Electronic Supplementary Material (ESI) for Organic & Biomolecular Chemistry


# Synthesis of Functionalised 4*H*-Quinolizin-4-ones via Tandem Horner-Wadsworth-Emmons Olefination/Cyclisation

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## Supporting Information

## 1. General

### 1.1. Reagents

All reagents and solvents were obtained from commercial suppliers and were used without further purification unless otherwise stated. Purification was carried out according to standard laboratory methods.[1]

### 1.2 Purification of Solvents

i) All solvents used for dry reactions (dichloromethane, tetrahydrofuran, toluene) were obtained from a PureSolv SPS-400-5 solvent purification system. These solvents were transferred to and stored in a septum-sealed oven-dried flask over previously activated 4 Å molecular sieves and purged with and stored under nitrogen.

ii) Dichloromethane, diethyl ether, ethyl acetate, methanol, and petroleum ether 40-60$^{o}$ for purification purposes were used as obtained from suppliers without further purification.

### 1.3 Purification of Starting Materials

2-Picoline was dried by heating to reflux over calcium chloride and then distilled under reduced pressure, then purged with and stored under nitrogen over 4 Å molecular sieves.

### 1.4 Organometallic Reagents

*n*-Butyllithium (1.6 M in hexanes) and isopropylmagnesium chloride (2 M in $Et_2O$) were used as obtained from commercial suppliers.

### 1.5 Experimental Details

i) Air-sensitive reactions were carried out using conventional glassware. The glassware was oven-dried and purged with $N_2$ before use.

ii) Purging refers to a vacuum/nitrogen-refilling procedure.

iii) Reactions were carried out at -78 $^{o}$C using dry ice/acetone baths.

iv) Reactions were carried out at -20 $^{o}$C using controlled dry ice/acetone baths.

v) Reactions were carried out at 0 $^{o}$C using ice/water baths.

vi) Room temperature was generally ca. 18 $^{o}$C.

vii) Reactions were carried out at elevated temperatures using a temperature-regulated hotplate/stirrer.

### 1.6 Purification of Products

i) Thin layer chromatography was carried out using Merck silica plates coated with fluorescent indicator UV254. These were analysed under 254 nm UV light or developed using potassium permanganate solution.

ii) Flash chromatography was carried out using ZEOprep 60 HYD 40-63 µm silica gel or IST Isolute Flash silica cartridges.

### 1.4 Analysis of Products

i) Fourier Transformed Infra-Red (FTIR) spectra were obtained on a Shimadzu IRAffinity-1 machine.

ii) $^{1}H$ and $^{13}C$ NMR spectra were obtained on a Bruker AV 400 at 400 MHz and 100 MHz respectively. Chemical shifts are reported in ppm and coupling constants are reported in Hz with $CDCl_3$ referenced at 7.27 ($^{1}H$) and 77.36 ppm ($^{13}C$), respectively.[2]

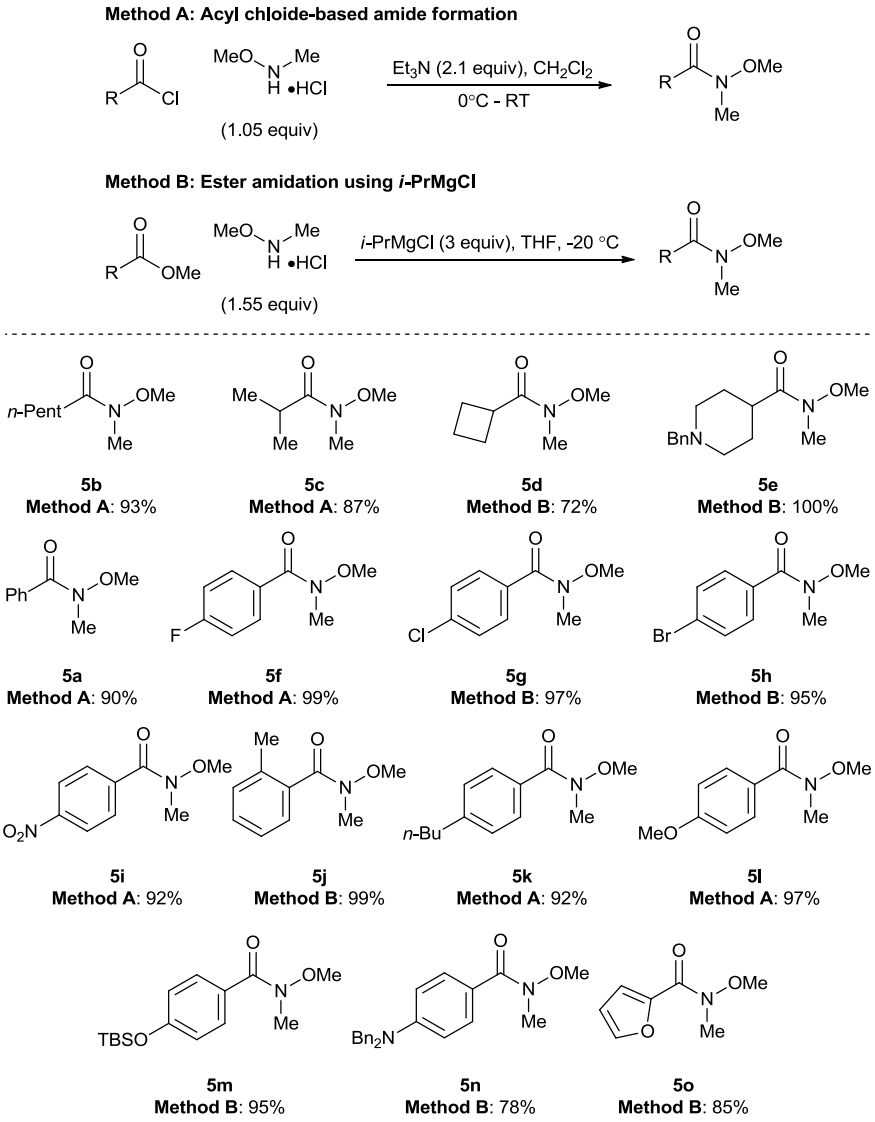
iii) High-resolution mass spectra were obtained on a Thermo Surveyor HPLC coupled to a LTQ Orbitrap mass spectrometer (ThermoFisher) instrument at the Strathclyde Institute for Pharmacy and Biomedical Science, University of Strathclyde, Glasgow. Run conditions 4.6 x 50 mm Gemini C18 column (Phenomenex) flow rate 0.4 ml $min^{-1}$ MeCN/$H_2O$ containing 0.1% v/v formic acid (95:5): (i) run time = 3 min; (ii) positive ion ESI mode spray voltage 4.5 kV; (iii) sheath gas 50 psi; (iv) auxiliary gas 15 psi; (v) heated capillary temperature 275 $^{o}C$; (vi) resolution setting = 30,000.

(iv) Crystal data for **3a** ($C_{15}H_{11}NO$, MW = 221.25) were measured at 123 K using an Oxford Diffraction Xcalibur E instrument and MoKα radiation, λ = 0.71073 Å. Found monoclinic, space group P21/c, a = 9.0140(5), b= 10.7721(5), c= 11.3234(7) Å, β = 101.481(6)$^{o}$, V = 1077.50(10) Å3, Z = 4, µ = 0.086 mm-1, 2θmax = 54$^{o}$, 4957 reflections, 2347 unique, Rint 0.0276; final refinement to convergence on F2 gave R = 0.0475 (F, 1703 obs. data only) and Rw = 0.1061 (F2, all data), GOF = 1.041. CCDC reference number 915082.

## 2. Experimental Procedures

### 2.1 Preparation of Weinreb Amides

The Weinreb amides required for the synthesis of the ketopyridines were prepared either via the corresponding acyl chloride (Method A) or ester (Method B) as per the following chart.




## 2.2 General Experimental Procedure for the Preparation of Weinreb Amides from Acyl Chlorides and *N*,*O*-Dimethylhydroxylamine Hydrochloride

For example, for **Compound 5d. 4-(*n*-Butyl)-*N*-methoxy-*N*-methylbenzamide**

An oven-dried flask containing a stir bar and fitted with a septum was purged with $N_2$. The flask was then charged with *N*,*O*-dimethylhydroxylamine hydrochloride (1.1 equiv, 27.5 mmol, 2.68 g) and dry $CH_2Cl_2$ (100 mL). The mixture was cooled to 0 °C and stirred for 5 min before addition of $Et_3N$ (2.5 equiv, 50 mmol, 5.06 g, 6.97 mL) and 4-*n*-butylbenzoyl chloride (1 equiv, 25 mmol, 4.92 g). The resulting mixture was stirred for 30 min before warming to room temperature and stirring for 16 h. The mixture was treated with sat. aq. $NaHCO_3$ solution (30 mL) and stirred vigorously for 10 min. The phases were separated and the aqueous layer was re-extracted with $CH_2Cl_2$ (3 x 20 mL). The combined organic phases were dried by passing through a hydrophobic frit and concentrated under reduced pressure to afford a residue that was purified by flash column chromatography (1:3 EtOAc/petroleum ether 40-60°) to afford the title compound (5.083 g, 92% yield).

## 2.3 General Experimental Procedure for the Preparation of Weinreb Amides from Esters and *N*,*O*-Dimethylhydroxylamine Hydrochloride Using Isopropylmagnesium Chloride

For example, for **Compound 5p. *N*-Methoxy-*N*-methylfuran-2-carboxamide**

Following the procedure of Williams:[3] An oven-dried flask containing a stir bar and fitted with a septum was purged with $N_2$. The flask was then charged with *N*,*O*-dimethylhydroxylamine hydrochloride (1.55 equiv, 15.5 mmol, 1.51 g), methyl 2-furoate (1 equiv, 10 mmol, 1.26 g, 1.07 mL) and dry THF (20 mL). The mixture was cooled to -20 °C and stirred for 5 min before addition of *i*-PrMgCl (2 M in $Et_2O$, 3 equiv, 30 mmol, 15 mL) dropwise over 15 min. The resulting mixture was stirred for a further 10 min before quenching with sat. aq. $NaHCO_3$ solution (10 mL) and $H_2O$ (10 mL). The mixture was allowed to warm to room temperature and was stirred vigorously for 10 min. EtOAc (10 mL) was added and the phases were separated. The aqueous layer was re-extracted with EtOAc (3 x 20 mL). The combined organic phases were dried ($MgSO_4$), filtered, and concentrated under reduced pressure to afford a residue that was purified by flash column chromatography (1:1 EtOAc/petroleum ether 40-60°) to afford the title compound (1.32 g, 85% yield).

### 2.4 General Experimental Procedure for the Deprotonation of 2-Picoline and Nucleophilic Addition to Weinreb Amides

For example, for **Compound 1a. 1-Phenyl-2-(pyridin-2-yl)ethanone**

An oven-dried flask equipped with a stirrer bar and fitted with a septum was purged with $N_2$. The flask was cooled to -78 °C by submerging in a bath of dry ice/acetone. The flask was then charged with dry THF (11 mL) and 2-picoline (2 equiv, 4 mmol, 372.5 mg, 0.395 mL) and stirred. *n*-Butyllithium (1.6 M in hexanes, 2 equiv, 4 mmol, 2.5 mL) was added to the flask dropwise over 5 minutes. Concurrently, an additional oven dried flask equipped with a stirrer bar and fitted with a septum was purged with $N_2$. The flask was cooled to -78 °C by submerging in dry a dry ice/acetone bath. The flask was then charged with dry THF (5 mL) and *N*-methoxy-*N*-methylbenzamide (1 equiv, 2 mmol, 330.4 mg, 0.304 mL) and stirred. After 30 min, the deprotonated picoline solution was then added to the Weinreb amide solution by dropwise addition via syringe over 10 minutes. The reaction was allowed to proceed for 3 hours before quenching with water. EtOAc (5 mL) was added and the phases were separated. The aqueous layer was then re-extracted with EtOAc (5 x 5 mL). The combined organic phases were dried ($MgSO_4$), passed through a hydrophobic frit, and concentrated under reduced pressure to afford a residue that was purified by flash column chromatography (1:2 EtOAc/petroleum ether 40-60°) to afford the title compound (327 mg, 83% yield).

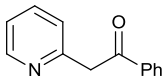
### 2.5 General Experimental Procedure for the Synthesis of Quinolizinones via Tandem Horner-Wadsworth-Emmons Olefination/Intramolecular Cyclisation

For example, for **Compound 3a. 2-Phenyl-4*H*-quinolizin-4-one**

An oven-dried flask equipped with stirrer bar was purged with $N_2$ and cooled to 0 °C by submerging in an ice/water bath. The flask was charged with dry toluene (5 mL), triethyl phosphonoacetate (2 equiv, 2 mmol, 448.4 mg, 0.398 mL), and NaH (60% dispersion in mineral oil, 2 equiv, 2 mmol, 83.0 mg). The mixture was stirred for 15 min before removing from the cooling bath and warming to room temperature. 1-Phenyl-2-(pyridin-2-yl)ethanone (**1a**, 1 equiv, 1 mmol, 197.1 mg) was added and the reaction mixture was heated to reflux for 20 hours. The reaction was then treated with $Et_2O$ (5 mL), concentrated under reduced pressure to a residue that was purified by flash column chromatography (1:1 EtOAc/petroleum ether 40-60°) to afford the title compound (203.5 mg, 92% yield).

## 3. Compound Characterisation Data

### Compound 1a. 1-Phenyl-2-(pyridin-2-yl)ethanone




1-Phenyl-2-(pyridin-2-yl)ethanone
Chemical Formula: $C_{13}H_{11}NO$
Molecular Weight: 197.2325

Appearance: Orange solid

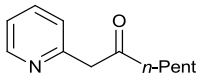
$\upsilon_{max}$ (solid): 3051, 2922, 1680, 1624, 1595, 1543, 1491, 1465 $cm^{-1}$.

Approx. 3:1 keto:enol and approx. 3.8:1 enol olefin stereoisomers based on $^{1}H$ NMR taken in $CDCl_3$ at 298 K.[2]

For $^{1}H$ and $^{13}C$ NMR spectra, see Section 3.5.

HRMS ($C_{13}H_{12}NO$) $[M+H^+]$ requires 198.0919, found $[M+H^+]$ 198.0913.

### Compound 1b. 1-(Pyridin-2-yl)heptan-2-one




1-(Pyridin-2-yl)heptan-2-one
Chemical Formula: $C_{12}H_{17}NO$
Molecular Weight: 191.2695

Appearance: Yellow oil.

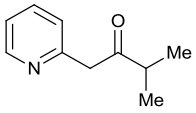
$\upsilon_{max}$ (neat): 2959, 2926, 1709, 1636, 1585, 1464 $cm^{-1}$.

Approx. 5.6:1 keto:enol and approx. 1.5:1 enol olefin stereoisomers based on $^{1}H$ NMR taken in $CDCl_3$ at 298 K.[2]

For $^{1}H$ and $^{13}C$ NMR spectra, see Section 3.5.

HRMS ($C_{12}H_{18}NO$) $[M+H^+]$ requires 192.1388, found $[M+H^+]$ 192.1381.

### Compound 1c. 3-Methyl-1-(pyridin-2-yl)butan-2-one




3-Methyl-1-(pyridin-2-yl)butan-2-one
Chemical Formula: $C_{10}H_{13}NO$
Molecular Weight: 163.2163

Appearance: Orange oil.

$\upsilon_{max}$ (neat): 2957, 2928, 2870, 1709, 1636, 1585, 1475 $cm^{-1}$.

Approx. 12.5:1 keto:enol and approx. 7:1 enol olefin stereoisomers based on $^{1}H$ NMR taken in $CDCl_3$ at 298 K.[2]

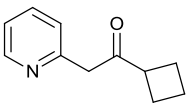
For $^{1}H$ and $^{13}C$ NMR spectra, see Section 3.5.

$^{1}H$ NMR (400 MHz, $CDCl_3$): $\delta$ 8.55 (d, 1H, $J$ = 4.9 Hz, keto), 8.47 (d, 1H, $J$ = 5.6 Hz, enol), 8.38 (d, 1H, $J$ = 5.8, enol), 8.21 (d, 1H, $J$ = 7.5 Hz, enol),

$^{13}C$ NMR (400 MHz, $CDCl_3$): $\delta$

HRMS ($C_{10}H_{14}NO$) $[M+H^+]$ requires 164.1075, found $[M+H^+]$ 164.1070.

### Compound 1d. 1-Cyclobutyl-2-(pyridin-2-yl)ethanone




1-Cyclobutyl-2-(pyridin-2-yl)ethanone
Chemical Formula: $C_{11}H_{13}NO$
Molecular Weight: 175.2270

Appearance: Yellow oil.

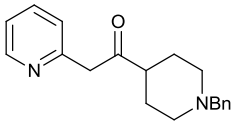
$\upsilon_{max}$ (neat): 2982, 2943, 1705, 1643, 1591, 1474, 1435 $cm^{-1}$.

Approx. 5:1 keto:enol and approx. 1:1 enol olefin stereoisomers based on $^{1}H$ NMR taken in $CDCl_3$ at 298 K.[2]

For $^{1}H$ and $^{13}C$ NMR spectra, see Section 3.5.

HRMS ($C_{11}H_{14}NO$) $[M+H^+]$ requires 176.1075, found $[M+H^+]$ 176.1069.

**Compound 1e. 1-(1-Benzylpiperidin-4-yl)-2-(pyridin-2-yl)ethanone**




1-(1-Benzylpiperidin-4-yl)-2-(pyridin-2-yl)ethanone
Chemical Formula: $C_{19}H_{22}N_2O$
Molecular Weight: 294.3908

Appearance: Brown oil.

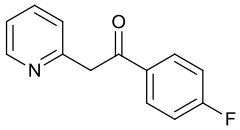
$\upsilon_{max}$ (neat): 2940, 2801, 2758, 1709, 1641, 1595, 1551, 1474 $cm^{-1}$.

Approx. 8.3:1 keto:enol and only one olefin stereoisomer based on $^{1}H$ NMR taken in $CDCl_3$ at 298 K.[2]

For $^{1}H$ and $^{13}C$ NMR spectra, see Section 3.5.

HRMS ($C_{19}H_{23}N_2O$) $[M+H^+]$ requires 295.1810, found $[M+H^+]$ 295.1805.

**Compound 1f. 1-(4-Fluorophenyl)-2-(pyridin-2-yl)ethanone**




1-(4-Fluorophenyl)-2-(pyridin-2-yl)ethanone
Chemical Formula: $C_{13}H_{10}FNO$
Molecular Weight: 215.2230

Appearance: Yellow solid.

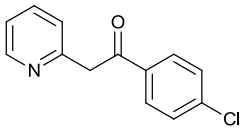
$\upsilon_{max}$ (solid): 2922, 1632, 1595, 1506, 1456 $cm^{-1}$.

Approx. 2:1 keto:enol and approx. 1.7:1 enol olefin stereoisomers based on $^{1}H$ NMR taken in $CDCl_3$ at 298 K.[2]

For $^{1}H$ and $^{13}C$ NMR spectra, see Section 3.5.

HRMS ($C_{13}H_{11}FNO$) $[M+H^+]$ requires 216.0825, found $[M+H^+]$ 216.0816.

**Compound 1g. 1-(4-Chlorophenyl)-2-(pyridin-2-yl)ethanone**




1-(4-Chlorophenyl)-2-(pyridin-2-yl)ethanone
Chemical Formula: $C_{13}H_{10}ClNO$
Molecular Weight: 231.6776

Appearance: Yellow powder.

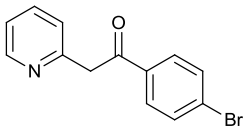
$\upsilon_{max}$ (solid): 3088, 3026, 1626, 1589, 1549, 1454, 1406 $cm^{-1}$.

Approx. 1.3:1 keto:enol and approx. 7.6:1 enol olefin stereoisomers based on $^{1}H$ NMR taken in $CDCl_3$ at 298 K.[2]

For $^{1}H$ and $^{13}C$ NMR spectra, see Section 3.5.

HRMS ($C_{13}H_{11}ClNO$) $[M+H^+]$ requires 232.0529, found $[M+H^+]$ 232.0525.

**Compound 1h. 1-(4-Bromophenyl)-2-(pyridin-2-yl)ethanone**




1-(4-Bromophenyl)-2-(pyridin-2-yl)ethanone
Chemical Formula: $C_{13}H_{10}BrNO$
Molecular Weight: 276.1286

Appearance: Orange powder.

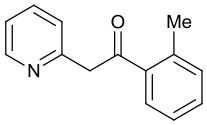
$\upsilon_{max}$ (solid): 2922, 1626, 1585, 1547, 1450, 1404 $cm^{-1}$.

Approx. 1.2:1 keto:enol and approx. 3.5:1 enol olefin stereoisomers based on $^{1}H$ NMR taken in $CDCl_3$ at 298 K.[2]

For $^{1}H$ and $^{13}C$ NMR spectra, see Section 3.5.

HRMS ($C_{13}H_{11}BrNO$) $[M+H^+]$ requires 276.0024, found $[M+H^+]$ 276.0020.

**Compound 1j. 2-(Pyridin-2-yl)-1-(*o*-tolyl)ethanone**




2-(Pyridin-2-yl)-1-(*o*-tolyl)ethanone
Chemical Formula: $C_{14}H_{13}NO$
Molecular Weight: 211.2591

Appearance: Red solid.

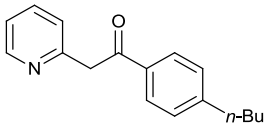
$\upsilon_{max}$ (solid): 3053, 2924, 1665, 1579, 1568, 1468, 1454, 1431 $cm^{-1}$.

Approx. 2.4:1 keto:enol and only one enol olefin stereoisomer based on $^{1}H$ NMR taken in $CDCl_3$ at 298 K.[2]

For $^{1}H$ and $^{13}C$ NMR spectra, see Section 3.5.

HRMS ($C_{14}H_{14}NO$) [M+$H^+$] requires 212.1075, found [M+$H^+$] 212.1068.

**Compound 1k. 1-(4-(*n*-Butyl)phenyl)-2-(pyridin-2-yl)ethanone**




1-(4-(*n*-Butyl)phenyl)-2-(pyridin-2-yl)ethanone
Chemical Formula: $C_{17}H_{19}NO$
Molecular Weight: 253.3389

Appearance: Yellow solid.

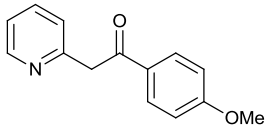
$\upsilon_{max}$ (solid): 2953, 2928, 2857, 1681, 1628, 1595, 1547, 1464 $cm^{-1}$.

Approx. 2:1 keto:enol and approx. 2.2:1 enol olefin stereoisomers based on $^{1}H$ NMR taken in $CDCl_3$ at 298 K.[2]

For $^{1}H$ and $^{13}C$ NMR spectra, see Section 3.5.

HRMS ($C_{17}H_{20}NO$) [M+$H^+$] requires 254.1545, found [M+$H^+$] 254.1538.

**Compound 1l. 1-(4-Methoxyphenyl)-2-(pyridin-2-yl)ethanone**




1-(4-Methoxyphenyl)-2-(pyridin-2-yl)ethanone
Chemical Formula: $C_{14}H_{13}NO_2$
Molecular Weight: 227.2585

Appearance: Yellow solid.

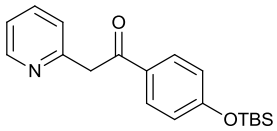
$\upsilon_{max}$ (solid): 3011, 1624, 1591, 1547, 1510 $cm^{-1}$.

Approx. 7.1:1 keto:enol and approx. 16:1 enol olefin stereoisomers based on $^{1}H$ NMR taken in $CDCl_3$ at 298 K.[2]

For $^{1}H$ and $^{13}C$ NMR spectra, see Section 3.5.

HRMS ($C_{14}H_{14}NO_2$) [M+$H^+$] requires 228.1025, found [M+$H^+$] 228.1021.

**Compound 1m. 1-(4-((*tert*-Butyldimethylsilyl)oxy)phenyl)-2-(pyridin-2-yl)ethanone**




1-(4-((*tert*-Butyldimethylsilyl)oxy)phenyl)-2-(pyridin-2-yl)ethanone
Chemical Formula: $C_{19}H_{25}NO_2Si$
Molecular Weight: 327.4928

Appearance: Yellow solid.

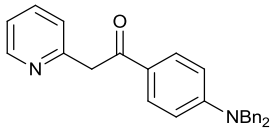
$\upsilon_{max}$ (solid): 3055, 2934, 1636, 1599, 1574, 1513, 1466 $cm^{-1}$.

Approx. 8.3:1 keto:enol and only one enol olefin stereoisomer based on $^{1}H$ NMR taken in $CDCl_3$ at 298 K.[2]

For $^{1}H$ and $^{13}C$ NMR spectra, see Section 3.5.

HRMS ($C_{19}H_{26}NO_2Si$) [M+$H^+$] requires 328.1733, found [M+$H^+$] 328.1725.

**Compound 1n. 1-(4-(Dibenzylamino)phenyl)-2-(pyridin-2-yl)ethanone**




1-(4-(Dibenzylamino)phenyl)-2-(pyridin-2-yl)ethanone
Chemical Formula: $C_{27}H_{24}N_2O$
Molecular Weight: 392.4923

Appearance: Brown oil.

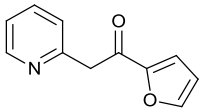
$\upsilon_{max}$ (neat): 3024, 2914, 1661, 1593, 1555, 1522, 1493, 1450 $cm^{-1}$.

Approx. 20:1 keto:enol and approx. 1.5:1 enol olefin stereoisomers based on $^1H$ NMR taken in $CDCl_3$ at 298 K.[2]

For $^1H$ and $^{13}C$ NMR spectra, see Section 3.5.

HRMS ($C_{27}H_{25}N_2O$) $[M+H^+]$ requires 393.1967, found $[M+H^+]$ 393.1958.

**Compound 1o. 1-(Furan-2-yl)-2-(pyridin-2-yl)ethanone**




1-(Furan-2-yl)-2-(pyridin-2-yl)ethanone
Chemical Formula: $C_{11}H_9NO_2$
Molecular Weight: 187.1947

Appearance: Brown solid.

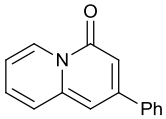
$\upsilon_{max}$ (solid): 3129, 3049, 3007, 1670, 1589, 1564, 1493, 1433 $cm^{-1}$.

Approx. 4.5:1 keto:enol and only one enol olefin stereoisomer based on $^1H$ NMR taken in $CDCl_3$ at 298 K.[2]

For $^1H$ and $^{13}C$ NMR spectra, see Section 3.5.

HRMS ($C_{11}H_{10}NO_2$) $[M+H^+]$ requires 188.0712, found $[M+H^+]$ 188.0705.

**Compound 3a. 2-Phenyl-4*H*-quinolizin-4-one**




2-Phenyl-4*H*-quinolizin-4-one
Chemical Formula: $C_{15}H_{11}NO$
Molecular Weight: 221.2539

Appearance: Yellow crystalline solid.

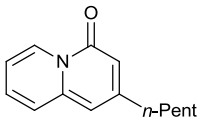
$\upsilon_{max}$ (solid): 3121, 3057, 1651, 1626, 1543, 1466, 1429, 1408 $cm^{-1}$.

$^1H$ NMR (400 MHz, $CDCl_3$): $\delta$ 9.13 (d, 1H, *J* = 7.4 Hz), 7.70-7.72 (m, 2H), 7.44-7.54 (m, 4H), 7.34-7.38 (m, 1H), 6.99-7.03 (m, 1H), 6.91 (s, 2H).

$^{13}C$ NMR (400 MHz, $CDCl_3$): $\delta$ 158.7, 150.5, 142.3, 138.4, 129.7, 129.3, 129.0, 127.3, 127.2, 125.7, 114.9, 106.6, 102.2.

HRMS ($C_{15}H_{12}NO$) $[M+H^+]$ requires 222.0919, found $[M+H^+]$ 222.0912.

**Compound 3b. 2-Pentyl-4*H*-quinolizin-4-one**




2-Pentyl-4*H*-quinolizin-4-one
Chemical Formula: $C_{14}H_{17}NO$
Molecular Weight: 215.2909

Appearance: Brown oil.

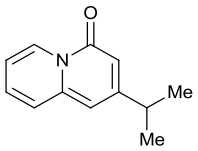
$\upsilon_{max}$ (neat): 2965, 2932, 2970, 1709, 1636, 1597, 1553, 1475, 1435 $cm^{-1}$.

$^1H$ NMR (400 MHz, $CDCl_3$): $\delta$ 9.04 (d, 1H, *J* = 8.0 Hz), 7.37 (d, 1H, *J* = 8.9 Hz), 7.24-7.28 (m, 1H), 6.90 (ddd, 1H, *J* = 7.70, 6.60, 1.4 Hz), 6.49 (d, 2H, *J* = 2.1 Hz), 2.61 (t, 2H, *J* = 8.0 Hz), 1.64-1.72 (m, 2H), 1.31-1.37 (m, 4H), 0.90 (t, 3H, *J* = 7.0 Hz).

$^{13}C$ NMR (400 MHz, $CDCl_3$): $\delta$ 158.9, 154.8, 142.1, 129.4, 127.4, 125.3, 114.5, 109.0, 104.3, 36.2, 31.7, 30.0, 22.8, 14.2.

HRMS ($C_{14}H_{18}NO$) [M+H$^+$] requires 216.1388, found [M+H$^+$] 216.1380.

**Compound 3c. 2-Isopropyl-4*H*-quinolizin-4-one**




2-Isopropyl-4*H*-quinolizin-4-one
Chemical Formula: $C_{12}H_{13}NO$
Molecular Weight: 187.2377

Appearance: Yellow crystalline solid.

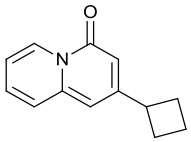
$\upsilon_{max}$ (solid): 2965, 2870, 1708, 1636, 1553, 1476, 1435 cm$^{-1}$.

$^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 9.03 (d, 1H, *J* = 7.4 Hz), 7.39 (d, 1H, *J* = 8.9 Hz), 7.26 (m, 1H), 6.91 (m, 1H), 6.54 (s, 2H), 2.89 (dt, 1H, *J* = 13.8, 6.9 Hz), 1.29 (d, *J* = 6.9 Hz, 6H).

$^{13}$C NMR (400 MHz, $CDCl_3$): $\delta$ 160.2, 158.9, 142.0, 129.0, 127.0, 125.2, 114.2, 106.9, 102.4, 34.3, 22.9.

HRMS ($C_{12}H_{14}NO$) [M+H$^+$] requires 188.1075, found [M+H$^+$] 188.1069.

**Compound 3d. 2-Cyclobutyl-4*H*-quinolizin-4-one**




2-Cyclobutyl-4*H*-quinolizin-4-one
Chemical Formula: $C_{13}H_{13}NO$
Molecular Weight: 199.2484

Appearance: Brown oil.

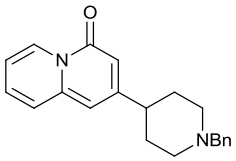
$\upsilon_{max}$ (neat): 3109, 3061, 2960, 2935, 2864, 1659, 1627, 1560, 1547, 1413 cm$^{-1}$.

$^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 9.01 (d, 1H, *J* = 7.4 Hz), 7.37 (d, 1H, *J* = 8.9 Hz), 7.22-7.26 (m, 1H), 6.88 (m, 1H), 6.48 (s, 2H), 3.53 (pent, 1H, *J* = 8.7 Hz), 2.32-2.40 (m, 2H), 2.13-2.23 (m, 2H), 1.98-2.08 (m, 1H), 1.84-1.92 (m, 1H).

$^{13}$C NMR (400 MHz, $CDCl_3$): $\delta$ 158.7, 157.5, 141.9, 129.0, 127.0, 125.0, 114.2, 106.4, 101.9, 39.8, 28.7, 18.1.

HRMS ($C_{13}H_{14}NO$) [M+H$^+$] requires 200.1075, found [M+H$^+$] 200.1069.

**Compound 3e. 2-(1-Benzylpiperidin-4-yl)-4*H*-quinolizin-4-one**




2-(1-Benzylpiperidin-4-yl)-4*H*-quinolizin-4-one
Chemical Formula: $C_{21}H_{22}N_2O$
Molecular Weight: 318.4122

Appearance: Brown oil.

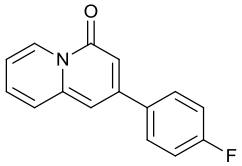
$\upsilon_{max}$ (neat): 2936, 2797, 2755, 1652, 1629, 1452 cm$^{-1}$.

$^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 9.03 (dd, 1H, *J* = 7.3, 0.6 Hz), 7.24-7.39 (m, 7H), 6.89-6.93 (m, 1H), 6.52-6.55 (m, 2H), 3.56 (s, 2H), 3.04 (d, 2H, *J* = 11.8 Hz), 2.47-2.55 (m, 1H), 2.08-2.14 (m, 2H), 1.77-1.86 (m, 4H).

$^{13}$C NMR (400 MHz, $CDCl_3$): $\delta$ 158.8, 157.7, 142.0, 138.2, 129.2, 129.1, 128.2, 128.2, 127.0, 125.2, 114.3, 107.4, 102.4, 63.3, 53.8, 42.6, 32.4.

HRMS ($C_{21}H_{23}N_2O$) [M+H$^+$] requires 319.1810, found [M+H$^+$] 319.1802.

**Compound 3f. 2-(4-Fluorophenyl)-4*H*-quinolizin-4-one**




2-(4-Fluorophenyl)-4*H*-quinolizin-4-one
Chemical Formula: $C_{15}H_{10}FNO$
Molecular Weight: 239.2444

Appearance: Yellow crystalline solid.

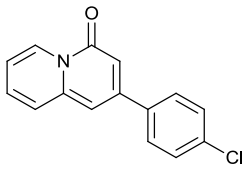
$\upsilon_{max}$ (solid): 3123, 2922, 1653, 1626, 1599, 1562, 1543, 1506, 1454 $cm^{-1}$.

$^1H$ NMR (400 MHz, $CDCl_3$): δ 9.12 (d, 1H, *J* = 7.3 Hz), 7.66-7.70 (m, 2H), 7.53 (d, 1H, *J* = 8.9 Hz), 7.35-7.39 (m, 1H), 7.17-7.21 (m, 2H), 6.99-7.03 (m, 1H), 6.85 (d, 2H, *J* = 3.5 Hz).

$^{13}C$ NMR (400 MHz, $CDCl_3$): δ 163.8 (d, $^1J_{C-F}$ = 249.4 Hz), 162.6, 158.8, 149.5, 142.6, 134.0 (d, $^4J_{C-F}$ = 2.9 Hz), 128.5 (d, $^3J_{C-F}$ = 8.5 Hz), 127.5, 125.8, 116.4, 115.5 (d, $^2J_{C-F}$ = 21.6 Hz), 106.5, 102.0.

HRMS ($C_{15}H_{11}FNO$) $[M+H^+]$ requires 240.0825, found $[M+H^+]$ 240.0818.

**Compound 3g. 2-(4-Chlorophenyl)-4*H*-quinolizin-4-one**




2-(4-Chlorophenyl)-4*H*-quinolizin-4-one
Chemical Formula: $C_{15}H_{10}ClNO$
Molecular Weight: 255.6990

Appearance: Yellow powder.

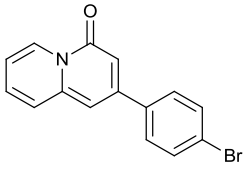
$\upsilon_{max}$ (solid): 3105, 2928, 1651, 1620, 1558, 1541, 1494, 1454, 1435, 1414 $cm^{-1}$.

$^1H$ NMR (400 MHz, $CDCl_3$): δ 9.12 (d, 1H, *J* = 7.3 Hz), 7.62-7.64 (m, 2H), 7.53 (d, 1H, *J* = 8.8 Hz), 7.46-7.49 (m, 2H), 7.36-7.40 (m, 1H), 7.00-7.04 (m, 1H), 6.85 (d, 2H, *J* = 3.8 Hz).

$^{13}C$ NMR (400 MHz, $CDCl_3$): δ 158.9, 149.5, 142.8, 137.2, 135.8, 130.2, 129.6, 128.8, 127.6, 126.0, 115.3, 106.7, 102.0.

HRMS ($C_{15}H_{11}ClNO$) $[M+H^+]$ requires 256.0529, found $[M+H^+]$ 256.0524.

**Compound 3h. 2-(4-Bromophenyl)-4*H*-quinolizin-4-one**




2-(4-Bromophenyl)-4*H*-quinolizin-4-one
Chemical Formula: $C_{15}H_{10}BrNO$
Molecular Weight: 300.1500

Appearance: Yellow solid.

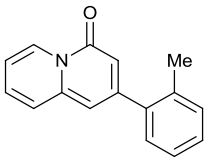
$\upsilon_{max}$ (solid): 3106, 2927, 1651, 1620, 1558, 1542, 1495, 1455 $cm^{-1}$.

$^1H$ NMR (400 MHz, $CDCl_3$): δ 9.13 (d, 1H, *J* = 7.3 Hz), 7.62-7.64 (m, 2H), 7.56-7.58 (m, 2H), 7.53 (d, 1H, *J* = 8.9 Hz), 7.36-7.40 (m, 1H), 7.00-7.04 (m, 1H), 6.83-6.85 (m, 2H).

$^{13}C$ NMR (400 MHz, $CDCl_3$): δ 159.0, 149.6, 142.9, 137.8, 132.6, 130.3, 129.1, 127.8, 126.0, 124.1, 115.3, 106.7, 102.0.

HRMS ($C_{15}H_{11}BrNO$) $[M+H^+]$ requires 300.0024, found $[M+H^+]$ 300.0020.

**Compound 3j. 2-(*o*-Tolyl)-4*H*-quinolizin-4-one**




2-(*o*-Tolyl)-4*H*-quinolizin-4-one
Chemical Formula: $C_{16}H_{13}NO$
Molecular Weight: 235.2805

Appearance: Brown oil.

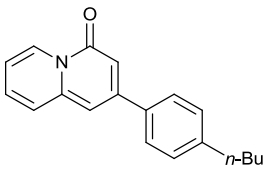
$\upsilon_{max}$ (neat): 3061, 3016, 1655, 1628, 1560, 1547, 1489, 1439, 1406 $cm^{-1}$.

$^1H$ NMR (400 MHz, $CDCl_3$): δ 9.13 (dd, 1H, *J* = 7.4 Hz), 7.46 (d, 1H, *J* = 8.9 Hz), 7.25-7.36 (m, 5H), 7.00 (ddd, 1H, *J* = 7.7, 6.6, 1.4 Hz), 6.61 (m, 2H), 2.33 (s, 3H).

$^{13}$C NMR (400 MHz, $CDCl_3$): δ 158.3, 152.2, 141.7, 139.5, 134.9, 130.5, 129.5, 128.8, 128.3, 127.1, 125.9, 125.4, 114.8, 109.4, 104.6, 20.2.

HRMS ($C_{16}H_{14}NO$) [M+H$^+$] requires 236.1075, found [M+H$^+$] 236.1068.

**Compound 3k. 2-(4-(*n*-Butyl)phenyl)-4*H*-quinolizin-4-one**




2-(4-(*n*-Butyl)phenyl)-4*H*-quinolizin-4-one
Chemical Formula: $C_{19}H_{19}NO$
Molecular Weight: 277.3603

Appearance: Brown solid.

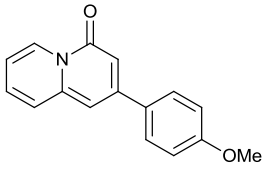
$\upsilon_{max}$ (solid): 2955, 2928, 2856, 1735, 1681, 1628, 1562, 1545, 1512, 1454 cm$^{-1}$.

$^1$H NMR (400 MHz, $CDCl_3$): δ 9.04 (d, 1H, *J* = 7.5 Hz), 8.67 (d, 1H, *J* = 4.7 Hz), 7.74 (d, 1H, *J* = 7.7 Hz), 7.38-7.42 (m, H), 7.12 (d, 2H, *J* = 8.3 Hz), 6.91 (t, 1H, *J* = 7.2 Hz), 6.60 (s, 1H), 6.50 (s, 1H), 2.57 (m, 2H), 1.28-1.38 (m, 4H), 0.90 (t, 3H, *J* = 7.3 Hz).

$^{13}$C NMR (400 MHz, $CDCl_3$): δ 159.1, 150.6, 144.8, 142.6, 135.9, 129.8, 129.4, 127.5, 127.4, 125.9, 114.9, 106.6, 102.2, 35.7, 33.8, 22.7, 14.2.

HRMS ($C_{19}H_{20}NO$) [M+H$^+$] requires 278.1545, found [M+H$^+$] 278.1540.

**Compound 3l. 2-(4-Methoxyphenyl)-4*H*-quinolizin-4-one**




2-(4-Methoxyphenyl)-4*H*-quinolizin-4-one
Chemical Formula: $C_{16}H_{13}NO_2$
Molecular Weight: 251.2799

Appearance: Yellow solid.

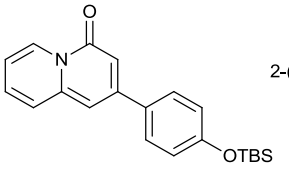
$\upsilon_{max}$ (solid): 3115, 2994, 2839, 1651, 1620, 1560, 1545, 1510, 1442, 1418 cm$^{-1}$.

$^1$H NMR (400 MHz, $CDCl_3$): δ 9.09 (d, 1H, *J* = 7.4 Hz), 7.65-7.69 (m, 2H), 7.50 (d, 1H, *J* = 8.9 Hz), 7.31-7.35 (m, 1H), 7.00-7.04 (m, 2H), 6.95-6.98 (m, 1H), 6.87 (s, 2H), 3.88 (s, 3H).

$^{13}$C NMR (400 MHz, $CDCl_3$): δ 161.1, 159.1, 150.2, 142.6, 130.9, 129.9, 128.8, 127.6, 125.9, 115.0, 114.8, 106.2, 102.1, 55.8.

HRMS ($C_{16}H_{14}NO_2$) [M+H$^+$] requires 252.1025, found [M+H$^+$] 252.1018.

**Compound 3m. 2-(4-((*tert*-Butyldimethylsilyl)oxy)phenyl)-4*H*-quinolizin-4-one**




2-(4-((*tert*-Butyldimethylsilyl)oxy)phenyl)-4*H*-quinolizin-4-one
Chemical Formula: $C_{21}H_{25}NO_2Si$
Molecular Weight: 351.5142

Appearance: Brown solid.

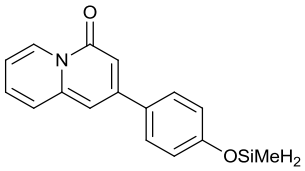
$\upsilon_{max}$ (solid): 2930, 2857, 1736, 1649, 1603, 1552, 1512, 1454 cm$^{-1}$.

$^1$H NMR (400 MHz, $CDCl_3$): δ 9.09 (d, 1H, *J* = 7.3 Hz), 7.58-7.62 (m, 2H), 7.49 (d, 1H, *J* = 8.9 Hz), 7.30-7.34 (m, 1H), 6.94-6.98 (m, 3H), 6.86 (s, 2H), 1.02 (s, 9H), 0.26 (s, 6H).

$^{13}$C NMR (400 MHz, $CDCl_3$): δ 159.1, 157.5, 150.4, 142.6, 131.5, 129.9, 128.8, 127.6, 125.9, 121.0, 114.9, 106.3, 102.2, 26.0, 18.6, 4.0.

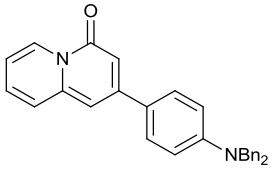
HRMS ($C_{16}H_{15}NO_2Si$) [M-(Me + *t*-Bu)+2H] requires 281.0872, found [M-(Me + *t*-Bu)+2H] 281.1515 (fragment shown below).

**HRMS fragment of compound 3n.**




2-(4-((Methylsilyl)oxy)phenyl)-4*H*-quinolizin-4-one
Chemical Formula: $C_{16}H_{15}NO_2Si$
Molecular Weight: 281.3813

**Compound 3n. 2-(4-(Dibenzylamino)phenyl)-4*H*-quinolizin-4-one**




2-(4-(Dibenzylamino)phenyl)-4*H*-quinolizin-4-one
Chemical Formula: $C_{29}H_{24}N_2O$
Molecular Weight: 416.5137

Appearance: Brown/yellow solid.

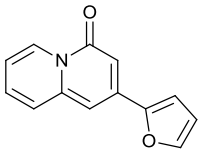
$\upsilon_{max}$ (solid): 3061, 2913, 2862, 1655, 1603, 1518, 1450 $cm^{-1}$.

$^1H$ NMR (400 MHz, $CDCl_3$): $\delta$ 9.05 (d, 1H, *J* = 7.3 Hz), 7.57-7.60 (m, 2H), 7.45 (d, 1H, *J* = 8.9 Hz), 7.35-7.39 (m, 4H), 7.26-7.32 (m, 7H), 6.82-6.94 (m, 5H), 4.74 (s, 4H).

$^{13}C$ NMR (400 MHz, $CDCl_3$): $\delta$ 150.5, 150.3, 142.5, 138.1, 129.7, 129.2, 128.6, 127.5, 127.5, 126.9, 125.9, 120.0, 114.6, 112.9, 105.2, 54.5.

HRMS ($C_{29}H_{25}N_2O$) [M+$H^+$] requires 417.1967, found [M+$H^+$] 417.1961.

**Compound 3o. 2-(Furan-2-yl)-4*H*-quinolizin-4-one**




2-(Furan-2-yl)-4*H*-quinolizin-4-one
Chemical Formula: $C_{13}H_9NO_2$
Molecular Weight: 211.2161

Appearance: Brown solid.

