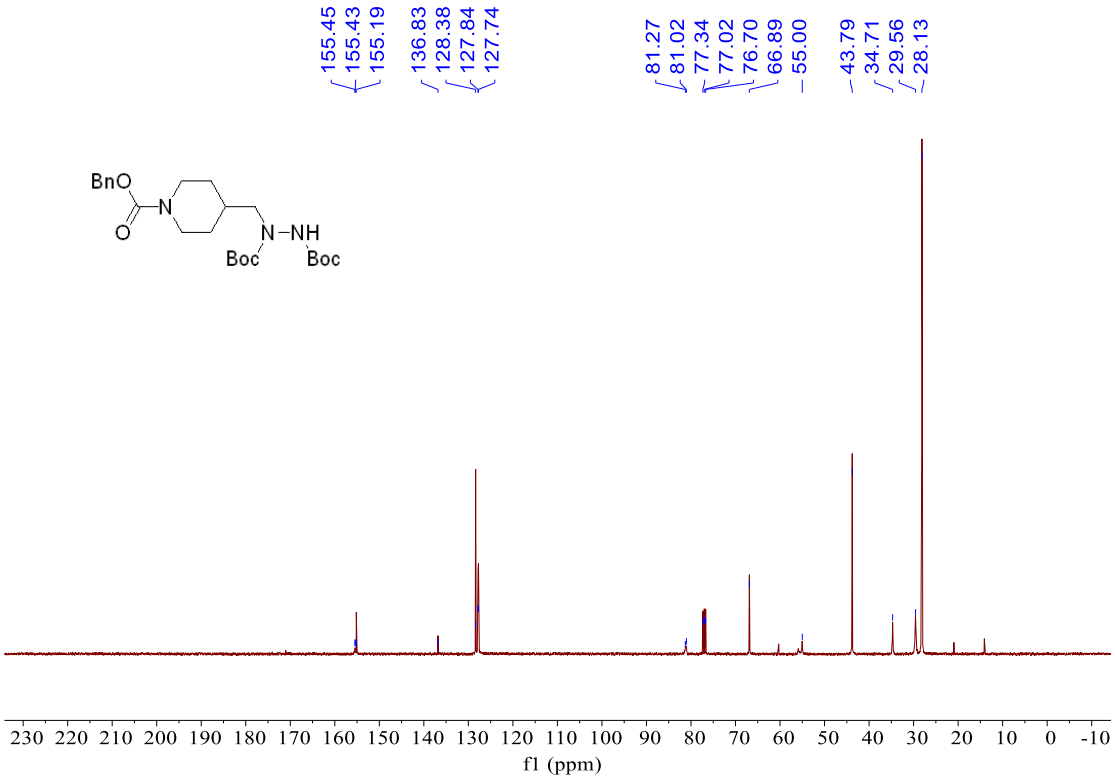
di-tert-butyl 1-(2-((3r,5r,7r)-adamantan-1-yl)ethyl)hydrazine-1,2-dicarboxylate (**2ai**)



