Photocatalyzed regioselective arylation of trialkylamines

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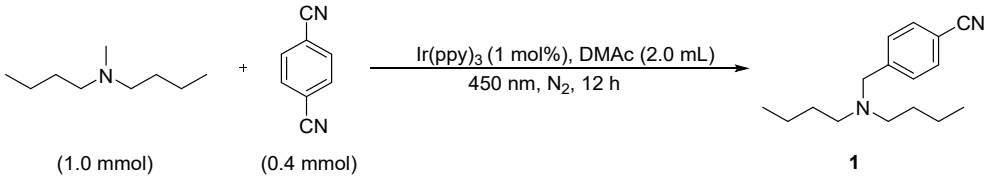
1. General remarks

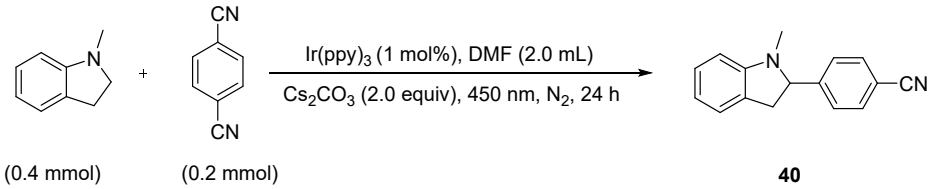
All reactions were conducted in clean glassware with magnetic stirring. Chromatographic purification was performed on silica gel (400~500 mesh) andanalytical thin layer chromatography (TLC) on silica gel HG/T2354–2010 GF254(Qindao), which was detected by fluorescence. ^{1}H NMR, ^{13}C NMR and ^{19}F NMR spectra were measured on a Bruker Avance NMR spectrometer (600 MHz) in $CDCl_3$ as solvent, and tetramethylsilane (TMS; δ = 0.00 ppm) served as an internal standard for ^{1}H NMR. The corresponding deuterated solvent signal ($CDCl_3$; δ = 77.00 ppm) was used as internal standard for ^{13}C NMR. Data for ^{1}H NMR, ^{13}C NMR and ^{19}F NMR are reported as follows: δ, chemical shift; coupling constants (*J* are given in Hertz, Hz) and integration. Abbreviations to denote the multiplicity of a particular signal were s (singlet), d (doublet), t (triplet), q (quartet), and m (multiplet). High resolution mass spectra were obtained with Thermo Scientific LTQ Orbitrap XL mass spectrometer or Thermo Scientific Q Exactive mass spectrometer (ESI). Melting points were determined on a digital melting point apparatus and temperatures were uncorrected.

2. Optimization conditions

General Procedure:

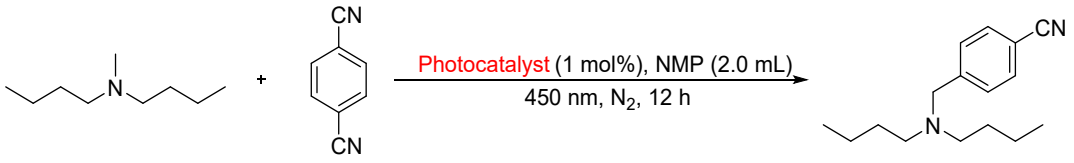


An oven-dried sealed tube equipped with a PTFE-coated stir bar was charged with 1,4-dicyanobenzene (51 mg, 0.4 mmol), $Ir(ppy)_3$ (2 mg, 0.004 mmol) and brought into a N_2-filled glovebox. *N*-butyl-*N*-methylbutan-1-amine (143 mg, 1.0 mmol) was added, followed by DMAc (2 mL). The reaction mixture was stirred under 450 nm LED irradiation for 12 h. The resulting mixture was quenched with sat. NH_4Cl solution (2 mL) and further diluted with water (5 mL). The aqueous layer was extracted with EtOAc (3×5 mL) and the combined organic layers were washed with brine, dried over anhydrous Na_2SO_4, filtered, and concentrated under vacuum. Then the residue was purified by silica gel column chromatography (petroleum ether/EtOAc = 10:1) to obtain pure product (74 mg, 76%).



An oven-dried sealed tube equipped with a PTFE-coated stir bar was charged with 1,4-dicyanobenzene (26 mg, 0.2 mmol), $Ir(ppy)_3$ (1 mg, 0.002 mmol) and brought into a N_2-filled glovebox. 1-Methylindoline (53 mg, 0.4 mmol) was added, followed by DMF (2 mL). The reaction mixture was stirred under 450 nm LED irradiation for 24 h. The resulting mixture was quenched with sat. NH_4Cl solution (2 mL) and further diluted with water (5 mL). The aqueous layer was extracted with EtOAc (3×5 mL) and the combined organic layers were washed with brine, dried over anhydrous Na_2SO_4, filtered, and concentrated under vacuum. Then the residue was purified by silica gel column chromatography (petroleum ether/EtOAc = 10:1) to obtain pure product (40 mg, 86% yield).

Table S1: Screening of photocatalysts[a]

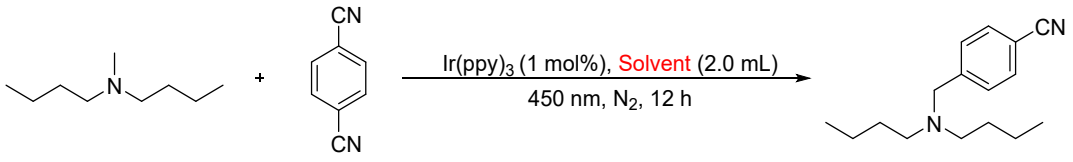


(1.0 mmol) (0.4 mmol) **1**

Entry	Photocatalyst	Yield of **1**[b]
1	$[Ir(dF(CF_3)ppy)_2(bpy)]PF_6$	N.R.[c]
2	$[Ir(dtbbpy)(ppy)_2]PF_6$	51%
3	$[Ir(ppy)_2(bpy)]PF_6$	63%
4	$[Ir(dF(CF_3)ppy)_2(dtbpy)]PF_6$	trace
5	4CzIPN	trace
6	$[Ru(bpy)_3]PF_6$	N.R.[c]
7	$Ir(ppy)_3$	76%
8	--	N.R.[c]

[a] Reaction conditions: *N*-butyl-*N*-methylbutan-1-amine (1.0 mmol), 1,4-dicyanobenzene (0.4 mmol), photocatalyst (1.0 mol%), and NMP (2.0 mL), under Blue LEDs (450 nm, 3 W) irradiation for 12 h. [b] Isolated yield. [c] N.R. = No reaction.

Table S2: Screening of solvents[a]



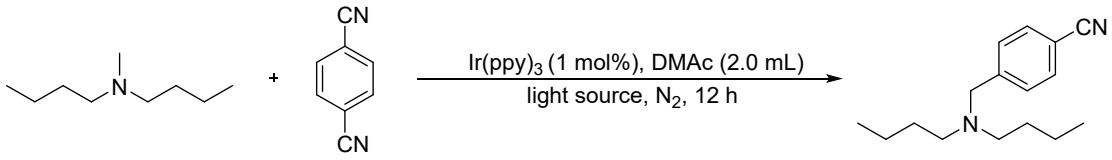
(1.0 mmol) (0.4 mmol) **1**

Entry	Solvent	Yield of **1**[b]
1	CH_3CN	80%
2	DMSO	N.R.[c]
3	DMAc	86%
4	DMF	74%
5	1,4-dioxane	N.R.[c]
6	THF	N.R.[c]

7	DCM	N.R.[c]
8	Cy	N.R.[c]

[a] Reaction conditions: *N*-butyl-*N*-methylbutan-1-amine (1.0 mmol), 1,4-dicyanobenzene (0.4 mmol), $Ir(ppy)_3$ (1.0 mol%), and Solvent (2.0 mL), under Blue LEDs (450 nm, 3 W) irradiation for 12 h. [b] Isolated yield. [c] N.R. = No reaction.

Table S3: Screening of light source[a]

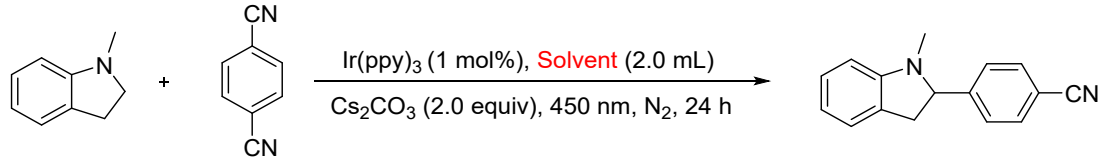


(1.0 mmol) (0.4 mmol) **1**

Entry	Light source	Yield of **1**[b]
1	390 nm	68%
2	420 nm	65%
3	425 nm	75%
4	520 nm	60%
5	540 nm	60%
6	dark	N.R.[c]

[a] Reaction conditions: *N*-butyl-*N*-methylbutan-1-amine (1.0 mmol), 1,4-dicyanobenzene (0.4 mmol), $Ir(ppy)_3$ (1.0 mol%), and DMAc (2.0 mL), under Blue LEDs (450 nm, 3 W) irradiation for 12 h. [b] Isolated yield. [c] N.R. = No reaction.

Table S4: Screening of solvent for the reaction of benzonitrile and 1-methylindoline[a]



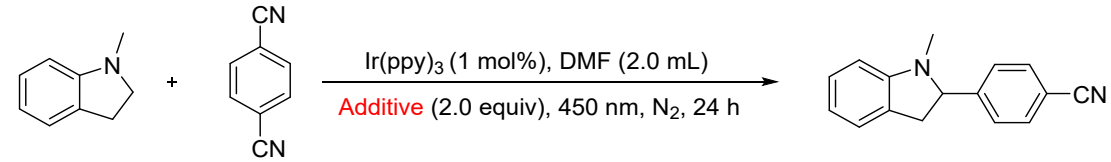
(0.4 mmol) (0.2 mmol) **40**

Entry	Solvent	Yield of **40**[b]

1	CH_3CN	N.R.[c]
2	DMSO	30%
3	DMAc	58%
4	DMF	65%
5	1,4-dioxane	N.R.[c]
6	THF	trace
7	DCM	N.R.[c]
8	Cy	N.R.[c]

[a] Reaction conditions: 1-methylindoline (0.4 mmol), 1,4-dicyanobenzene (0.2 mmol), $Ir(ppy)_3$ (1.0 mol%), and Solvent (2.0 mL), under Blue LEDs (450 nm, 3 W) irradiation for 24 h. [b] Yield of the isolated product. [c] N.R. = No reaction.

Table S5: Screening of additive for the reaction of benzonitrile and 1-methylindoline[a]



(0.4 mmol) (0.2 mmol) **40**

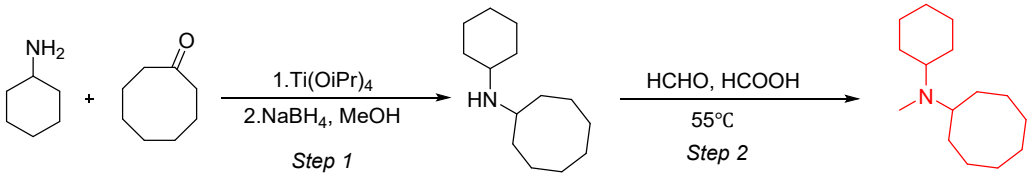
Entry	Additive	Yield of **40**[b]
1	Cs_2CO_3	87%
2	K_2CO_3	83%
3	HEH	N.R.[c]
4	$MgCl_2$	29%
5	$NaBF_4$	21%
6	Et_3N	77%
7	NaOAc	76%
8	NaI	N.R.[c]

[a] Reaction conditions: 1-methylindoline (0.4 mmol), 1,4-dicyanobenzene (0.2 mmol), $Ir(ppy)_3$ (1.0 mol%), and DMF (2.0 mL), Additive (2.0 equiv), under Blue LEDs (450 nm, 3 W) irradiation for 24 h. [b] Yield of the isolated product. [c] N.R. = No reaction.

3. Starting materials preparation and characterization data

3.1. Tertiary amine

3.1.1. Synthesis of tertiary amine substrate [1]



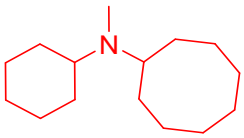
Step 1

To a round-bottom flask was added cyclohexylamine (3.0 g, 30 mmol, 1.0 equiv.) and cyclooctanone (3.4 g, 30 mmol, 1.0 equiv.), then $Ti(O^iPr)_4$ (10.7 mL, 36 mmol, 1.2 equiv.) was added to the stirring mixture. The reaction mixture was stirred at room temperature for 2 hours. After that, MeOH (100 mL) was added, and the reaction mixture was cooled to 0 °C. Then $NaBH_4$ (1.1 g, 30 mmol, 1.0 equiv.) was added for several portions at 0 °C, and the reaction mixture was stirred at room temperature for 2 h. After completion, the mixture was quenched by aqueous NH_4Cl, then concentrated to remove MeOH. Aqueous NaOH (1 M, 60 mL) was added, and the reaction mixture was extracted with EtOAc (3 × 50 mL). The organic layer was separated, dried over anhydrous Na_2SO_4 and concentrated in vacuum to give the desired product as a colorless oil, which was directly used in the next step without further purification.

Step 2

The formic acid (2.8 g, 60 mmol, 2.0 equiv.) was added dropwise to a mixture of secondary amine substrate (from *Step 1*, 30 mmol) and 37% solution of formaldehyde (2.7 g, 33 mmol, 1.1 equiv.) at 0 °C. The mixture was heated at 50-55 °C for 5 hours. After cooling to room temperature, aqueous NaOH (1 M, 90 mL) was added, and the reaction mixture was extracted with EtOAc (3 × 50 mL). The organic layer was separated, dried over anhydrous Na_2SO_4, concentrated, and purified by column chromatography (DCM/MeOH/Et_3N = 10:1:0.01) to give amine as a colorless oil (3.8 g, 57% yield over 2 steps).

***N*-cyclohexyl-*N*-methylcyclooctanamine**

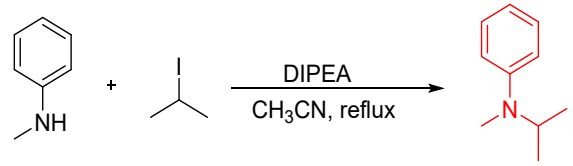


^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 2.75 (td, *J* = 8.9, 3.1 Hz, 1H), 2.24 (tt, *J* = 10.7, 3.5 Hz, 1H), 2.07 (s, 3H), 1.80–1.27 (m, 19H), 1.21–1.02 (m, 4H), 0.99 (ddd, *J* = 12.3, 9.7, 3.6 Hz, 1H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 59.9, 58.3, 32.6, 31.0, 30.7, 26.7, 26.6, 26.3, 26.0, 25.6.

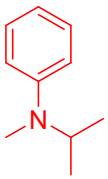
HRMS (ESI) calcd for $C_{15}H_{30}N$ $[M+H]^+$: 224.2373; Found: 224.2369.

3.1.2. Preparation of tertiary amine substrate [1]



To a 100 mL round-bottom flask was added N-methylaniline (20 mmol, 1.0 equiv.), isopropyl iodide (30 mmol, 1.5 equiv.), DIPEA (40 mmol, 2.0 equiv.), and CH_3CN (25 mL). The mixture was allowed to stirring at refluxing temperature for 24 hours. After that, the reaction mixture was cooled to room temperature. Aqueous NaOH (1 M, 60 mL) was added, and the reaction mixture was extracted with EtOAc (3 × 30 mL). The organic layer was separated, washed with aqueous $Na_2S_2O_3$ The organic layer was separated, dried over anhydrous Na_2SO_4, concentrated, and purified by column chromatography (DCM/MeOH/Et_3N = 10:1:0.01) to give amine (1.1 g, 35% yield).

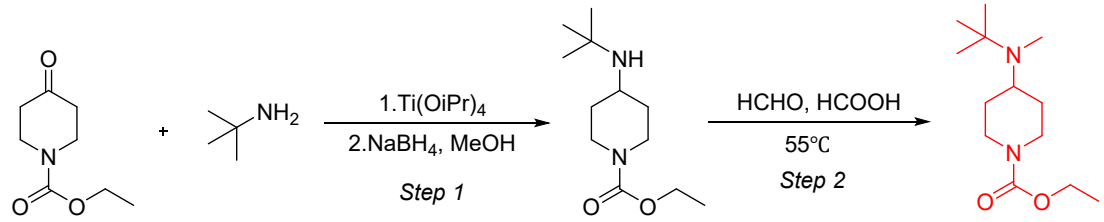
***N*-isopropyl-*N*-methylaniline**



^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.25 (t, 2H), 6.81 (d, *J* = 8.1 Hz, 2H), 6.71 (t, *J* = 7.2 Hz, 1H), 4.29–3.90 (m, 1H), 2.74 (s, 3H), 1.18 (d, *J* = 6.7, 1.4 Hz, 6H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 150.3, 129.2, 116.5, 113.4, 49.0, 29.8, 19.4.

3.1.3. Preparation of tertiary amine substrate [1]



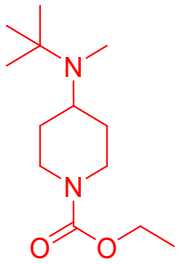
Step 1

To a round-bottom flask was added tert-butylamine (2.1 mL, 20 mmol, 2.0 equiv.) and N-Carbethoxy-4-Piperidone (1.8 g, 10 mmol, 1.0 equiv.), then $Ti(O^iPr)_4$ (3.6 mL, 12 mmol, 1.2 equiv.) was added to the stirring mixture. The reaction mixture was stirred at room temperature for 2 hours. After that, MeOH (40 mL) was added, and the reaction mixture was cooled to 0 °C. Then $NaBH_4$ (370 mg, 10 mmol, 1.0 equiv.) was added for several portions at 0 °C, and the reaction mixture was stirred at room temperature for 2 h. After completion, the mixture was quenched by aqueous NH_4Cl, then concentrated to remove MeOH. Aqueous NaOH (1 M, 20 mL) was added, and the reaction mixture was extracted with EtOAc (3 × 20 mL). The organic layer was separated, dried over anhydrous Na_2SO_4 and concentrated in vacuum to give the desired product, which was directly used in the next step without further purification.

Step 2

The formic acid (1.9 g, 40 mmol, 4.0 equiv.) was added dropwise to a mixture of diamine substrate (from *Step 1*, 30 mmol) and 37% solution of formaldehyde (1.8 g, 22 mmol, 2.2 equiv.) at 0 °C. The mixture was heated at 50-55 °C for 5 hours. After cooling to room temperature, aqueous NaOH (2 M, 30 mL) was added, and the reaction mixture was extracted with EtOAc (3 × 20 mL). The organic layer was separated, dried over anhydrous Na_2SO_4, concentrated, and purified by column chromatography (DCM/MeOH/Et_3N = 10:1:0.01) to give amine (840 mg, 45% yield over 2 steps).

ethyl 4-(tert-butyl(methyl)amino)piperidine-1-carboxylate

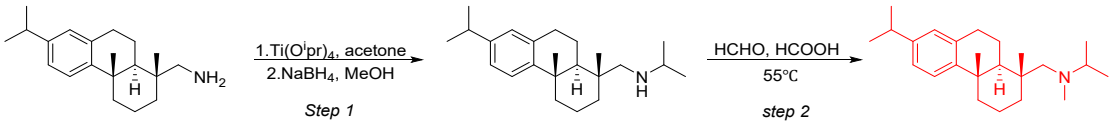


^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 4.22–3.97 (m, 4H), 3.02–2.77 (m, 1H), 2.67 (s, 2H), 2.14 (s, 3H), 1.50 (d, J = 4.1 Hz, 3H), 1.28–1.13 (m, 4H), 1.04 (s, 9H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 155.4, 61.1, 54.7, 54.2, 44.0, 30.0, 29.2, 27.6, 14.7.

HRMS (ESI) calcd for $C_{13}H_{27}N_2O_2$ $[M+H]^+$: 243.2067; Found: 243.2062.

3.1.4. Preparation of tertiary amine substrate [4]



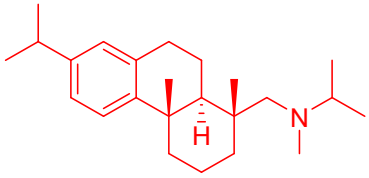
Step 1

To a round-bottom flask was added dehydroabietylamine (5.7 g, 20 mmol, 1.0 equiv.) and acetone (10 mL), then $Ti(O^iPr)_4$ (7.1 mL, 24 mmol, 1.2 equiv.) was added to the stirring mixture. The reaction mixture was stirred at room temperature for 2 hours. After that, the mixture was concentrated to remove acetone, then MeOH (100 mL) was added, and the mixture was cooled to 0 °C. Then $NaBH_4$ (0.76 g, 20 mmol, 1.0 equiv.) was added in several portions at 0 °C, and the reaction mixture was stirred at room temperature for 2 hours. After completion, the mixture was quenched by aq. NH_4Cl, then concentrated to remove MeOH. Aq. NaOH (1 M, 40 mL) was added, and the reaction mixture was extracted with EtOAc (3 × 50 mL). The organic layer was separated, dried over anhydrous Na_2SO_4 and concentrated in vacuum to give the desired product as a colorless oil, which was directly used in the next step without further purification.

Step 2

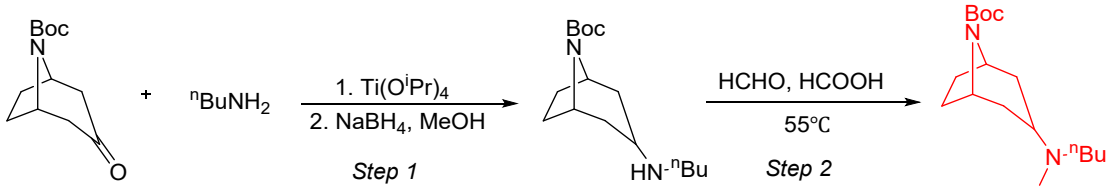
The formic acid (1.9 g, 40 mmol, 2.0 equiv.) was added dropwise to a mixture of secondary amine substrate (from *Step 1*, 20 mmol) and 37% solution of formaldehyde (1.8 g, 22 mmol, 1.1 equiv.) at 0 °C. The mixture was heated at 55 °C for 5 hours. After cooling to room temperature, aq. NaOH (1 M, 60 mL) was added, and the reaction mixture was extracted with EtOAc (3 × 50 mL). The organic layer was separated, dried over anhydrous Na_2SO_4, concentrated, and purified by column chromatography (PE/EA/Et_3N = 10:1:0.05) to give amine as a thick colorless oil (4.5 g, 66% yield over two steps).

N-(((1R,4aS,10aR)-7-isopropyl-1,4a-dimethyl-1,2,3,4,4a,9,10,10a-octahydrophenanthren-1-yl)methyl)-N-methylpropan-2-amine



^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.18 (d, 1H), 6.98 (d, J = 8.2, 2.0 Hz, 1H), 6.88 (s, 1H), 2.95–2.75 (m, 3H), 2.75–2.63 (m, 1H), 2.34–2.21 (m, 2H), 2.15 (s, 3H), 2.05 (d, J = 14.3 Hz, 1H), 1.84–1.77 (m, 1H), 1.74–1.57 (m, 4H), 1.52 (td, J = 13.4, 4.1 Hz, 1H), 1.40 (td, J = 13.1, 3.8 Hz, 1H), 1.31–1.14 (m, 10H), 0.95 (t, J = 8.8, 7.3 Hz, 6H), 0.82 (s, 3H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 145.3, 135.0, 126.9, 124.2, 123.7, 67.2, 56.3, 43.9, 39.1, 38.5, 37.8, 37.5, 36.6, 33.5, 30.3, 25.9, 24.1, 19.2, 19.2, 19.0, 18.5, 17.5.

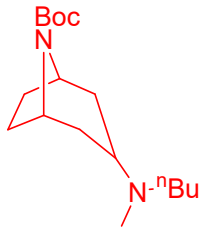


Step 1

To a round-bottom flask was added n-butylamine (2.2 g, 30 mmol, 1.5 equiv.) and Boc-tropinone (4.5 g, 20 mmol, 1.0 equiv.), then $Ti(O^iPr)_4$ (7.1 mL, 24 mmol, 1.2 equiv.) was added to the stirring mixture. The reaction mixture was stirred at room temperature for 2 hours. After that, MeOH (100 mL) was added, and the reaction mixture was cooled to 0 °C. Then $NaBH_4$ (1.1 g, 30 mmol, 1.0 equiv.) was added in several portions at 0 °C, and the reaction mixture was stirred at room temperature for 2 hours. After completion, the mixture was quenched by aq. NH_4Cl, then concentrated to remove MeOH. Aq. NaOH (1 M, 60 mL) was added, and the reaction mixture was extracted with EtOAc (3 × 50 mL). The organic layer was separated, dried over anhydrous Na_2SO_4 and concentrated in vacuum to give the desired product as a colorless oil, which was directly used in the next step without further purification.

Step 2

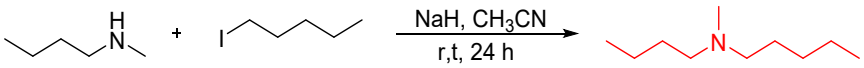
The formic acid (1.9 g, 40 mmol, 2.0 equiv.) was added dropwise to a mixture of secondary amine substrate (from *Step 1*, 20 mmol) and 37% solution of formaldehyde (1.8 g, 22 mmol, 1.1 equiv.) at 0 °C. The mixture was heated at 55 °C for 5 hours. After cooling to room temperature, aq. NaOH (1 M, 90 mL) was added, and the reaction mixture was extracted with EtOAc (3 × 50 mL). The organic layer was separated, dried over anhydrous Na_2SO_4, concentrated, and purified by column chromatography (PE/EA/Et_3N = 4:1:0.02) to give amine as a thick colorless oil (3.6 g, 61% yield over two steps).



^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 4.23 (s, 1H), 4.12 (s, 1H), 2.48–2.30 (m, 3H), 2.21 (d, 5H), 1.91 (s, 2H), 1.84–1.71 (m, 2H), 1.59–1.42 (m, 11H), 1.44–1.36 (m, 2H), 1.34–1.22 (m, 2H), 0.91 (t, *J* = 7.4 Hz, 3H).

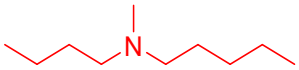
^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 154.0, 78.8, 54.6, 54.6, 51.9, 51.1, 39.5, 33.2, 31.6, 30.7, 30.1, 29.1, 28.4, 20.7, 14.1.

3.1.5. Preparation of tertiary amine substrate [2]



To a stirred mixture of NaH (60% dispersion in mineral oil, 2.0 equiv.) in dry MeCN (25 mL) was added *N*-methylbutylamine (20 mmol) at 0 °C. After being stirred at rt for 30 min, the reaction was cooled to 0 °C and iodopentane (30 mmol, 1.5 equiv.) in dry MeCN (5 mL) was added dropwise. The mixture was then stirred at room temperature overnight. After the reaction was complete (monitored by TLC), the mixture was quenched with saturated aqueous NH_4Cl at 0 °C and extracted with EtOAc (40 mL × 3). The combined extracts were washed with water and brine, dried over Na_2SO_4, filtered, and concentrated in vacuo. The residue was purified by column chromatography (petroleum ether/EtOAc = 10:1) on silica gel to afford desired amines in 63% yield.

***N*-butyl-*N*-methylpentan-1-amine**

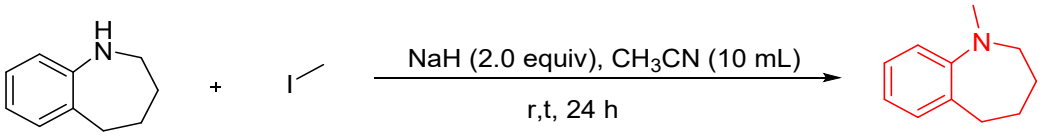


^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 2.32–2.22 (m, 4H), 2.16 (s, 3H), 1.48–1.36 (m, 4H), 1.33–1.20 (m, 6H), 0.92–0.78 (m, 6H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 57.9, 57.6, 42.3, 29.8, 29.5, 27.0, 22.6, 20.7, 14.0, 13.9.

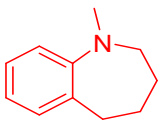
HRMS (ESI) calcd for $C_{10}H_{24}N$ $[M+H]^+$: 158.1903; Found: 158.1900.

3.1.6. Preparation of tertiary amine substrate[2]



To a stirred mixture of NaH (60% dispersion in mineral oil, 2.0 equiv.) in dry MeCN (25 mL) was added 2,3,4,5-tetrahydro-1*H*-benzo[*b*]azepine (20 mmol) at 0 °C. After being stirred at rt for 30 min, the reaction was cooled to 0 °C and iodomethane (30 mmol, 1.5 equiv.) in dry MeCN (5 mL) was added dropwise. The mixture was then stirred at room temperature overnight. After the reaction was complete (monitored by TLC), the mixture was quenched with saturated aqueous NH_4Cl at 0 °C and extracted with EtOAc (40 mL × 3). The combined extracts were washed with water and brine, dried over Na_2SO_4, filtered, and concentrated in vacuo. The residue was purified by column chromatography (petroleum ether/EtOAc = 20:1) on silica gel to afford desired amines in 81% yield.

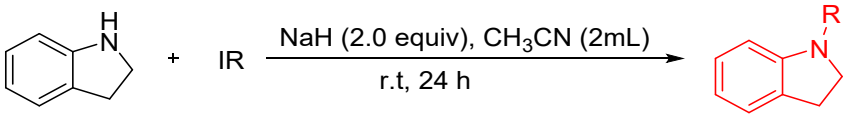
***1*-methyl-2,3,4,5-tetrahydro-1*H*-benzo[*b*]azepine**



^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.13 (t, J = 7.8 Hz, 1H), 7.07 (d, J = 7.4 Hz, 1H), 6.90 (d, J = 8.0 Hz, 1H), 6.83 (t, J = 7.5 Hz, 1H), 2.93–2.81 (m, 5H), 2.80–2.74 (m, 2H), 1.74 (tt, J = 7.0, 2.8 Hz, 2H), 1.58 (qt, J = 6.0, 2.9 Hz, 2H).

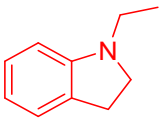
^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 152.9, 135.6, 130.2, 126.8, 121.1, 116.3, 57.2, 43.3, 35.4, 30.3, 25.8.

3.1.7. Preparation of tertiary amine substrate[2]



To a stirred mixture of NaH (60% dispersion in mineral oil, 2.0 equiv.) in dry MeCN (25 mL) was added Indoline (20 mmol) at 0 °C. After being stirred at rt for 30 min, the reaction was cooled to 0 °C and alkyl iodide (30 mmol, 1.5 equiv.) in dry MeCN (5 mL) was added dropwise. The mixture was then stirred at room temperature overnight. After the reaction was complete (monitored by TLC), the mixture was quenched with saturated aqueous NH_4Cl at 0 °C and extracted with EtOAc (40 mL × 3). The combined extracts were washed with water and brine, dried over Na_2SO_4, filtered, and concentrated in vacuo. The residue was purified by column chromatography (petroleum ether/EtOAc = 20:1) on silica gel to afford desired amines in 53%-81% yield.

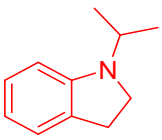
1-ethylindoline



^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.1–7.0 (m, 2H), 6.6 (t, J = 7.4 Hz, 1H), 6.5 (d, J = 7.8 Hz, 1H), 3.3 (t, 2H), 3.2–3.1 (m, 2H), 3.0 (t, J = 8.3 Hz, 2H), 1.2 (t, J = 7.2, 1.7 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 152.3, 130.3, 127.3, 124.4, 117.5, 107.2, 52.3, 43.2, 28.5, 12.0.

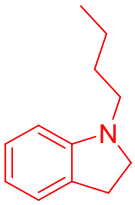
1-isopropylindoline



^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.2–7.1 (m, 2H), 6.7 (t, J = 7.3, 1.0 Hz, 1H), 6.5 (d, 1H), 4.0–3.7 (m, 1H), 3.4 (t, J = 8.4 Hz, 2H), 3.0 (t, J = 8.4 Hz, 2H), 1.2 (d, J = 6.7 Hz, 6H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 151.4, 130.4, 127.3, 124.4, 116.9, 107.2, 45.9, 45.5, 28.2, 18.2.

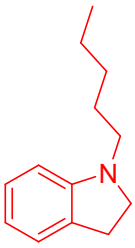
1-butylindoline



^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.0 (t, *J* = 7.4, 1.2 Hz, 2H), 6.6 (t, *J* = 7.3, 1.0 Hz, 1H), 6.4 (d, 1H), 3.3 (t, *J* = 8.3 Hz, 2H), 3.0 (t, 2H), 2.9 (t, *J* = 8.3 Hz, 2H), 1.6–1.5 (m, 2H), 1.5–1.4 (m, 2H), 1.0 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 152.9, 130.1, 127.4, 124.4, 117.3, 106.9, 53.1, 49.1, 29.6, 28.7, 20.5, 14.1.

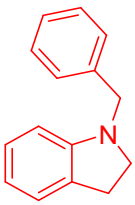
1-pentylindoline



^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.1 (t, *J* = 7.4, 1.1 Hz, 2H), 6.7 (t, *J* = 7.3, 1.0 Hz, 1H), 6.5 (d, 1H), 3.4 (t, *J* = 8.3 Hz, 2H), 3.1 (t, 2H), 3.0 (t, *J* = 8.3 Hz, 2H), 1.8–1.6 (m, 2H), 1.5–1.4 (m, 4H), 1.0 (t, *J* = 7.0, 3.6, 2.5 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 152.9, 130.1, 127.4, 124.4, 117.3, 106.9, 53.1, 49.4, 29.6, 28.7, 27.2, 22.7, 14.2.

1-benzylindoline

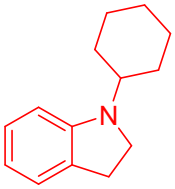


^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.6–7.5 (m, 4H), 7.5 (t, 1H), 7.3–7.3 (m, 2H), 6.9 (t, *J* = 7.3 Hz, 1H), 6.7 (d, *J* = 7.9 Hz, 1H), 4.5 (s, 2H), 3.5 (t, *J* = 8.3 Hz, 2H), 3.2 (t, *J* = 8.3 Hz, 2H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 152.8, 138.7, 130.2, 128.7, 128.2, 127.6, 127.3, 124.7, 118.0,

107.3, 53.9, 53.8, 28.8.

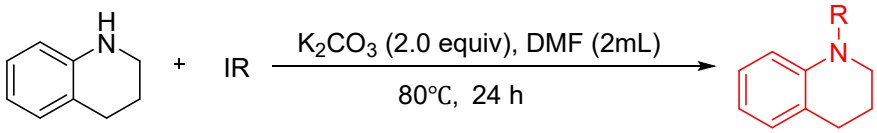
1-cyclohexylindoline



^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.1 (t, 2H), 6.6 (t, 1H), 6.4 (d, J = 7.8 Hz, 1H), 3.5–3.3 (m, 3H), 3.0 (t, J = 8.4 Hz, 2H), 1.9 (d, 4H), 1.7 (d, 1H), 1.5–1.3 (m, 4H), 1.2–1.1 (m, 1H).

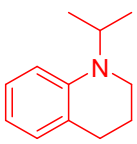
^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 151.2, 130.1, 127.2, 124.4, 116.6, 106.8, 54.6, 46.7, 28.7, 28.4, 26.1, 26.1.

3.1.8. Preparation of tertiary amine substrate[2]



To a stirred mixture of K_2CO_3 (2.0 equiv.) in dry DMF (25 mL) was added 1,2,3,4-Tetrahydroquinoline (20 mmol) at 0℃. After being stirred at 80℃ for 30 min, the reaction was cooled to 0℃ and alkyl iodide (30 mmol, 1.5 equiv.) in dry DMF (5 mL) was added dropwise. The mixture was then stirred at 80℃ overnight. After the reaction was complete (monitored by TLC), the mixture was quenched with saturated aqueous NH_4Cl at 0℃ and extracted with EtOAc (40 mL × 3). The combined extracts were washed with water and brine, dried over Na_2SO_4, filtered, and concentrated in vacuo. The residue was purified by column chromatography (petroleum ether/EtOAc = 20:1) on silica gel to afford desired amines in 53%-81% yield.

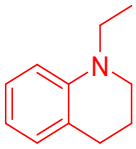
1-isopropyl-1,2,3,4-tetrahydroquinoline



^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.2 (t, 1H), 7.0 (d, *J* = 7.3 Hz, 1H), 6.8 (d, *J* = 8.3 Hz, 1H), 6.7 (t, *J* = 7.3 Hz, 1H), 4.3–4.1 (m, 1H), 3.3 (t, 2H), 2.8 (t, *J* = 6.5 Hz, 2H), 2.1–1.9 (m, 2H), 1.3 (d, *J* = 6.8 Hz, 6H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 145.6, 129.3, 127.1, 123.2, 115.2, 110.7, 46.8, 40.2, 28.6, 22.5, 19.0.

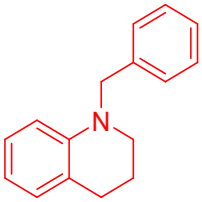
1-ethyl-1,2,3,4-tetrahydroquinoline



^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.1 (t, 1H), 7.0 (d, *J* = 7.3 Hz, 1H), 6.6 (d, *J* = 8.3 Hz, 1H), 6.6 (t, *J* = 7.3 Hz, 1H), 3.4 (q, *J* = 7.1 Hz, 2H), 3.3 (t, 2H), 2.8 (t, *J* = 6.4 Hz, 2H), 2.1–1.9 (m, 2H), 1.2 (t, *J* = 7.1 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 145.0, 129.2, 127.1, 122.5, 115.4, 110.6, 48.4, 45.3, 28.2, 22.3, 10.8.

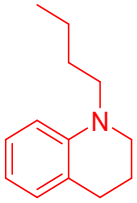
1-benzyl-1,2,3,4-tetrahydroquinoline



^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.6 (t, *J* = 7.5 Hz, 2H), 7.5 (d, *J* = 7.6 Hz, 2H), 7.5 (t, *J* = 7.3 Hz, 1H), 7.2 (t, *J* = 7.7 Hz, 2H), 6.8 (t, *J* = 7.3 Hz, 1H), 6.8 (d, *J* = 8.2 Hz, 1H), 4.7 (s, 2H), 3.6 (t, *J* = 5.7 Hz, 2H), 3.1 (t, *J* = 6.4 Hz, 2H), 2.4–2.1 (m, 2H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 145.8, 139.2, 129.3, 128.8, 127.5, 127.0, 126.8, 122.4, 116.2, 111.3, 55.4, 50.1, 28.5, 22.7.

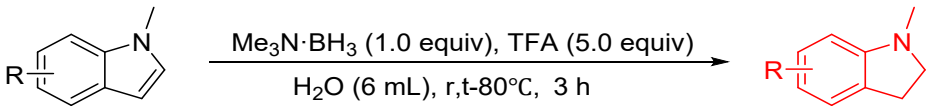
1-butyl-1,2,3,4-tetrahydroquinoline



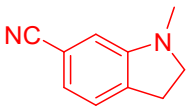
^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.2 (t, *J* = 7.8 Hz, 1H), 7.1 (d, *J* = 7.4 Hz, 1H), 6.7–6.6 (m, 2H), 3.4–3.3 (m, 4H), 2.9 (t, *J* = 6.5 Hz, 2H), 2.1–2.0 (m, 2H), 1.8–1.7 (m, 2H), 1.6–1.5 (m, 2H), 1.1 (t, *J* = 7.4, 1.7 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 145.4, 129.1, 127.1, 122.2, 115.2, 110.5, 51.3, 49.5, 28.4, 28.3, 22.3, 20.5, 14.1.

3.1.9. Preparation of tertiary amine substrate[3]



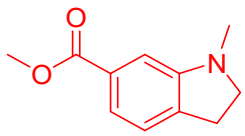
To a Schenk tube, TFA (50 mmol, 5.0 equiv.) was added to a solution of indole (10 mmol) and $Me_3N{\cdot}BH_3$ (10 mmol, 1.0 equiv.) in H_2O (25 mL). The mixture was stirred at different temperatures for 3 h. Subsequently, the reaction mixture was neutralized with NaOH (1.0 mol/L) and extracted with CH_2Cl_2 for three times. The combined organic phase was dried over anhydrous sodium sulfate, and concentrated under reduced pressure. The residue was purified by flash column chromatography (petroleum ether/EtOAc = 20:1) over silica gel using a mixture of petroleum ether and ethyl acetate as eluent to give the target products.[3]



Stir at room temperature for 3 hours.

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.1 (d, *J* = 7.3, 1.3 Hz, 1H), 6.9 (d, *J* = 7.4, 1.4 Hz, 1H), 6.5 (s, 1H), 3.4 (t, *J* = 8.4 Hz, 2H), 3.0 (t, *J* = 8.4, 1.2 Hz, 2H), 2.8 (s, 3H).

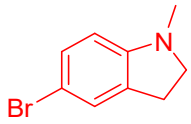
^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 153.5, 135.9, 124.5, 122.2, 120.1, 110.8, 108.5, 55.4, 35.3, 28.8.



Stir at 80℃ for 3 hours.

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.4 (dd, *J* = 7.6, 1.6 Hz, 1H), 7.1–7.1 (m, 2H), 3.9 (d, *J* = 1.1 Hz, 3H), 3.4–3.3 (m, 2H), 3.0 (t, *J* = 8.2 Hz, 2H), 2.8 (d, *J* = 1.1 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 168.3, 136.1, 132.1, 120.4, 120.3, 111.7, 101.4, 56.1, 52.0, 33.0, 28.8.

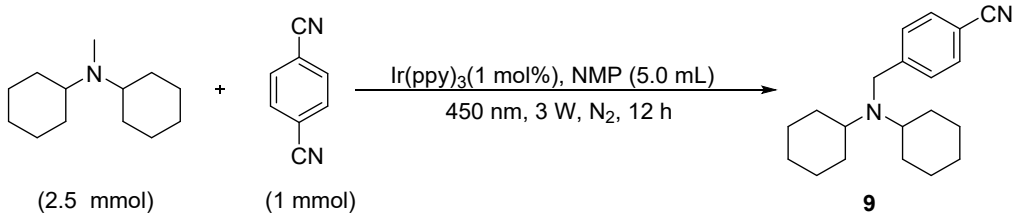


Stir at 80℃ for 3 hours.

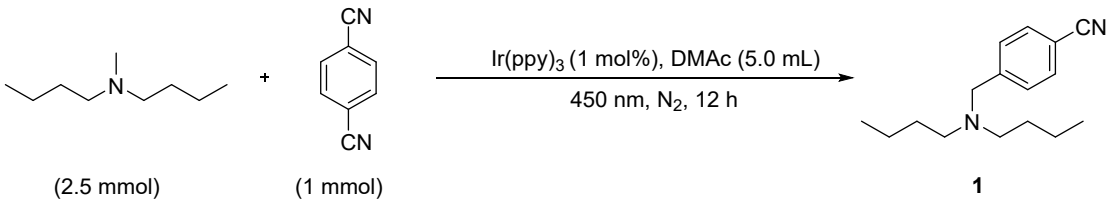
^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.2–7.1 (m, 2H), 6.3 (d, 1H), 3.3 (t, *J* = 8.2 Hz, 2H), 2.9 (t, *J* = 8.2 Hz, 2H), 2.7 (s, 3H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 152.5, 132.6, 129.9, 127.2, 109.3, 108.3, 56.1, 36.1, 28.5.

4. Typical procedure for the synthesis on a 1.0 mmol scale

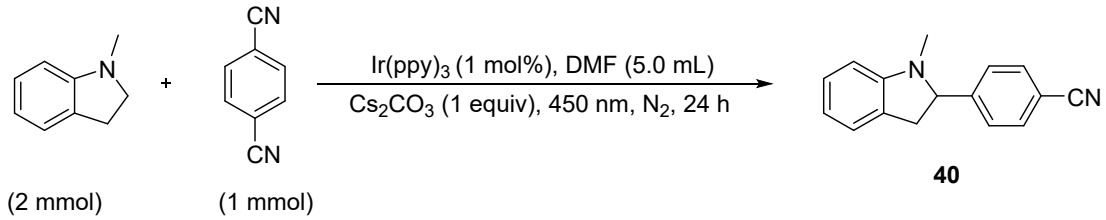


An oven-dried sealed tube equipped with a PTFE-coated stir bar was charged with 1,4-dicyanobenzene (128 mg, 1.0 mmol), $Ir(ppy)_3$ (6 mg, 0.01 mmol) and brought into a N_2-filled glovebox. *N*-methyldicyclohexylamine (488 mg, 2.5 mmol) was added, followed by NMP (5 mL). The reaction mixture was stirred under 450 nm LED irradiation for 12 h. The resulting mixture was quenched with sat. NH_4Cl solution (5 mL) and further diluted with water (20 mL). The aqueous layer was extracted with EtOAc (3×20 mL) and the combined organic layers were washed with brine, dried over anhydrous Na_2SO_4, filtered, and concentrated under vacuum. Then the residue was purified by silica gel column chromatography (petroleum ether/EtOAc = 10:1) to obtain pure product (252 mg, 85% yield).



An oven-dried sealed tube equipped with a PTFE-coated stir bar was charged with 1,4-dicyanobenzene (128 mg, 1.0 mmol), $Ir(ppy)_3$ (6 mg, 0.01 mmol) and brought into a N_2-filled glovebox. *N*-butyl-*N*-methylbutan-1-amine (358 mg, 2.5 mmol) was added, followed by DMAc (5 mL). The reaction mixture was stirred under 450 nm LED irradiation for 12 h. The resulting mixture was quenched with sat. NH_4Cl solution (5 mL) and further diluted with water (20 mL). The aqueous layer was extracted with EtOAc (3×20 mL) and the combined organic layers were washed with brine, dried over anhydrous Na_2SO_4, filtered, and concentrated under vacuum. Then the residue was

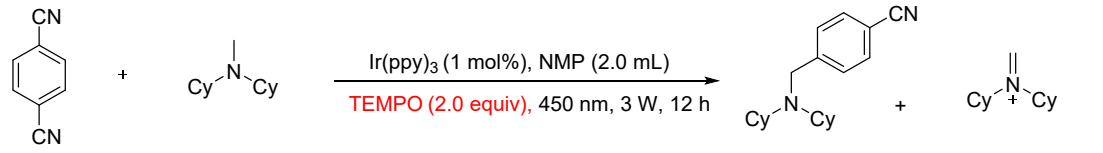
purified by silica gel column chromatography (petroleum ether/EtOAc = 10:1) to obtain pure product (202 mg, 83%).



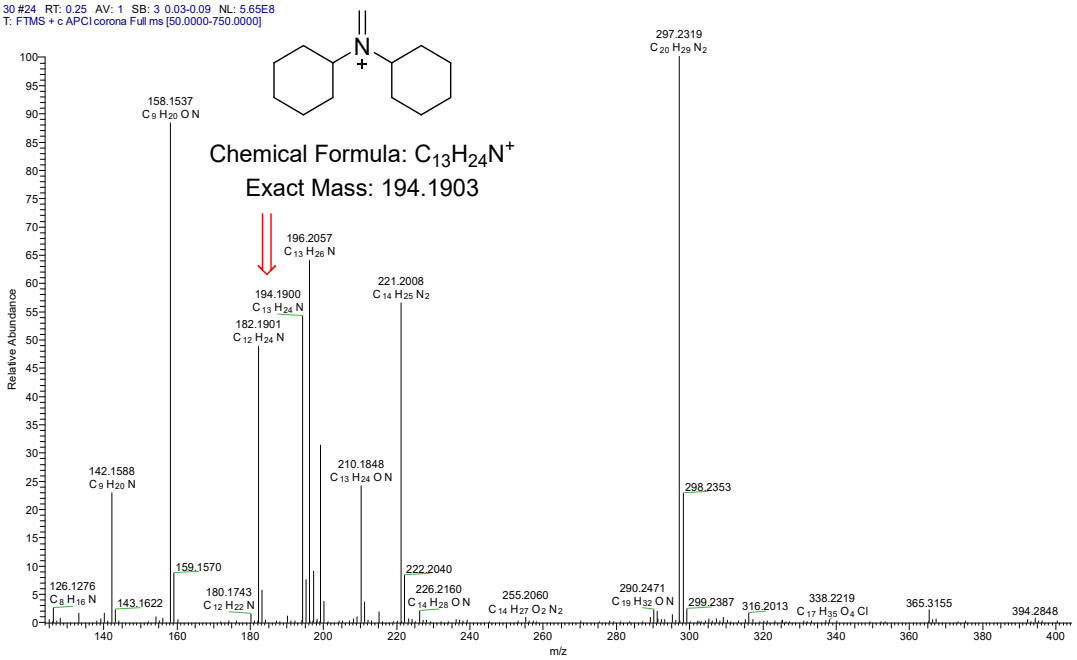
An oven-dried sealed tube equipped with a PTFE-coated stir bar was charged with 1,4-dicyanobenzene (128 mg, 1.0 mmol), $Ir(ppy)_3$ (6 mg, 0.01 mmol) and brought into a N_2-filled glovebox. 1-Methylindoline (266 mg, 2 mmol) was added, followed by DMF (5 mL). The reaction mixture was stirred under 450 nm LED irradiation for 24 h. The resulting mixture was quenched with sat. NH_4Cl solution (5 mL) and further diluted with water (20 mL). The aqueous layer was extracted with EtOAc (3×20 mL) and the combined organic layers were washed with brine, dried over anhydrous Na_2SO_4, filtered, and concentrated under vacuum. Then the residue was purified by silica gel column chromatography (petroleum ether/EtOAc = 10:1) to obtain pure product (175 mg, 75% yield).

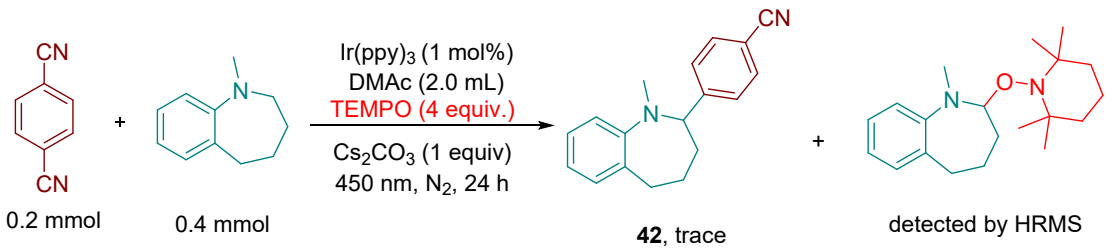
5. Mechanistic experiments

5.1. TEMPO-capture experiment

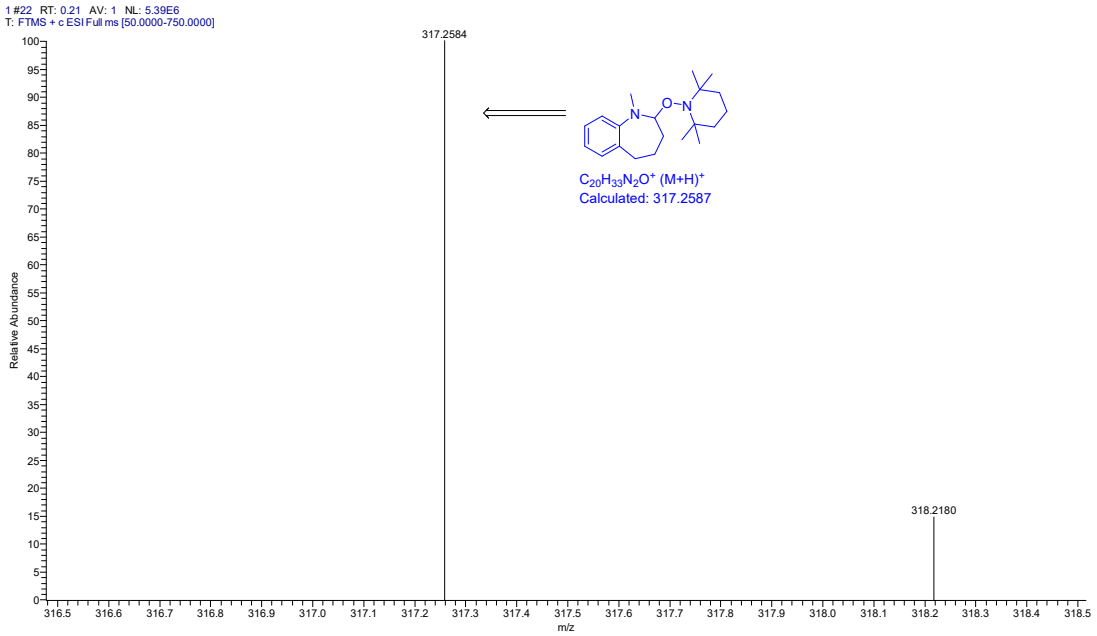


(0.4 mmol) (1.0 mmol) **9**,trace detected by HRMS

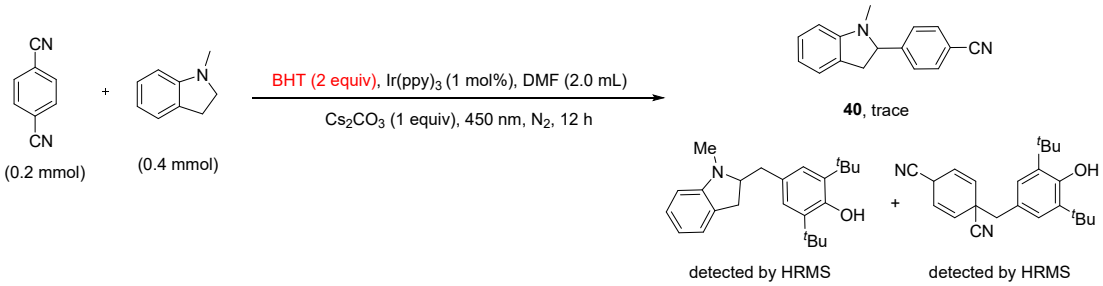


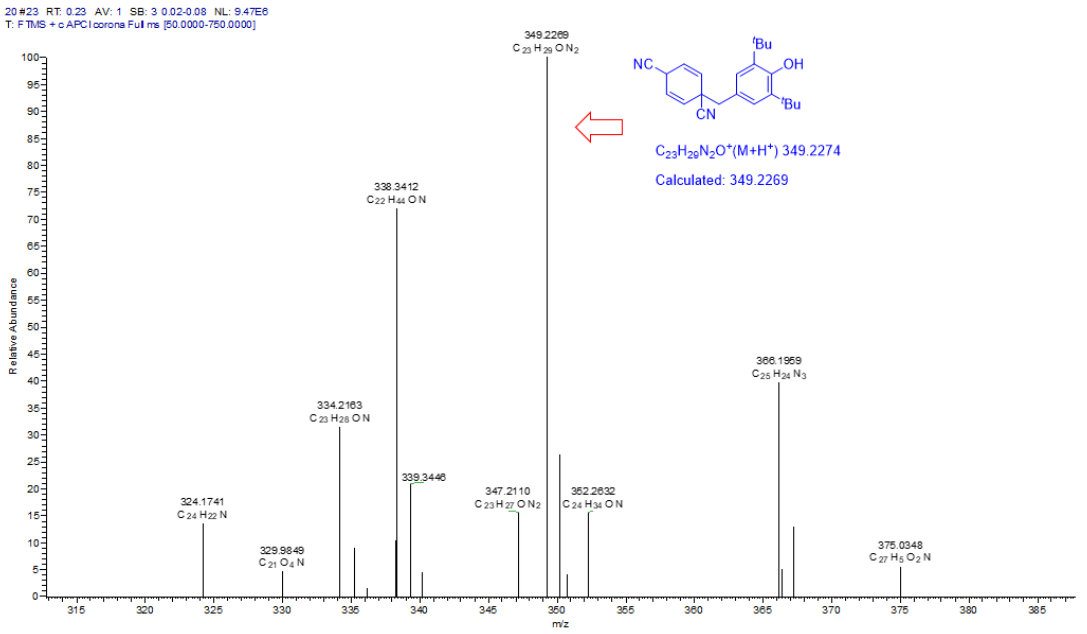


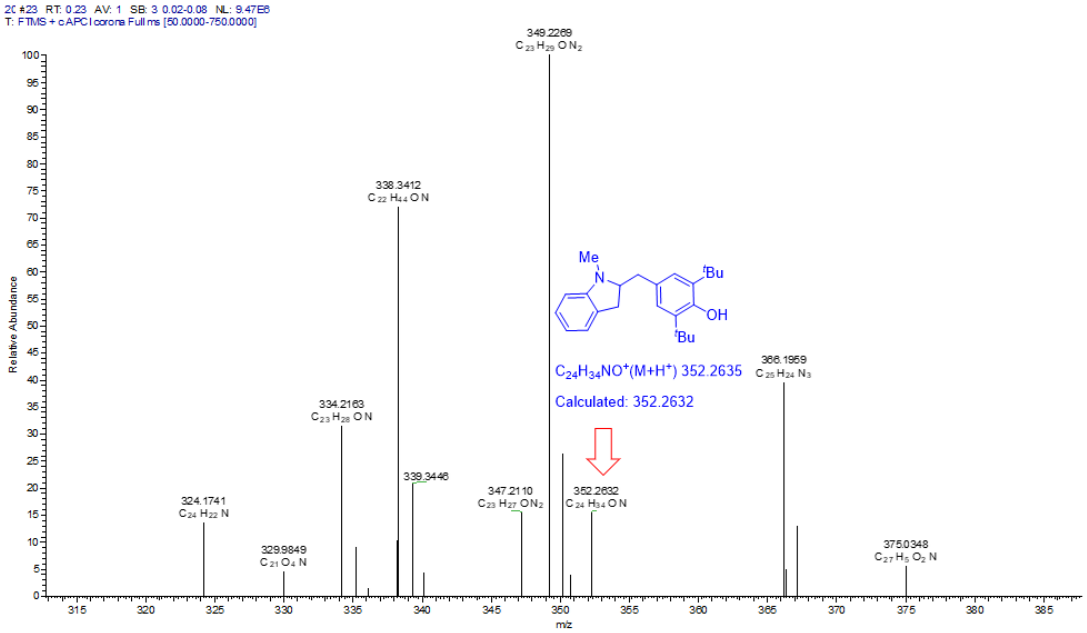
0.2 mmol 0.4 mmol **42**, trace detected by HRMS



5.2. BHT-capture experiment

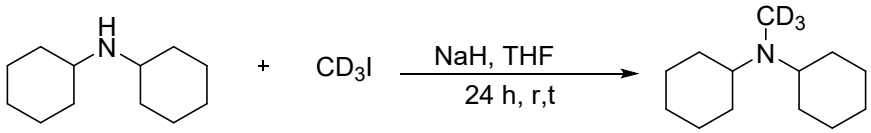






5.3. Isotopic labelling experiment

5.3.1. Synthesis of Cy_2NCD_3



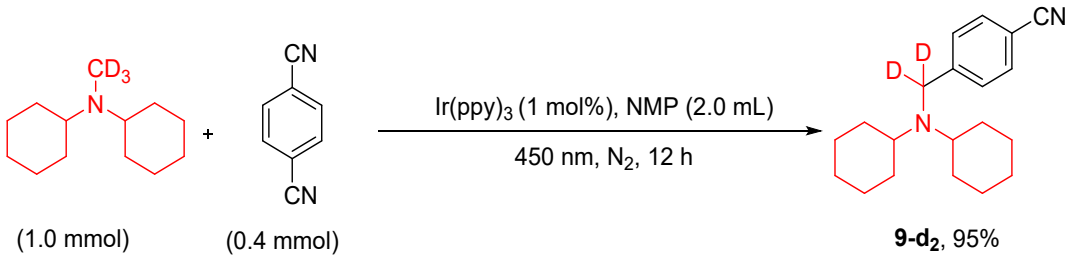
To a 100 mL round-bottom flask was added dicyclohexylamine (10 mmol, 1.0 equiv.), NaH (2.0 equiv.), CH_3CN (25 mL). The mixture was allowed to stirring at room temperature for 20 minutes. After that, aqueous iodobutylamine (30 mmol, 1.5 equiv.) was added. The mixture was allowed to stirring at room temperature for 24 hours. After the reaction is complete, concentrated, and purified by column chromatography (petroleum ether/EtOAc = 10:1) to give desired amines in 63% yield.