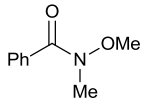
$\upsilon_{max}$ (soild): 3102, 2957, 2922, 2853, 1736, 1651, 1618, 1593, 1460 $cm^{-1}$.

$^1H$ NMR (400 MHz, $CDCl_3$): $\delta$ 9.08 (d, 1H, *J* = 7.4 Hz), 7.59 (d, 1H, *J* = 1.2 Hz), 7.48 (d, 1H, *J* = 8.9 Hz), 7.30-7.34 (m, 1H), 6.90-6.97 (m, 4H), 6.56 (dd, 1H, *J* = 3.4, 1.8 Hz).

$^{13}C$ NMR (400 MHz, $CDCl_3$): $\delta$ 159.0, 151.7, 144.6, 143.0, 139.4, 130.1, 127.8, 125.9, 114.9, 112.6, 110.2, 102.6, 98.9.

HRMS ($C_{13}H_{10}NO_2$) [M+$H^+$] requires 212.0712, found [M+$H^+$] 212.0704.

**Compound 5a. *N*-Methoxy-*N*-methylbenzamide**




*N*-Methoxy-*N*-methylbenzamide
Chemical Formula: $C_9H_{11}NO_2$
Molecular Weight: 165.1891

Appearance: Colourless oil.

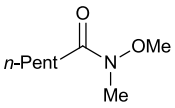
$\upsilon_{max}$ (neat): 2970, 1638, 1447, 1412 $cm^{-1}$.

$^1H$ NMR (400 MHz, $CDCl_3$): $\delta$ 7.67-7.70 (m, 2H), 7.41-7.46 (m, 3H), 3.57 (s, 3H), 3.37 (s, 3H).

$^{13}C$ NMR (400 MHz, $CDCl_3$): $\delta$ 169.9, 134.1, 130.5, 128.1, 128.0, 61.0, 33.7.

HRMS ($C_9H_{12}NO_2$) [M+H$^+$] requires 166.0868, found [M+H$^+$] 166.0863.

**Compound 5b. *N*-Methoxy-*N*-methylhexanamide**




*N*-Methoxy-*N*-methylhexanamide
Chemical Formula: $C_8H_{17}NO_2$
Molecular Weight: 159.2261

Appearance: Colourless oil.

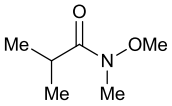
$\upsilon_{max}$ (neat): 2955, 2934, 2860, 1637, 1462, 1443, 1412 cm$^{-1}$.

$^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 3.69 (s, 3H), 3.18 (s, 3H), 2.41 (t, 2H, *J* = 7.6 Hz), 1.60-1.68 (m, 2H), 1.29-1.38 (m, 4H), 0.91 (t, 3H, *J* = 7.0 Hz).

$^{13}$C NMR (100 MHz, $CDCl_3$): $\delta$ 174.5, 60.8, 31.8, 31.5, 31.3, 24.0, 22.1, 13.6.

HRMS ($C_8H_{18}NO_2$) [M+H$^+$] requires 160.1338, found [M+H$^+$] 160.1331.

**Compound 5c. *N*-Methoxy-*N*-methylisobutyramide**




*N*-Methoxy-*N*-methylisobutyramide
Chemical Formula: $C_6H_{13}NO_2$
Molecular Weight: 131.1729

Appearance: Colourless oil.

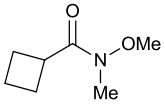
$\upsilon_{max}$ (neat): 2961, 1732, 1647, 1483, 1460, 1404 cm$^{-1}$.

$^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 3.69 (s, 3H), 3.18 (s, 3H), 2.93-3.00 (m, 1H), 1.13 (d, 6H, *J* = 6.9 Hz).

$^{13}$C NMR (400 MHz, $CDCl_3$): $\delta$ 178.9, 60.3, 39.1, 33.4, 26.9.

HRMS ($C_6H_{14}NO_2$) [M+H$^+$] requires 132.1025, found [M+H$^+$] 132.1018.

**Compound 5d. *N*-Methoxy-*N*-methylcyclobutanecarboxamide**




*N*-Methoxy-*N*-methylcyclobutanecarboxamide
Chemical Formula: $C_7H_{13}NO_2$
Molecular Weight: 143.1836

Appearance: Colourless oil.

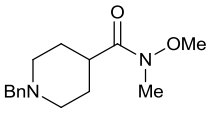
$\upsilon_{max}$ (neat): 2943, 2870, 1674, 1462, 1443, 1414 cm$^{-1}$.

$^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 3.58 (s, 3H), 3.41 (br m, 1H), 3.10 (s, 3H), 2.20-2.30 (m, 2H), 2.02-2.10 (m, 2H), 1.85-1.96 (m, 1H), 1.74-1.84 (m, 1H).

$^{13}$C NMR (400 MHz, $CDCl_3$): $\delta$ 175.0, 61.1, 35.9, 32.1, 24.7, 18.5.

HRMS ($C_7H_{14}NO_2$) [M+H$^+$] requires 144.1025, found [M+H$^+$] 144.1020.

**Compound 5e. 1-Benzyl-*N*-methoxy-*N*-methylpiperidine-4-carboxamide**




1-Benzyl-*N*-methoxy-*N*-methylpiperidine-4-carboxamide
Chemical Formula: $C_{15}H_{22}N_2O_2$
Molecular Weight: 262.3474

Appearance: Orange oil.

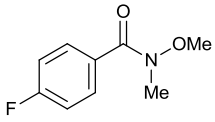
$\upsilon_{max}$ (neat): 2947, 2754, 1651, 1447 cm$^{-1}$.

$^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 7.32-7.34 (m, 3H), 7.24-7.30 (m, 2H), 3.70 (s, 3H), 3.53 (s, 2H), 3.18 (s, 3H), 2.94-2.97 (m, 2H), 2.63-2.69 (m, 1H), 2.01-2.06 (m, 2H), 1.80-1.90 (m, 2H), 1.70-1.73 (m, 2H).

$^{13}$C NMR (400 MHz, $CDCl_3$): $\delta$ 176.4, 138.4, 129.0, 128.1, 126.9, 63.2, 61.5, 53.1, 38.2, 32.3, 28.3.

HRMS ($C_{15}H_{23}N^2O_2$) [M+H$^+$] requires 263.1760, found [M+H$^+$] 263.1751.

**Compound 5f. 4-Fluoro-*N*-methoxy-*N*-methylbenzamide**




4-Fluoro-*N*-methoxy-*N*-methylbenzamide
Chemical Formula: $C_9H_{10}FNO_2$
Molecular Weight: 183.1796

Appearance: Colourless oil.

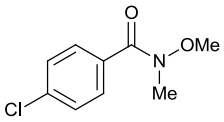
$\upsilon_{max}$ (neat): 2970, 2938, 1637, 1603, 1506, 1460, 1441, 1418 $cm^{-1}$.

$^1H$ NMR (400 MHz, $CDCl_3$): $\delta$ 7.73-7.76 (m, 2H), 7.07-7.11 (m, 2H), 3.54 (s, 3H), 3.37 (s, 3H).

$^{13}C$ NMR (400 MHz, $CDCl_3$): 164.4 (d, $^1J_{C\text{-}F}$ = 250.9 Hz), 162.8, 131.2 (d, $^3J_{C\text{-}F}$ = 8.5 Hz), 130.2 (d, $^4J_{C\text{-}F}$ = 3.0 Hz), 115.4 (d, $^2J_{C\text{-}F}$ = 21.9 Hz), 61.0, 33.6.

HRMS ($C_9H_{11}FNO_2$) $[M+H^+]$ requires 184.0774, found $[M+H^+]$ 184.0767.

**Compound 5g. 4-Chloro-*N*-methoxy-*N*-methylbenzamide**




4-Chloro-*N*-methoxy-*N*-methylbenzamide
Chemical Formula: $C_9H_{10}ClNO_2$
Molecular Weight: 199.6342

Appearance: Pale yellow oil.

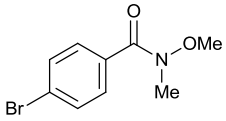
$\upsilon_{max}$ (neat): 2968, 1638, 1593, 1458, 1442, 1414 $cm^{-1}$.

$^1H$ NMR (400 MHz, $CDCl_3$): $\delta$ 7.66 (d, 2H, *J* = 8.6 Hz), 7.38 (d, 2H, *J* = 8.6 Hz), 3.54 (s, 3H), 3.36 (s, 3H).

$^{13}C$ NMR (400 MHz, $CDCl_3$): $\delta$ 168.6, 136.7, 132.3, 129.8, 128.2, 61.0, 33.5.

HRMS ($C_9H_{11}ClNO_2$) $[M+H^+]$ requires 200.0478, found $[M+H^+]$ 200.0474.

**Compound 5h. 4-Bromo-*N*-methoxy-*N*-methylbenzamide**




4-Bromo-*N*-methoxy-*N*-methylbenzamide
Chemical Formula: $C_9H_{10}BrNO_2$
Molecular Weight: 244.0852

Appearance: Pale yellow oil.

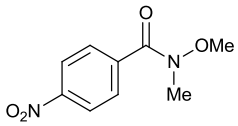
$\upsilon_{max}$ (neat): 2968, 2934, 1635, 1587, 1458, 1412 $cm^{-1}$.

$^1H$ NMR (400 MHz, $CDCl_3$): $\delta$ 7.59 (d, 2H, *J* = 8.7 Hz), 7.55 (d, 2H, *J* = 8.7 Hz), 3.54 (s, 3H), 3.36 (s, 3H).

$^{13}C$ NMR (400 MHz, $CDCl_3$): $\delta$ 168.7, 132.8, 131.2, 130.0, 125.1, 61.1, 33.5.

HRMS ($C_9H_{11}BrNO_2$) $[M+H^+]$ requires 243.9973, found $[M+H^+]$ 243.9971.

**Compound 5i. *N*-Methoxy-*N*-methyl-4-nitrobenzamide**




*N*-Methoxy-*N*-methyl-4-nitrobenzamide
Chemical Formula: $C_9H_{10}N_2O_4$
Molecular Weight: 210.1867

Appearance: Colourless oil.

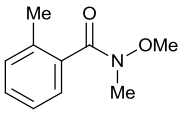
$\upsilon_{max}$ (neat): 3115, 2986, 2930, 1634, 1595, 1524, 1423 $cm^{-1}$.

$^1H$ NMR (400 MHz, $CDCl_3$): $\delta$ 8.27 (d, 2H, *J* = 8.9 Hz), 7.84 (d, 2H, *J* = 8.9 Hz), 3.53 (s, 3H), 3.40 (s, 3H)

$^{13}C$ NMR (400 MHz, $CDCl_3$): $\delta$ 167.7, 148.8, 140.0, 129.2, 123.2, 61.4, 33.1.

HRMS ($C_9H_{10}N_2O_4$) $[M+H^+]$ requires 211.0719, found $[M+H^+]$ 211.0713.

**Compound 5j. *N*-Methoxy-*N*,2-dimethylbenzamide**




*N*-Methoxy-*N*,2-dimethylbenzamide
Chemical Formula: $C_{10}H_{13}NO_2$
Molecular Weight: 179.2157

Appearance: Pale yellow oil.

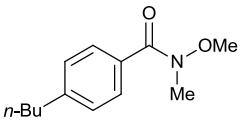
$\upsilon_{max}$ (neat): 2968, 2934, 1668, 1459, 1410 $cm^{-1}$.

$^1H$ NMR (400 MHz, $CDCl_3$): $\delta$ 7.18-7.31 (m, 4H), 3.52 (br s, 3H), 3.30 (s, 3H), 2.34 (s, 3H).

$^{13}C$ NMR (400 MHz, $CDCl_3$): $\delta$ 170.6, 135.6, 135.0, 130.2, 129.2, 126.4, 125.5, 61.1, 33.5, 19.1.

HRMS ($C_{10}H_{14}NO_2$) [M+$H^+$] requires 180.1025, found [M+$H^+$] 180.1018.

**Compound 5k. 4-(*n*-Butyl)-*N*-methoxy-*N*-methylbenzamide**




4-(*n*-Butyl)-*N*-methoxy-*N*-methylbenzamide
Chemical Formula: $C_{13}H_{19}NO_2$
Molecular Weight: 221.2955

Appearance: Colourless oil.

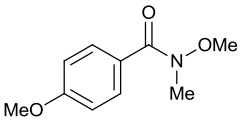
$\upsilon_{max}$ (neat): 2957, 2930, 1639, 1611, 1458, 1416 $cm^{-1}$.

$^1H$ NMR (400 MHz, $CDCl_3$): $\delta$ 7.61 (d, 2H, *J* = 8.2 Hz), 7.21 (d, 2H, *J* = 8.3 Hz), 3.57 (s, 3H), 3.35 (s, 3H), 2.64 (t, 2H, *J* = 8.0 Hz), 1.58-1.65 (m, 2H), 1.32-1.41 (m, 2H), 0.93 (t, 3H, *J* = 7.3 Hz).

$^{13}C$ NMR (400 MHz, $CDCl_3$): $\delta$ 169.9, 145.7, 131.2, 128.2, 127.9, 60.8, 35.4, 33.8, 33.2, 22.2, 13.8.

HRMS ($C_{13}H_{20}NO_2$) [M+$H^+$] requires 222.1494, found [M+$H^+$] 222.1488.

**Compound 5l. 4-Methoxy-*N*-methoxy-*N*-methylbenzamide**




*N*,4-Dimethoxy-*N*-methylbenzamide
Chemical Formula: $C_{10}H_{13}NO_3$
Molecular Weight: 195.2151

Appearance: Pale yellow oil.

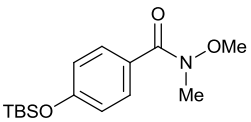
$\upsilon_{max}$ (neat): 2965, 2934,1632, 1605, 1510, 1460, 1420 $cm^{-1}$.

$^1H$ NMR (400 MHz, $CDCl_3$): $\delta$ 7.74 (d, 2H, *J* = 8.9 Hz), 6.91 (d, 2H, *J* = 8.9 Hz), 3.85 (s, 3H), 3.57 (s, 3H), 3.36 (s, 3H).

$^{13}C$ NMR (400 MHz, $CDCl_3$): $\delta$ 169.3, 161.5, 130.5, 126.0, 113.2, 60.8, 55.2, 33.8.

HRMS ($C_{10}H_{14}NO_3$) [M+$H^+$] requires 196.0974, found [M+$H^+$] 196.0968.

**Compound 5m. 4-((*tert*-Butyldimethylsilyl)oxy)-*N*-methoxy-*N*-methylbenzamide**




4-((*tert*-Butyldimethylsilyl)oxy)-*N*-methoxy-*N*-methylbenzamide
Chemical Formula: $C_{15}H_{25}NO_3Si$
Molecular Weight: 295.4494

Appearance: Colourless oil.

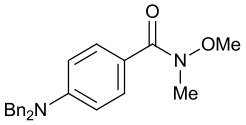
$\upsilon_{max}$ (neat): 2955, 2930, 2859, 1639, 1603, 1506, 1462, 1415 $cm^{-1}$.

$^1H$ NMR (400 MHz, $CDCl_3$): $\delta$ 7.65 (d, 2H, *J* = 8.7 Hz), 6.85 (d, 2H, *J* = 8.7 Hz), 3.56 (s, 3H), 3.35 (s, 3H), 0.99 (s, 9H), 0.22 (s, 6H).

$^{13}C$ NMR (100 MHz, $CDCl_3$): $\delta$ 169.5, 158.0, 130.3, 126.7, 119.4, 60.8, 33.9, 25.6, 18.1, -4.5.

HRMS ($C_{15}H_{26}NO_3Si$) [M+$H^+$] requires 296.1682, found [M+$H^+$] 296.1677.

**Compound 5n. 4-(Dibenzylamino)-*N*-methoxy-*N*-methylbenzamide**




4-(Dibenzylamino)-*N*-methoxy-*N*-methylbenzamide
Chemical Formula: $C_{23}H_{24}N_2O_2$
Molecular Weight: 360.4489

Appearance: Colourless oil.

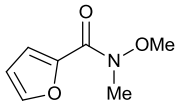
$\upsilon_{max}$ (neat): 3030, 2932, 1620, 1609, 1522, 1445 $cm^{-1}$.

$^1H$ NMR (400 MHz, $CDCl_3$): $\delta$ 7.66 (d, 2H, *J* = 9.1 Hz), 7.33-7.37 (m, 4H), 7.28-7.3 (m, 2H), 7.23-7.25 (m, 4H), 6.72 (d, 2H, *J* = 9.0 Hz), 4.71 (s, 4H), 3.60 (s, 3H), 3.34 (s, 3H).

$^{13}C$ NMR (400 MHz, $CDCl_3$): $\delta$ 169.8, 151.1, 137.7, 130.7, 128.7, 127.1, 126.5, 121.2, 111.1, 60.7, 53.9, 34.2.

HRMS ($C_{23}H_{25}N_2O_2$) [M+$H^+$] requires 361.1916, found [M+$H^+$] 361.1911.

**Compound 5o. *N*-Methoxy-*N*-methylfuran-2-carboxamide**




*N*-Methoxy-*N*-methylfuran-2-carboxamide
Chemical Formula: $C_7H_9NO_3$
Molecular Weight: 155.1513

Appearance: Brown oil.

$\upsilon_{max}$ (neat): 3119, 2968, 2938, 1627, 1560, 1407 $cm^{-1}$.

$^1H$ NMR (400 MHz, $CDCl_3$): $\delta$ 7.59 (d, 1H, *J* = 1.5 Hz), 7.14 (d, 1H, *J* = 3.5 Hz), 6.51 (dd, 1H, *J* = 3.5, 1.7 Hz), 3.77 (s, 3H), 3.35 (s, 3H).

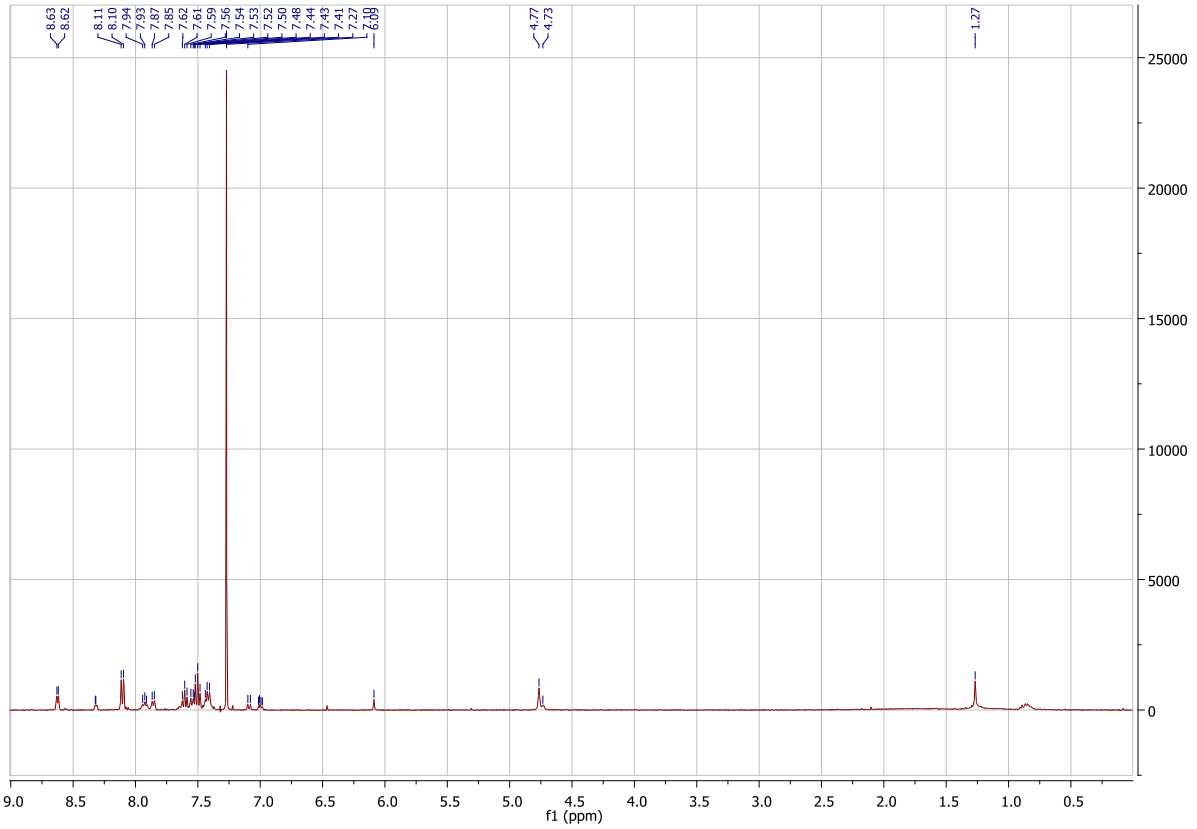
$^{13}C$ NMR (400 MHz, $CDCl_3$): $\delta$ 159.1, 145.7, 145.2, 117.3, 111.5, 61.3, 33.1.

HRMS ($C_7H_{10}NO_3$) [M+$H^+$] requires 156.0661, found [M+$H^+$] 156.0654.

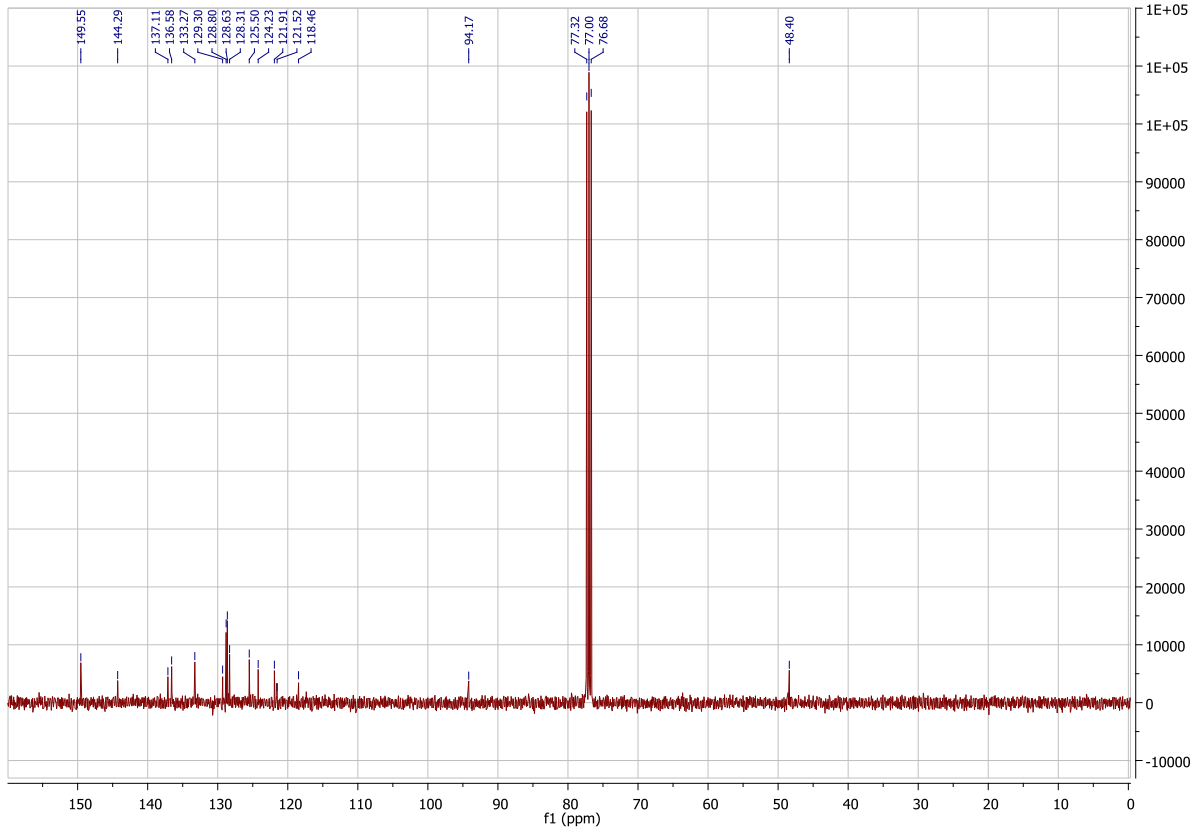
## 3.5 IR, $^{1}$H NMR, $^{13}$C NMR, and HRMS Spectra for Compounds