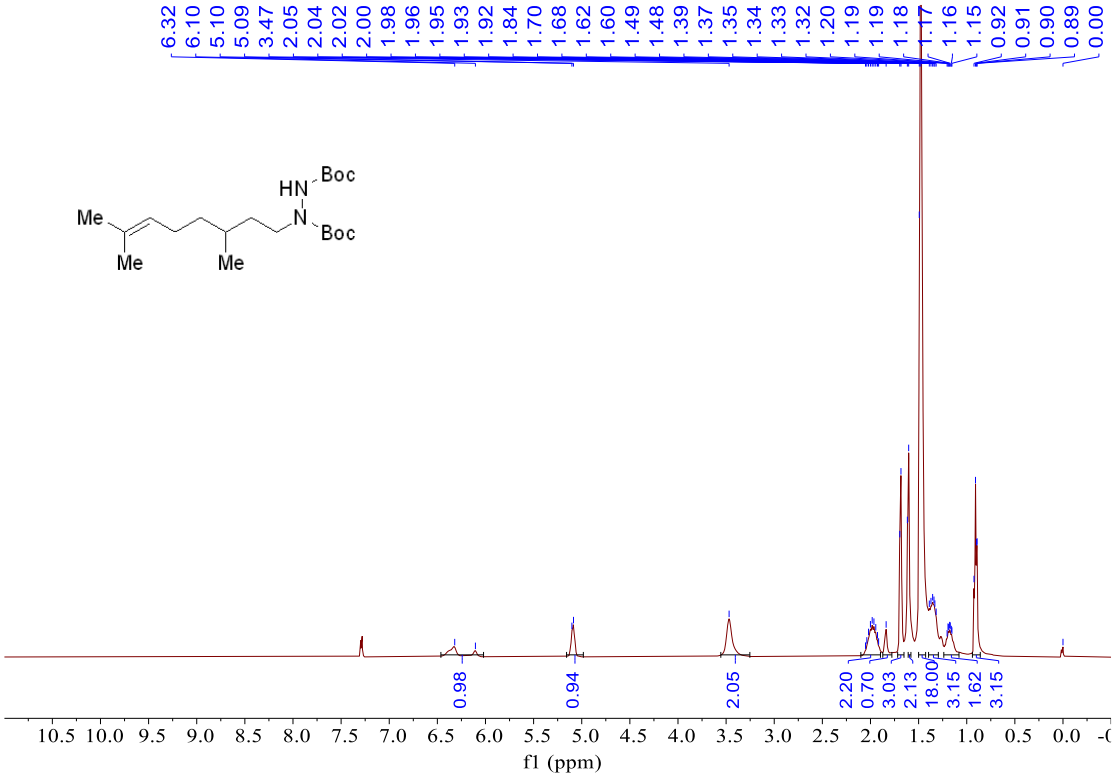


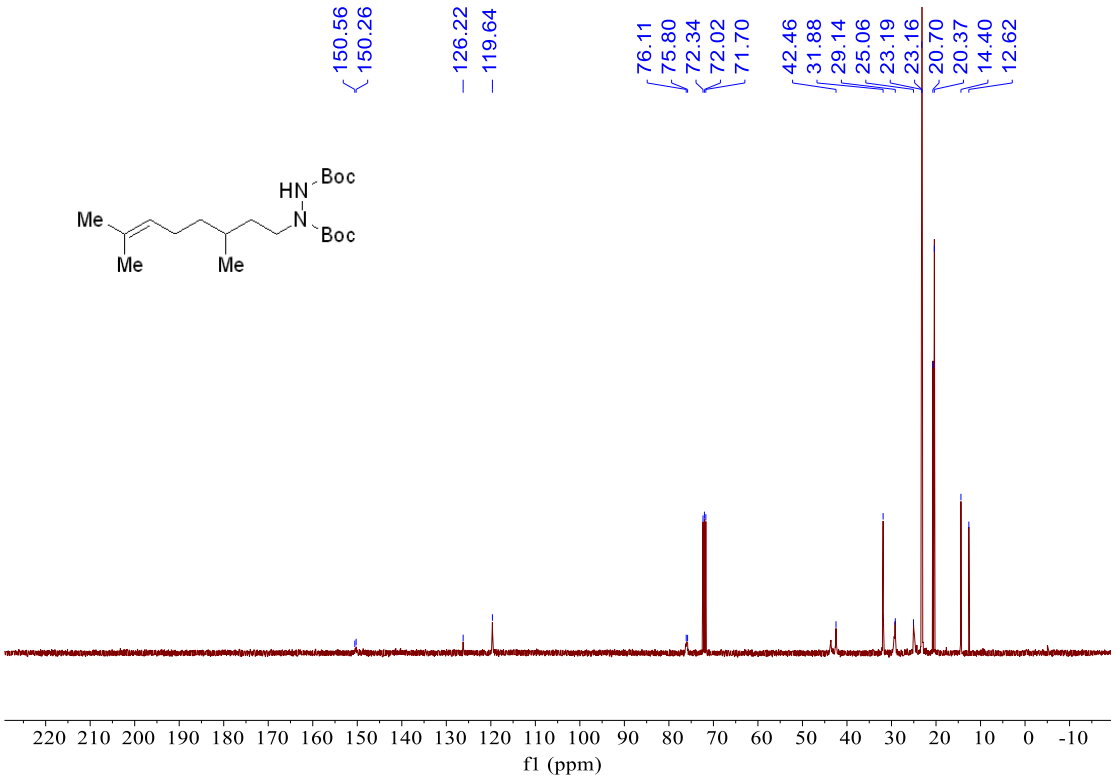
di-tert-butyl 1-((1-((benzyloxy)carbonyl)piperidin-4-yl)methyl)hydrazine-1,2-dicarboxylate (**2aj**)