4-((dicyclohexylamino)methyl)benzonitrile

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 2.47–2.38 (m, 2H), 1.80–1.66 (m, 8H), 1.62–1.51 (m, 2H), 1.27–1.13 (m, 8H), 1.09–0.97 (m, 2H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 59.2, 34.4, 30.6, 26.3, 26.2.

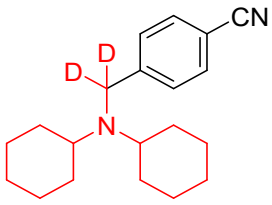
5.3.2. Isotopic-labelling experiment



(1.0 mmol) (0.4 mmol) **9-d_2**, 95%

An oven-dried sealed tube equipped with a PTFE-coated stir bar was charged with 1,4-dicyanobenzene (52 mg, 0.4 mmol), $Ir(ppy)_3$ (3.2 mg, 0.004 mmol, 1 mol%) and brought into a N_2-filled glovebox. Cy_2NCD_3 (198 mg, 1.0 mmol, 2.5 equiv.) was added, followed by NMP (2 mL). The reaction mixture was stirred under 450 nm LED irradiation for 12 h. The resulting mixture was quenched with sat. NH_4Cl solution (5 mL) and further diluted with water (10 mL). The aqueous layer was extracted with EtOAc (3×10 mL) and the combined organic layers were washed with brine, dried over anhydrous Na_2SO_4, filtered, and concentrated under vacuum. The residue was purified by silica gel column chromatography (petroleum ether/EtOAc = 10:1) to obtain white solid products **9-d_2** (113 mg, 95% yield).

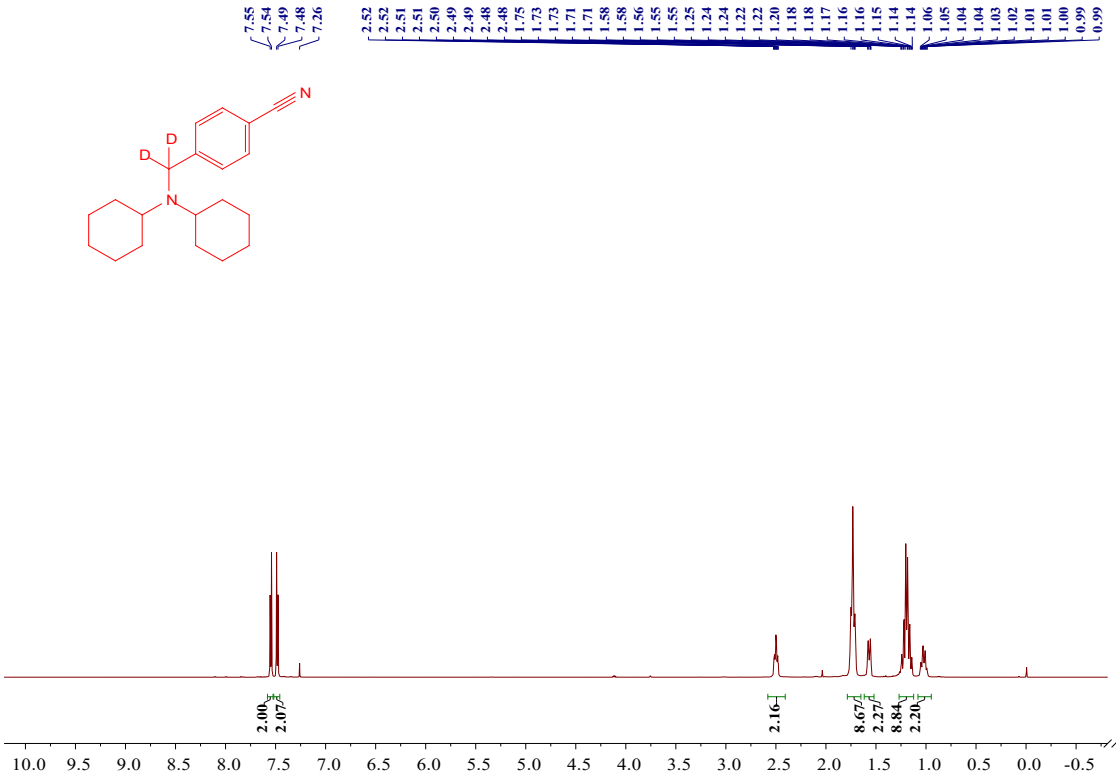
4-((dicyclohexylamino)methyl-d2)benzonitrile (9-d_2)



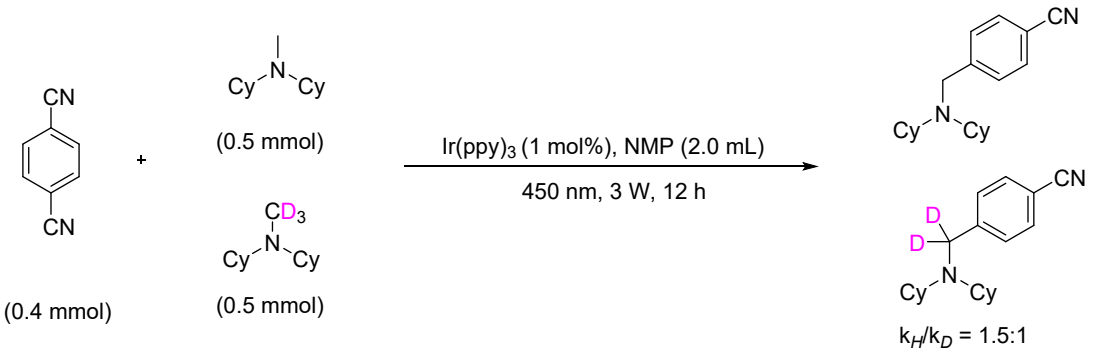
^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.57–7.52 (m, 2H), 7.50–7.45 (m, 2H), 2.50 (tt, *J*=11.1, 3.4 Hz, 2H), 1.72 (t, 8H), 1.56 (d, 2H), 1.30–1.11 (m, 8H), 1.08–0.94 (m, 2H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 150.0, 131.9, 128.3, 119.4, 109.8, 58.2, 49.4, 31.9, 26.4, 26.2.

HRMS (ESI) calcd for $C_{20}H_{27}D_2N_2$ $(M+H)^+$: 299.2451; Found: 299.2445.

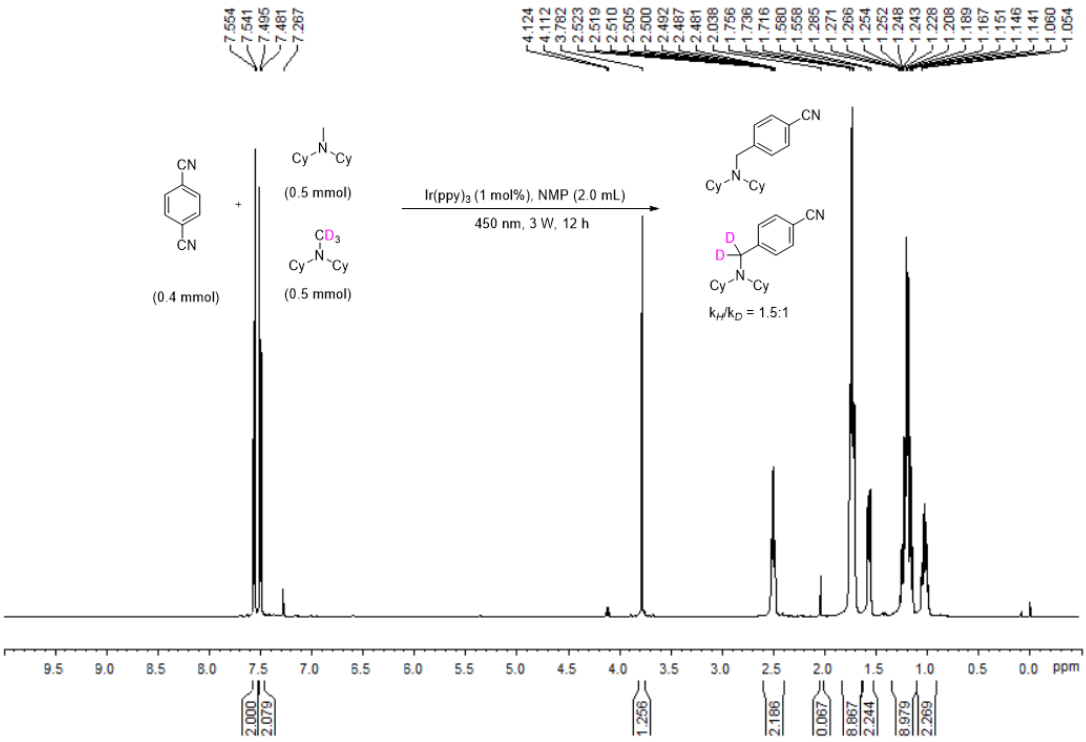


5.3.3 KIE experiment



An oven-dried sealed tube equipped with a PTFE-coated stir bar was charged with 1,4-dicyanobenzene (0.40 mmol), $Ir(ppy)_3$ (0.004 mmol, 1 mol%) and brought into a N_2-filled glovebox. Cy_2NCD_3 (0.5 mmol), Cy_2NMe (0.5 mmol) was added, followed by NMP (2 mL). The reaction mixture was stirred under 450 nm LED irradiation for 12 h. The resulting mixture was quenched with sat. NH_4Cl solution (5 mL) and further diluted with water (10 mL). The aqueous layer was extracted with EtOAc (3×10 mL)

and the combined organic layers were washed with brine, dried over anhydrous Na_2SO_4, filtered, and concentrated under vacuum. The residue was purified by silica gel column chromatography (petroleum ether/EtOAc = 10:1) to obtain white solid products (98 mg, 82% yield).



6. References

[1] Zhang, T. Z.; Prof. Dr. Huang, H. M. Photocatalyzed Aminomethylation of Alkyl Halides Enabled by Sterically Hindered N-Substituents. *Angew. Chem. Int. Ed*. **2023**, e202310114.

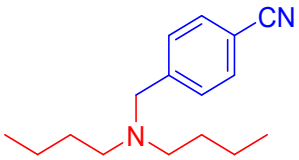
[2] Yu, S. J.; Li, X. W. Rhodium(III)-Catalyzed C−C Coupling of Arenes with 2-Vinyloxiranes: Synthesis of Allylic Alcohols. *Org. Lett*. **2014**, 16, 1200−1203.

[3] Zeng, Y. F.; Li, Y. N.; Zhou, M. X.; Han, S.; Guo, Y.; Wang, Z. Metal-Free Hydrogenation of N-Heterocycles with Trimethylamine Borane and TFA in Aqueous Solution. *Adv. Synth. Catal.* **2022**, 364, 3664–3669.

[4] Zhang, T. Z.; Gu, P. W.; Huang, H, M. Photoredox Fe-Catalyzed Aminoalkylation toward Sterically Hindered Chiral β-Amino Acids. *J. Am. Chem. Soc*. **2025**, 147, 37565−37575.

7. Characterization data of products

4-((dibutylamino)methyl)benzonitrile (1)

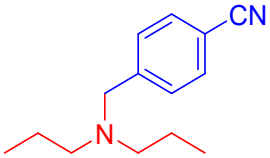


The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Colorless oil (84 mg, 86%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.57 (d, *J* = 7.8 Hz, 2H), 7.44 (d, *J* = 7.9 Hz, 2H), 3.56 (s, 2H), 2.38 (t, *J* = 7.3 Hz, 4H), 1.48–1.35 (m, 4H), 1.35–1.21 (m, 4H), 0.86 (t, *J* = 7.4 Hz, 6H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 146.7, 131.9, 129.1, 119.1, 110.3, 58.5, 53.8, 29.3, 20.5, 14.0.

4-((dipropylamino)methyl)benzonitrile (2)

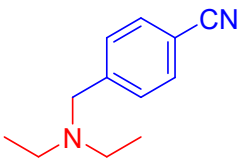


The title compound purified by column chromatography (petroleum ether/EtOAc = 3:1). Yellow oil (63 mg, 73%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.57 (d, *J* = 8.2 Hz, 2H), 7.45 (d, *J* = 8.0 Hz, 2H), 3.57 (s, 2H), 2.35 (t, *J* = 7.4 Hz, 4H), 1.51–1.36 (m, 4H), 0.85 (t, *J* = 7.4 Hz, 6H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 146.7, 131.9, 129.1, 119.1, 110.4, 58.5, 56.1, 20.3, 11.8.

4-((diethylamino)methyl)benzonitrile (3)



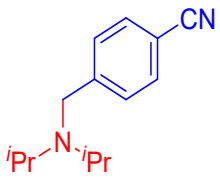
The title compound purified by column chromatography (petroleum ether/EtOAc =

3:1). Colorless oil (41 mg, 54%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.59 (d, *J* = 8.2 Hz, 2H), 7.46 (d, *J* = 7.7 Hz, 2H), 3.59 (s, 2H), 2.51 (q, *J* = 7.1, 1.7 Hz, 4H), 1.03 (t, *J* = 7.1, 1.7 Hz, 6H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 146.2, 132.0, 129.3, 119.1, 110.5, 57.3, 47.0, 11.8.

4-((diisopropylamino)methyl)benzonitrile (4)

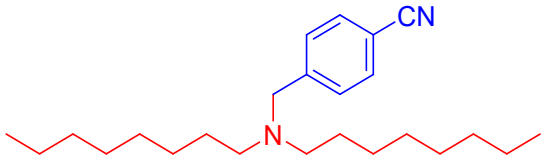


The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Colorless oil (59 mg, 68%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.55 (d, *J* = 7.9 Hz, 2H), 7.49 (d, *J* = 7.9 Hz, 2H), 3.67 (s, 2H), 3.07–2.88 (m, 2H), 1.00 (d, *J* = 6.7, 1.3 Hz, 12H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 149.7, 131.9, 128.4, 119.3, 109.9, 49.0, 48.4, 20.8.

4-((dioctylamino)methyl)benzonitrile (5)



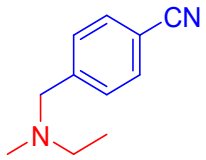
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Colorless oil (75 mg, 53%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.58 (d, *J* = 7.7 Hz, 2H), 7.44 (d, *J* = 7.7 Hz, 2H), 3.56 (s, 2H), 2.37 (t, *J* = 7.4 Hz, 4H), 1.35–1.16 (m, 24H), 0.88 (t, *J* = 7.0 Hz, 6H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 146.7, 131.9, 129.2, 119.1, 110.4, 58.5, 54.1, 31.9, 29.5, 29.3, 27.4, 27.1, 22.7, 14.1.

HRMS (ESI) calcd for $C_{24}H_{41}N_2$ $[M+H]^+$: 357.3264; Found: 357.3258.

4-((ethyl(methyl)amino)methyl)benzonitrile (6)

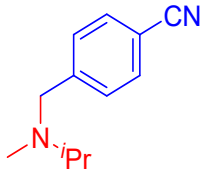


The title compound purified by column chromatography (petroleum ether/EtOAc = 3:1). Colorless oil (49 mg, 70%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.60 (d, *J* = 8.1, 1.8 Hz, 2H), 7.44 (d, *J* = 7.7 Hz, 2H), 3.52 (s, 2H), 2.44 (q, *J* = 7.2, 1.7 Hz, 2H), 2.18 (s, 3H), 1.09 (t, *J* = 7.1, 1.7 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 144.8, 132.1, 129.6, 119.0, 110.8, 61.4, 51.4, 41.6, 12.3.

4-((isopropyl(methyl)amino)methyl)benzonitrile (7)

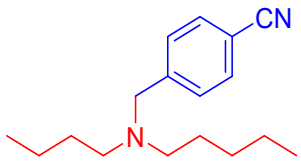


The title compound purified by column chromatography (petroleum ether/EtOAc = 3:1). Yellow oil (46 mg, 61%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.58 (d, *J* = 7.8 Hz, 2H), 7.45 (d, *J* = 7.8 Hz, 2H), 3.54 (s, 2H), 2.95–2.77 (m, 1H), 2.12 (s, 3H), 1.06 (d, *J* = 6.8 Hz, 6H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 146.4, 132.0, 129.2, 119.1, 110.5, 57.2, 53.5, 37.0, 17.9.

4-((butyl(pentyl)amino)methyl)benzonitrile (8)



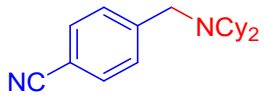
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Colorless oil (62 mg, 60%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.58 (d, *J* = 8.0 Hz, 2H), 7.45 (d, *J* = 7.9 Hz, 2H), 3.57 (s, 2H), 2.38 (q, *J* = 6.7 Hz, 4H), 1.47–1.38 (m, 4H), 1.32–1.21 (m, 6H), 0.88-0.86 (m, 6H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 146.7, 131.9, 129.2, 119.2, 110.3, 58.5, 54.1, 53.8, 29.6, 29.3, 26.8, 22.6, 20.5, 14.1, 14.0.

HRMS (ESI) calcd for $C_{17}H_{27}N_2$ $[M+H]^+$: 259.2169; Found: 259.2165.

4-((dicyclohexylamino)methyl)benzonitrile (9)

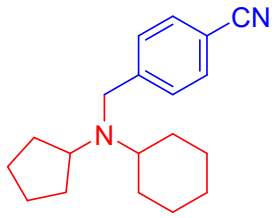


The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). White solid (114 mg, 96%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.55 (d, *J* = 7.9 Hz, 2H), 7.48 (d, *J* = 8.0 Hz, 2H), 3.78 (s, 2H), 2.50 (t, *J* = 14.6, 9.4, 3.3 Hz, 2H), 1.73 (t, 8H), 1.57 (d, *J* = 13.5, 3.6 Hz, 2H), 1.31–1.11 (m, 8H), 1.03 (q, *J* = 18.2, 12.8, 6.5 Hz, 2H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) 150.1, 131.85, 128.3, 119.4, 109.8, 58.2, 50.1, 31.9, 26.4, 26.2.

4-((cyclohexyl(cyclopentyl)amino)methyl)benzonitrile (10)



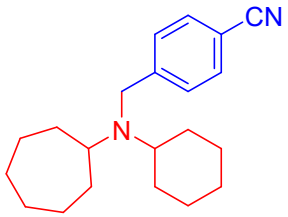
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Colorless oil (46 mg, 41%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.55 (d, *J* = 7.9 Hz, 2H), 7.50 (d, *J* = 7.9 Hz, 2H), 3.71 (s, 2H), 3.30–3.14 (m, 1H), 2.53 (t, *J* = 11.4, 7.5, 3.3 Hz, 1H), 1.85–1.63 (m, 6H), 1.62–1.52 (m, 3H), 1.52–1.41 (m, 2H), 1.37–1.24 (m, 2H), 1.22–1.11 (m, 4H), 1.10–0.98 (m, 1H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 149.2, 130.8, 127.1, 118.4, 108.7, 61.0, 59.0, 50.1, 30.1, 29.2, 25.3, 25.3, 22.8.

HRMS (ESI) calcd for $C_{19}H_{27}N_2$ $[M+H]^+$: 283.2169; Found: 283.2164.

4-((cycloheptyl(cyclohexyl)amino)methyl)benzonitrile (11)



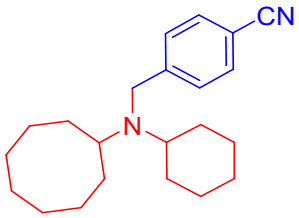
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). White solid (104 mg, 84%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.55 (d, *J* = 7.9 Hz, 2H), 7.48 (d, *J* = 7.9 Hz, 2H), 3.75 (s, 2H), 2.74 (tt, *J* = 9.6, 3.9 Hz, 1H), 2.40 (td, *J* = 11.0, 3.7 Hz, 1H), 1.85–1.68 (m, 6H), 1.65–1.32 (m, 12H), 1.25–1.10 (m, 4H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 148.8, 130.9, 127.3, 118.3, 108.8, 58.2, 57.7, 49.2, 32.2, 30.9, 26.9, 25.3, 25.1, 24.8.

HRMS (ESI) calcd for $C_{21}H_{31}N_2$: $[M+H]^+$: 309.2336; Found: 309.2332.

4-((cyclohexyl(cyclooctyl)amino)methyl)benzonitrile (12)



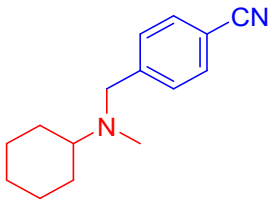
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). White solid (102 mg, 79%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.56-7.52 (m, 2H), 7.48 (d, *J* = 8.1 Hz, 2H), 3.72 (s, 2H), 2.88 (tt, *J* = 9.4, 3.1 Hz, 1H), 2.45-2.30 (m, 1H), 1.81–1.31 (m, 20H), 1.23-1.09 (m, 4H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 149.9, 131.9, 128.3, 119.3, 109.8, 58.9, 57.0, 50.1, 32.8, 31.9, 26.6, 26.5, 26.3, 26.2, 25.5.

HRMS (ESI) calcd for $C_{22}H_{33}N_2$ $[M+H]^+$: 325.2638; Found: 325.2633.

4-((cyclohexyl(methyl)amino)methyl)benzonitrile (13)

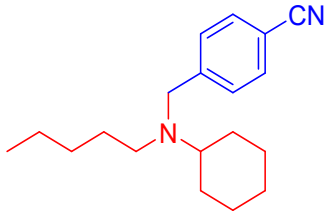


The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Colorless oil (64 mg,70%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.58 (d, *J* = 8.2, 1.8 Hz, 2H), 7.44 (d, *J* = 7.7 Hz, 2H), 3.60 (s, 2H), 2.41 (t, 1H), 2.17 (s, 3H), 1.83 (dd, *J* = 26.0, 12.1 Hz, 4H), 1.63 (d, *J* = 12.9 Hz, 1H), 1.38–1.17 (m, 4H), 1.18–1.02 (m, 1H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 146.7, 132.0, 129.1, 119.2, 110.4, 62.9, 57.6, 37.8, 28.8, 26.4, 26.0.

4-((cyclohexyl(pentyl)amino)methyl)benzonitrile (14)



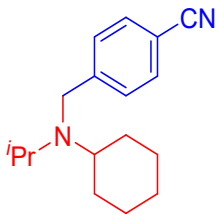
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Colorless oil (48 mg, 42%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.56 (d, *J* = 8.0 Hz, 2H), 7.47 (d, *J* = 8.0 Hz, 2H), 3.64 (s, 2H), 2.52–2.33 (m, 3H), 1.77 (t, 4H), 1.61 (d, 1H), 1.42–1.28 (m, 2H), 1.28–1.11 (m, 8H), 1.12–0.99 (m, 1H), 0.84 (t, *J* = 6.9 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 148.4, 131.9, 128.8, 119.3, 110.1, 59.7, 54.3, 50.7, 29.5, 29.0, 28.5, 26.4, 26.2, 22.6, 14.1.

HRMS (ESI) calcd for $C_{19}H_{29}N_2$ $[M+H]^+$: 285.2325; Found: 285.2321.

4-((cyclohexyl(isopropyl)amino)methyl)benzonitrile (15)



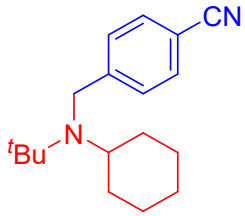
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Yellow oil (82 mg, 80%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.55 (d, *J* = 7.9 Hz, 2H), 7.49 (d, *J* = 7.9 Hz, 2H), 3.72 (s, 2H), 3.09–2.94 (m, 1H), 2.47 (tt, *J* = 11.0, 3.5 Hz, 1H), 1.73 (t, 4H), 1.57 (d, *J* = 13.6, 3.6 Hz, 1H), 1.30–1.13 (m, 5H), 1.00 (d, *J* = 6.6 Hz, 6H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 149.88, 131.87, 128.32, 119.35, 109.82, 57.96, 49.48, 48.57, 31.74, 26.32, 26.19, 20.91.

HRMS (ESI) calcd for $C_{17}H_{25}N_2$ $[M+H]^+$: 257.2012; Found: 257.2007.

4-((tert-butyl(cyclohexyl)amino)methyl)benzonitrile (16)



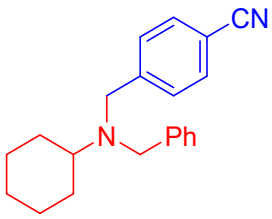
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Colorless oil (89 mg, 82%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.59–7.45 (m, 4H), 3.87 (s, 2H), 2.95 (t, 1H), 1.71 (d, *J* = 11.8 Hz, 4H), 1.56 (t, *J* = 13.3 Hz, 1H), 1.25 (q, 2H), 1.16 (q, *J* = 12.6 Hz, 2H), 1.06 (d, *J* = 2.0 Hz, 9H), 1.00–0.85 (m, 1H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 152.9, 131.7, 127.6, 119.5, 109.3, 56.6, 55.8, 47.1, 33.3, 29.1, 26.6, 26.0.

HRMS (ESI) calcd for $C_{18}H_{27}N_2$ $[M+H]^+$: 271.2168, Found: 271.2164.

4-((benzyl(cyclohexyl)amino)methyl)benzonitrile (17)



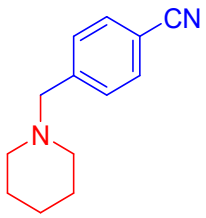
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Yellow oil (61 mg, 50%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.56 (d, *J* = 8.0 Hz, 2H), 7.47 (d, *J* = 8.0 Hz, 2H), 7.34 (d, *J* = 7.5 Hz, 2H), 7.29 (t, *J* = 7.5 Hz, 2H), 7.21 (t, *J* = 7.3 Hz, 1H), 3.66 (d, *J* = 24.8 Hz, 4H), 2.43 (tt, *J* = 11.6, 3.4 Hz, 1H), 1.89 (d, 2H), 1.78 (d, *J* = 12.9, 3.1 Hz, 2H), 1.61 (d, 1H), 1.38–1.25 (m, 2H), 1.21–1.00 (m, 3H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 147.4, 140.5, 132.0, 128.9, 128.4, 128.2, 126.8, 119.2, 110.3, 58.4, 54.2, 53.7, 28.7, 26.4, 26.1.

HRMS (ESI) calcd for $C_{21}H_{25}N_2$ $[M+H]^+$: 305.2012; Found: 305.2007.

4-(piperidin-1-ylmethyl)benzonitrile (18)

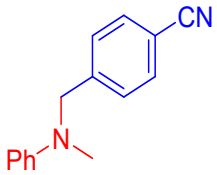


The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Colorless oil (32 mg, 40%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.52 (d, *J* = 7.8 Hz, 2H), 7.37 (d, *J* = 7.8 Hz, 2H), 3.43 (s, 2H), 2.29 (s, 4H), 1.56–1.44 (m, 4H), 1.42–1.30 (m, 2H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 144.9, 132.0, 129.5, 119.1, 110.6, 63.3, 54.6, 26.0, 24.2.

4-((methyl(phenyl)amino)methyl)benzonitrile (19)

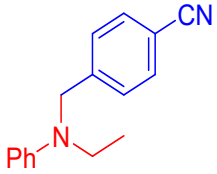


The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Colorless oil (52 mg, 59%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.58 (d, *J* = 8.0 Hz, 2H), 7.33 (d, *J* = 7.9 Hz, 2H), 7.22 (t, *J* = 7.7 Hz, 2H), 6.74 (t, *J* = 7.3 Hz, 1H), 6.69 (d, *J* = 8.2 Hz, 2H), 4.56 (s, 2H), 3.03 (s, 3H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 149.2, 145.1, 132.5, 129.4, 127.4, 119.0, 117.3, 112.5, 110.8, 56.7, 38.9.

4-((ethyl(phenyl)amino)methyl)benzonitrile (20)



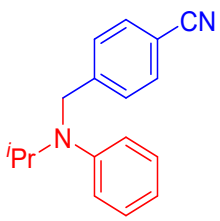
The title compound purified by column chromatography (petroleum ether/EtOAc = 20:1). Yellow oil (80 mg, 85%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.58 (d, *J* = 8.1 Hz, 2H), 7.35 (d, *J* = 8.0 Hz, 2H), 7.19 (t, 2H), 6.70 (t, *J* = 7.3, 1.1 Hz, 1H), 6.64 (d, 2H), 4.54 (s, 2H), 3.48 (q, *J* = 7.1 Hz, 2H), 1.21 (t, *J* = 7.1 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 147.9, 145.4, 132.5, 129.4, 127.3, 119.0, 116.8, 112.3, 110.7, 54.0, 45.6, 12.2.

HRMS (ESI) calcd for $C_{16}H_{17}N_2$: $[M+H]^+$: 237.1386; Found: 237.1382.

4-((isopropyl(phenyl)amino)methyl)benzonitrile (21)



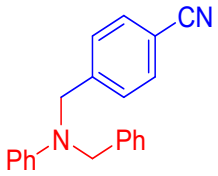
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Yellow oil (67 mg, 67%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.60 (d, J = 8.0 Hz, 2H), 7.42 (d, J = 7.9 Hz, 2H), 7.19 (t, 2H), 6.72 (t, J = 7.3 Hz, 1H), 6.66 (d, J = 8.2 Hz, 2H), 4.45 (s, 2H), 4.36–4.25 (m, 1H), 1.21 (d, J = 6.6 Hz, 6H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 147.7, 145.8, 131.3, 128.3, 126.1, 118.0, 116.2, 112.4, 109.4, 47.4, 47.2, 18.8.

HRMS (ESI) calcd for $C_{17}H_{19}N_2$ $[M+H]^+$: 251.1543; Found: 251.1538.

4-((benzyl(phenyl)amino)methyl)benzonitrile (22)



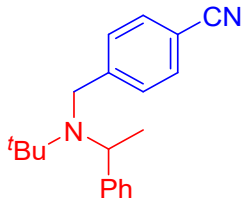
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). White solid (63 mg, 53%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.58 (d, J = 8.0 Hz, 2H), 7.32 (dd, J = 16.2, 7.9 Hz, 4H), 7.24 (dd, J = 16.4, 7.5 Hz, 3H), 7.17 (t, J = 8.5, 7.1 Hz, 2H), 6.73 (t, J = 7.3 Hz, 1H), 6.69 (d, J = 8.2 Hz, 2H), 4.65 (d, J = 10.4 Hz, 4H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 148.7, 144.7, 138.1, 132.6, 129.5, 128.8, 127.4, 127.2, 126.8, 118.9, 117.6, 112.7, 110.9, 54.6, 54.2.

HRMS (ESI) calcd for $C_{21}H_{19}N_2$ $[M+H]^+$: 299.1543; Found: 299.1538.

4-((tert-butyl(1-phenylethyl)amino)methyl)benzonitrile (23)



The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Colorless oil (94 mg, 80%)

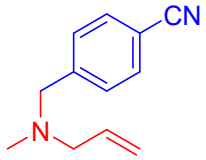
^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.27 (d, J = 8.0 Hz, 2H), 7.22 (d, J = 7.6 Hz, 2H),

7.13 (t, J = 7.5 Hz, 2H), 7.10–7.00 (m, 3H), 4.41 (q, J = 6.9 Hz, 1H), 3.80 (s, 2H), 1.35 (d, J = 7.0 Hz, 3H), 1.05 (s, 9H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 150.2, 144.5, 130.4, 126.9, 126.9, 126.6, 125.4, 118.3, 108.2, 55.3, 53.7, 46.3, 28.3, 16.3.

HRMS (ESI) calcd for $C_{20}H_{25}N_2$ $[M+H]^+$: 293.2012; Found: 293.2007.

4-((allyl(methyl)amino)methyl)benzonitrile (24)



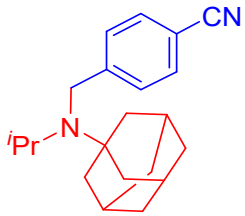
The title compound purified by column chromatography (petroleum ether/EtOAc = 3:1). Colorless oil (22 mg, 30%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.60 (d, J = 8.1, 1.5 Hz, 2H), 7.44 (d, J = 7.7 Hz, 2H), 5.96–5.79 (m, 1H), 5.24–4.99 (m, 2H), 3.53 (s, 2H), 3.03 (d, 2H), 2.18 (s, 3H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 145.2, 135.4, 132.1, 129.4, 119.0, 117.9, 110.8, 61.1, 60.7, 42.2.

HRMS (ESI) calcd for $C_{12}H_{15}N_2$ $[M+H]^+$:187.1230; Found:187.1227.

4-((adamantan-1-yl(isopropyl)amino)methyl)benzonitrile (25)



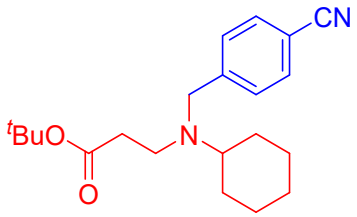
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). White solid (107 mg, 87%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.54 (s, 4H), 3.84 (s, 2H), 3.71–3.49 (m, 1H), 2.00 (s, 3H), 1.65 (d, J = 3.0 Hz, 6H), 1.63–1.51 (m, 6H), 0.99 (d, J = 6.6 Hz, 6H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 153.1, 131.7, 127.5, 119.5, 109.2, 56.1, 44.9, 44.5, 41.4, 36.7, 29.8, 26.9.

HRMS (ESI) calcd for $C_{21}H_{29}N_2$ $[M+H]^+$: 309.2325; Found: 309.2320.

tert-butyl 3-((4-cyanobenzyl)(cyclohexyl)amino)propanoate (26)



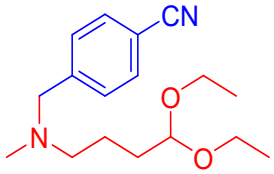
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Yellow oil (82 mg, 60%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.55 (d, *J* = 8.0 Hz, 2H), 7.45 (d, *J* = 7.9 Hz, 2H), 3.67 (s, 2H), 2.78 (t, *J* = 7.0 Hz, 2H), 2.37 (tt, *J* = 11.6, 3.1 Hz, 1H), 2.27 (t, *J* = 7.0 Hz, 2H), 1.83–1.68 (m, 4H), 1.58 (d, *J* = 12.8 Hz, 1H), 1.42 (s, 9H), 1.29–1.09 (m, 4H), 1.09–0.98 (m, 1H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 171.0, 146.6, 130.9, 127.7, 118.2, 109.3, 79.2, 58.9, 53.2, 45.7, 34.8, 27.9, 27.1, 25.2, 25.1.

HRMS (ESI) calcd for $C_{21}H_{31}N_2O_2$ $[M+H]^+$: 343.2380; Found: 343.2375.

4-(((4,4-diethoxybutyl)(methyl)amino)methyl)benzonitrile (27)



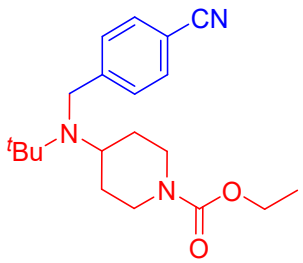
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Colorless oil (82 mg, 71%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.56 (d, *J* = 8.1, 1.4 Hz, 2H), 7.41 (d, *J* = 7.7 Hz, 2H), 4.45 (t, *J* = 5.5 Hz, 1H), 3.69–3.57 (m, 2H), 3.55–3.38 (m, 4H), 2.35 (t, *J* = 7.1 Hz, 2H), 2.14 (s, 3H), 1.65–1.45 (m, 4H), 1.16 (t, *J* = 7.1, 1.4 Hz, 6H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 145.3, 132.1, 129.4, 119.0, 110.7, 102.8, 61.9, 61.1, 57.3, 42.1, 31.3, 22.5, 15.3.

HRMS (ESI) calcd for $C_{17}H_{27}N_2O_2$ $[M+H]^+$:291.2067; Found:291.2062.

ethyl 4-(tert-butyl(4-cyanobenzyl)amino)piperidine-1-carboxylate (28)



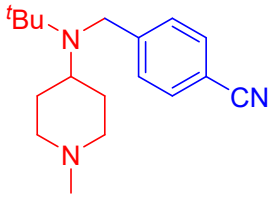
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). White solid (103 mg, 75%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.51 (d, *J* = 8.0 Hz, 2H), 7.46 (d, *J* = 8.0 Hz, 2H), 4.27–3.96 (m, 4H), 3.82 (s, 2H), 3.15 (t, *J* = 11.7, 3.7 Hz, 1H), 2.70 (t, *J* = 13.2 Hz, 2H), 1.62 (d, *J* = 12.6 Hz, 2H), 1.37 (d, *J* = 18.6 Hz, 2H), 1.18 (t, *J* = 7.1 Hz, 3H), 1.07 (s, 9H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 155.3, 151.8, 131.8, 127.4, 119.3, 109.6, 61.2, 55.9, 55.0, 47.0, 43.9, 29.1, 26.9, 14.7.

HRMS (ESI) calcd for $C_{20}H_{30}N_3O_2$ $[M+H]^+$: 342.2187; Found: 342.2182.

4-((tert-butyl(1-methylpiperidin-4-yl)amino)methyl)benzonitrile (29)



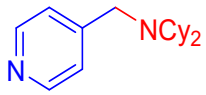
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Colorless oil (71 mg, 62%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.51 (d, *J* = 8.1 Hz, 2H), 7.47 (d, *J* = 8.1 Hz, 2H), 3.87 (s, 2H), 3.05–2.95 (m, 1H), 2.80 (d, *J* = 12.4, 2.7 Hz, 2H), 2.20 (s, 3H), 1.94 (td, *J* = 11.7, 3.0 Hz, 2H), 1.65–1.48 (m, 4H), 1.07 (s, 9H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 152.1, 131.8, 127.5, 119.4, 109.4, 56.0, 55.8, 54.6, 47.0, 46.1, 31.7, 29.1.

HRMS (ESI) calcd for $C_{18}H_{28}N_3$ $[M+H]^+$:286.2278; Found: 286.2274.

N-cyclohexyl-N-(pyridin-4-ylmethyl)cyclohexanamine (30)



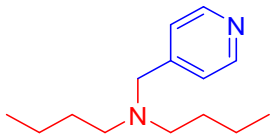
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). White solid (93 mg, 85%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 8.45 (d, *J* = 4.9 Hz, 2H), 7.29 (d, *J* = 4.8 Hz, 2H), 3.71 (s, 2H), 2.49 (t, *J* = 14.6, 9.1, 3.4 Hz, 2H), 1.71 (t, 8H), 1.55 (d, *J* = 13.5, 3.5 Hz, 2H), 1.26–1.10 (m, 8H), 1.08–0.93 (m, 2H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 153.6, 149.3, 122.9, 58.2, 49.4, 31.9, 26.3, 26.2.

HRMS (ESI) calcd for $C_{18}H_{29}N_2$ $[M+H]^+$: 273.2325; Found: 273.2320

N-butyl-N-(pyridin-4-ylmethyl)butan-1-amine (31)



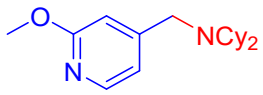
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Colorless oil (36 mg, 41%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 8.51 (d, 2H), 7.27 (d, *J* = 4.7 Hz, 2H), 3.53 (s, 2H), 2.39 (t, *J* = 7.3 Hz, 4H), 1.51–1.36 (m, 4H), 1.36–1.24 (m, 4H), 0.88 (t, *J* = 7.4 Hz, 6H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 150.1, 149.6, 123.6, 57.8, 53.9, 29.4, 20.5, 14.0.

HRMS (ESI) calcd for $C_{14}H_{25}N_2$ $[M+H]^+$:221.2012; Found:221.2009.

N-cyclohexyl-N-((2-methoxypyridin-4-yl)methyl)cyclohexanamine (32)



The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). White solid (63 mg, 52%)

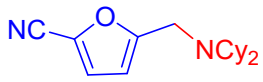
^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 8.03 (d, *J* = 5.2 Hz, 1H), 6.89 (d, *J* = 5.3 Hz, 1H), 6.81 (s, 1H), 3.92 (s, 3H), 3.68 (s, 2H), 2.58–2.46 (m, 2H), 1.73 (t, 8H), 1.57 (t, 2H), 1.26–1.13 (m, 8H), 1.08–0.97 (m, 2H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 164.5, 156.8, 146.1, 116.5, 109.3, 58.1, 53.3, 49.4,

31.9, 26.4, 26.2.

HRMS (ESI) calcd for $C_{19}H_{31}N_2O$ $[M+H]^+$: 303.2430; Found: 303.2426.

5-((dicyclohexylamino)methyl)furan-2-carbonitrile (33)



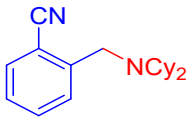
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). White solid (48 mg, 42%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.00 (d, *J* = 3.4 Hz, 1H), 6.29 (d, *J* = 3.5 Hz, 1H), 3.74 (s, 2H), 2.56 (s, 2H), 1.73 (s, 8H), 1.58 (t, 2H), 1.26–1.16 (m, 8H), 1.11–0.93 (m, 2H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 164.2, 124.3, 123.2, 112.1, 107.9, 58.6, 43.9, 31.8, 26.3, 26.1.

HRMS (ESI) calcd for $C_{18}H_{27}N_2O$ $[M+H]^+$:287.2118; Found: 287.3113.

2-((dicyclohexylamino)methyl)benzonitrile (34)



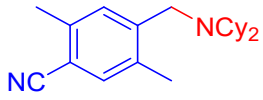
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Colorless oil (92 mg, 78%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.75 (d, *J* = 7.9 Hz, 1H), 7.55 (d, *J* = 7.7 Hz, 1H), 7.50 (t, *J* = 7.6 Hz, 1H), 7.24 (q, 1H), 3.94 (s, 2H), 2.52 (t, *J* = 11.2, 3.4 Hz, 2H), 1.74 (dd, 8H), 1.56 (d, *J* = 13.0, 3.8 Hz, 2H), 1.31–1.09 (m, 8H), 1.08–0.93 (m, 2H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 148.1, 132.5, 132.4, 129.1, 126.6, 118.0, 111.0, 58.4, 48.5, 31.9, 26.4, 26.2.

HRMS (ESI) calcd for $C_{20}H_{29}N_2$ $[M+H]^+$: 297.2325; Found: 297.2320

4-((dicyclohexylamino)methyl)-2,5-dimethylbenzonitrile (35)



The title compound purified by column chromatography (petroleum ether/EtOAc =

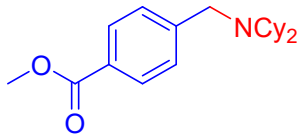
10:1). White solid (109 mg, 84%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.54 (s, 1H), 7.29 (s, 1H), 3.67 (s, 2H), 2.59–2.46 (m, 5H), 2.26 (s, 3H), 1.74 (t, 8H), 1.58 (d, *J* = 12.8, 3.7 Hz, 2H), 1.30–1.12 (m, 8H), 1.10–0.97 (m, 2H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 147.0, 138.9, 133.8, 133.2, 130.0, 118.9, 109.7, 58.3, 47.7, 31.8, 26.4, 26.2, 20.2, 18.5.

HRMS (ESI) calcd for $C_{22}H_{33}N_2$ $[M+H]^+$: 325.2638; Found: 325.2633.

methyl 4-((dicyclohexylamino)methyl)benzoate (36)



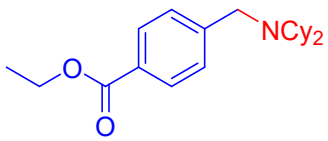
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). White solid (80 mg, 61%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.94 (d, *J* = 7.8 Hz, 2H), 7.44 (d, *J* = 7.9 Hz, 2H), 3.90 (s, 3H), 3.78 (s, 2H), 2.51 (t, *J* = 11.3, 5.6 Hz, 2H), 1.74 (t, *J* = 20.4, 12.9 Hz, 8H), 1.56 (d, *J* = 15.0 Hz, 2H), 1.32–1.11 (m, 8H), 1.08–0.98 (m, 2H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 167.3, 149.8, 129.3, 128.1, 127.6, 58.0, 51.9, 50.1, 31.9, 26.4, 26.3.

HRMS (ESI) calcd for $C_{21}H_{32}NO_2$ $[M+H]^+$: 330.2428; Found: 330.2424.

ethyl 4-((dicyclohexylamino)methyl)benzoate (37)



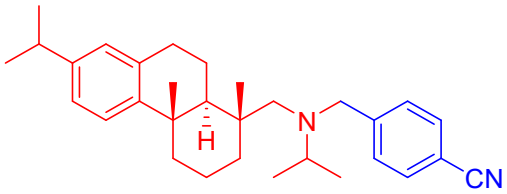
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Colorless oil (64.0 mg, 47%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.95 (d, *J* = 8.1 Hz, 2H), 7.44 (d, *J* = 8.0 Hz, 2H), 4.36 (q, *J* = 7.1 Hz, 2H), 3.78 (s, 2H), 2.59–2.45 (m, 2H), 1.74 (q, *J* = 24.1, 14.8, 3.8 Hz, 8H), 1.56 (d, 2H), 1.38 (t, *J* = 7.1 Hz, 3H), 1.30–1.12 (m, 8H), 1.11–0.93 (m, 2H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 166.9, 149.6, 129.3, 128.4, 127.6, 60.7, 58.0, 50.1, 31.9, 26.4, 26.3, 14.4.

HRMS (ESI) calcd for $C_{22}H_{34}NO_2$ $[M+H]^+$: 344.2584; Found: 344.2579.

4-((isopropyl(((1R,4aS)-7-isopropyl-1,4a-dimethyl-1,2,3,4,4a,9,10,10a-octahydrophenanthren-1-yl)methyl)amino)methyl)benzonitrile (38)



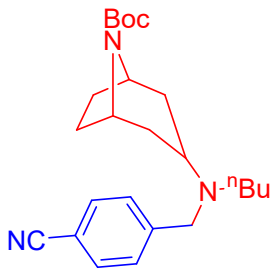
The title compound purified by column chromatography (petroleum ether/EtOAc = 5:1). Colorless oil (54.0 mg, 61%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.53 (d, J = 8.3 Hz, 2H), 7.47 (d, J = 8.0 Hz, 2H), 7.15 (d, J = 8.1 Hz, 1H), 6.98 (d, J = 8.2, 2.0 Hz, 1H), 6.84 (d, J = 2.0 Hz, 1H), 3.70 (t, 2H), 2.93–2.78 (m, 2H), 2.78–2.61 (m, 2H), 2.42 (d, J = 14.2 Hz, 1H), 2.33–2.19 (m, 2H), 1.85–1.75 (m, 1H), 1.75–1.61 (m, 2H), 1.62–1.55 (m, 1H), 1.43 (t, J = 11.6, 9.3, 3.0 Hz, 2H), 1.39–1.26 (m, 2H), 1.22 (d, J = 6.9 Hz, 6H), 1.19 (s, 3H), 0.97 (dd, J = 13.3, 6.6 Hz, 6H), 0.88 (s, 3H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 148.0, 147.7, 145.5, 134.6, 132.0, 128.7, 126.8, 123.9, 123.7, 119.2, 110.1, 62.2, 57.6, 52.5, 46.0, 38.5, 38.4, 37.6, 37.5, 33.4, 29.9, 25.7, 24.0, 24.0, 19.3, 19.2, 18.9, 18.8, 17.1.

HRMS (ESI) calcd for $C_{31}H_{43}N_2$ $[M+H]^+$: 443.3420; Found: 443.3415.

tert-butyl(1R,5S)-3-(butyl(4-cyanobenzyl)amino)-8-azabicyclo[3.2.1]octane-8-carboxylate (39)



The title compound purified by column chromatography (petroleum ether/EtOAc =

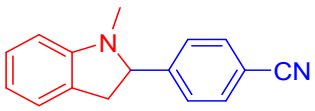
3:1). Colorless oil (48.0 mg, 60%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.57 (d, *J* = 7.9 Hz, 2H), 7.43 (d, *J* = 7.8 Hz, 2H), 4.25 (s, 1H), 4.13 (s, 1H), 3.72–3.51 (m, 2H), 2.70–2.61 (m, 1H), 2.42 (t, *J* = 7.4 Hz, 2H), 2.33 (d, *J* = 16.0 Hz, 1H), 2.24 (s, 1H), 2.09 (s, 1H), 1.98 (d, *J* = 16.5 Hz, 1H), 1.66 (d, *J* = 7.7 Hz, 1H), 1.61 (t, *J* = 8.0 Hz, 2H), 1.45 (d, *J* = 7.0 Hz, 2H), 1.37–1.21 (m, 12H), 0.83 (t, *J* = 7.3 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 154.3, 147.4, 132.1, 128.6, 119.2, 110.3, 79.1, 54.7, 51.2, 50.6, 50.5, 33.4, 31.9, 31.4, 31.0, 29.9, 28.5, 28.3, 20.4, 14.1.

HRMS (ESI) calcd for $C_{24}H_{36}N_3O_2$ $[M+H]^+$: 398.2802; Found: 398.2797.

4-(1-methylindolin-2-yl)benzonitrile (40)



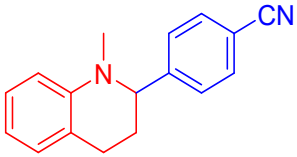
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). White solid (40 mg, 86%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.67 (d, *J* = 8.2, 1.6 Hz, 2H), 7.57 (d, 2H), 7.17 (t, *J* = 7.7 Hz, 1H), 7.08 (d, *J* = 7.1 Hz, 1H), 6.76 (t, *J* = 7.4 Hz, 1H), 6.57 (d, *J* = 7.8 Hz, 1H), 4.43 (t, *J* = 10.8, 9.1 Hz, 1H), 3.38 (dd, *J* = 15.6, 8.9 Hz, 1H), 2.87 (dd, *J* = 15.7, 11.0 Hz, 1H), 2.63 (s, 3H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 153.0, 148.4, 132.6, 128.0, 128.0, 127.9, 124.1, 118.9, 118.7, 111.4, 107.5, 71.7, 39.5, 34.6.

HRMS (ESI) calcd for $C_{17}H_{18}NO_2$ $[M+H]^+$:268.1332; Found: 268.1330.

4-(1-methyl-1,2,3,4-tetrahydroquinolin-2-yl)benzonitrile (41)



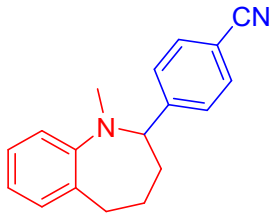
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). White solid (42 mg, 85%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.62 (d, *J* = 8.2, 2.2 Hz, 2H), 7.32 (d, *J* = 8.2, 2.2

Hz, 2H), 7.20 (t, J = 8.0 Hz, 1H), 7.01 (d, J = 7.7 Hz, 1H), 6.75–6.61 (m, 2H), 4.55 (d, 1H), 2.89 (d, J = 2.2 Hz, 3H), 2.66 (d, 1H), 2.52 (t, 1H), 2.30–2.18 (m, 1H), 2.13–1.91 (m, 1H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 150.0, 145.5, 132.4, 128.6, 127.6, 127.4, 122.3, 118.9, 116.3, 110.8, 110.3, 63.2, 37.9, 29.8, 24.0.

4-((2,3,4,5-tetrahydro-1H-benzo[b]azepin-1-yl)methyl)benzonitrile (42)



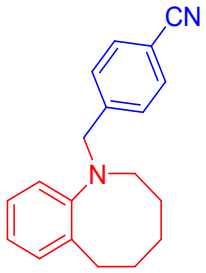
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Colorless oil (65 mg, 62%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.67 (d, J = 8.4 Hz, 2H), 7.61 (d, J = 8.1 Hz, 2H), 7.24 (dd, J = 7.6, 1.7 Hz, 1H), 7.08 (dd, J = 7.3, 1.6 Hz, 1H), 7.01–6.92 (m, 2H), 4.08 (t, J = 5.5, 3.9 Hz, 1H), 3.15–2.84 (m, 1H), 2.69 (s, 3H), 2.67–2.56 (m, 1H), 1.91–1.79 (m, 1H), 1.77–1.61 (m, 1H), 1.56 (s, 1H), 1.54–1.44 (m, 1H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 149.7, 148.8, 134.0, 132.3, 128.8, 128.0, 127.2, 121.9, 119.1, 118.2, 110.5, 66.7, 40.0, 31.6, 30.4, 19.5.

HRMS (ESI) calcd for $C_{18}H_{18}N_2$ $[M+H]^+$:263.1542; Found:263.1538.