### Compound 1a: 1-Phenyl-2-(pyridin-2-yl)ethanone

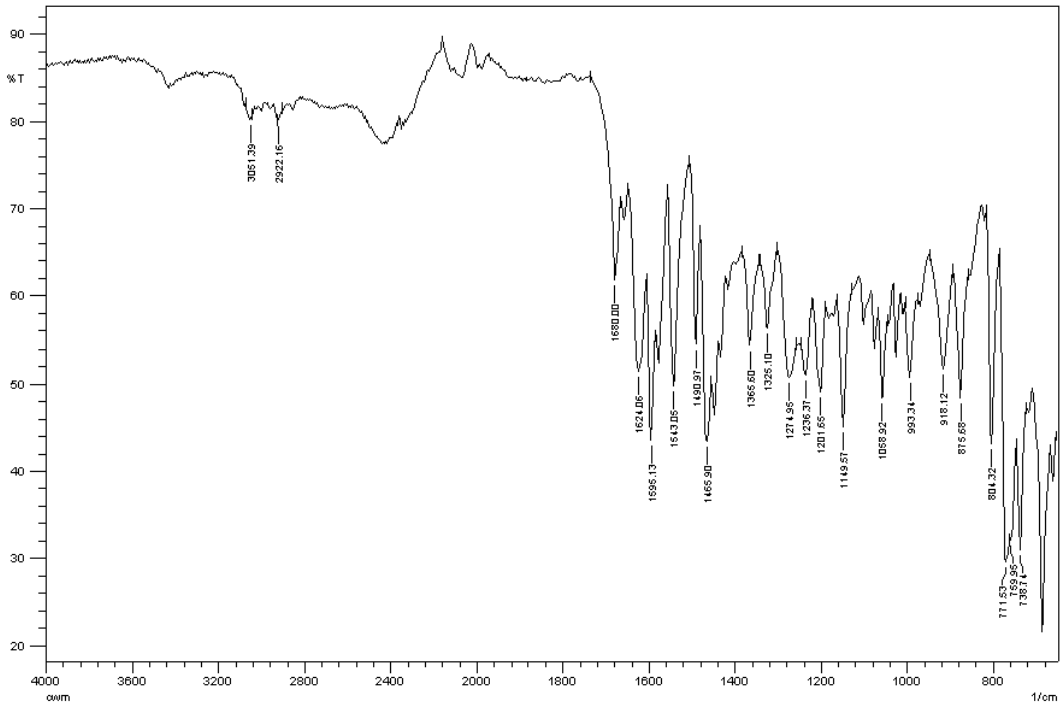
**$^{1}$H NMR:**



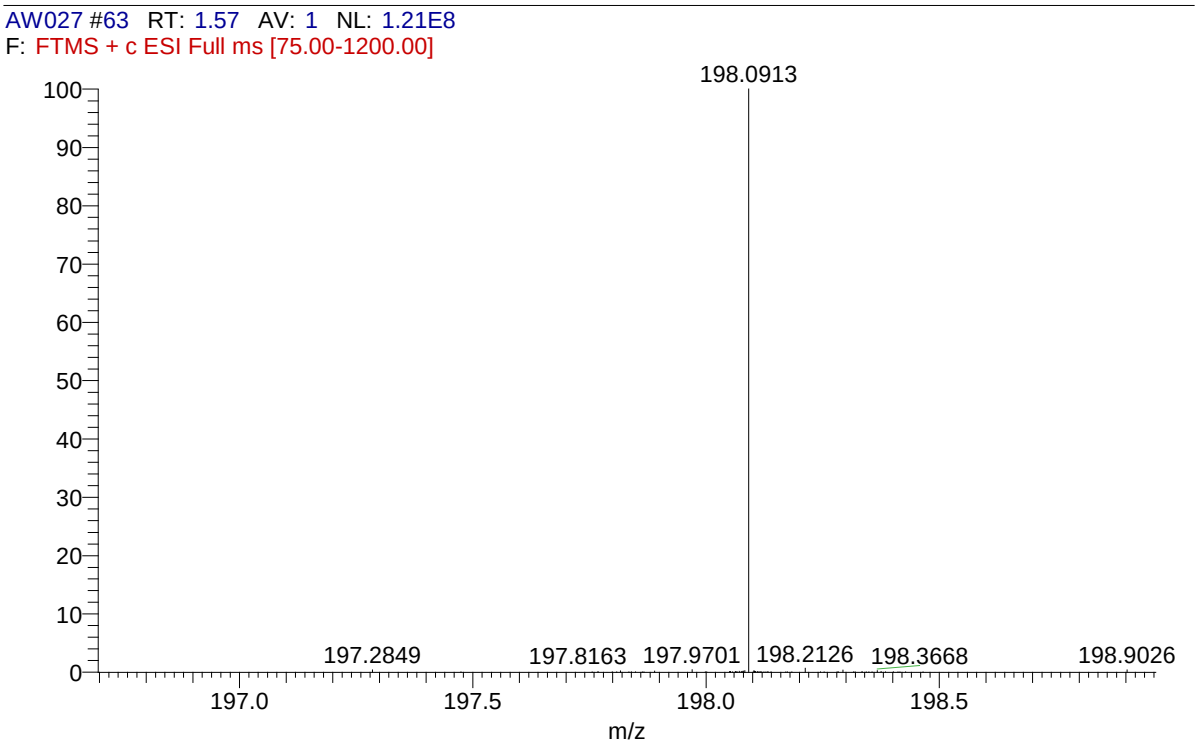

**$^{13}$C NMR:**



**FTIR:**

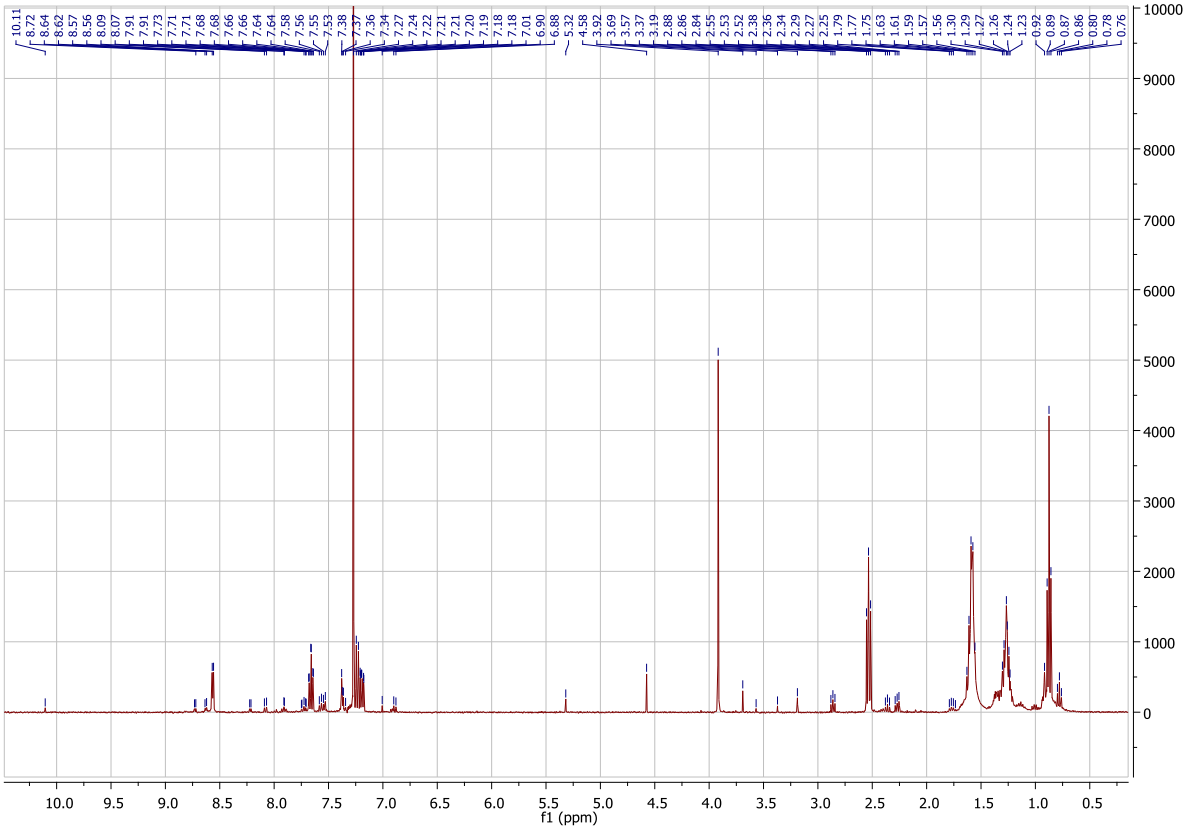



**HRMS:**

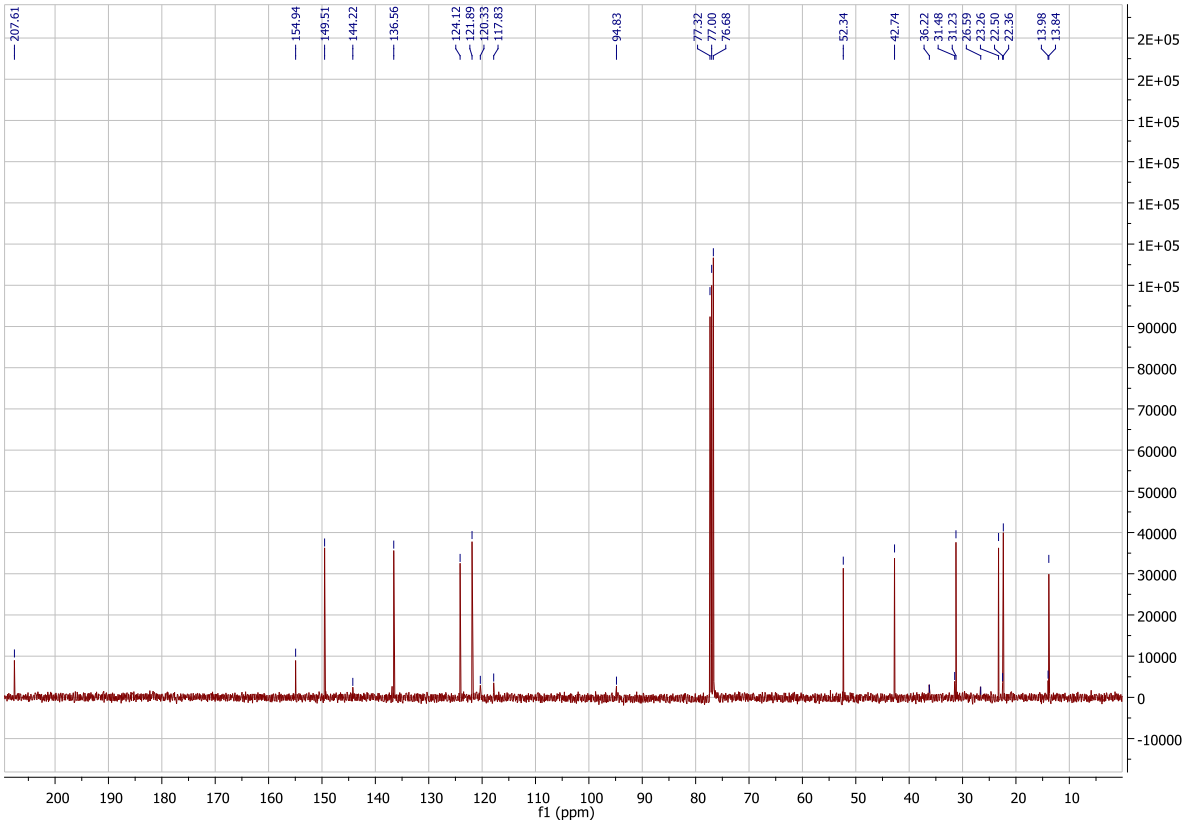


**Compound 1b: 1-(Pyridin-2-yl)heptan-2-one**

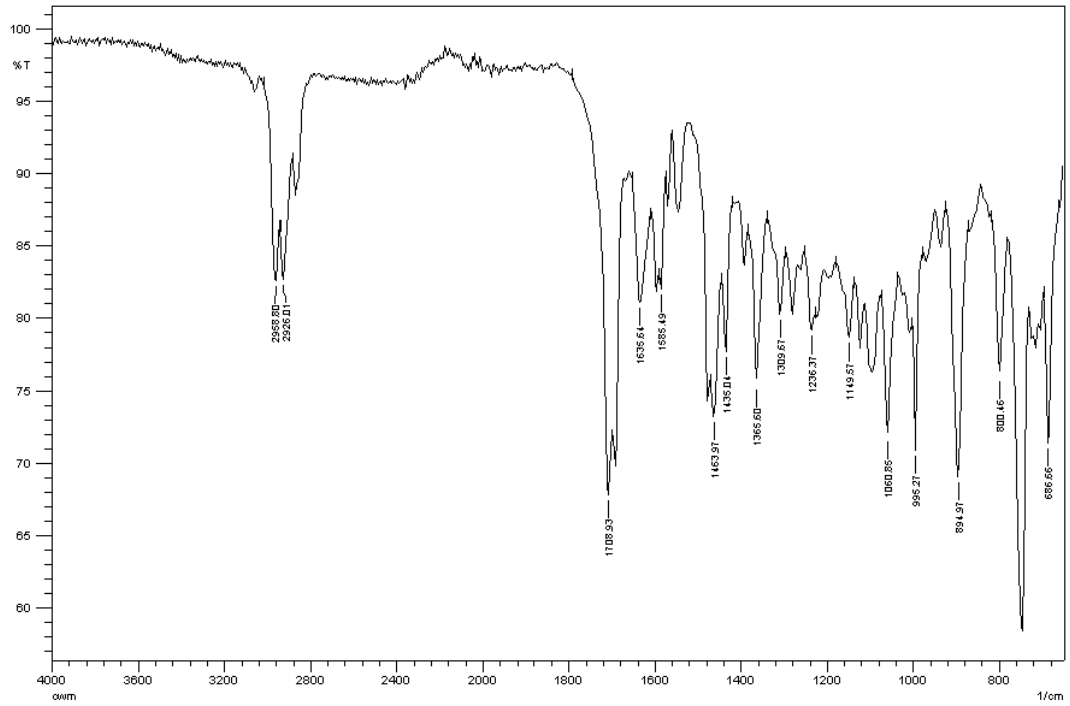
**$^{1}$H NMR:**



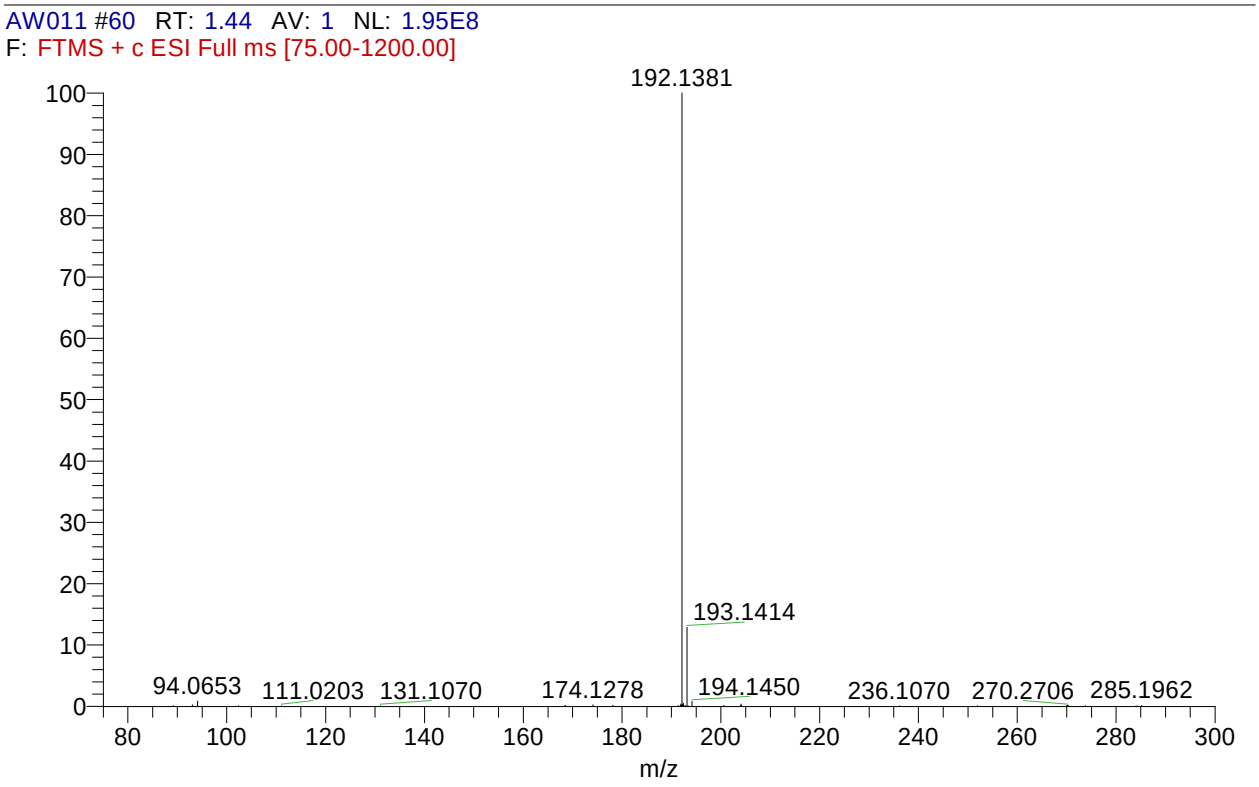

**$^{13}$C NMR:**



**FTIR:**

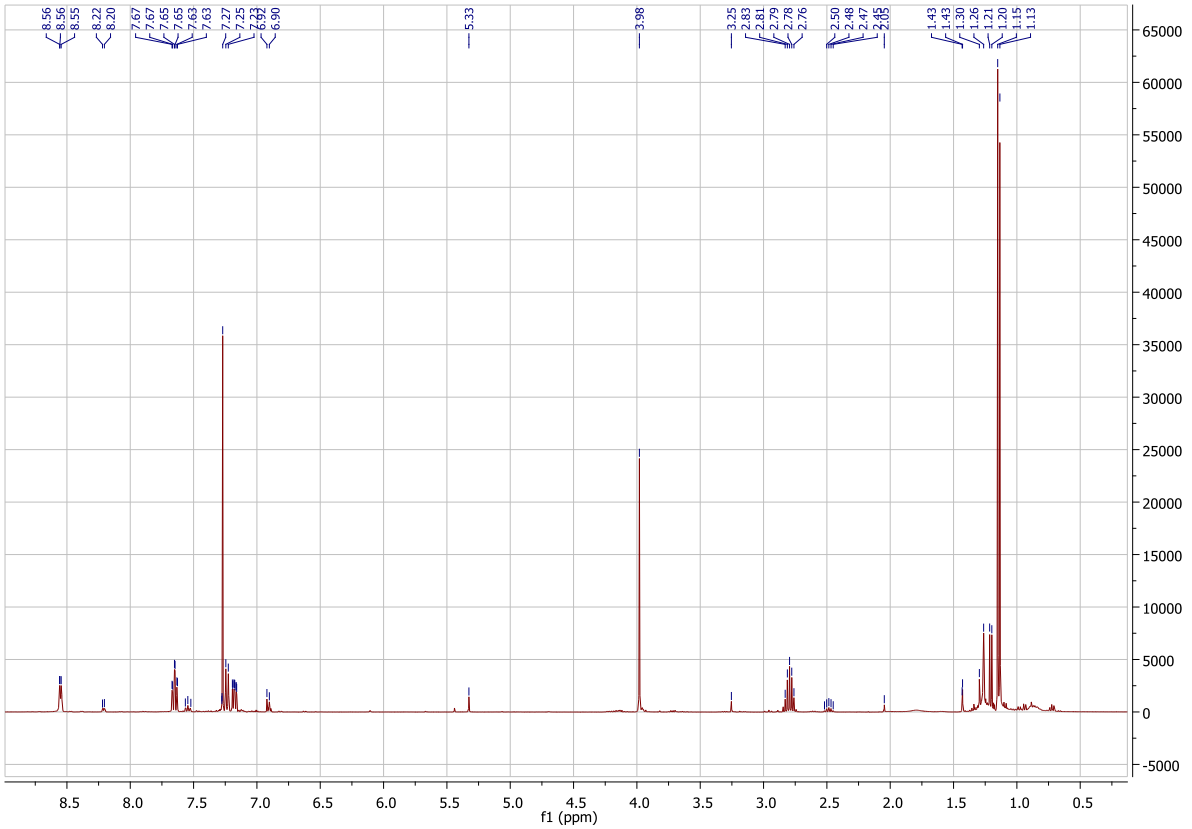



**HRMS:**

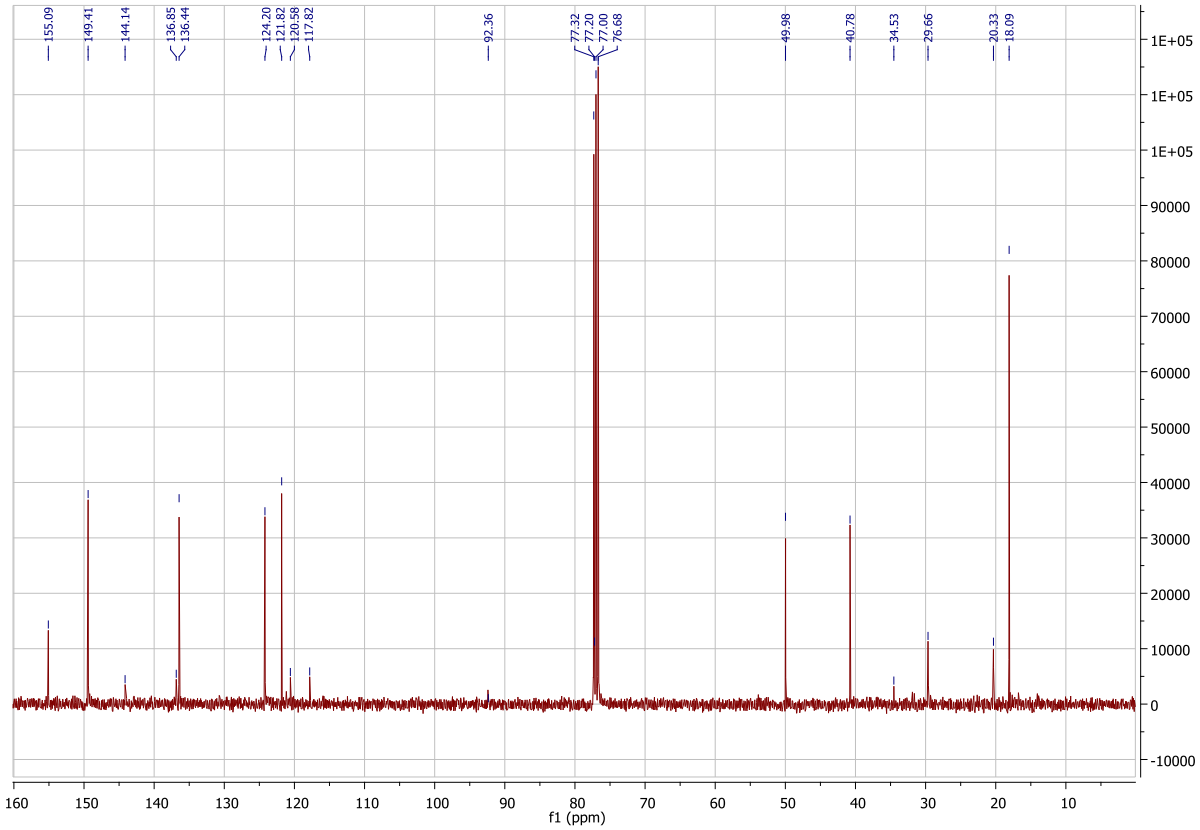


**Compound 1c: 3-Methyl-1-(pyridin-2-yl)butan-2-one**

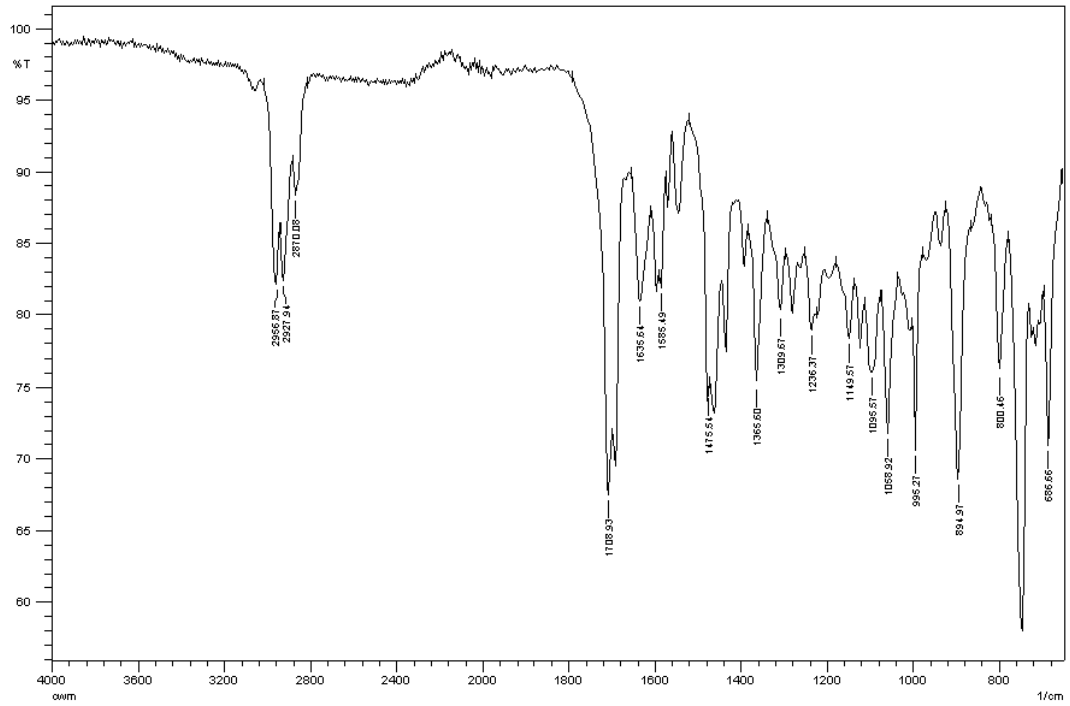
**$^{1}$H NMR:**



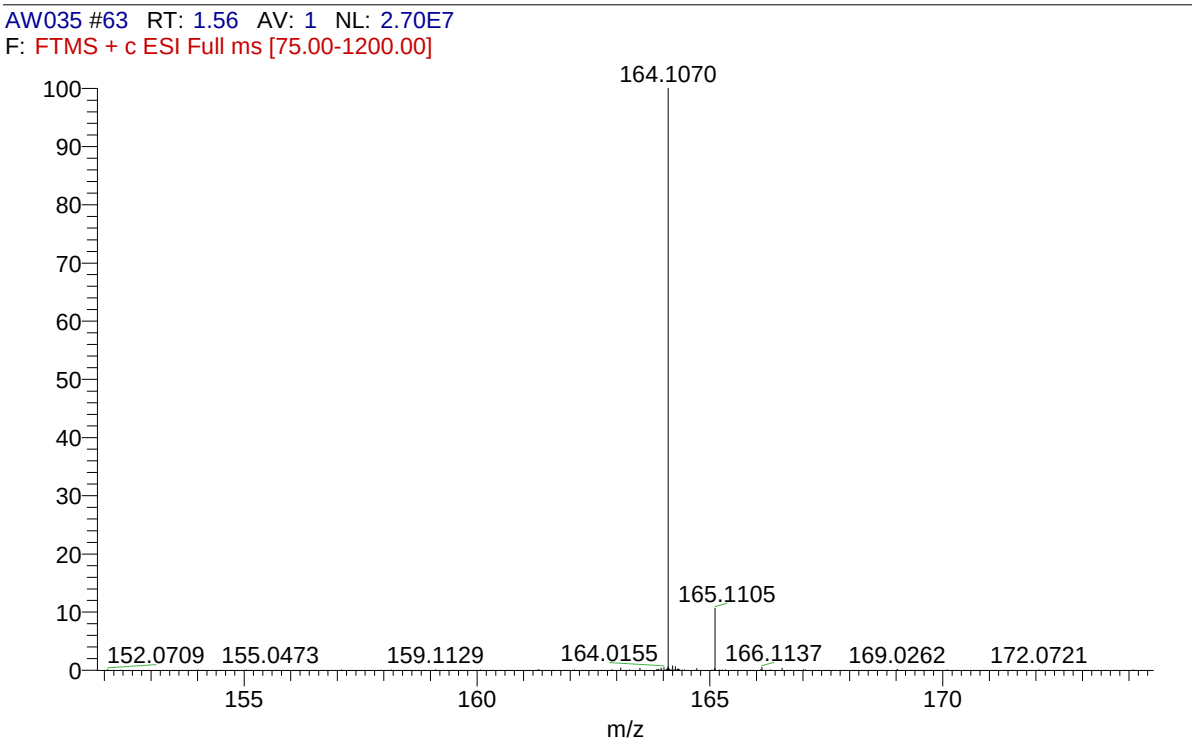

**$^{13}$C NMR:**



**FTIR:**

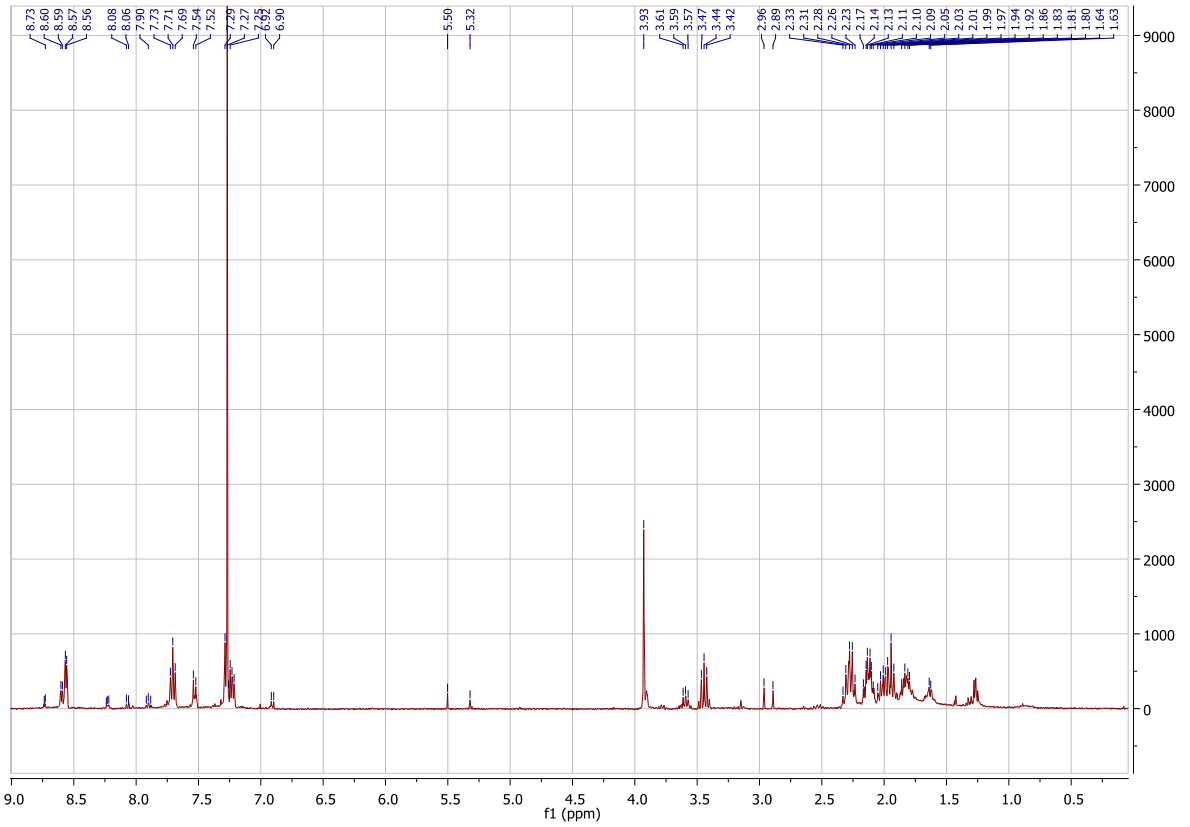



**HRMS:**

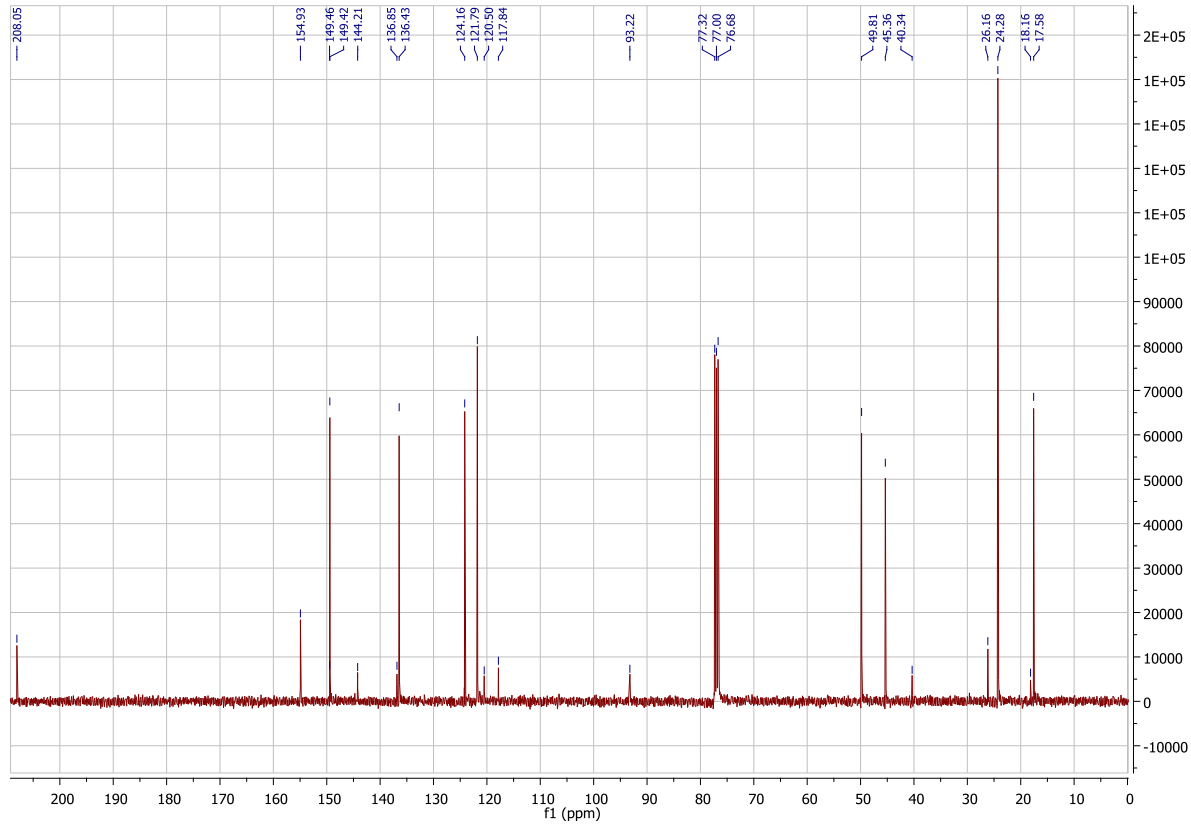


**Compound 1d: 1-Cyclobutyl-2-(pyridin-2-yl)ethanone**

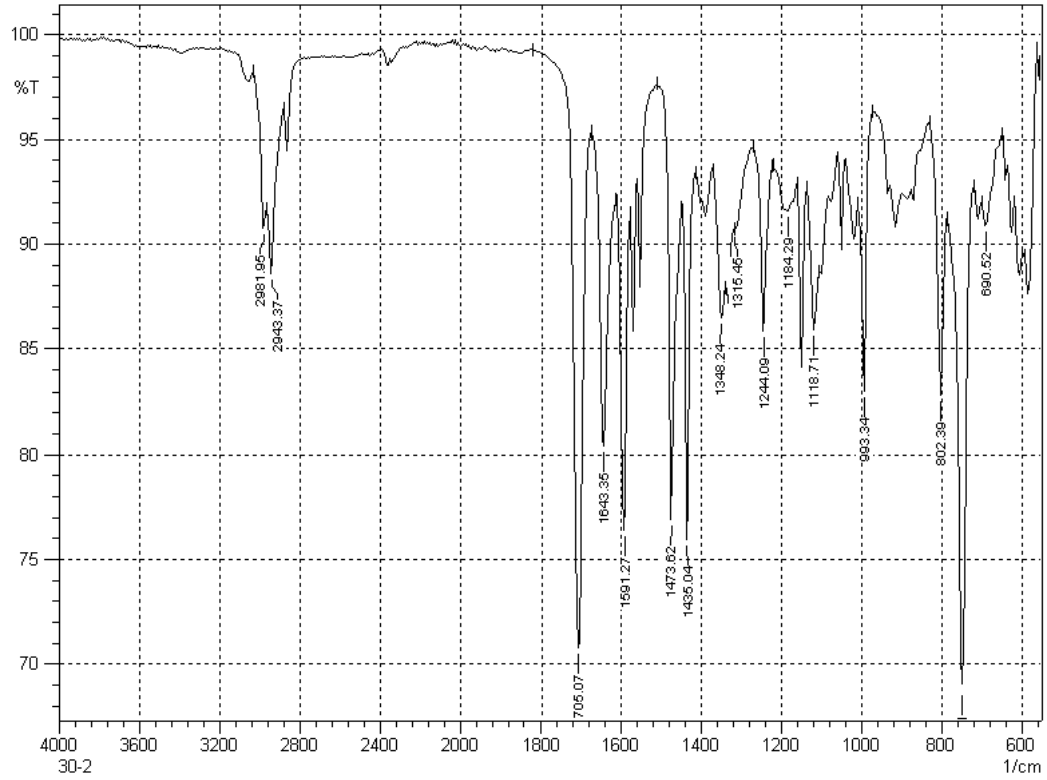
**$^{1}$H NMR:**



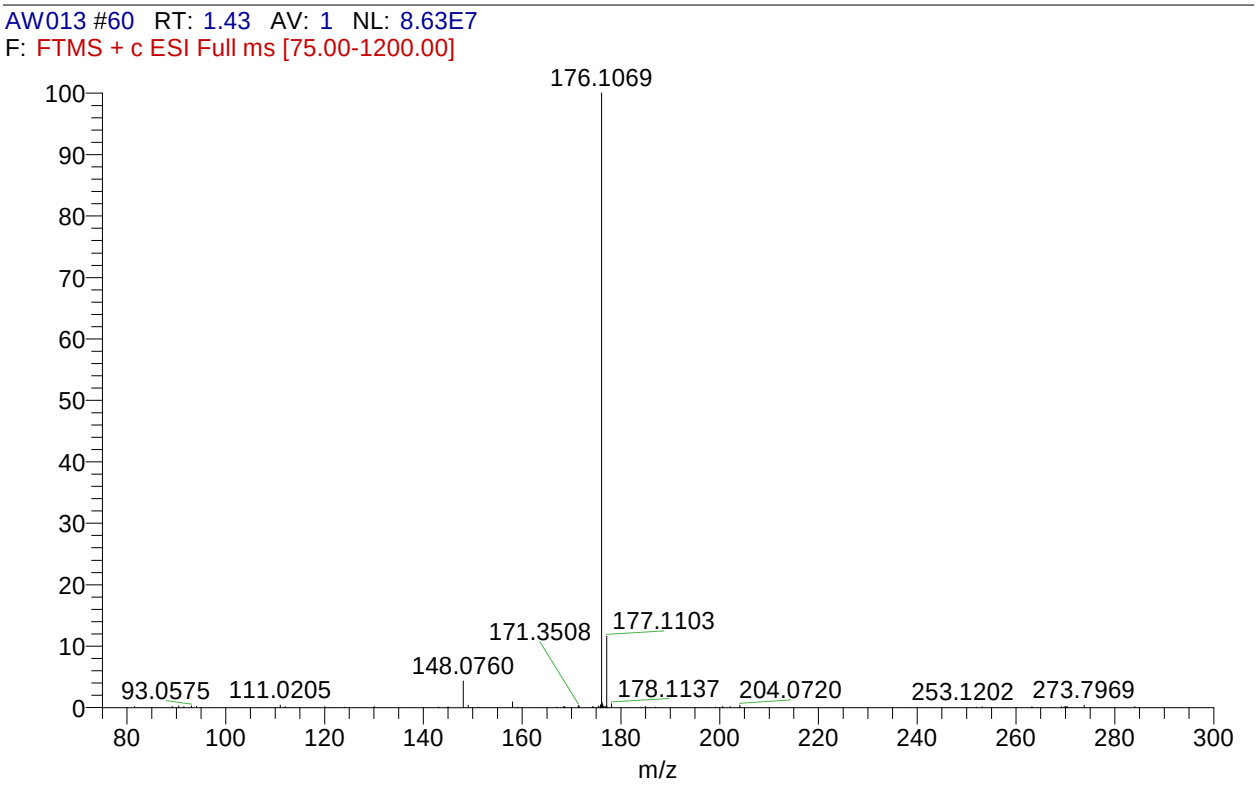

**$^{13}$C NMR:**



**FTIR:**

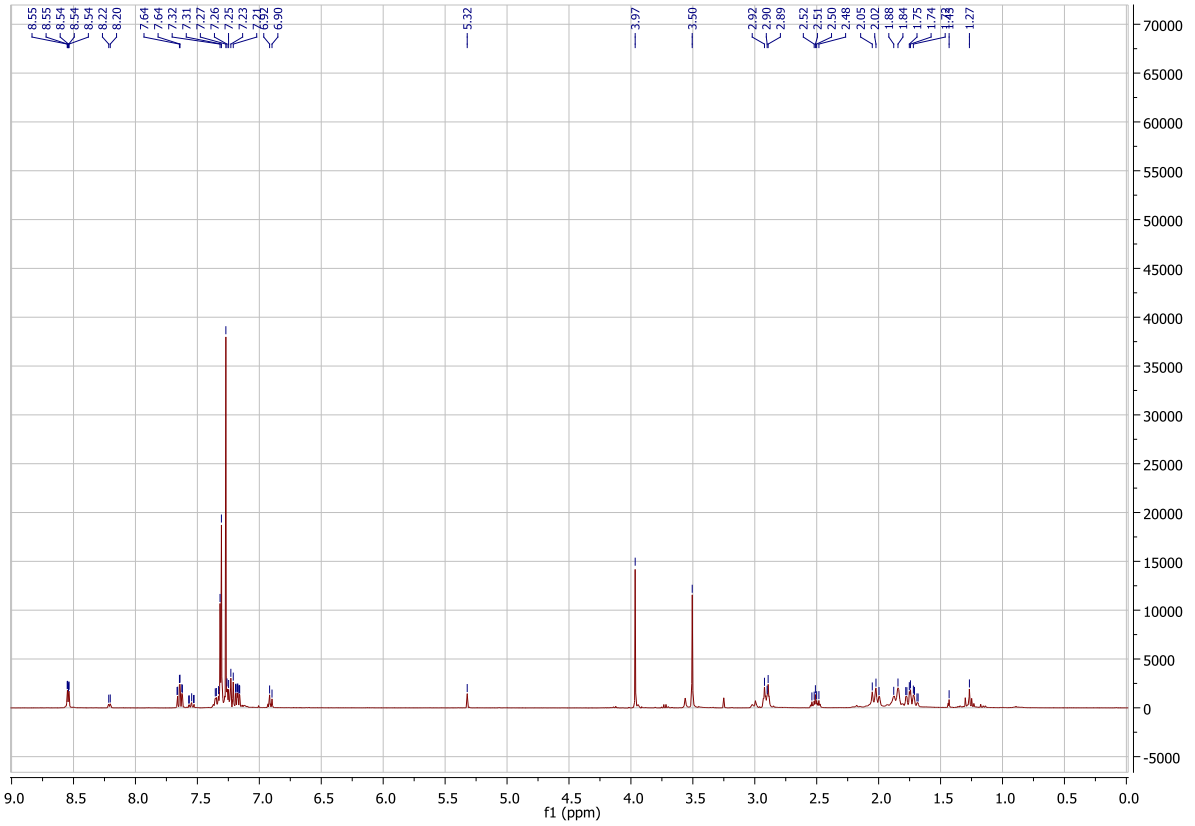



**HRMS:**

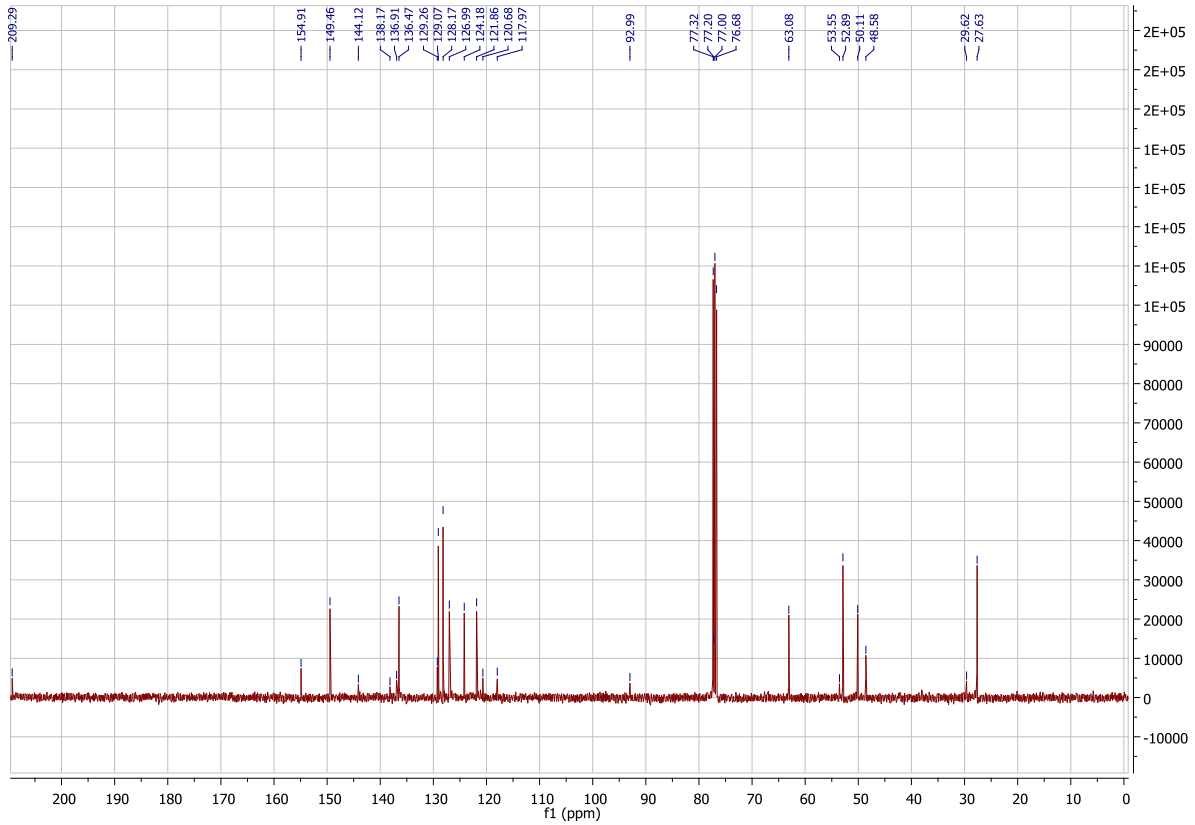


**Compound 1e: 1-(1-Benzylpiperidin-4-yl)-2-(pyridin-2-yl)ethanone**

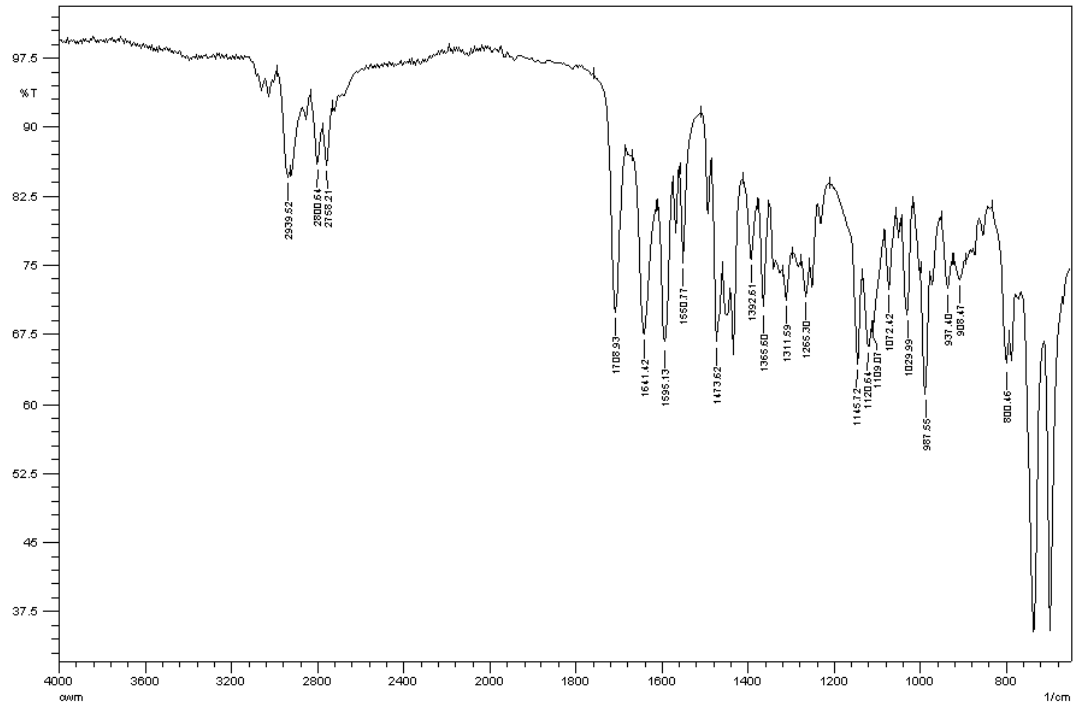
**$^{1}$H NMR:**



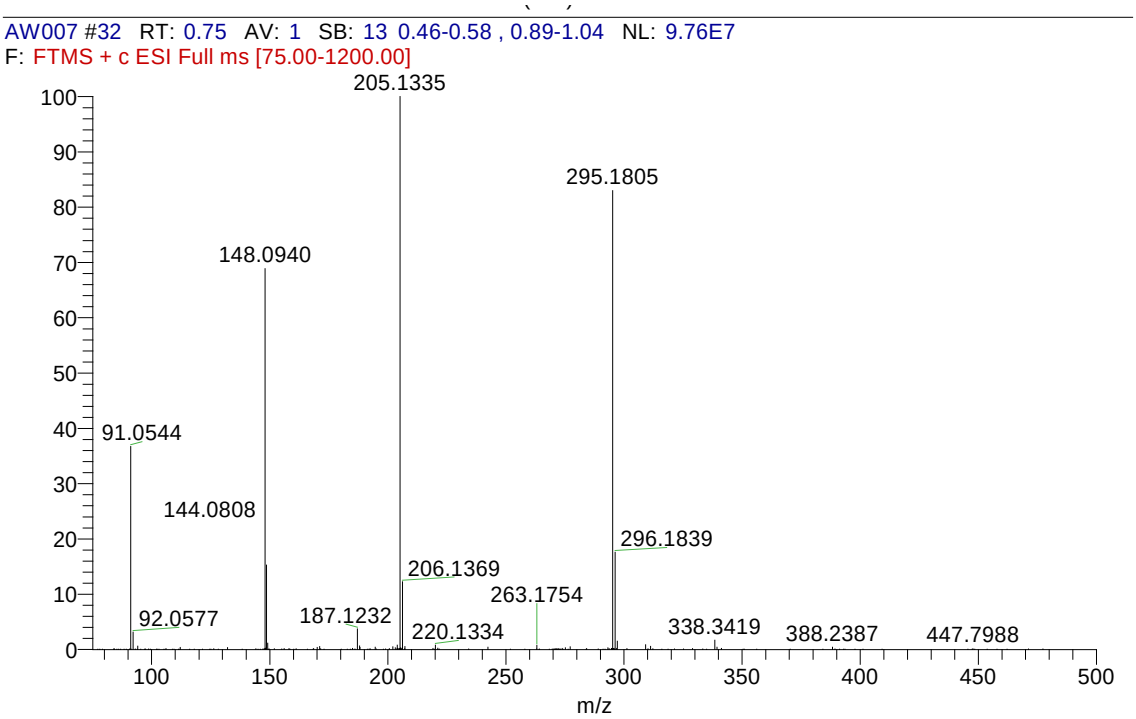

**$^{13}$C NMR:**



**FTIR:**

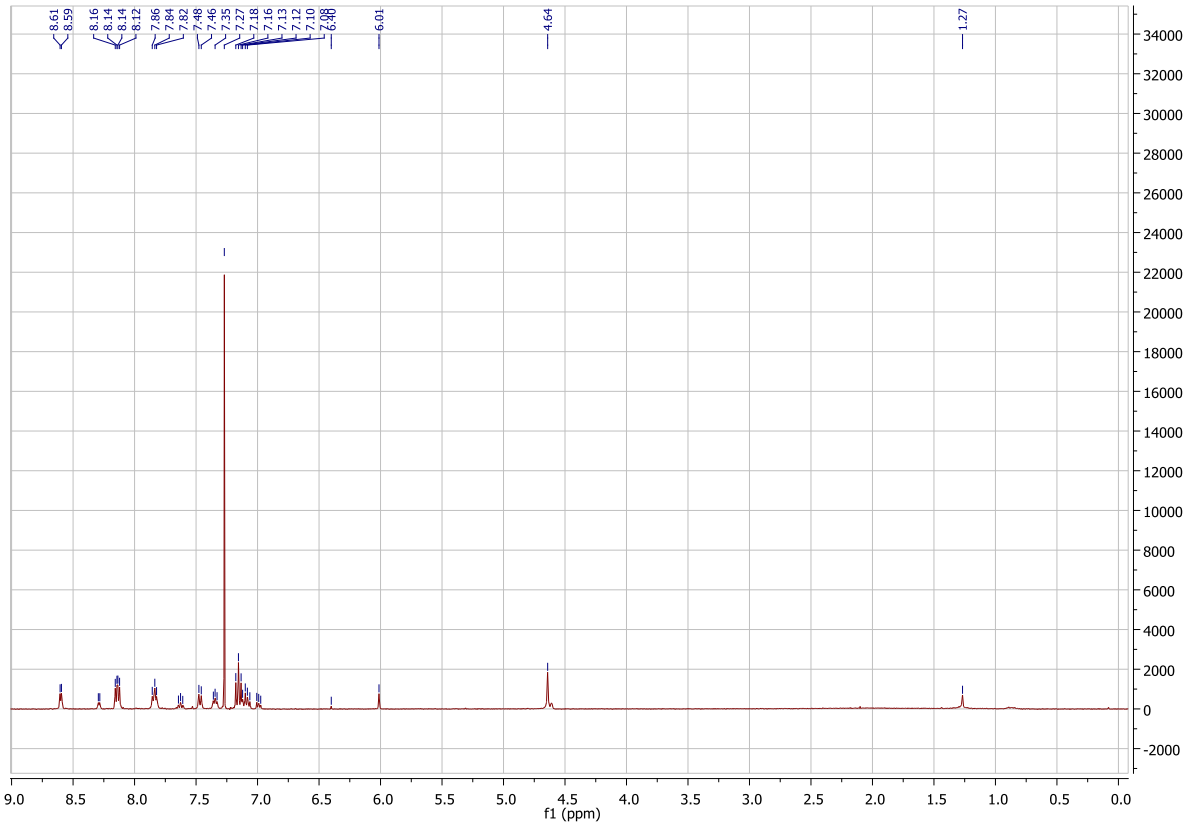



**HRMS:**

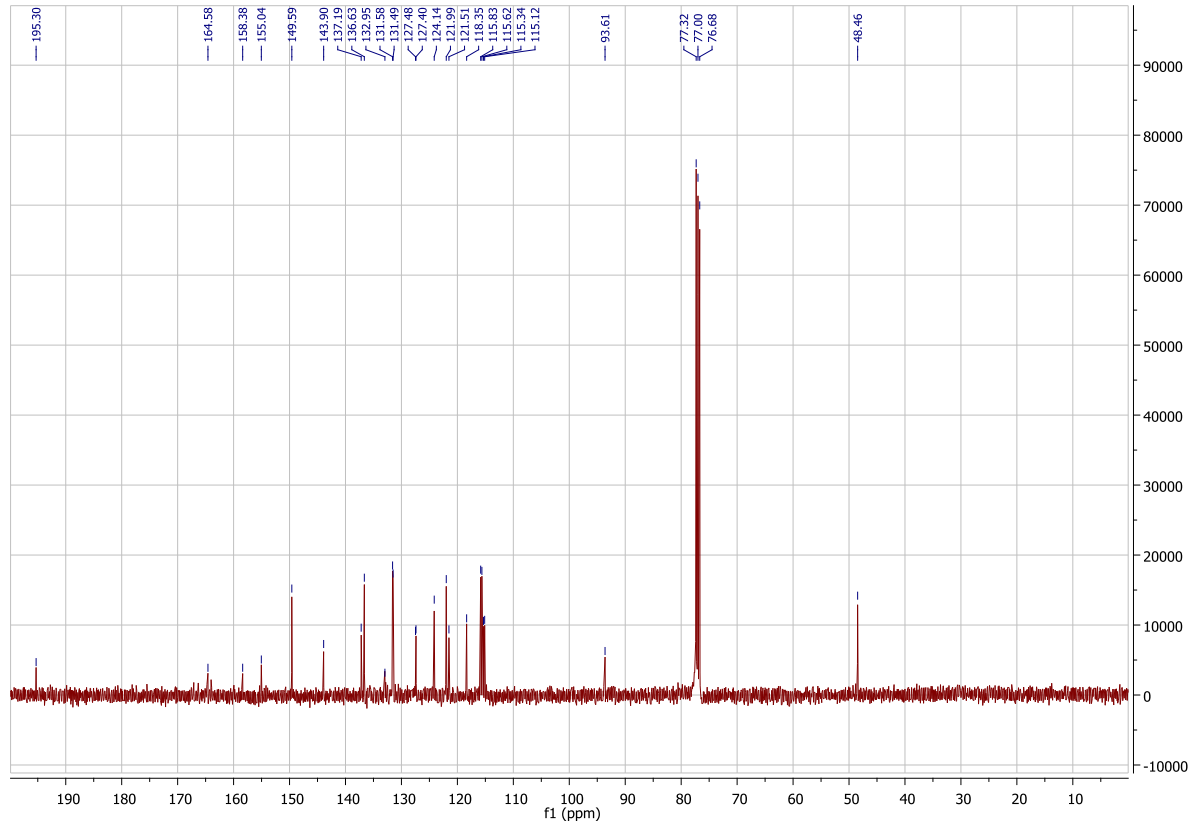


**Compound 1f: 1-(4-Fluorophenyl)-2-(pyridin-2-yl)ethanone**

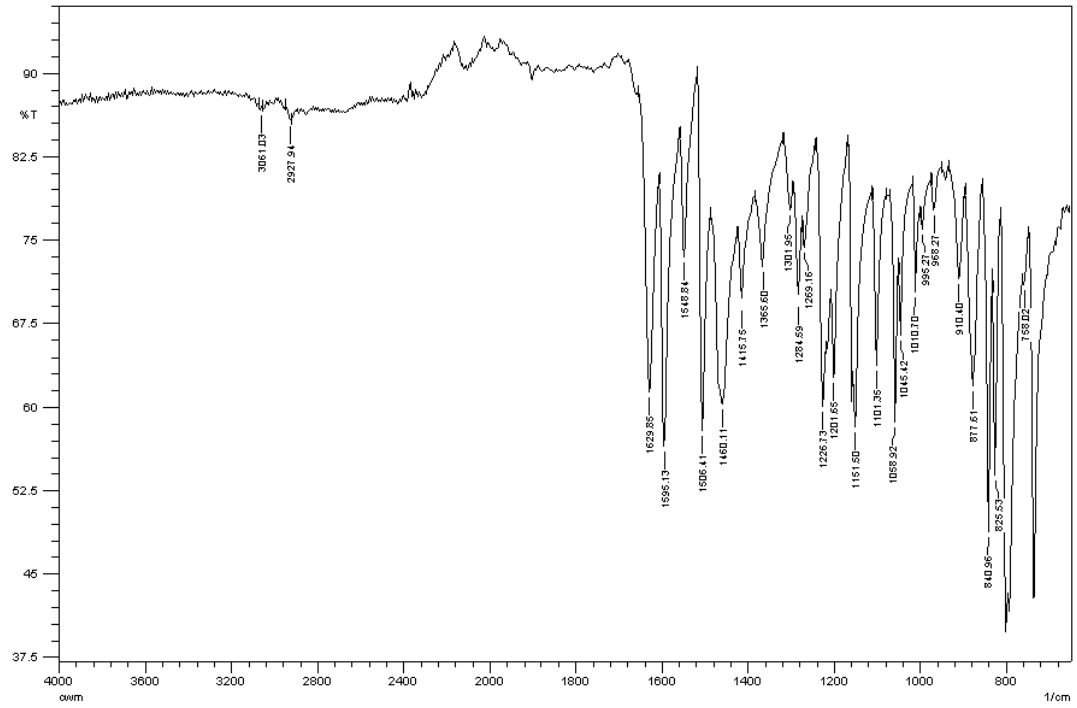
**$^{1}$H NMR:**



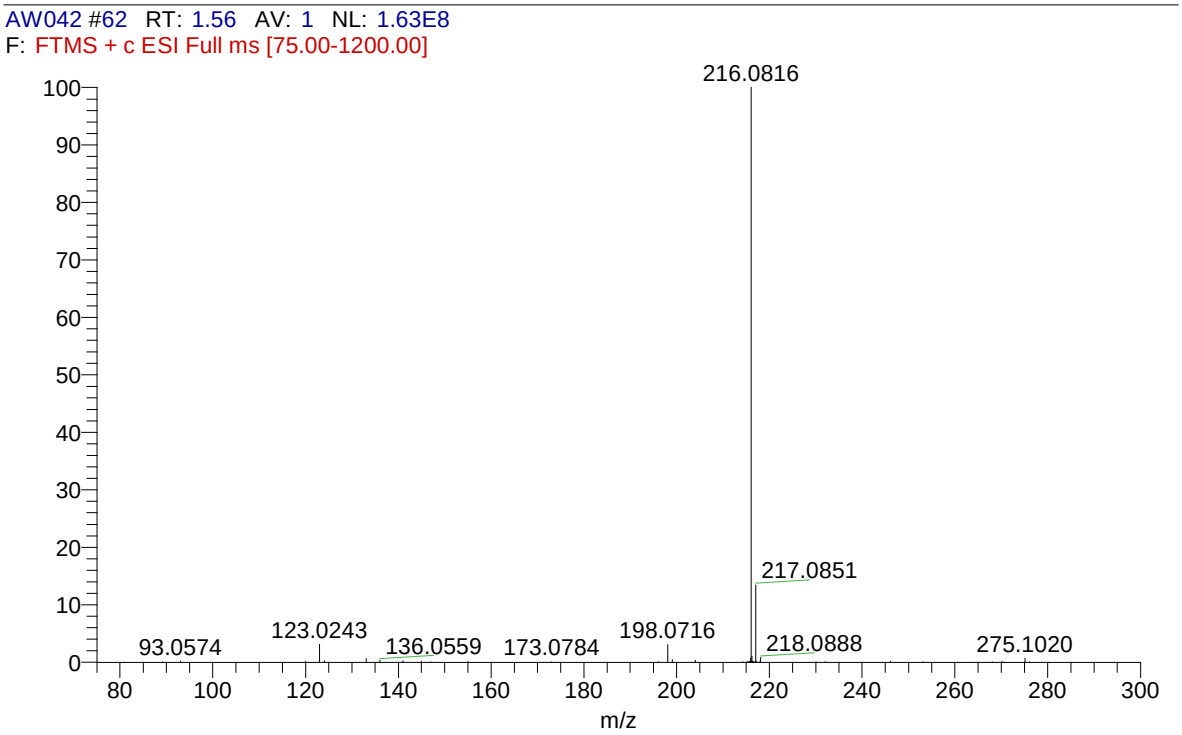

**$^{13}$C NMR:**



**FTIR:**

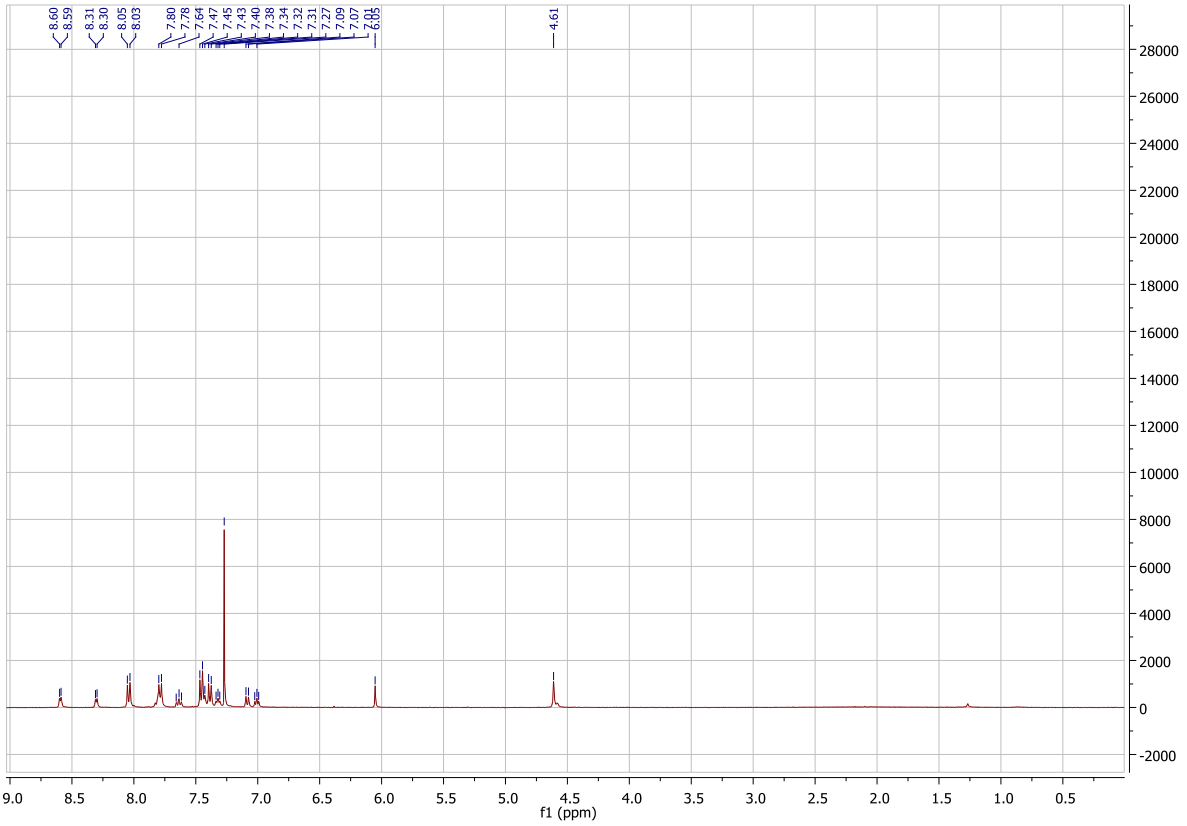

%T
90
82.5
75
67.5
60
52.5
45
37.5
4000
3600
3200
2800
2400
2000
1800
1600
1400
1200
1000
800
cm
1/cm
3061.03
2927.94
1629.85
1595.13
1548.84
1506.41
1460.11
1416.75
1365.60
1301.95
1269.16
1284.59
1226.73
1201.65
1151.80
1101.35
1045.42
1010.70
996.21
965.27
910.40
877.61
840.96
825.53
758.02