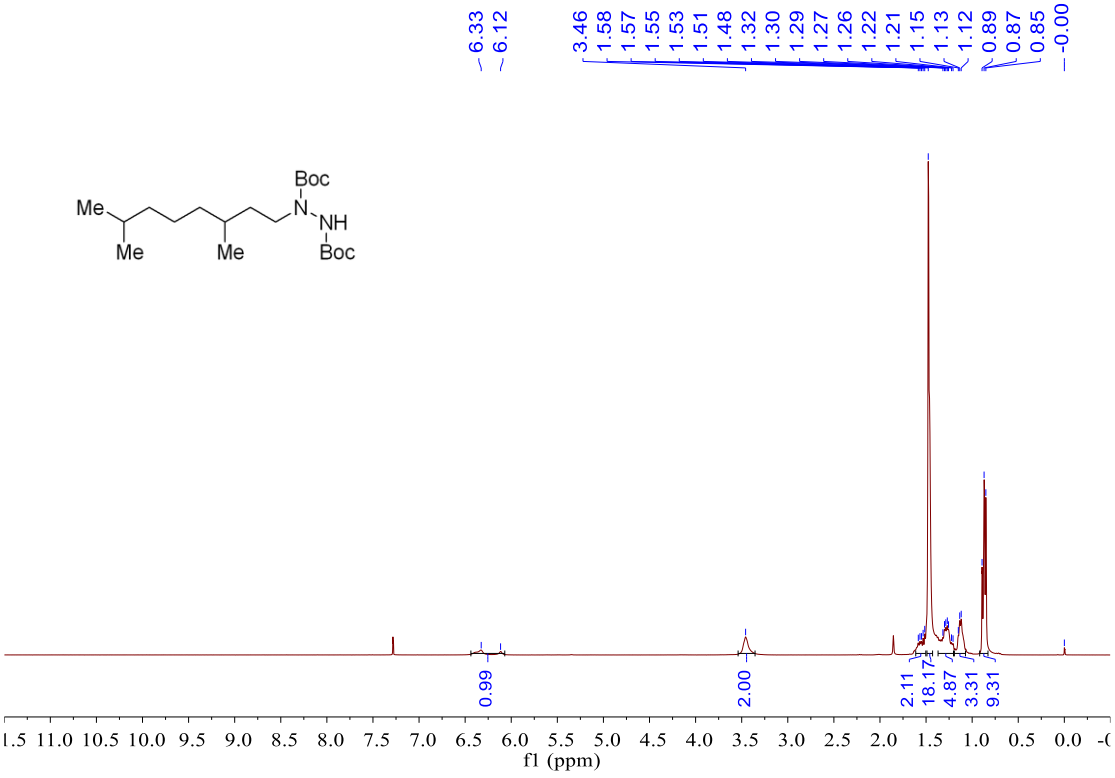


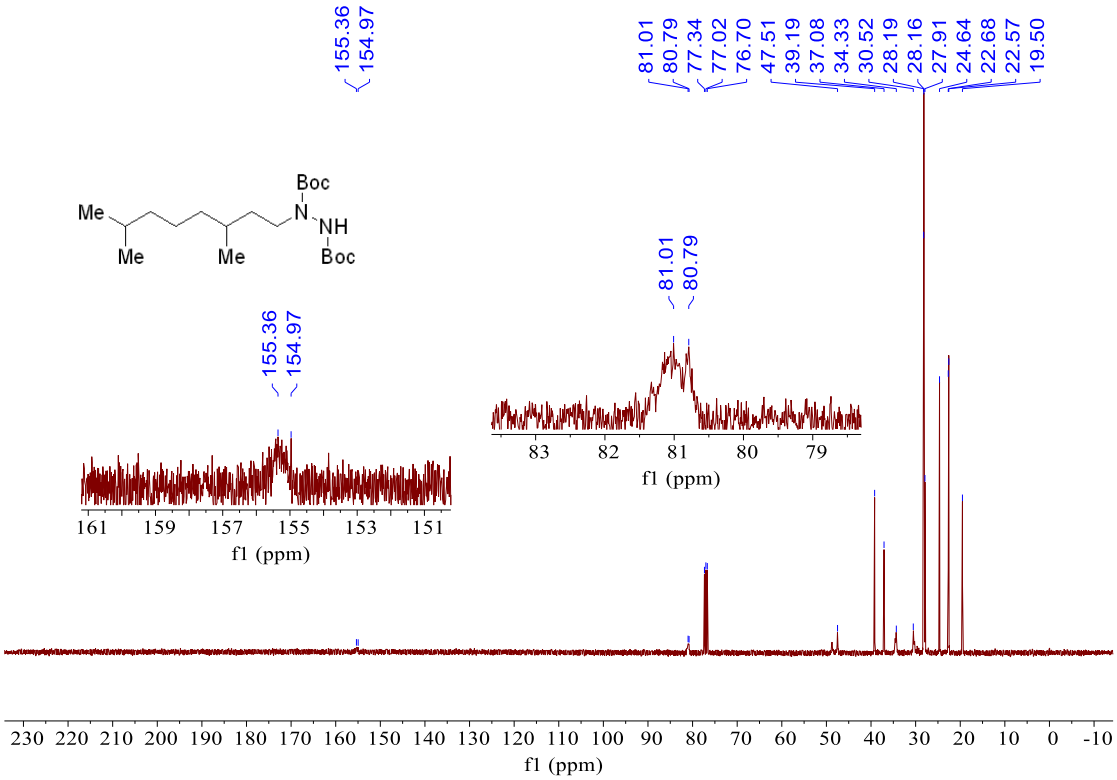
di-tert-butyl 1-(3,7-dimethyloct-6-en-1-yl)hydrazine-1,2-dicarboxylat (**4a**)