4-((3,4,5,6-tetrahydrobenzo[b]azocin-1(2H)-yl)methyl)benzonitrile (43)



The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Colorless oil (50 mg, 89%)

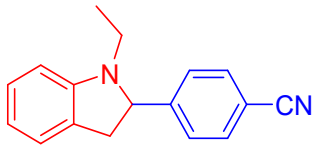
^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.59 (q, J = 8.2 Hz, 4H), 7.21 (d, J = 3.9 Hz, 2H), 7.16 (d, J = 7.4 Hz, 1H), 7.12–7.06 (m, 1H), 4.21 (s, 2H), 2.95–2.86 (m, 2H), 2.72 (t, J =

5.9 Hz, 2H), 1.78–1.67 (m, 2H), 1.65–1.56 (m, 2H), 1.26–1.17 (m, 2H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 149.4, 145.8, 142.7, 132.1, 129.7, 129.2, 127.2, 125.5, 122.5, 119.1, 110.6, 60.6, 59.6, 32.8, 32.7, 28.2, 26.7.

HRMS (ESI) calcd for $C_{19}H_{21}N_2$ $[M+H]^+$:277.1699; Found:277.1694.

4-(1-ethylindolin-2-yl)benzonitrile (44)



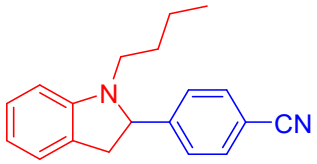
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). White solid (40 mg, 79%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.66 (d, 2H), 7.56 (d, 2H), 7.14 (t, J = 7.6 Hz, 1H), 7.05 (d, J = 7.3, 1.3 Hz, 1H), 6.71 (t, J = 7.4, 1.0 Hz, 1H), 6.54 (d, J = 7.8 Hz, 1H), 4.72 (t, J = 9.8 Hz, 1H), 3.41 (dd, J = 15.7, 9.3 Hz, 1H), 3.33–3.17 (m, 1H), 3.05–2.91 (m, 1H), 2.86 (dd, J = 15.5, 10.2, 1.1 Hz, 1H), 1.03 (t, J = 7.2 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 151.5, 149.1, 132.5, 128.0, 127.9, 127.8, 124.2, 118.9, 118.0, 111.4, 107.1, 67.6, 40.7, 39.6, 10.6.

HRMS (ESI) calcd for $C_{17}H_{17}N_2$ $[M+H]^+$:249.1386; Found: 249.1385.

4-(1-butylindolin-2-yl)benzonitrile (45)



The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Colorless oil (48 mg, 86%)

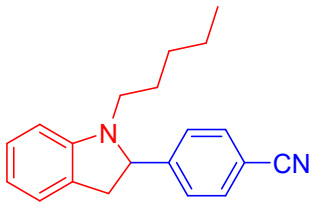
^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.65 (d, 2H), 7.53 (d, 2H), 7.13 (t, 1H), 7.04 (d, J = 7.2, 1.3 Hz, 1H), 6.70 (t, J = 7.4, 1.0 Hz, 1H), 6.51 (d, J = 7.8 Hz, 1H), 4.71 (t, J = 9.6 Hz, 1H), 3.43 (dd, J = 15.8, 9.4 Hz, 1H), 3.16–3.02 (m, 1H), 2.94–2.79 (m, 2H), 1.53–1.37 (m, 2H), 1.36–1.17 (m, 2H), 0.86 (t, J = 7.4 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 152.0, 149.2, 132.5, 128.0, 127.9, 127.5, 124.2,

118.9, 117.8, 111.4, 106.8, 68.4, 46.9, 39.6, 28.3, 20.5, 13.9.

HRMS (ESI) calcd for $C_{19}H_{21}N_2$ $[M+H]^+$:277.1699; Found: 277.1697.

4-(1-pentylindolin-2-yl)benzonitrile (46)



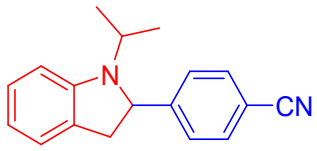
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Colorless oil (45 mg, 77%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.65 (d, 2H), 7.53 (d, 2H), 7.13 (t, *J* = 7.7, 1.1 Hz, 1H), 7.04 (d, *J* = 7.2, 1.3 Hz, 1H), 6.69 (t, *J* = 7.3, 0.9 Hz, 1H), 6.51 (d, *J* = 7.8 Hz, 1H), 4.70 (t, *J* = 9.6 Hz, 1H), 3.42 (dd, *J* = 15.7, 9.4 Hz, 1H), 3.16–3.03 (m, 1H), 2.92–2.78 (m, 2H), 1.52–1.39 (m, 2H), 1.30–1.16 (m, 4H), 0.84 (t, *J* = 7.1 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 150.4, 144.4, 132.3, 129.1, 127.6, 127.5, 121.7, 119.0, 115.6, 110.7, 110.1, 61.3, 50.3, 29.3, 26.4, 23.6, 22.6, 14.1.

HRMS (ESI) calcd for $C_{20}H_{23}N_2$ $[M+H]^+$:291.1856; Found: 291.1852.

4-(1-isopropylindolin-2-yl)benzonitrile (47)



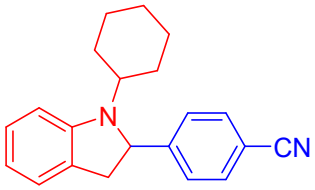
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). White solid (47 mg, 90%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.63 (d, 2H), 7.56 (d, 2H), 7.12 (t, *J* = 7.8, 1.2 Hz, 1H), 7.01 (d, 1H), 6.70 (t, *J* = 7.3, 0.9 Hz, 1H), 6.63 (d, *J* = 7.9 Hz, 1H), 4.79 (t, *J* = 10.1, 8.9 Hz, 1H), 3.69–3.56 (m, 1H), 3.49 (dd, *J* = 16.0, 10.1 Hz, 1H), 2.80 (dd, *J* = 16.0, 8.9, 1.1 Hz, 1H), 1.22 (d, *J* = 6.8 Hz, 3H), 0.97 (d, *J* = 6.9 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 152.0, 151.1, 132.5, 127.9, 127.7, 127.6, 124.3, 119.0, 118.0, 111.0, 108.6, 64.7, 48.6, 40.2, 19.7, 19.0.

HRMS (ESI) calcd for $C_{18}H_{19}N_2$ $[M+H]^+$:263.1543; Found: 263.1541.

4-(1-cyclohexylindolin-2-yl)benzonitrile (48)



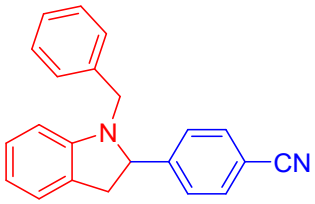
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Colorless oil (55 mg, 90%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.62 (d, *J* = 8.1 Hz, 2H), 7.53 (d, *J* = 8.0 Hz, 2H), 7.11 (t, *J* = 7.7 Hz, 1H), 6.99 (d, *J* = 7.0 Hz, 1H), 6.67 (t, *J* = 7.3 Hz, 1H), 6.61 (d, *J* = 7.9 Hz, 1H), 4.85 (t, *J* = 10.3, 8.3 Hz, 1H), 3.51 (dd, *J* = 16.1, 10.3 Hz, 1H), 3.23 (tt, *J* = 12.0, 3.5 Hz, 1H), 2.77 (dd, *J* = 16.0, 8.2 Hz, 1H), 1.92–1.74 (m, 2H), 1.74–1.64 (m, 1H), 1.64–1.55 (m, 2H), 1.54–1.42 (m, 1H), 1.29–1.15 (m, 2H), 1.12–0.96 (m, 2H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 152.4, 151.2, 132.5, 127.7, 127.6, 127.4, 124.3, 119.0, 117.7, 110.9, 108.1, 64.4, 57.5, 40.2, 31.2, 28.9, 26.3, 26.1, 25.8.

HRMS (ESI) calcd for $C_{21}H_{23}N_2$ $[M+H]^+$:303.1856; Found: 303.1853.

4-(1-benzylindolin-2-yl)benzonitrile (49)

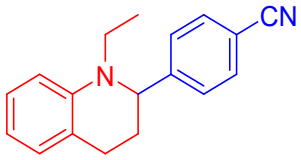


The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Colorless oil (54 mg, 86%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.52 (d, 2H), 7.42 (d, 2H), 7.21–7.07 (m, 5H), 6.99 (t, *J* = 7.7 Hz, 2H), 6.64 (t, *J* = 7.4, 1.0 Hz, 1H), 6.39 (d, 1H), 4.58 (t, *J* = 9.6 Hz, 1H), 4.27 (d, *J* = 15.8 Hz, 1H), 3.89 (d, *J* = 15.7 Hz, 1H), 3.34 (dd, *J* = 15.7, 9.3 Hz, 1H), 2.85 (dd, *J* = 15.7, 10.0, 1.2 Hz, 1H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 152.1, 148.4, 137.7, 132.6, 132.4, 128.6, 128.2, 127.9, 127.7, 127.2, 124.3, 118.8, 118.6, 111.5, 107.8, 68.7, 51.4, 39.5.

4-(1-ethyl-1,2,3,4-tetrahydroquinolin-2-yl)benzonitrile (50)



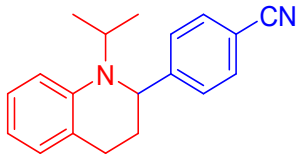
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Colorless oil (47 mg, 90%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.59 (d, 2H), 7.33 (d, J = 8.1 Hz, 2H), 7.16 (t, J = 7.8, 1.6 Hz, 1H), 6.99 (d, J = 7.3, 1.5 Hz, 1H), 6.75 (d, J = 8.2 Hz, 1H), 6.64 (t, J = 7.3, 1.1 Hz, 1H), 4.64 (t, J = 4.5 Hz, 1H), 3.62–3.46 (m, 1H), 3.12–2.95 (m, 1H), 2.60 (dt, J = 15.8, 4.3 Hz, 1H), 2.51–2.37 (m, 1H), 2.23–2.08 (m, 1H), 2.06–1.97 (m, 1H), 1.14 (t, J = 7.1 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 150.0, 145.5, 132.4, 128.6, 127.6, 127.4, 122.3, 118.9, 116.3, 110.8, 110.3, 63.2, 37.9, 29.8, 24.0.

HRMS (ESI) calcd for $C_{18}H_{19}N_2$ $[M+H]^+$:263.1543; Found: 263.1541.

4-(1-isopropyl-1,2,3,4-tetrahydroquinolin-2-yl)benzonitrile (51)



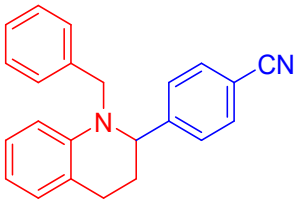
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Colorless oil (50 mg, 90%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.55 (d, 2H), 7.33 (d, J = 8.2 Hz, 2H), 7.17 (t, J = 8.0, 1.7 Hz, 1H), 6.99 (d, J = 7.3 Hz, 1H), 6.92 (d, J = 8.4 Hz, 1H), 6.64 (t, J = 7.3, 1.0 Hz, 1H), 4.78 (t, J = 3.9 Hz, 1H), 4.46–4.16 (m, 1H), 2.56 (d, J = 16.2, 3.6 Hz, 1H), 2.43–2.25 (m, 1H), 2.10–1.89 (m, 2H), 1.22 (d, J = 6.5 Hz, 3H), 1.02 (d, J = 6.8 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 152.1, 144.3, 132.1, 129.7, 127.5, 127.4, 122.2, 119.1, 115.7, 111.5, 110.3, 53.9, 48.4, 28.2, 23.4, 21.1, 19.0.

HRMS (ESI) calcd for $C_{19}H_{21}N_2$ $[M+H]^+$:277.1699; Found: 277.1697.

4-(1-benzyl-1,2,3,4-tetrahydroquinolin-2-yl)benzonitrile (52)

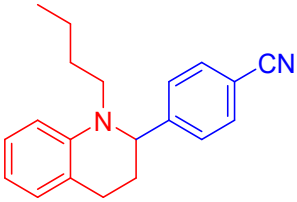


The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Colorless oil (56 mg, 86%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.58 (d, *J* = 8.1 Hz, 2H), 7.33–7.26 (m, 4H), 7.23 (t, 1H), 7.19 (d, *J* = 7.6 Hz, 2H), 7.04 (t, 1H), 7.01 (d, *J* = 7.4 Hz, 1H), 6.65 (t, *J* = 7.3 Hz, 1H), 6.61 (d, *J* = 8.3 Hz, 1H), 4.80–4.67 (m, 2H), 4.14 (d, *J* = 17.3 Hz, 1H), 2.64 (dt, *J* = 16.0, 4.1 Hz, 1H), 2.52 (ddd, *J* = 16.3, 12.6, 4.4 Hz, 1H), 2.41–2.28 (m, 1H), 2.15–1.99 (m, 1H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 149.8, 144.7, 138.0, 132.4, 129.1, 128.8, 127.7, 127.6, 127.1, 126.4, 121.8, 118.9, 116.4, 111.0, 110.8, 61.2, 53.0, 29.1, 23.4.

4-(1-butyl-1,2,3,4-tetrahydroquinolin-2-yl)benzonitrile (53)

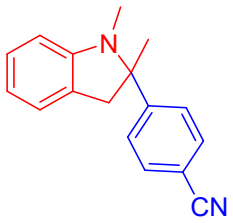


The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Colorless oil (52 mg, 89%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.59 (d, 2H), 7.30 (d, 2H), 7.16 (t, *J* = 7.8, 1.6 Hz, 1H), 6.98 (d, *J* = 7.3, 1.5 Hz, 1H), 6.72 (d, *J* = 8.2 Hz, 1H), 6.64 (t, *J* = 7.3, 1.1 Hz, 1H), 4.65 (t, *J* = 4.4 Hz, 1H), 3.56–3.40 (m, 1H), 2.98–2.85 (m, 1H), 2.60 (dt, *J* = 16.0, 4.2 Hz, 1H), 2.49–2.37 (m, 1H), 2.26–2.12 (m, 1H), 2.07–1.95 (m, 1H), 1.71–1.52 (m, 2H), 1.41–1.22 (m, 2H), 0.93 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 150.4, 144.4, 132.3, 129.1, 127.6, 127.5, 121.7, 119.0, 115.7, 110.7, 110.2, 61.3, 50.0, 29.0, 28.9, 23.6, 20.3, 14.0.

4-(1,2-dimethylindolin-2-yl)benzonitrile (54)



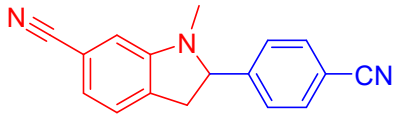
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Colorless oil (33 mg, 67%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.63 (dd, *J* = 9.4, 7.4 Hz, 4H), 7.15 (t, *J* = 7.8 Hz, 1H), 7.03 (d, *J* = 7.2 Hz, 1H), 6.69 (t, *J* = 7.4 Hz, 1H), 6.44 (d, *J* = 7.8 Hz, 1H), 3.09 (s, 2H), 2.59 (s, 3H), 1.59 (s, 3H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 152.2, 151.4, 132.3, 128.0, 127.0, 126.6, 124.2, 118.9, 117.6, 110.7, 106.2, 70.3, 47.2, 29.5, 20.7.

HRMS (ESI) calcd for $C_{17}H_{17}N_2$ $[M+H]^+$:249.1386; Found: 2249.1385.

2-(4-cyanophenyl)-1-methylindoline-6-carbonitrile (55)



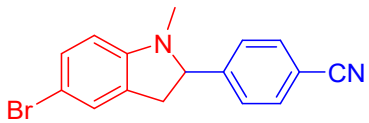
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Colorless oil (32 mg, 62%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.68 (d, 2H), 7.51 (d, *J* = 8.1 Hz, 2H), 7.09 (d, *J* = 7.4 Hz, 1H), 7.02 (d, *J* = 7.4, 1.3 Hz, 1H), 6.66 (s, 1H), 4.56 (t, *J* = 9.8 Hz, 1H), 3.45 (dd, *J* = 16.5, 9.2 Hz, 1H), 2.89 (dd, *J* = 16.6, 10.5, 1.4 Hz, 1H), 2.64 (s, 3H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 153.1, 147.1, 133.4, 132.8, 127.8, 124.5, 123.2, 119.7, 118.6, 112.0, 111.5, 109.0, 70.9, 39.2, 33.8.

HRMS (ESI) calcd for $C_{17}H_{14}N_3$ $[M+H]^+$:260.1182; Found: 260.1181.

4-(5-bromo-1-methylindolin-2-yl)benzonitrile (56)



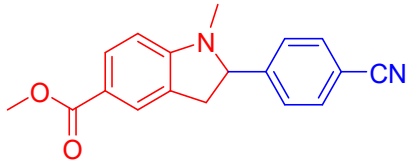
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Colorless oil (44 mg, 75%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.66 (d, 2H), 7.53 (d, 2H), 7.23 (d, *J* = 8.3, 2.0 Hz, 1H), 7.14 (s, 1H), 6.40 (d, *J* = 8.3 Hz, 1H), 4.44 (dd, *J* = 10.7, 9.0 Hz, 1H), 3.35 (dd, *J* = 15.9, 9.0 Hz, 1H), 2.84 (dd, *J* = 16.0, 10.8, 1.2 Hz, 1H), 2.59 (s, 3H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 152.0, 147.6, 132.6, 130.5, 130.1, 127.9, 127.1, 118.7, 111.7, 110.2, 108.7, 71.5, 39.0, 34.4.

HRMS (ESI) calcd for $C_{16}H_{14}BrN_2$ $[M+H]^+$:313.0335; Found: 313.0333.

methyl 2-(4-cyanophenyl)-1-methylindoline-5-carboxylate (57)



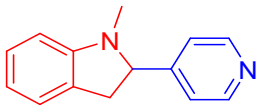
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Colorless oil (52 mg, 88%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.66 (d, 2H), 7.53 (d, 2H), 7.45 (d, *J* = 7.6, 1.5 Hz, 1H), 7.15 (s, 1H), 7.08 (d, *J* = 7.6 Hz, 1H), 4.49 (t, *J* = 10.7, 8.9 Hz, 1H), 3.90 (s, 3H), 3.41 (dd, *J* = 16.3, 9.0 Hz, 1H), 2.92–2.81 (m, 1H), 2.65 (s, 3H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 167.5, 153.1, 147.8, 133.4, 132.6, 130.1, 127.9, 123.7, 120.8, 118.7, 111.7, 107.6, 71.4, 52.1, 39.3, 34.3.

HRMS (ESI) calcd for $C_{18}H_{17}N_2O_2$ $[M+H]^+$:293.1285; Found: 293.1281.

1-methyl-2-(pyridin-4-yl)indoline (58)

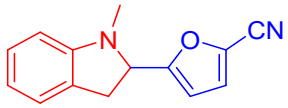


The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Colorless oil (22 mg, 51%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 8.60 (d, 2H), 7.37 (d, 2H), 7.16 (t, 1H), 7.07 (d, 1H), 6.75 (td, *J* = 7.4, 1.0 Hz, 1H), 6.56 (d, *J* = 7.8 Hz, 1H), 4.35 (dd, *J* = 11.0, 9.0 Hz, 1H), 3.38 (dd, *J* = 15.6, 9.0 Hz, 1H), 2.86 (dd, *J* = 15.5, 11.0, 1.2 Hz, 1H), 2.64 (s, 3H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 150.4, 128.3, 126.3, 124.5, 119.7, 118.3, 116.5, 108.3, 56.4, 34.3, 34.2.

5-(1-methylindolin-2-yl)furan-2-carbonitrile (59)



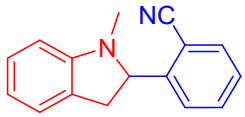
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). White solid (35 mg, 77%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.16 (t, *J* = 7.7 Hz, 1H), 7.13–7.07 (m, 2H), 6.77 (t, *J* = 7.5, 2.0 Hz, 1H), 6.55 (d, *J* = 7.8, 1.9 Hz, 1H), 6.44 (s, 1H), 4.44 (t, *J* = 9.8, 1.9 Hz, 1H), 3.37 (dd, 1H), 3.14 (dd, *J* = 15.6, 10.3 Hz, 1H), 2.73 (s, 3H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 161.1, 152.0, 128.0, 127.4, 125.7, 124.2, 122.9, 119.0, 111.5, 108.6, 107.9, 64.4, 35.6, 34.9.

HRMS (ESI) calcd for $C_{14}H_{13}N_2O$ $[M+H]^+$:225.1022; Found: 225.1021.

2-(1-methylindolin-2-yl)benzonitrile (60)



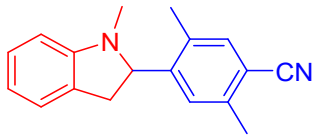
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). White solid (29 mg, 62%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.77 (d, *J* = 7.9 Hz, 1H), 7.69 (d, *J* = 7.8 Hz, 1H), 7.63 (t, *J* = 7.8 Hz, 1H), 7.40 (t, *J* = 7.7, 1.9 Hz, 1H), 7.17 (t, *J* = 7.8 Hz, 1H), 7.08 (d, *J* = 7.3 Hz, 1H), 6.76 (t, *J* = 7.4, 2.0 Hz, 1H), 6.58 (d, 1H), 4.84 (t, 1H), 3.60 (dd, 1H), 2.85 (t, 1H), 2.68 (s, 3H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 152.9, 146.9, 133.4, 133.1, 129.5, 127.9, 127.7, 127.2, 124.2, 118.8, 117.5, 111.8, 107.6, 69.5, 38.5, 34.9.

HRMS (ESI) calcd for $C_{16}H_{15}N_2$ $[M+H]^+$:235.1230; Found: 235.1228.

2,5-dimethyl-4-(1-methylindolin-2-yl)benzonitrile (61)



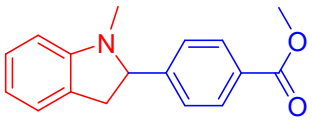
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Colorless oil (38 mg, 73%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 7.58 (s, 1H), 7.42 (s, 1H), 7.18 (t, *J* = 7.8 Hz, 1H), 7.08 (d, *J* = 7.2 Hz, 1H), 6.76 (t, *J* = 7.4, 2.1 Hz, 1H), 6.60 (d, *J* = 8.6 Hz, 1H), 4.60 (t, 1H), 3.45 (dd, *J* = 15.7, 9.1 Hz, 1H), 2.73 (dd, *J* = 15.3, 11.5 Hz, 1H), 2.66 (s, 3H), 2.52 (s, 3H), 2.36 (s, 3H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 153.1, 146.2, 140.0, 134.2, 134.0, 128.1, 127.9, 127.6, 124.2, 118.6, 118.4, 111.1, 107.6, 68.3, 37.5, 35.0, 20.2, 18.4.

HRMS (ESI) calcd for $C_{18}H_{19}N_2$ $[M+H]^+$:263.1543; Found: 263.1541.

methyl 4-(1-methylindolin-2-yl)benzoate (62)



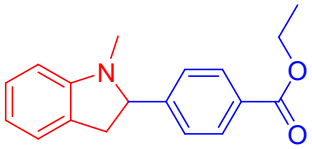
The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Colorless oil (22 mg, 40%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 8.05 (d, 2H), 7.52 (d, *J* = 8.2 Hz, 2H), 7.16 (t, *J* = 7.7 Hz, 1H), 7.07 (d, *J* = 7.2 Hz, 1H), 6.74 (t, *J* = 7.4 Hz, 1H), 6.55 (d, *J* = 7.8 Hz, 1H), 4.42 (t, 1H), 3.93 (s, 3H), 3.36 (dd, *J* = 15.7, 8.9 Hz, 1H), 2.90 (dd, *J* = 15.6, 11.1 Hz, 1H), 2.62 (s, 3H).

^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 167.0, 153.2, 148.0, 130.0, 129.5, 128.2, 127.8, 127.3, 124.1, 118.4, 107.3, 71.8, 52.1, 39.5, 34.5.

HRMS (ESI) calcd for $C_{17}H_{18}NO_2$ $[M+H]^+$:268.1332; Found: 268.1330.

ethyl 4-(1-methylindolin-2-yl)benzoate (63)



The title compound purified by column chromatography (petroleum ether/EtOAc = 10:1). Colorless oil (28 mg, 50%)

^{1}H NMR (600 MHz, $CDCl_3$, ppm) δ 8.06 (d, 2H), 7.52 (d, *J* = 7.8 Hz, 2H), 7.16 (t, *J* =

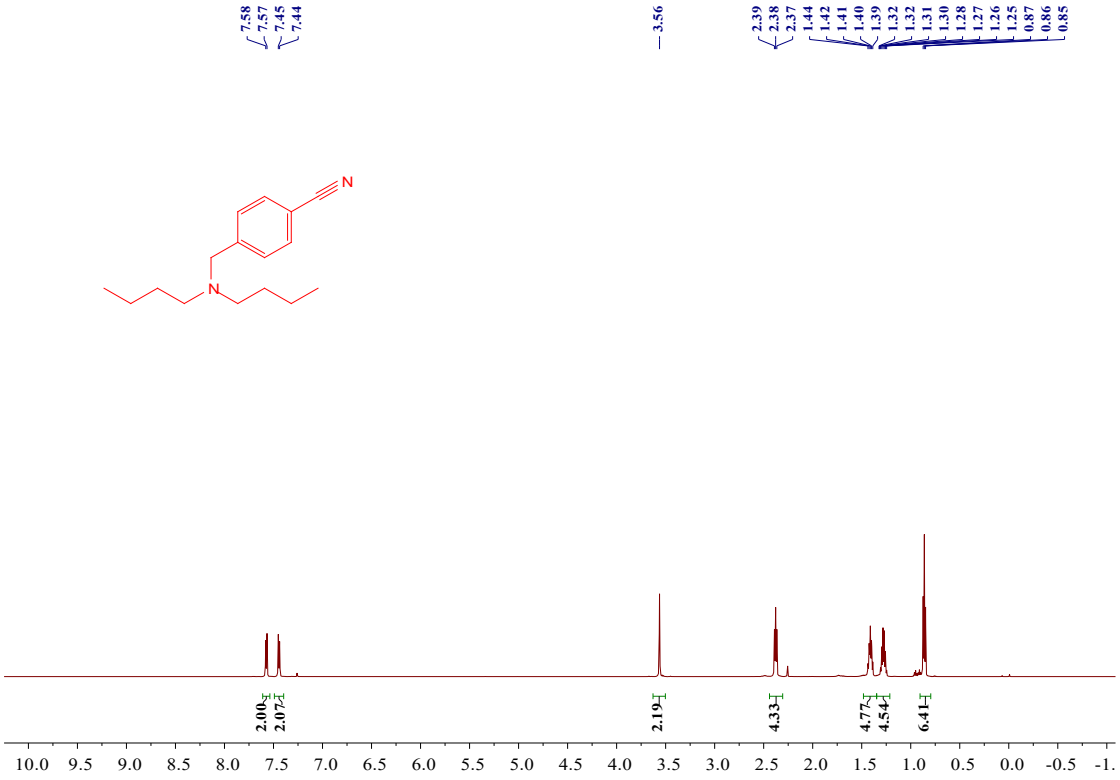
7.7 Hz, 1H), 7.07 (d, *J* = 7.5 Hz, 1H), 6.74 (t, *J* = 7.4 Hz, 1H), 6.55 (d, *J* = 7.8 Hz, 1H), 4.47–4.35 (m, 3H), 3.36 (dd, *J* = 15.9, 9.0 Hz, 1H), 2.90 (dd, *J* = 15.6, 11.1 Hz, 1H), 2.62 (s, 3H), 1.41 (t, 3H).

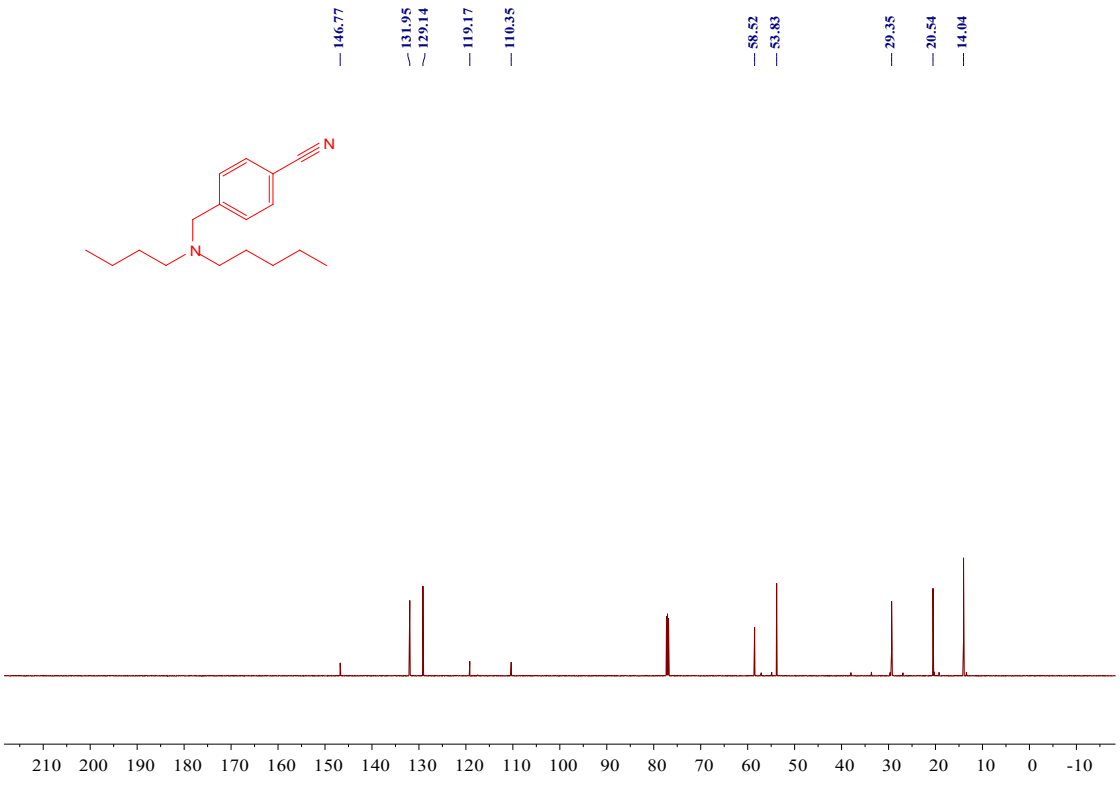
^{13}C NMR (150 MHz, $CDCl_3$, ppm) δ 166.5, 153.2, 147.9, 130.0, 129.9, 128.2, 127.8, 127.2, 124.1, 118.4, 107.3, 71.9, 61.0, 39.5, 34.5, 14.4.

HRMS (ESI) calcd for $C_{18}H_{20}NO_2$ $[M+H]^+$:282.1489; Found: 282.1486.

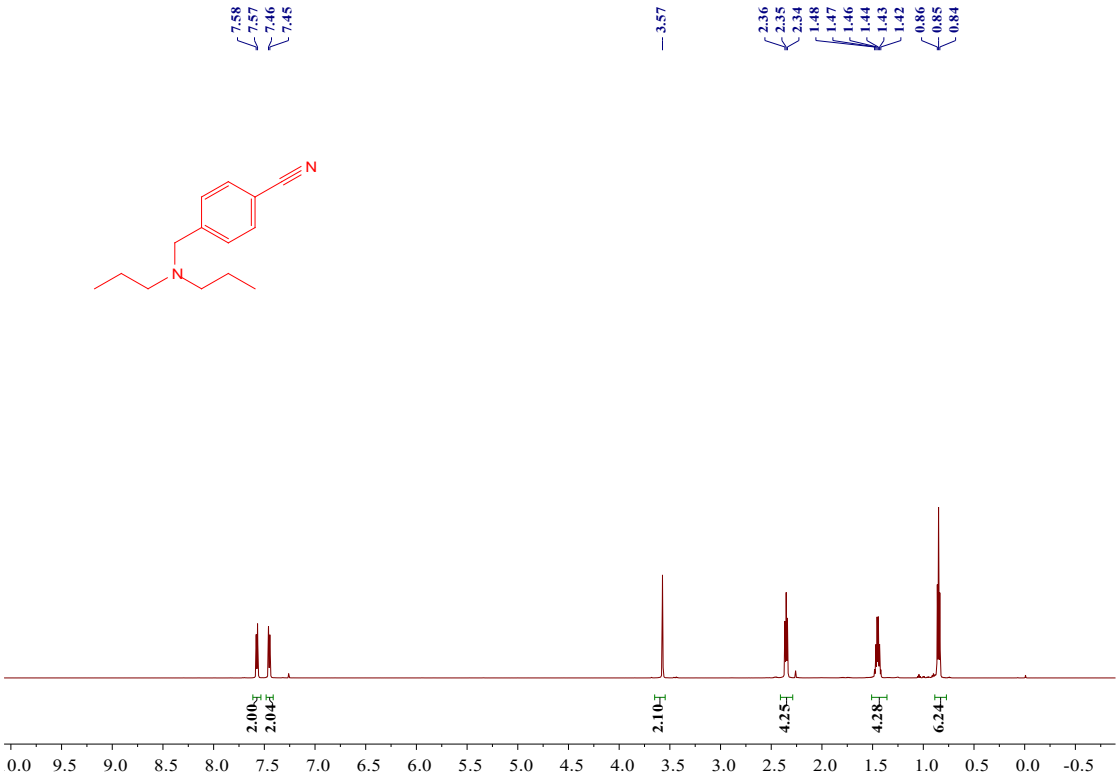
8. NMR Spectra

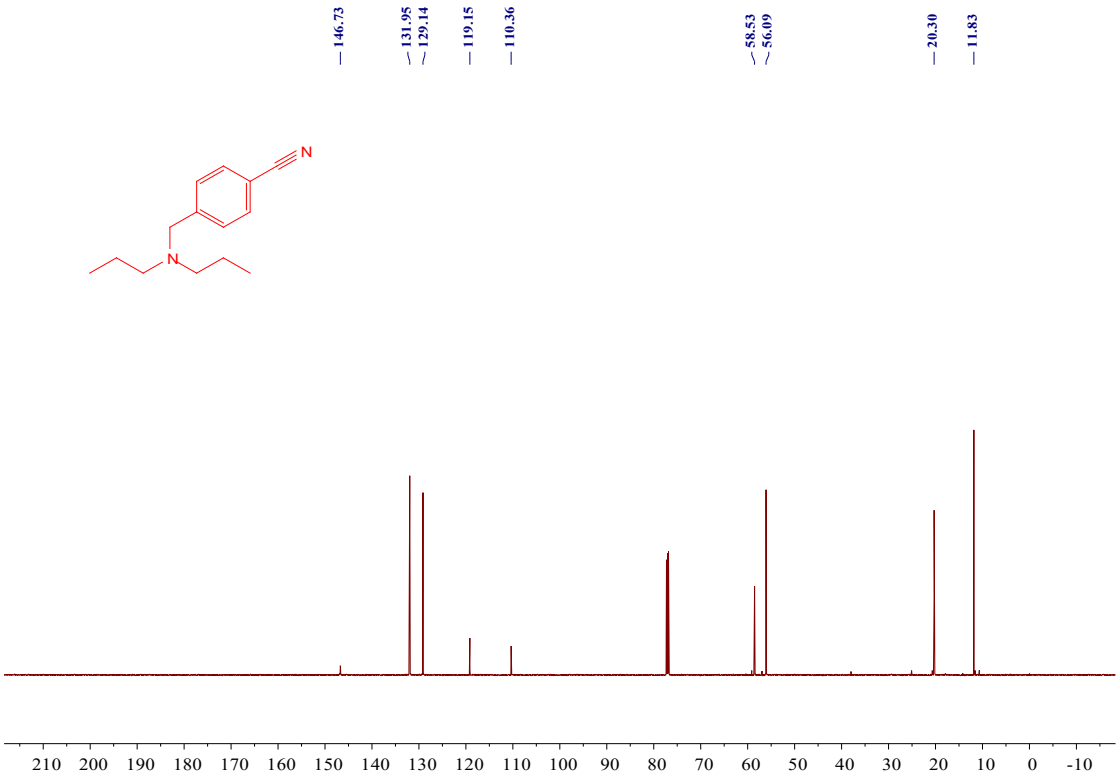
4-((dibutylamino)methyl)benzonitrile (1)



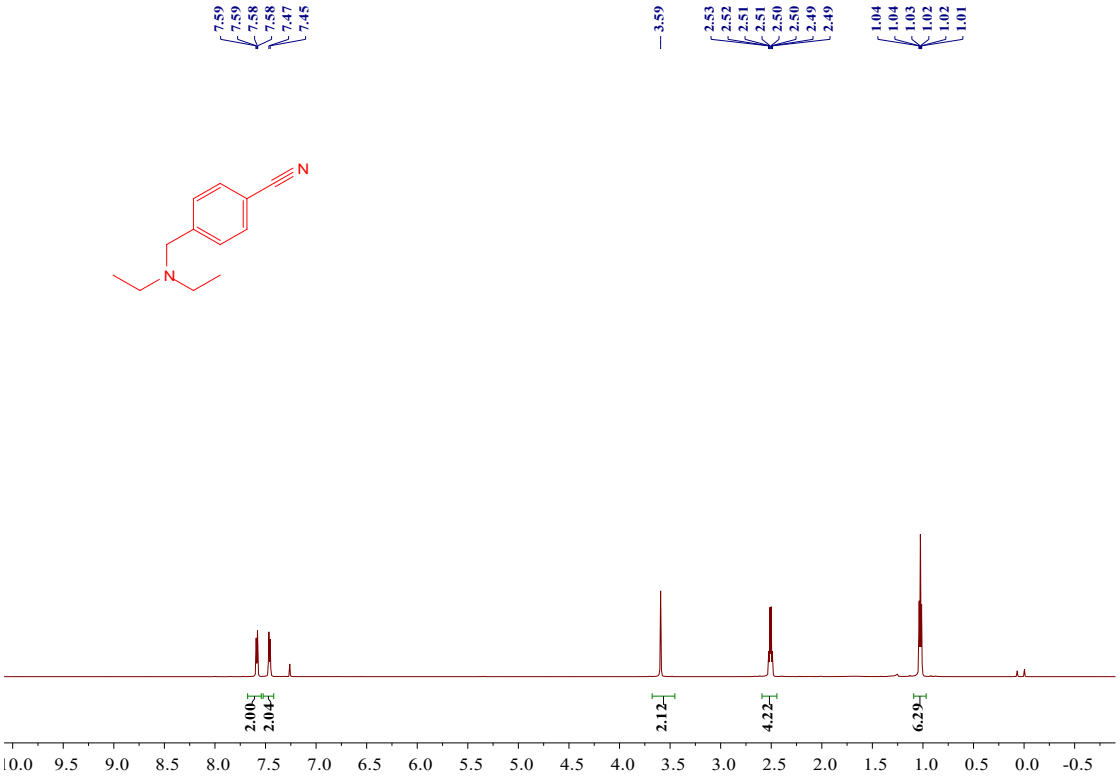


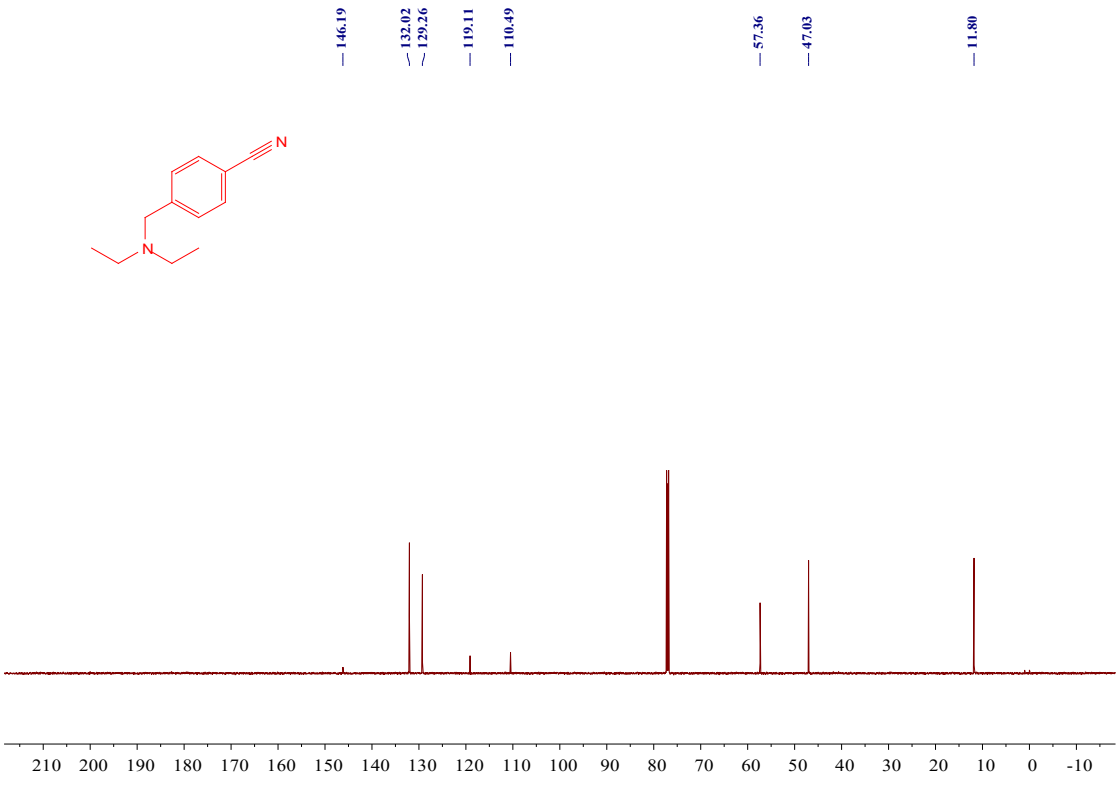
4-((dipropylamino)methyl)benzonitrile (2)



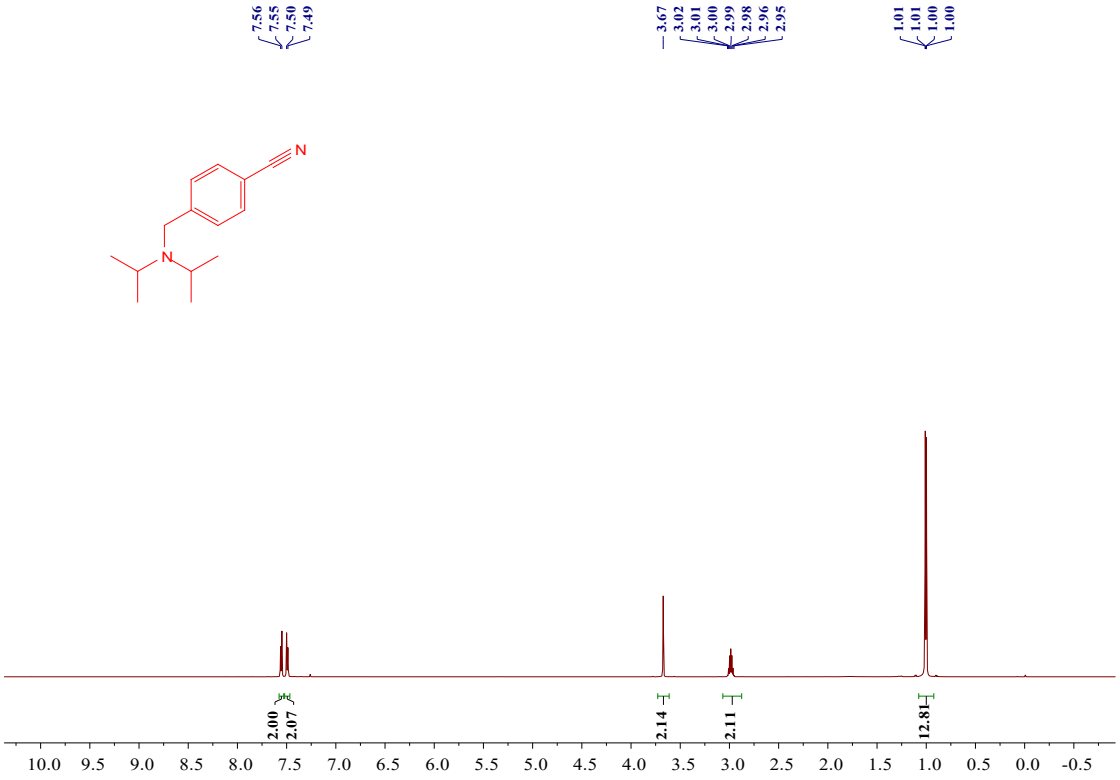


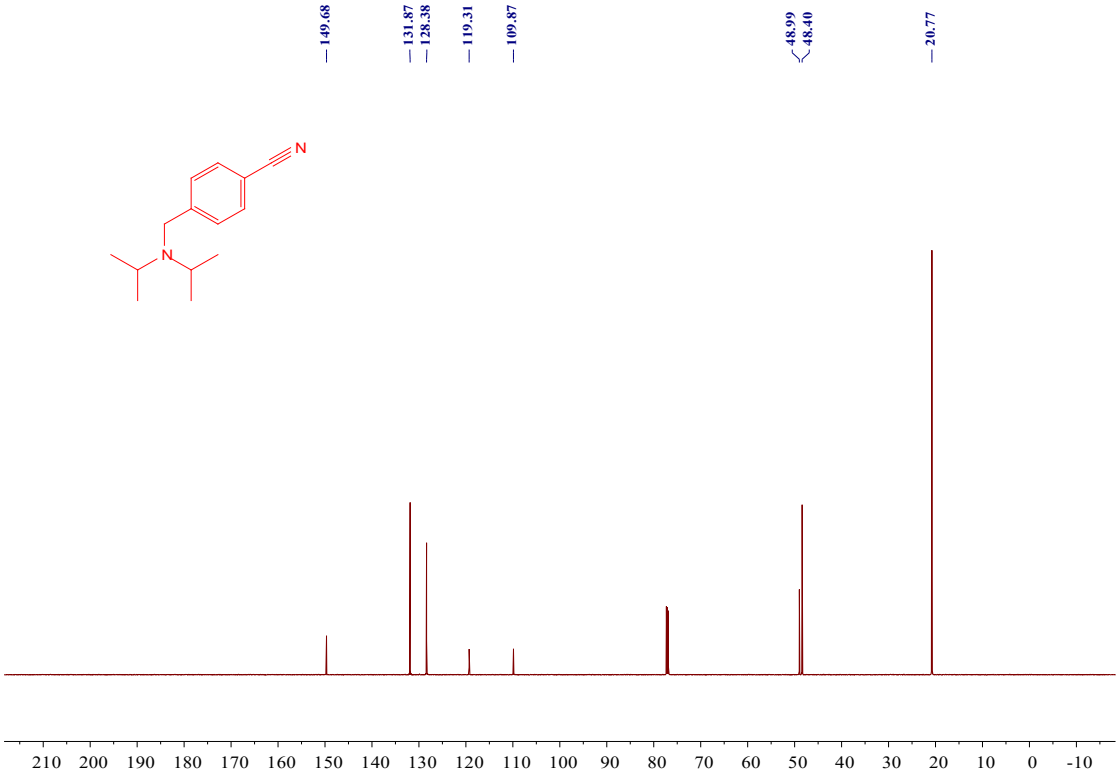
4-((diethylamino)methyl)benzonitrile (3)



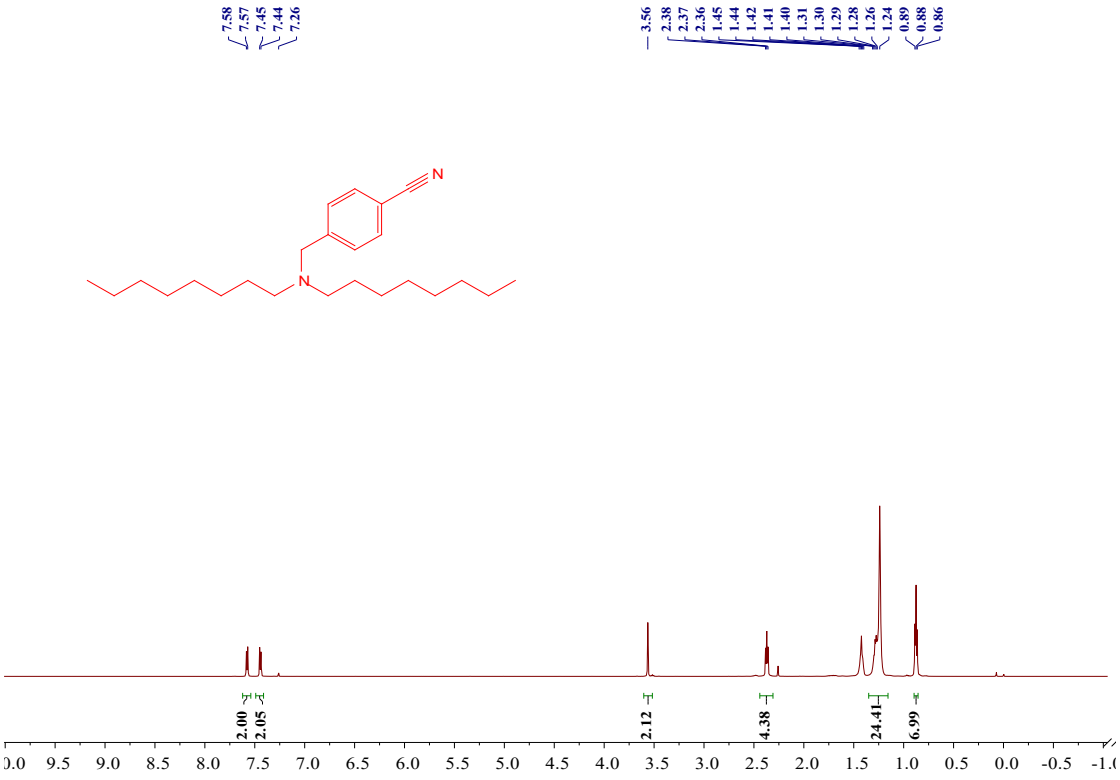


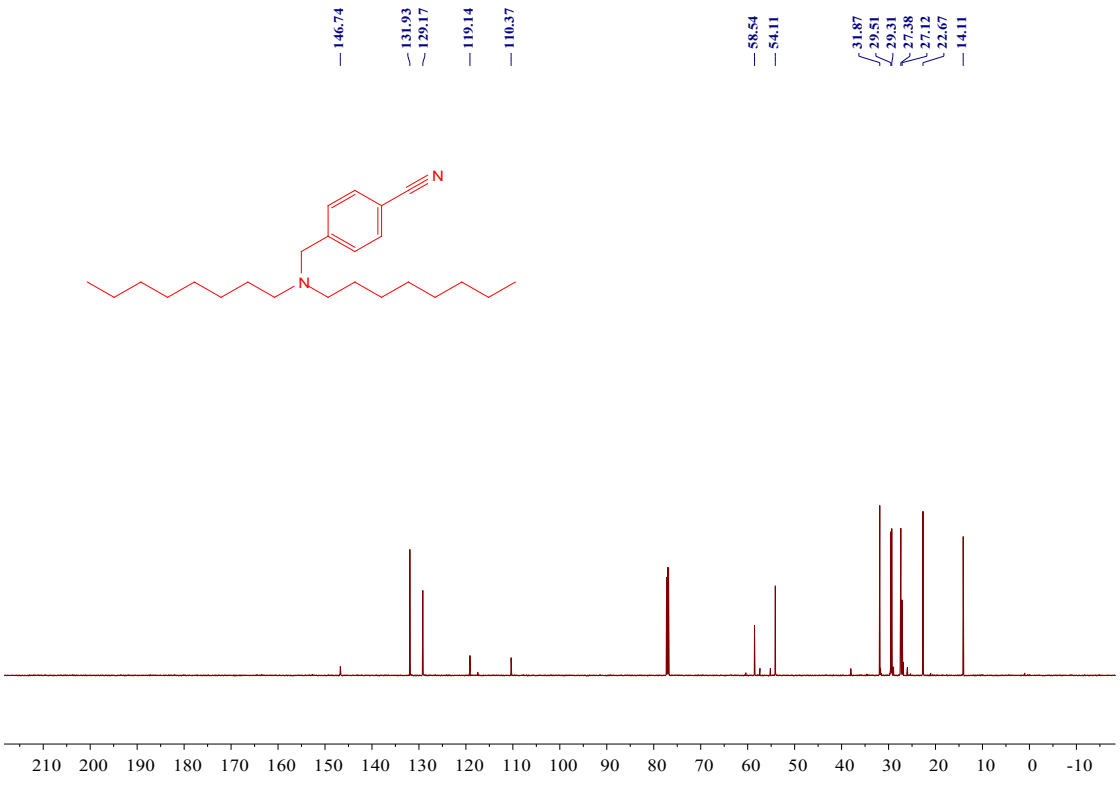
4-((diisopropylamino)methyl)benzonitrile (4)



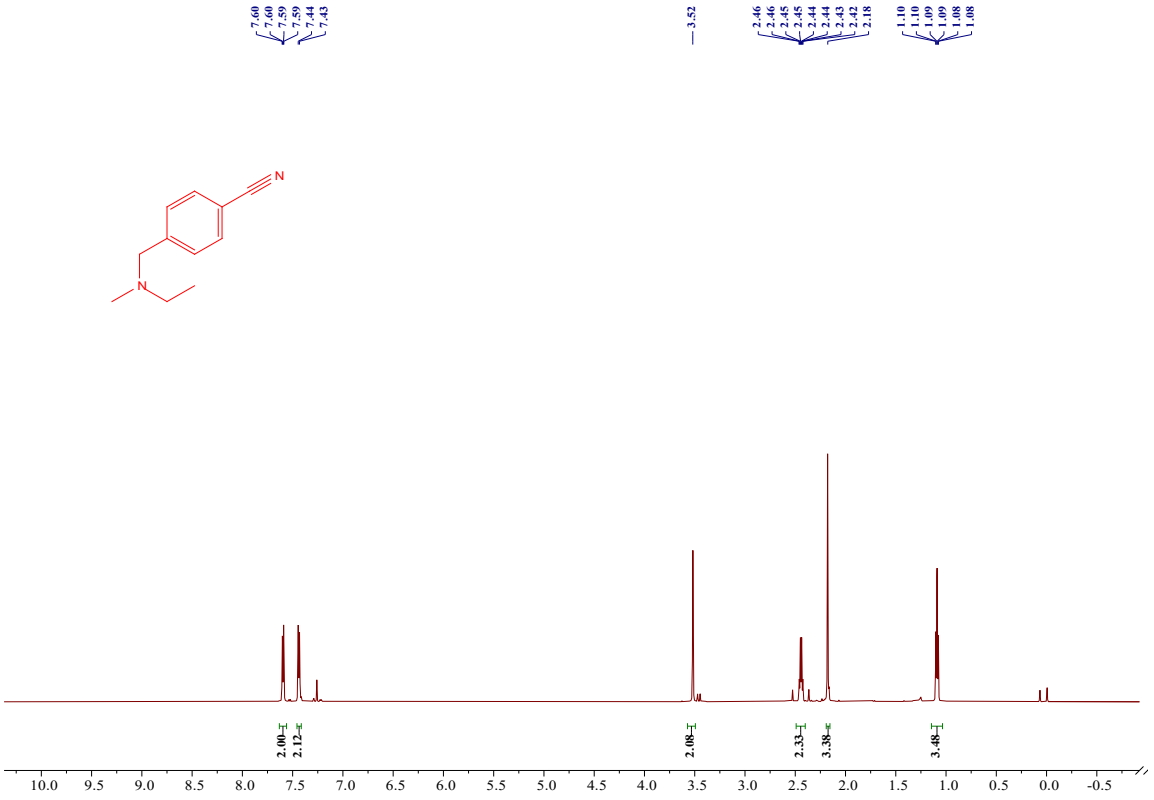


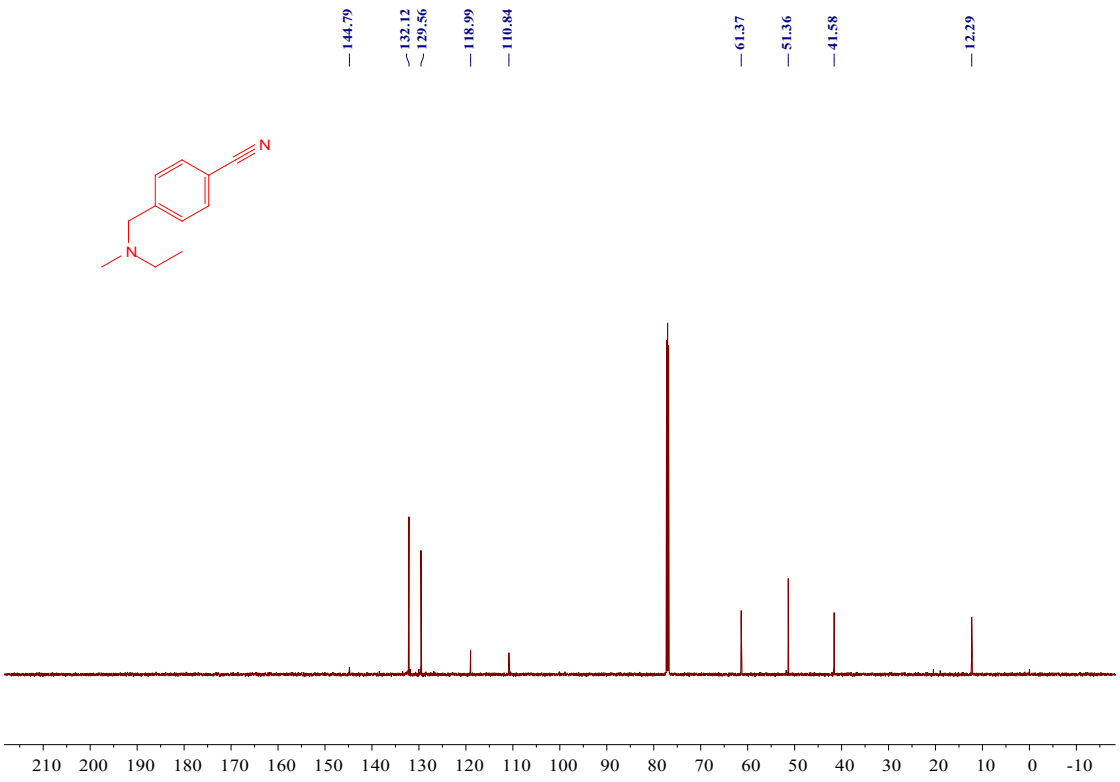
4-((dioctylamino)methyl)benzonitrile (5)