**HRMS:**

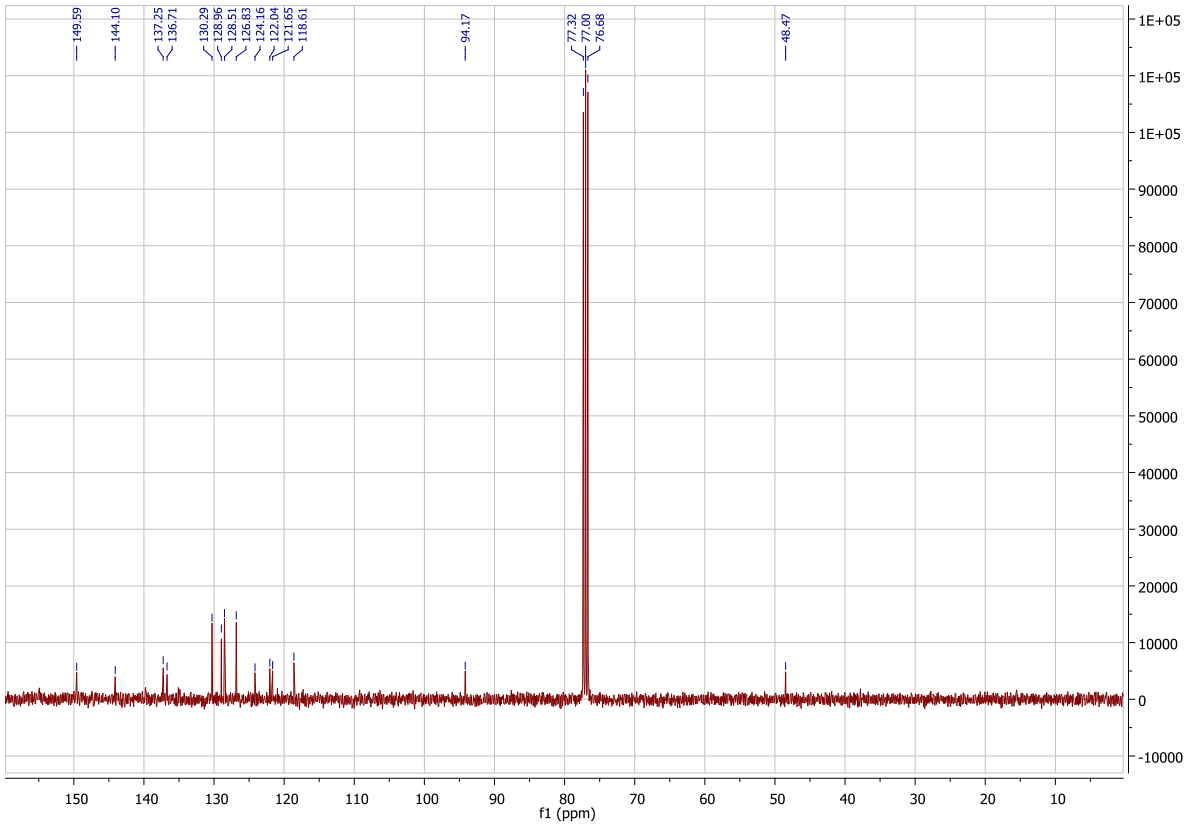

AW042 #62 RT: 1.56 AV: 1 NL: 1.63E8
F: FTMS + c ESI Full ms [75.00-1200.00]
100
90
80
70
60
50
40
30
20
10
0
80
100
120
140
160
180
200
220
240
260
280
300
m/z
216.0816
217.0851
218.0888
93.0574
123.0243
136.0559
173.0784
198.0716
275.1020