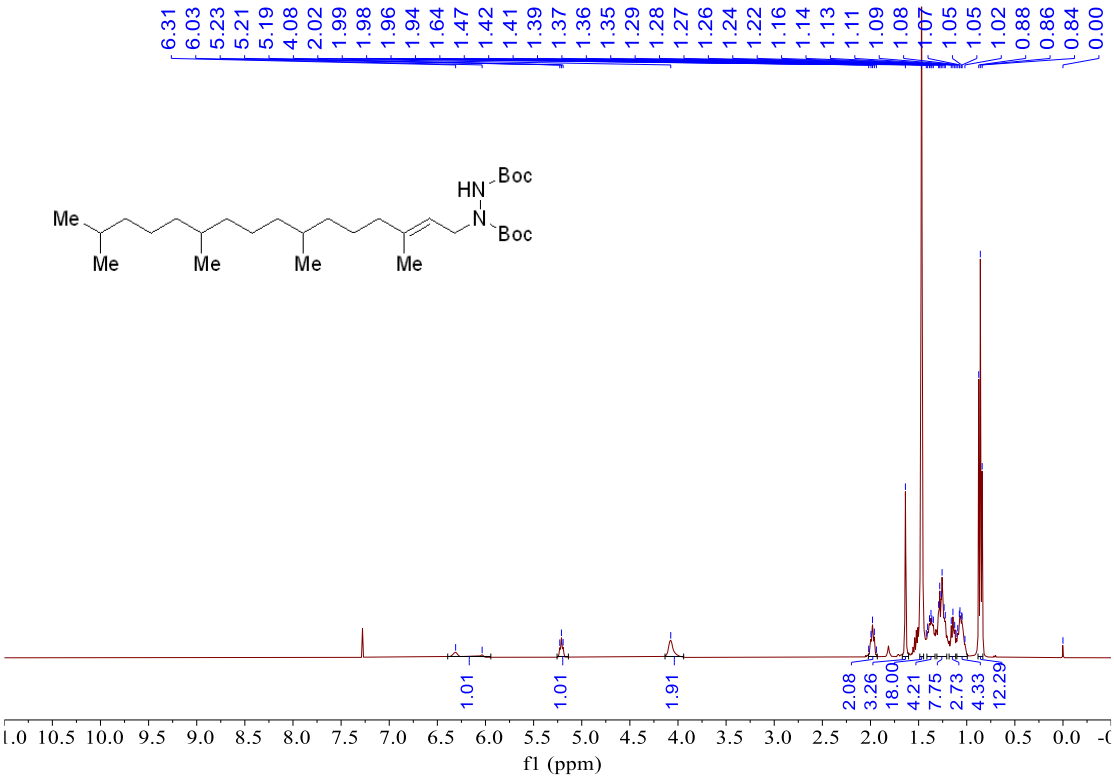


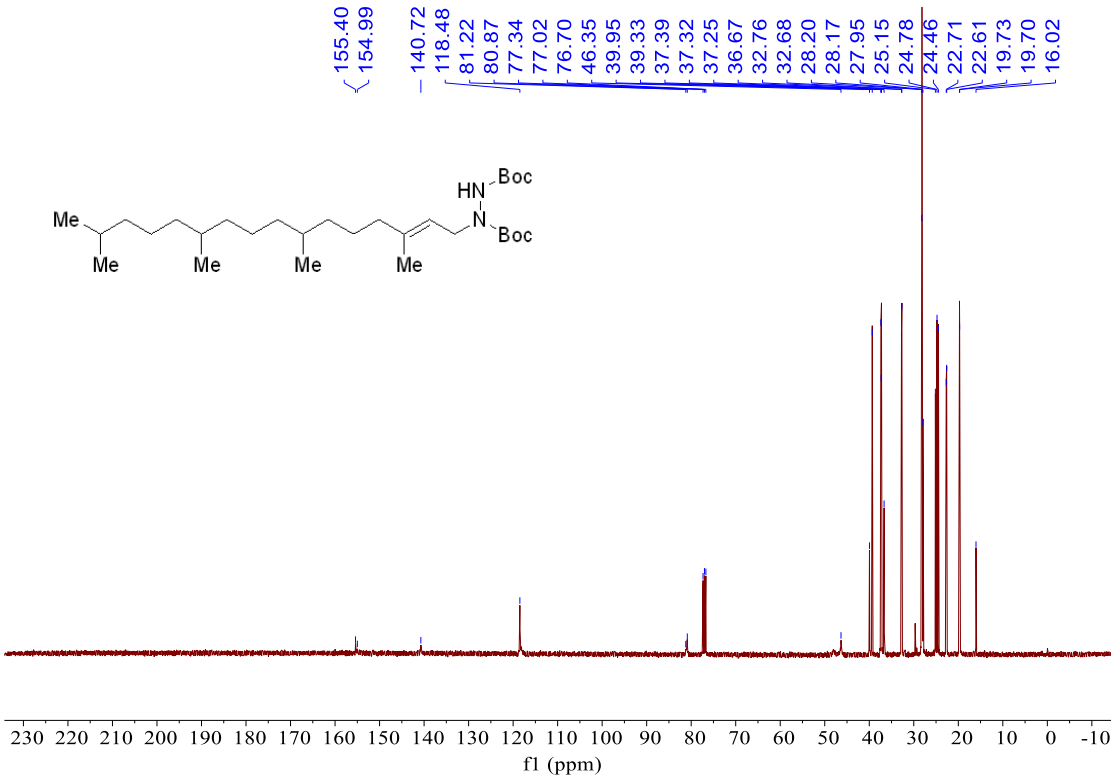
di-tert-butyl 1-(3,7-dimethyloctyl)hydrazine-1,2-dicarboxylate (**4b**)