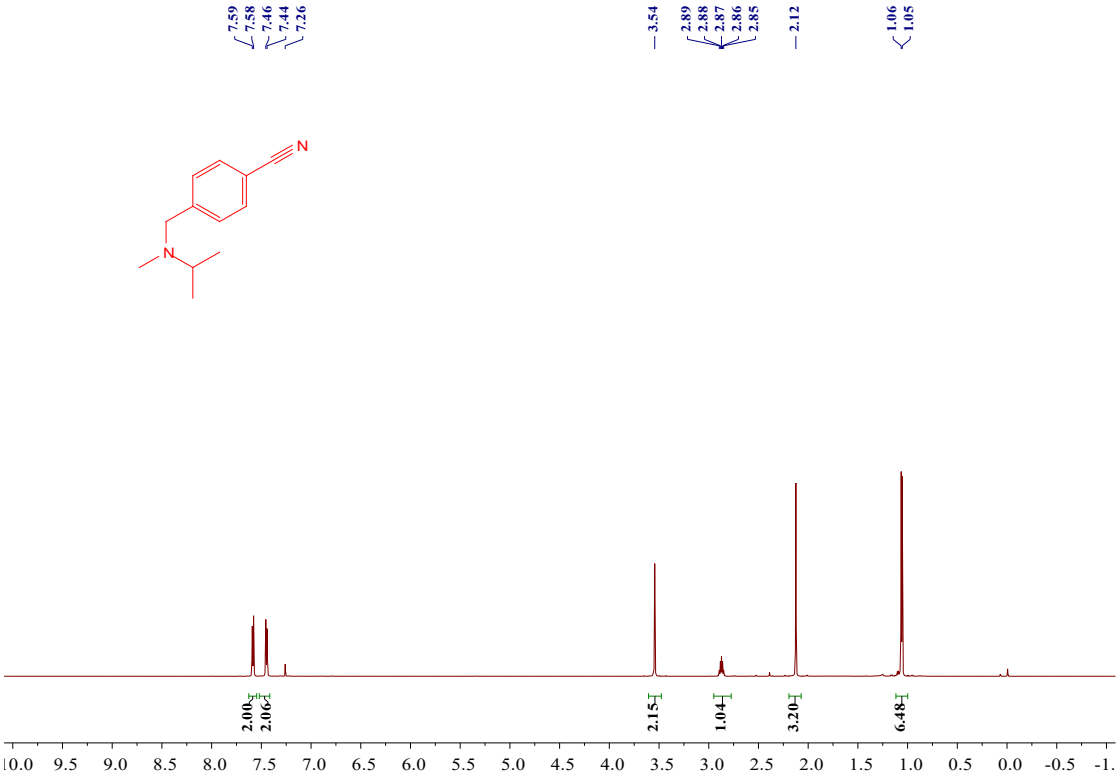


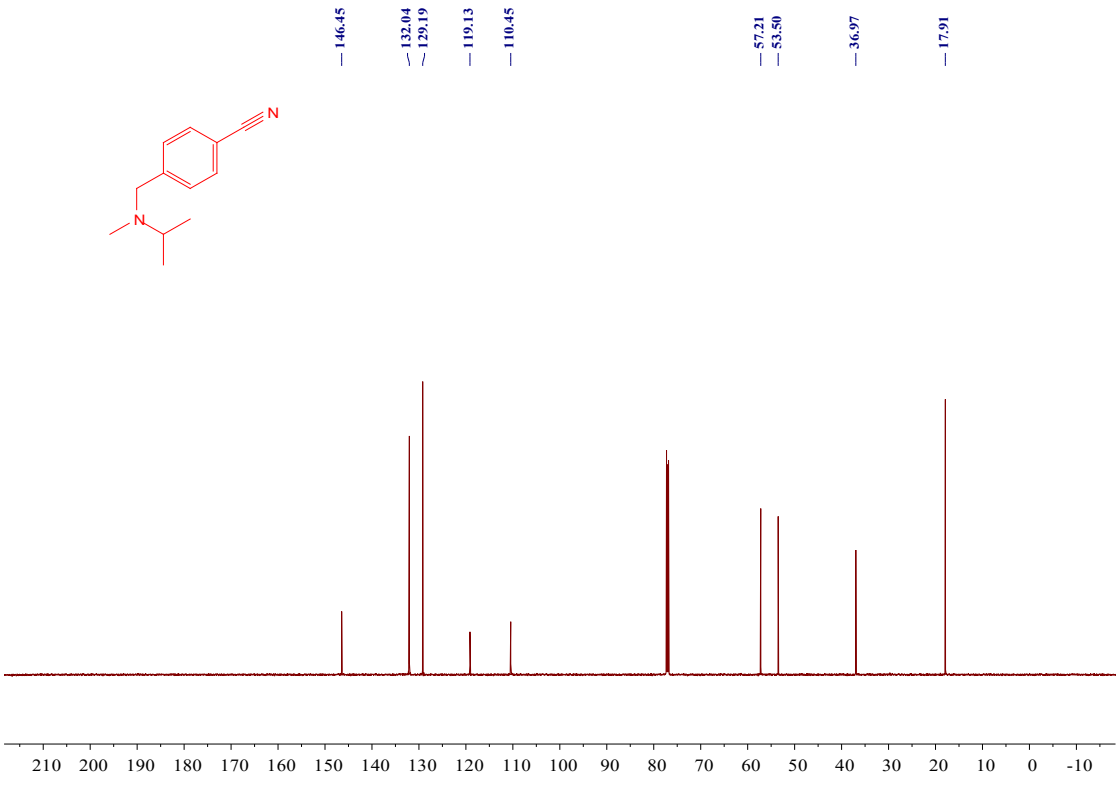
4-((ethyl(methyl)amino)methyl)benzonitrile (6)



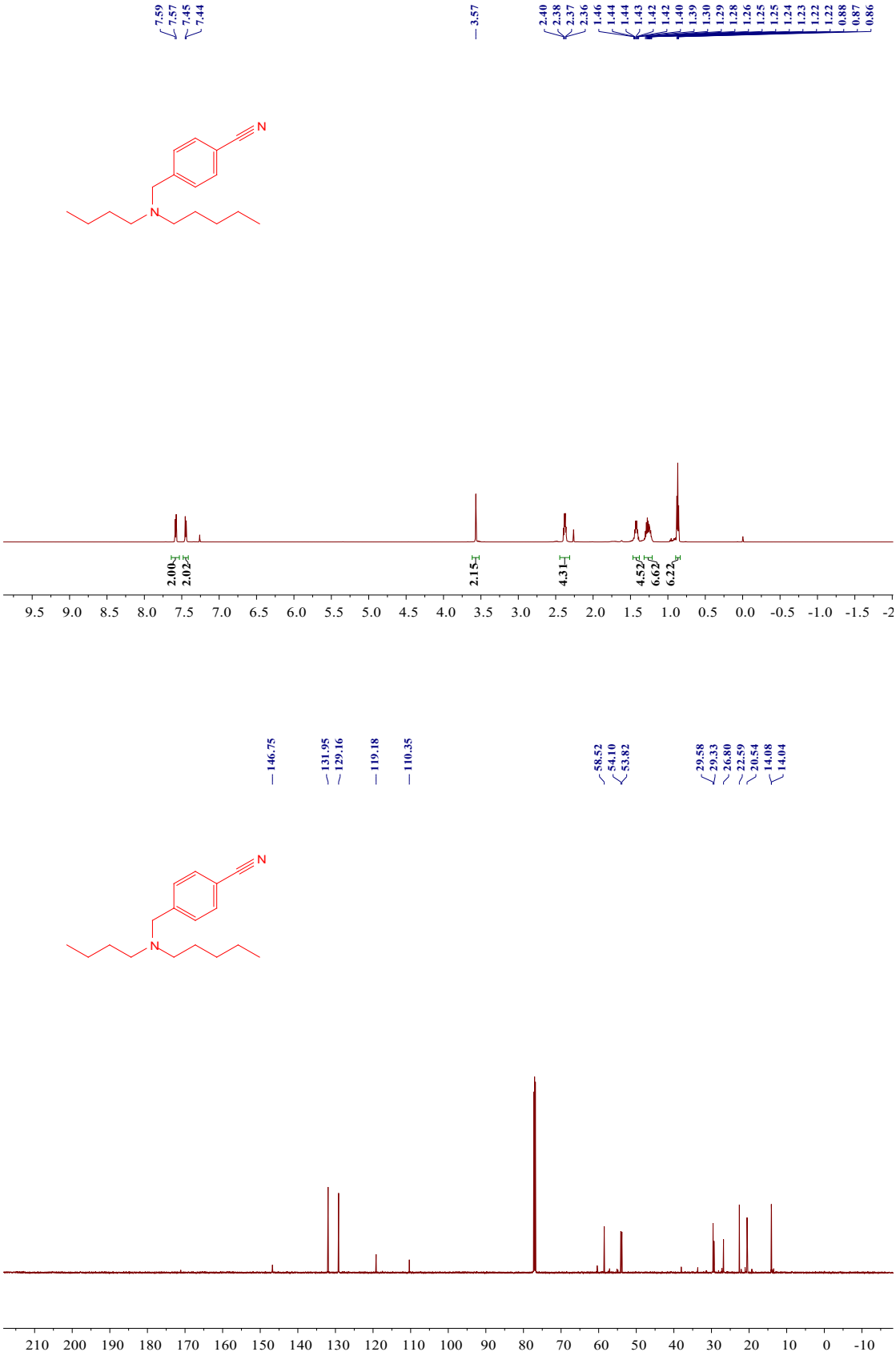


4-((isopropyl(methyl)amino)methyl)benzonitrile (7)

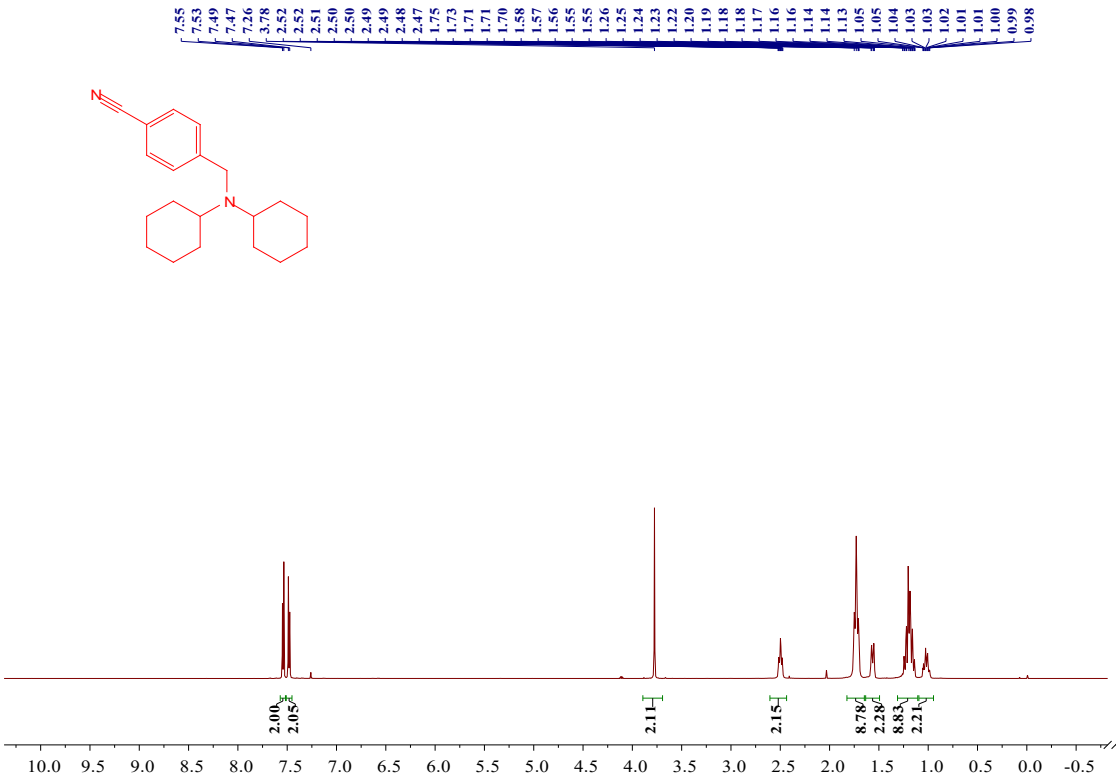


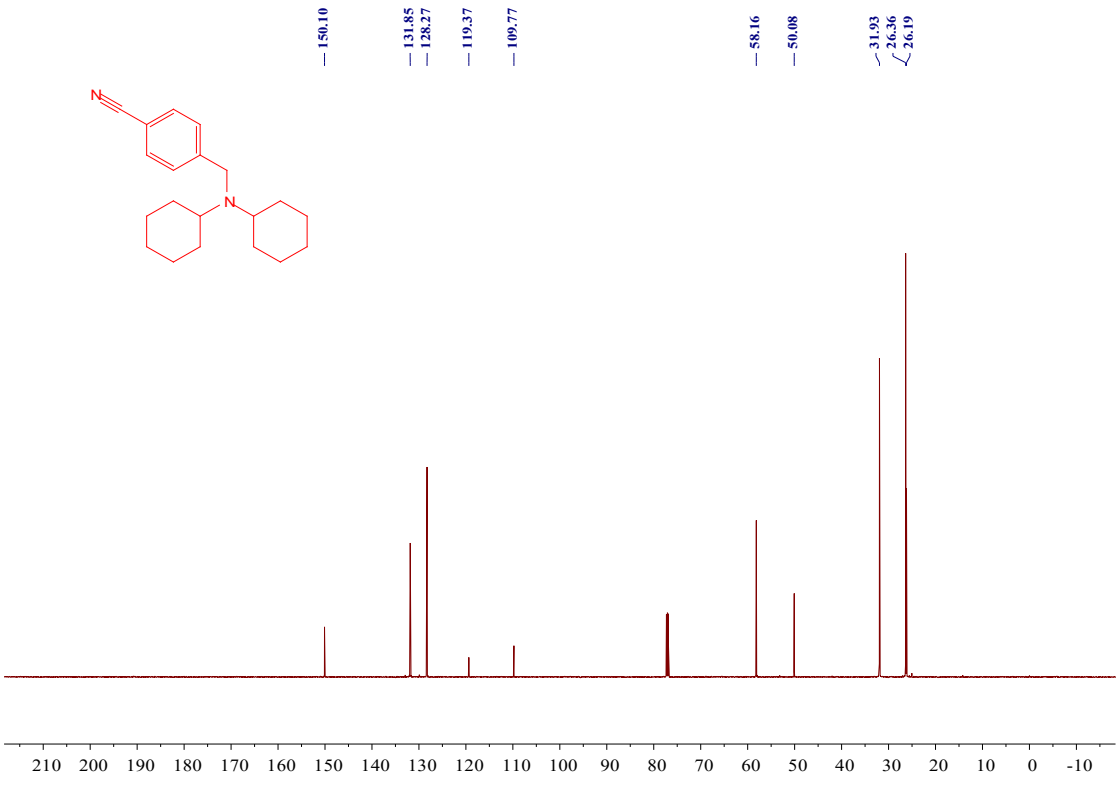


4-((butyl(pentyl)amino)methyl)benzonitrile (8)

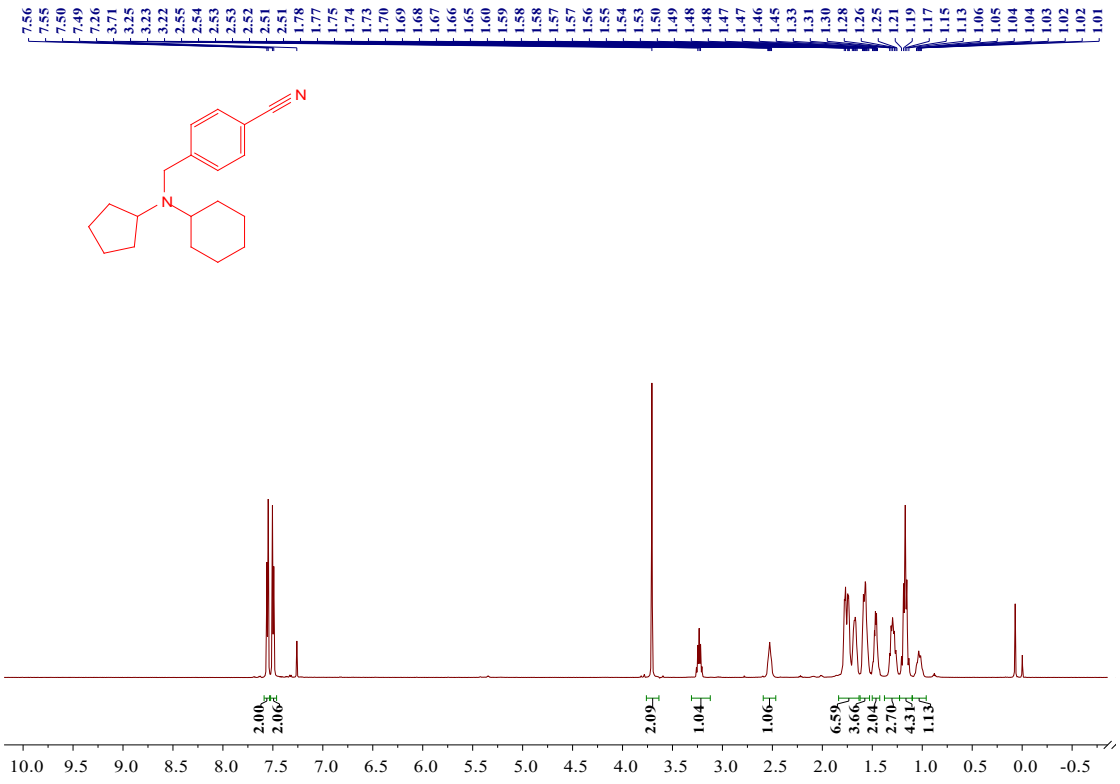


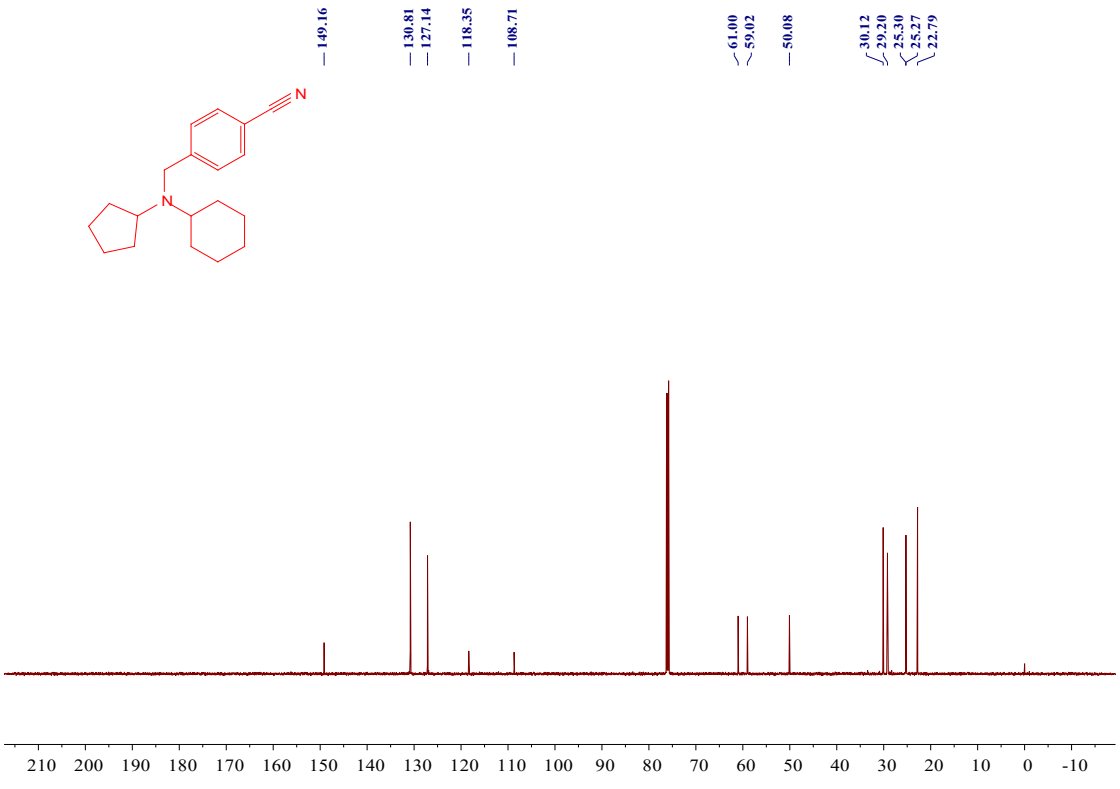
4-((dicyclohexylamino)methyl)benzonitrile (9)



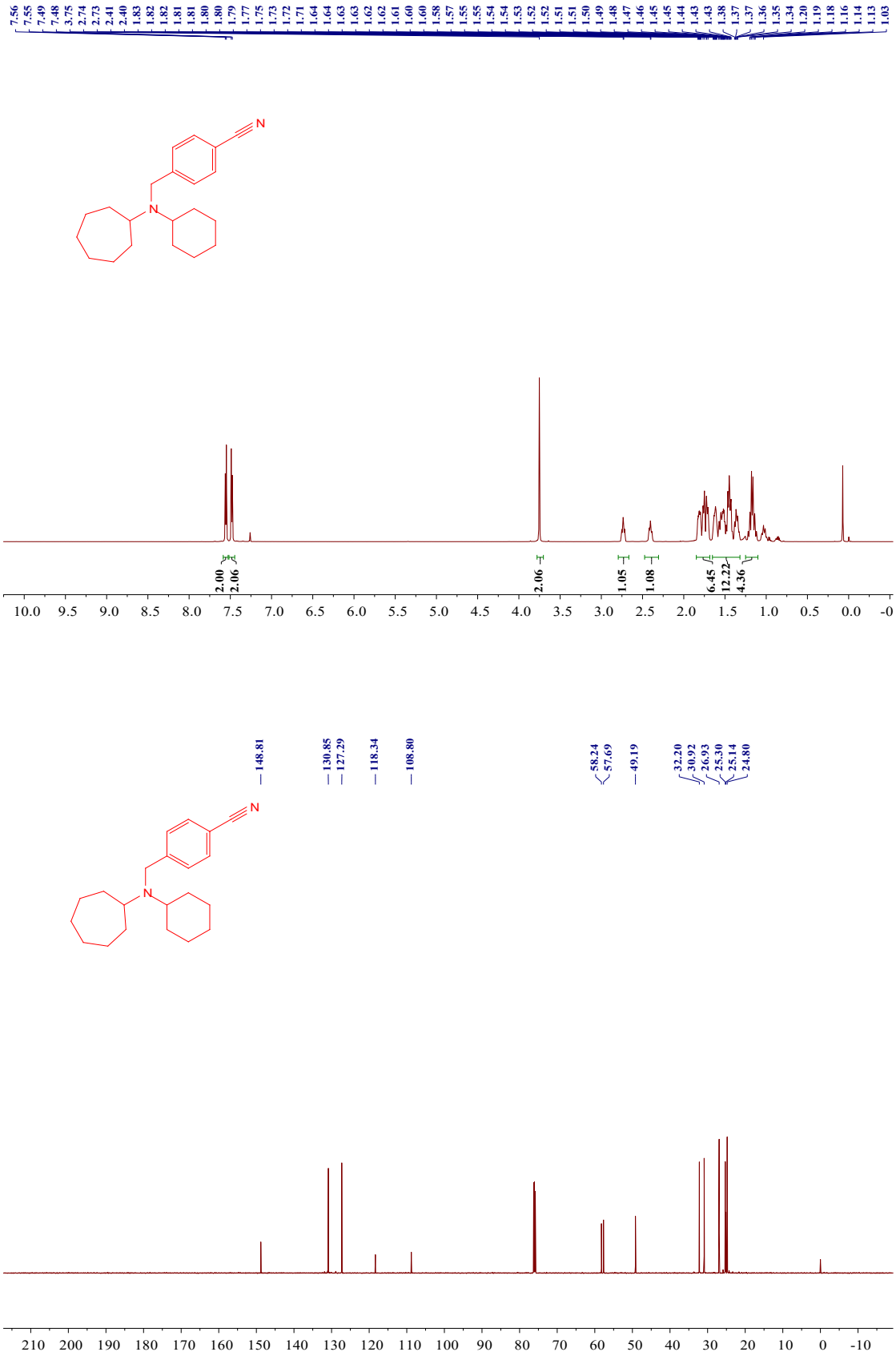


4-((cyclohexyl(cyclopentyl)amino)methyl)benzonitrile (10)

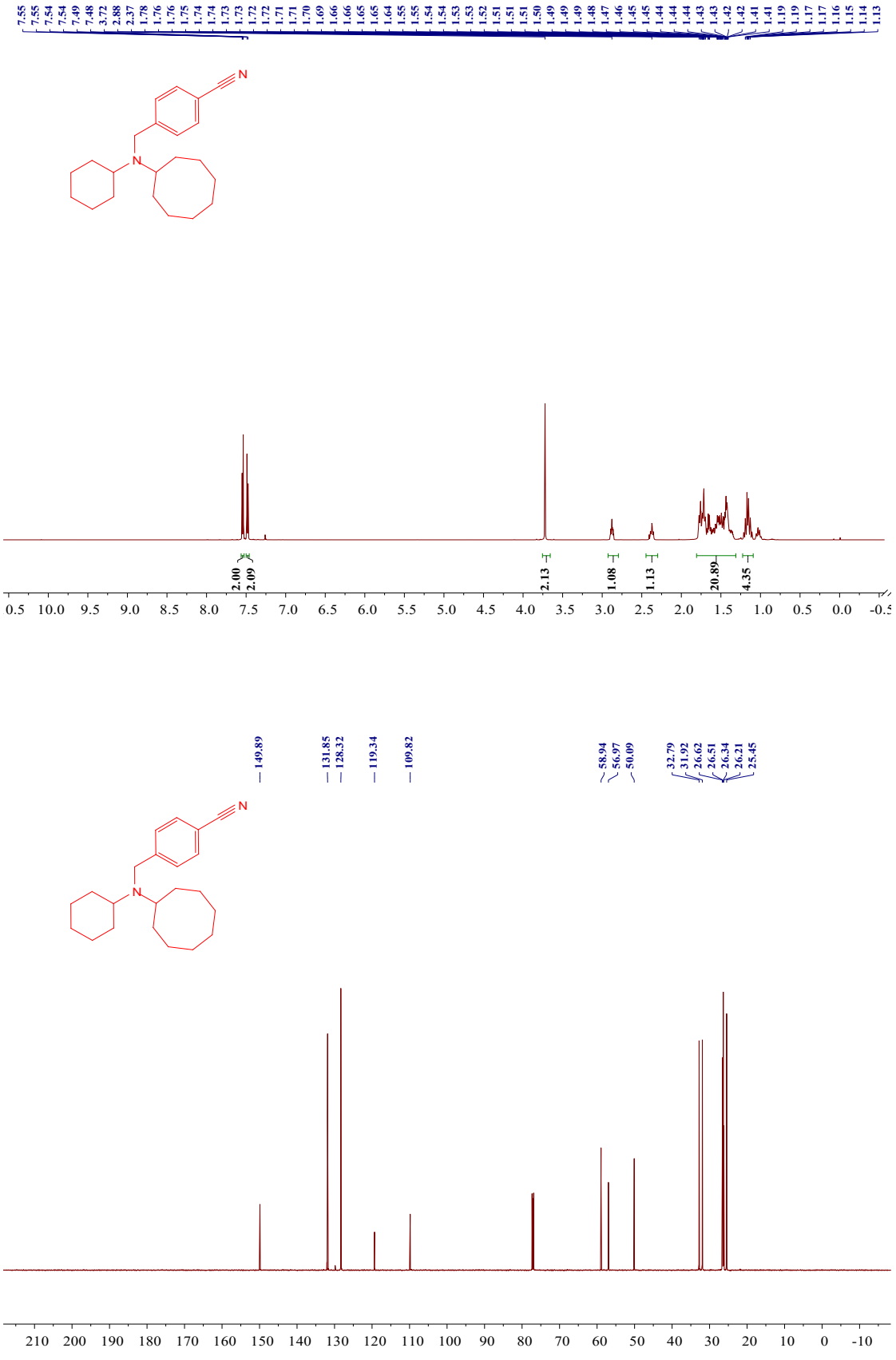




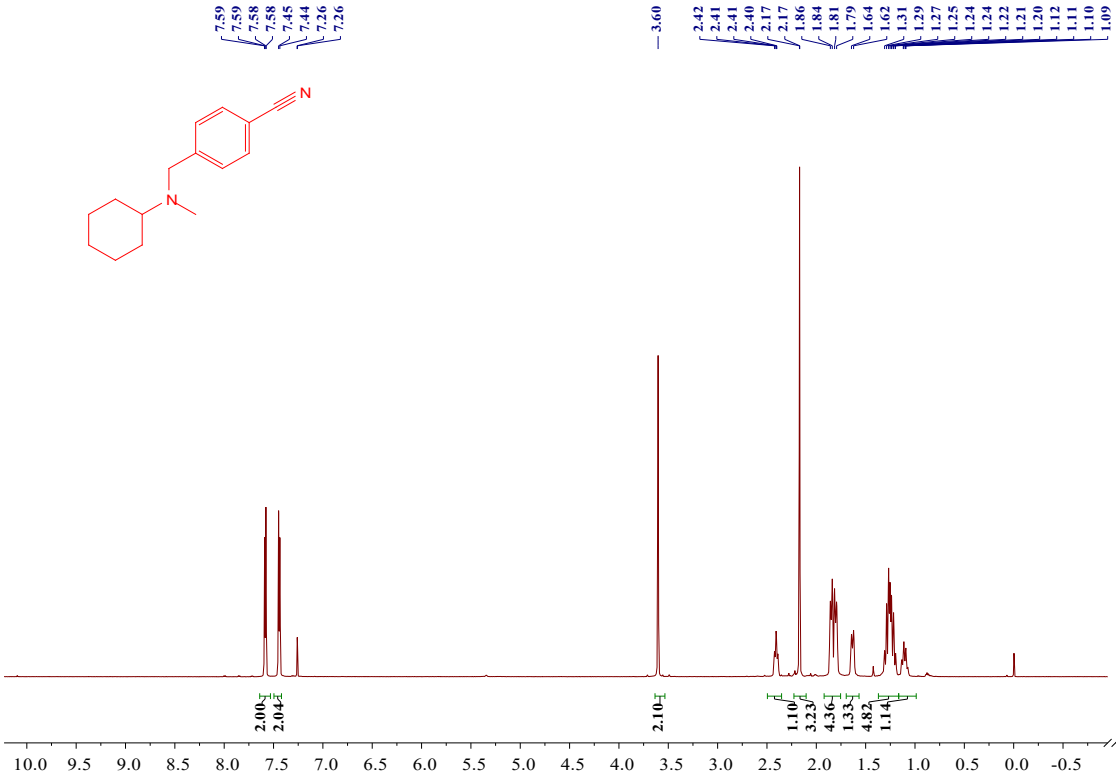
4-((cycloheptyl(cyclohexyl)amino)methyl)benzonitrile (11)

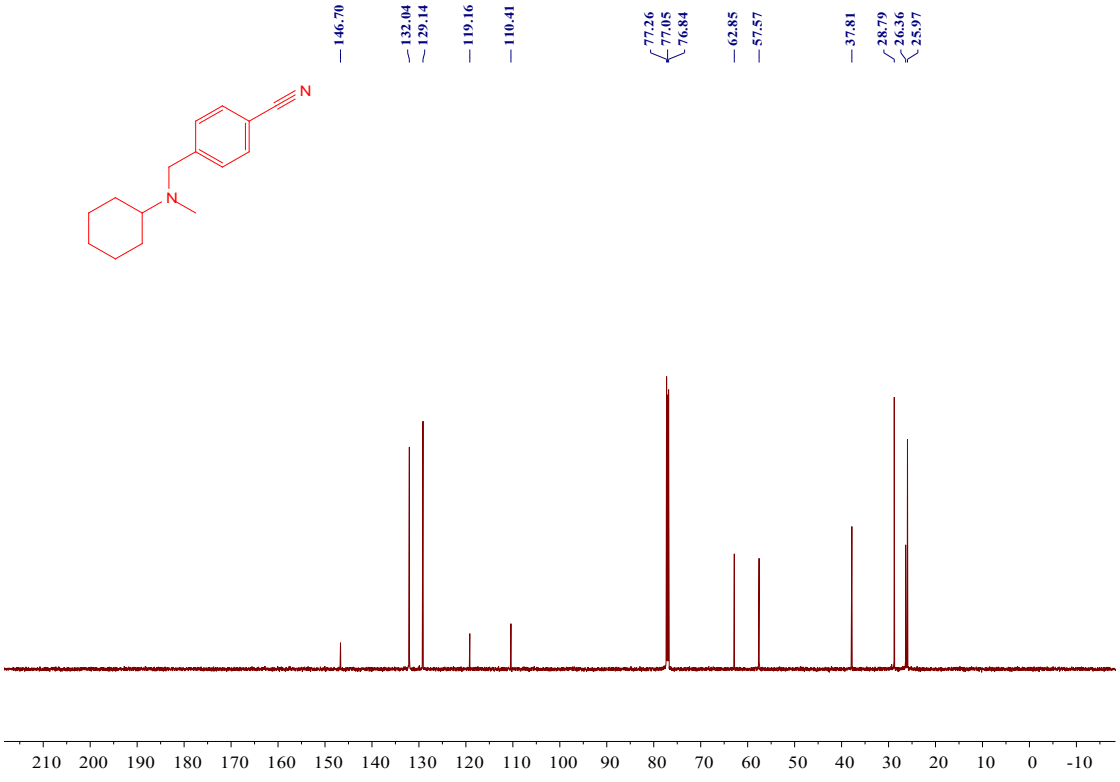


4-((cyclohexyl(cyclooctyl)amino)methyl)benzonitrile (12)

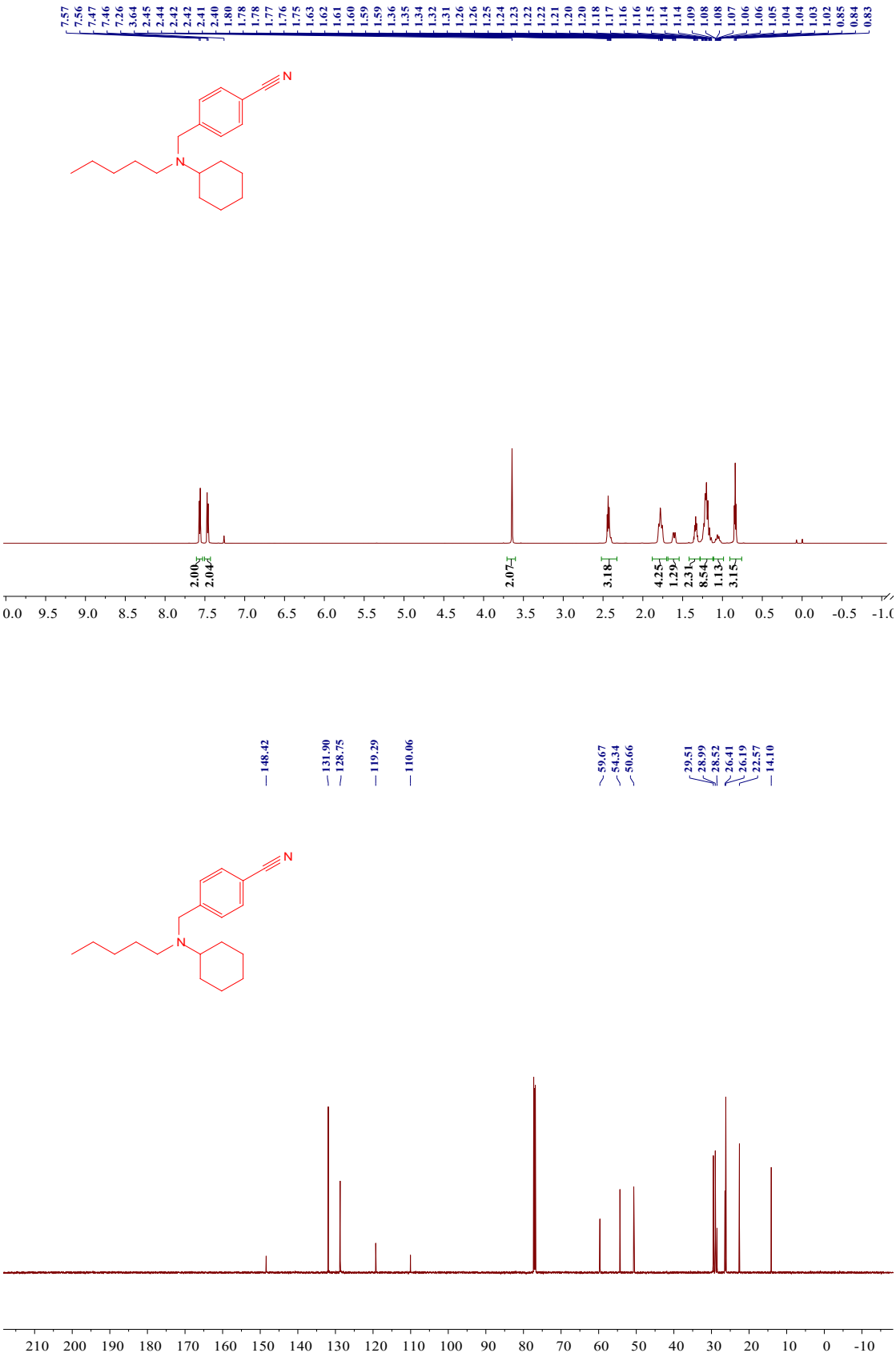


4-((cyclohexyl(methyl)amino)methyl)benzonitrile (13)

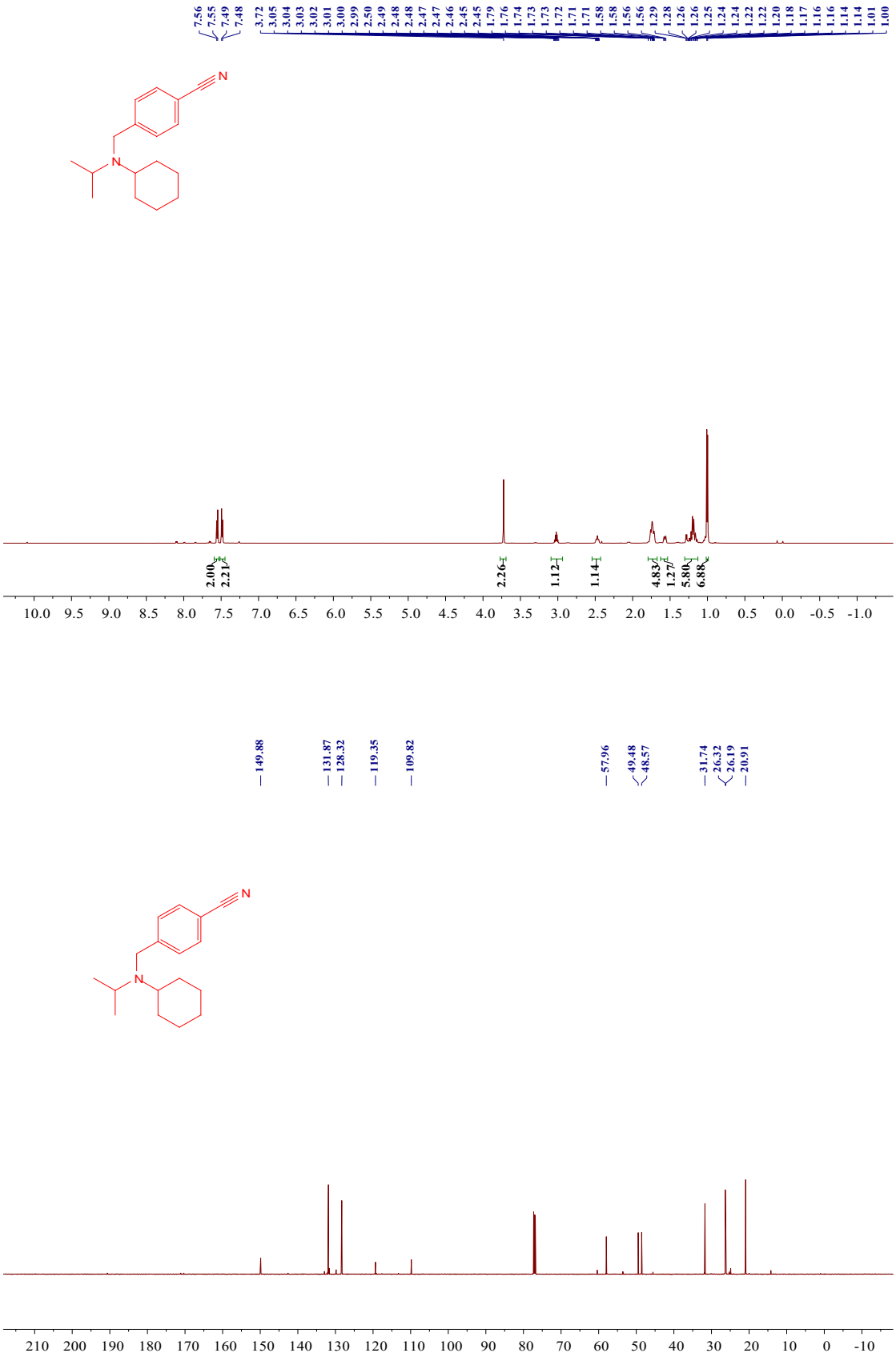




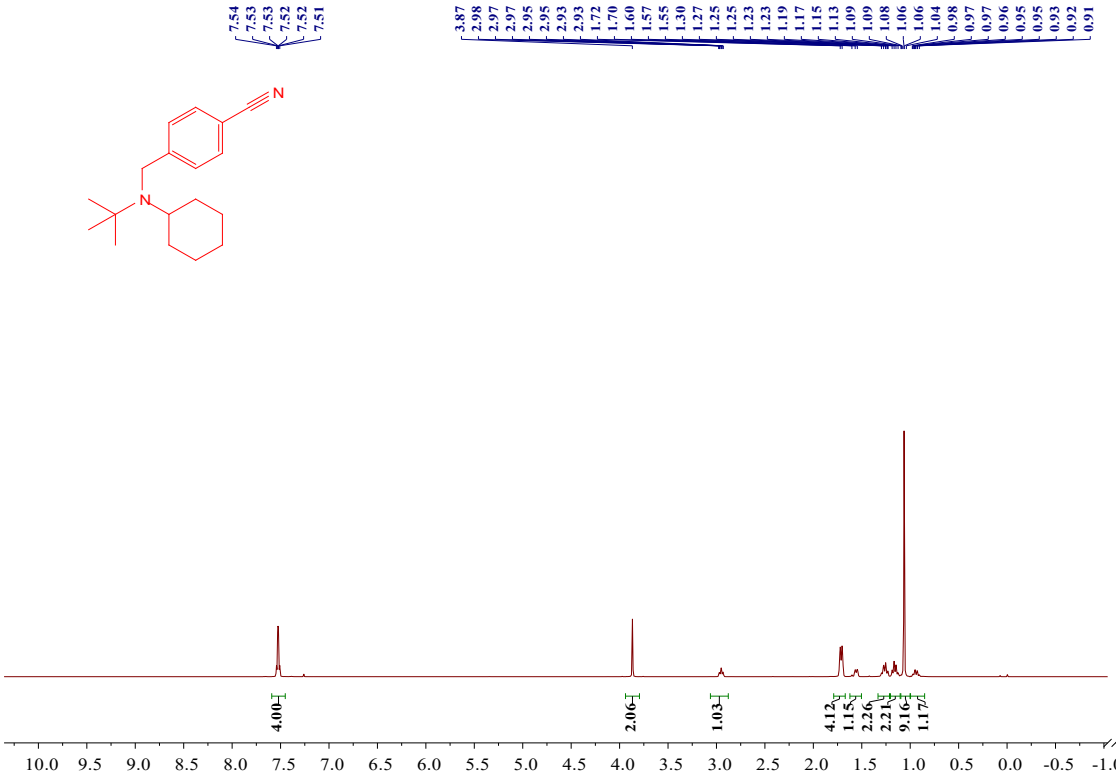
4-((cyclohexyl(pentyl)amino)methyl)benzonitrile (14)

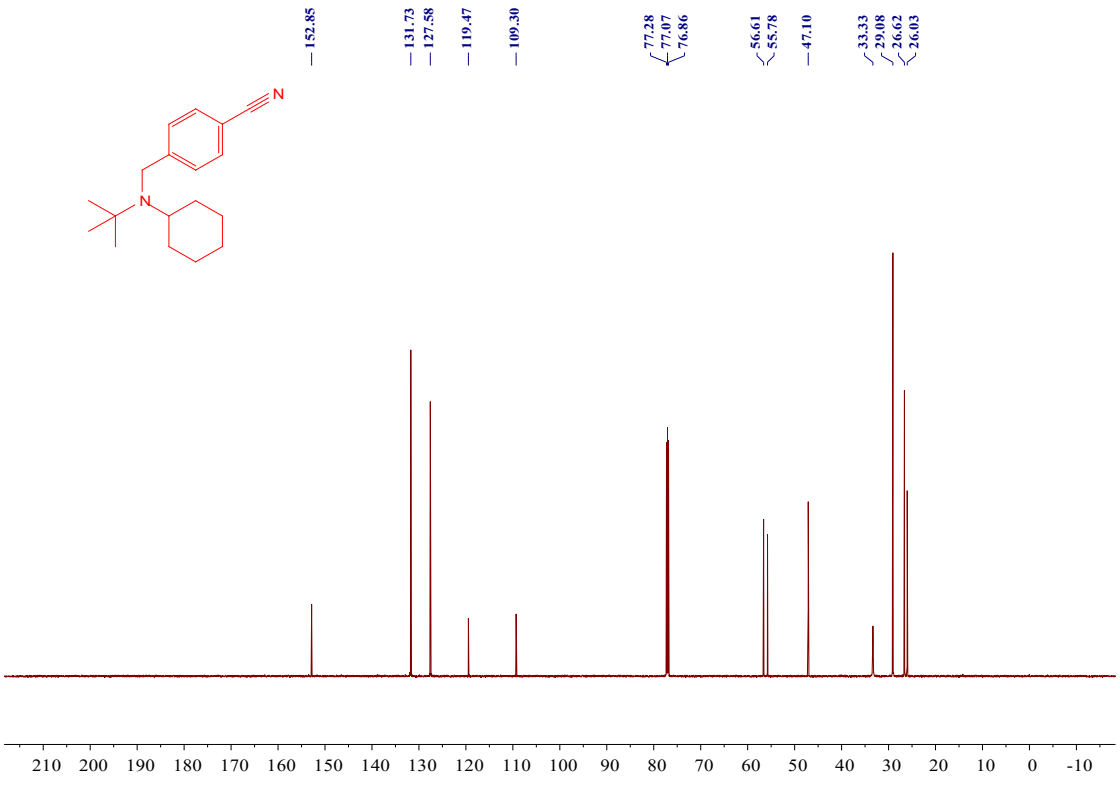


4-((cyclohexyl(isopropyl)amino)methyl)benzonitrile (15)

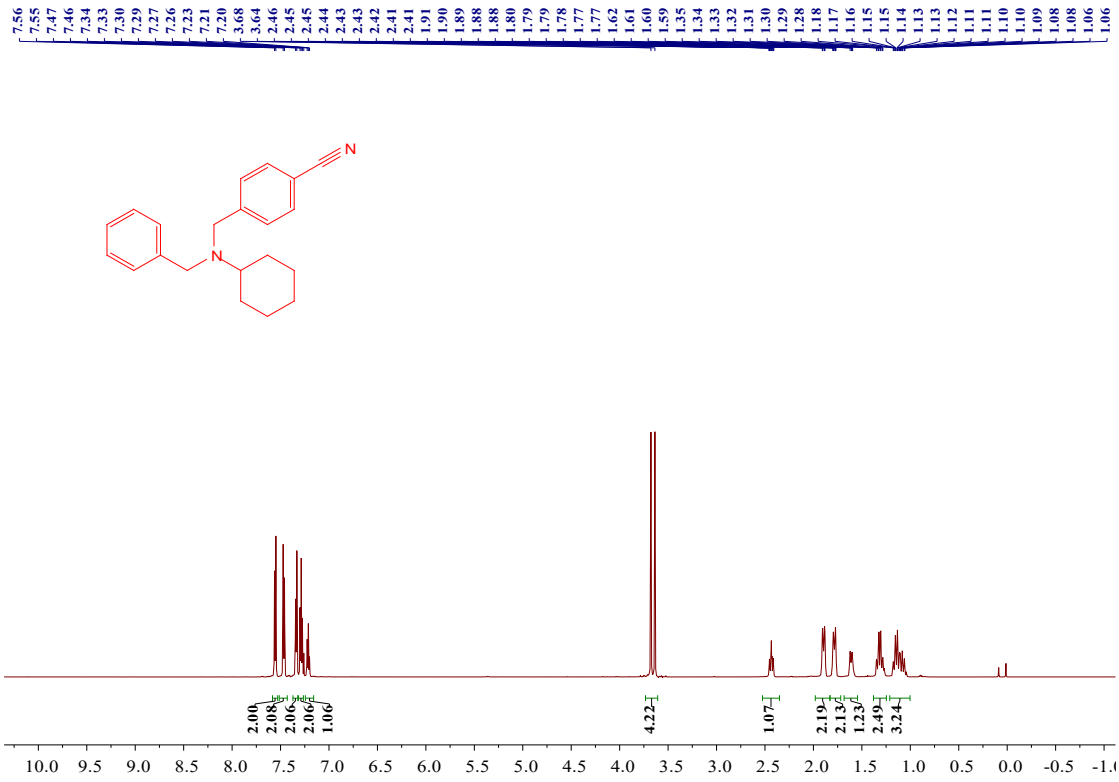


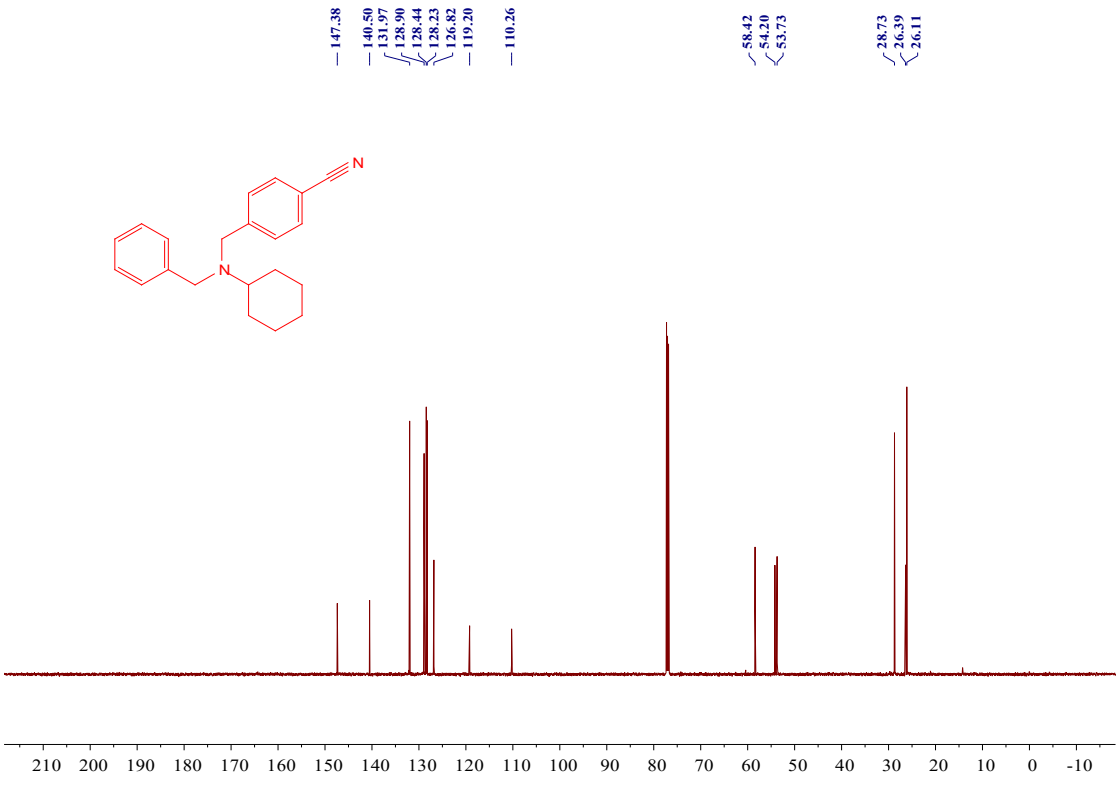
4-((tert-butyl(cyclohexyl)amino)methyl)benzonitrile (16)