## Compound 1g: 1-(4-Chlorophenyl)-2-(pyridin-2-yl)ethanone

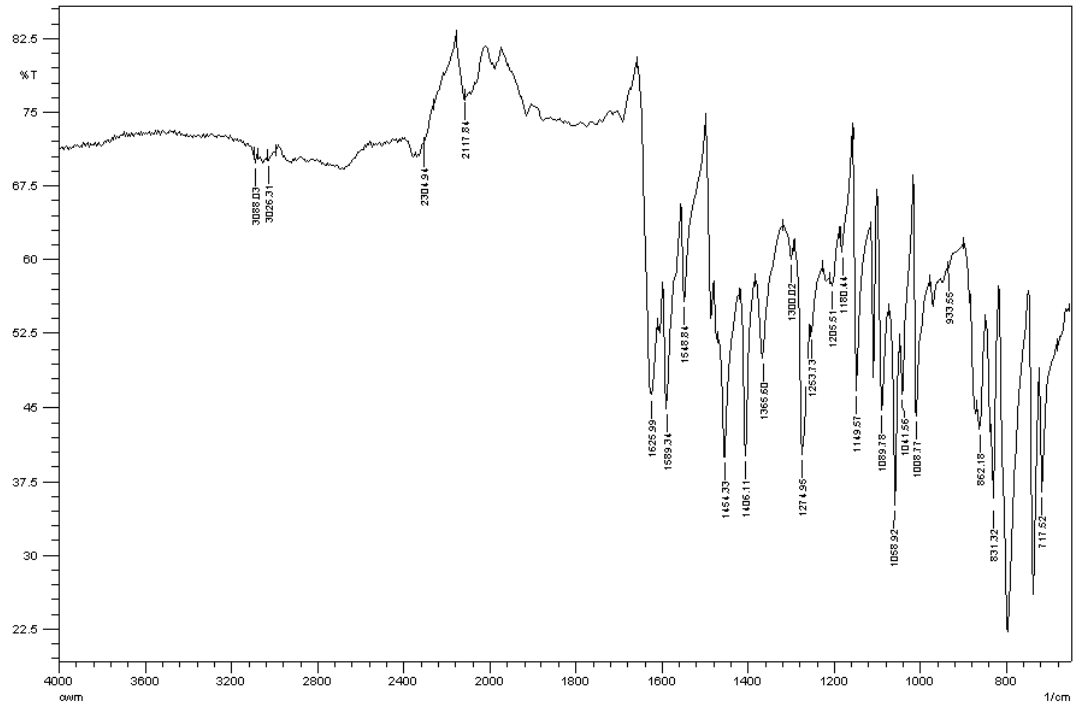
**$^{1}$H NMR:**



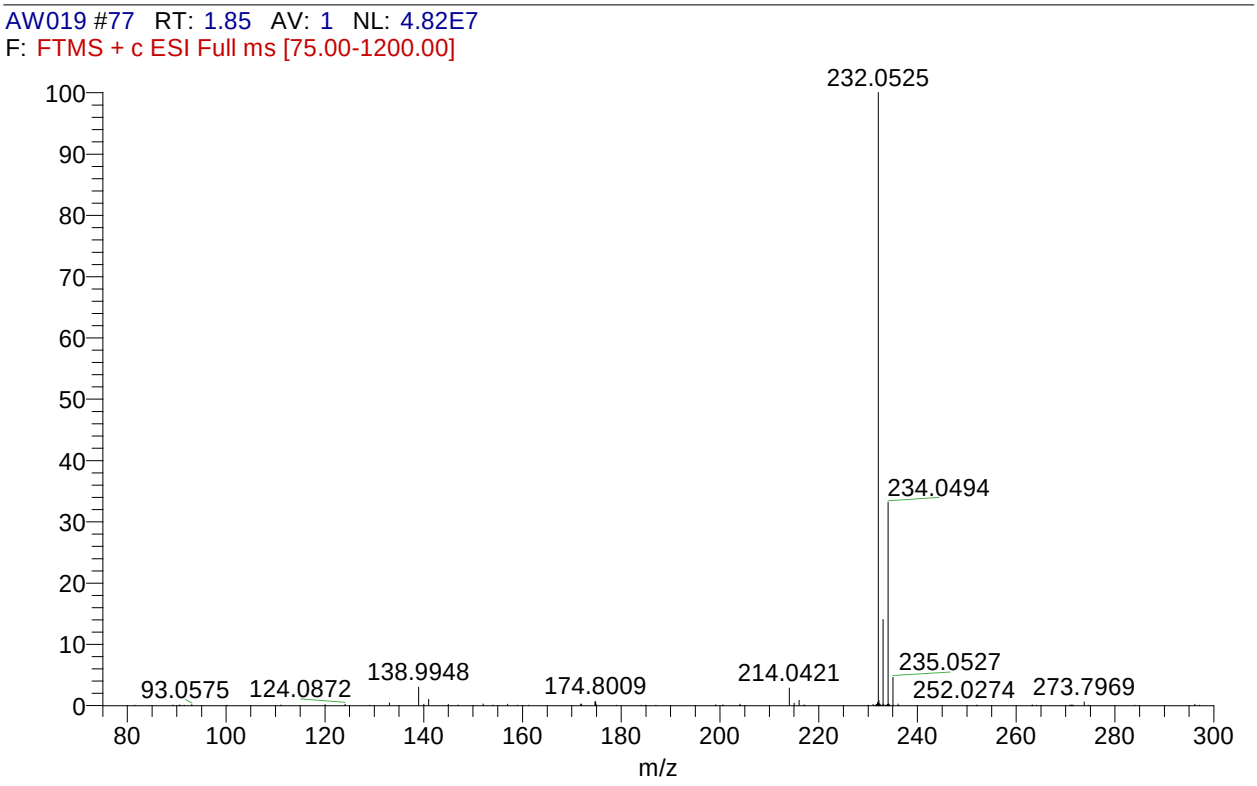

**$^{13}$C NMR:**



**FTIR:**

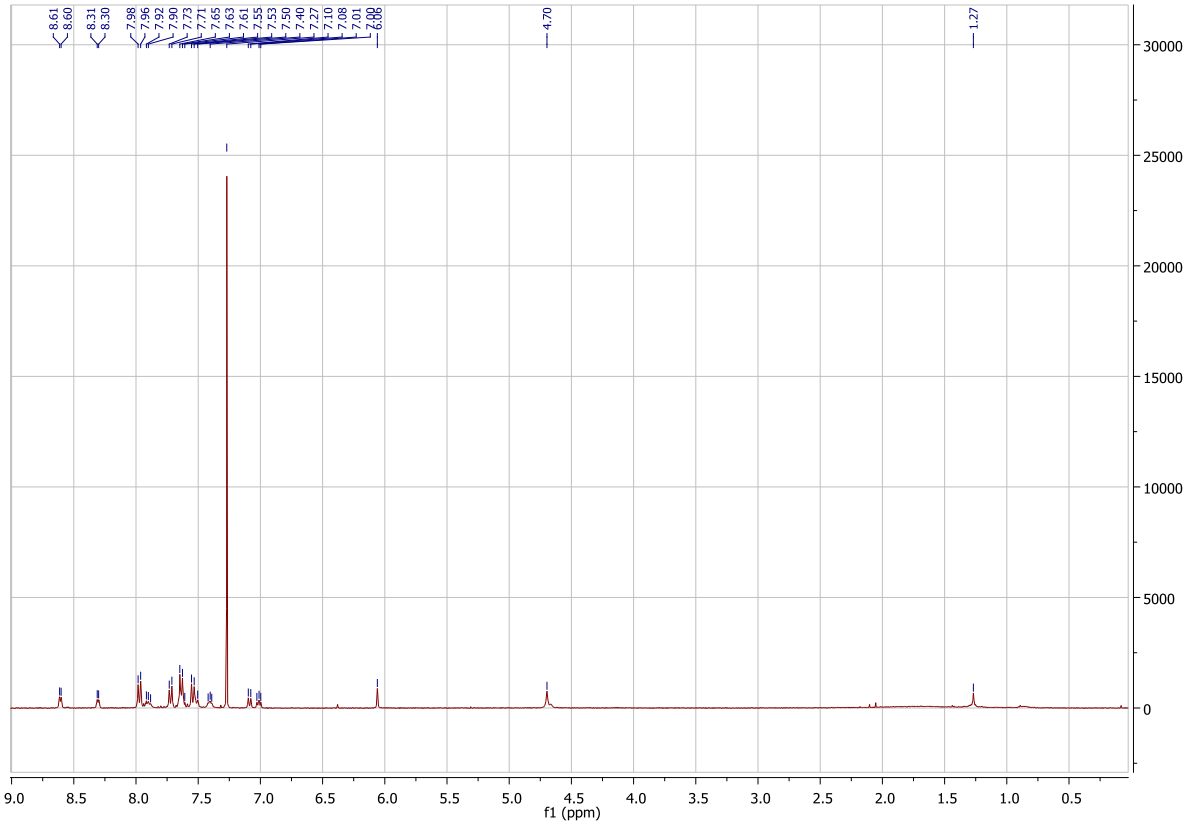



**HRMS:**

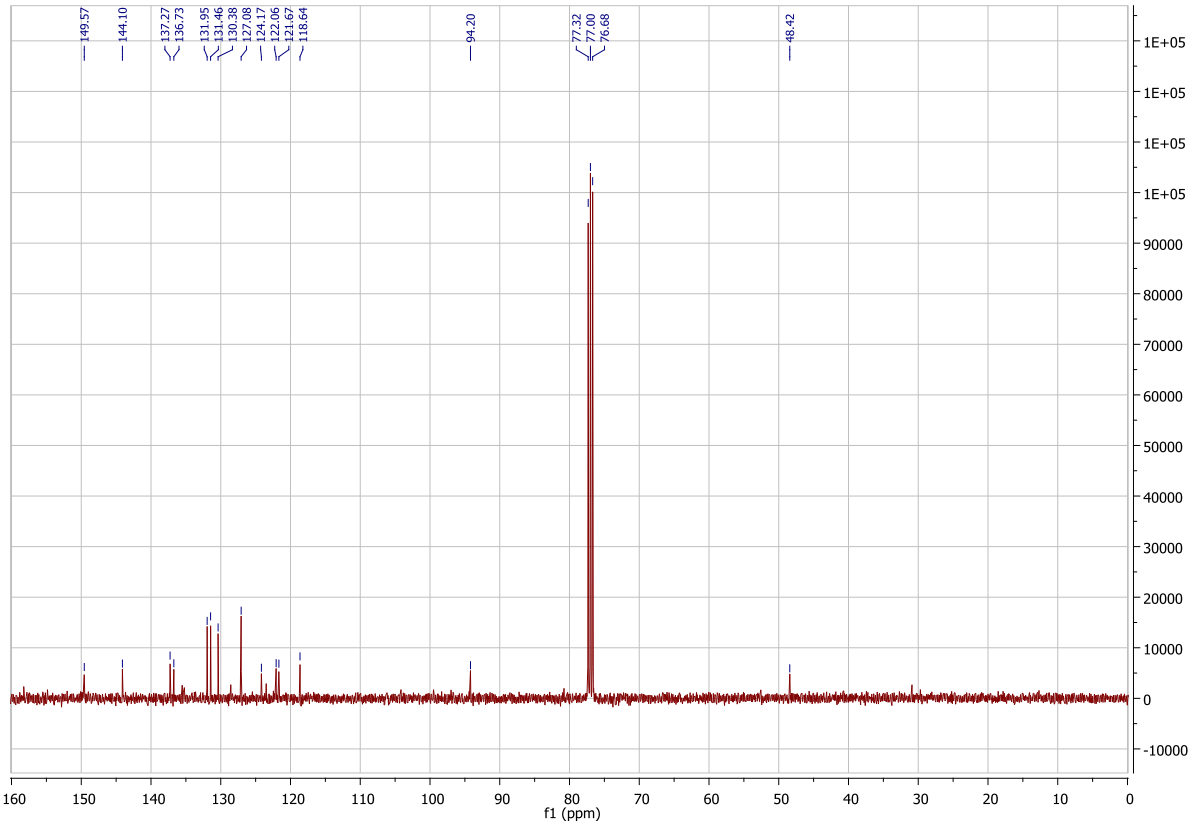


**Compound 1h: 1-(4-Bromophenyl)-2-(pyridin-2-yl)ethanone**

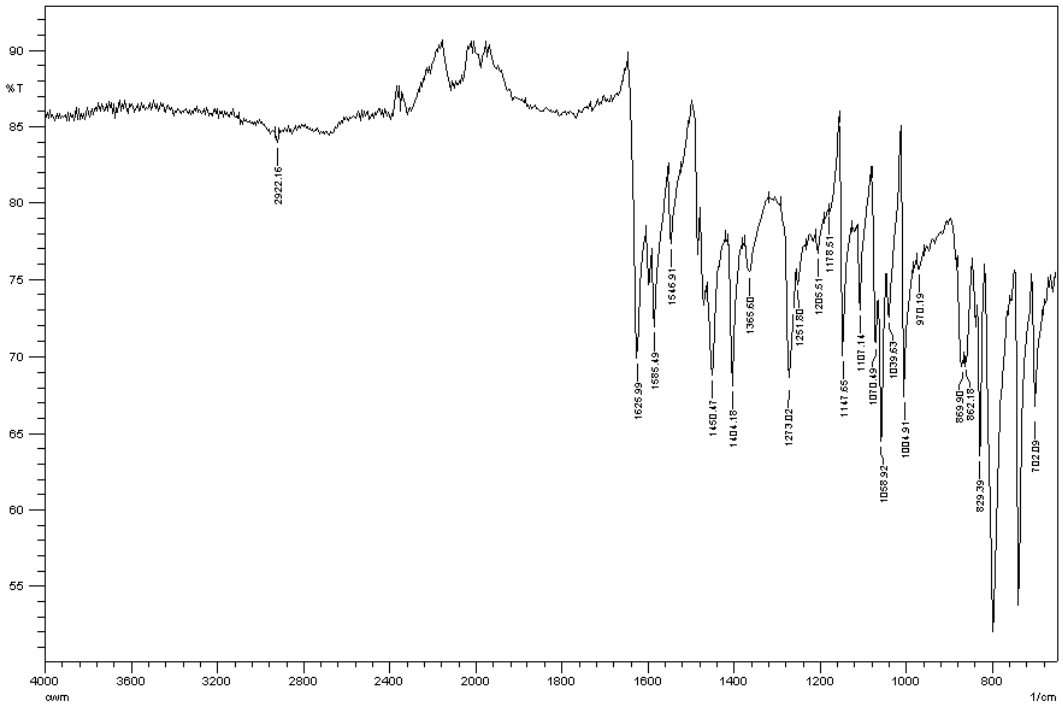
**$^{1}$H NMR:**



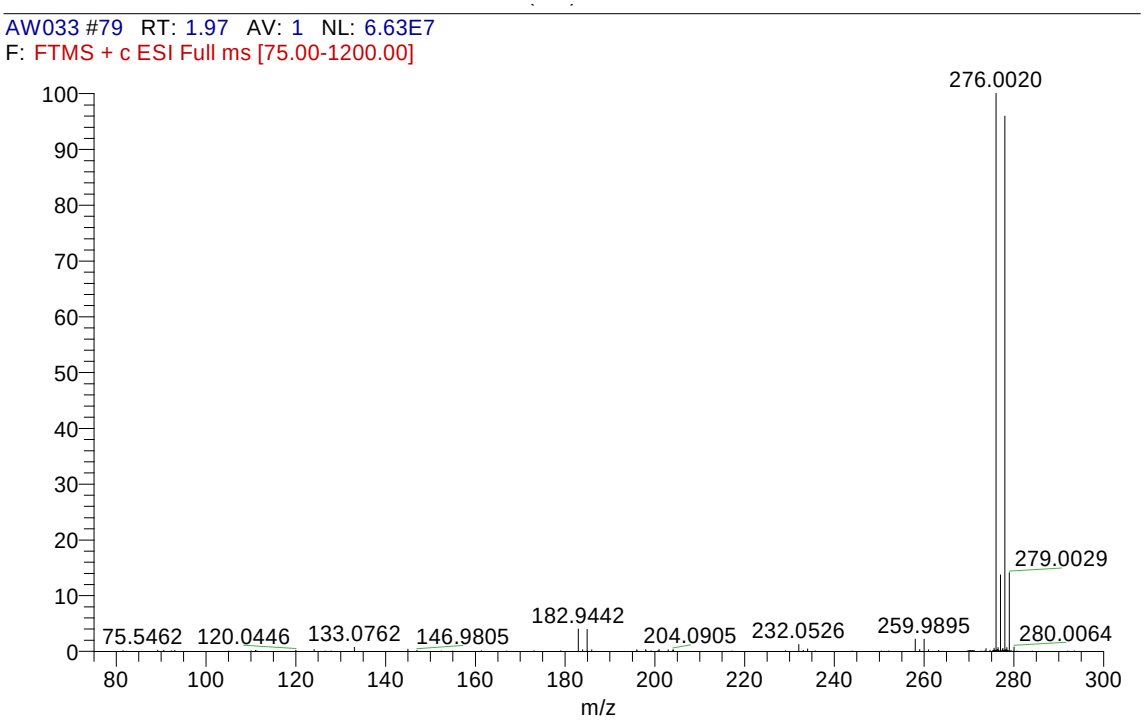

**$^{13}$C NMR:**



**FTIR:**

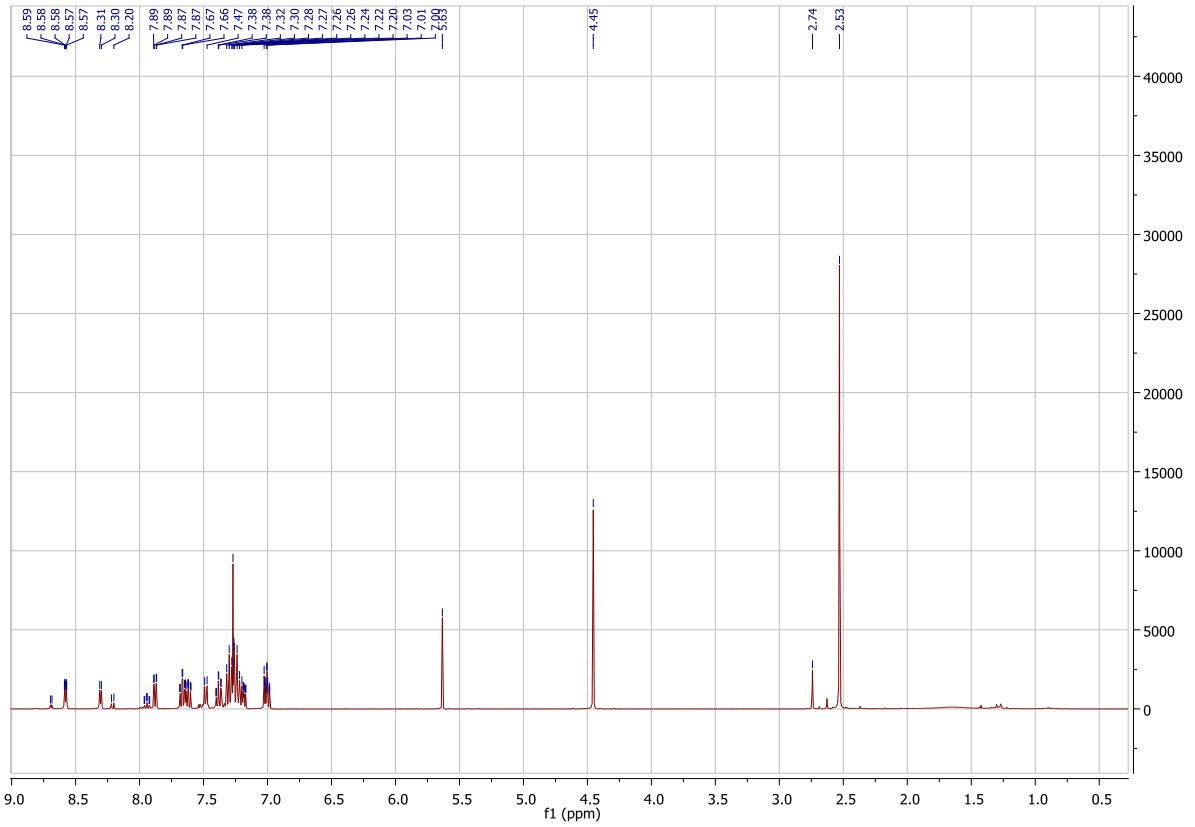



**HRMS:**

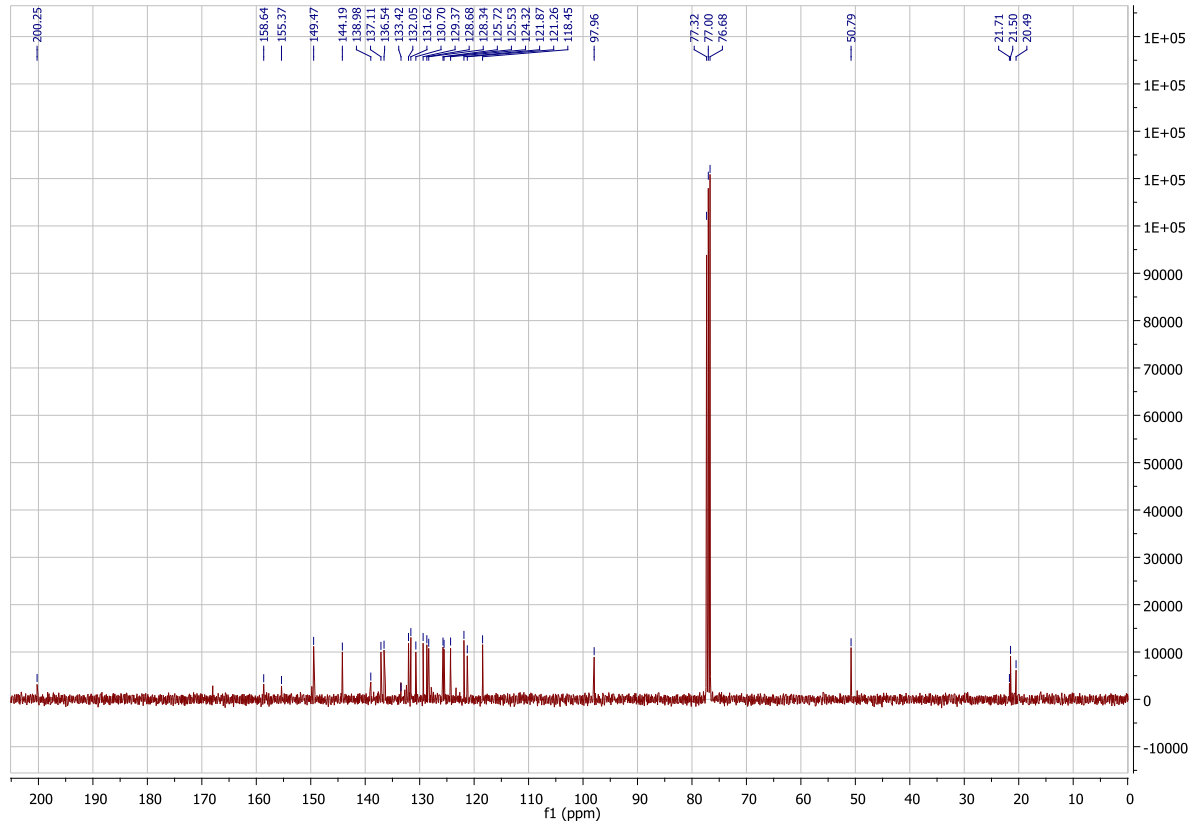


**Compound 1j: 2-(Pyridin-2-yl)-1-(*o*-tolyl)ethanone**

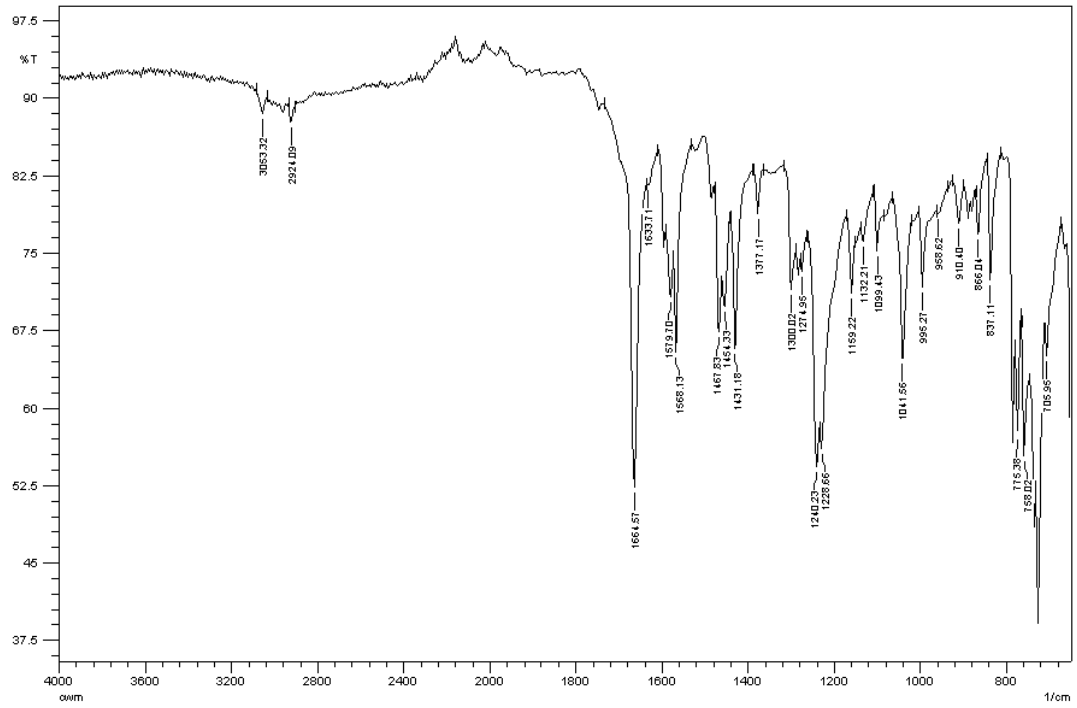
**$^{1}$H NMR:**



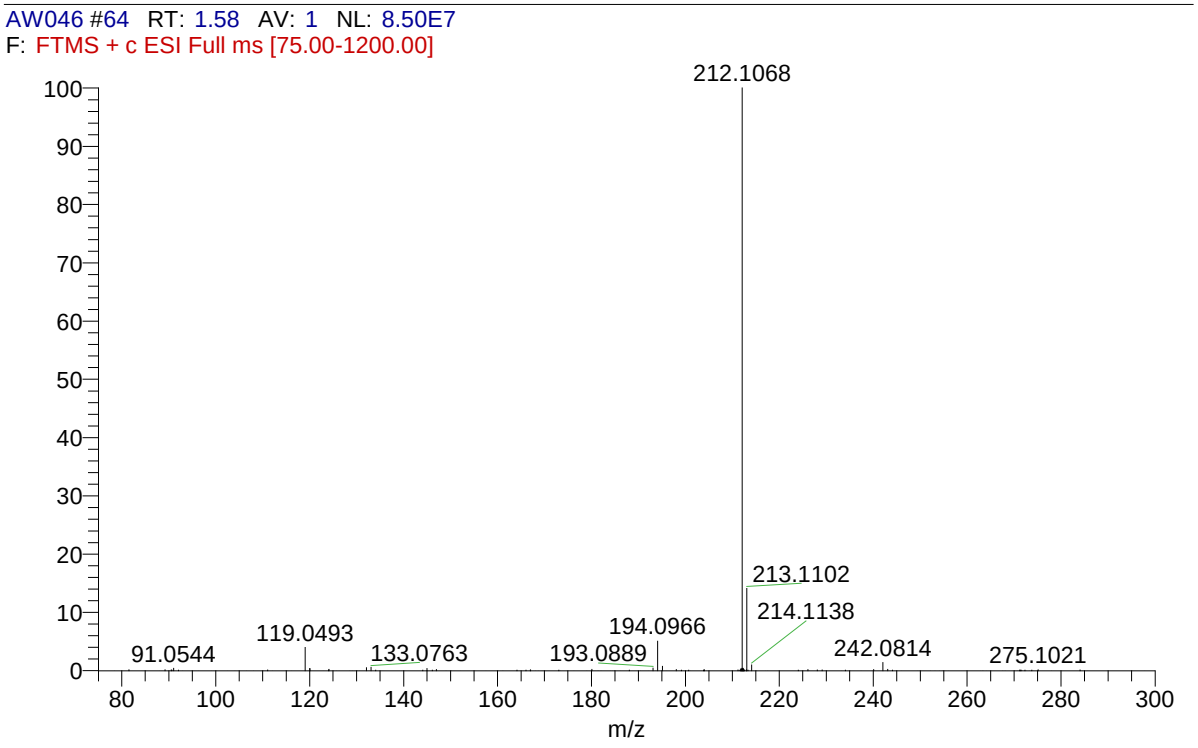

**$^{13}$C NMR:**



**FTIR:**

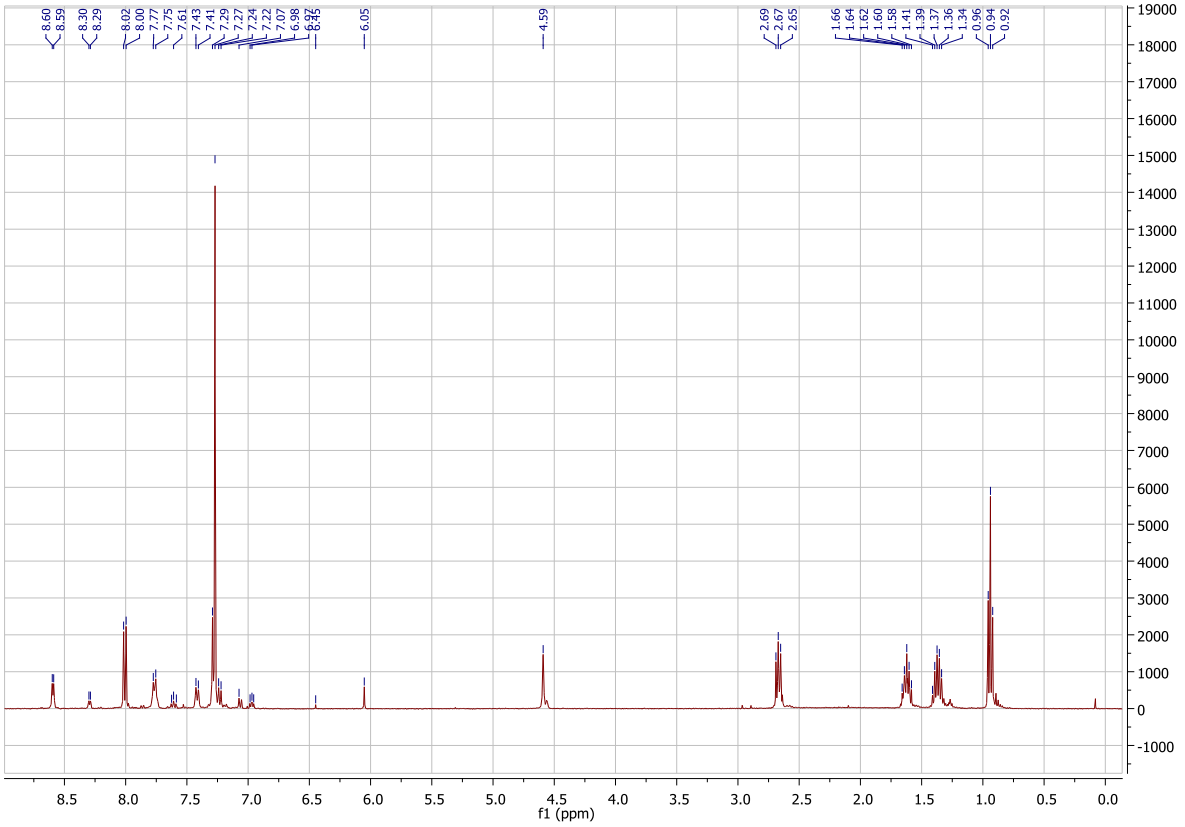



**HRMS:**

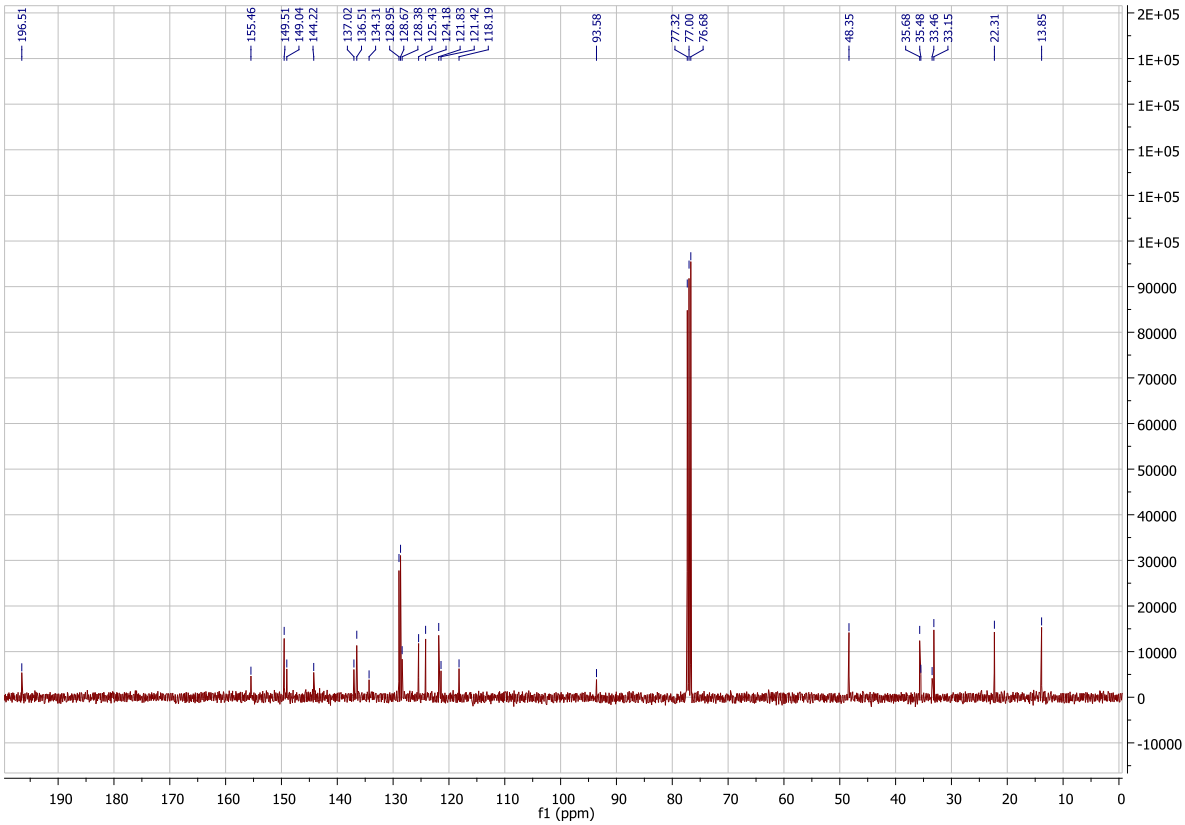


**Compound 1k: 1-(4-(*n*-Butyl)phenyl)-2-(pyridin-2-yl)ethanone**

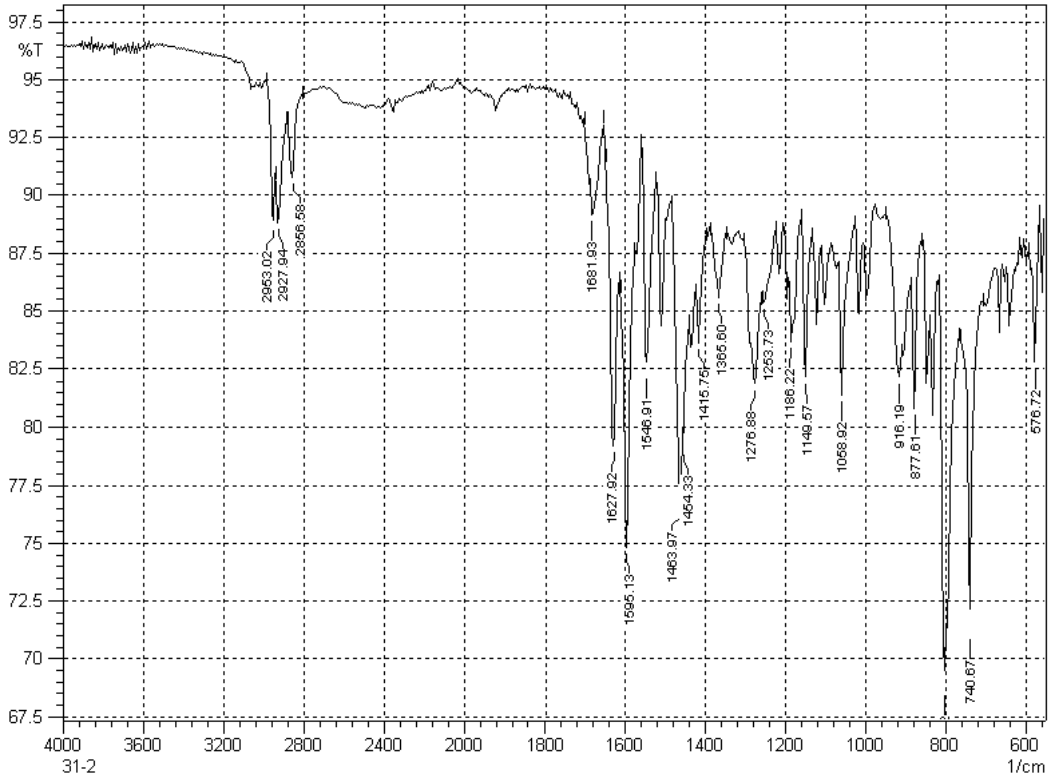
**$^{1}$H NMR:**



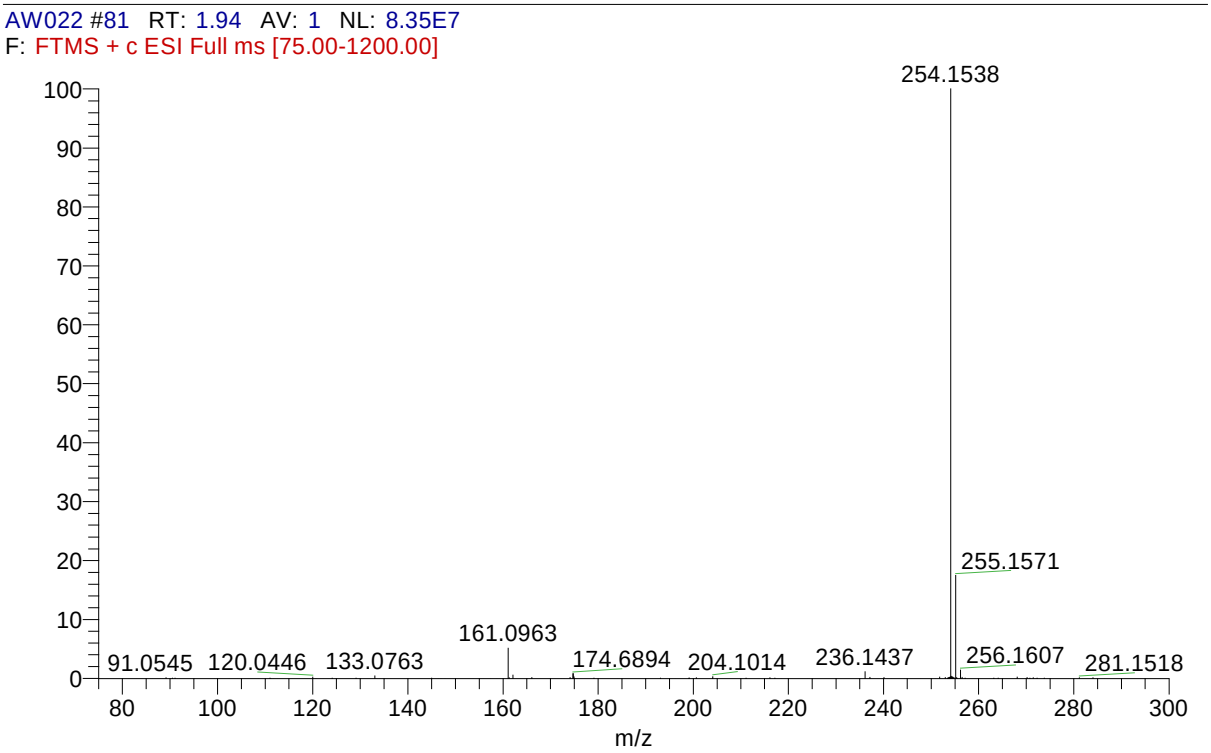

**$^{13}$C NMR:**



**FTIR:**

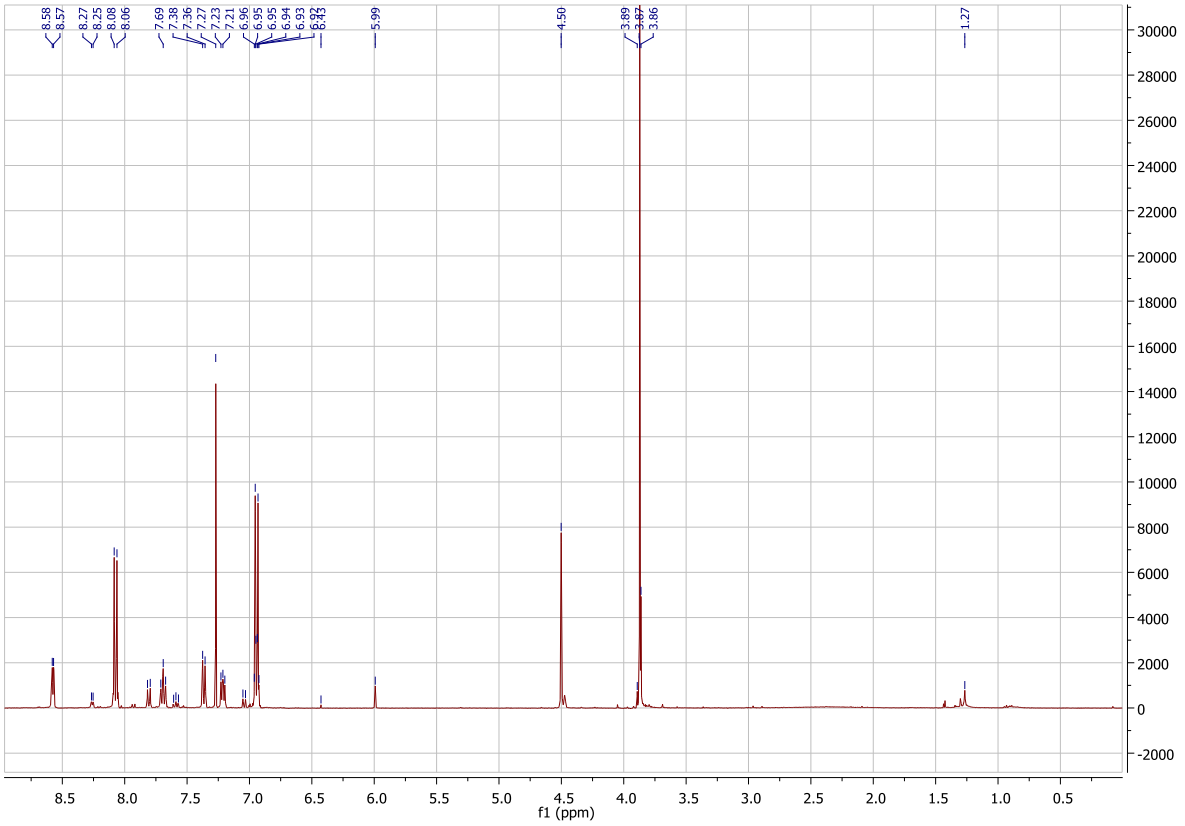



**HRMS:**

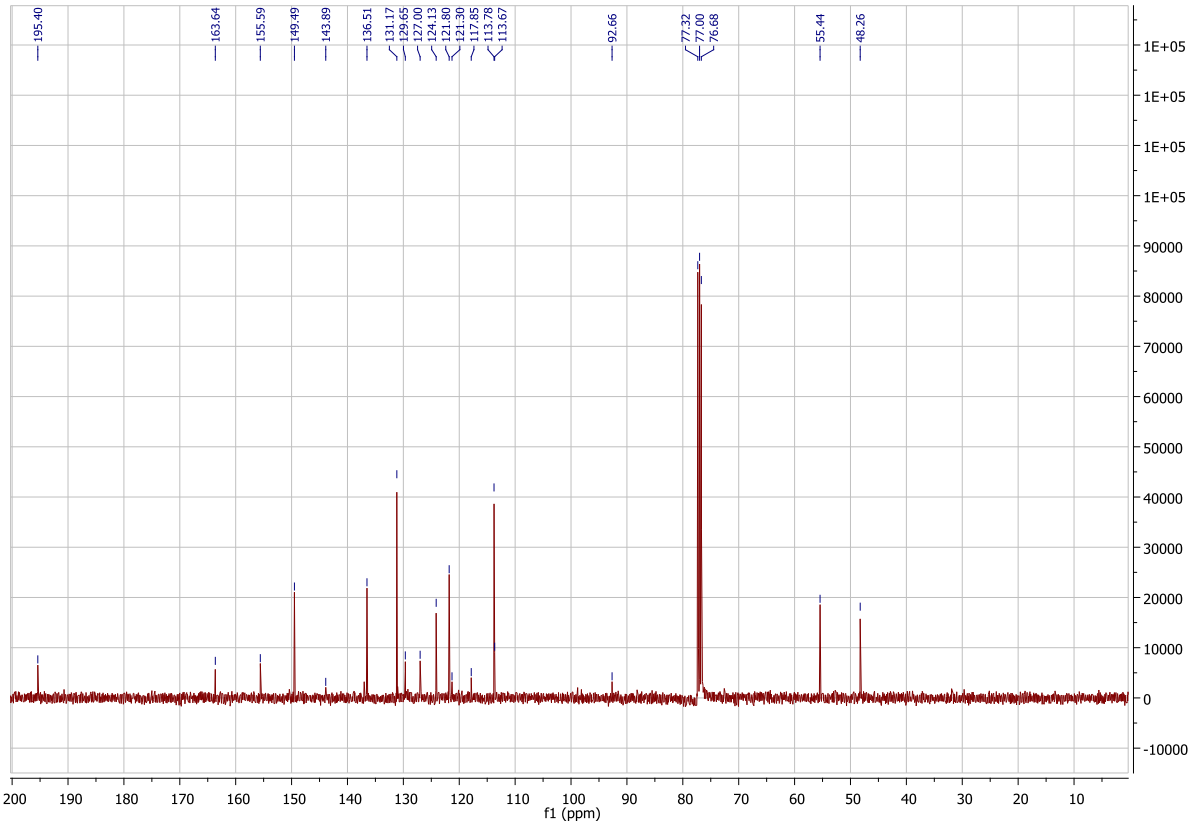


**Compound 1l: 1-(4-Methoxyphenyl)-2-(pyridin-2-yl)ethanone**

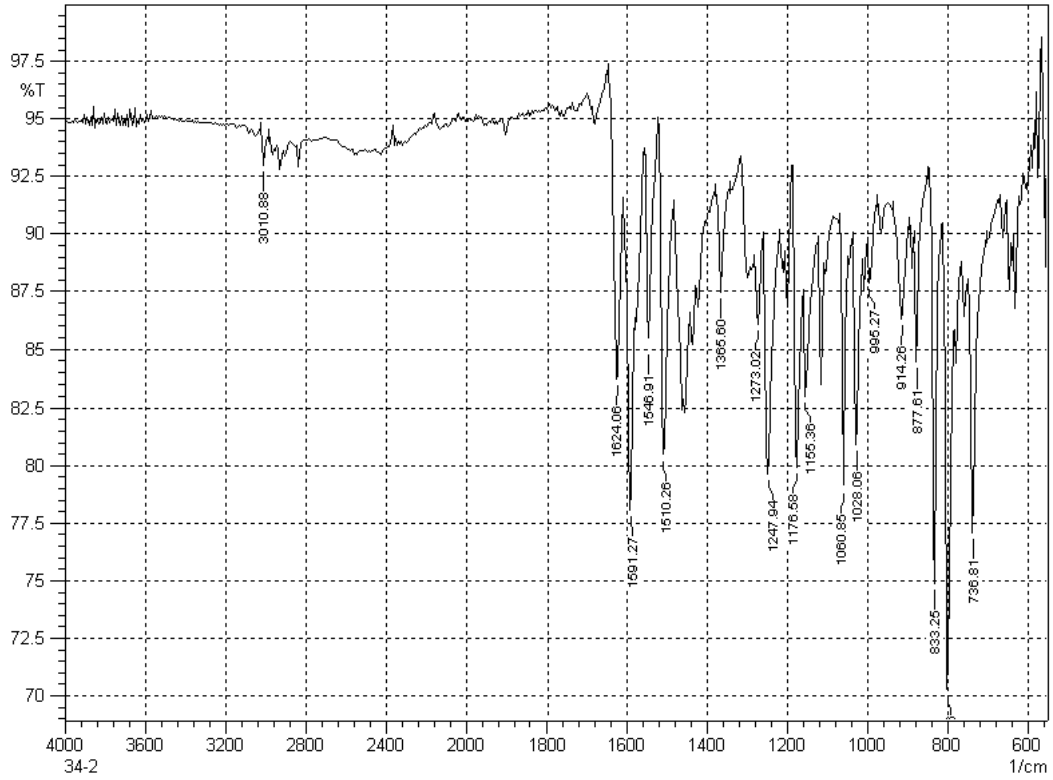
**$^{1}$H NMR:**



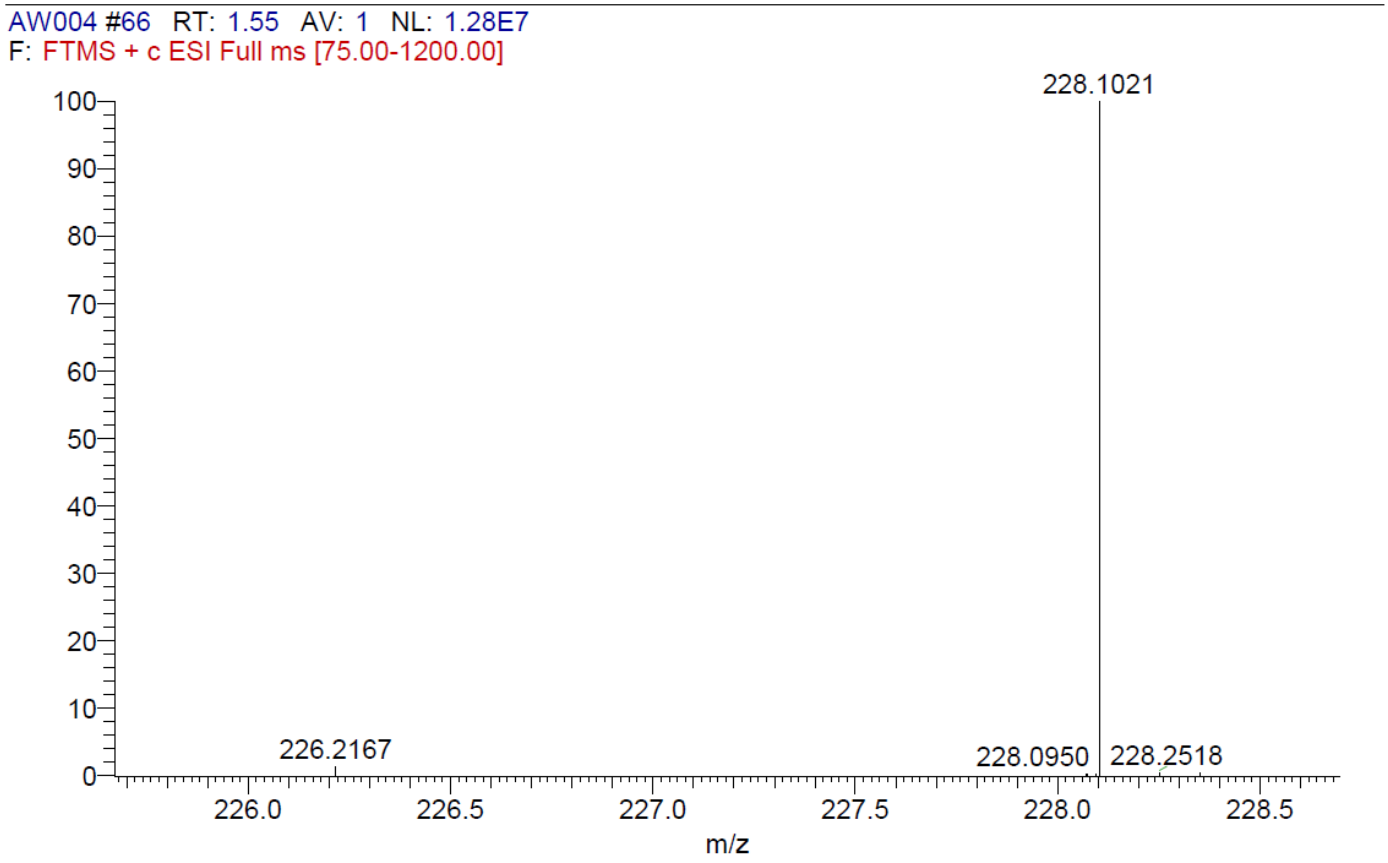

**$^{13}$C NMR:**



**FTIR:**

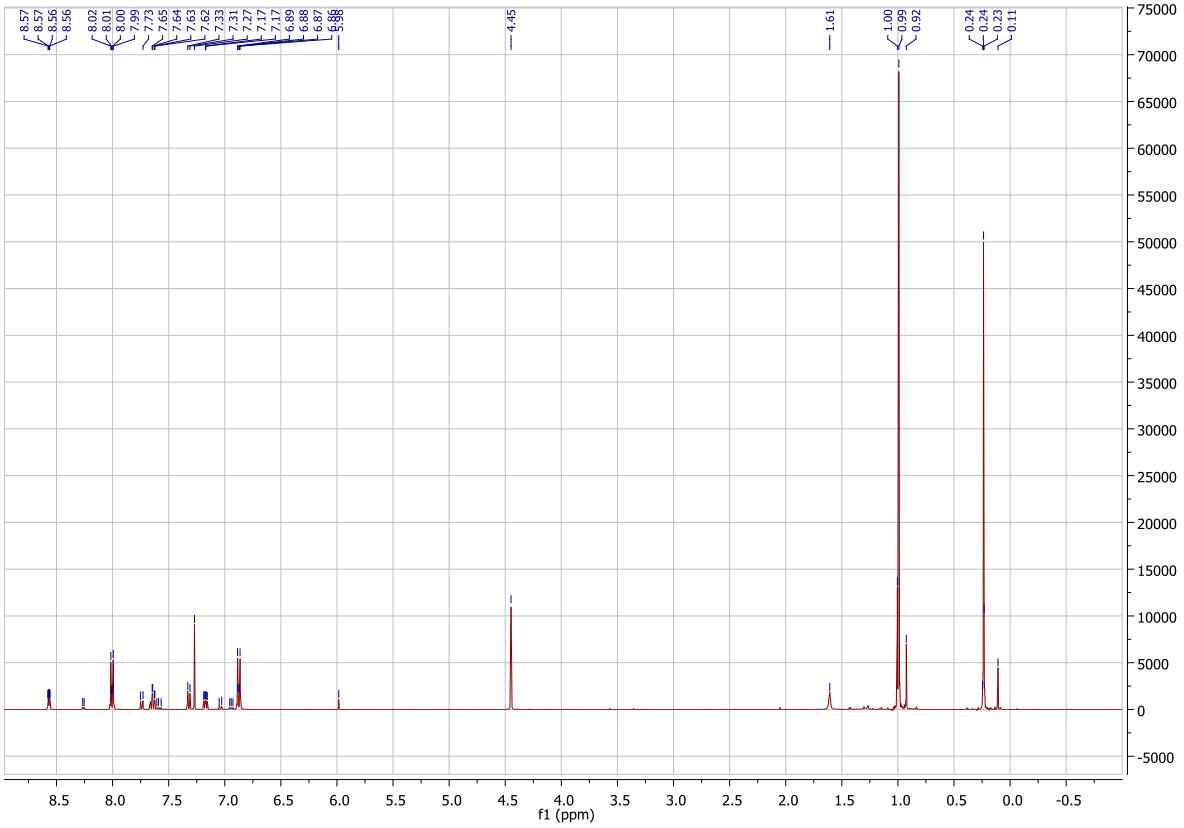

97.5
%T
95
92.5
90
87.5
85
82.5
80
77.5
75
72.5
70
3010.88
1624.06
1591.27
1546.81
1510.26
1365.60
1273.02
1247.94
1176.58
1155.36
1060.85
1028.06
995.27
914.26
877.61
833.25
736.81
4000
3600
3200
2800
2400
2000
1800
1600
1400
1200
1000
800
600
34-2
1/cm

**HRMS:**

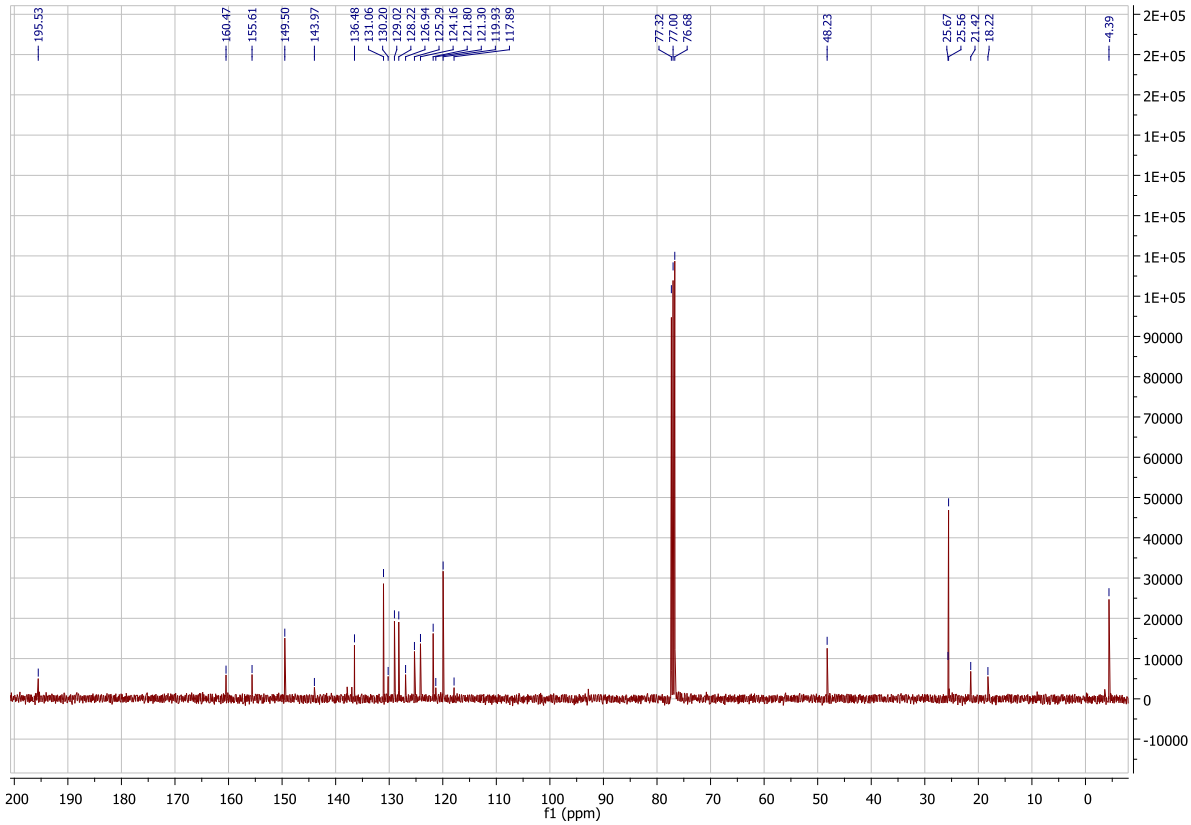

AW004 #66 RT: 1.55 AV: 1 NL: 1.28E7
F: FTMS + c ESI Full ms [75.00-1200.00]
228.1021
100
90
80
70
60
50
40
30
20
10
0
226.2167
228.0950
228.2518
226.0
226.5
227.0
227.5
228.0
228.5
m/z

**Compound 1m: 1-(4-((*tert*-Butyldimethylsilyl)oxy)phenyl)-2-(pyridin-2-yl)ethanone**

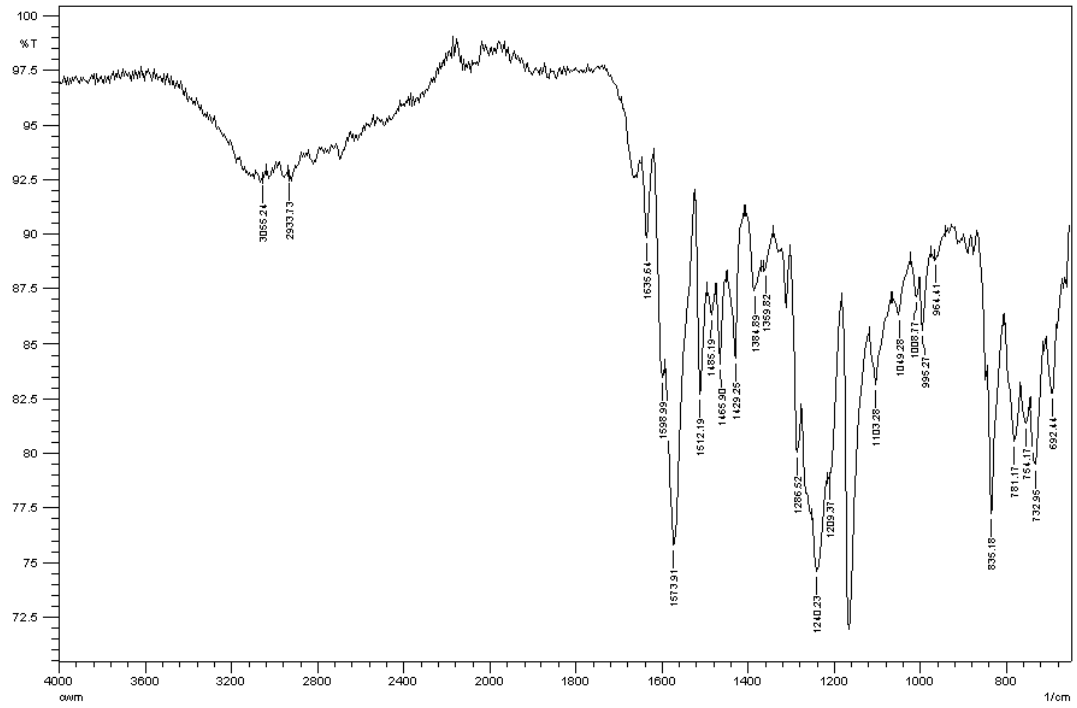
**$^{1}$H NMR:**



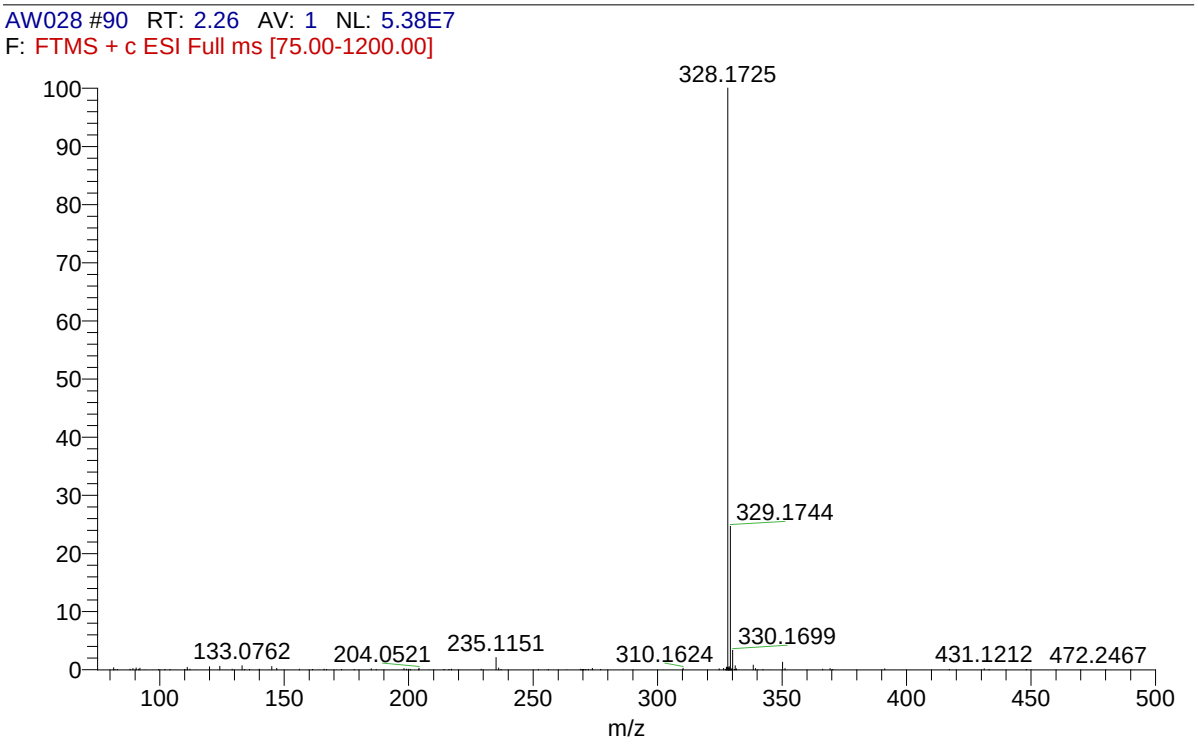

**$^{13}$C NMR:**



**FTIR:**

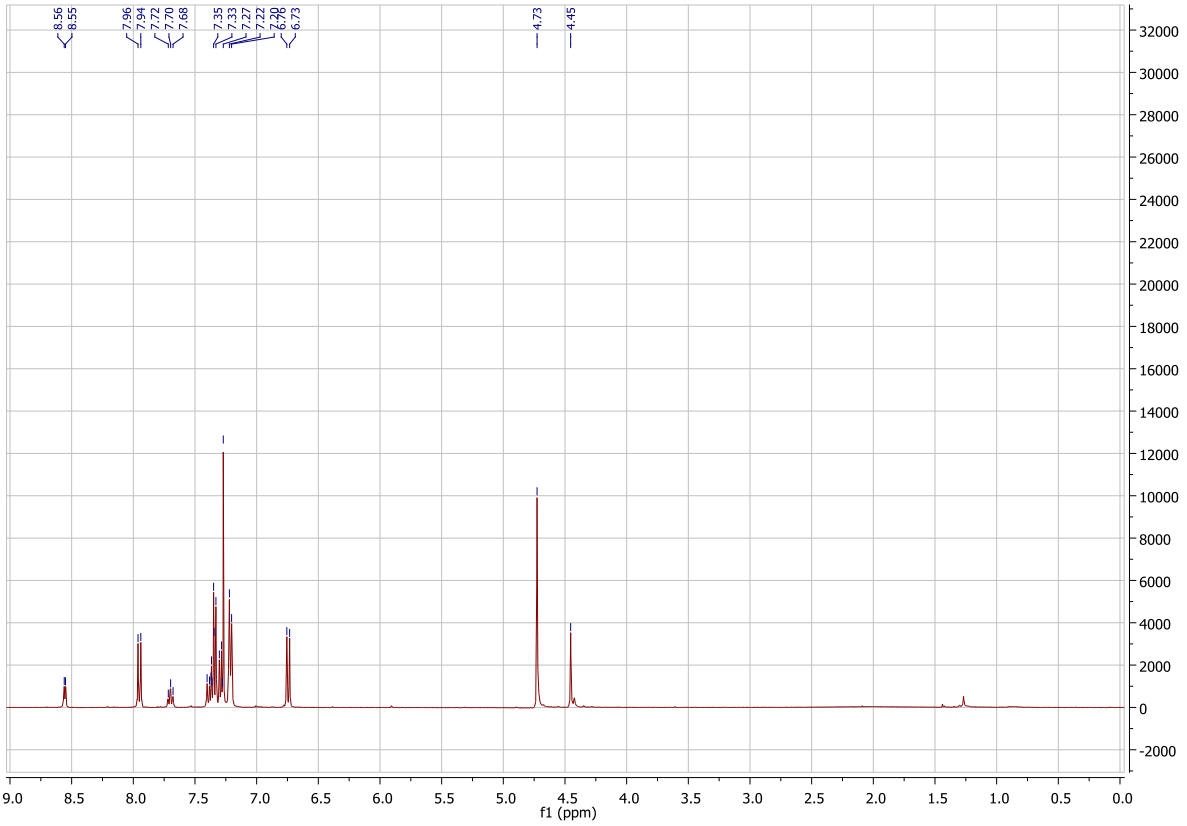

100
%T
97.5
95
92.5
90
87.5
85
82.5
80
77.5
75
72.5
3055.24
2933.13
1635.64
1598.99
1513.91
1512.19
1485.19
1465.90
1429.25
1384.89
1359.82
1286.52
1240.23
1209.37
1103.28
1049.28
1008.77
995.27
964.41
835.18
781.17
754.17
732.95
692.44
4000
3600
3200
2800
2400
2000
1800
1600
1400
1200
1000
800
cm
1/cm

**HRMS:**

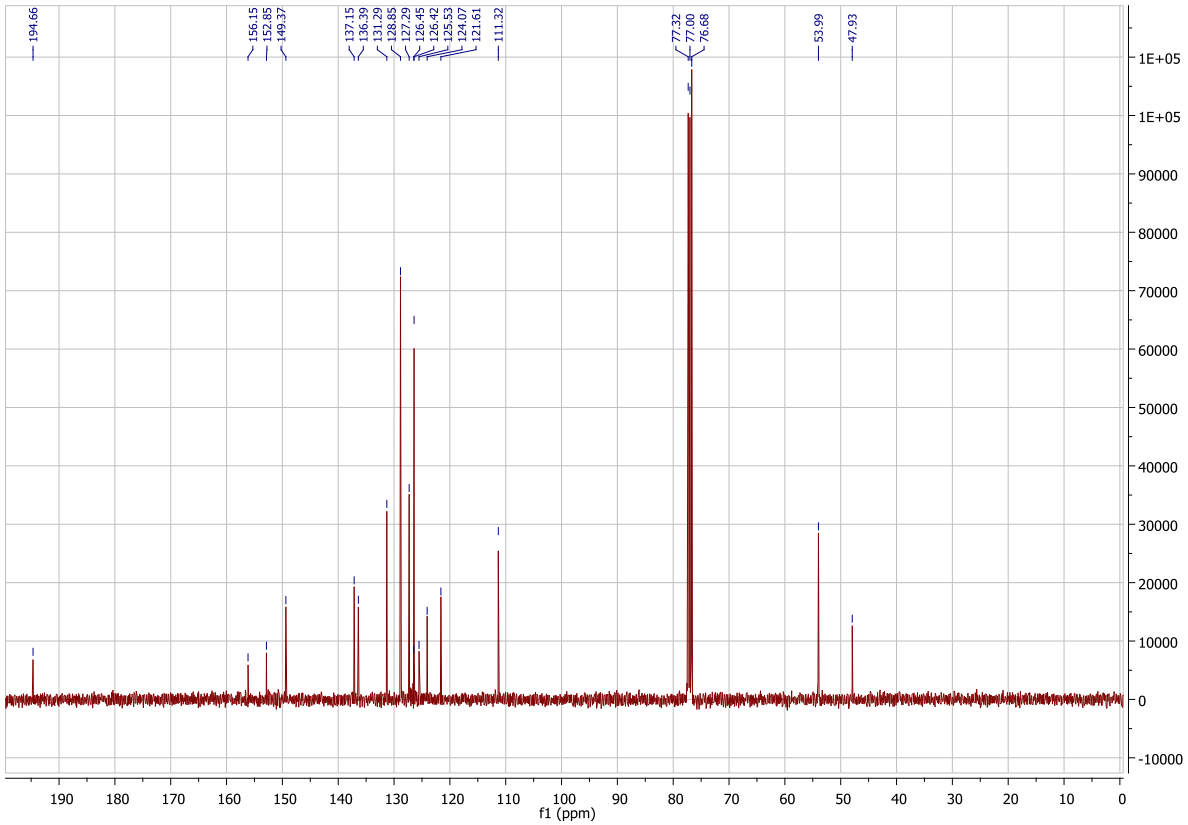

AW028 #90 RT: 2.26 AV: 1 NL: 5.38E7
F: FTMS + c ESI Full ms [75.00-1200.00]
328.1725
329.1744
330.1699
133.0762
204.0521
235.1151
310.1624
431.1212
472.2467
100
90
80
70
60
50
40
30
20
10
0
100
150
200
250
300
350
400
450
500
m/z