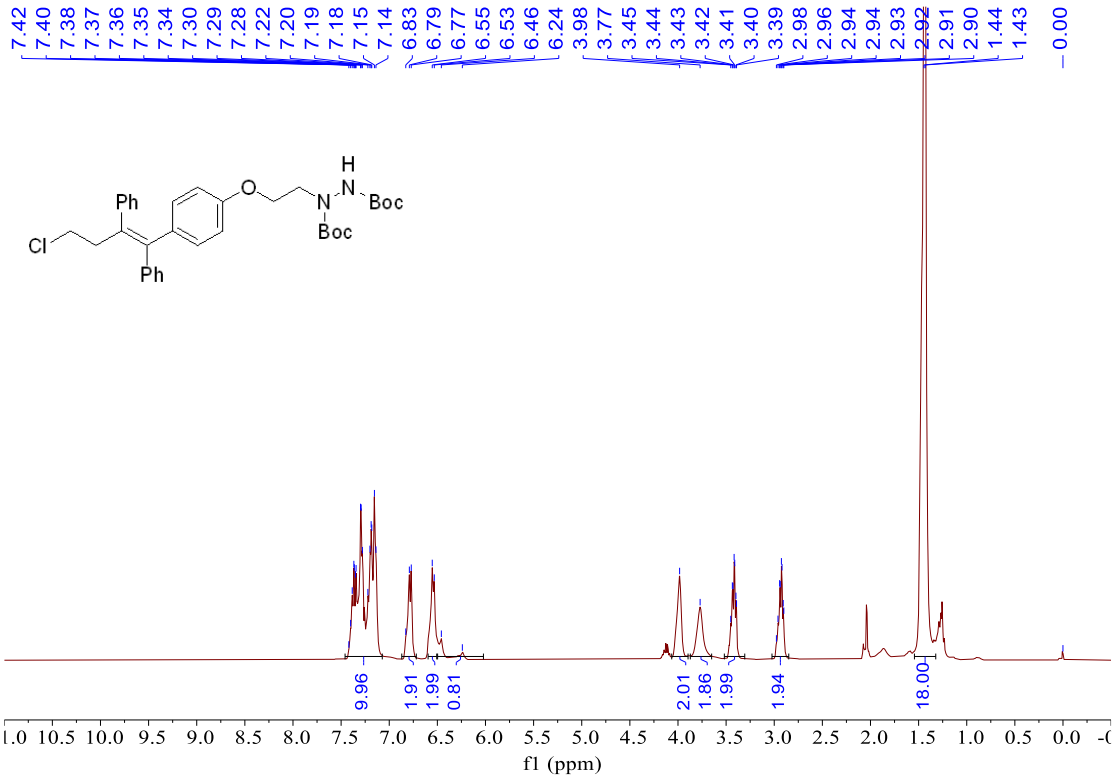


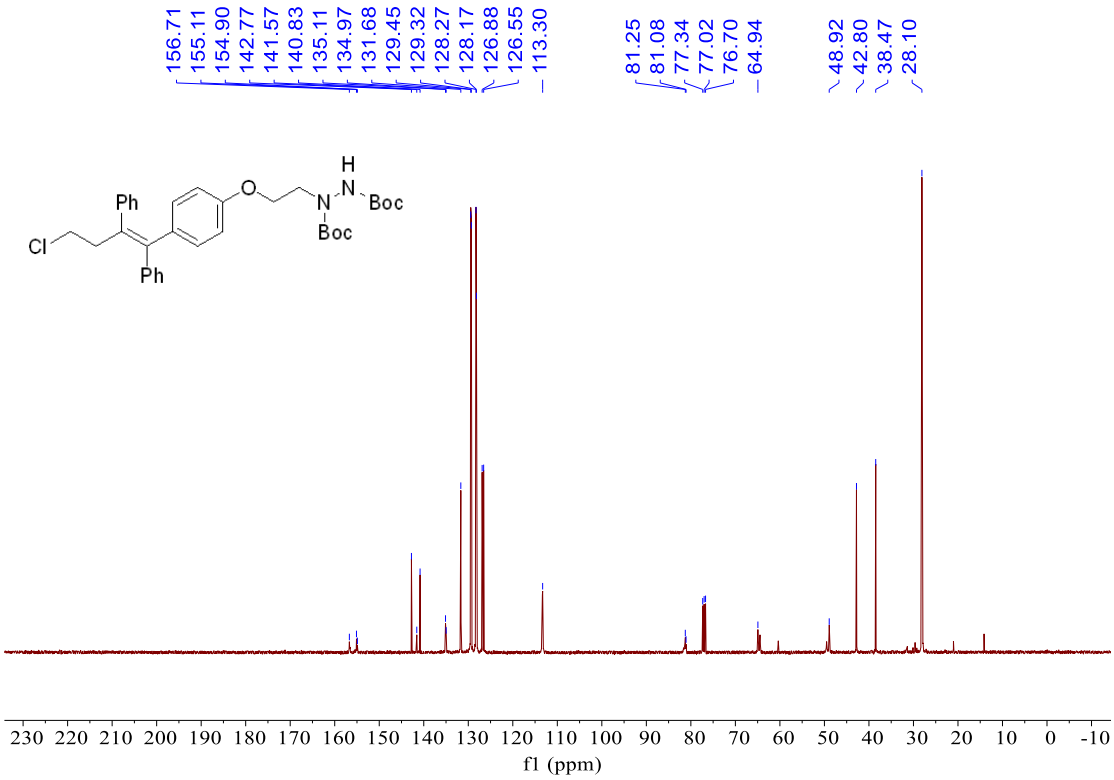
di-tert-butyl (E)-1-(3,7,11,15-tetramethylhexadec-2-en-1-yl)hydrazine-1,2-dicarboxylate (**4c**).