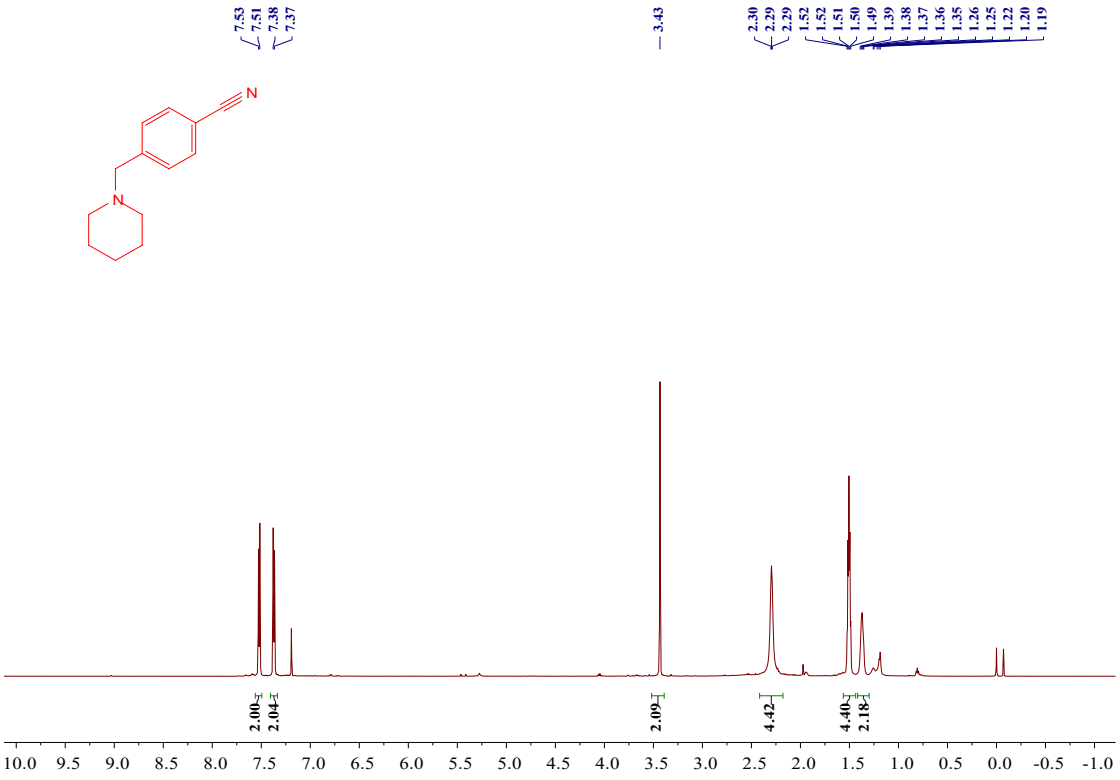


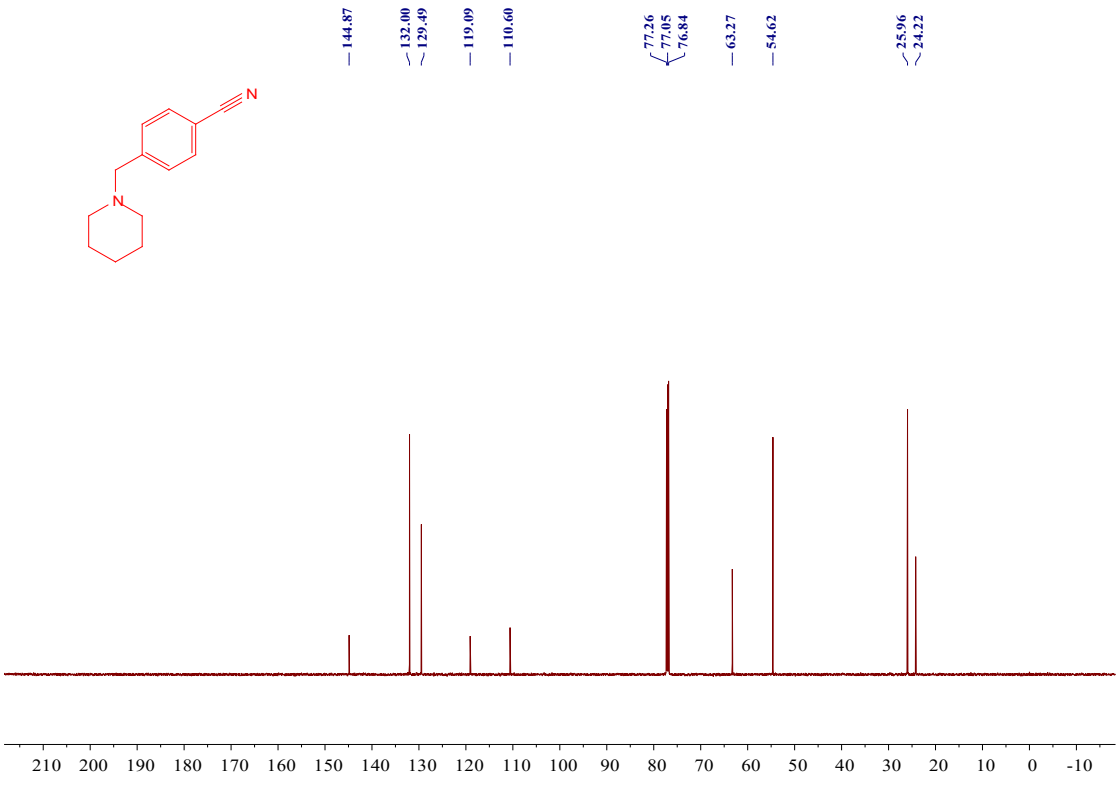
4-((benzyl(cyclohexyl)amino)methyl)benzonitrile (17)



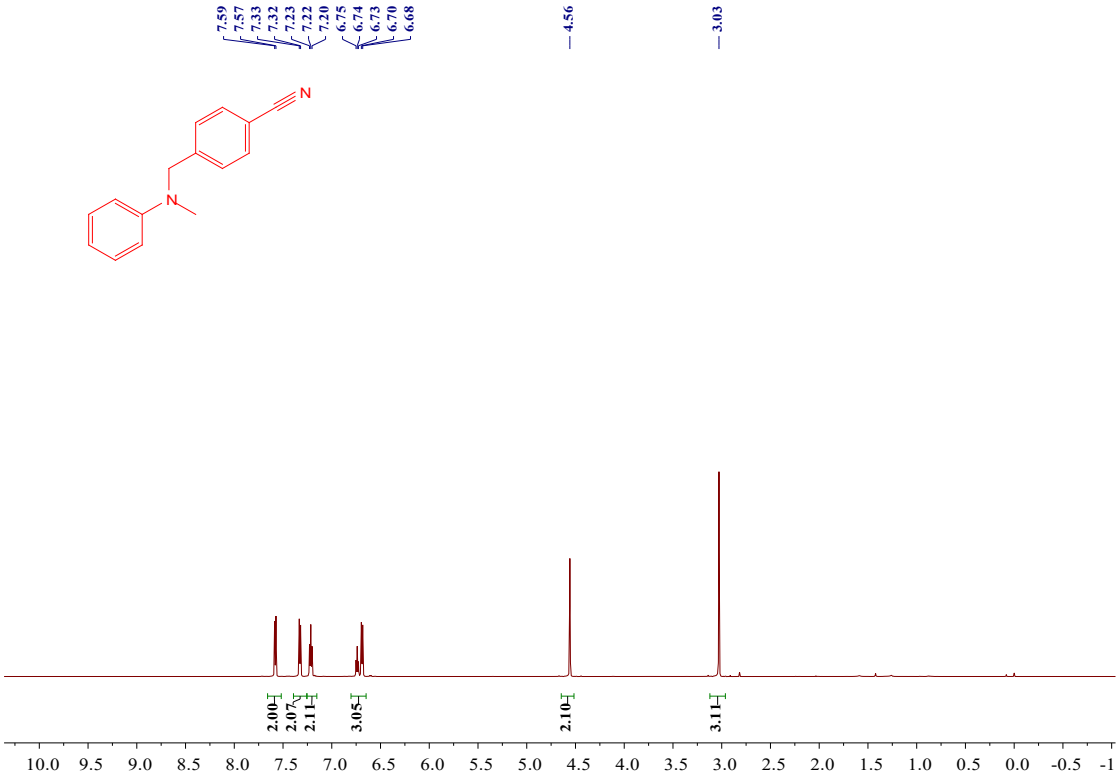


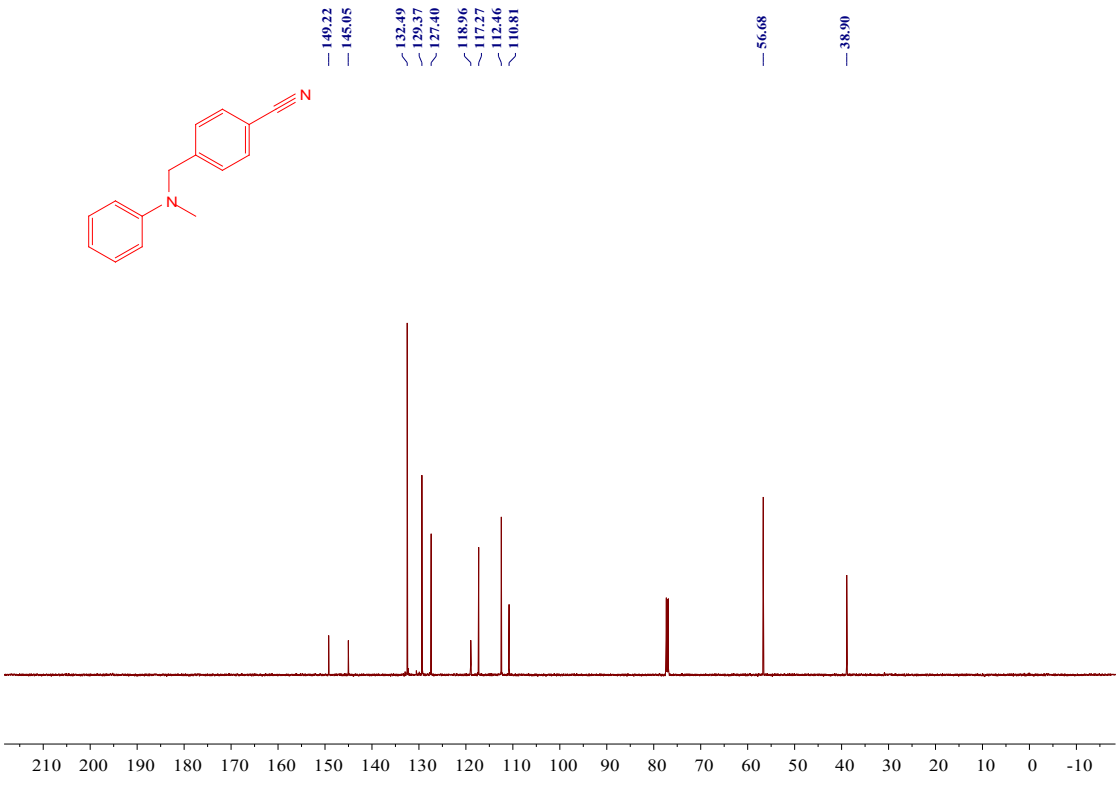
4-(piperidin-1-ylmethyl)benzonitrile (18)



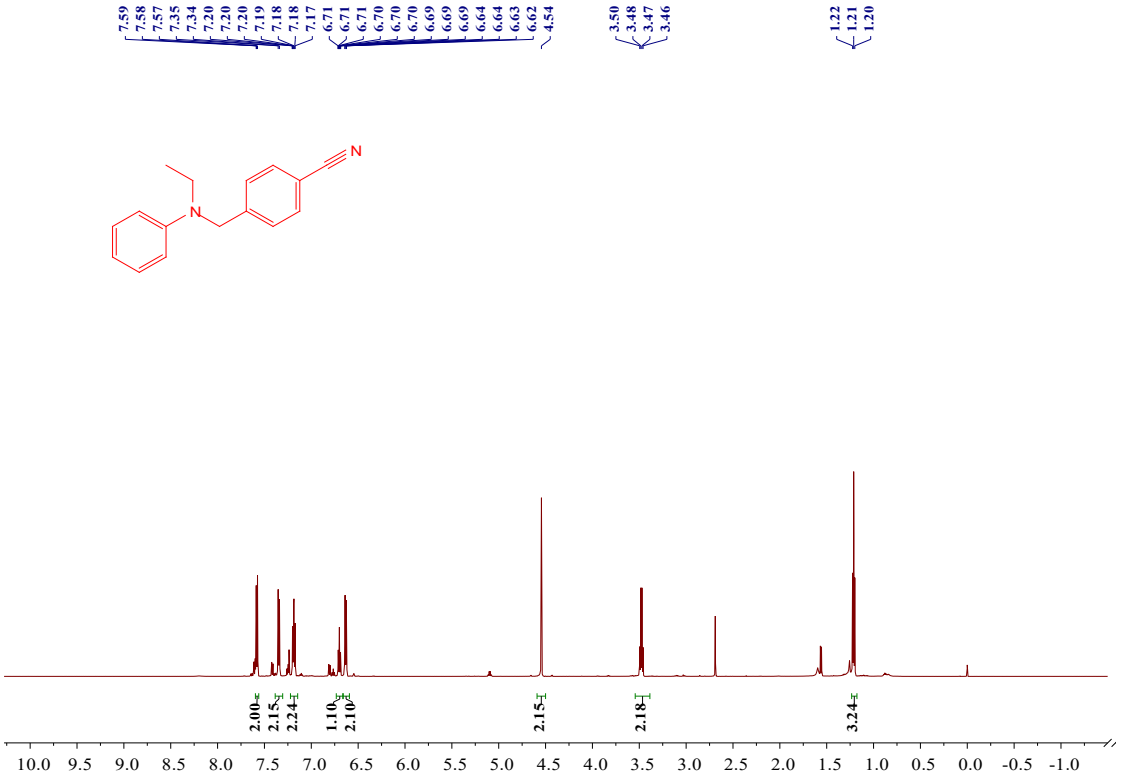


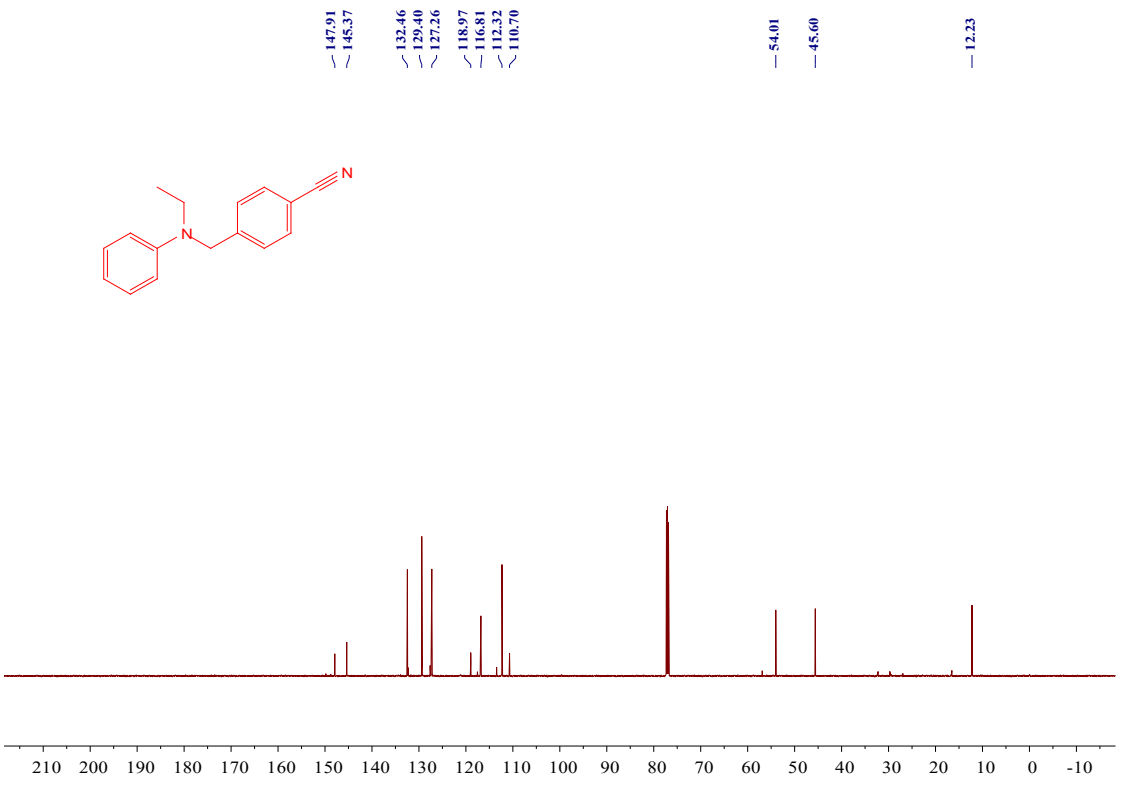
4-((methyl(phenyl)amino)methyl)benzonitrile (19)



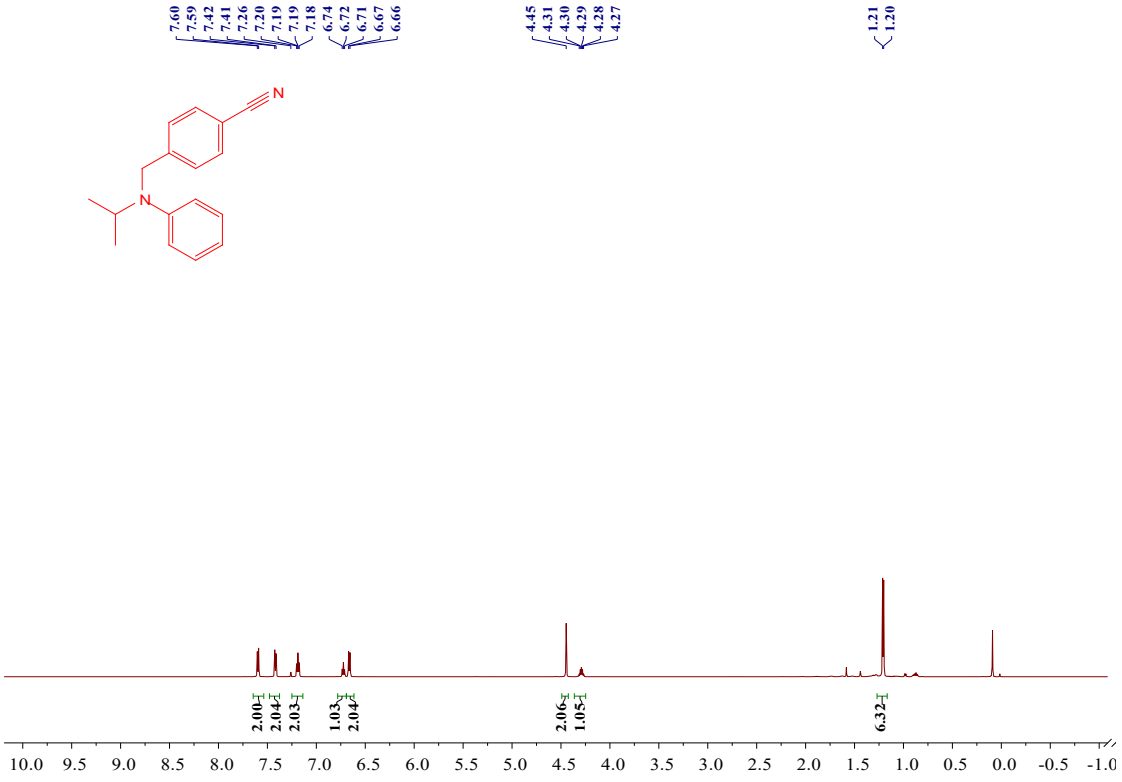


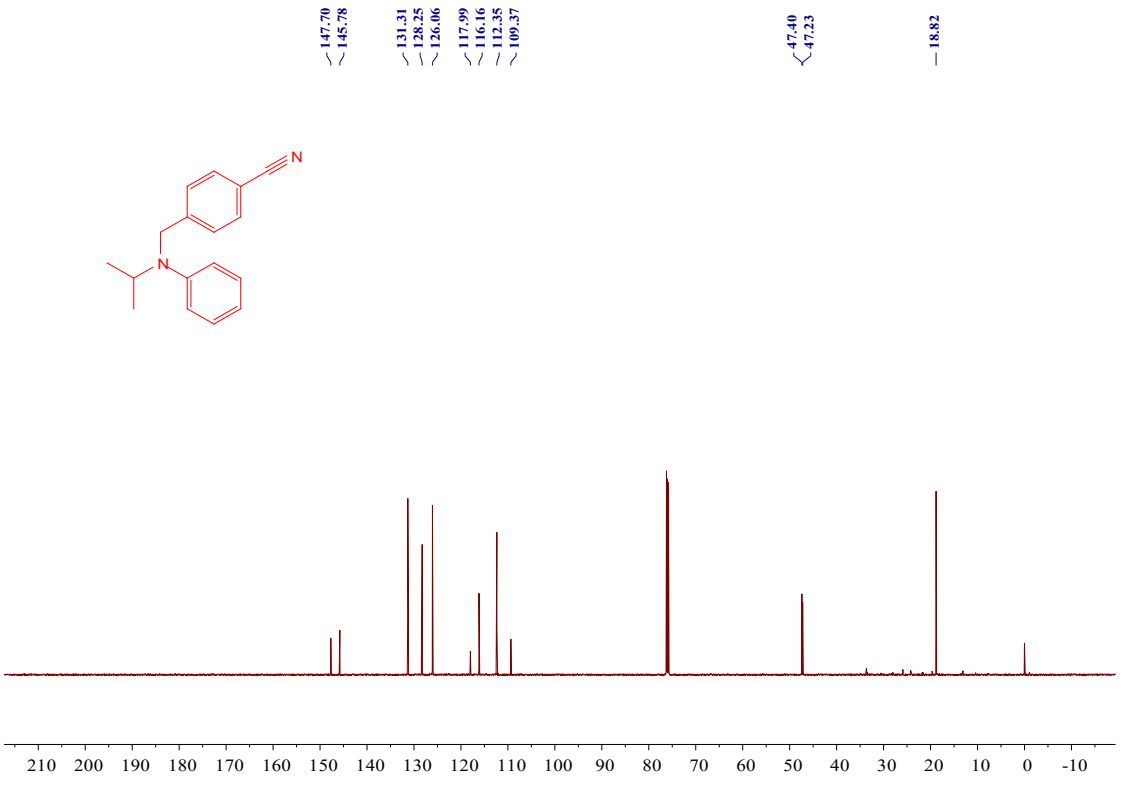
4-((ethyl(phenyl)amino)methyl)benzonitrile (20)



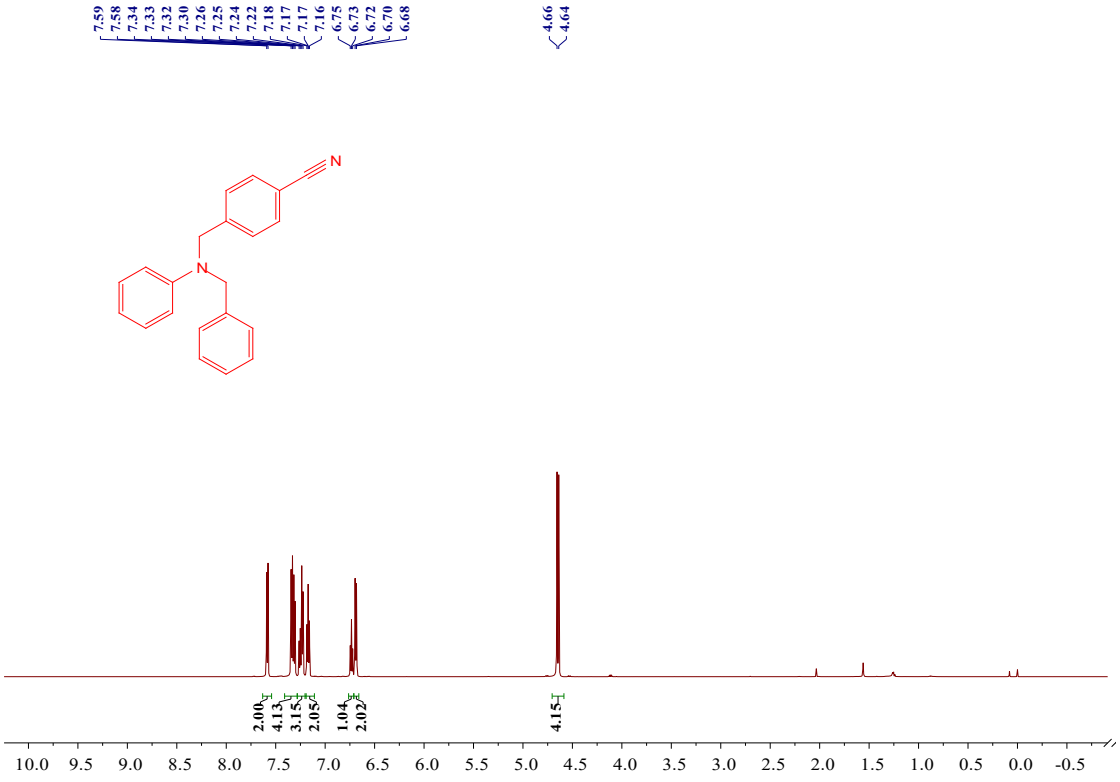


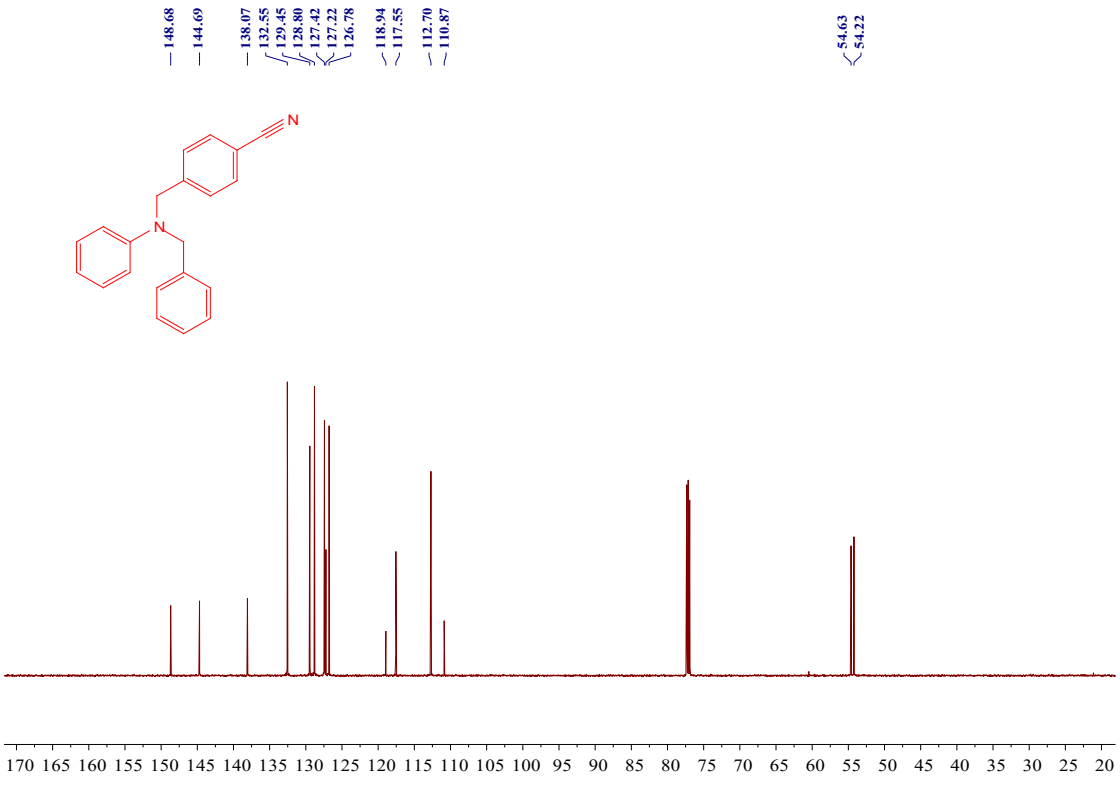
4-((isopropyl(phenyl)amino)methyl)benzonitrile (21)



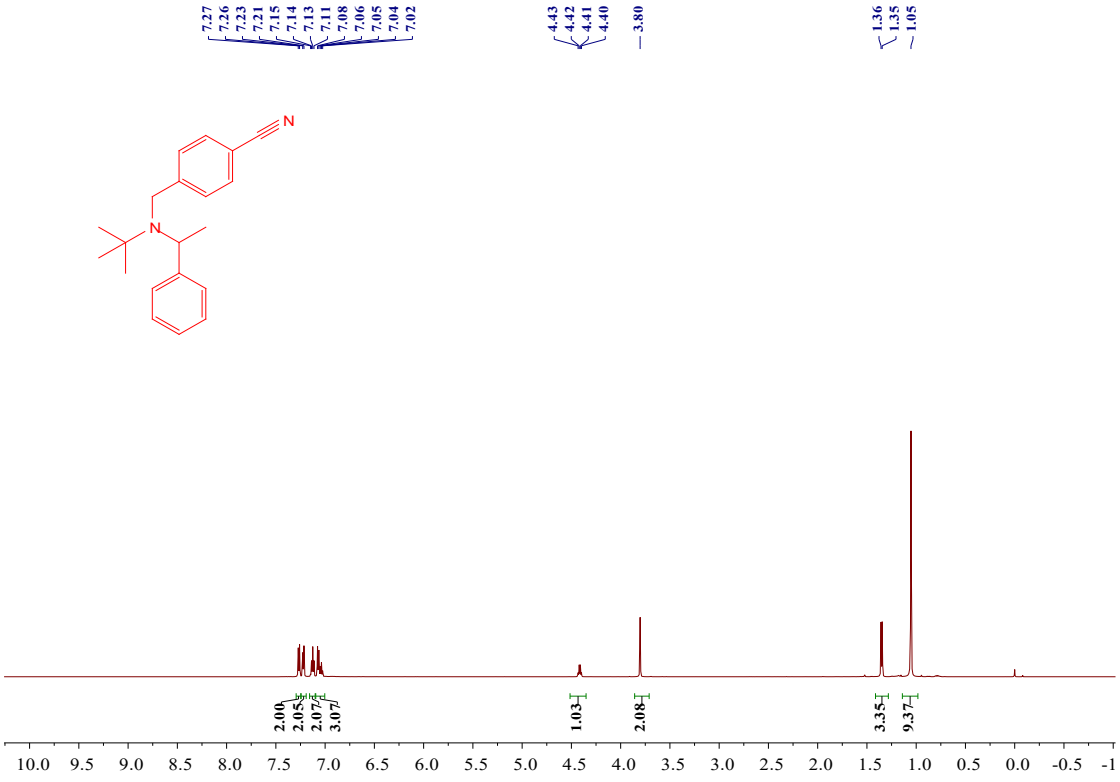


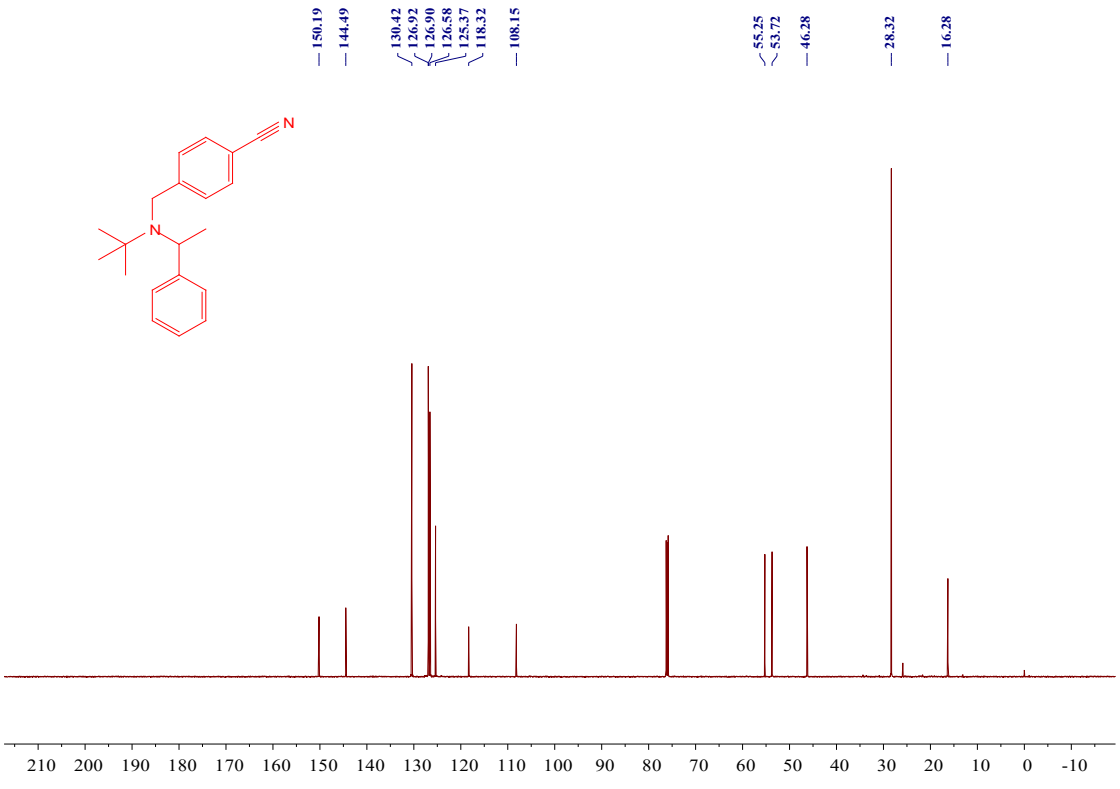
4-((benzyl(phenyl)amino)methyl)benzonitrile (22)



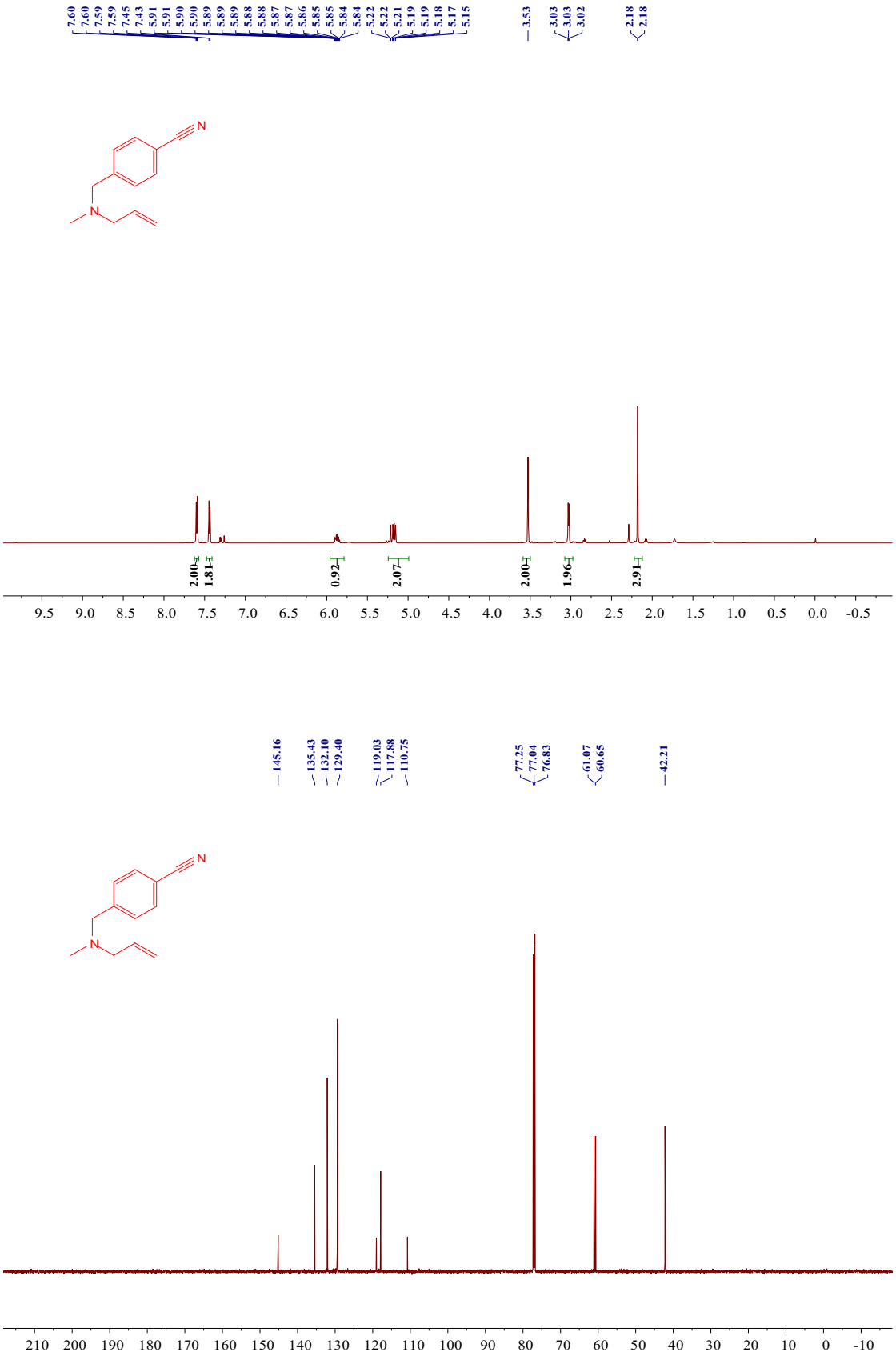


4-((tert-butyl(1-phenylethyl)amino)methyl)benzonitrile (23)

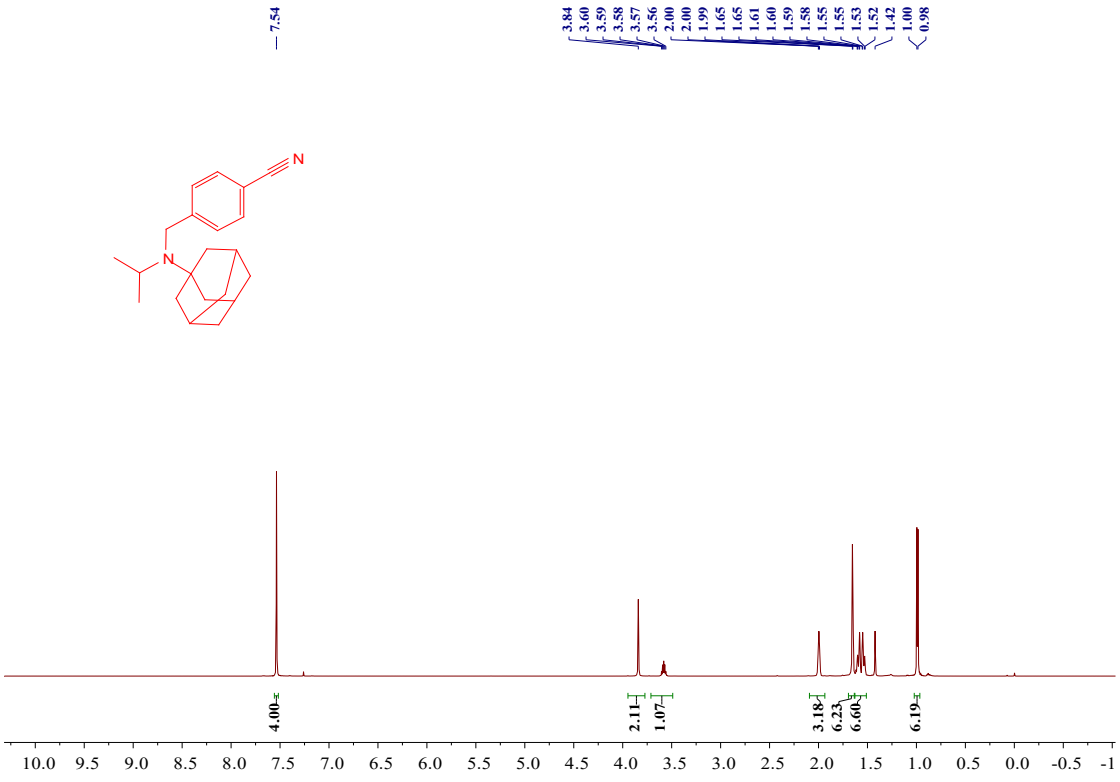


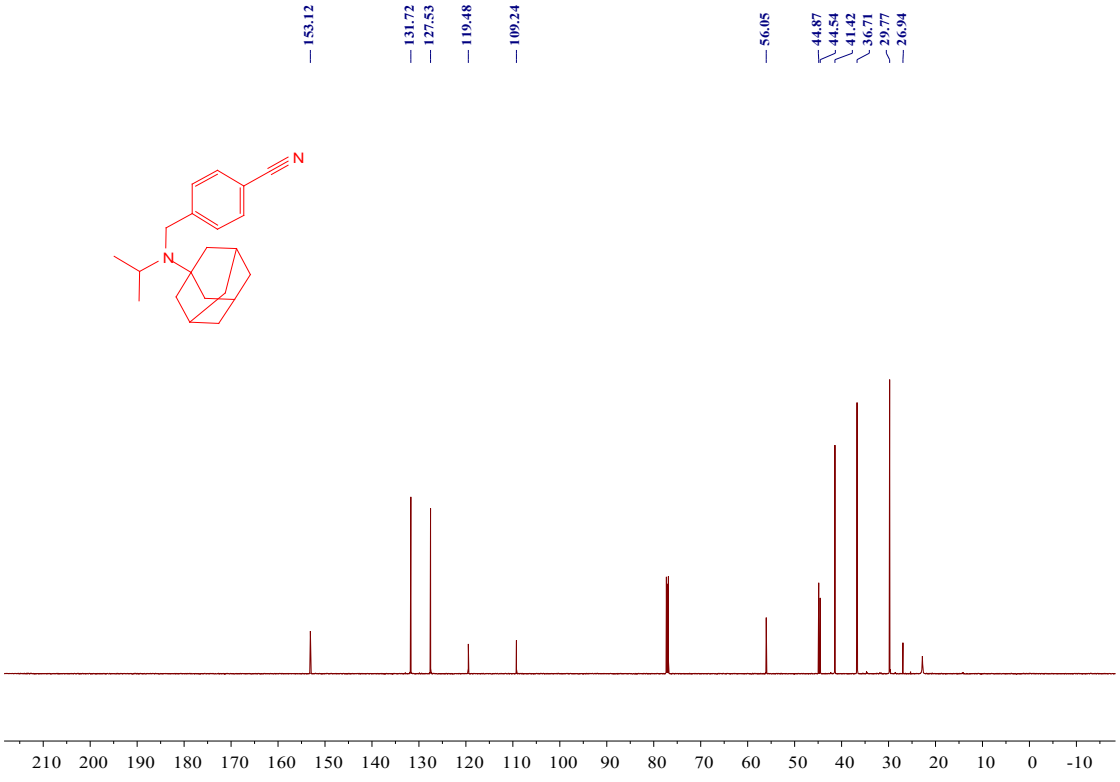


4-((allyl(methyl)amino)methyl)benzonitrile (24)

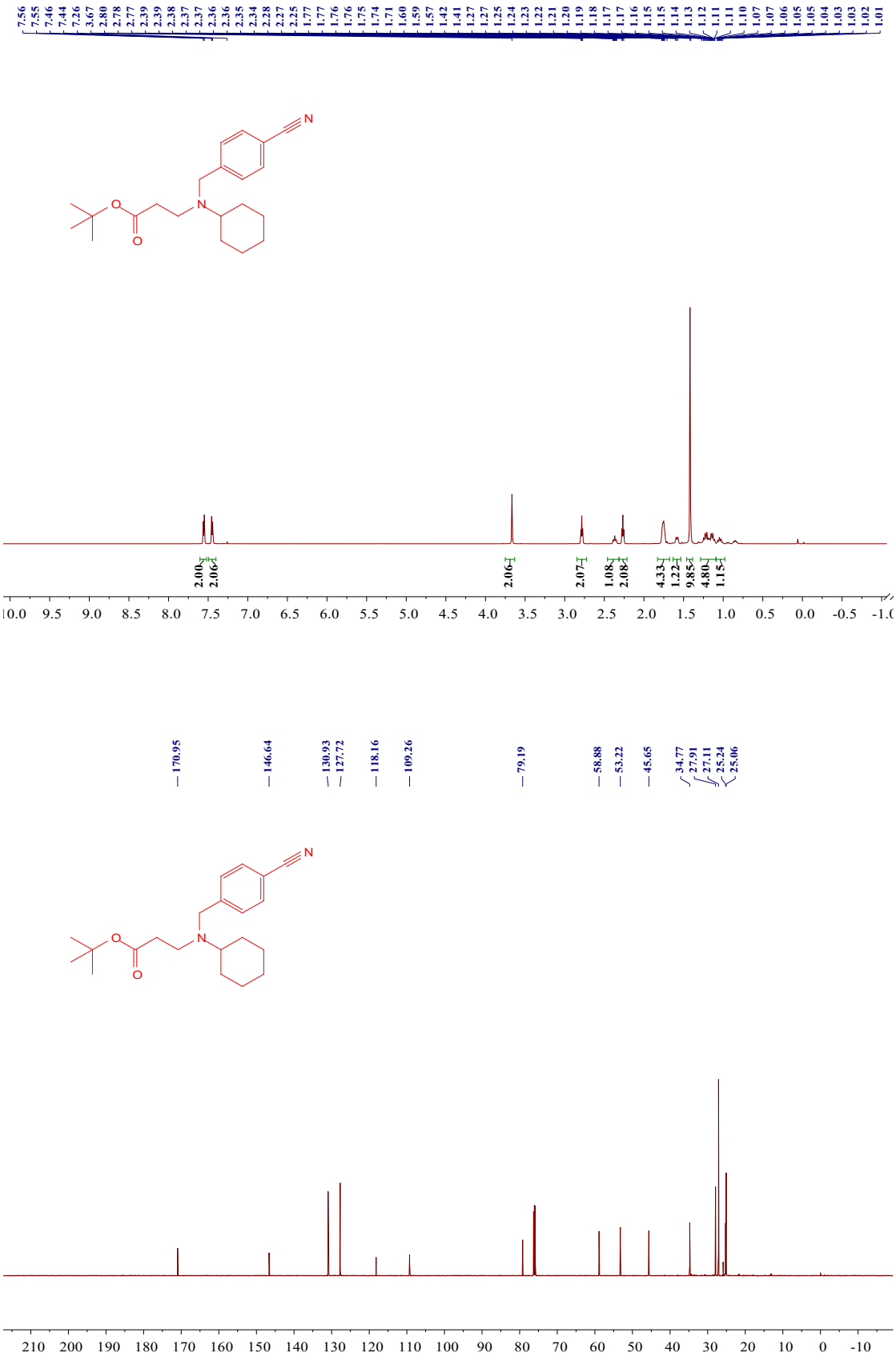


4-((adamantan-1-yl(isopropyl)amino)methyl)benzonitrile (25)

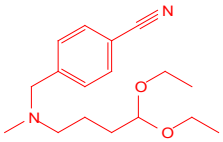


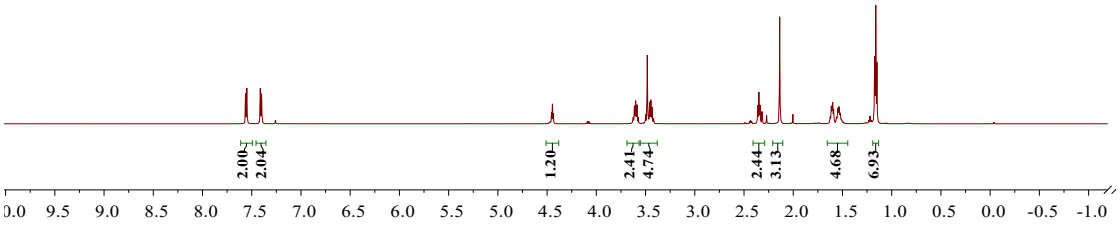


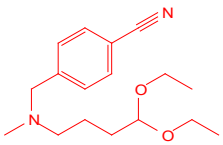
tert-butyl 3-((4-cyanobenzyl)(cyclohexyl)amino)propanoate (26)

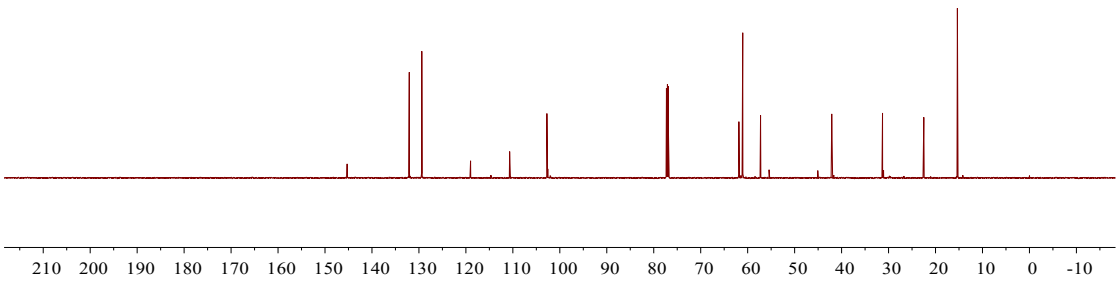


4-(((4,4-diethoxybutyl)(methyl)amino)methyl)benzonitrile (27)

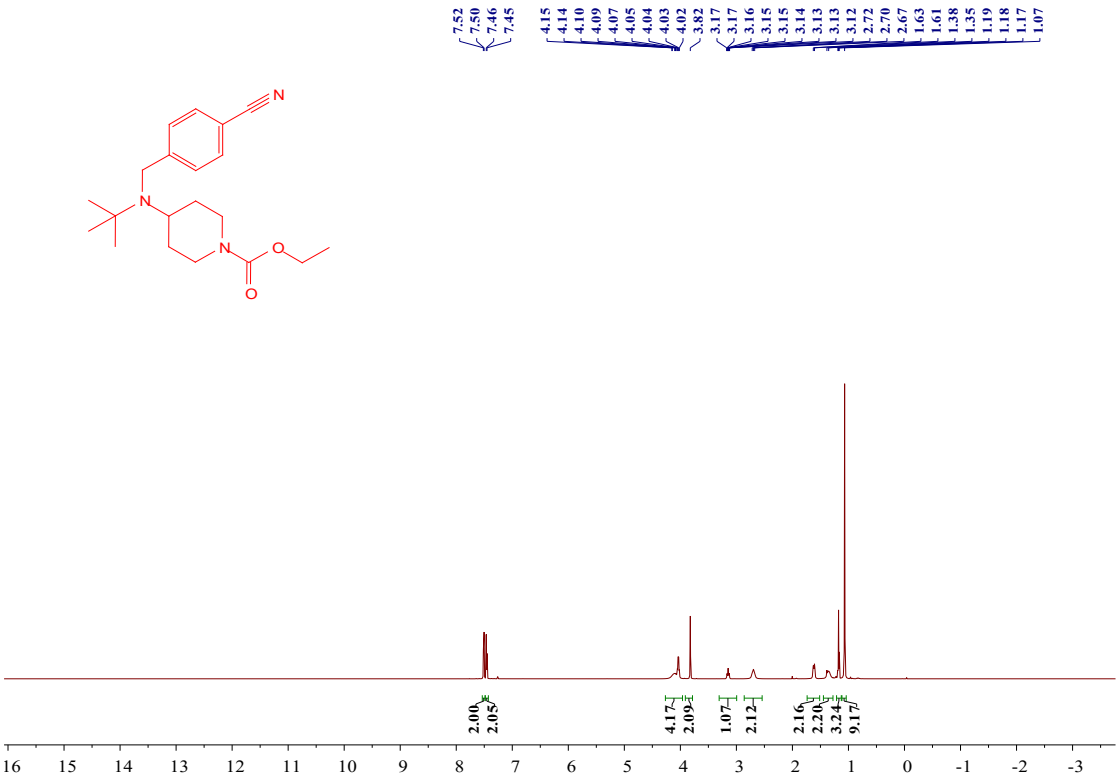


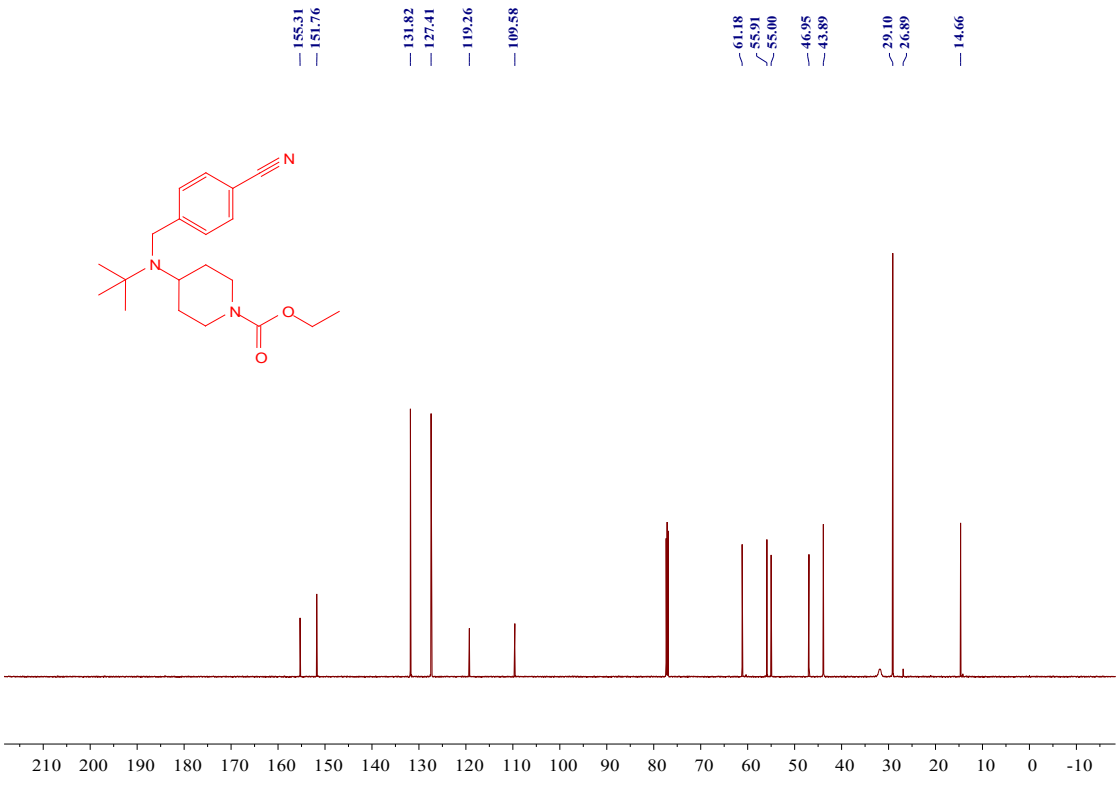




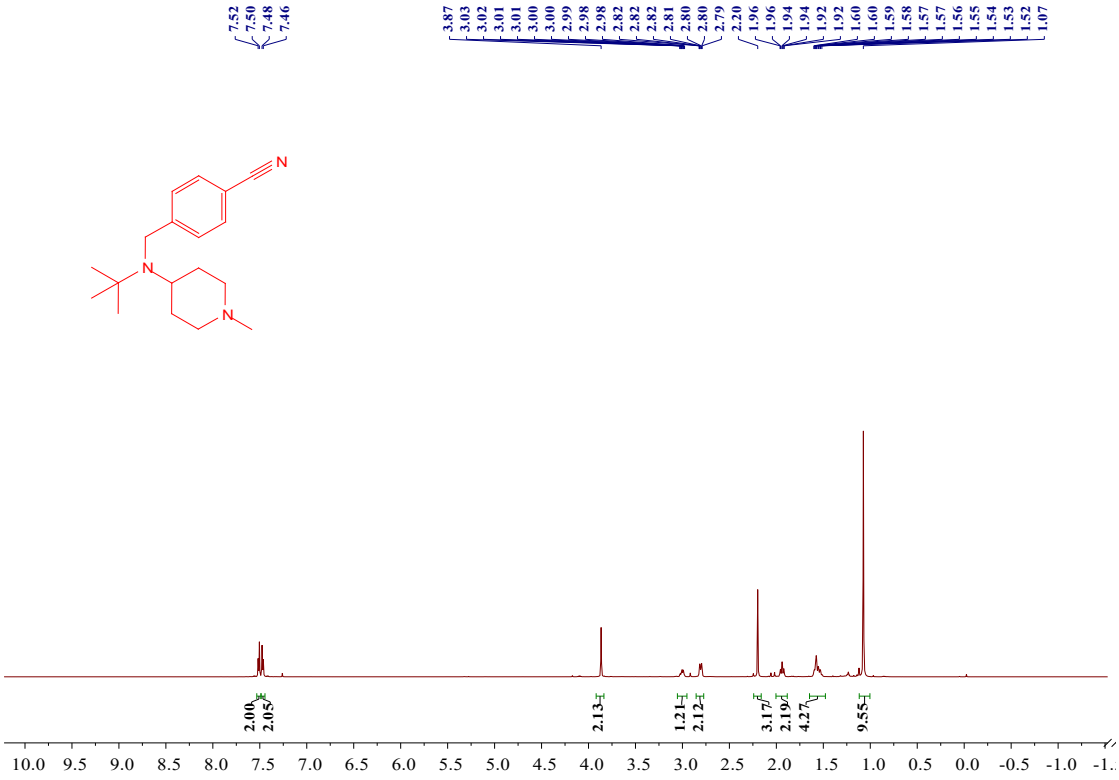


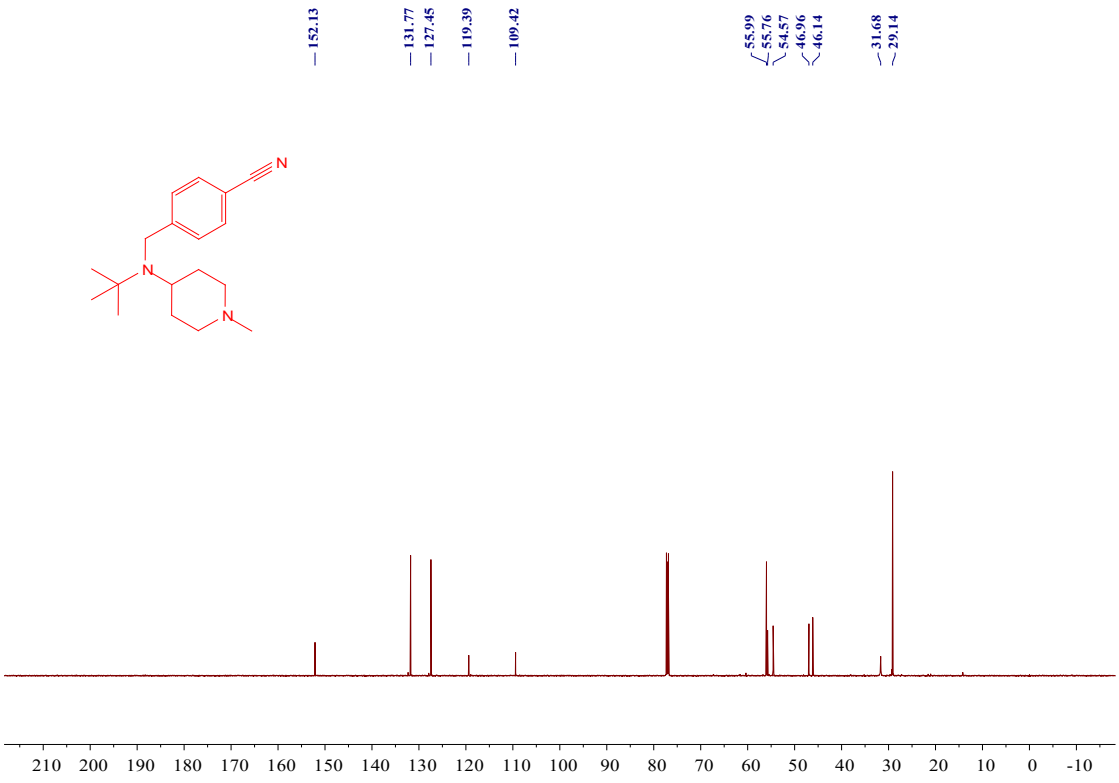
ethyl 4-(tert-butyl(4-cyanobenzyl)amino)piperidine-1-carboxylate (28)