**Compound 1n: 1-(4-(Dibenzylamino)phenyl)-2-(pyridin-2-yl)ethanone**

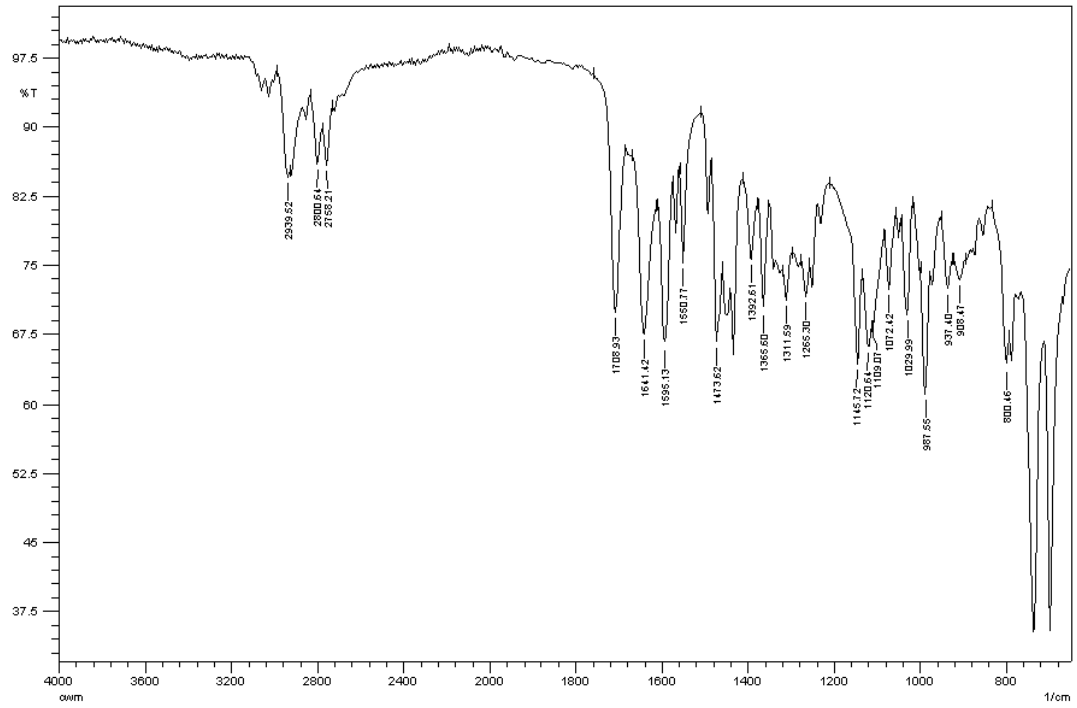
**$^{1}$H NMR:**



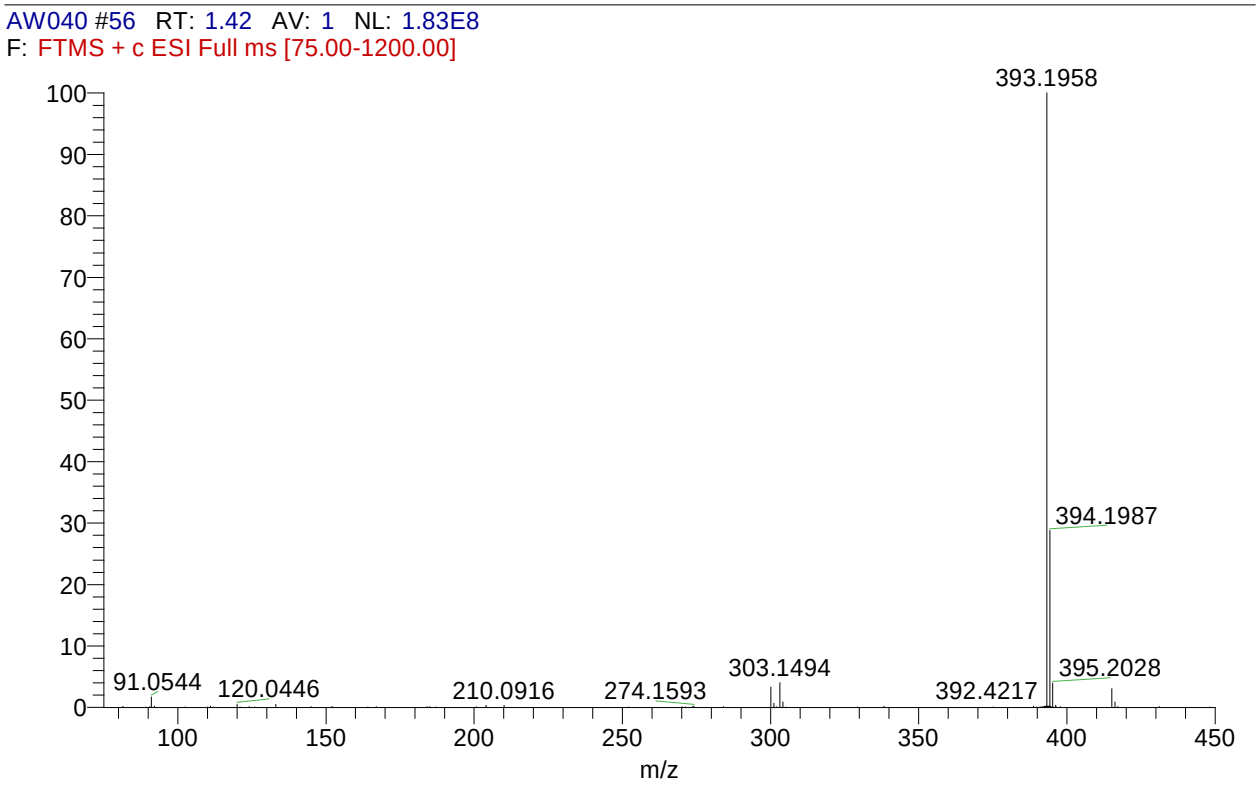

**$^{13}$C NMR:**



**FTIR:**

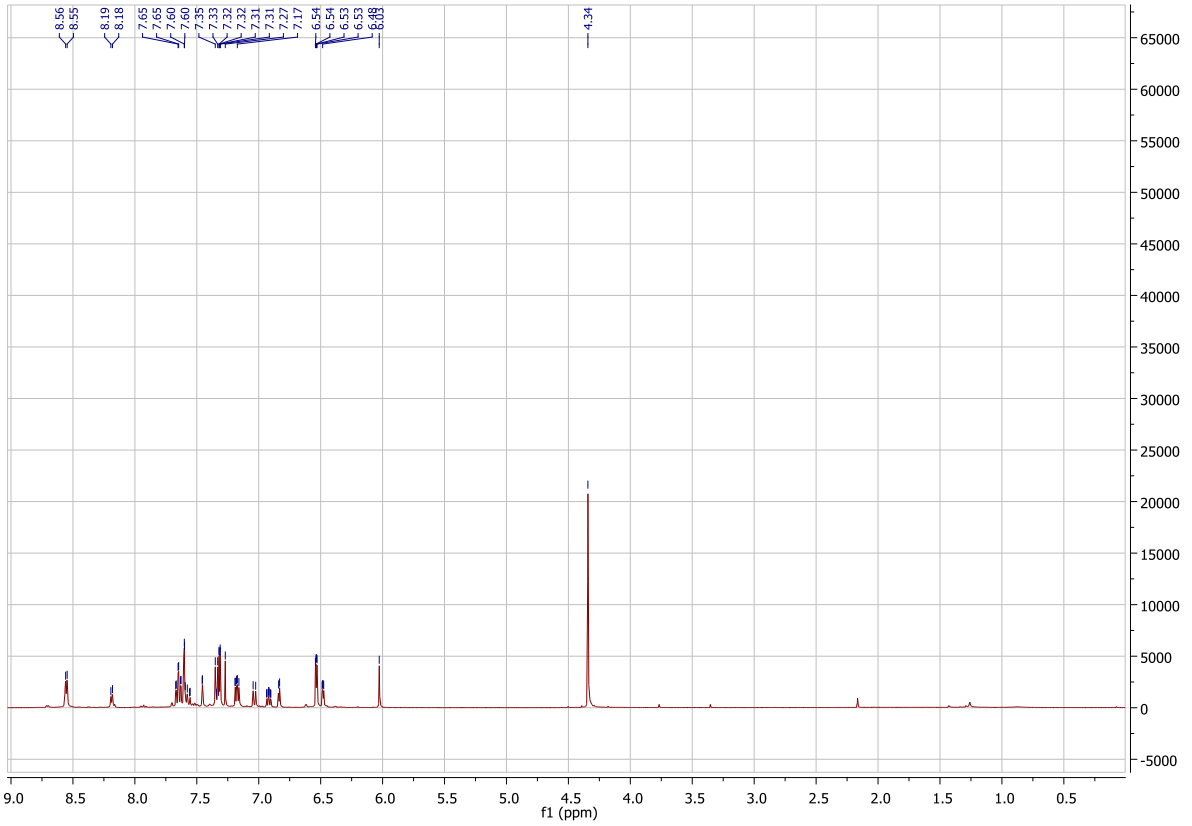



**HRMS:**

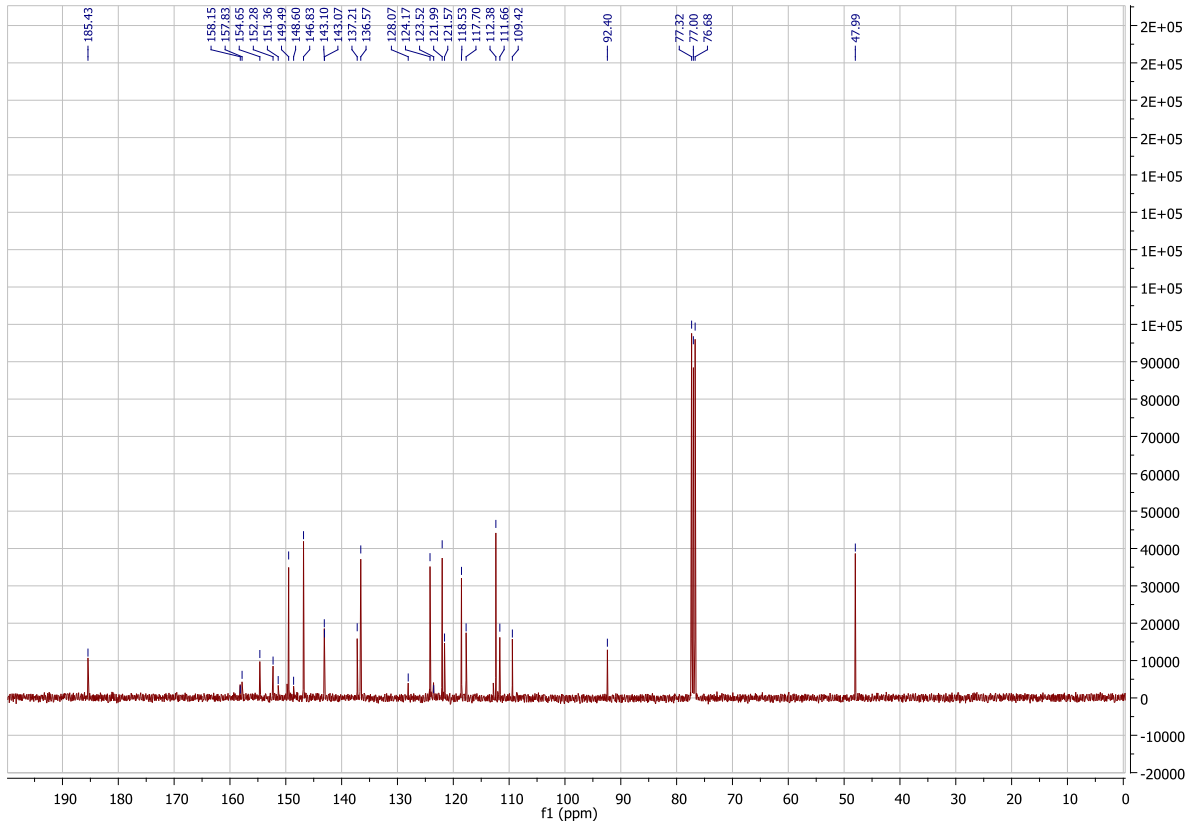


**Compound 1o: 1-(Furan-2-yl)-2-(pyridin-2-yl)ethanone**

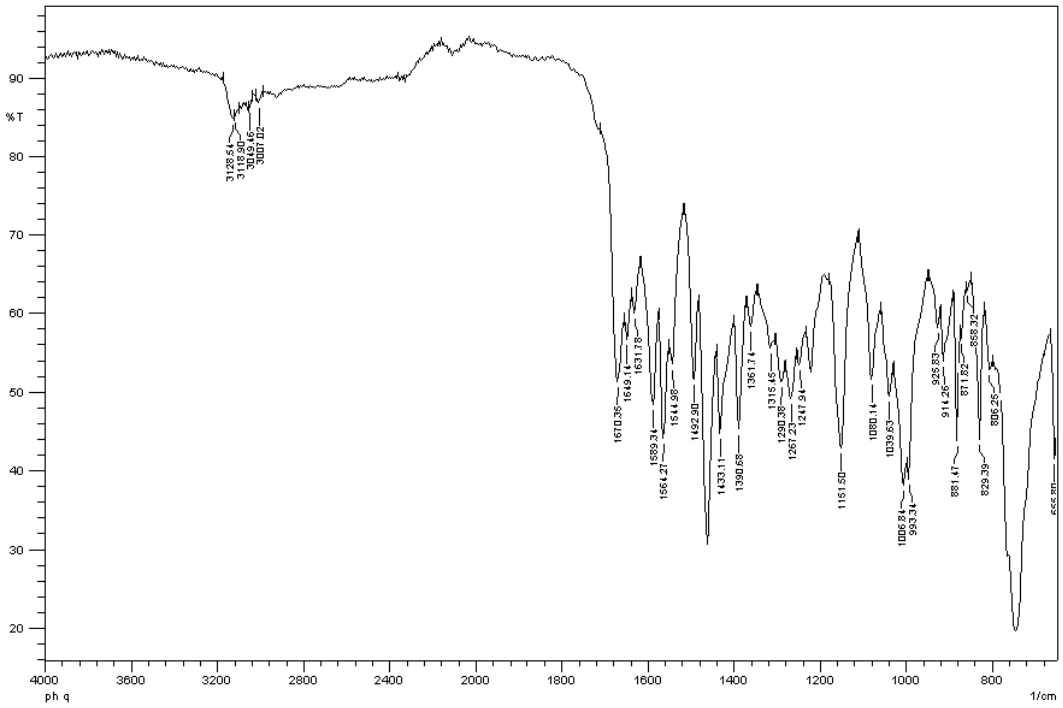
**$^{1}$H NMR:**



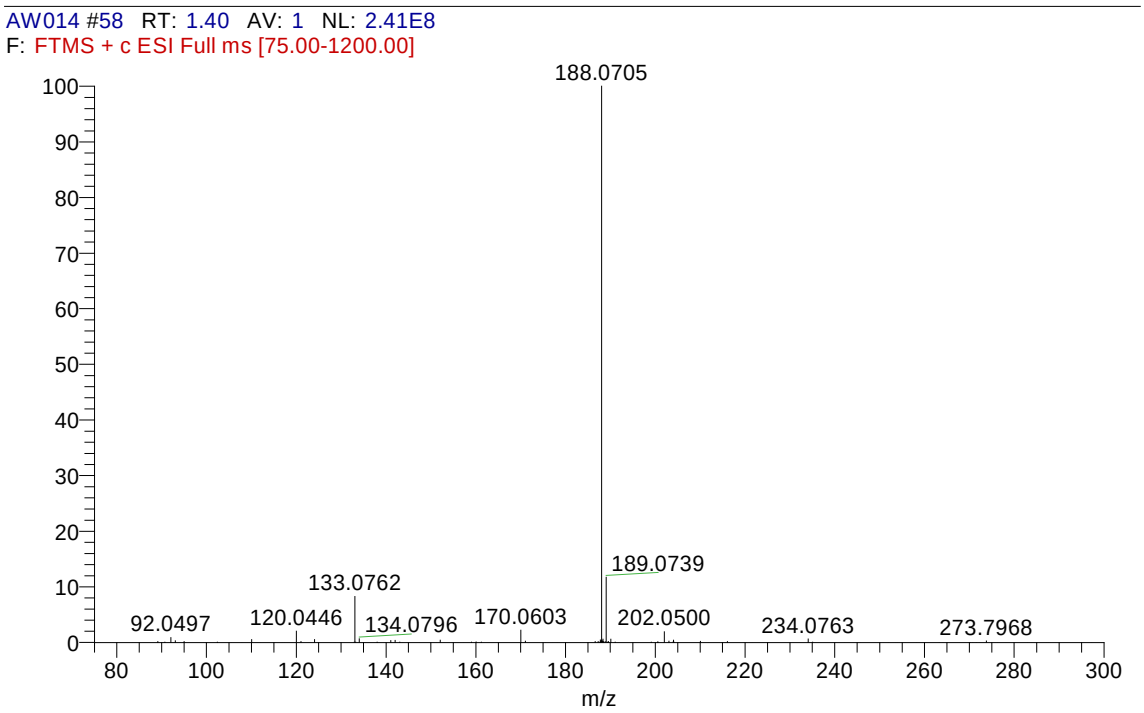

**$^{13}$C NMR:**



**FTIR:**

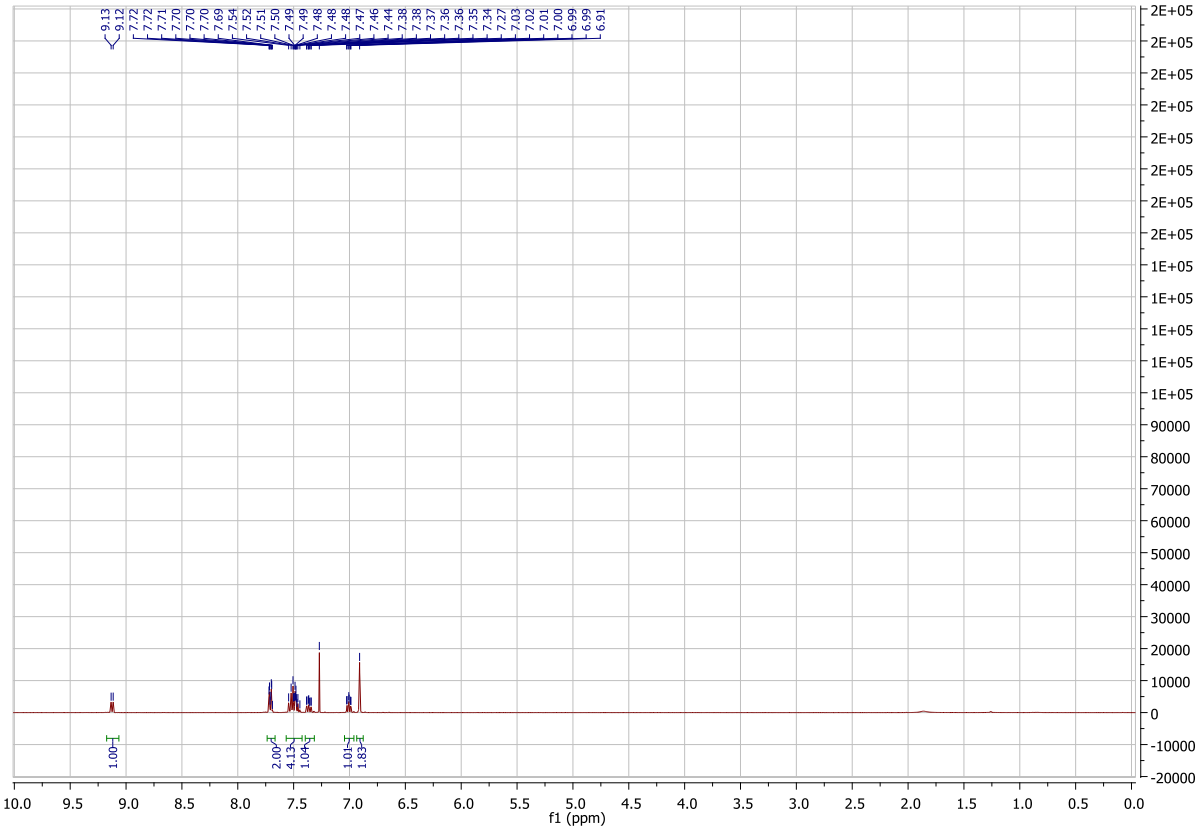



**HRMS:**

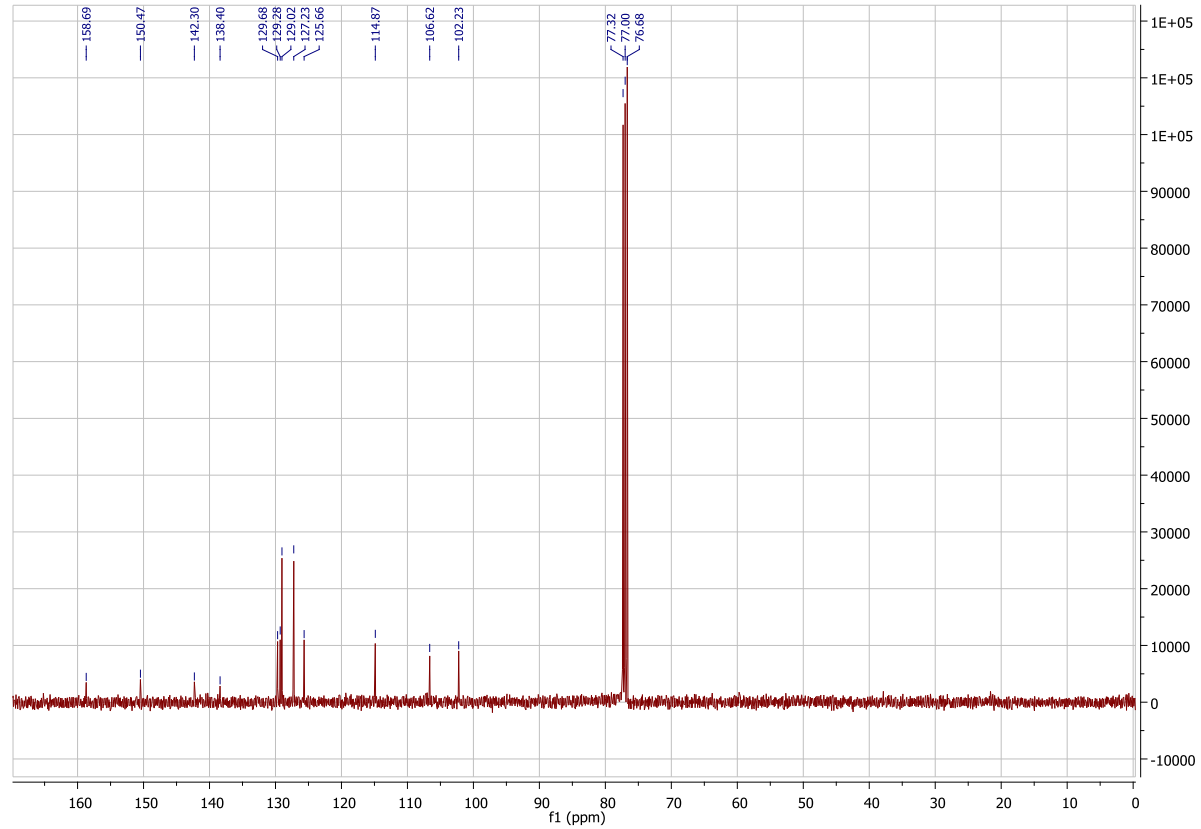


## Compound 3a: 2-Phenyl-4*H*-quinolizin-4-one

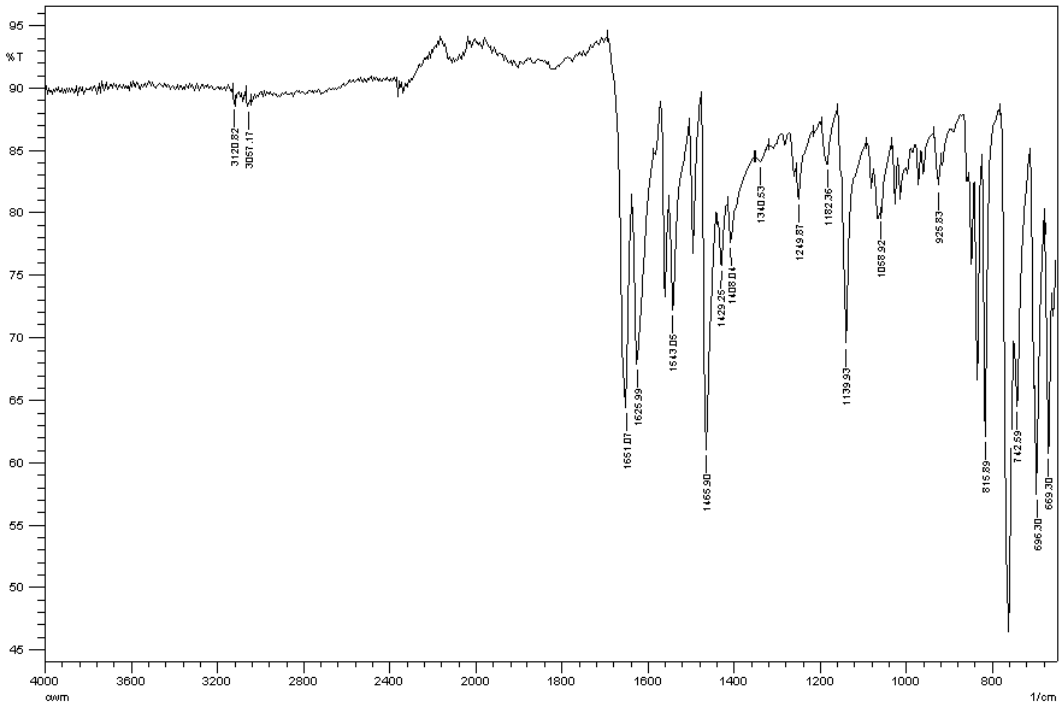
### $^{1}$H NMR:



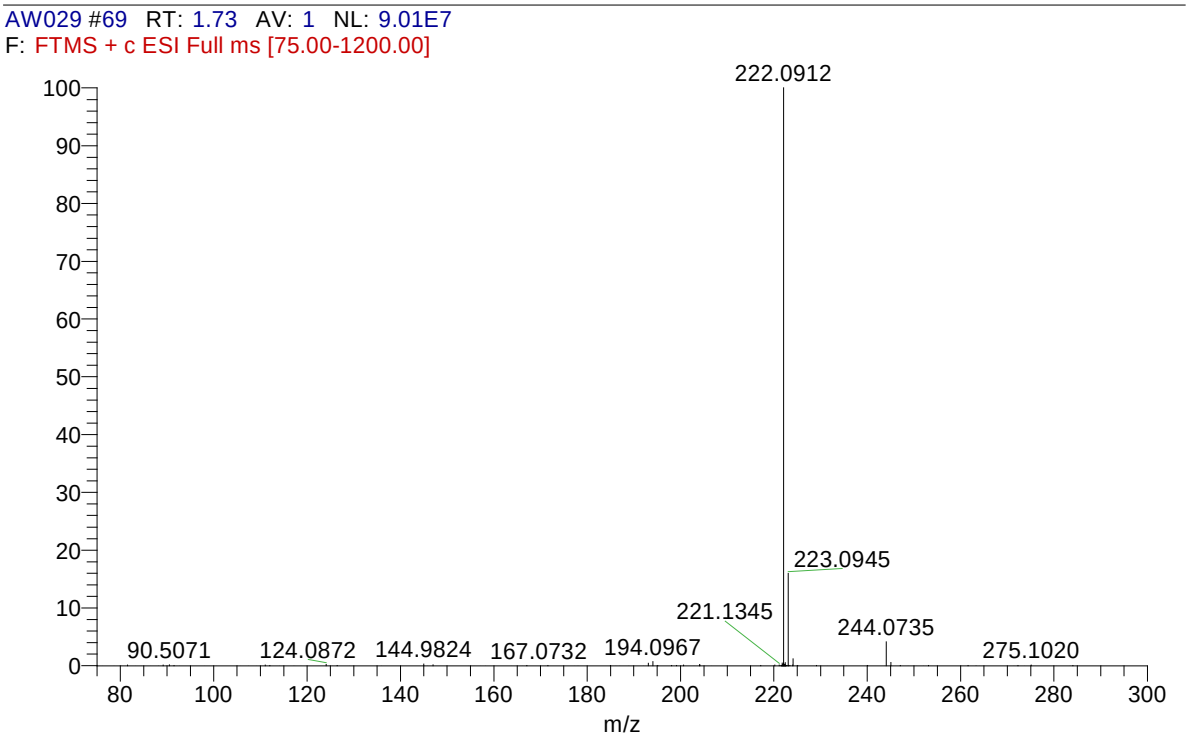

### $^{13}$C NMR:



**FTIR:**

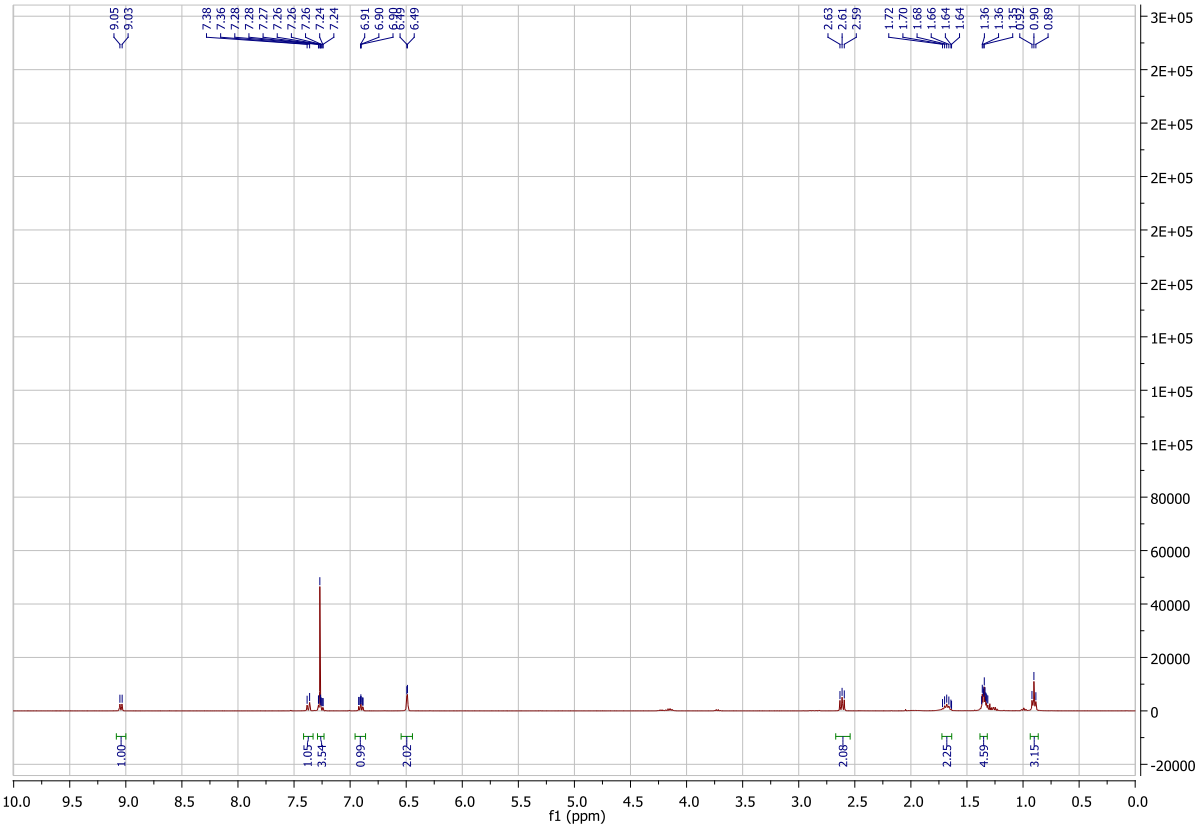



**HRMS:**

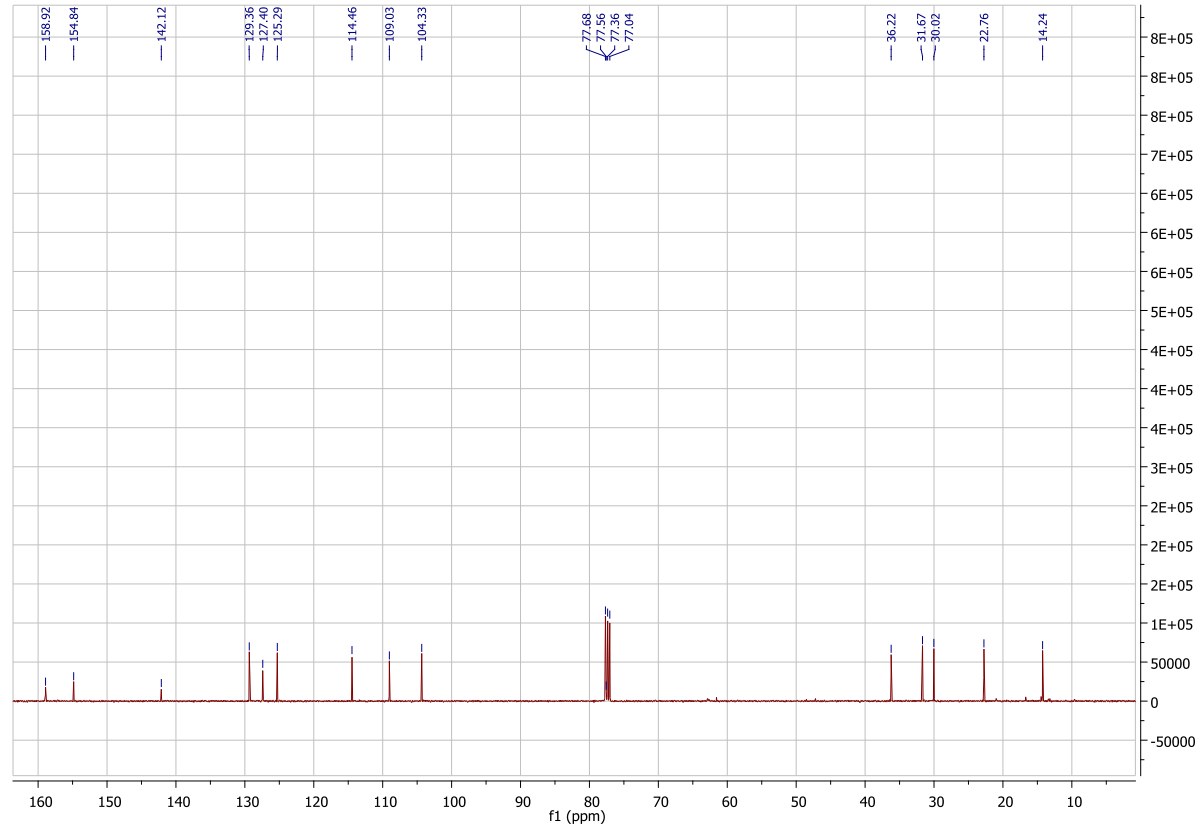


**Compound 3b: 2-Pentyl-4*H*-quinolizin-4-one**

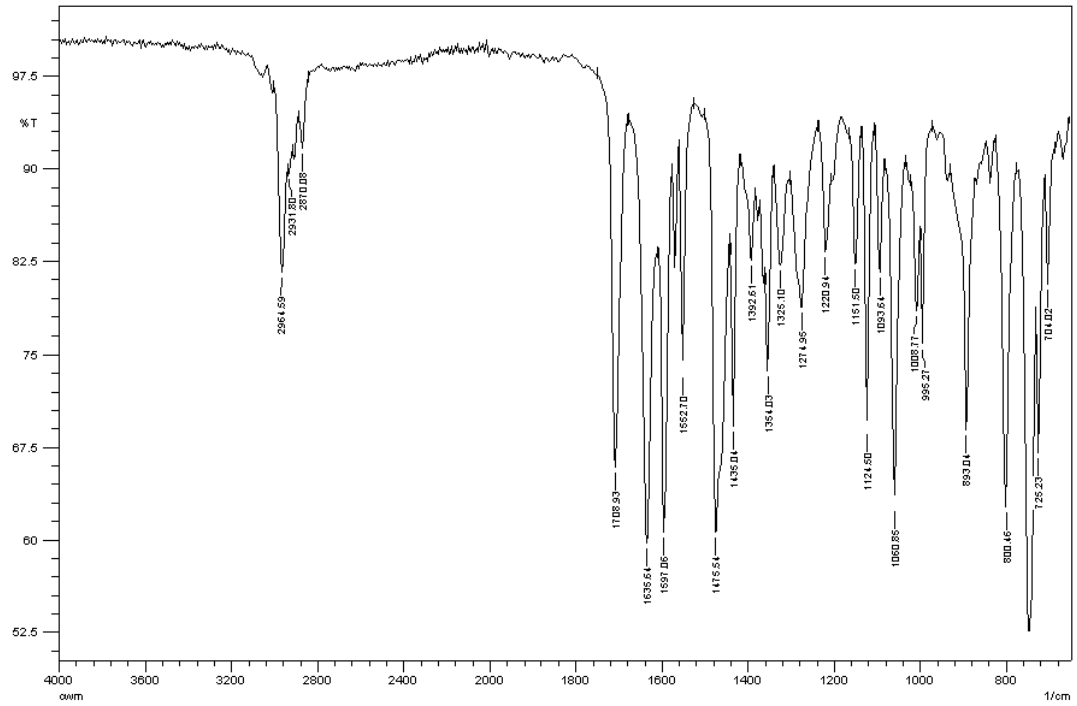
**$^{1}$H NMR:**



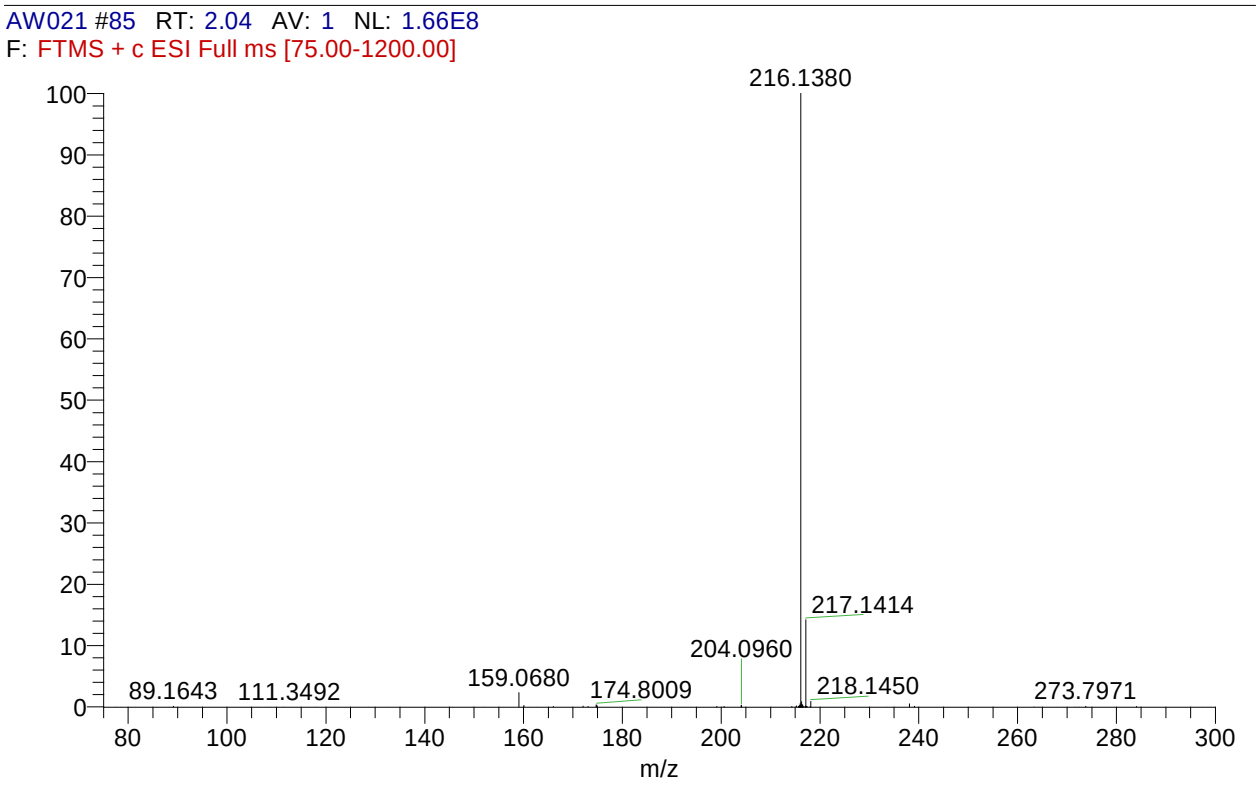

**$^{13}$C NMR:**



**FTIR:**

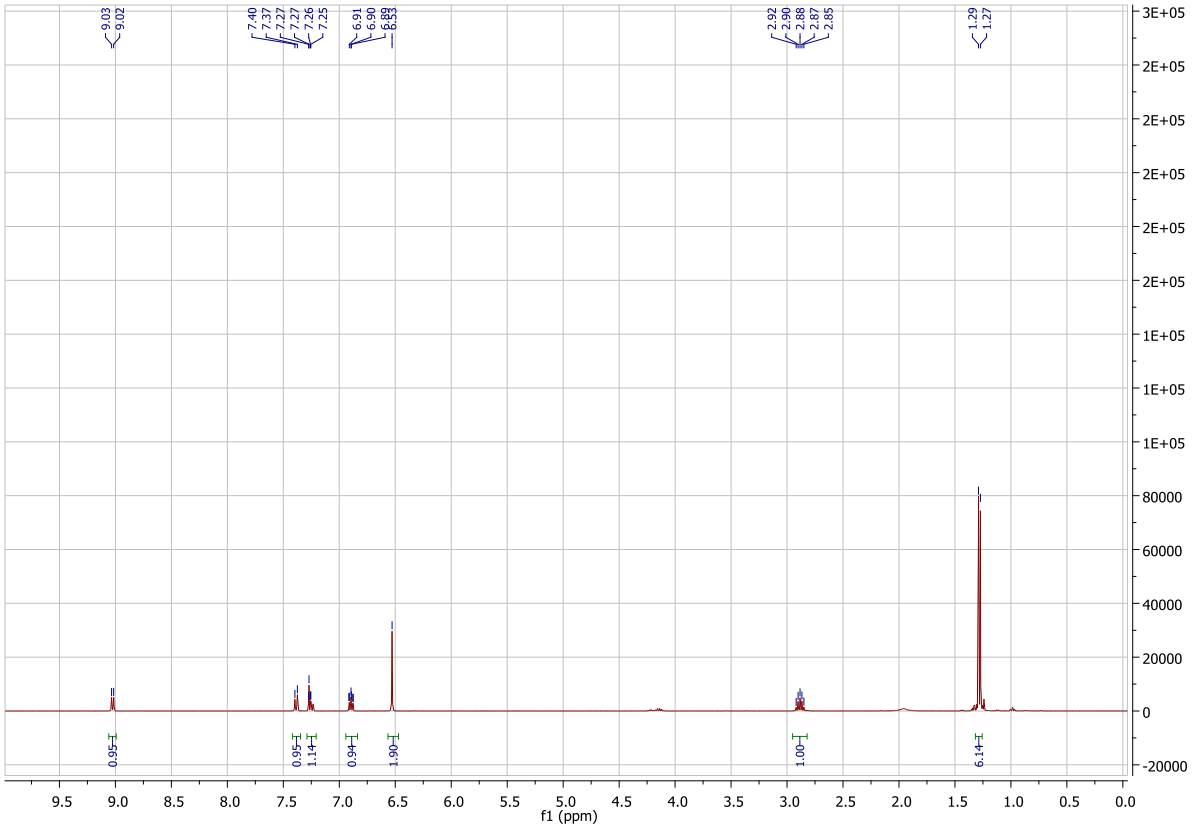



**HRMS:**

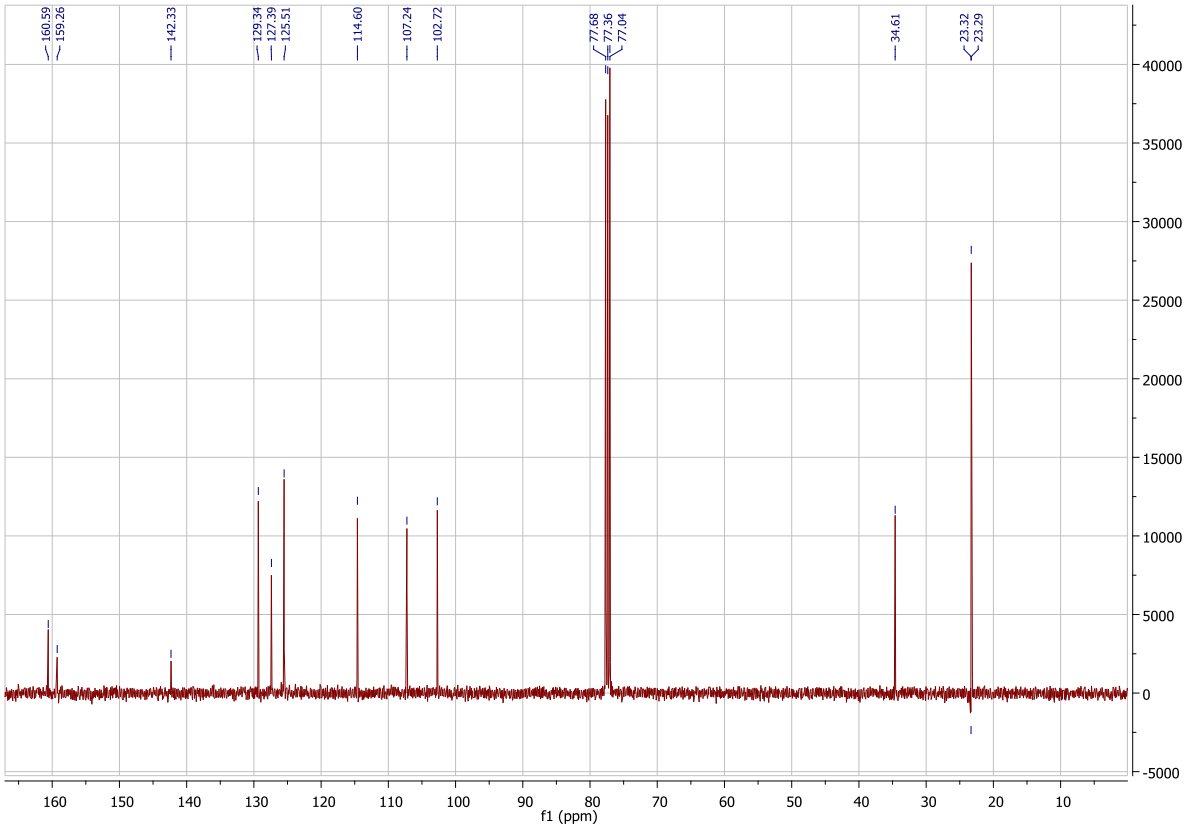


**Compound 3c: 2-Isopropyl-4*H*-quinolizin-4-one**

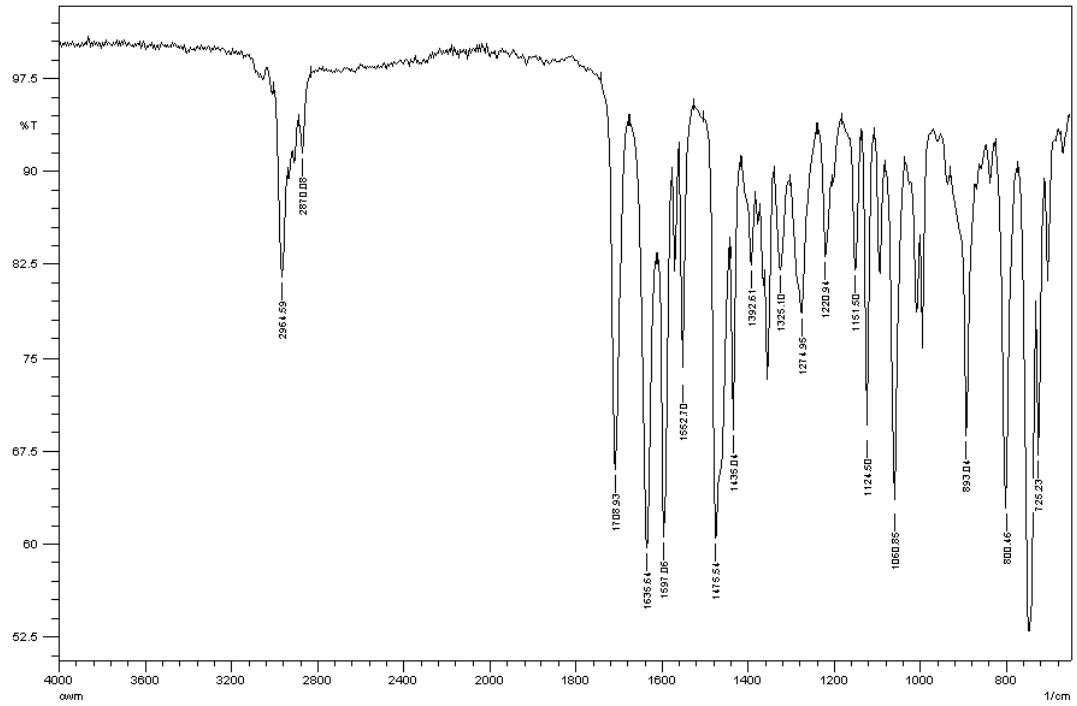
**$^{1}$H NMR:**



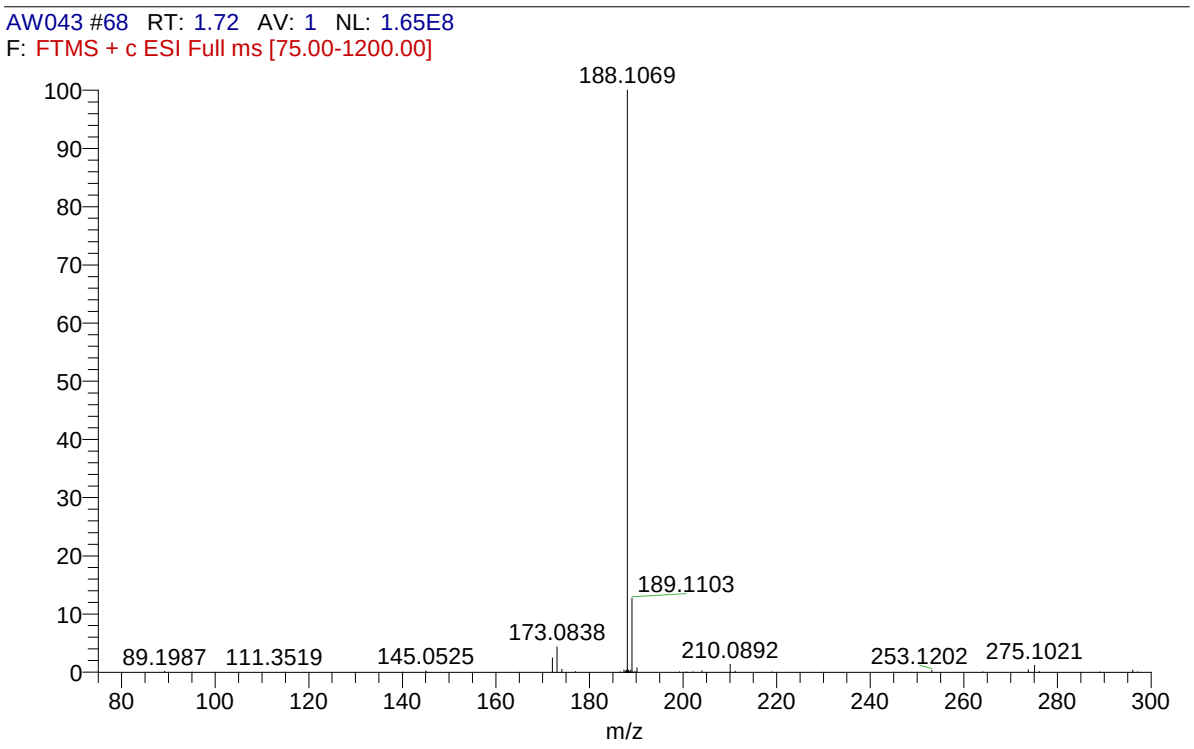

**$^{13}$C NMR:**



**FTIR:**

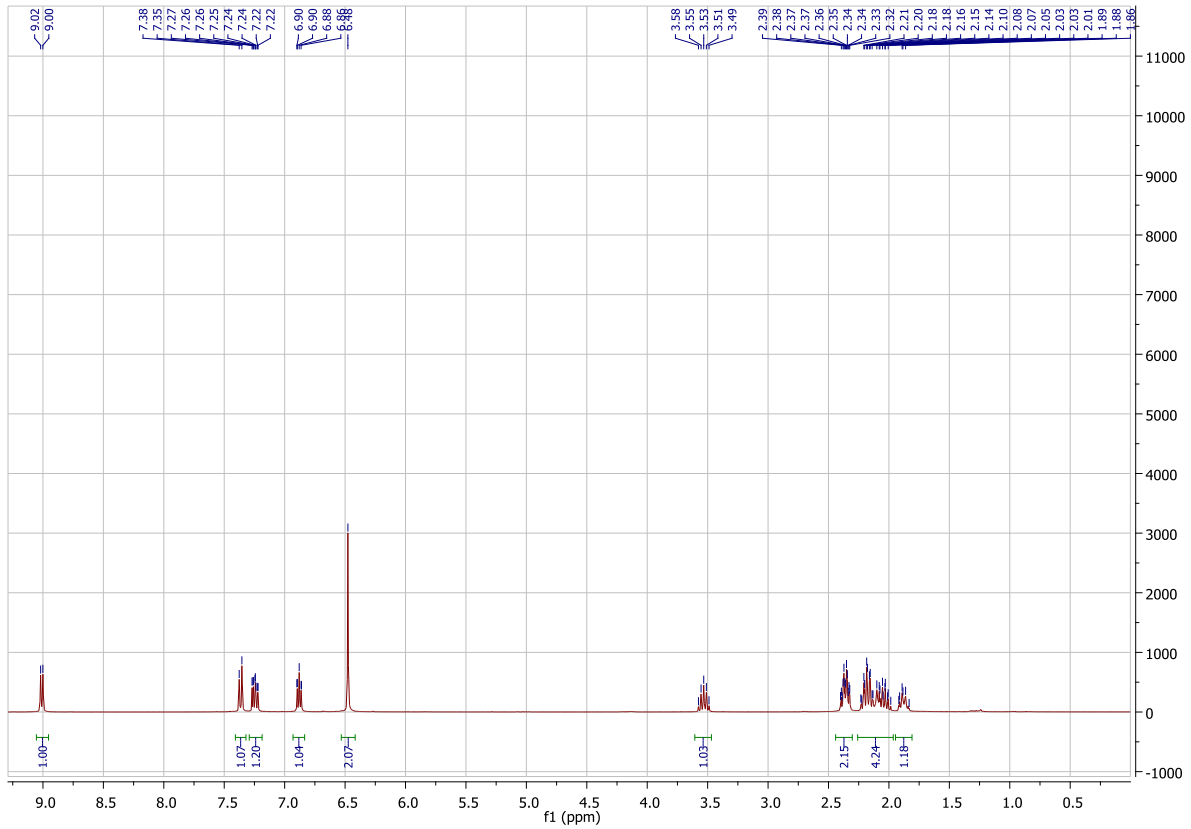



**HRMS:**

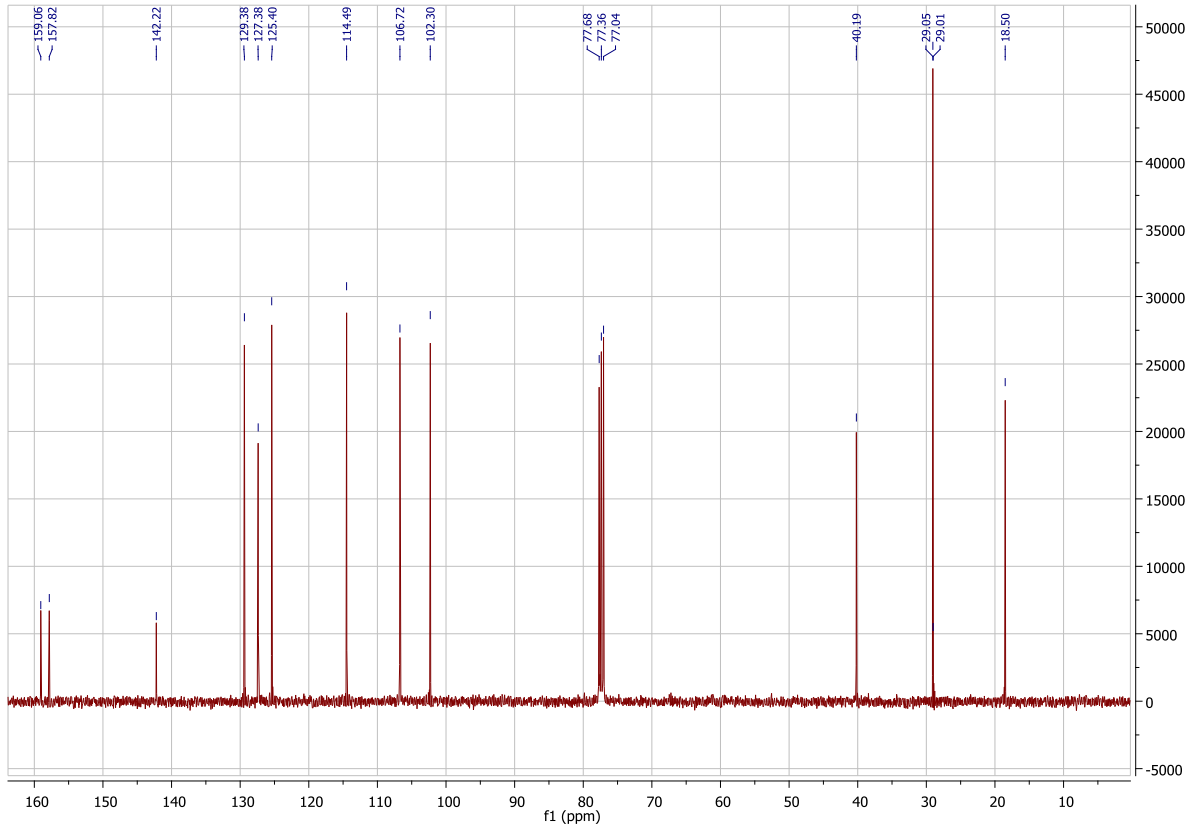


## Compound 3d: 2-Cyclobutyl-4*H*-quinolizin-4-one

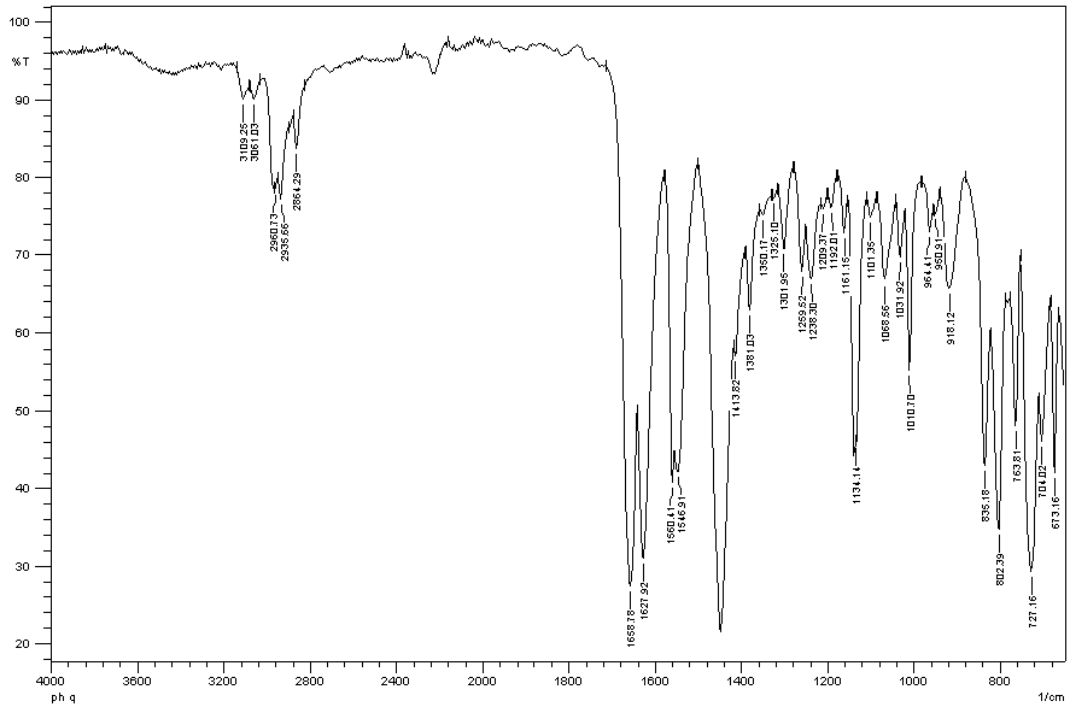
**$^{1}$H NMR:**




**$^{13}$C NMR:**



**FTIR:**


100
%T
90
80
70
60
50
40
30
20
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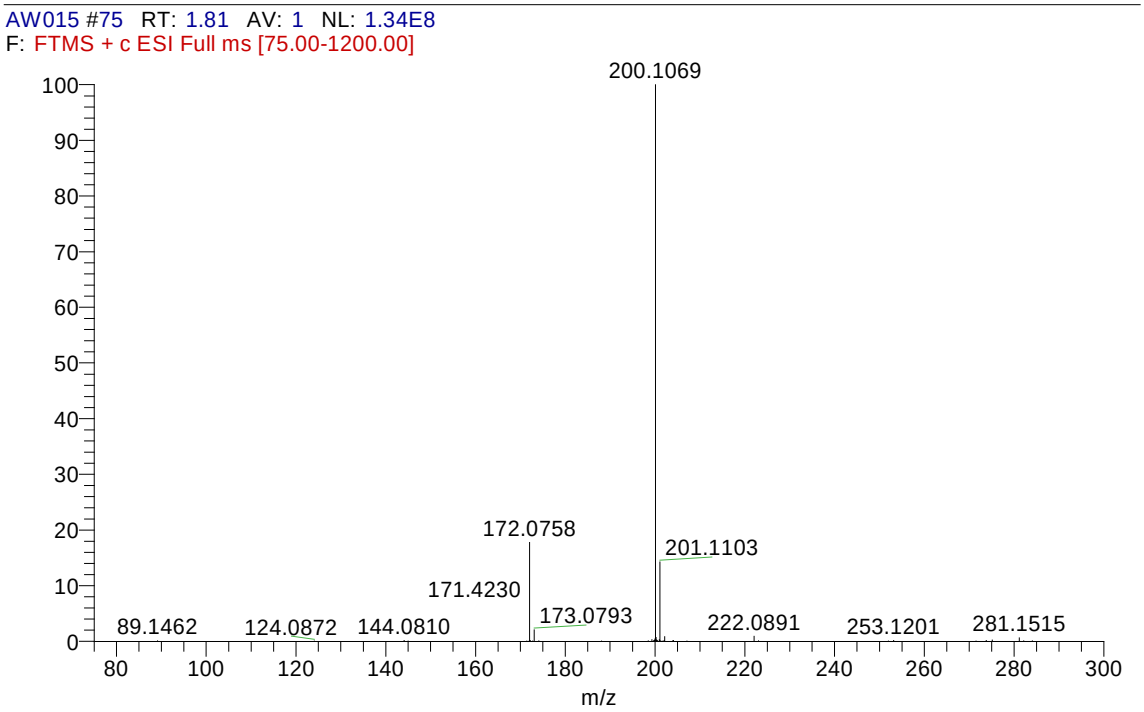
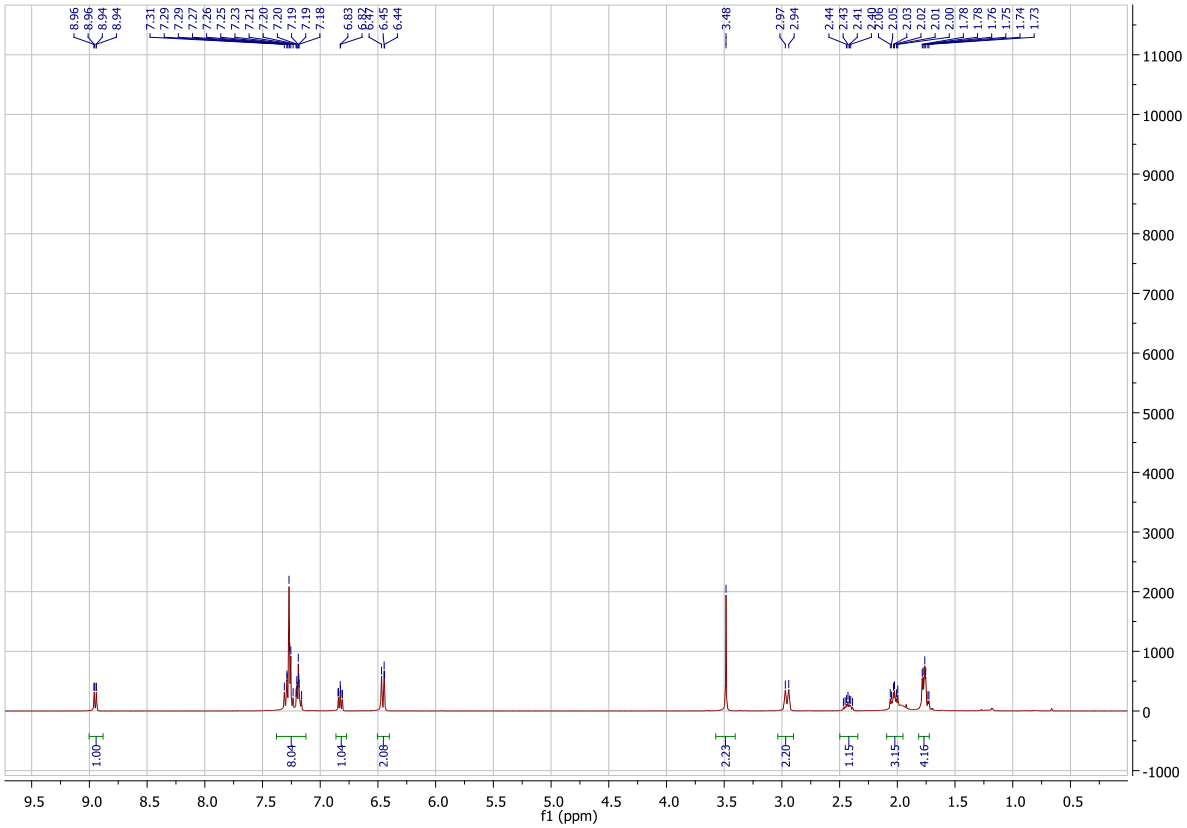
3061.03
2960.73
2935.66
2864.29
1658.78
1627.92
1560.41
1546.91
1413.82
1381.03
1350.17
1325.10
1301.95
1259.62
1238.30
1209.37
1192.01
1161.15
1134.14
1101.35
1069.56
1031.92
1010.70
964.41
950.91
918.12
835.18
802.39
763.81
727.16
704.02
673.16
4000
3600
3200
2800
2400
2000
1800
1600
1400
1200
1000
800
ph q
1/cm

**HRMS:**

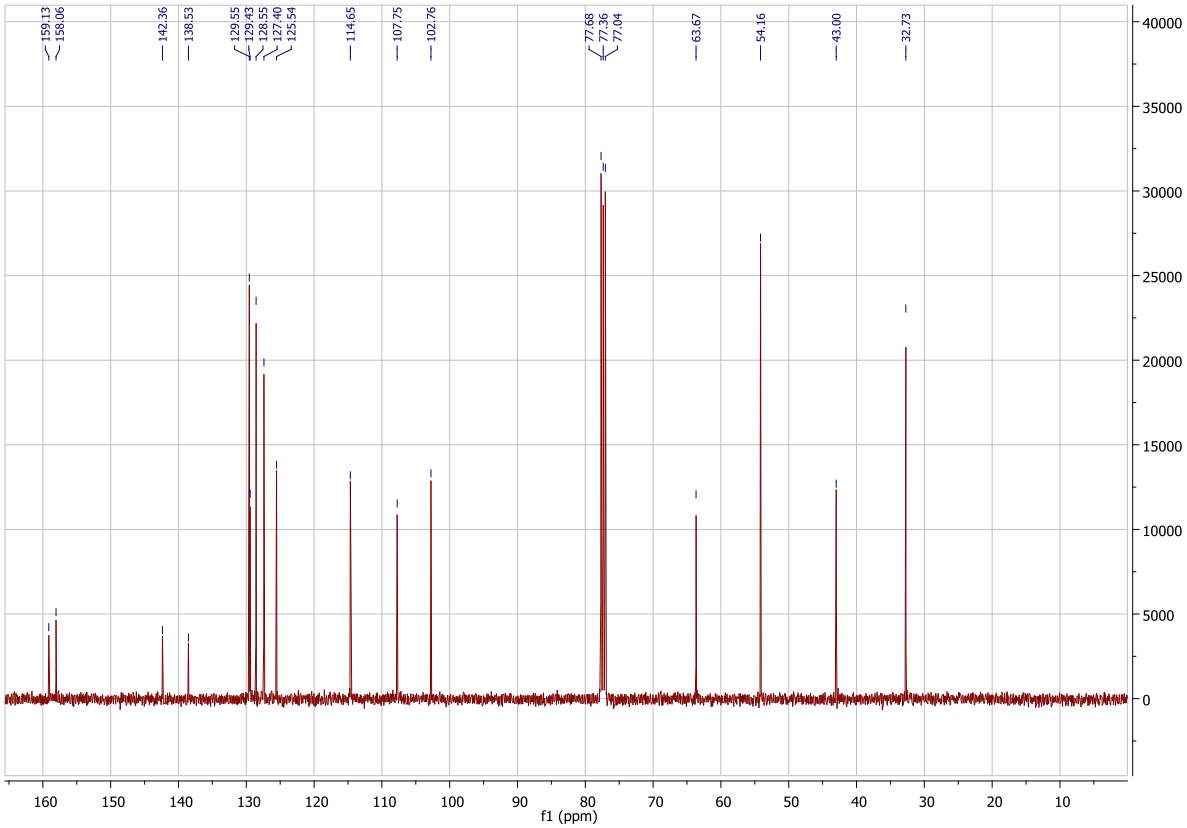

AW015 #75 RT: 1.81 AV: 1 NL: 1.34E8
F: FTMS + c ESI Full ms [75.00-1200.00]
200.1069
172.0758
201.1103
171.4230
173.0793
89.1462
124.0872
144.0810
222.0891
253.1201
281.1515
100
90
80
70
60
50
40
30
20
10
0
80
100
120
140
160
180
200
220
240
260
280
300
m/z