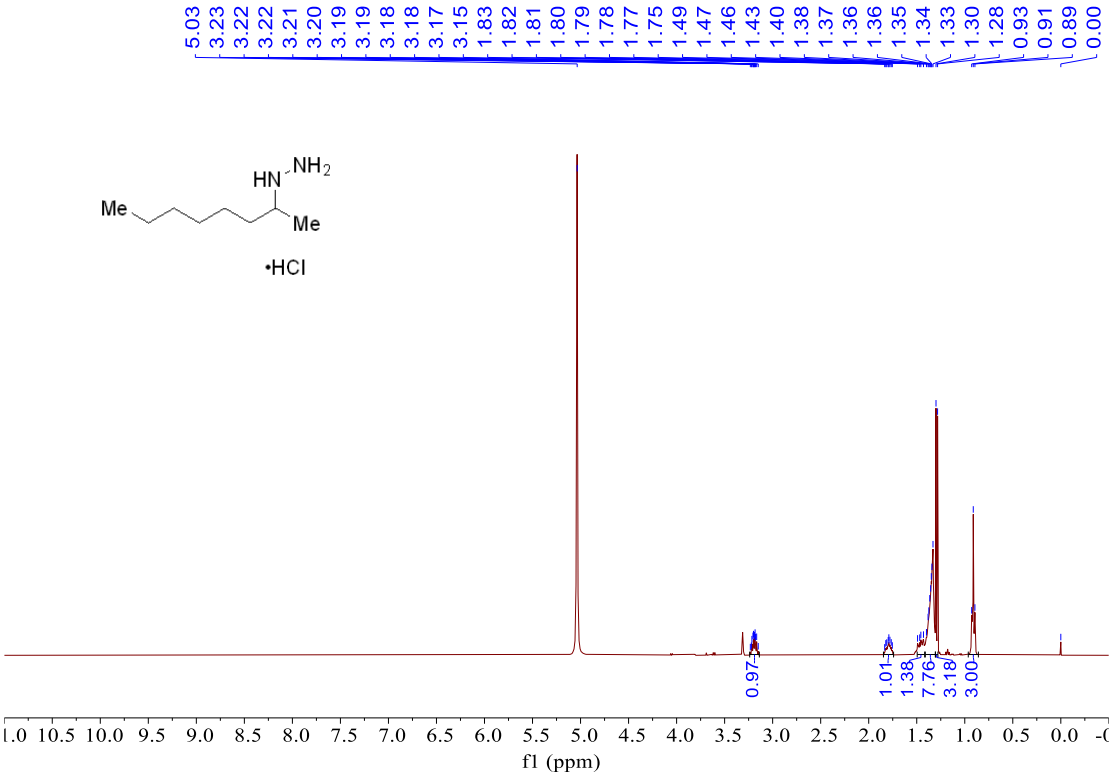


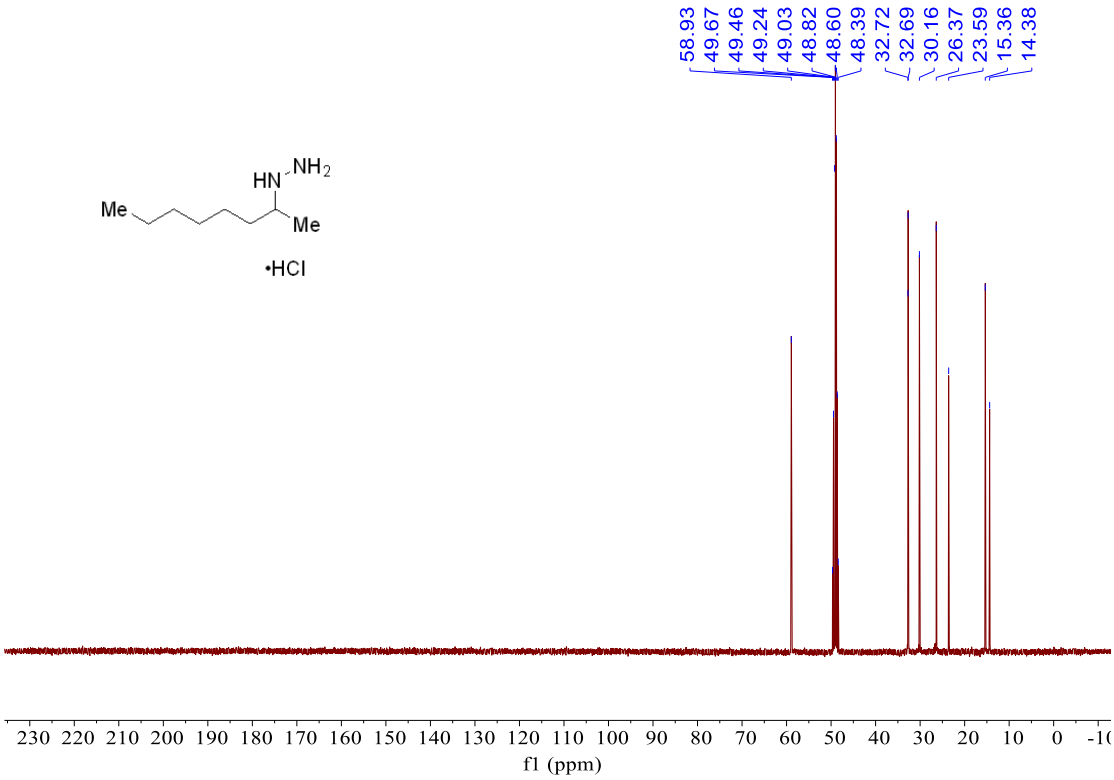
di-tert-butyl(Z)-1-(2-(4-(4-chloro-1,2-diphenylbut-1-en-1-yl)phenoxy)ethyl)hydrazine-1,2-dicarboxylate (**4d**)