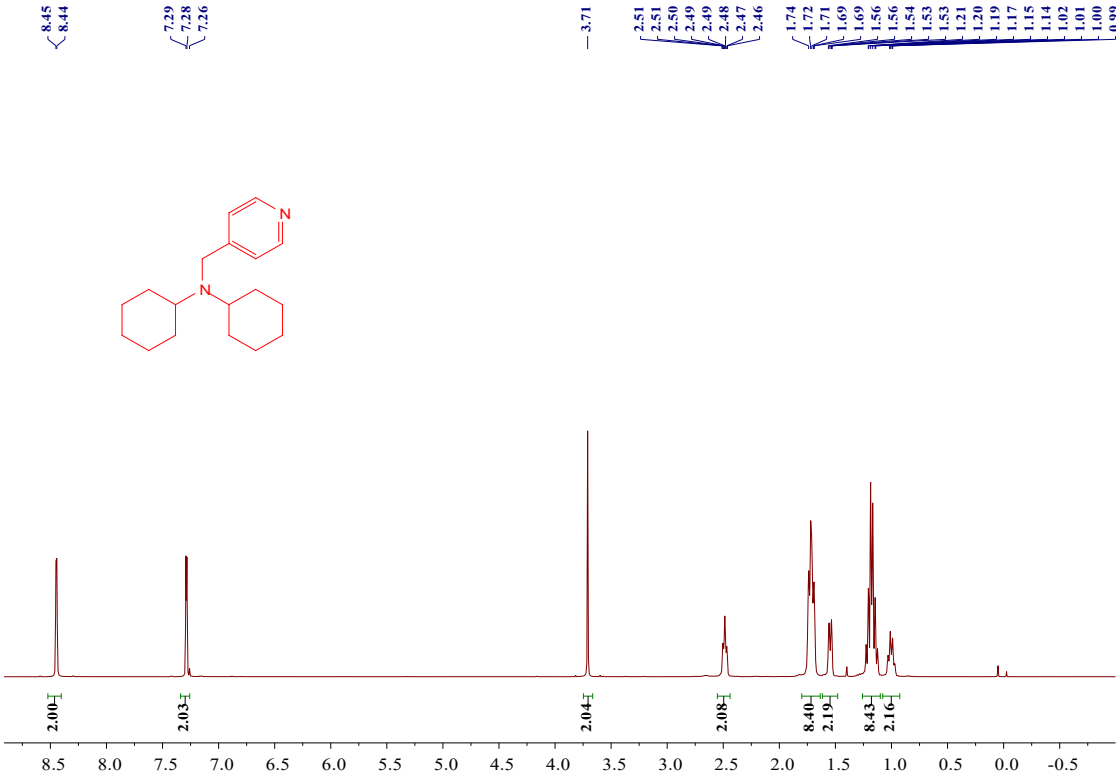


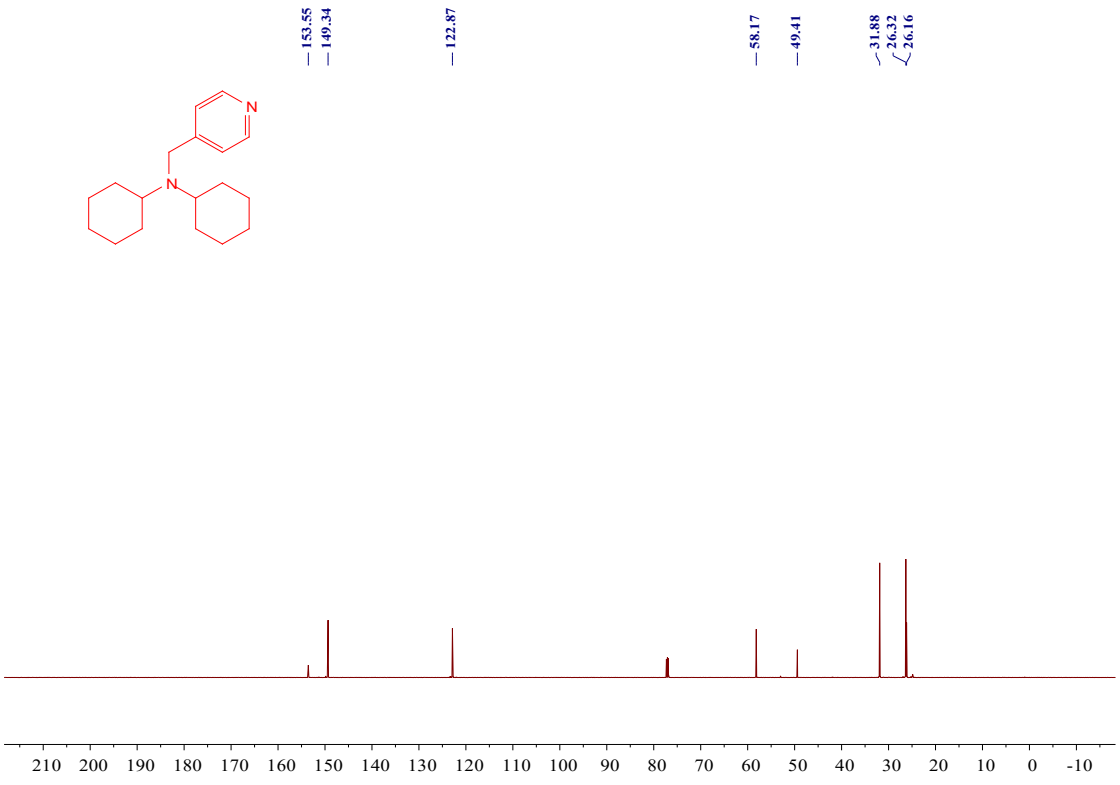
4-((tert-butyl(1-methylpiperidin-4-yl)amino)methyl)benzonitrile (29)



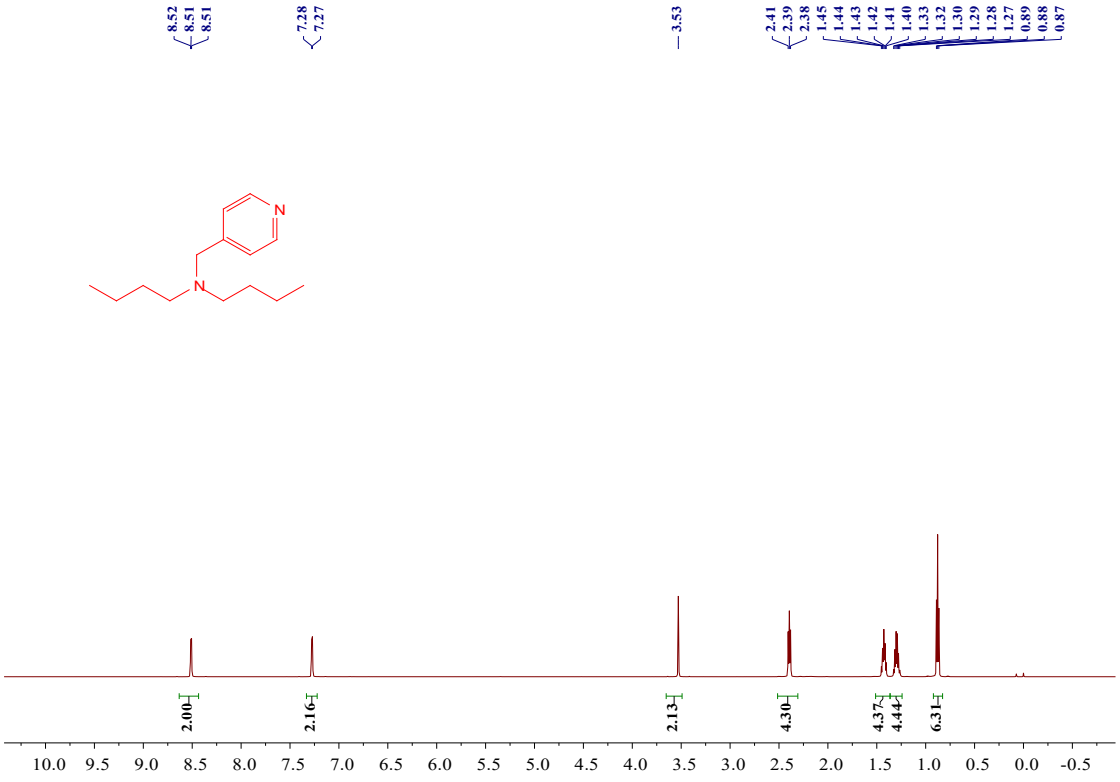


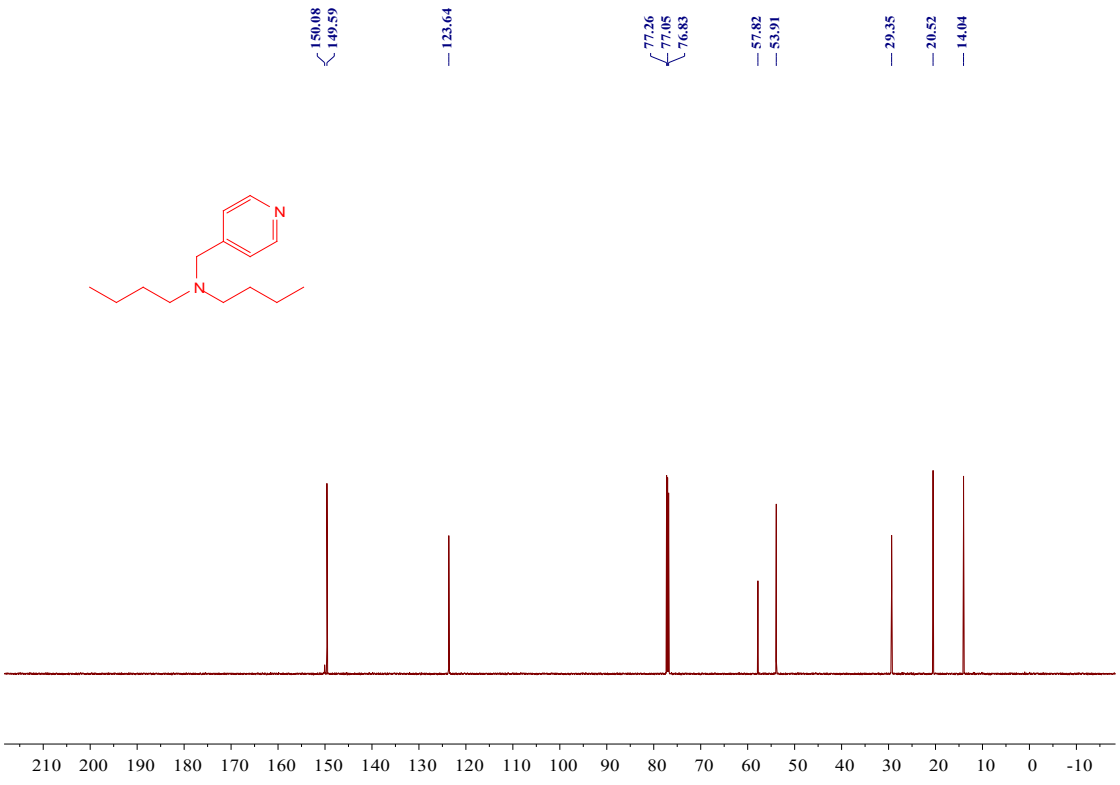
N-cyclohexyl-N-(pyridin-4-ylmethyl)cyclohexanamine (30)



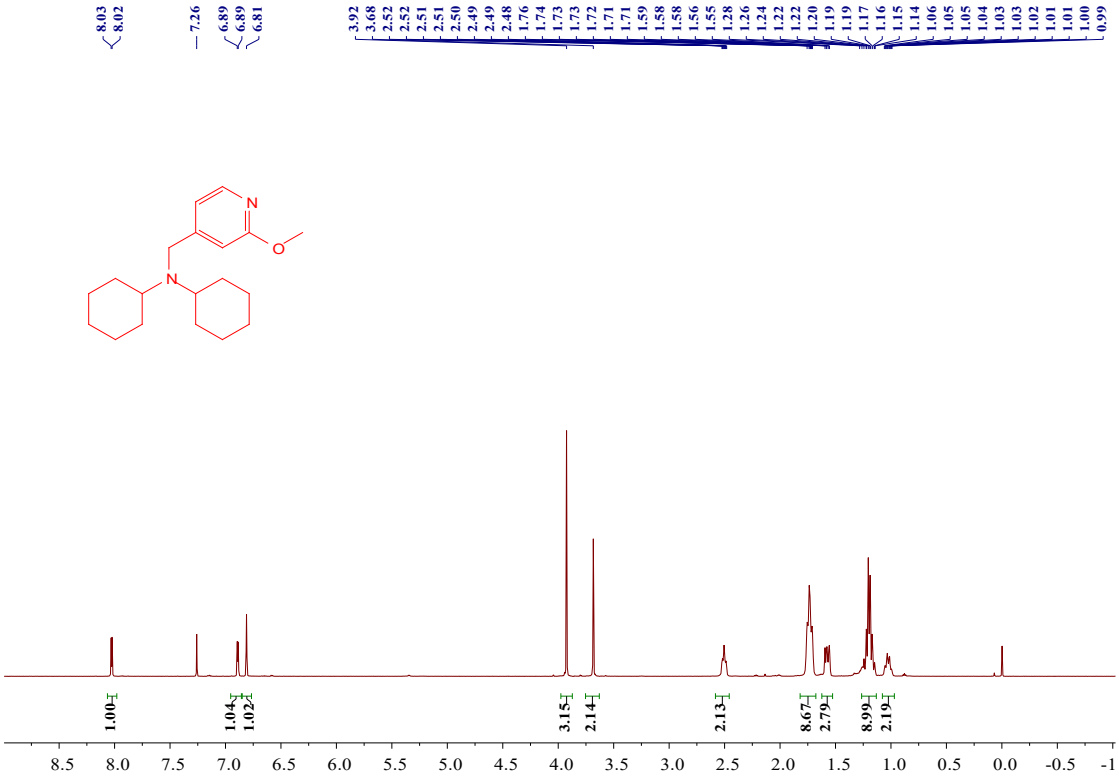


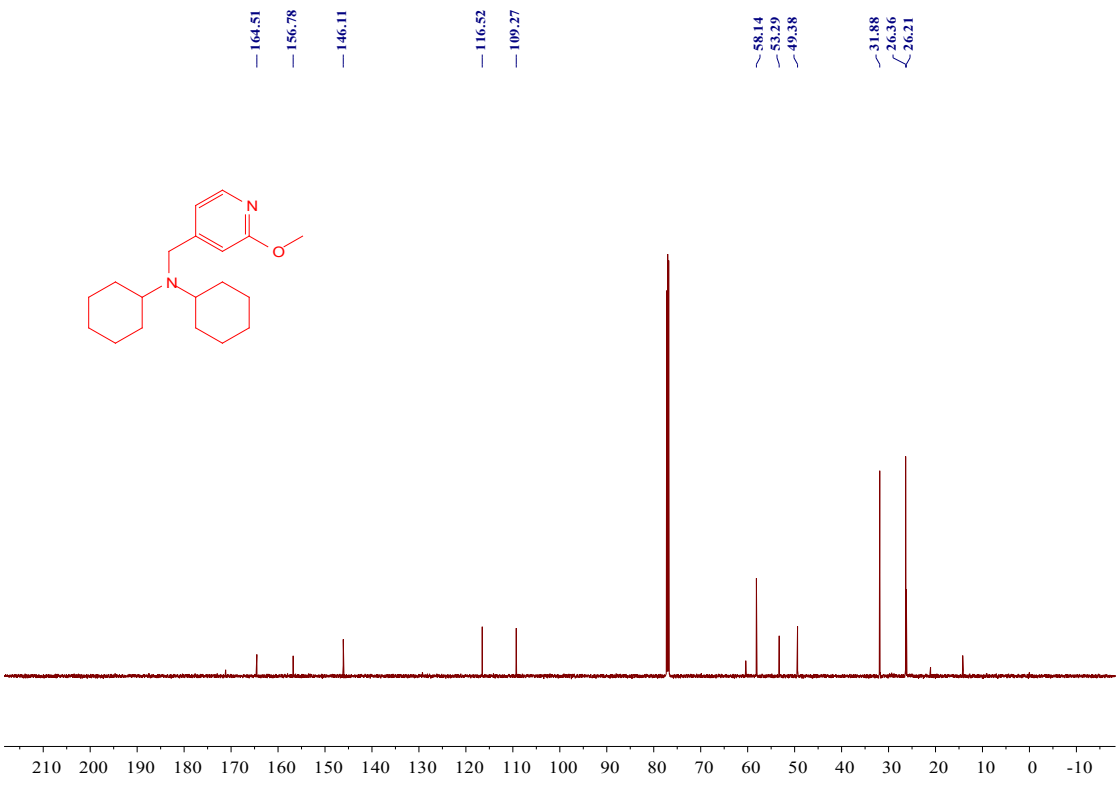
N-butyl-N-(pyridin-4-ylmethyl)butan-1-amine (31)



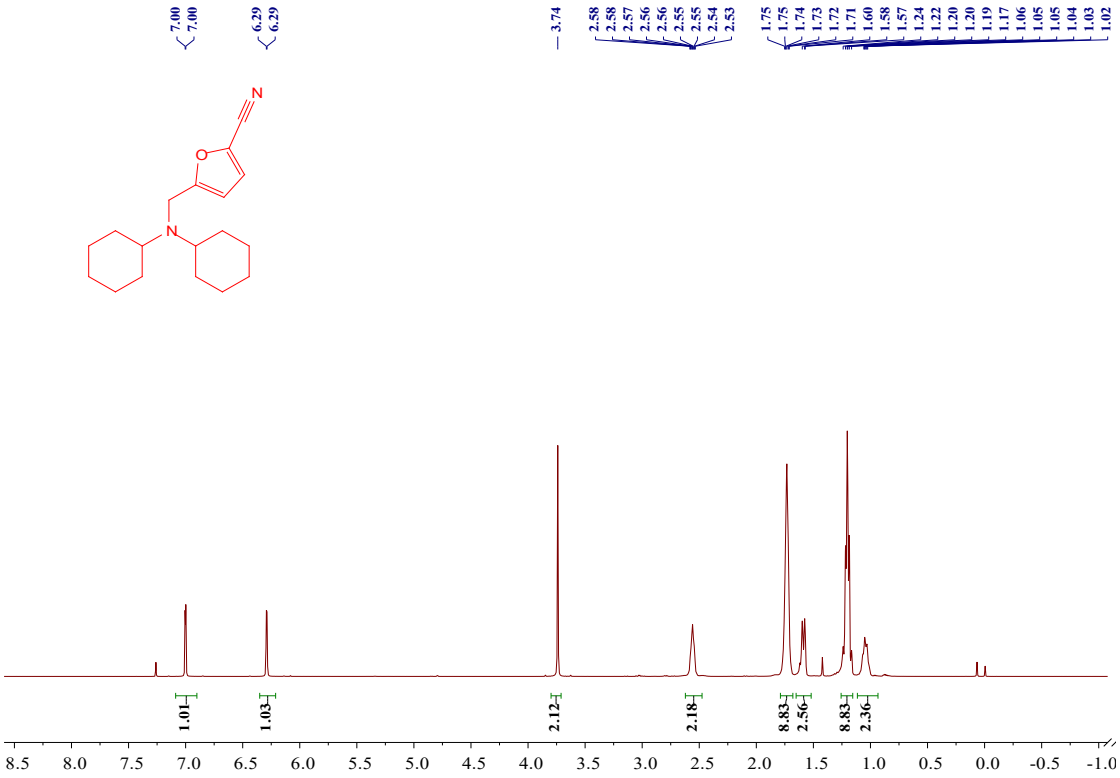


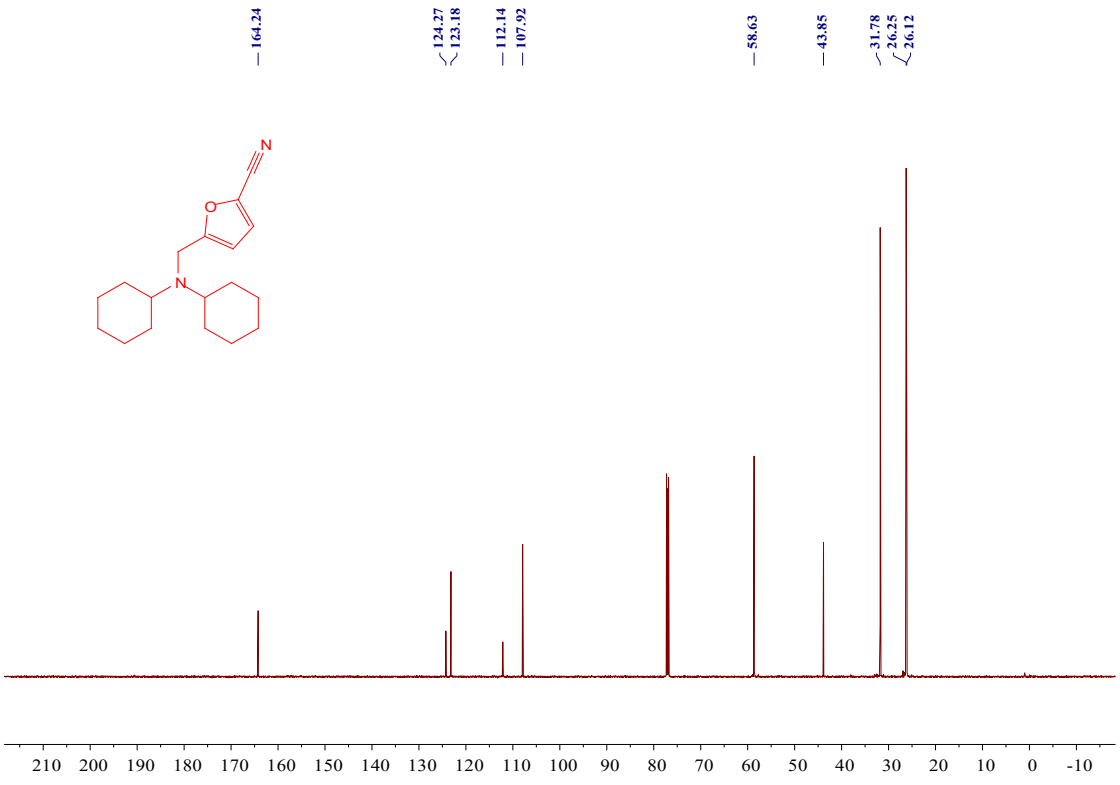
N-cyclohexyl-N-((2-methoxypyridin-4-yl)methyl)cyclohexanamine (32)



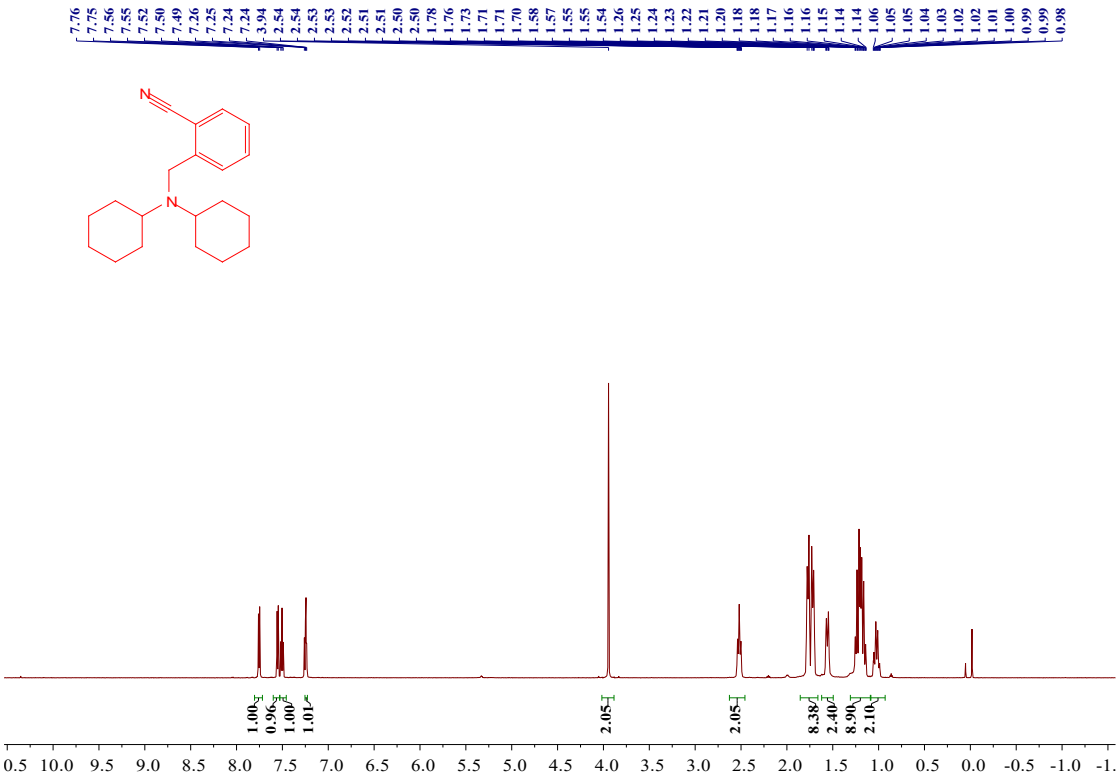


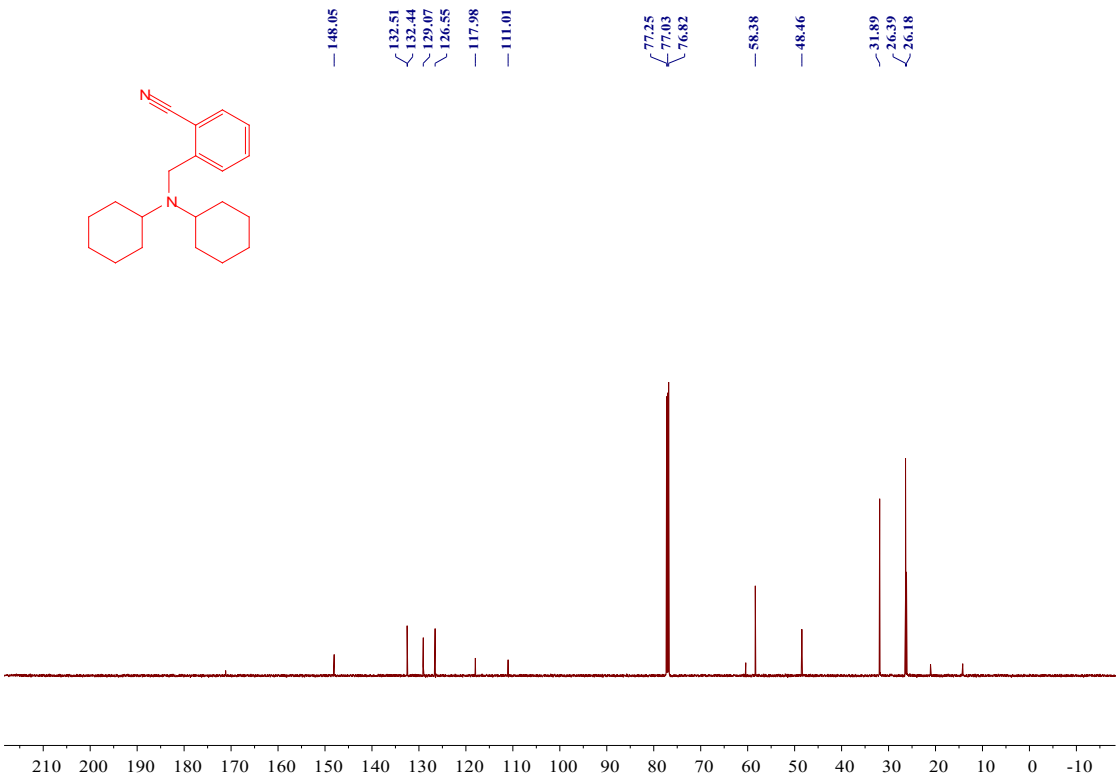
5-((dicyclohexylamino)methyl)furan-2-carbonitrile (33)



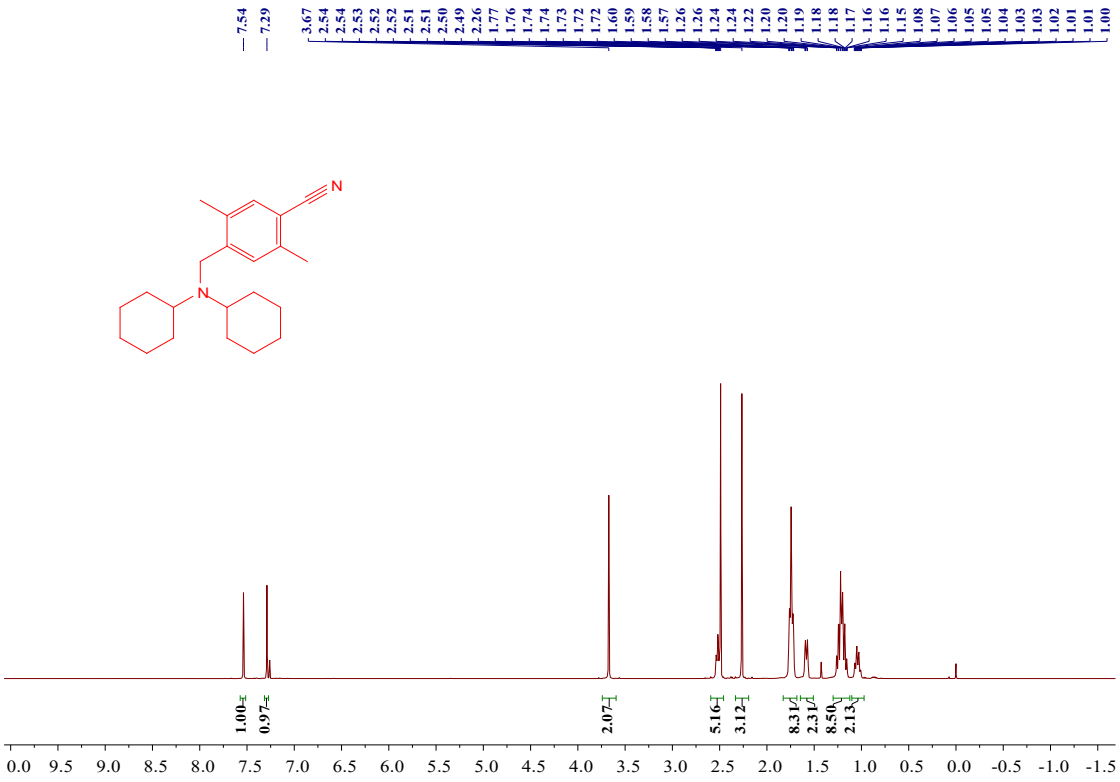


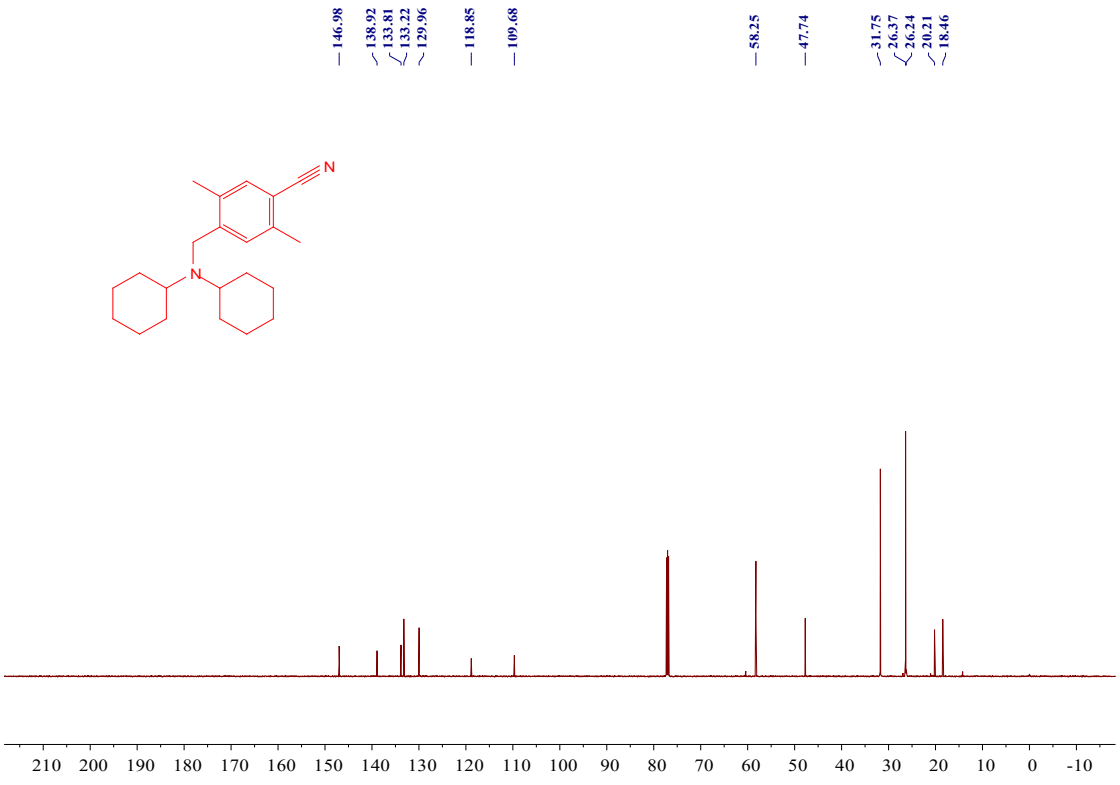
2-((dicyclohexylamino)methyl)benzonitrile (34)




148.05
132.51
132.44
129.07
126.55
117.98
111.01
77.25
77.03
76.82
58.38
48.46
31.89
26.39
26.18
N
N
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10

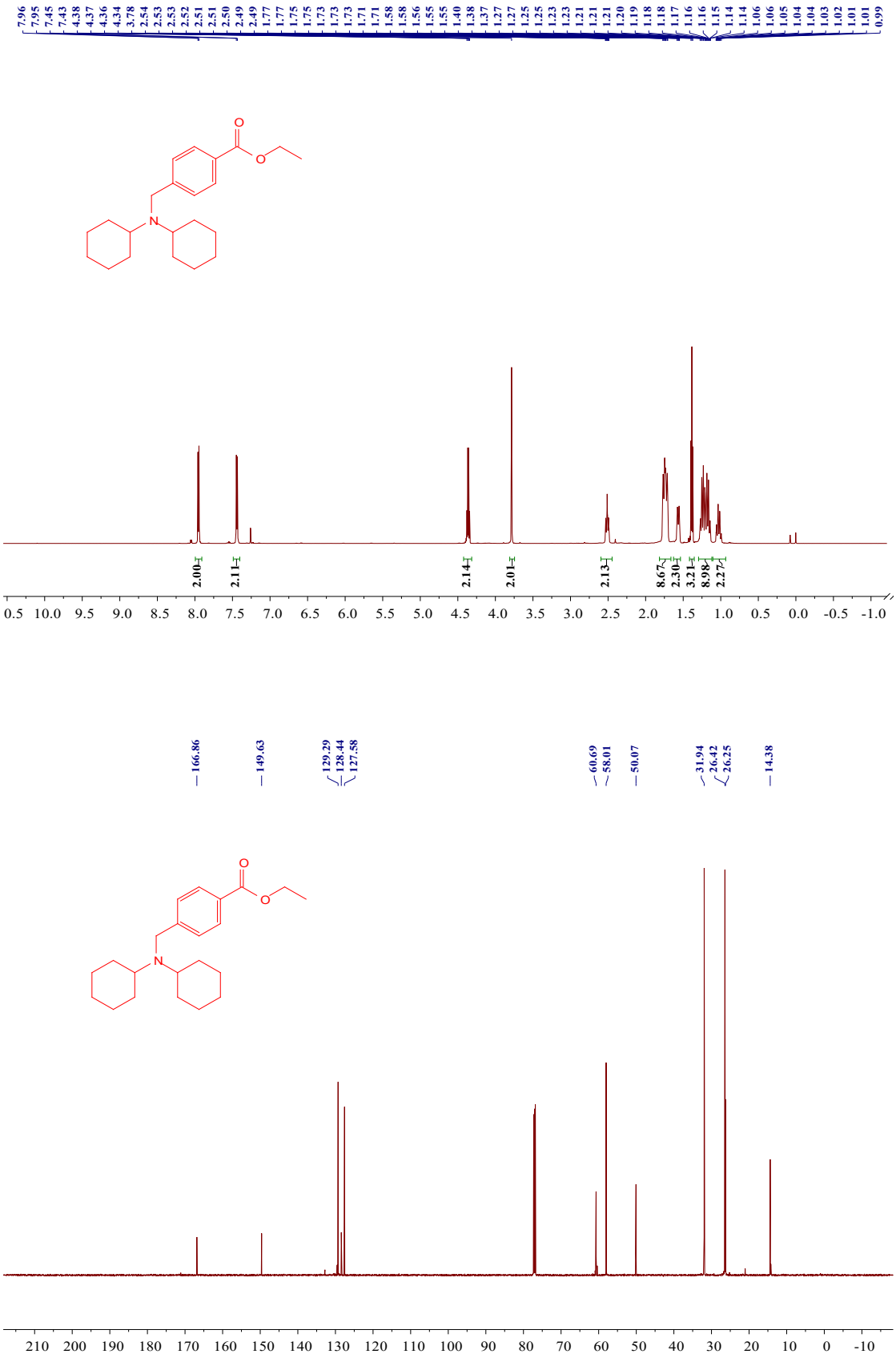
4-((dicyclohexylamino)methyl)-2,5-dimethylbenzonitrile (35)



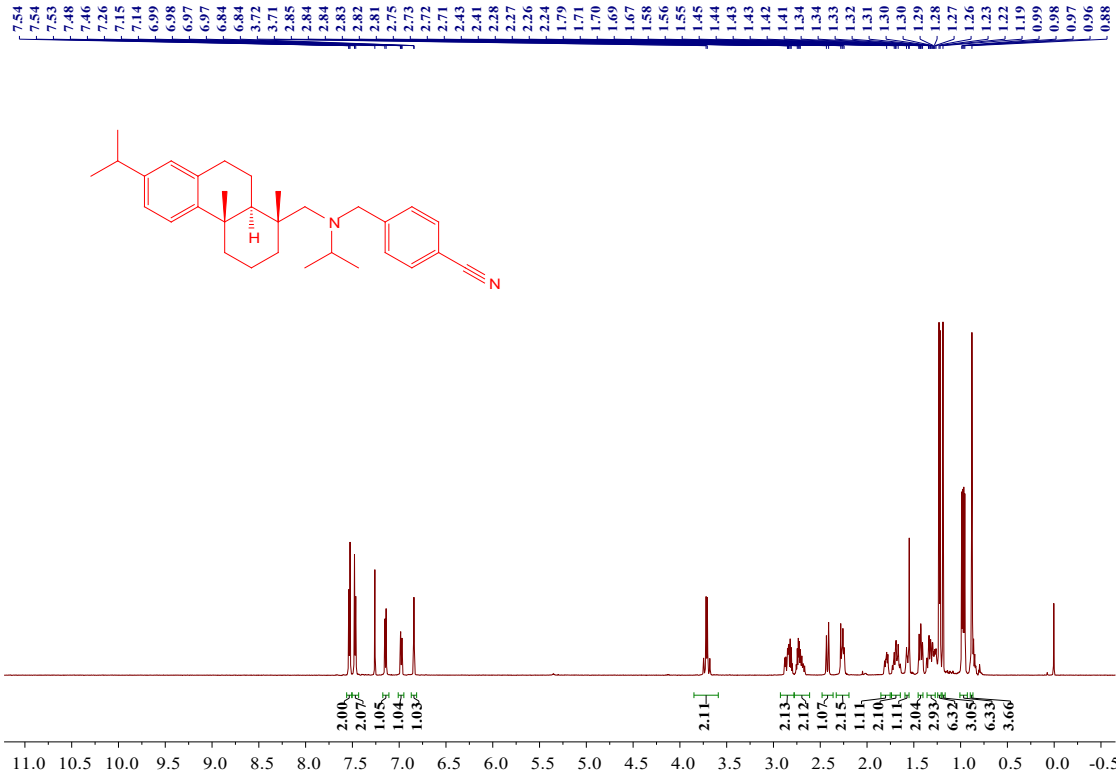


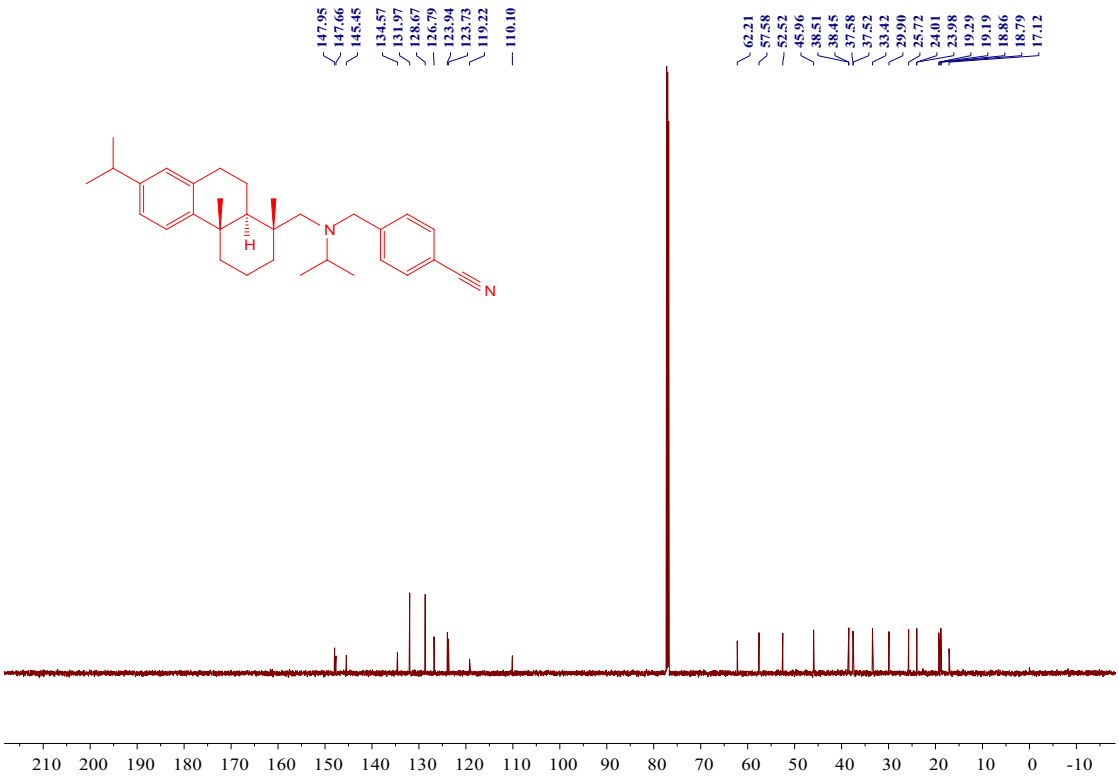
methyl 4-((dicyclohexylamino)methyl)benzoate (36)

ethyl 4-((dicyclohexylamino)methyl)benzoate (37)

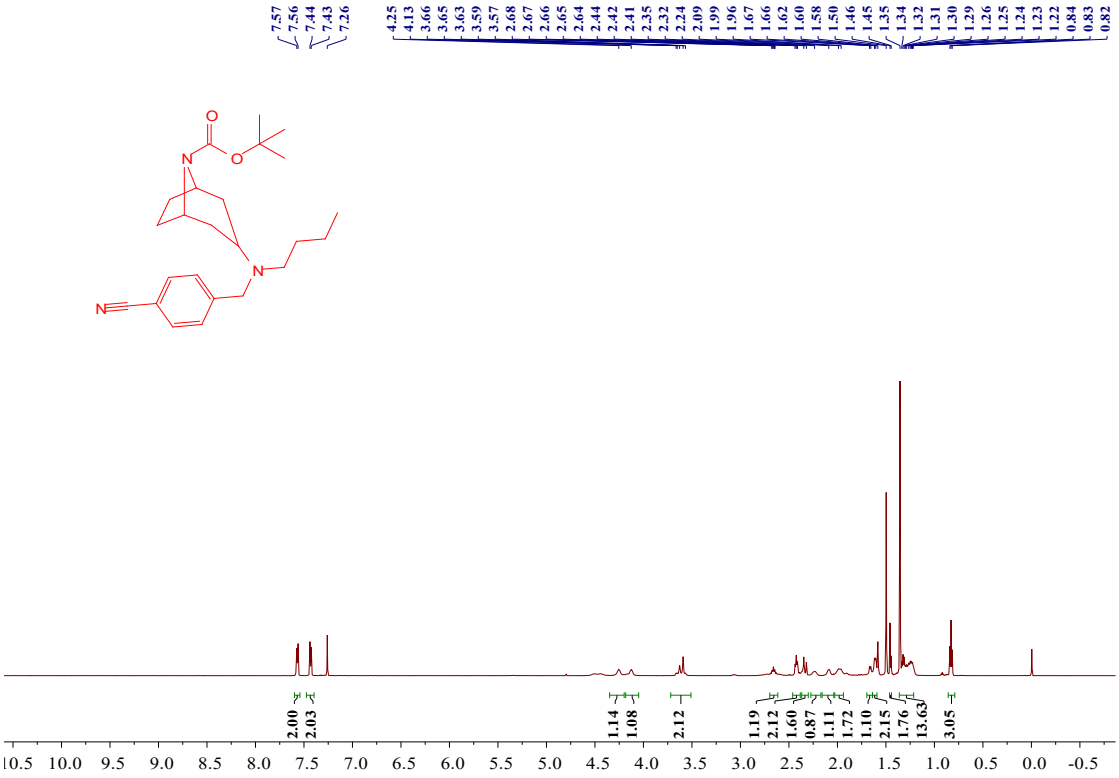


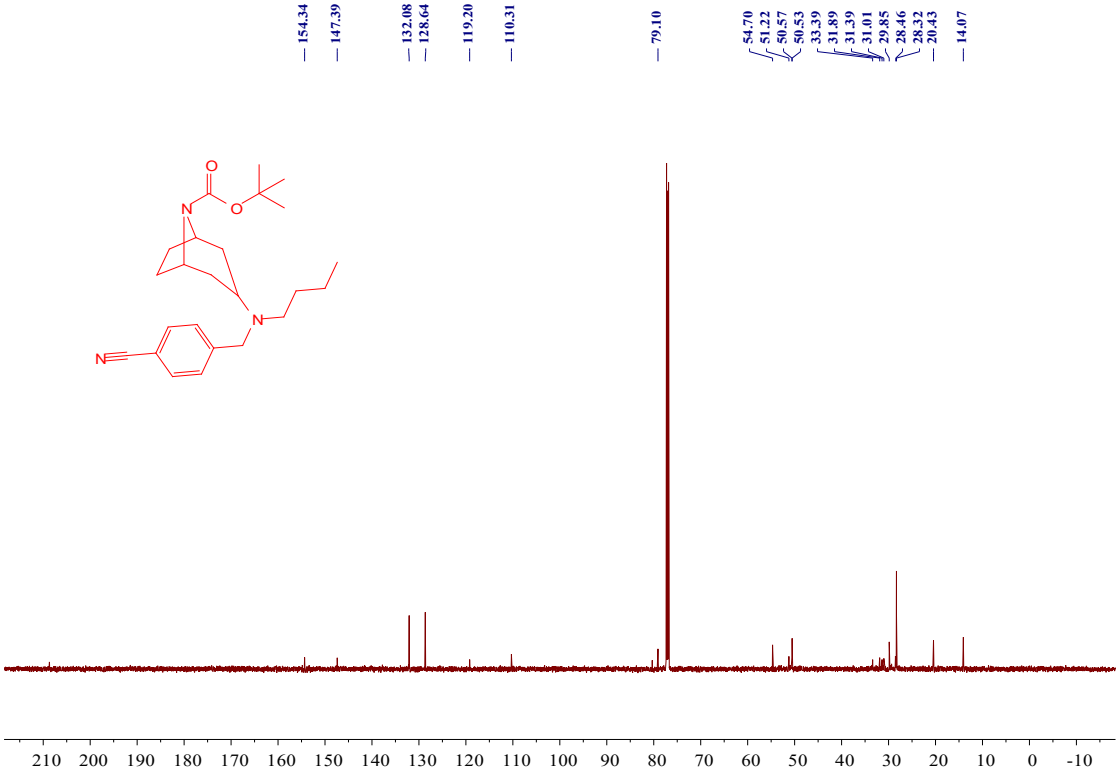
4-((isopropyl(((1R,4aS)-7-isopropyl-1,4a-dimethyl-1,2,3,4,4a,9,10,10a-octahydrophenanthren-1-yl)methyl)amino)methyl)benzonitrile (38)



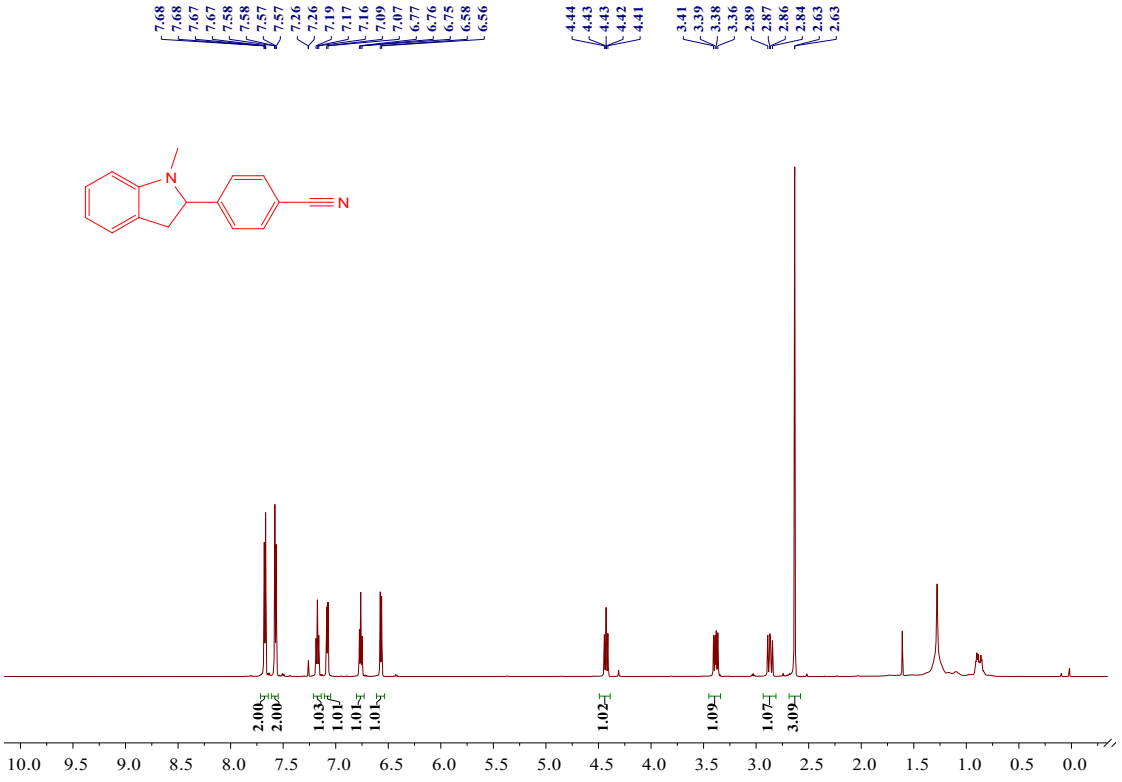


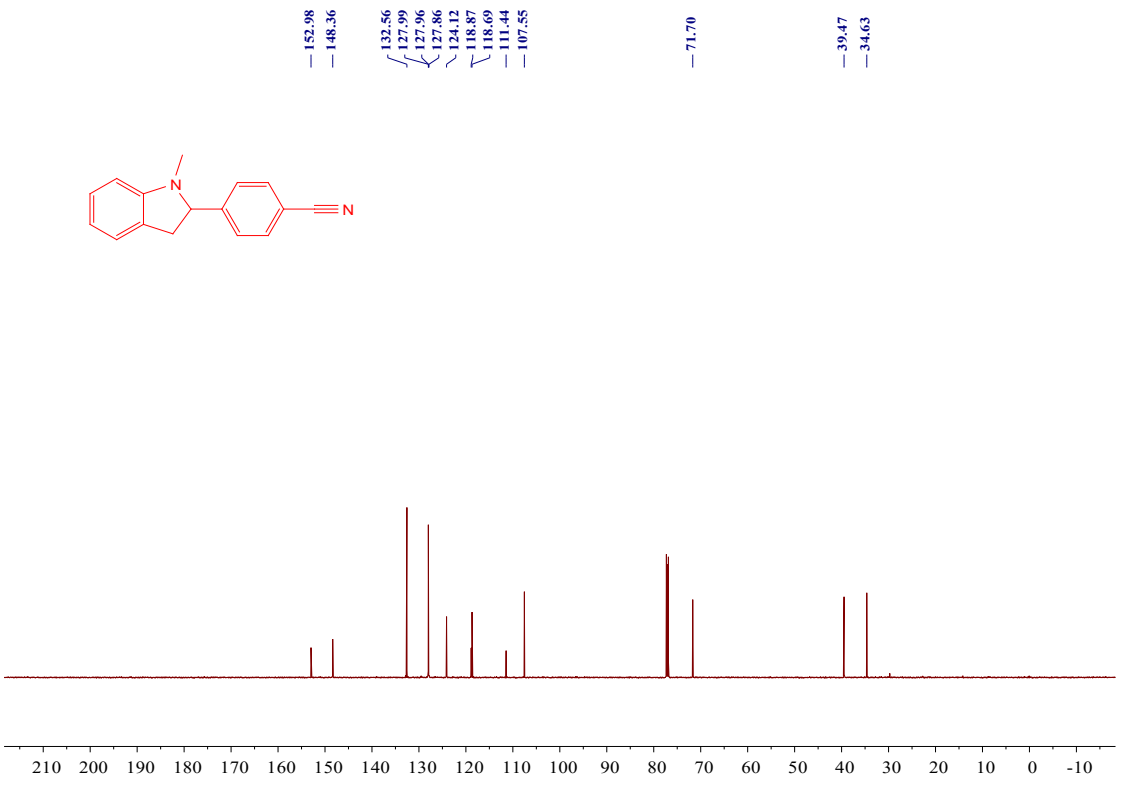
tert-butyl (1R,5S)-3-(butyl(methyl)amino)-8-azabicyclo[3.2.1]octane-8-carboxylate (39)