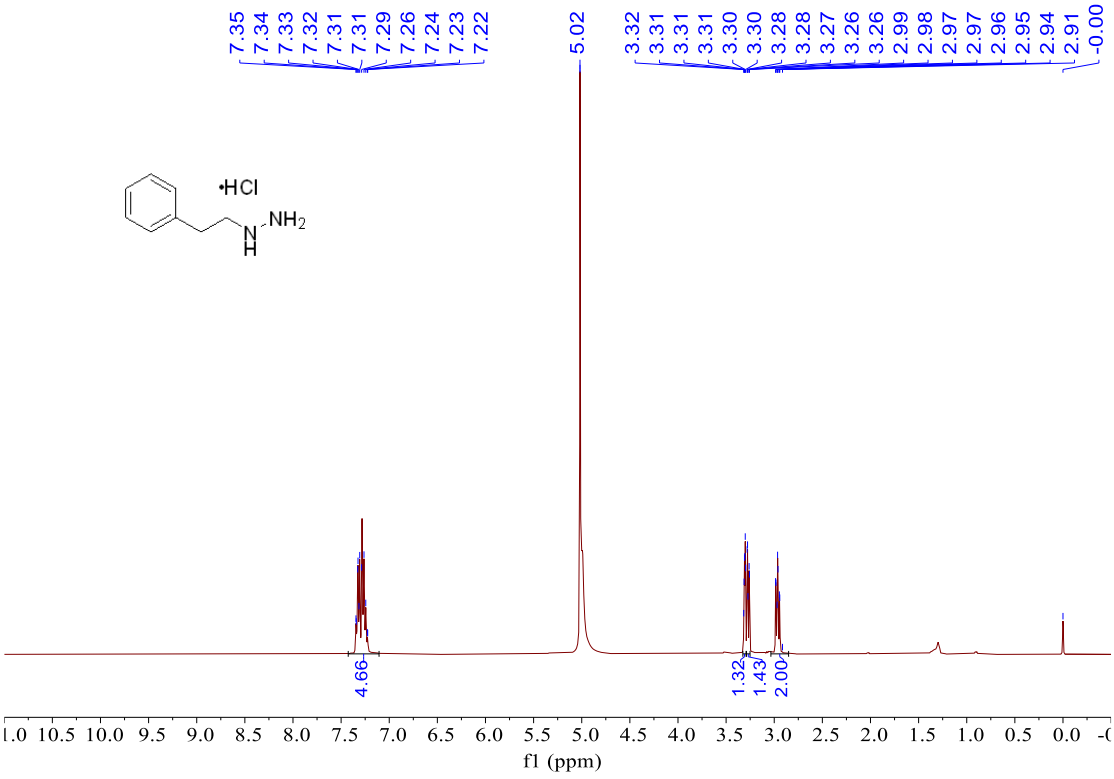


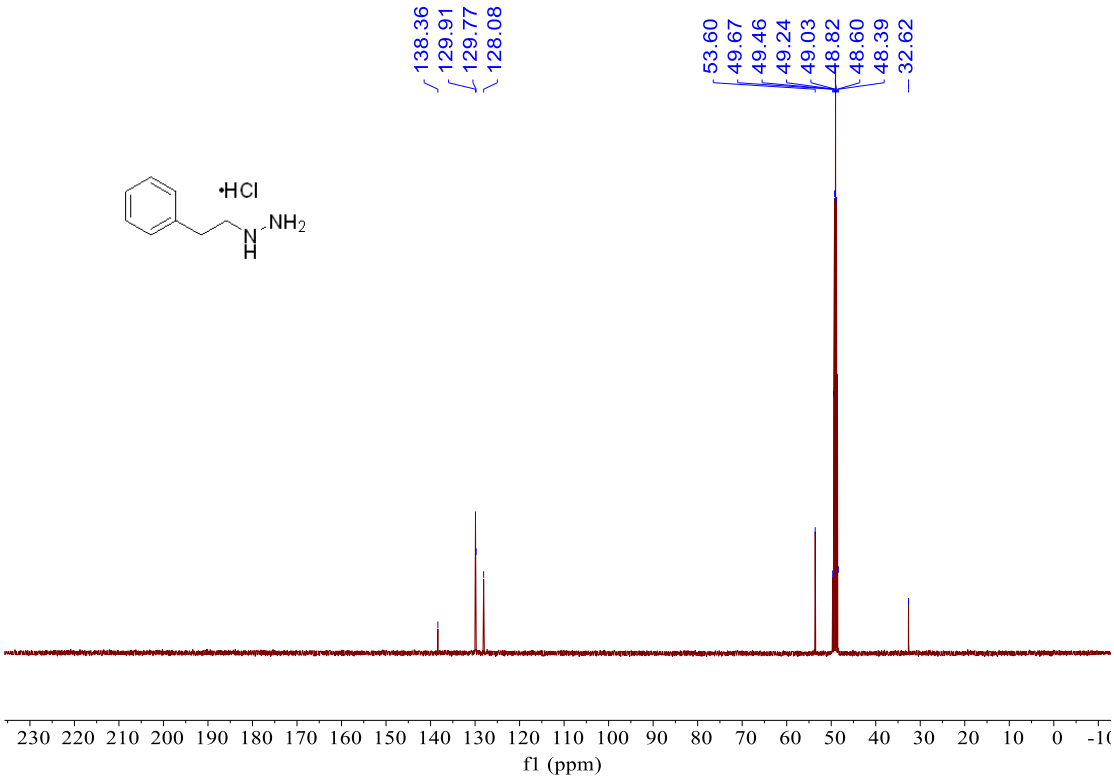
octan-2-ylhydrazine hydrochloride (**5a**)



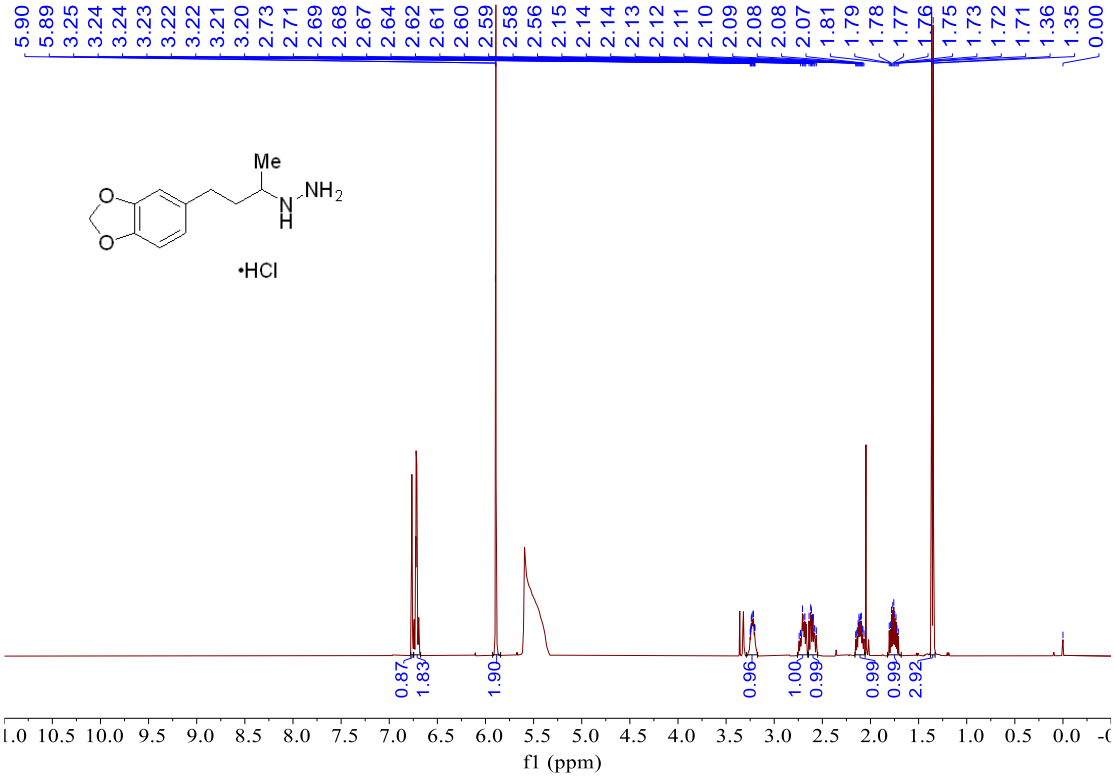


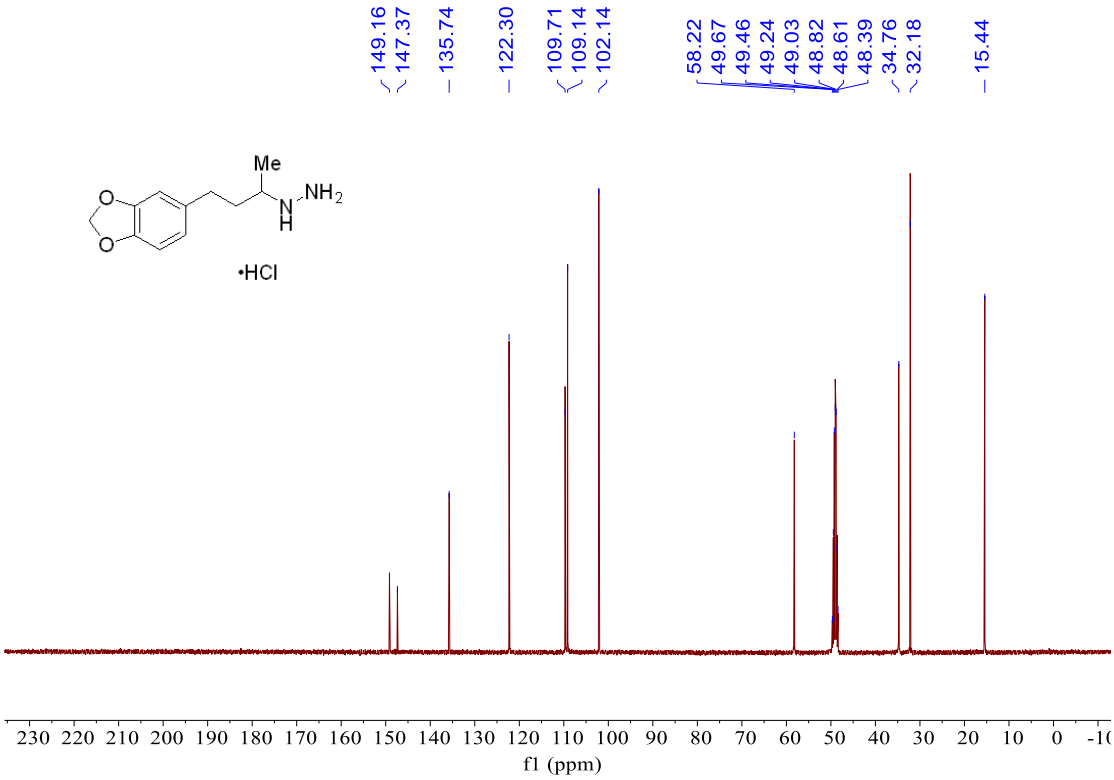
phenethylhydrazine hydrochloride (**5b**)





*(4-(benzo[d][1,3]dioxol-5-yl)butan-2-yl)hydrazine hydrochloride (**5c**)*





7. Reference

1. J. Waser, B. Gaspar, H. Nambu and E. M. Carreira, *J. Am. Chem. Soc.*, 2006, **128**, 11693.
2. V. R. Yatham, P. Bellotti and B. Konig, Chem. Commun., 2019, 55, 3489.
3. G. Feng, X. Wang and J. Jin, *Eur. J. Org. Chem.*, 2019, **2019**, 6728.