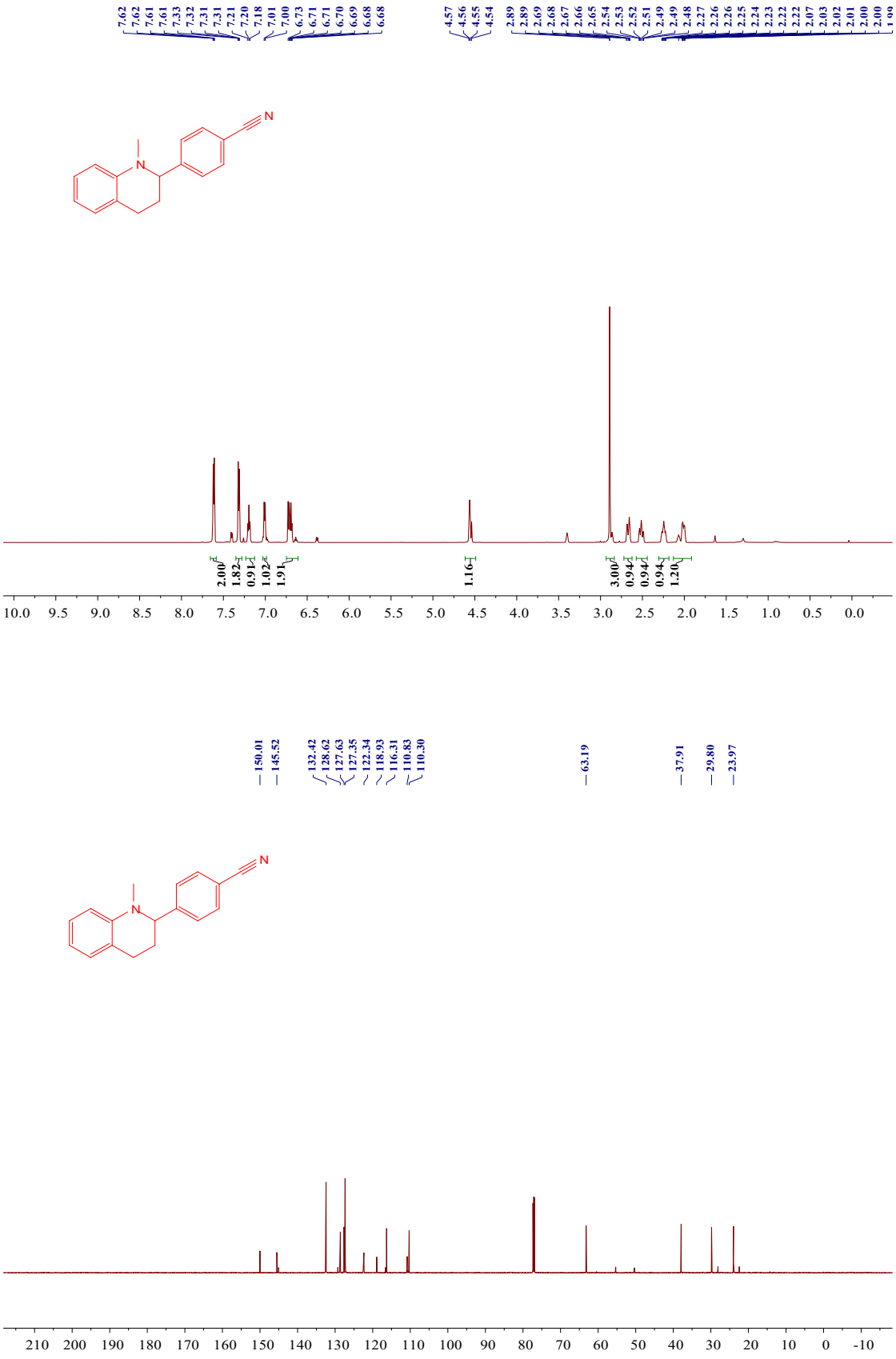


4-(1-methylindolin-2-yl)benzonitrile (40)

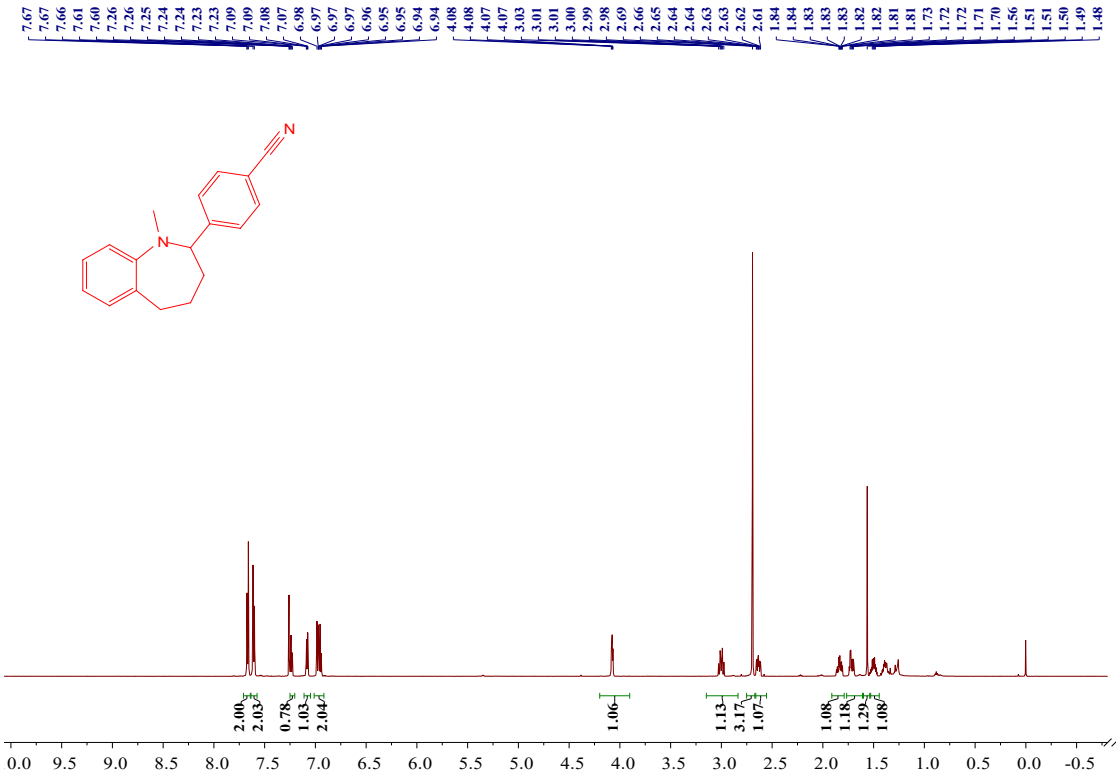


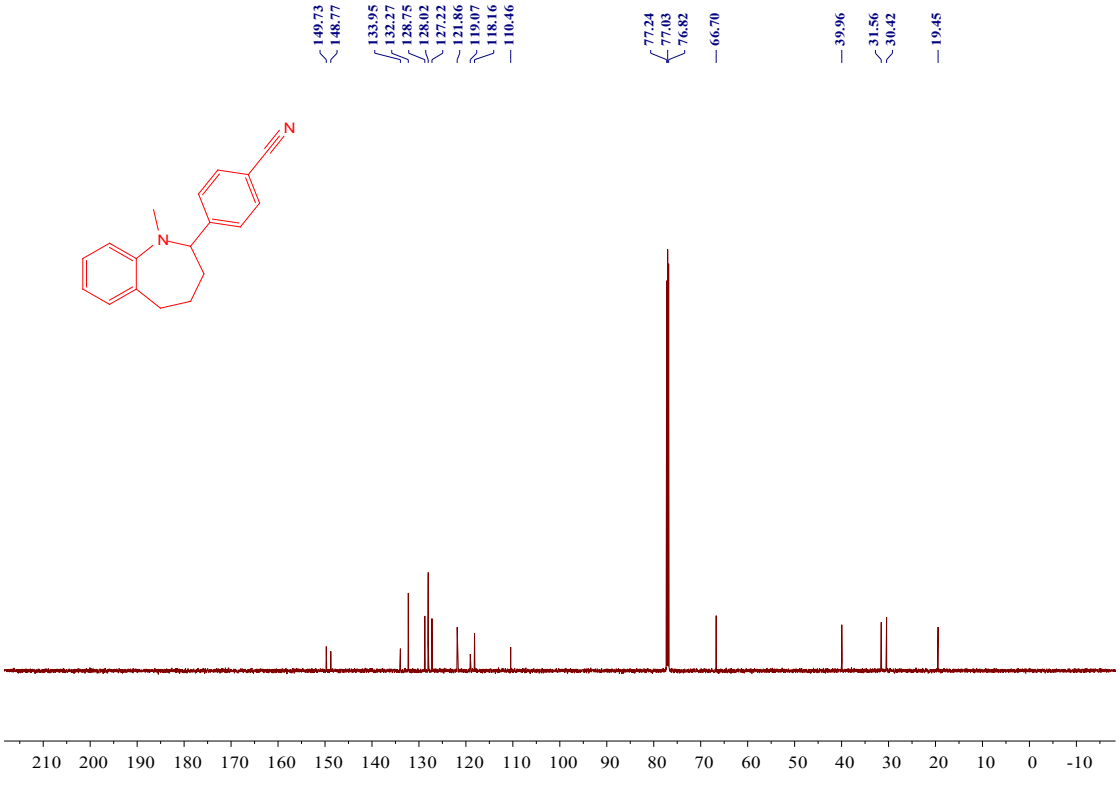


4-(1-methyl-1,2,3,4-tetrahydroquinolin-2-yl)benzonitrile (41)

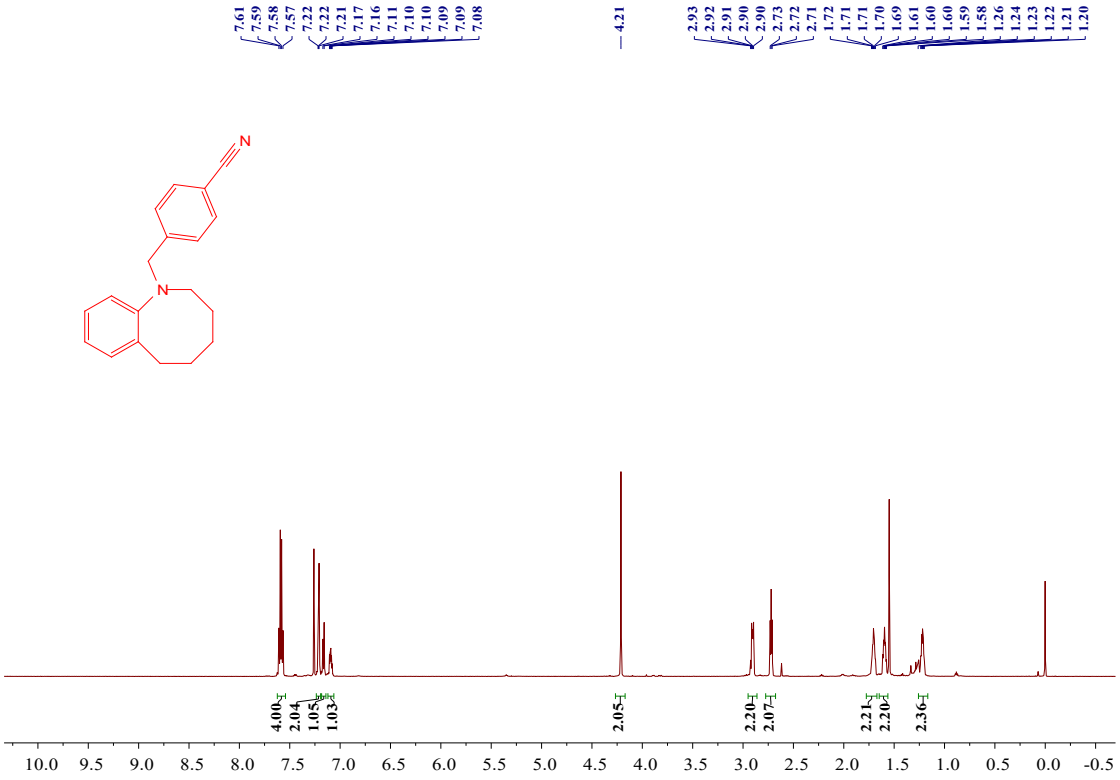


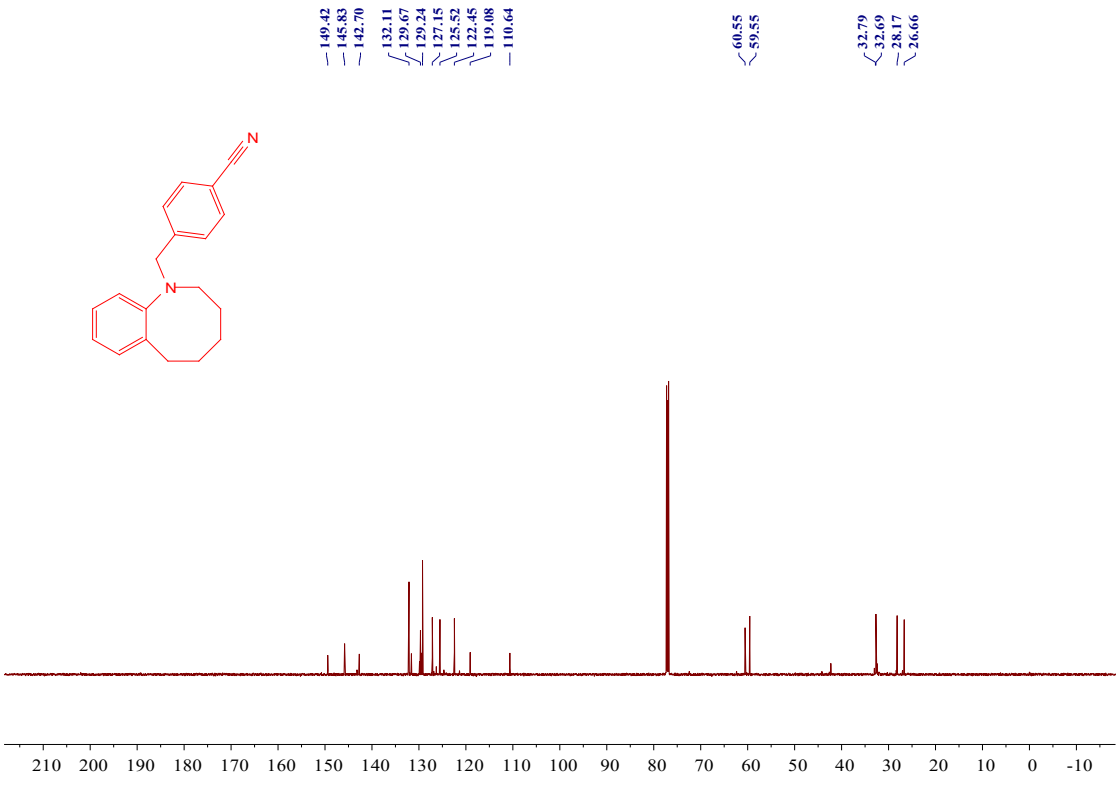
4-((2,3,4,5-tetrahydro-1H-benzo[b]azepin-1-yl)methyl)benzonitrile (42)



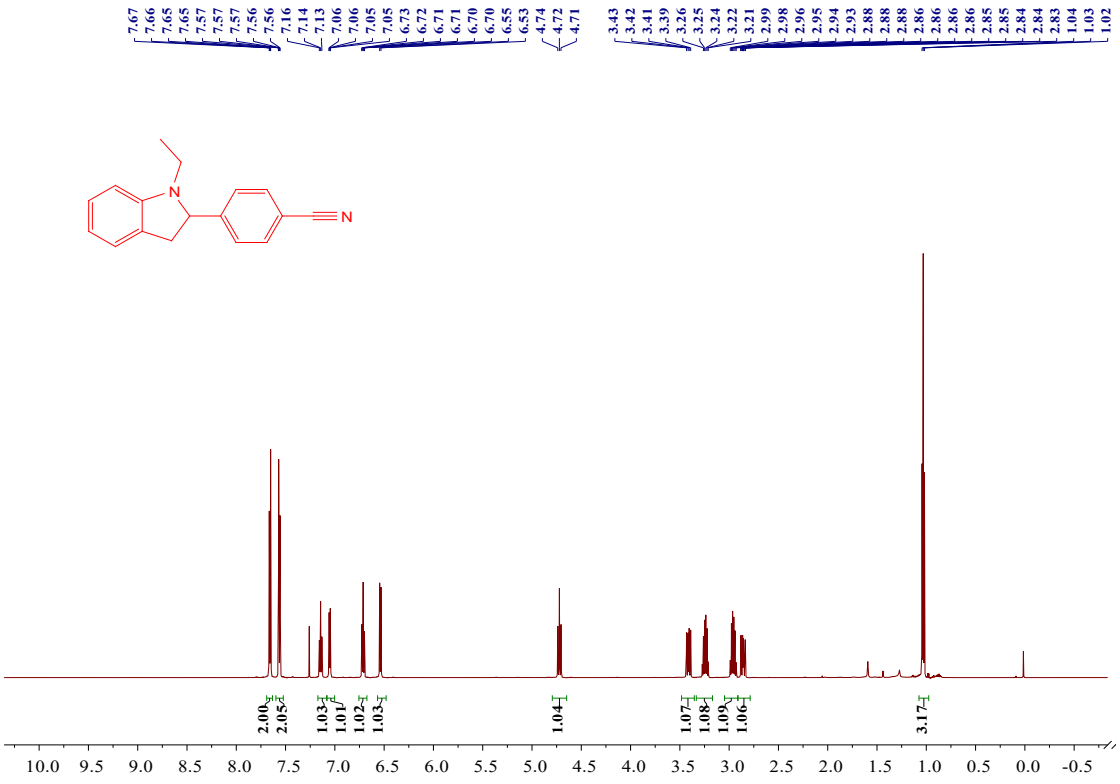


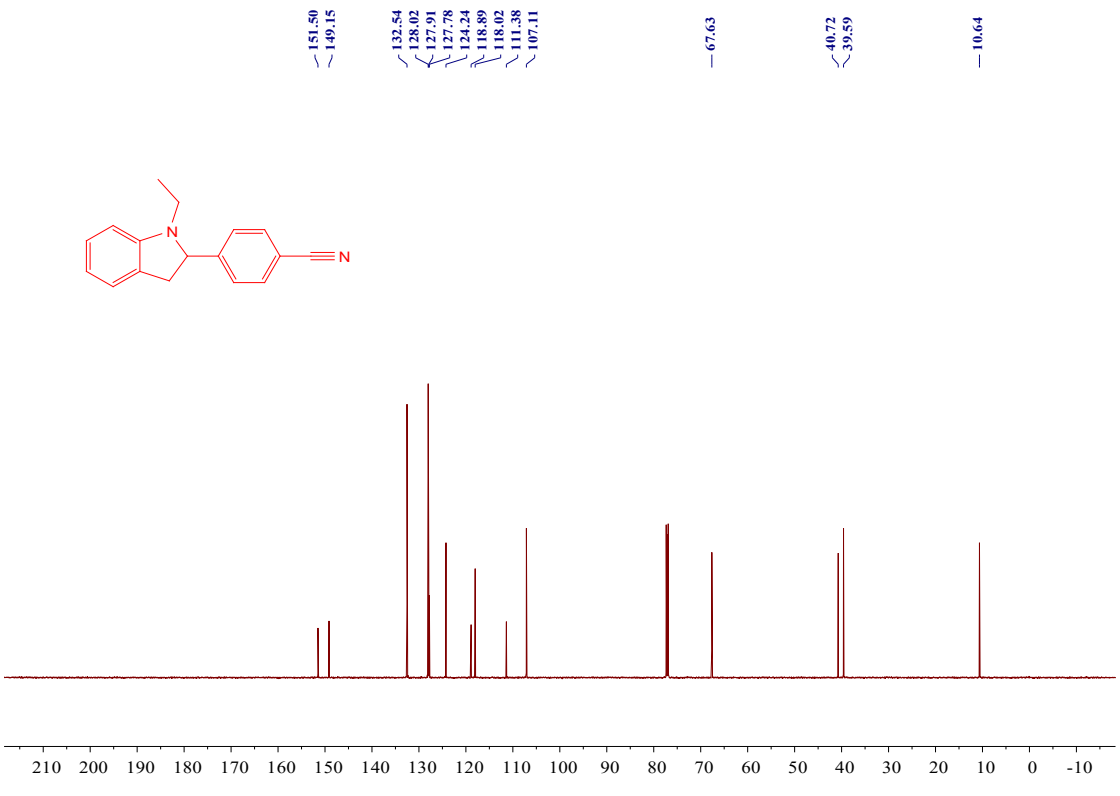
4-((3,4,5,6-tetrahydrobenzo[b]azocin-1(2H)-yl)methyl)benzonitrile (43)



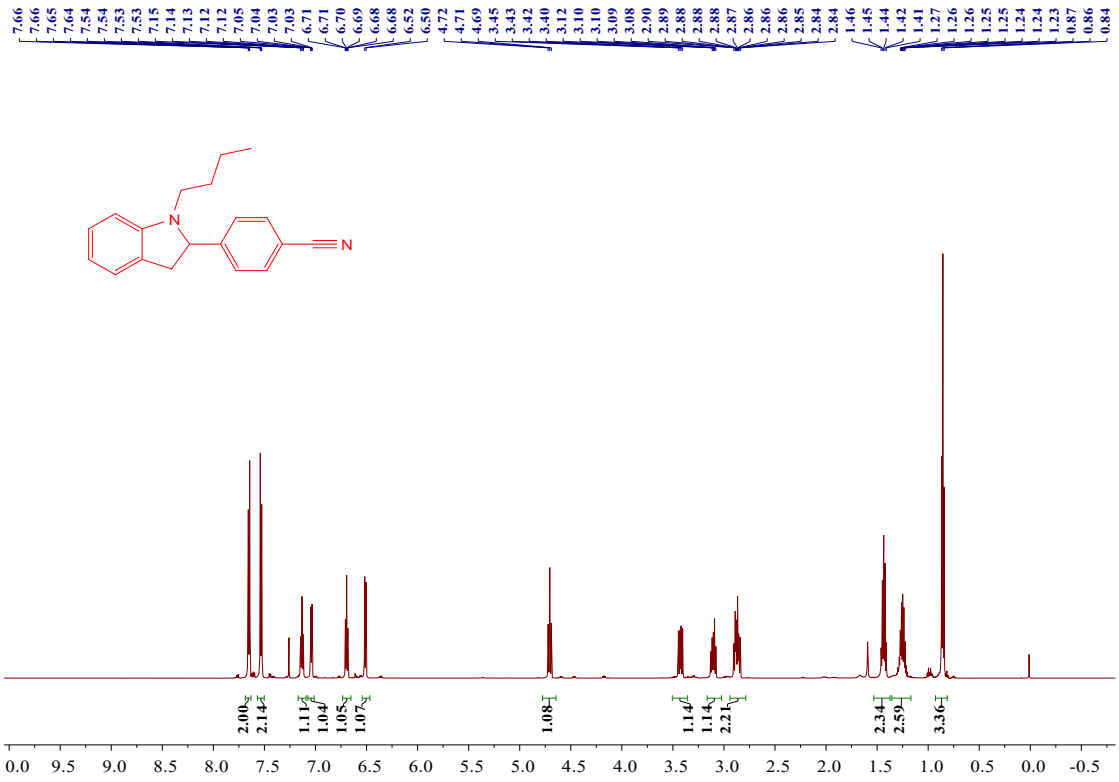


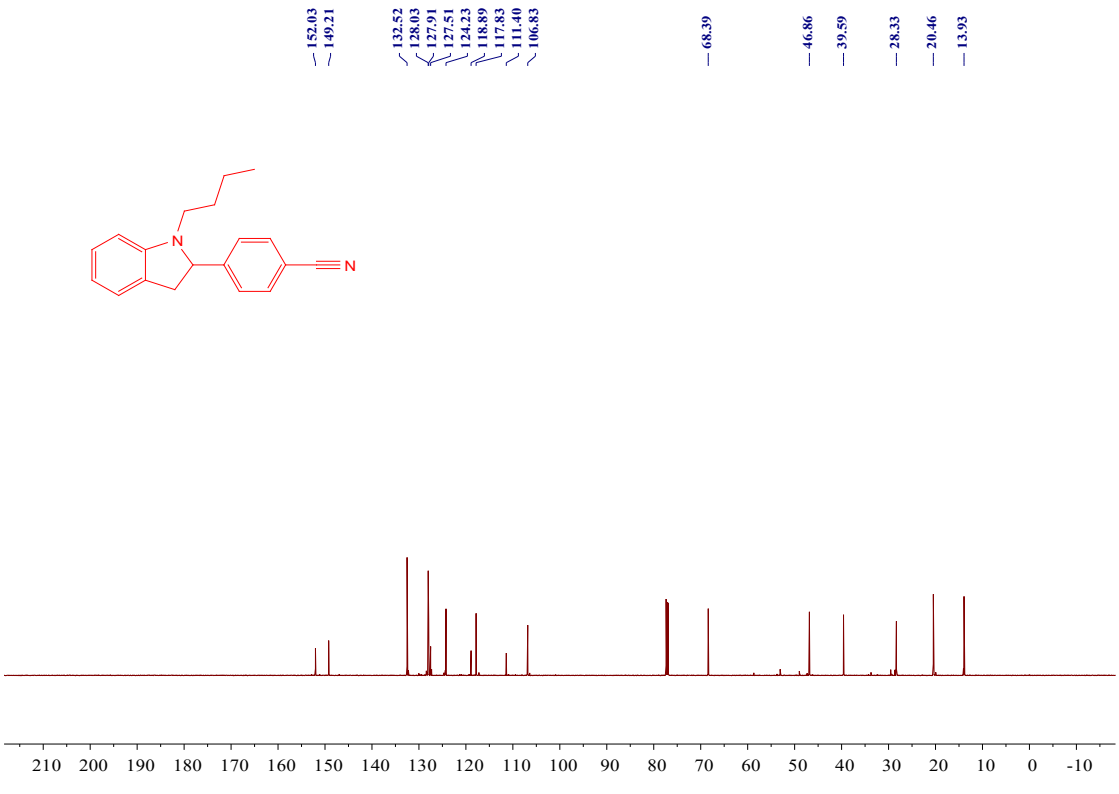
4-(1-ethylindolin-2-yl)benzonitrile (44)



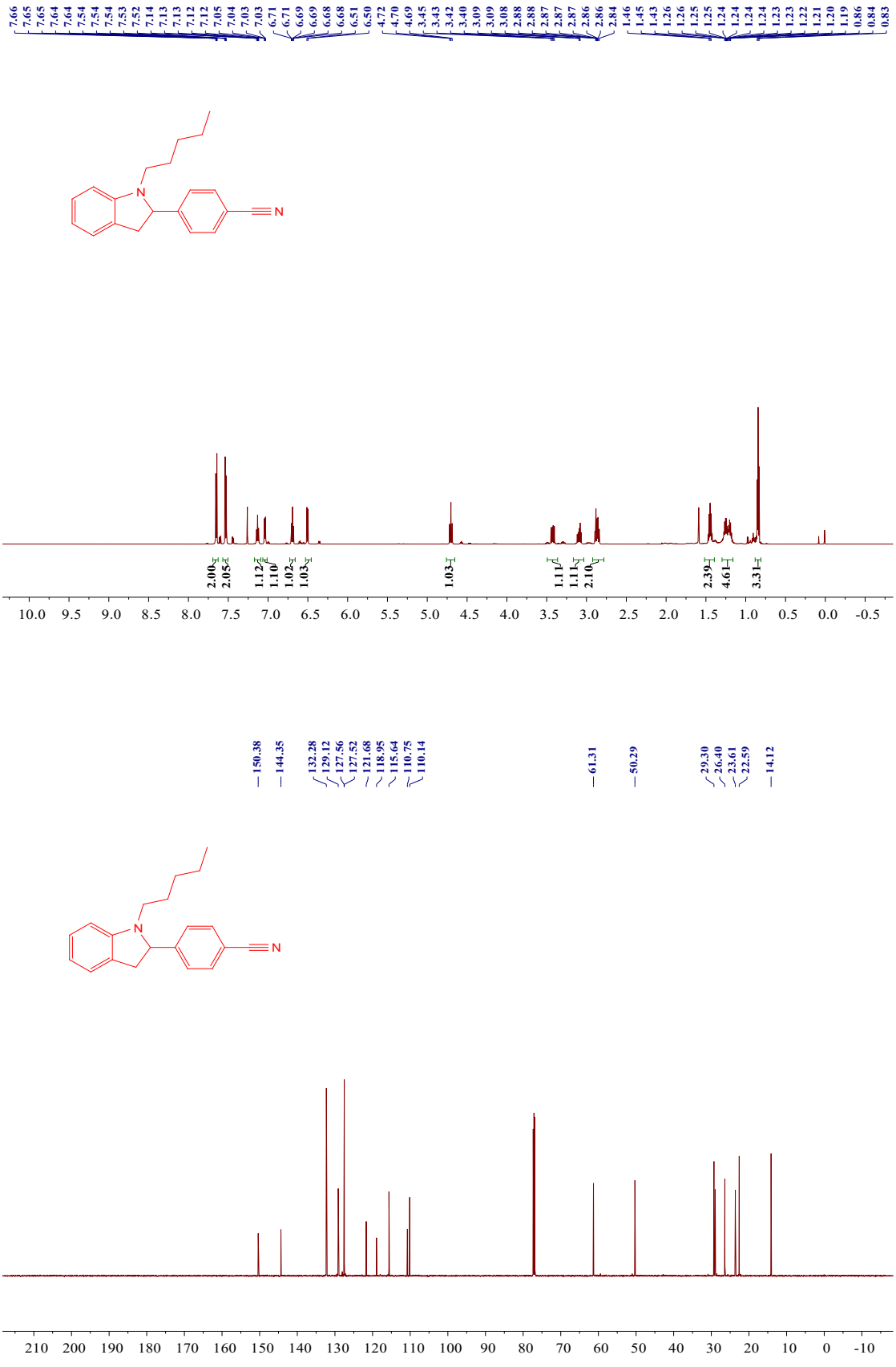


4-(1-butylindolin-2-yl)benzonitrile (45)

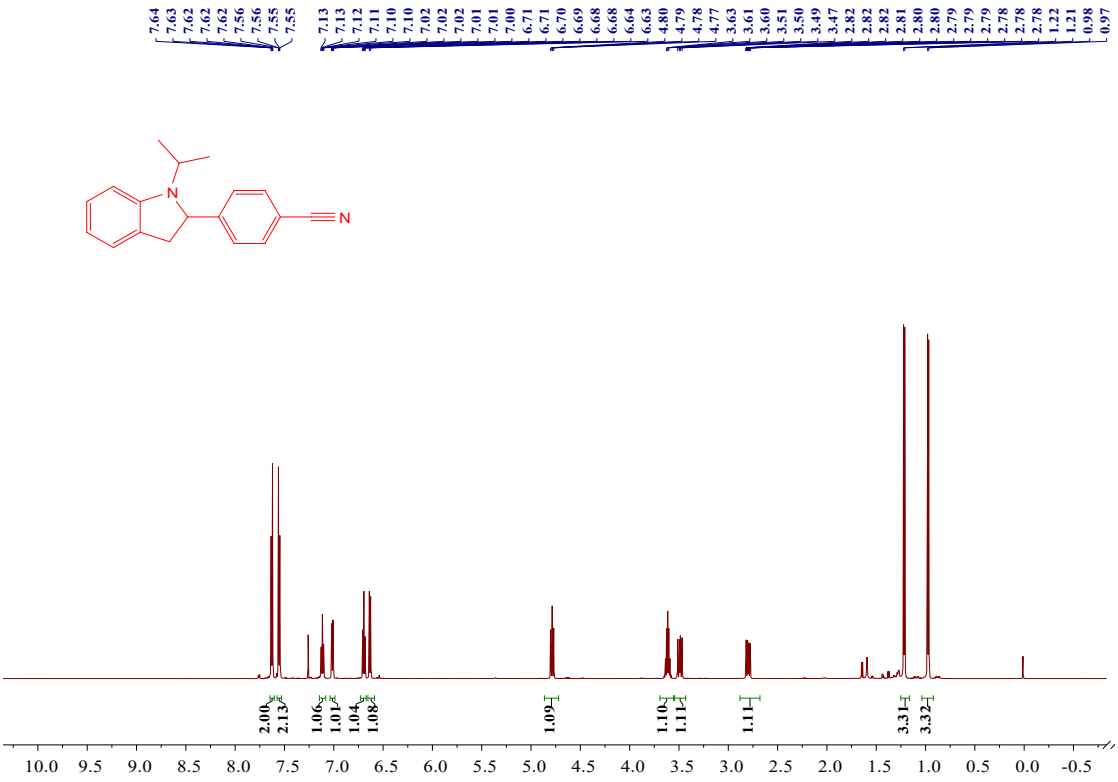


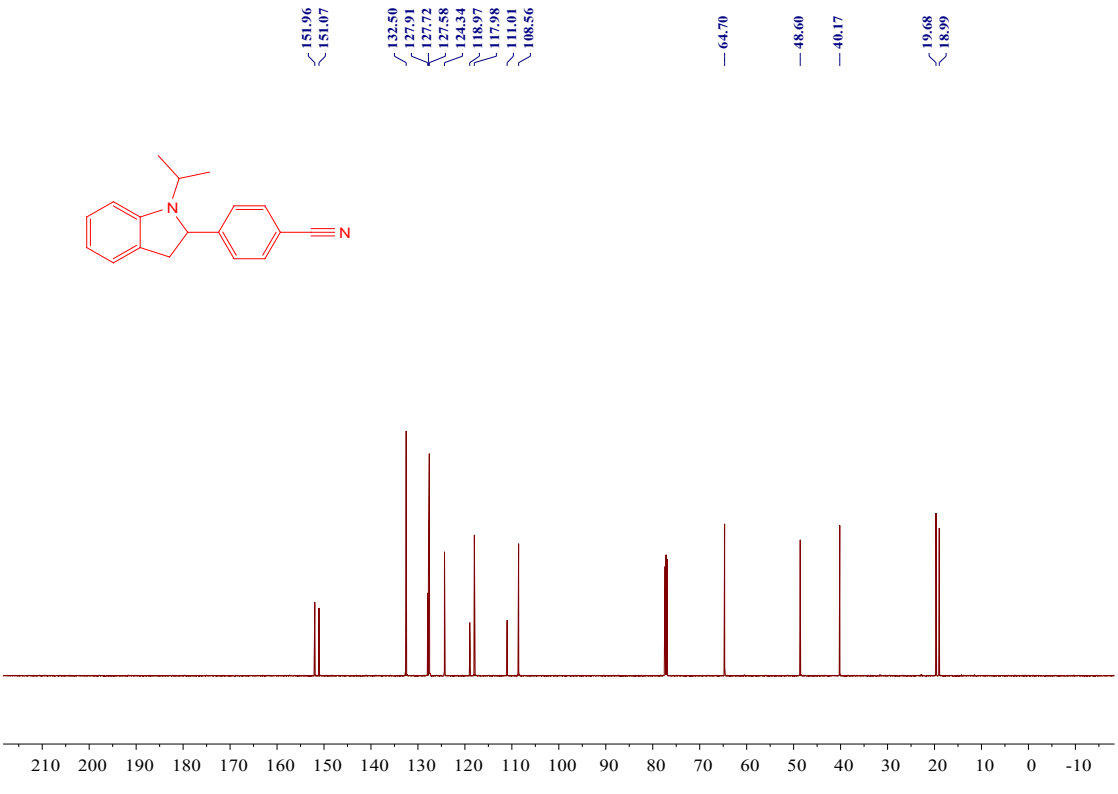


4-(1-pentylindolin-2-yl)benzonitrile (46)

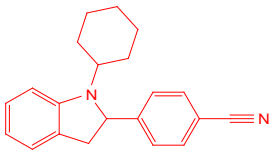


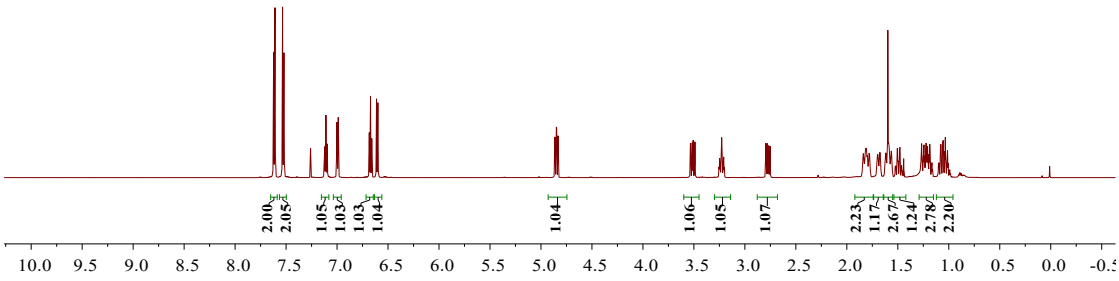
4-(1-isopropylindolin-2-yl)benzonitrile (47)

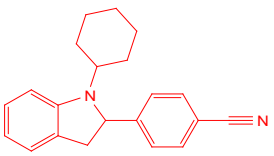


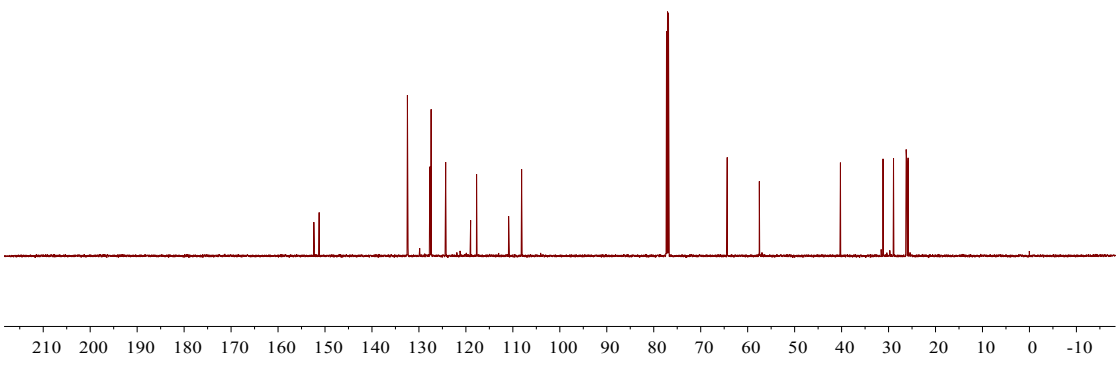


4-(1-cyclohexylindolin-2-yl)benzonitrile (48)

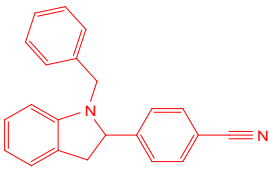


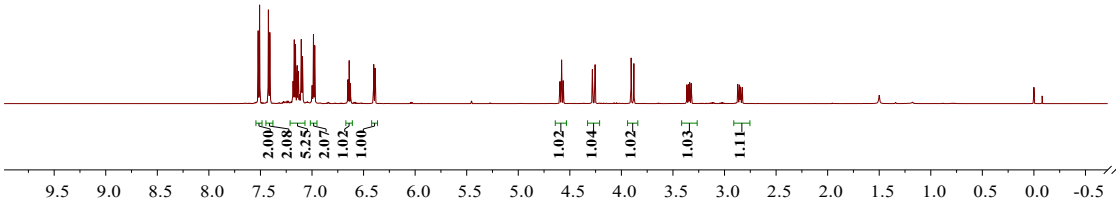


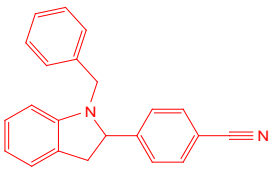


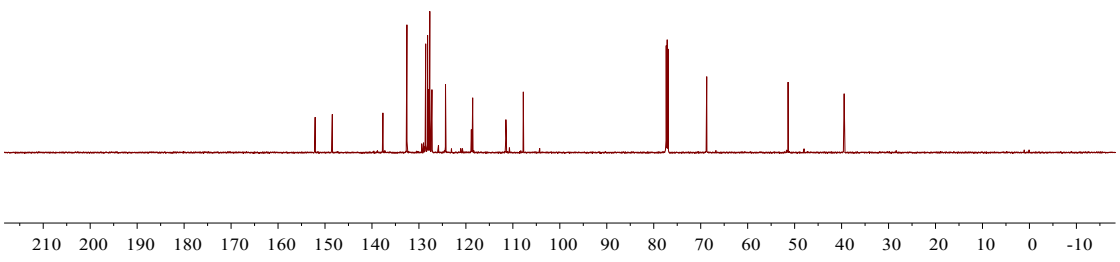


4-(1-benzylindolin-2-yl)benzonitrile (49)

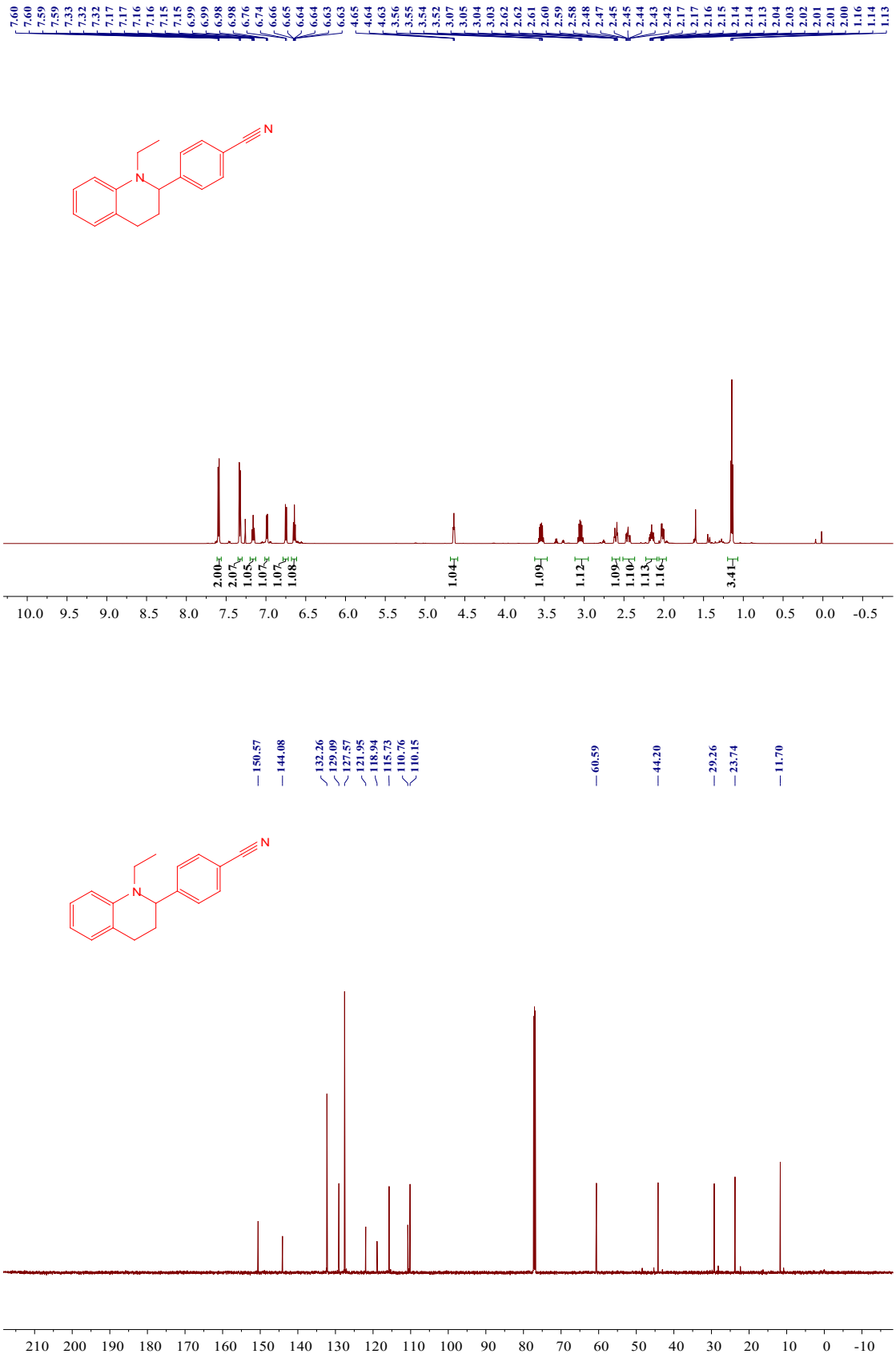




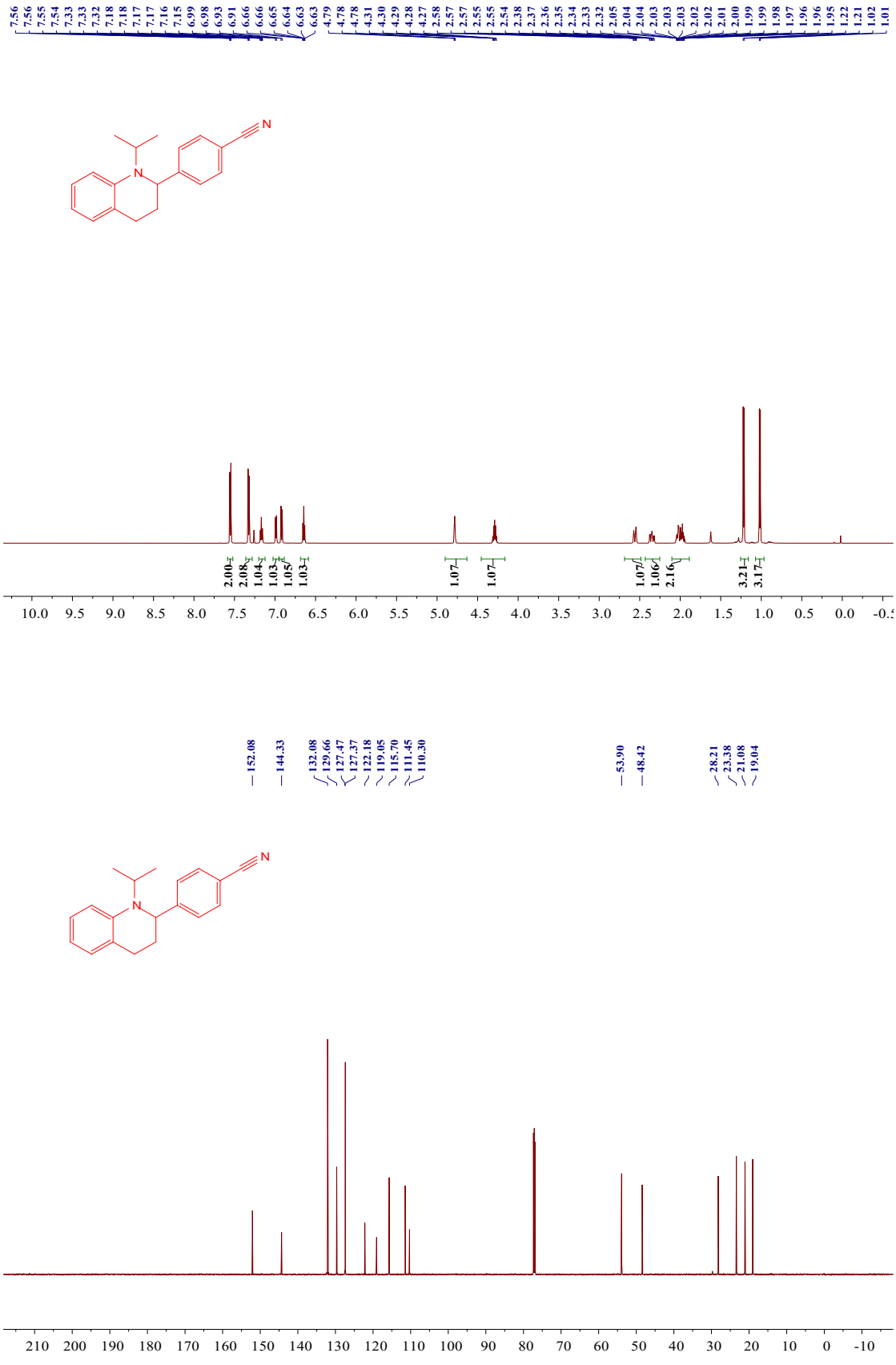




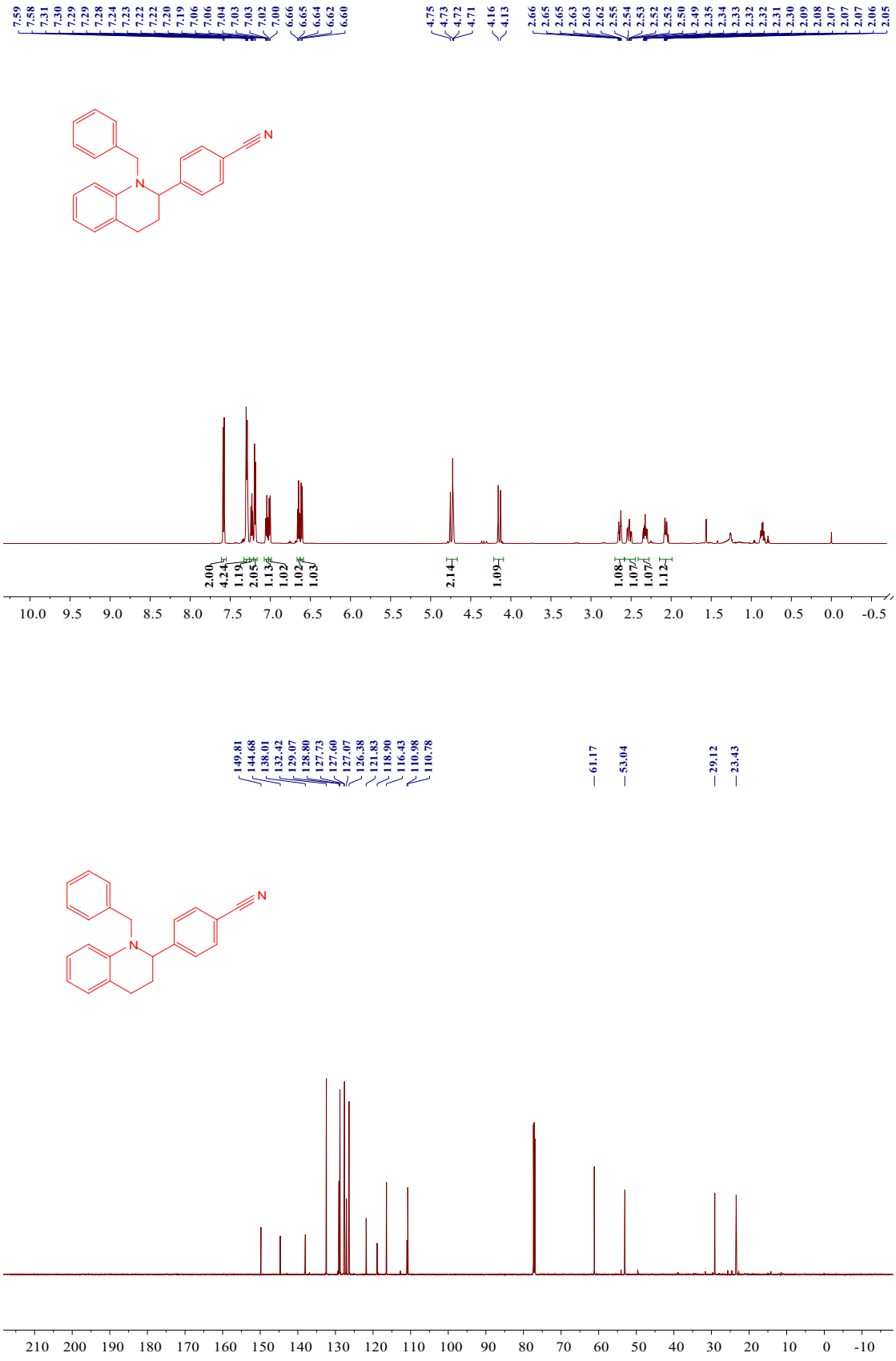
4-(1-ethyl-1,2,3,4-tetrahydroquinolin-2-yl)benzonitrile (50)



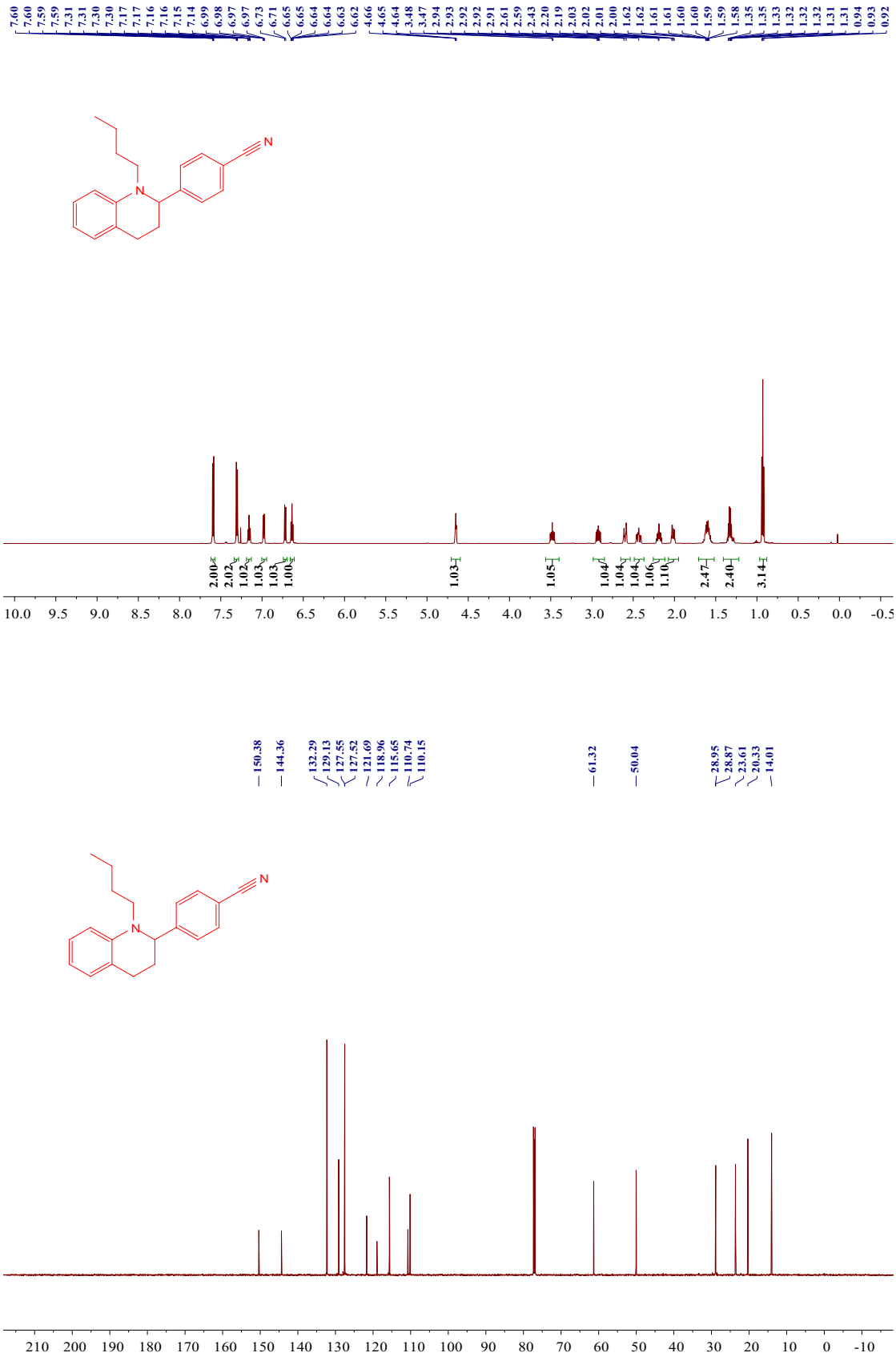
4-(1-isopropyl-1,2,3,4-tetrahydroquinolin-2-yl)benzonitrile (51)



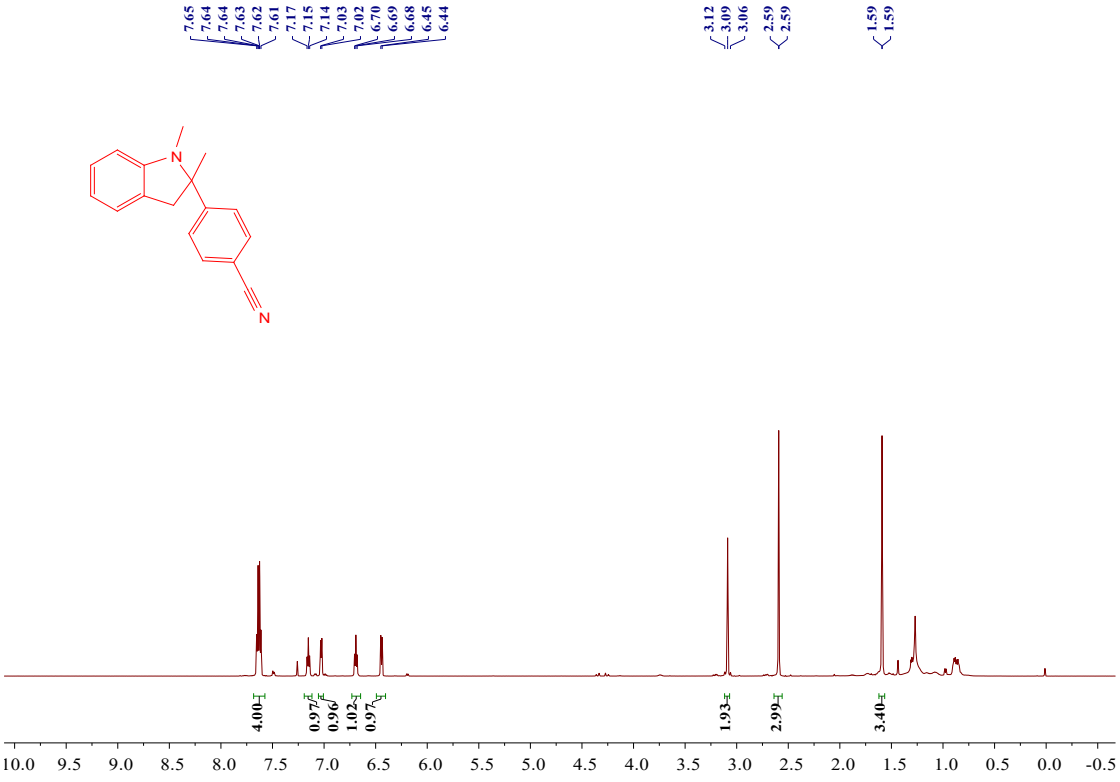
4-(1-benzyl-1,2,3,4-tetrahydroquinolin-2-yl)benzonitrile (52)

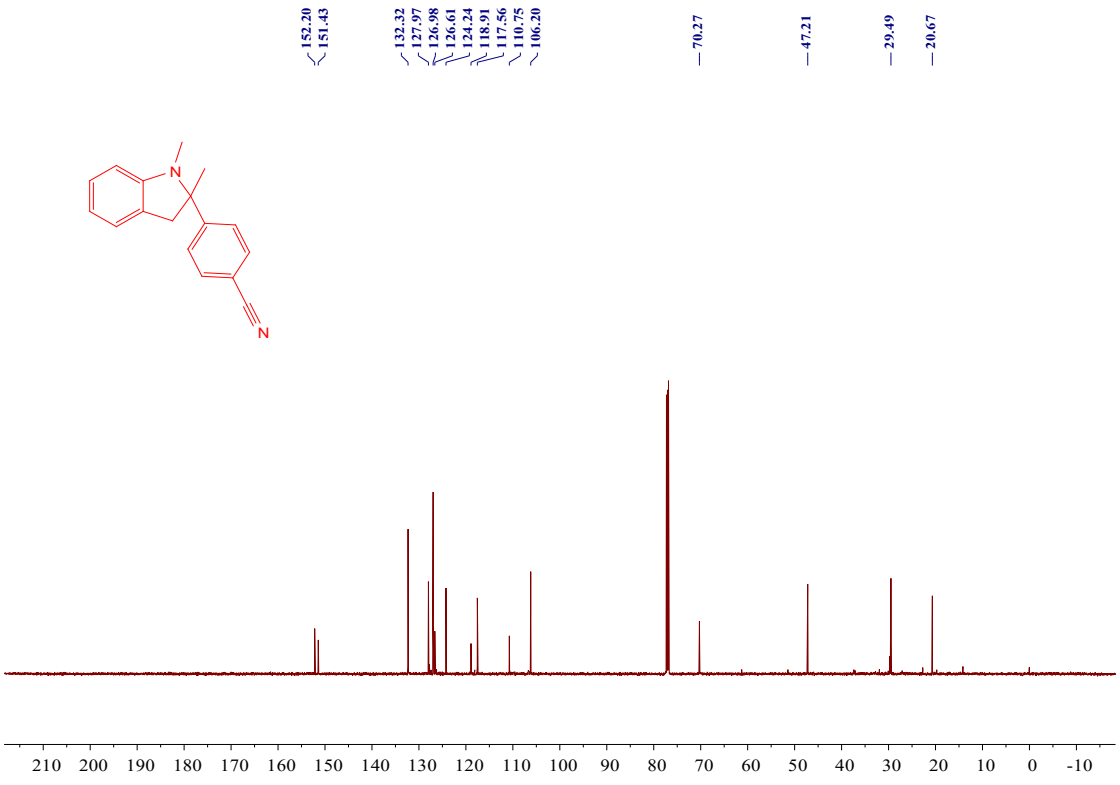


4-(1-butyl-1,2,3,4-tetrahydroquinolin-2-yl)benzonitrile (53)

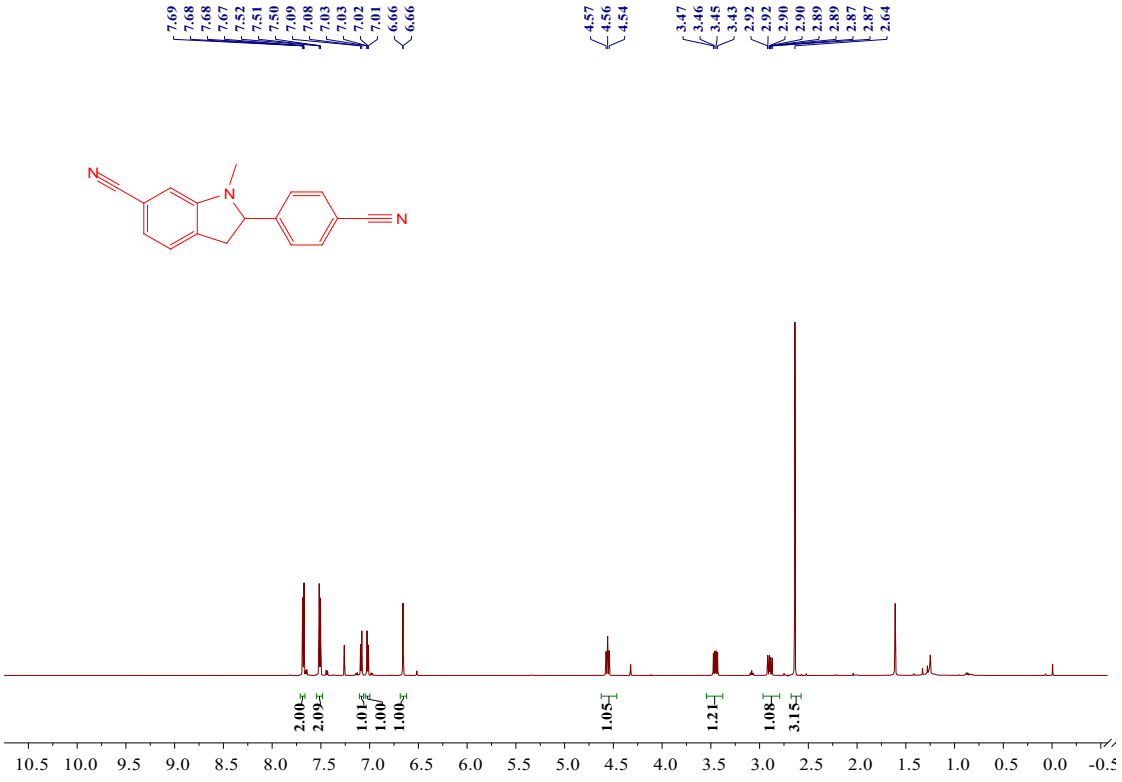


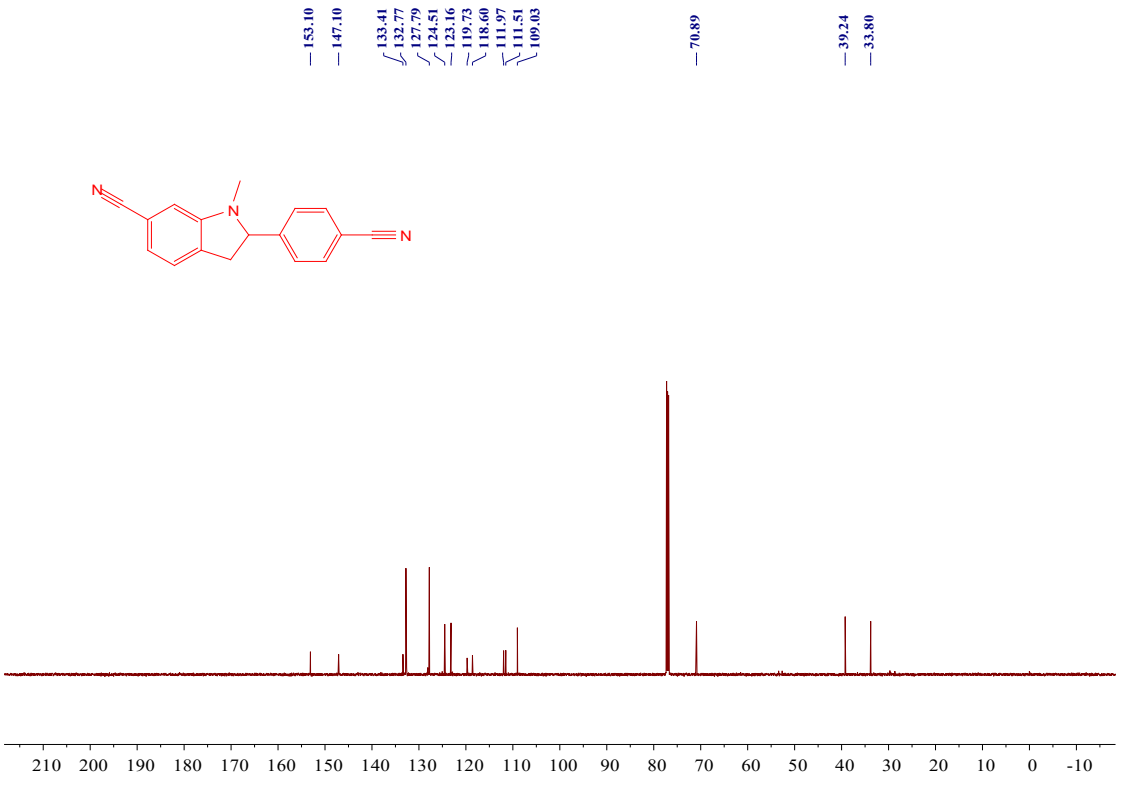
4-(1,2-dimethylindolin-2-yl)benzonitrile (54)



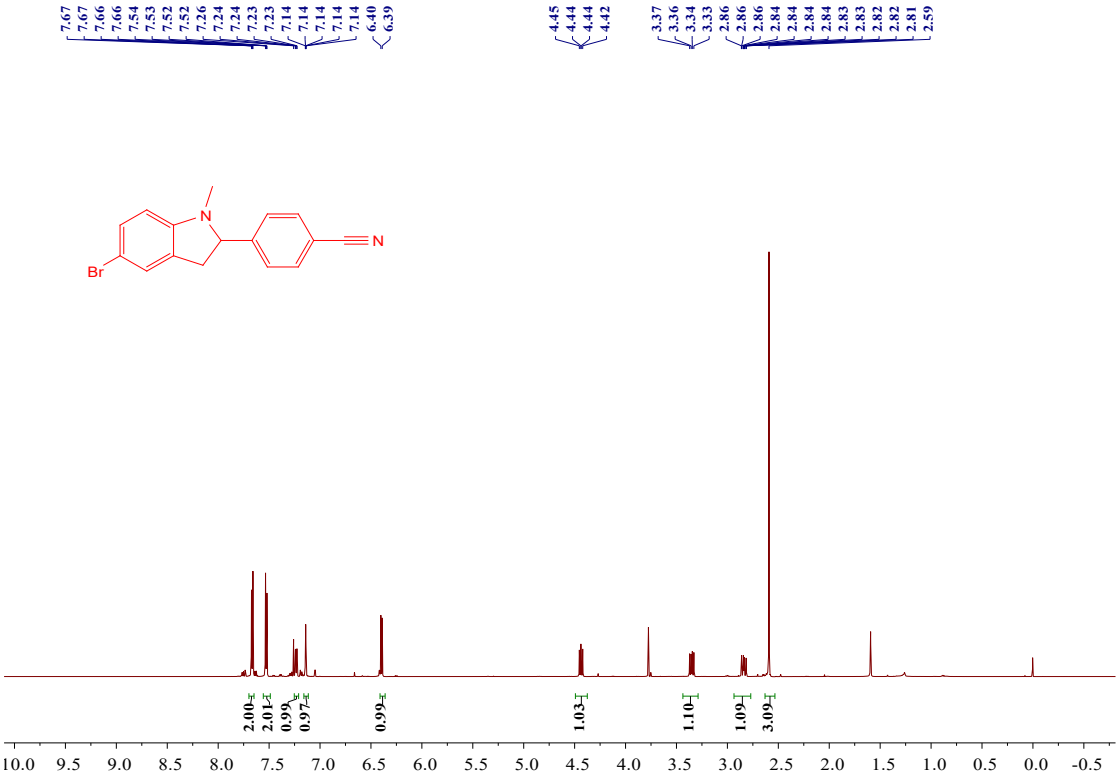


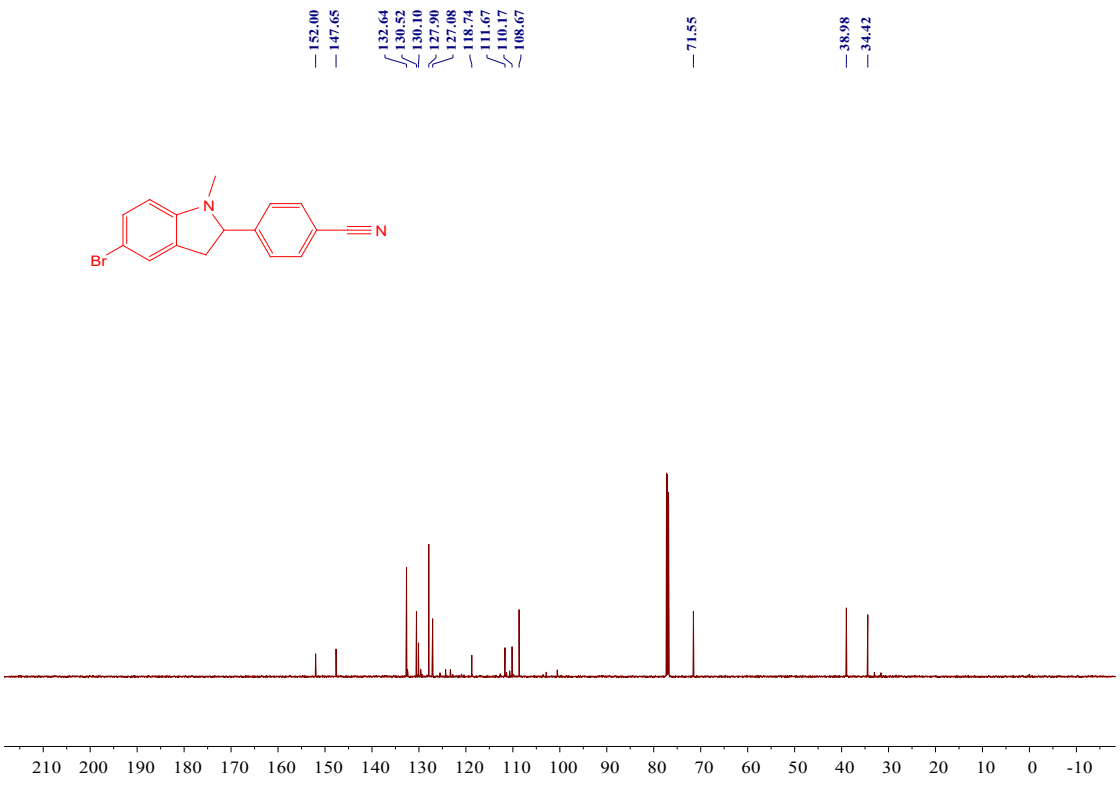
2-(4-cyanophenyl)-1-methylindoline-6-carbonitrile (55)



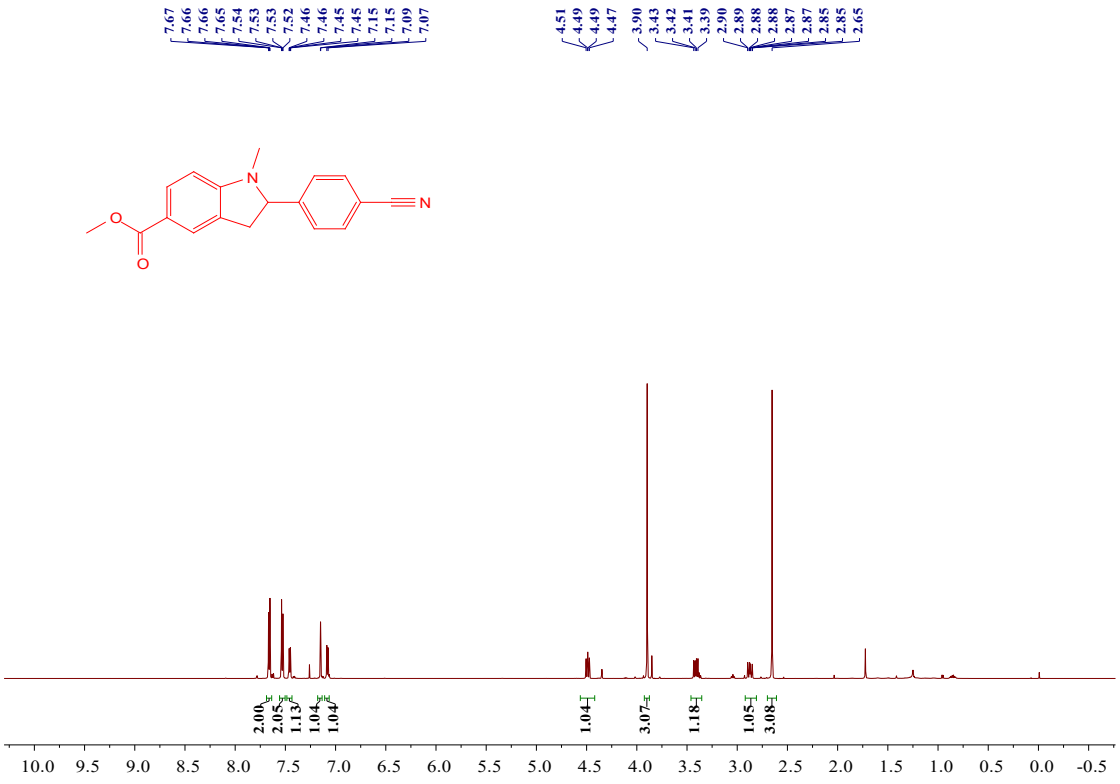


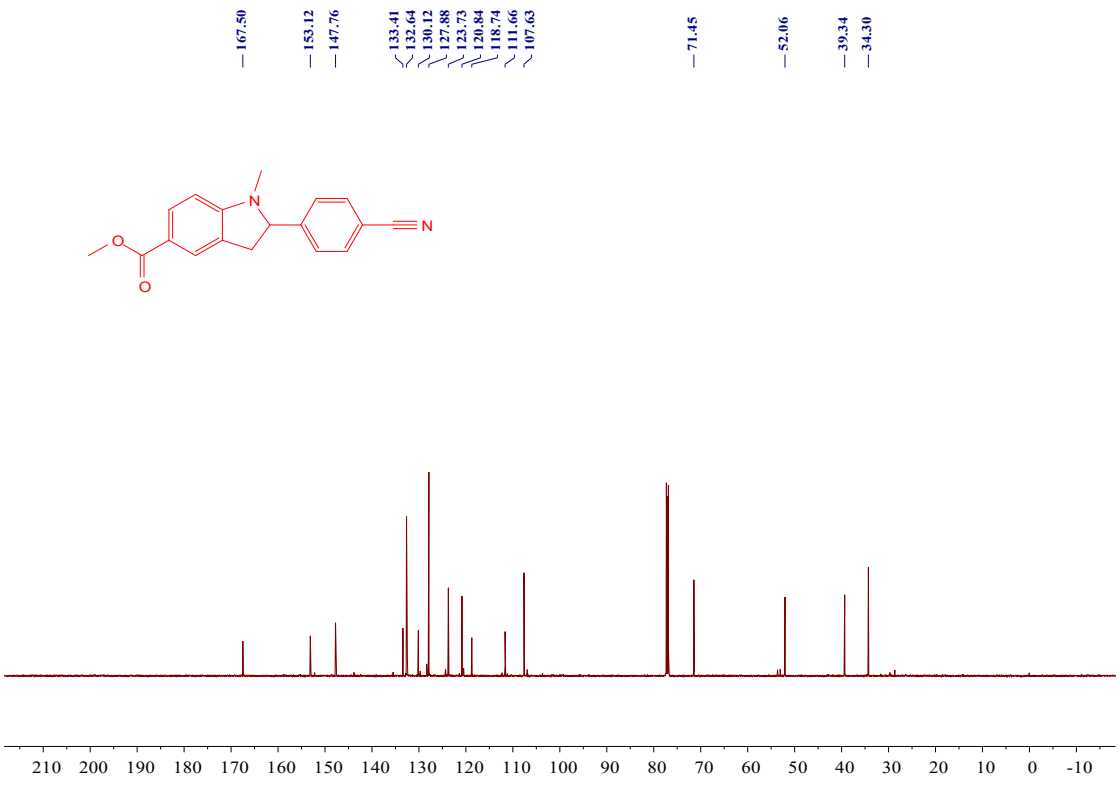
4-(5-bromo-1-methylindolin-2-yl)benzonitrile (56)



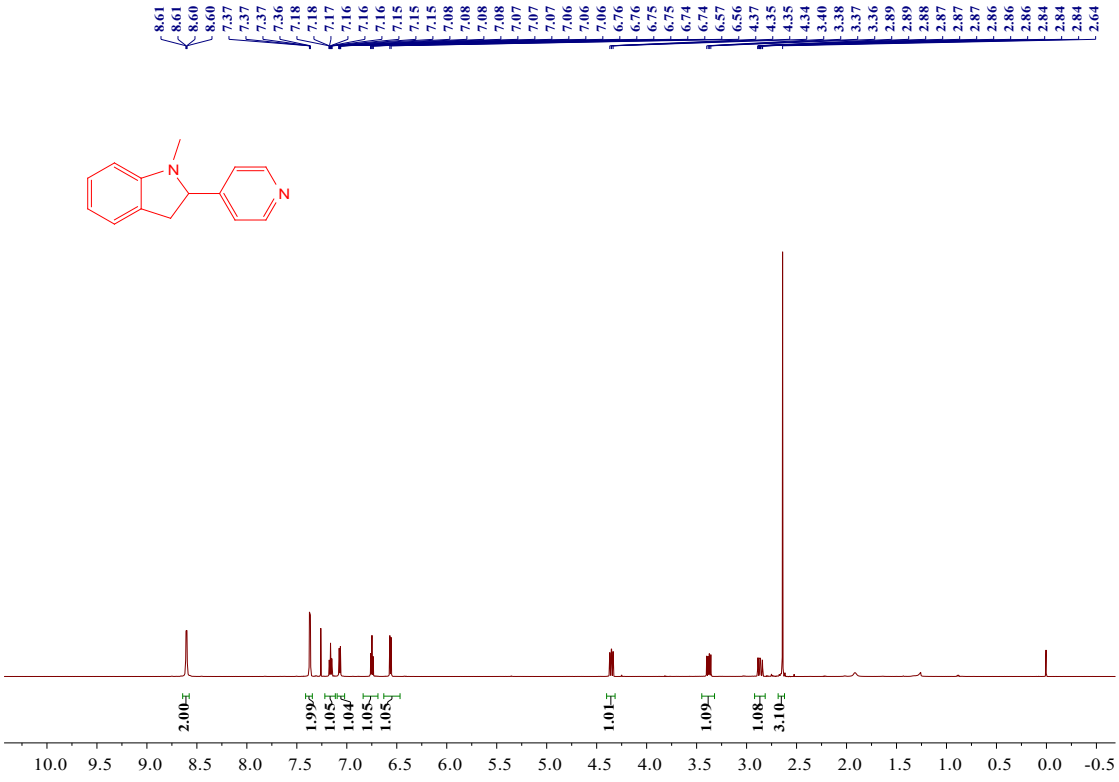


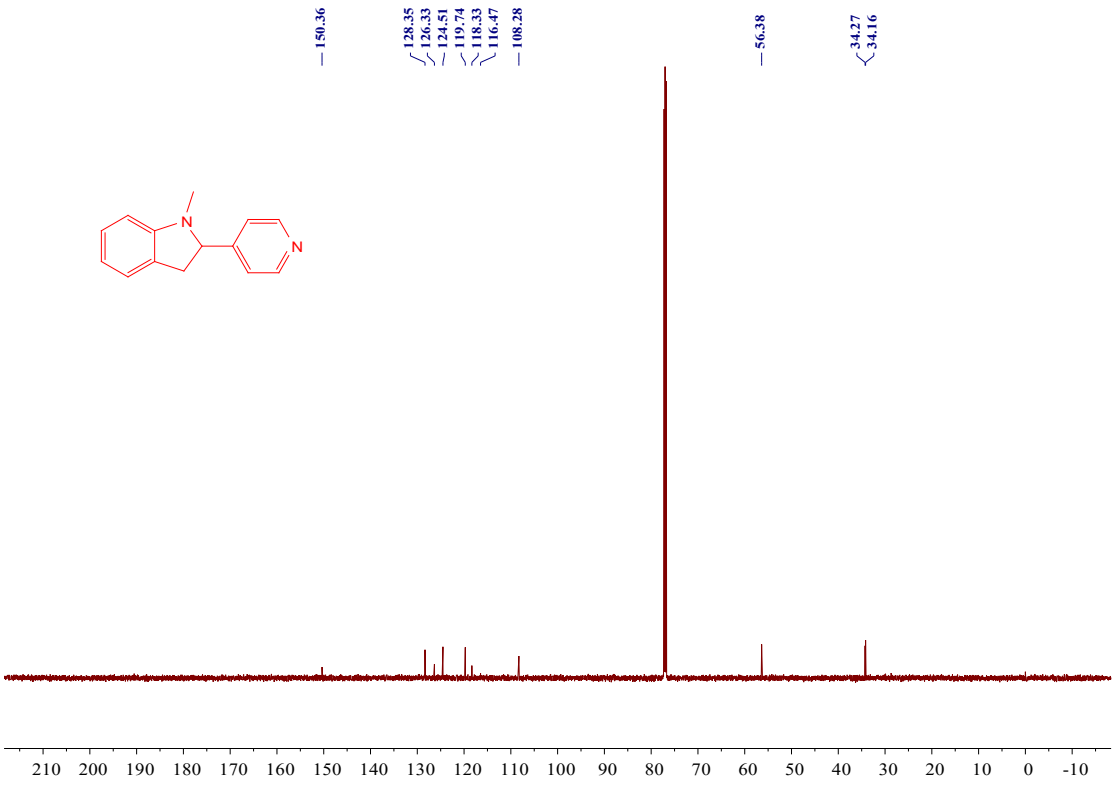
methyl 2-(4-cyanophenyl)-1-methylindoline-5-carboxylate (57)



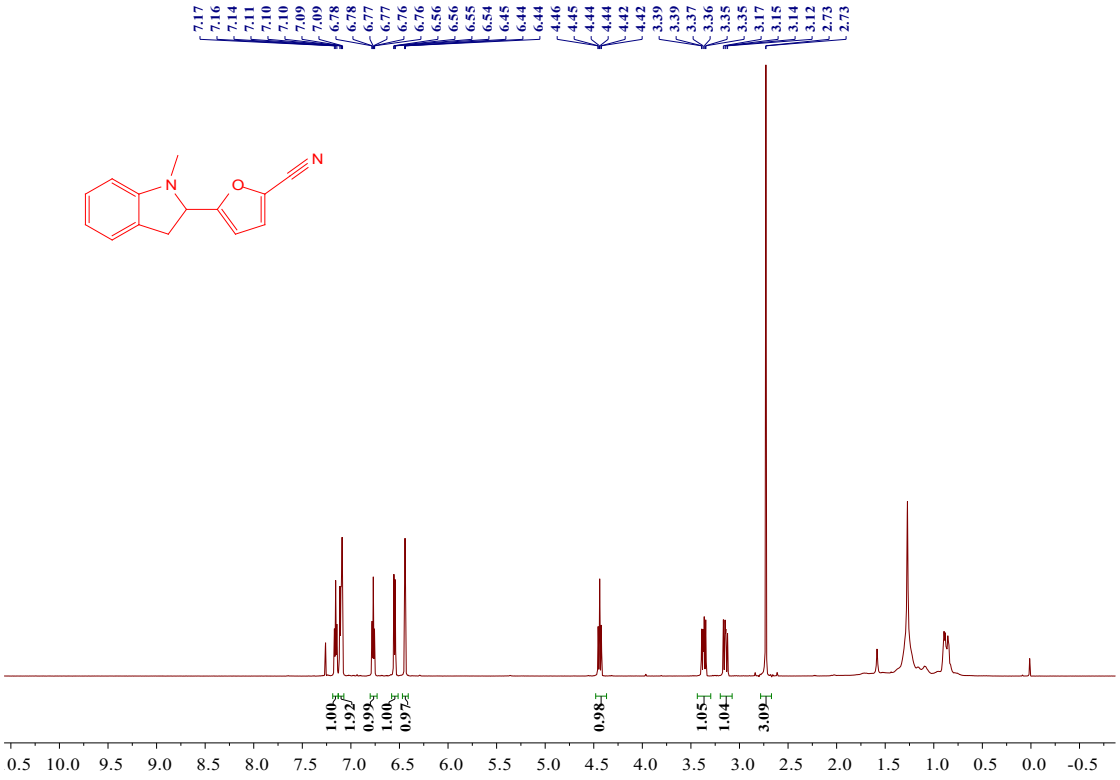


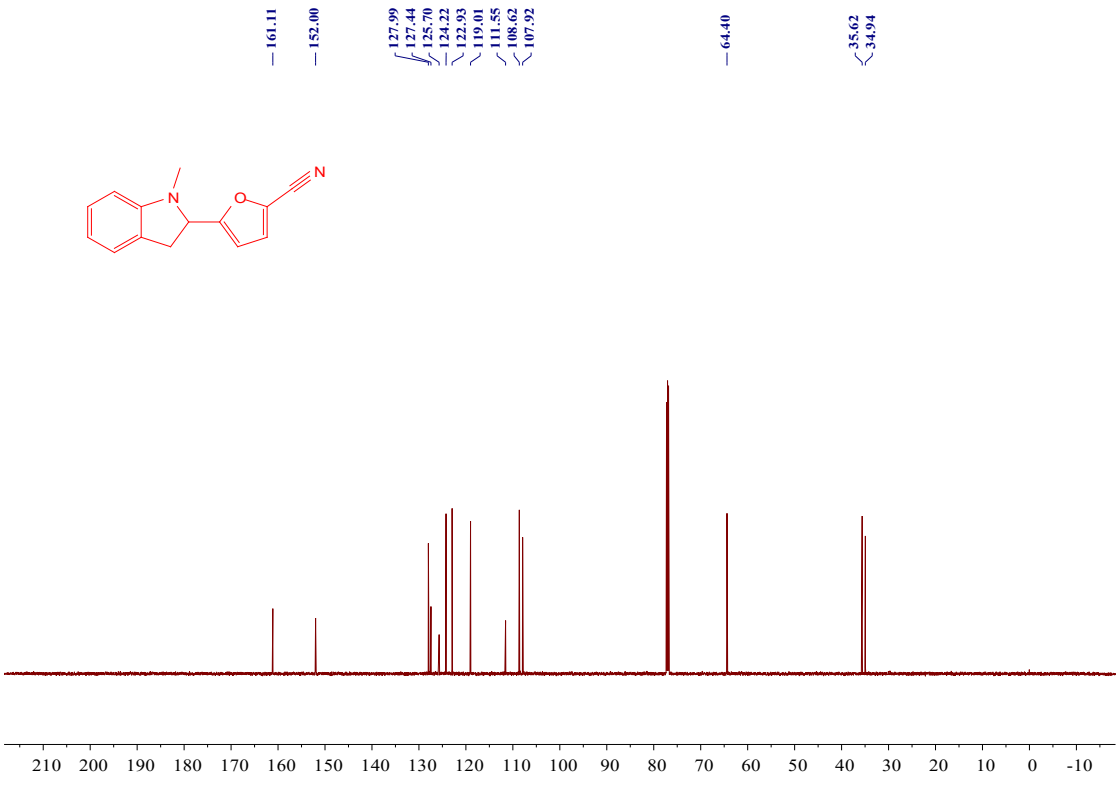
1-methyl-2-(pyridin-4-yl)indoline (58)



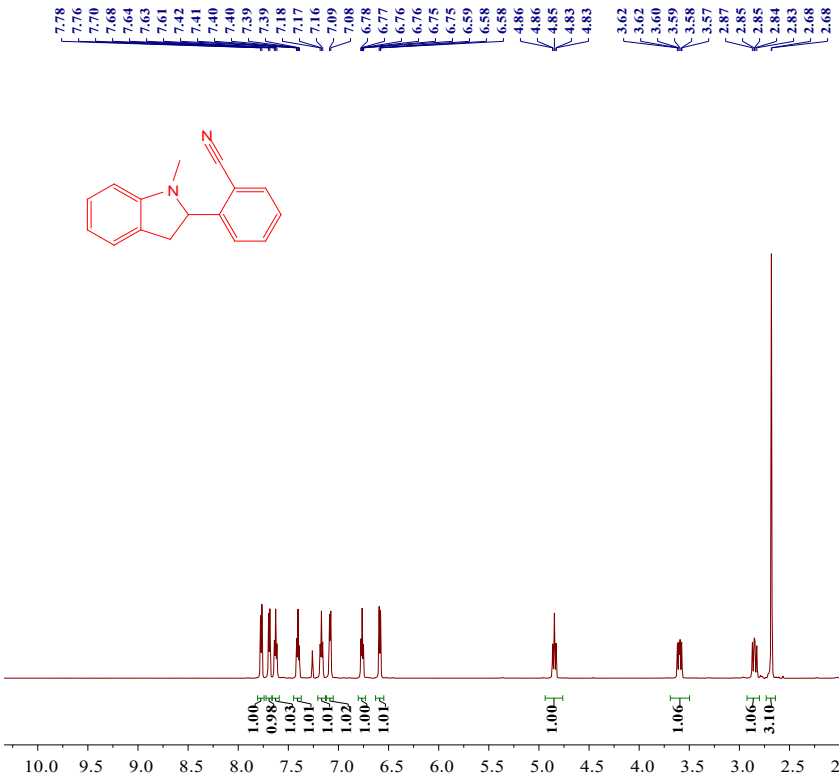


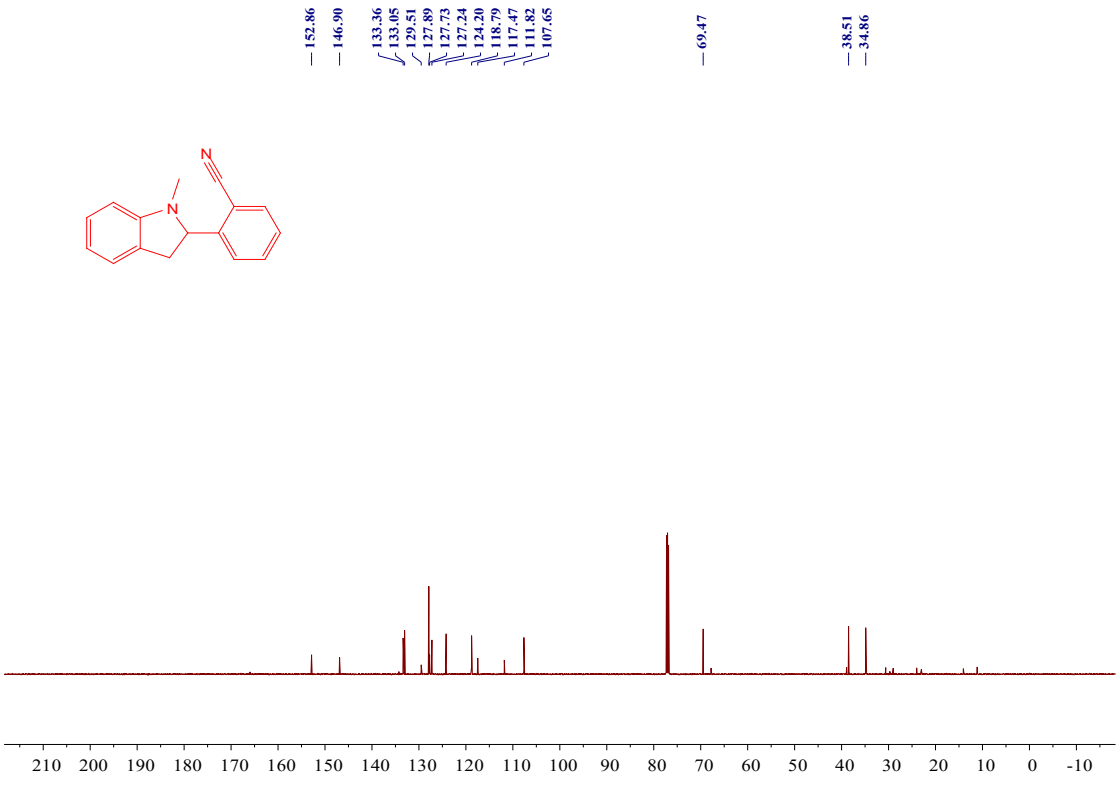
5-(1-methylindolin-2-yl)furan-2-carbonitrile (59)



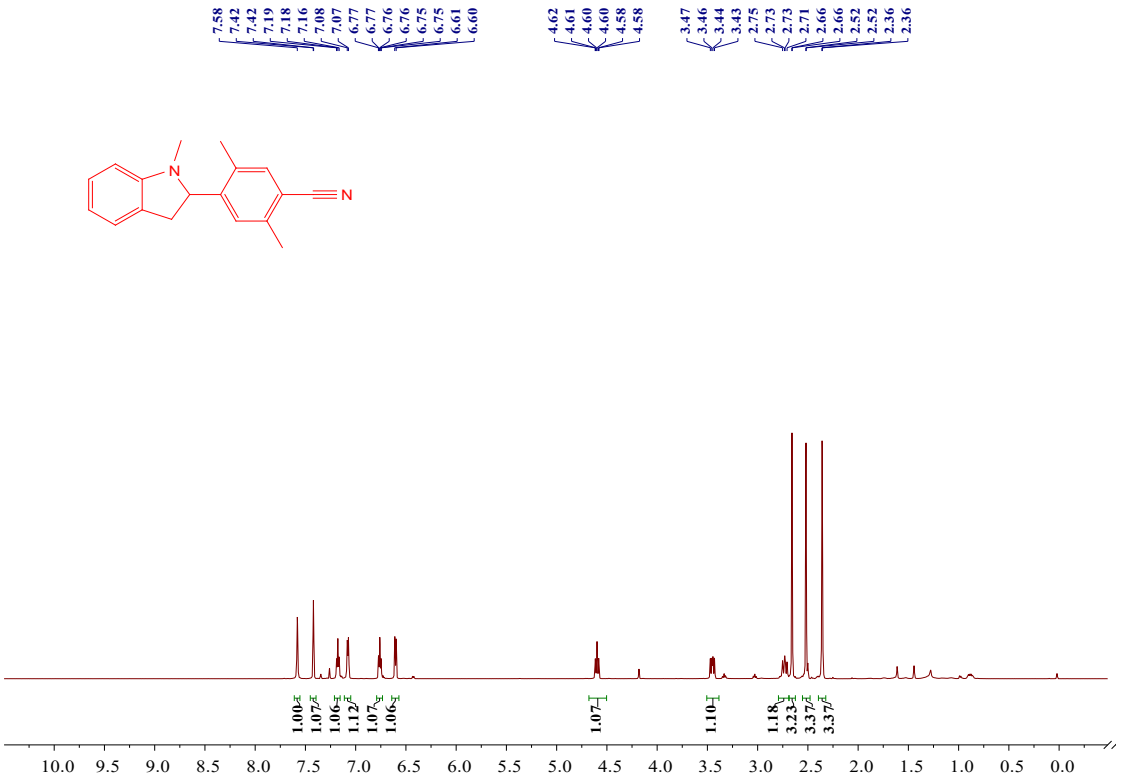


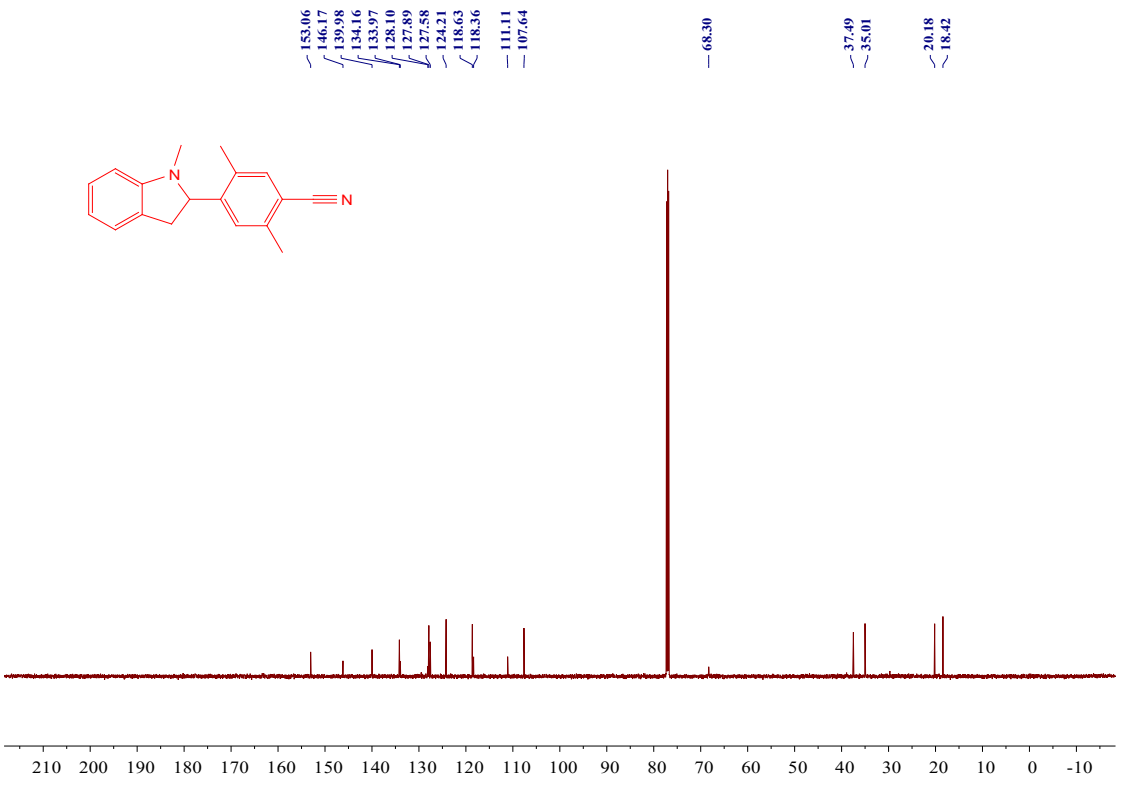
2-(1-methylindolin-2-yl)benzonitrile (60)



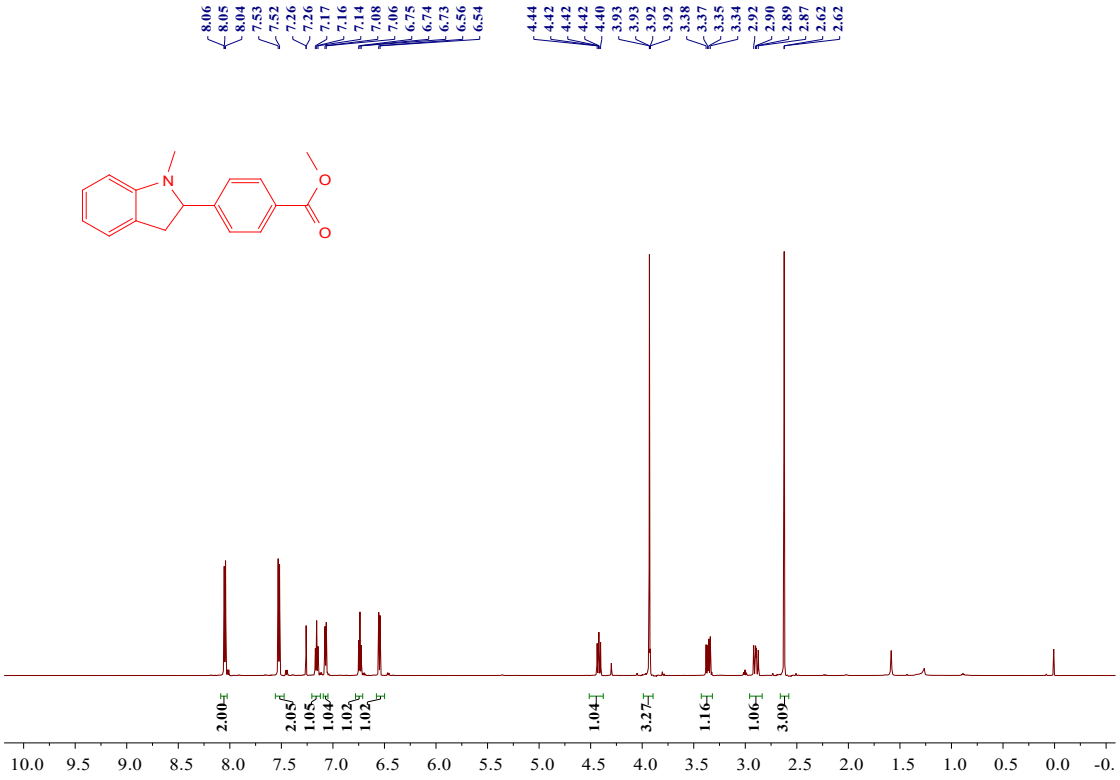


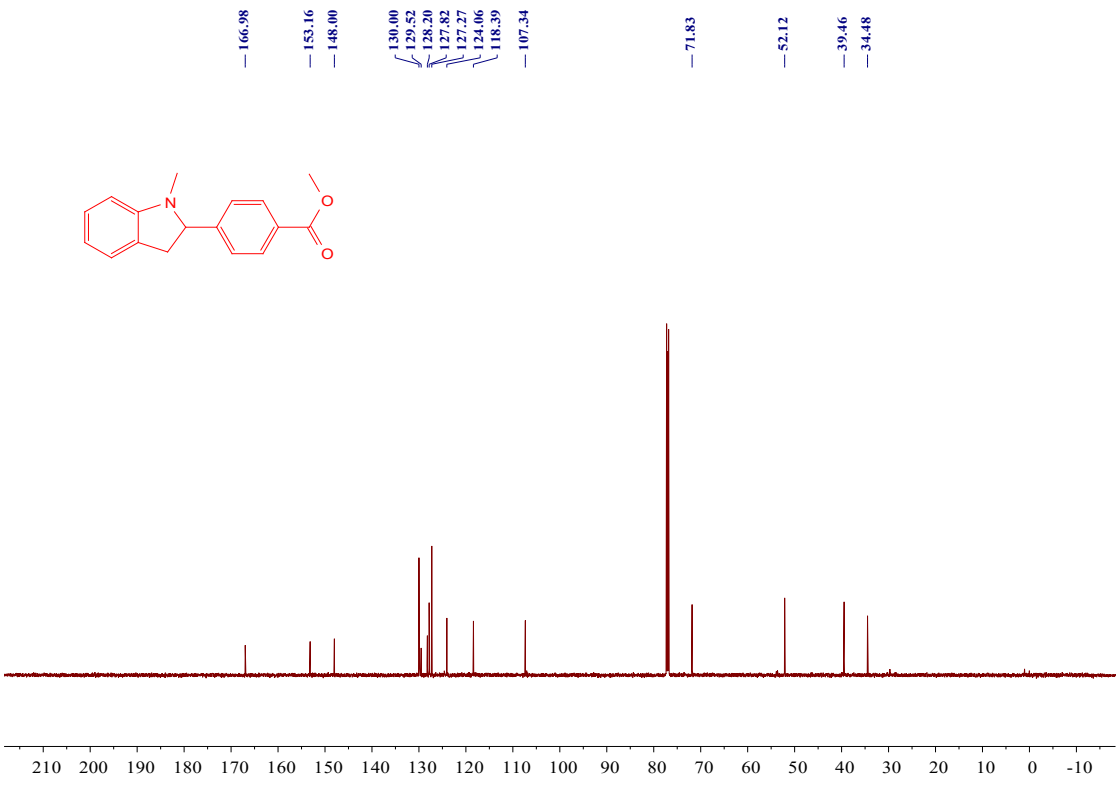
2,5-dimethyl-4-(1-methylindolin-2-yl)benzonitrile (61)



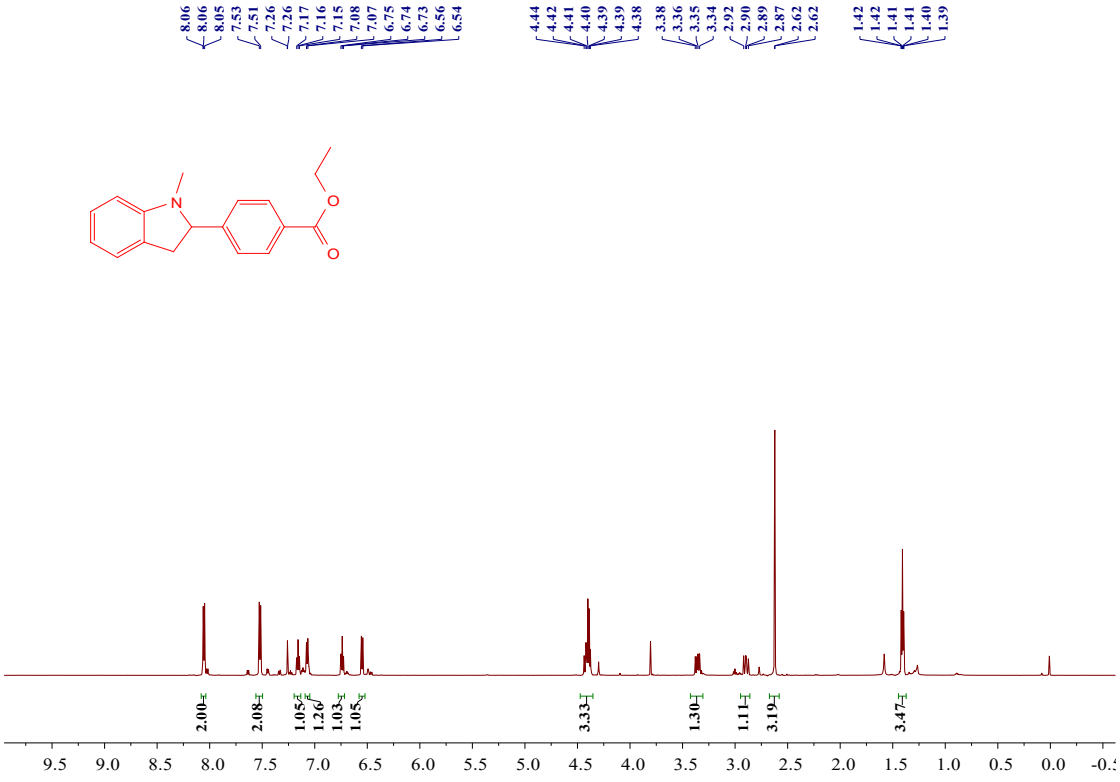


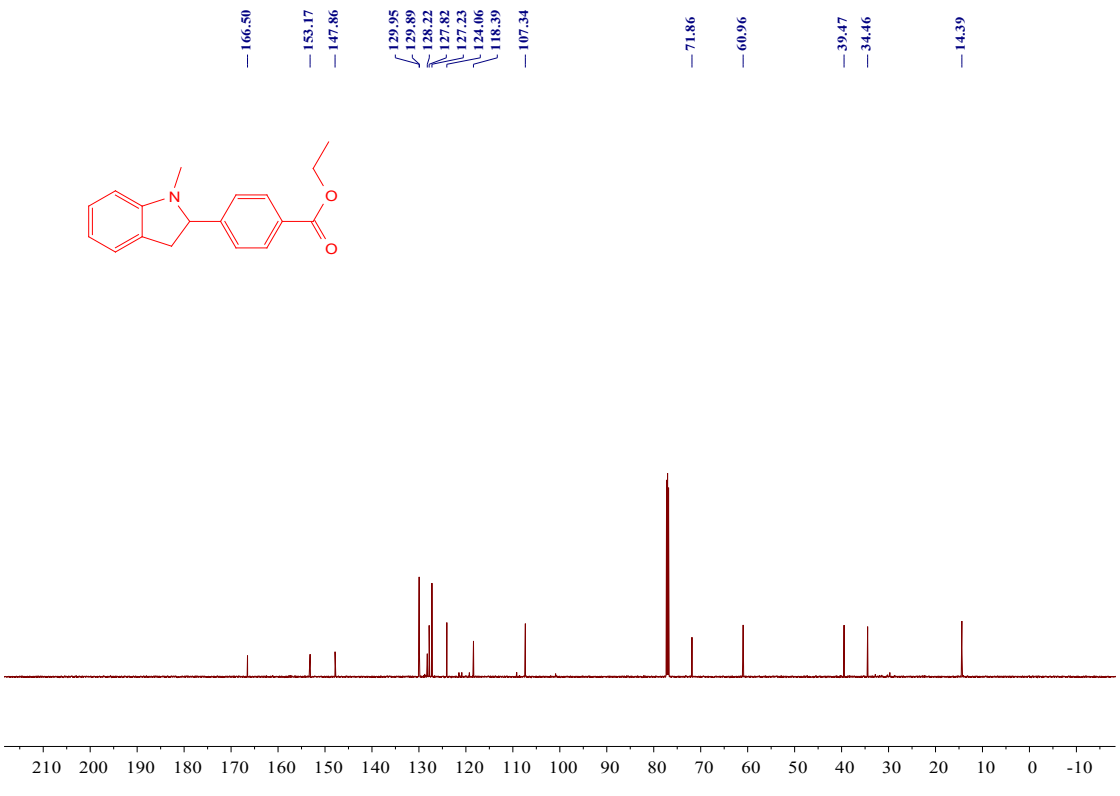
methyl 4-(1-methylindolin-2-yl)benzoate (62)





ethyl 4-(1-methylindolin-2-yl)benzoate (63)





4-((dicyclohexylamino)methyl-d2)benzonitrile (9-d_2)