**Compound 3e: 2-(1-Benzylpiperidin-4-yl)-4*H*-quinolizin-4-one**

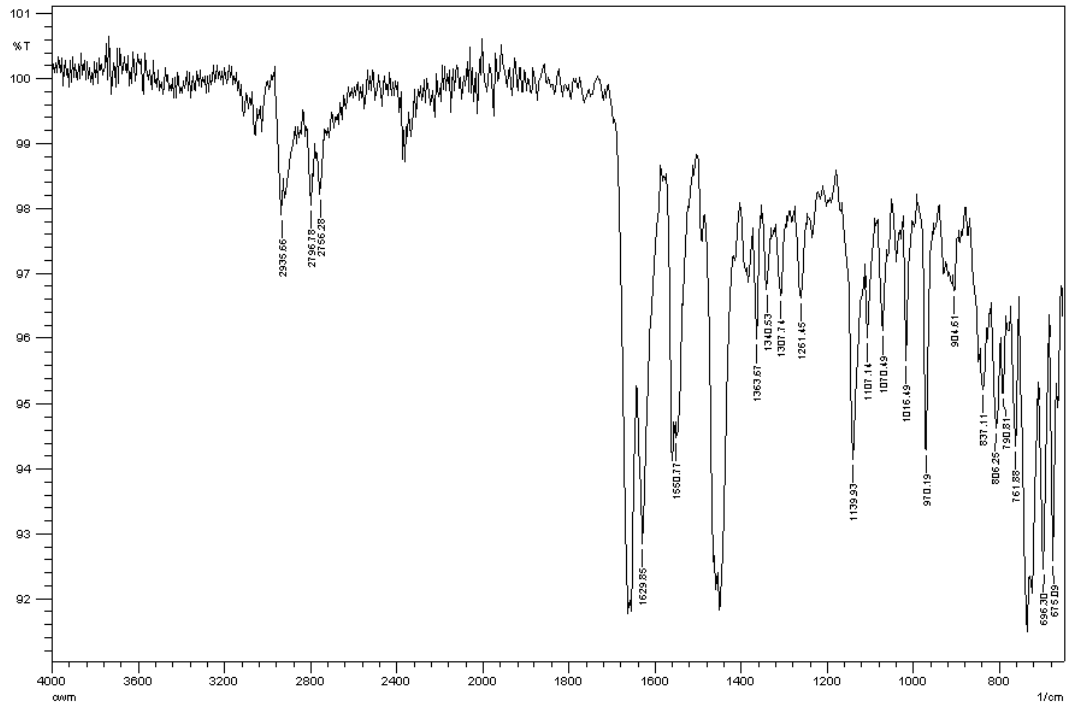
**$^{1}$H NMR:**



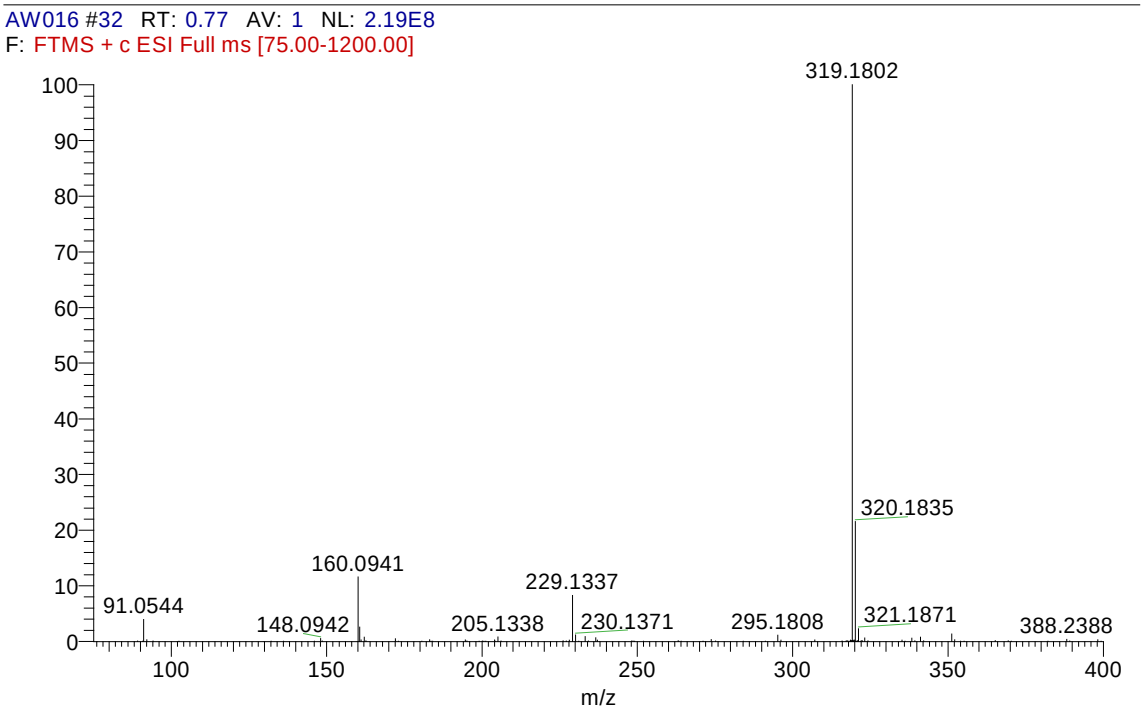

**$^{13}$C NMR:**



**FTIR:**

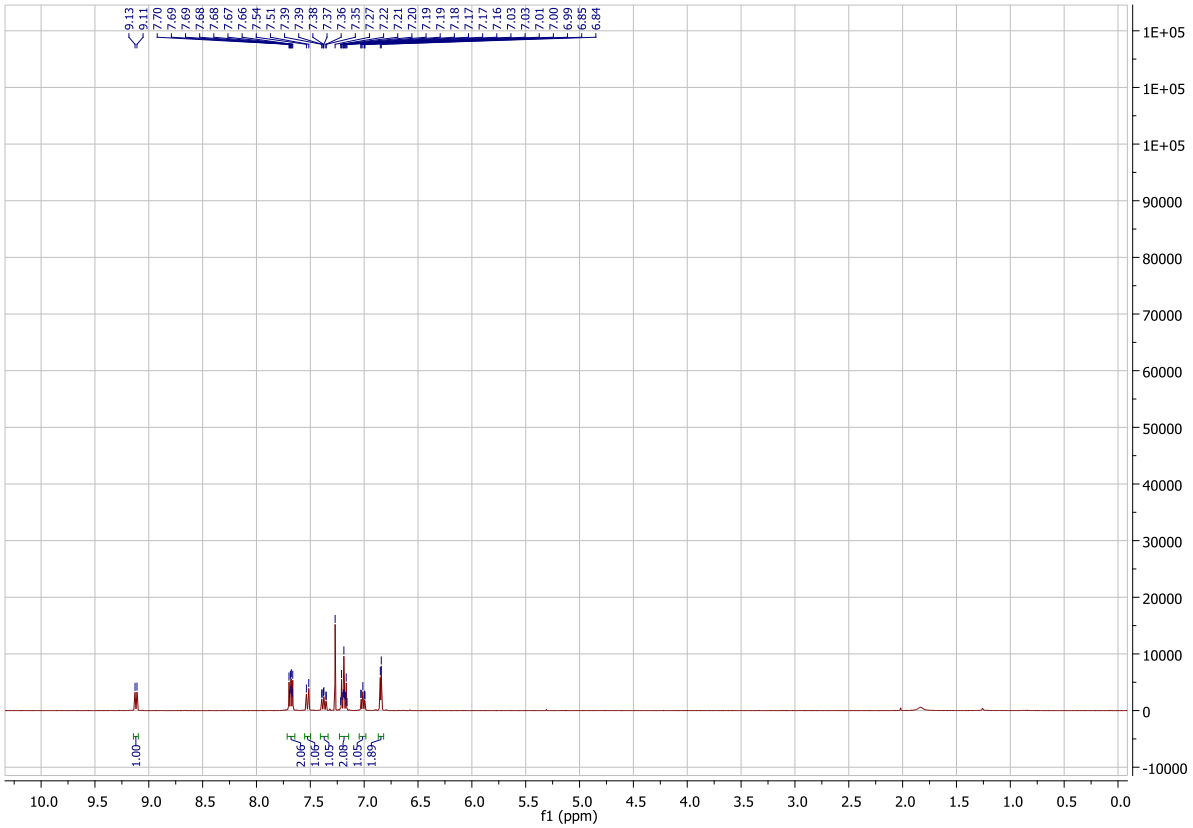



**HRMS:**

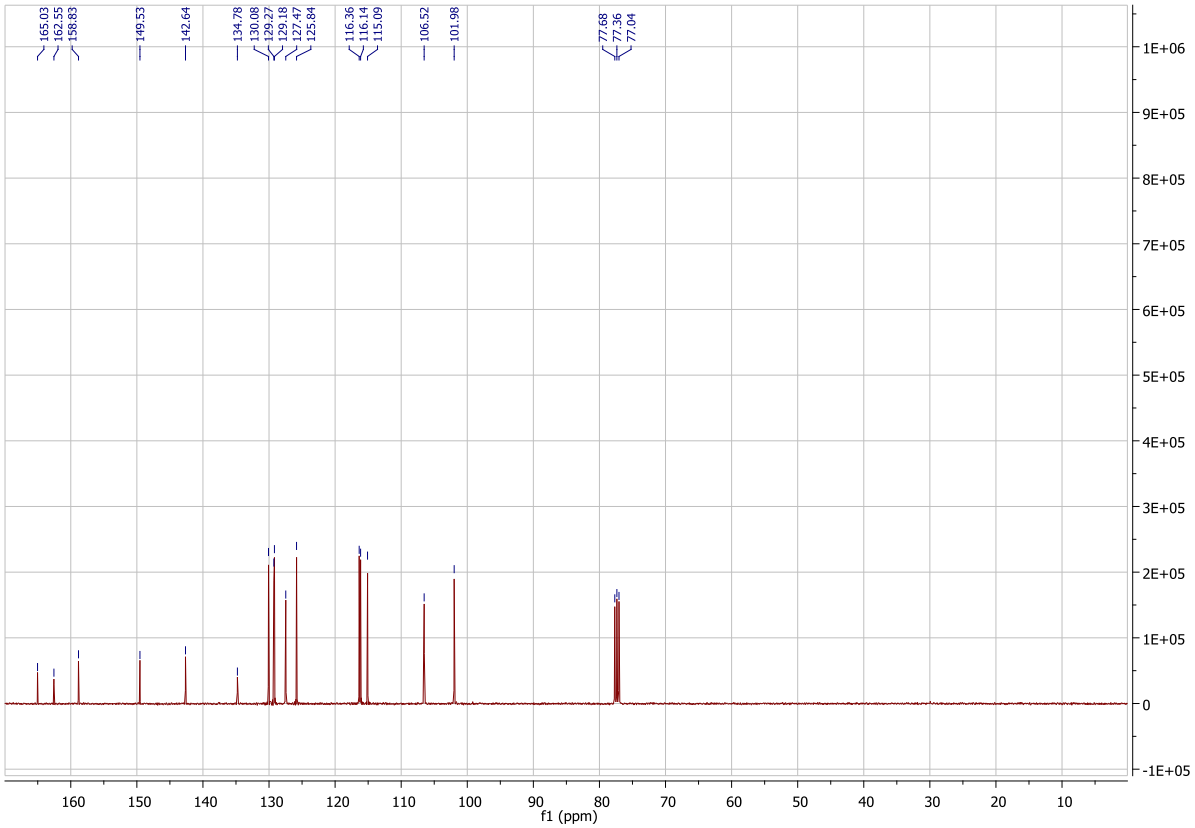


**Compound 3f: 2-(4-Fluorophenyl)-4*H*-quinolizin-4-one**

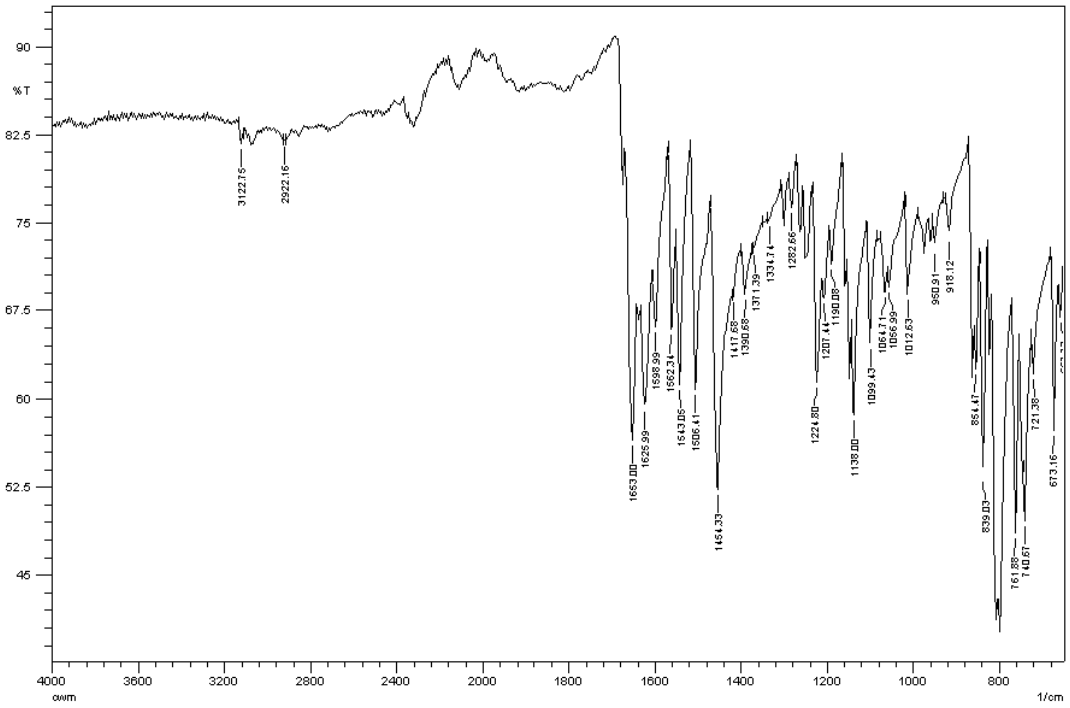
**$^{1}$H NMR:**



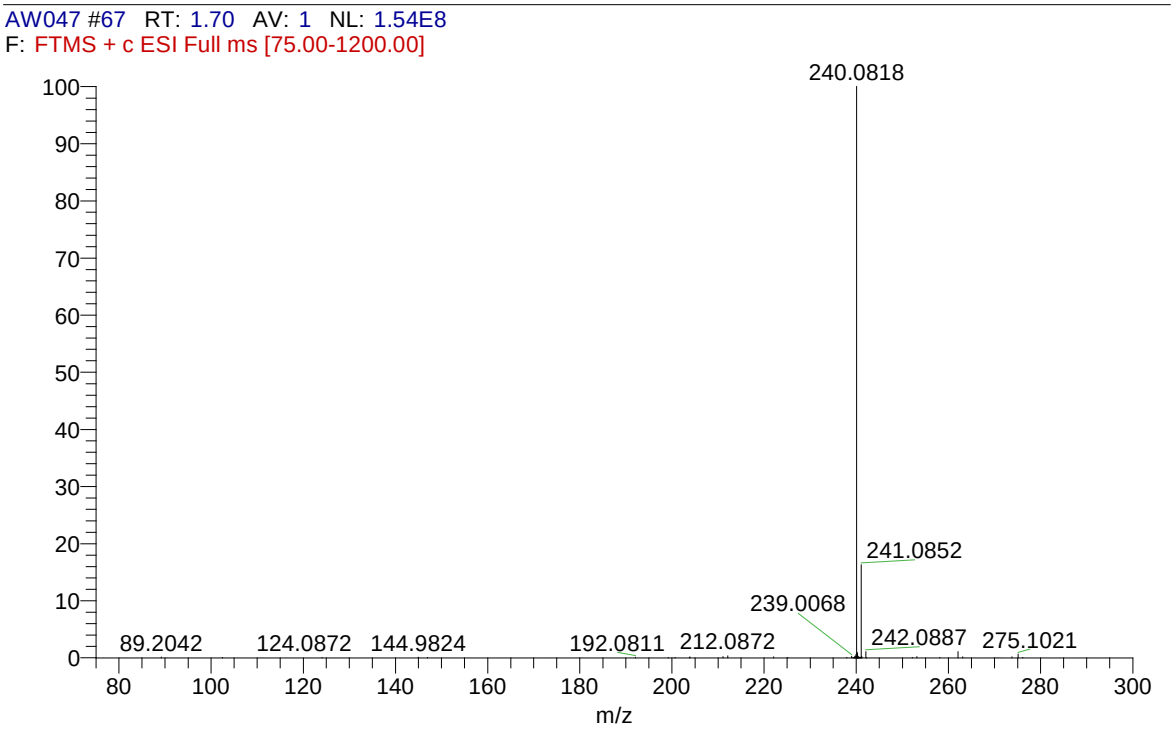

**$^{13}$C NMR:**



**FTIR:**

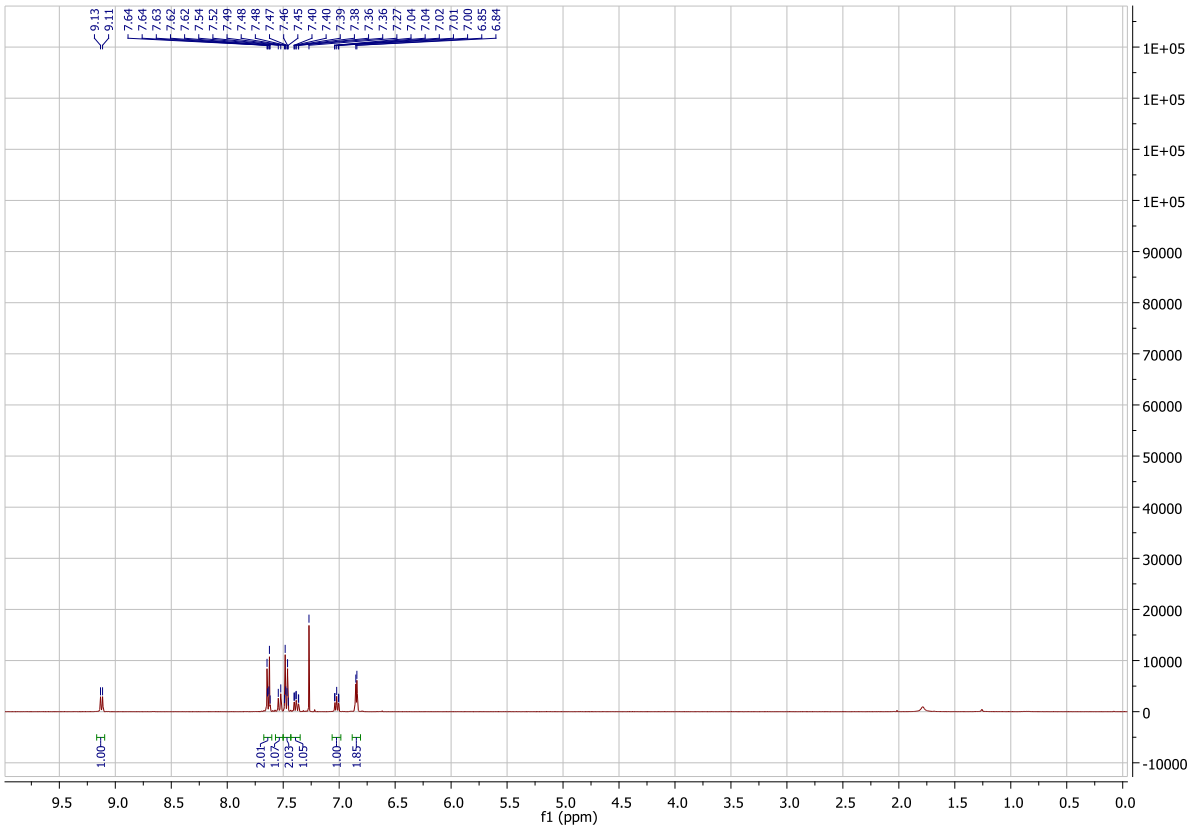



**HRMS:**

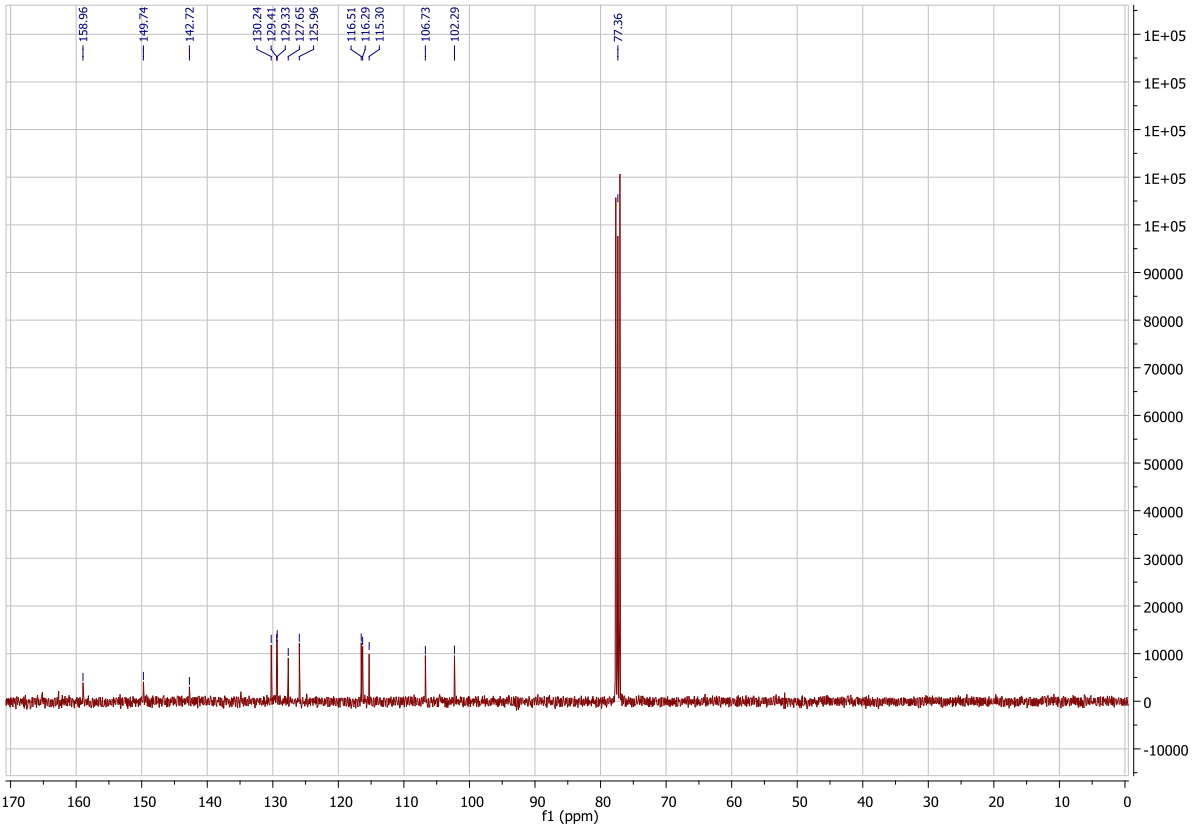


## Compound 3g: 2-(4-Chlorophenyl)-4*H*-quinolizin-4-one

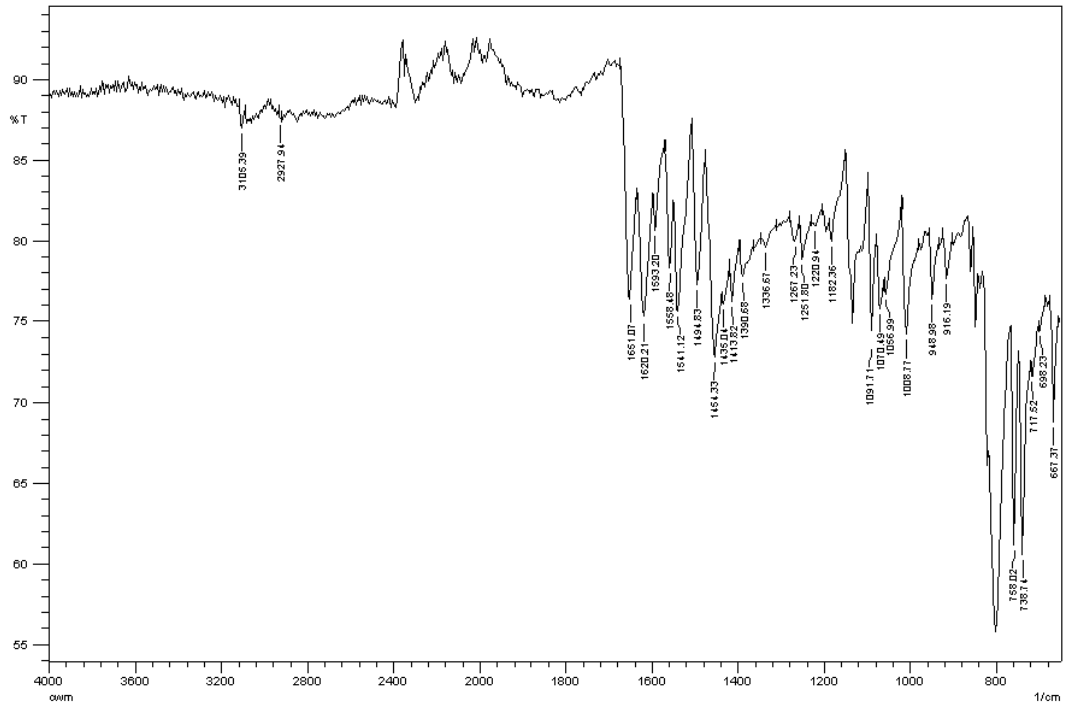
**$^{1}$H NMR:**



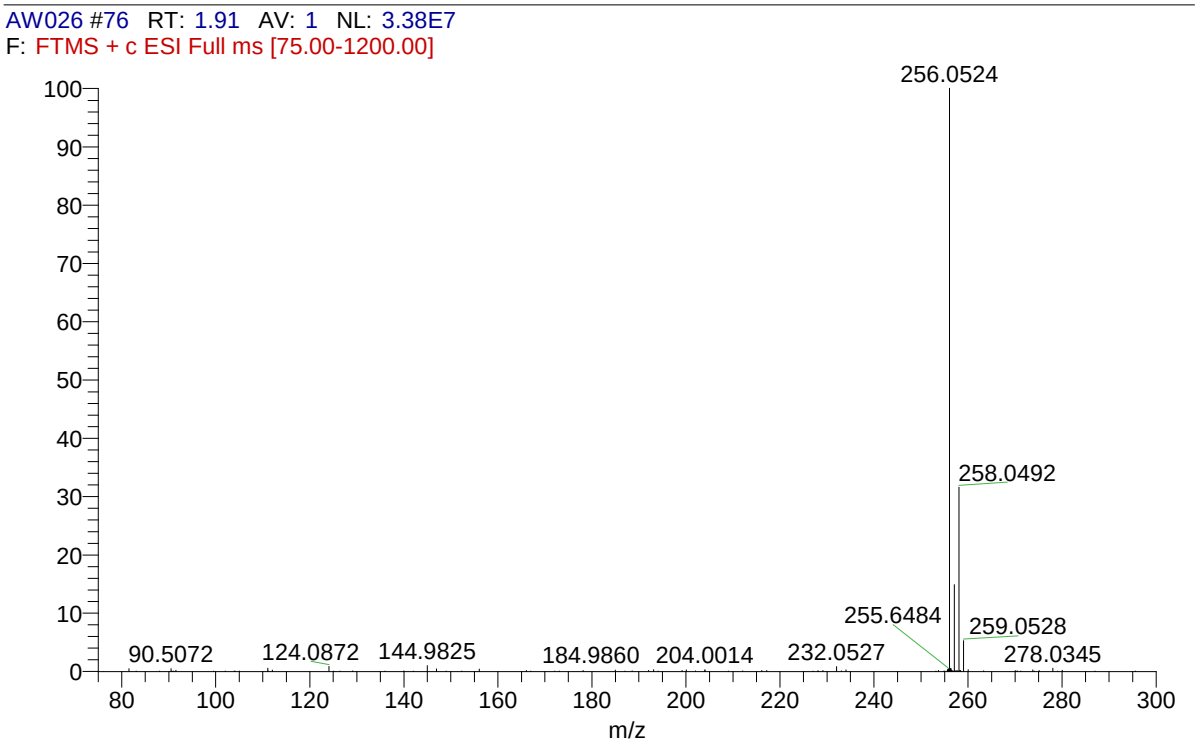

**$^{13}$C NMR:**



**FTIR:**

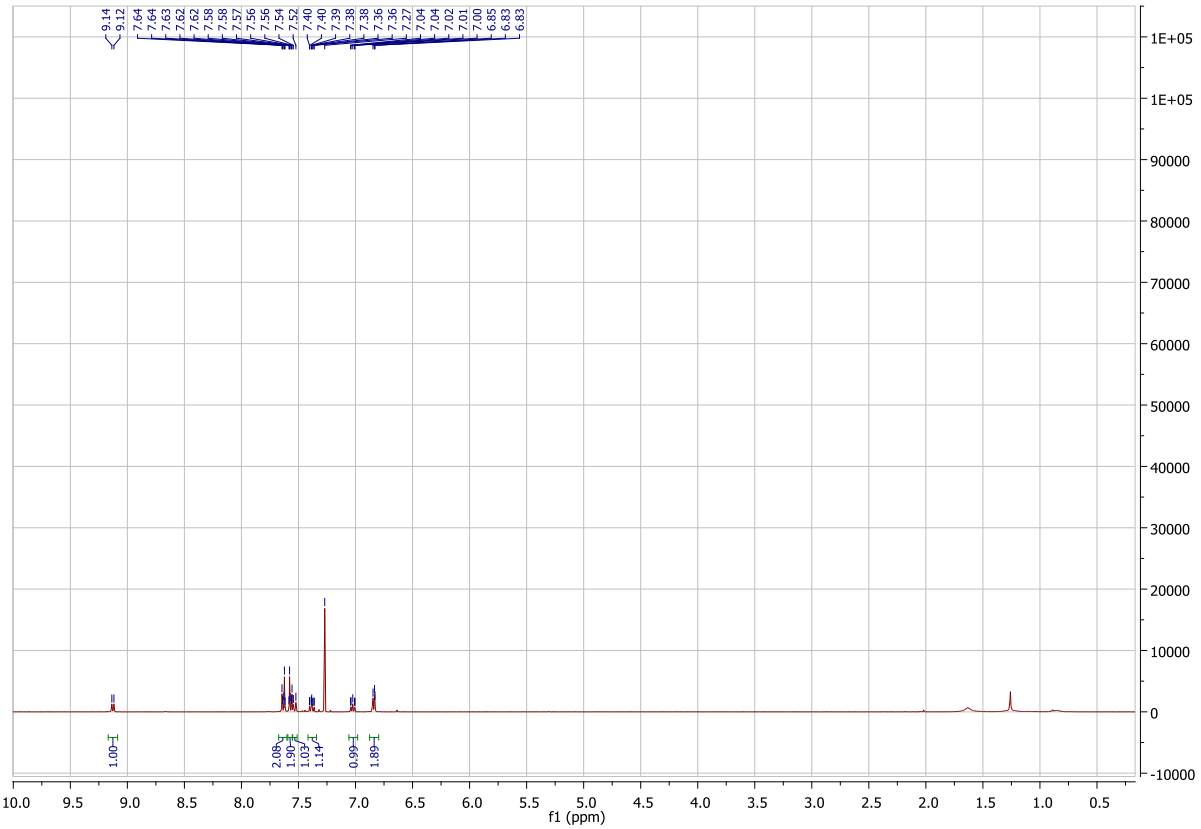



**HRMS:**

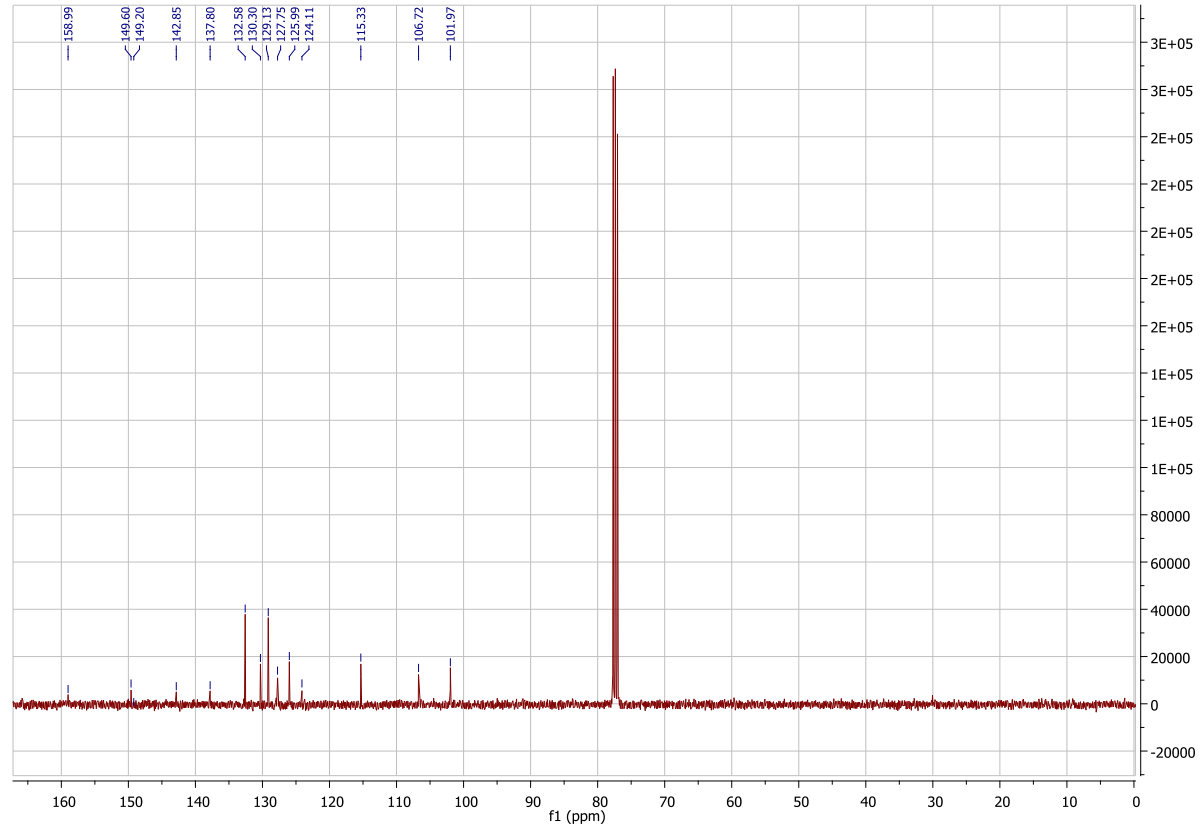


**Compound 3h: 2-(4-Bromophenyl)-4*H*-quinolizin-4-one**

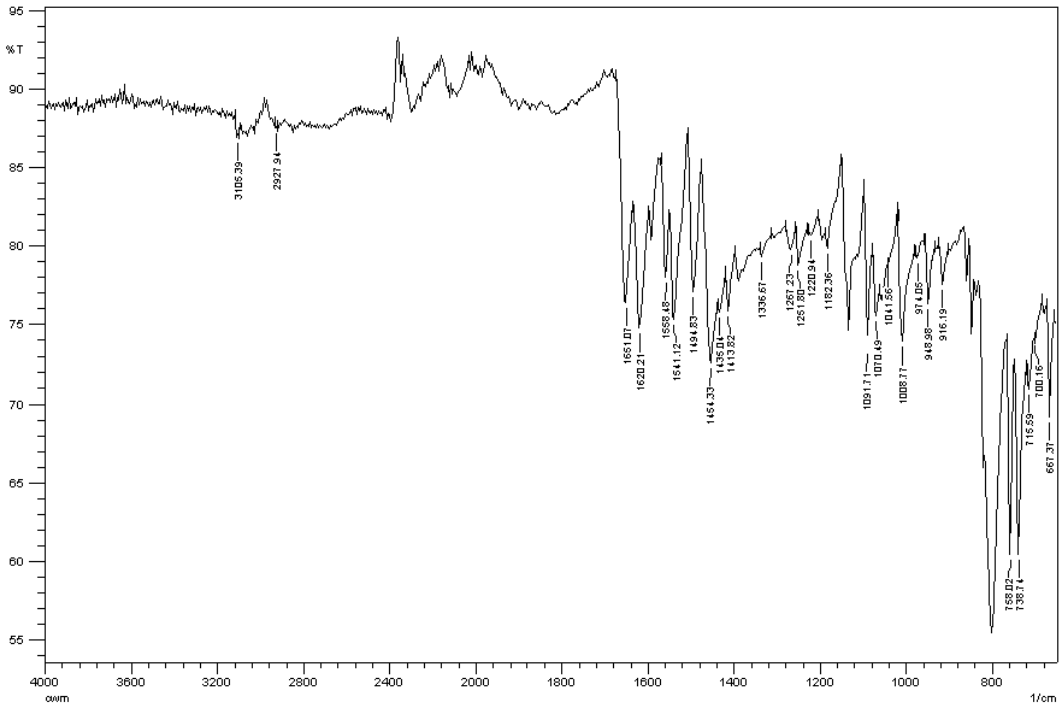
**$^{1}$H NMR:**



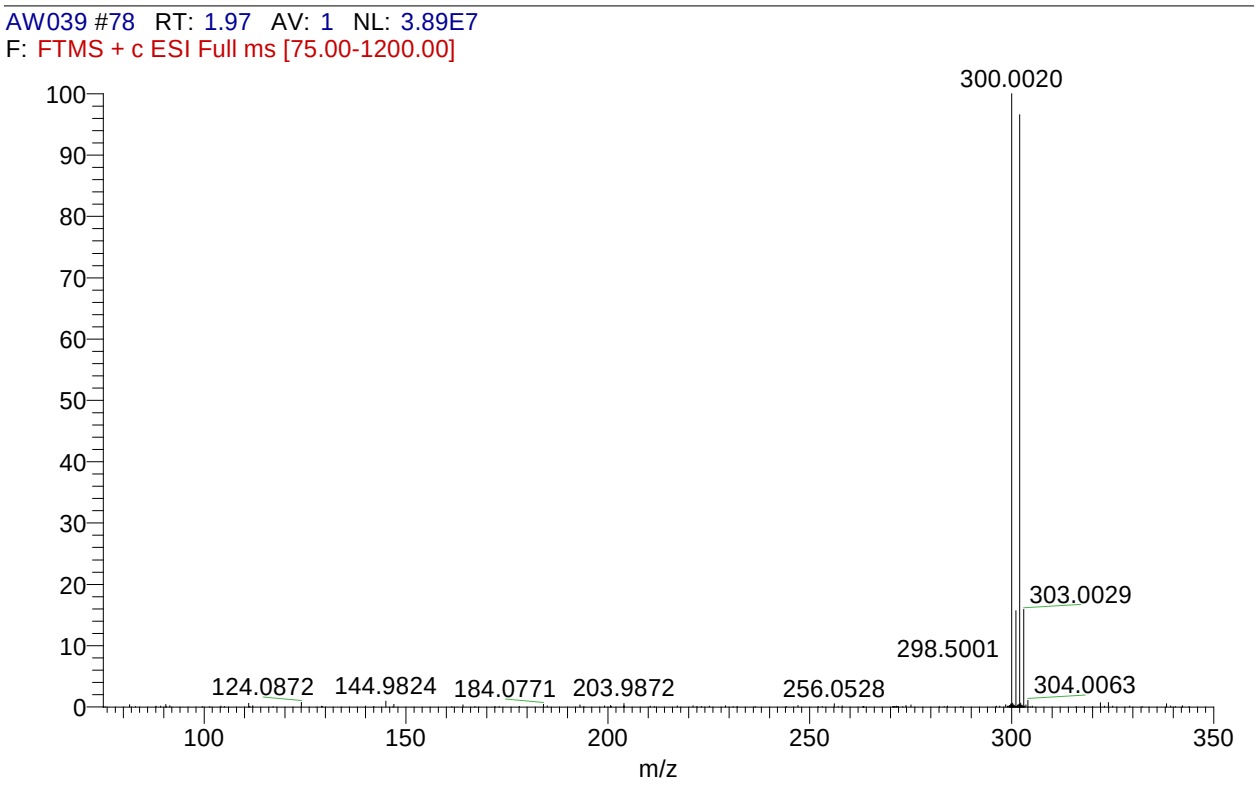

**$^{13}$C NMR:**



**FTIR:**

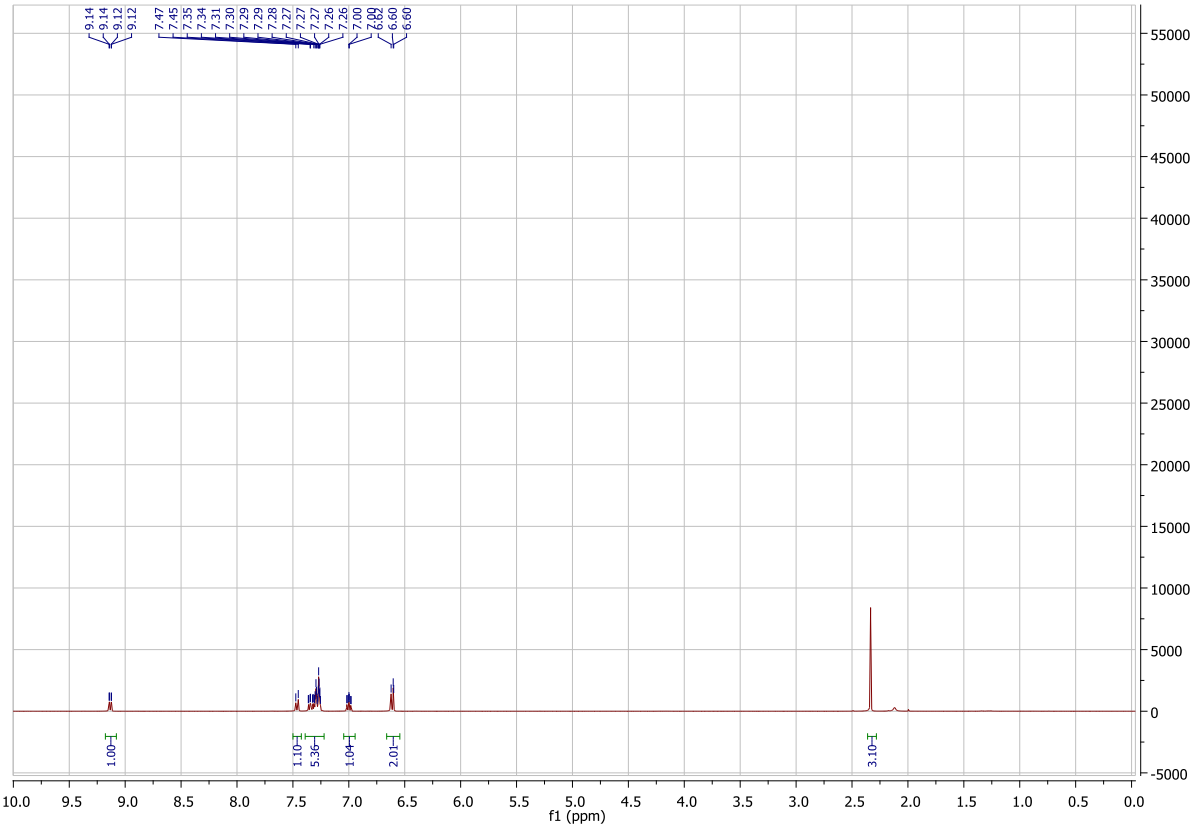



**HRMS:**

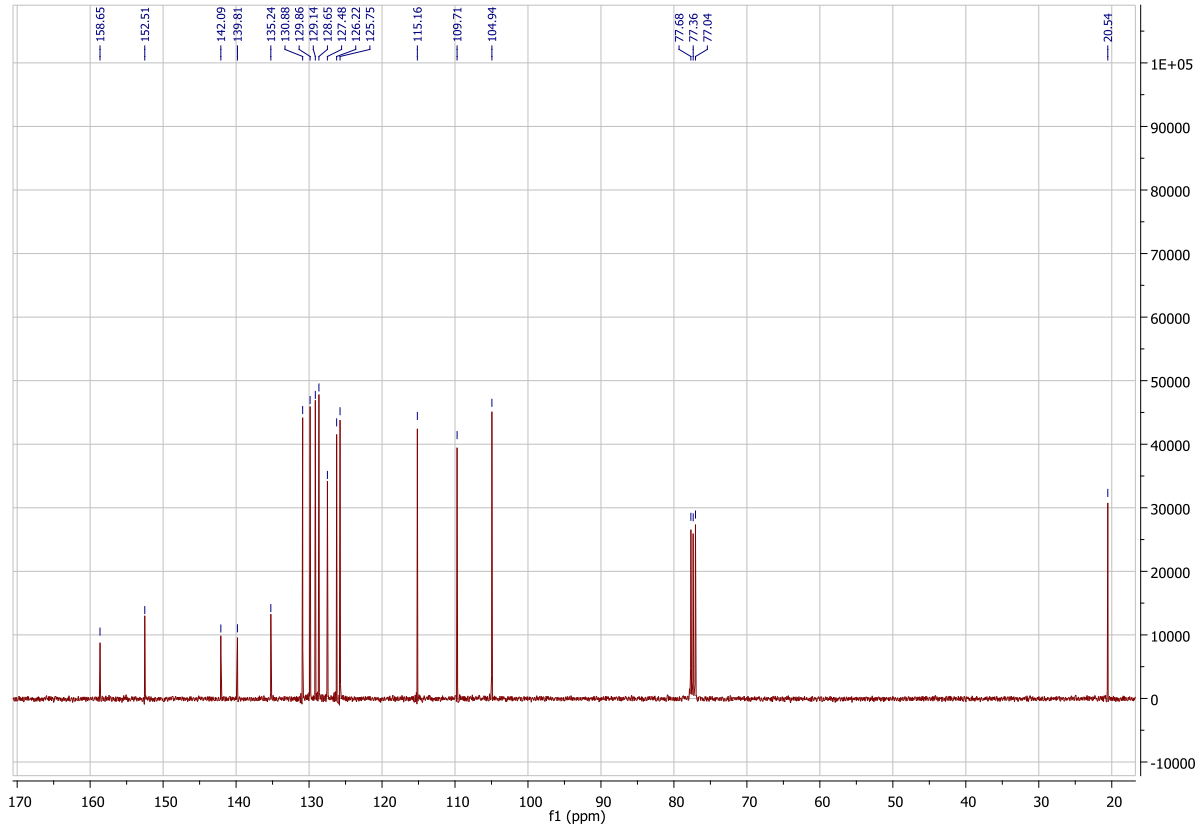


**Compound 3j: 2-(*o*-Tolyl)-4*H*-quinolizin-4-one**

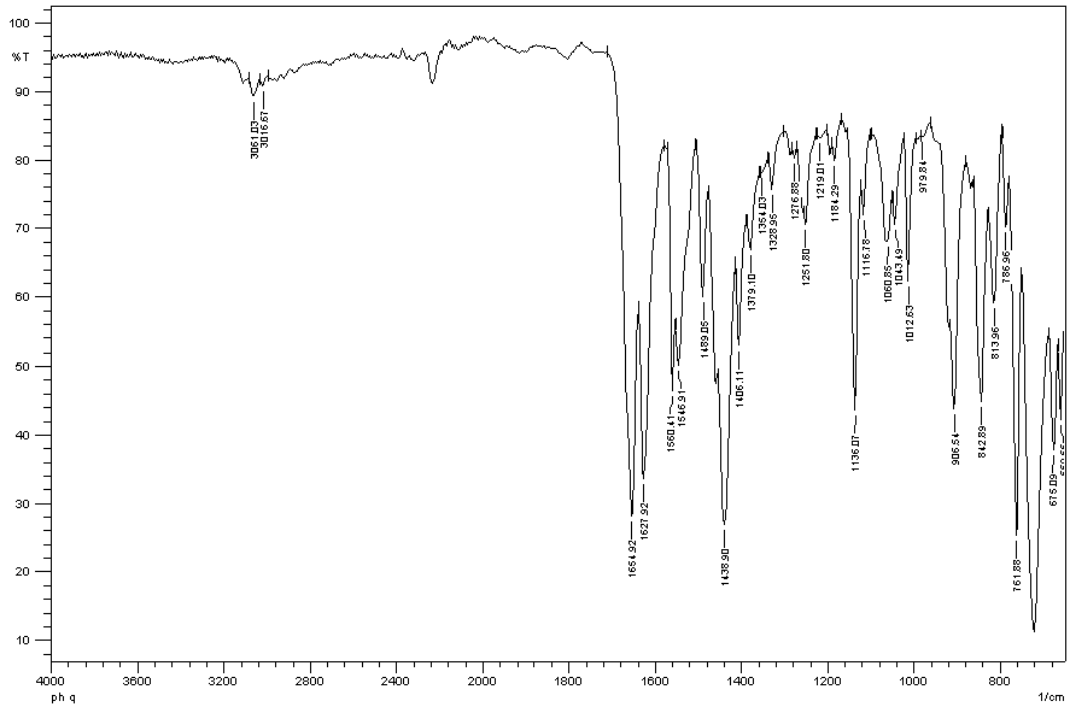
**$^{1}$H NMR:**



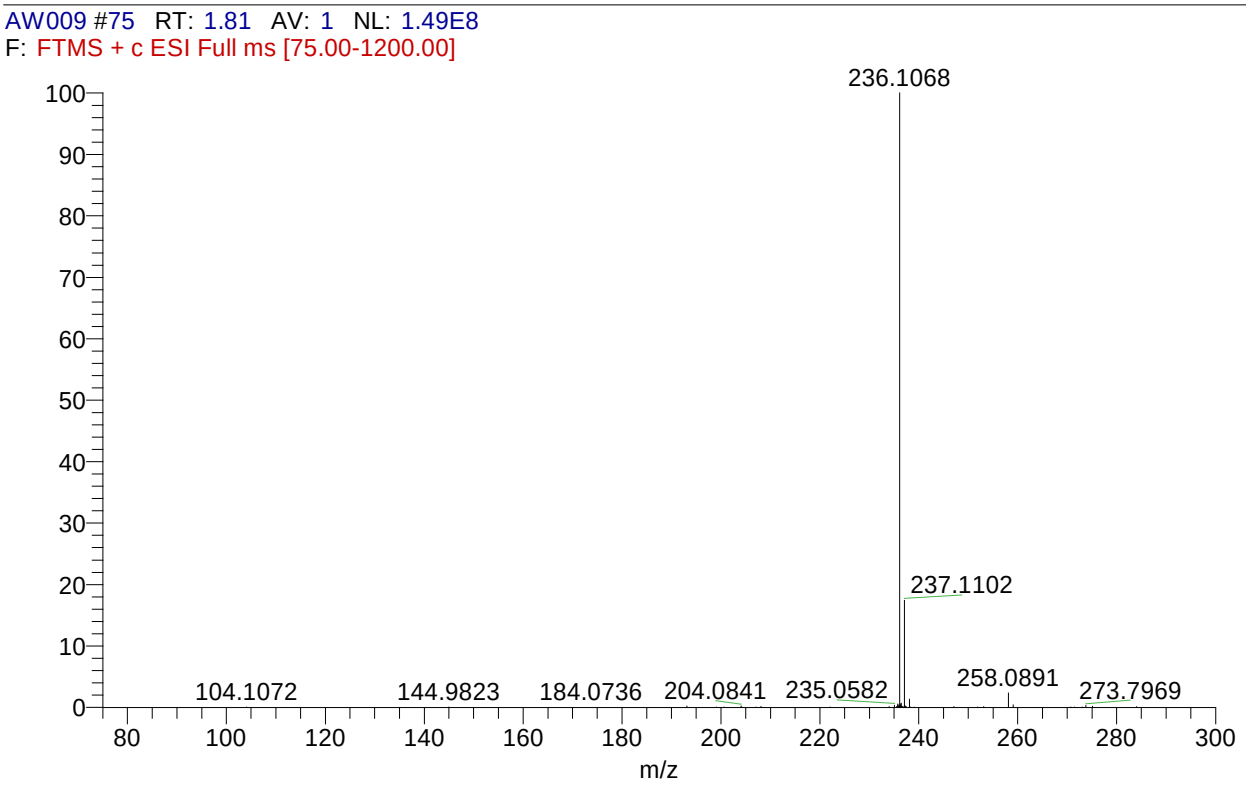

**$^{13}$C NMR:**



**FTIR:**

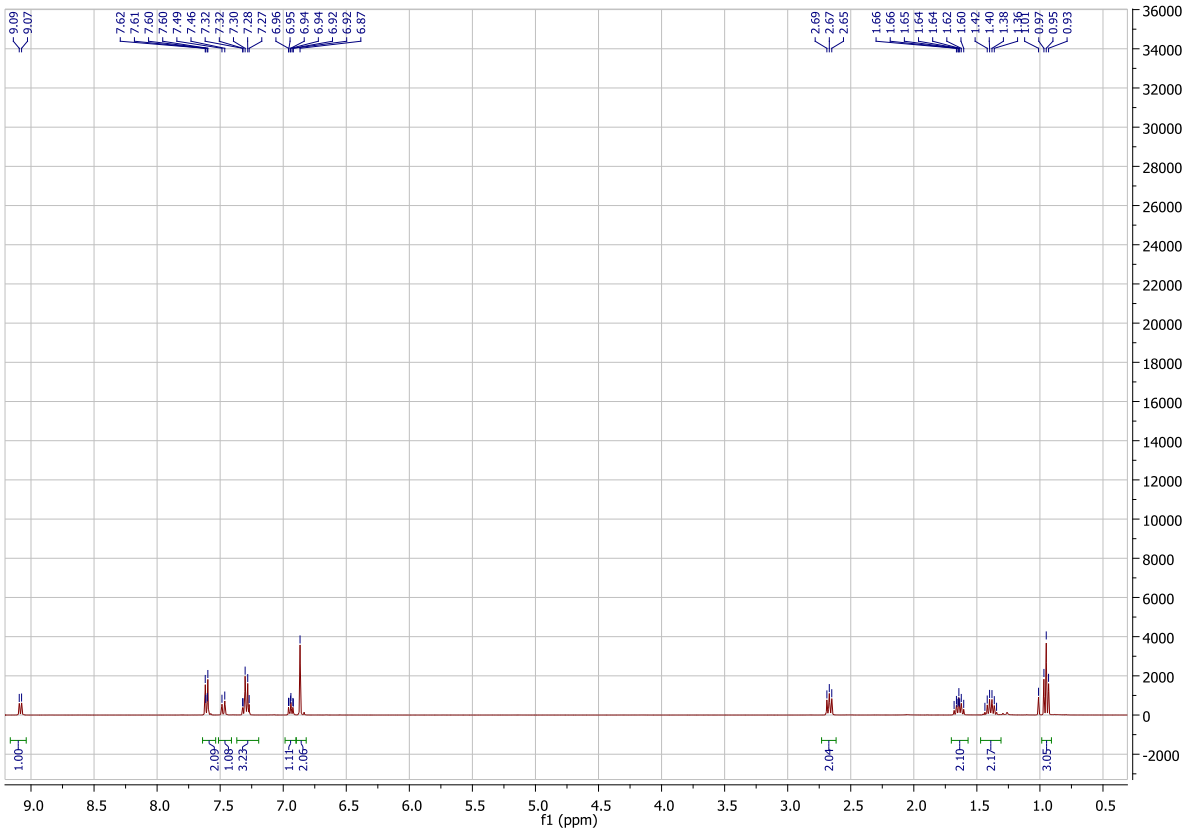



**HRMS:**

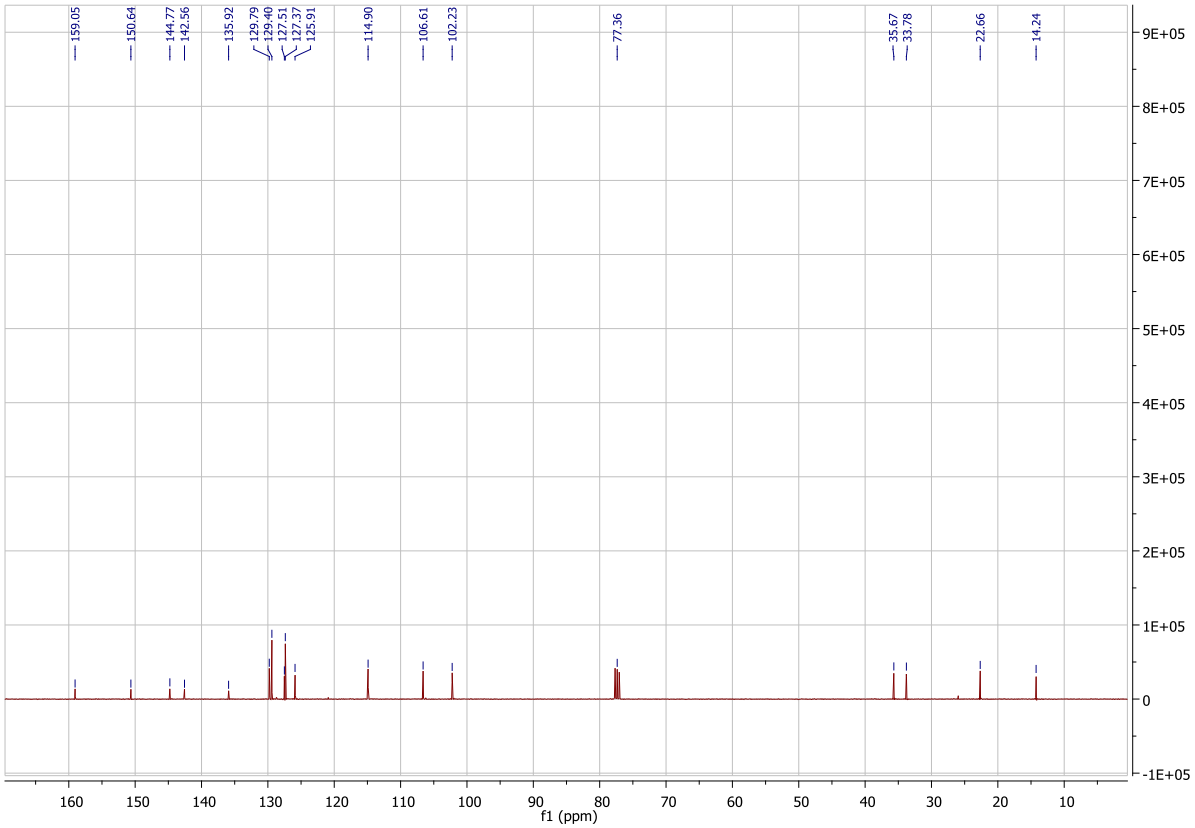


**Compound 3k: 2-(4-(*n*-Butyl)phenyl)-4*H*-quinolizin-4-one**

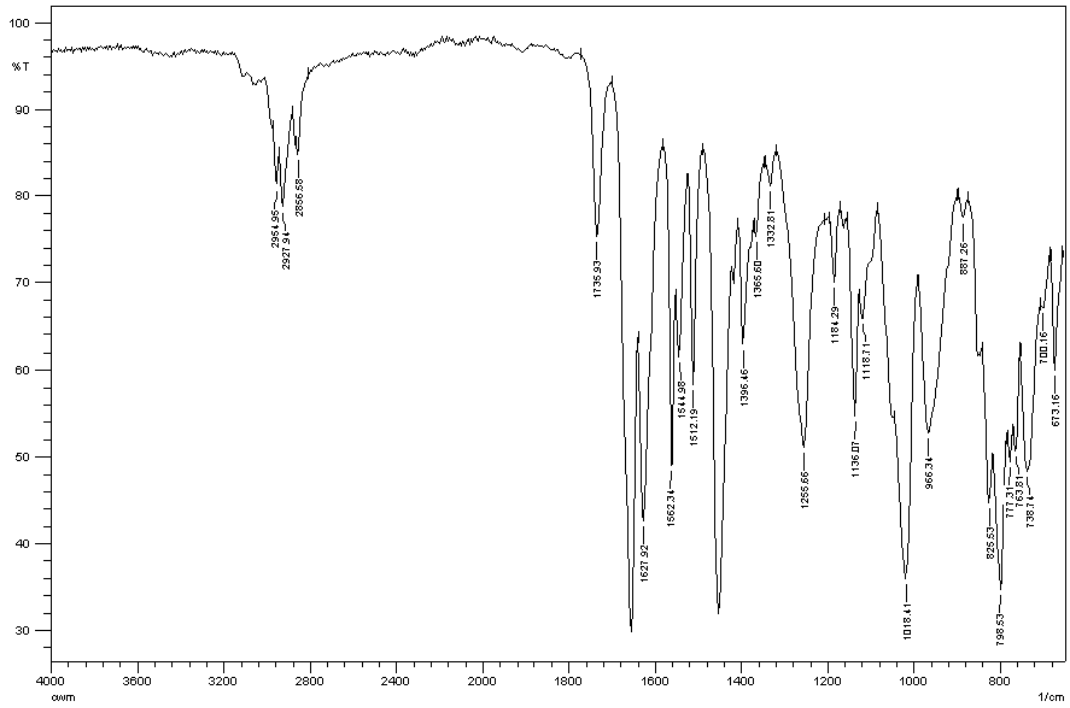
**$^{1}$H NMR:**



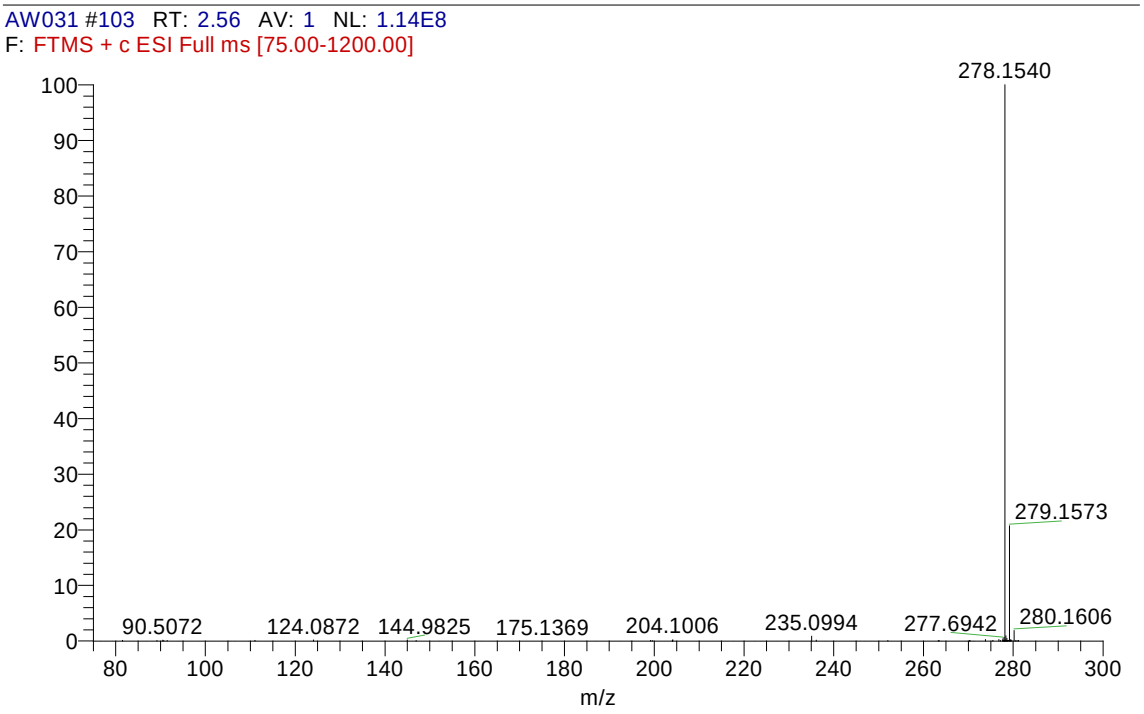

**$^{13}$C NMR:**



**FTIR:**

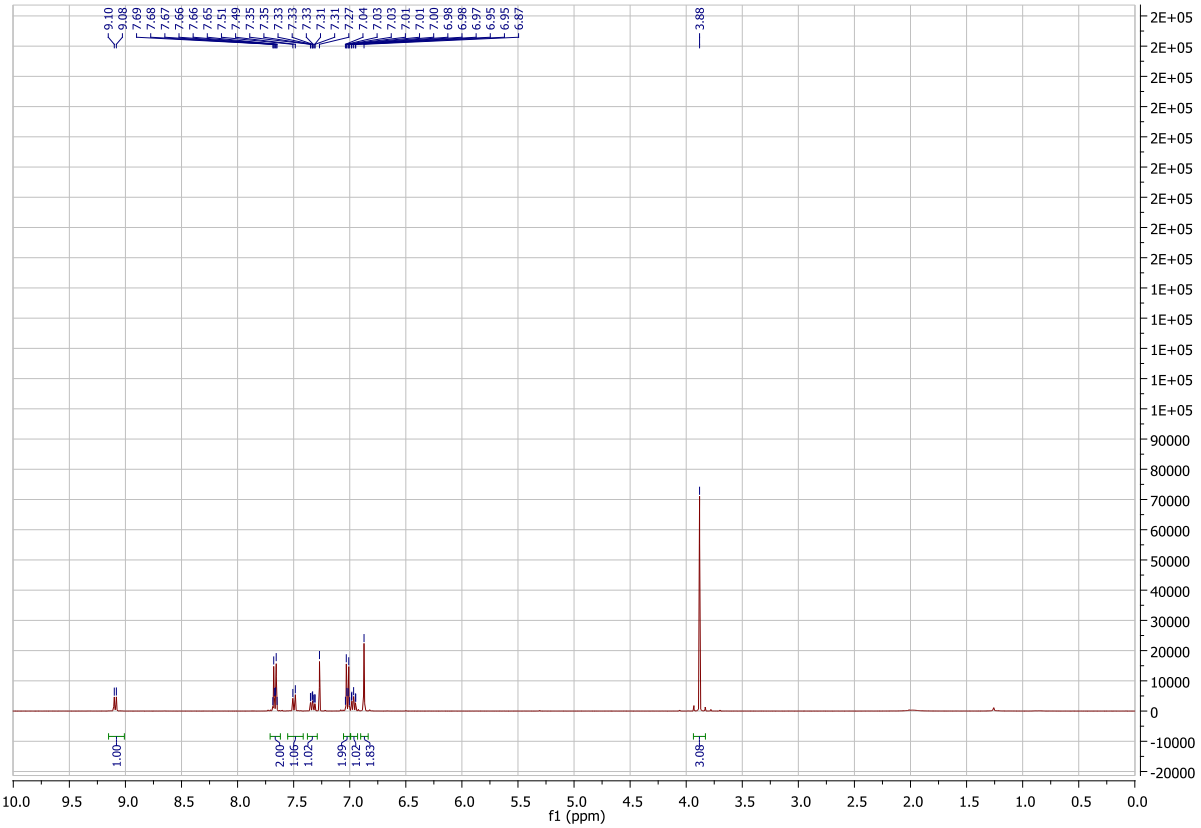



**HRMS:**

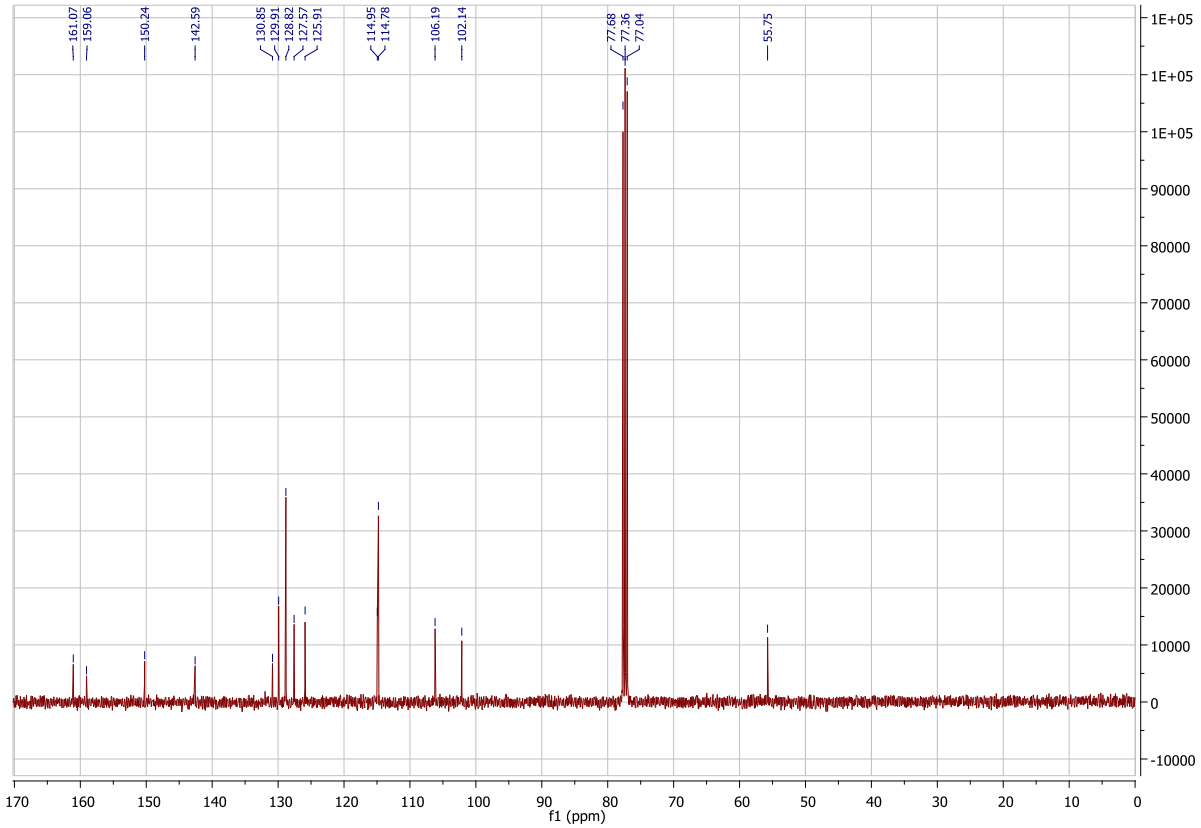


## Compound 3l: 2-(4-Methoxyphenyl)-4*H*-quinolizin-4-one

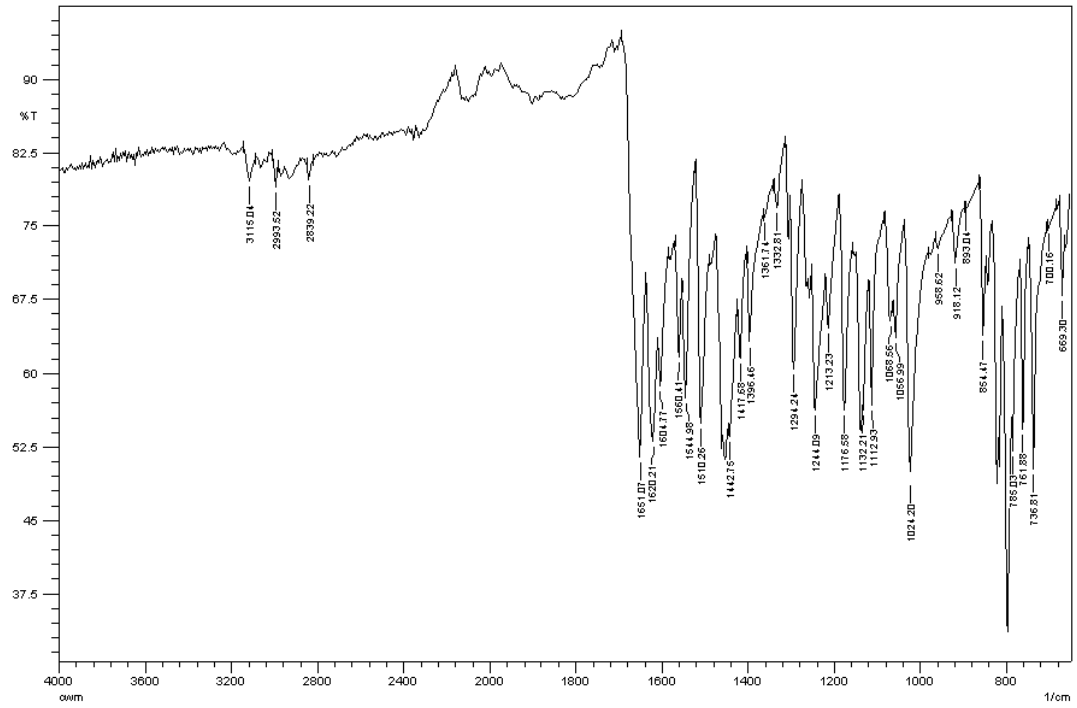
**$^{1}$H NMR:**



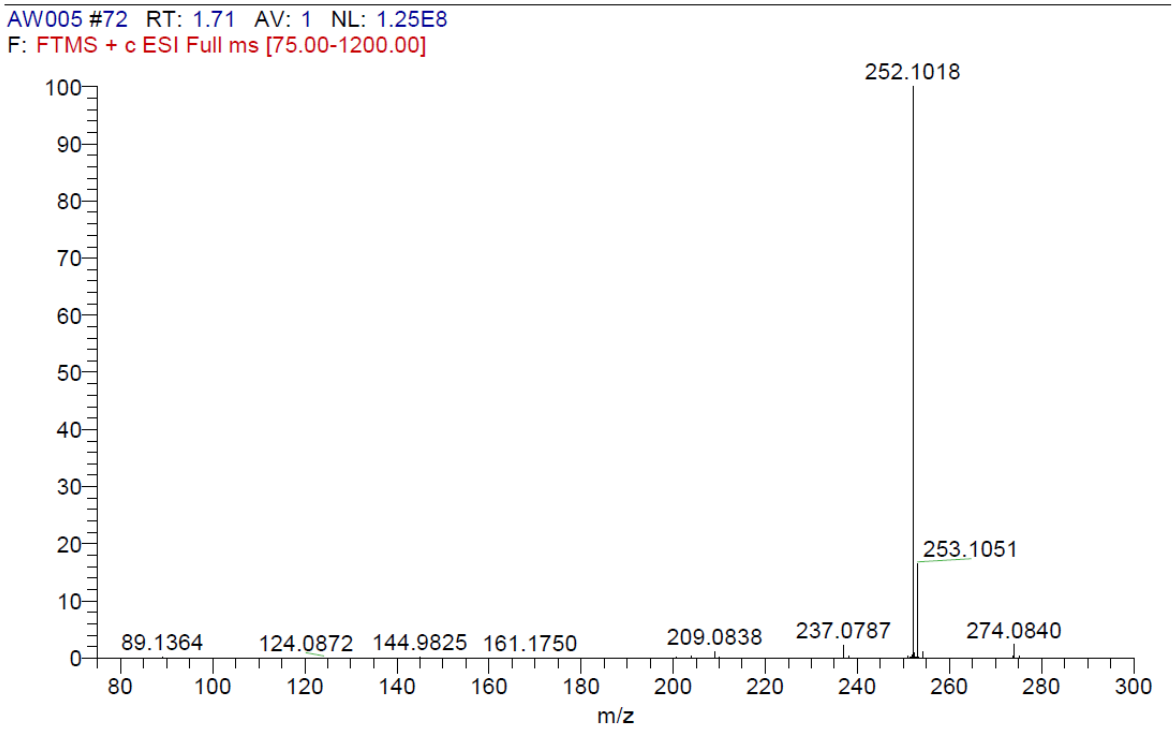

**$^{13}$C NMR:**



**FTIR:**

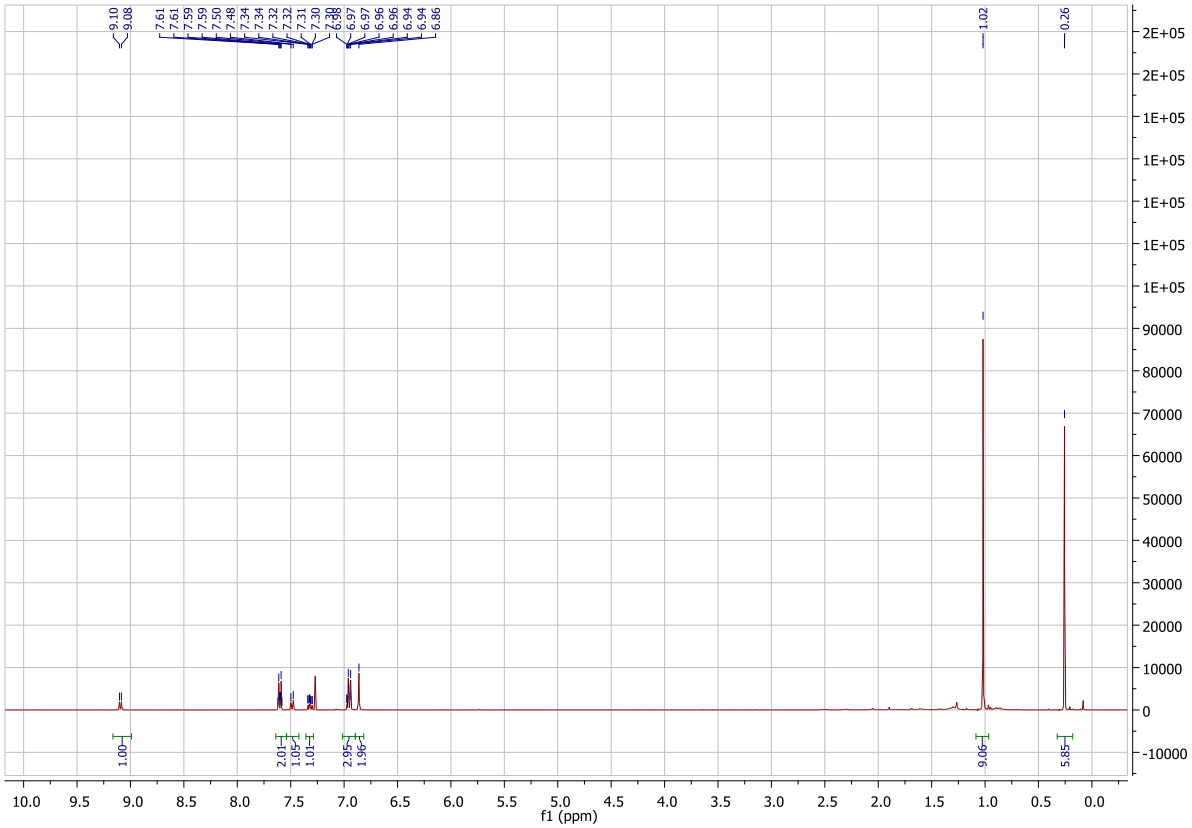



**HRMS:**

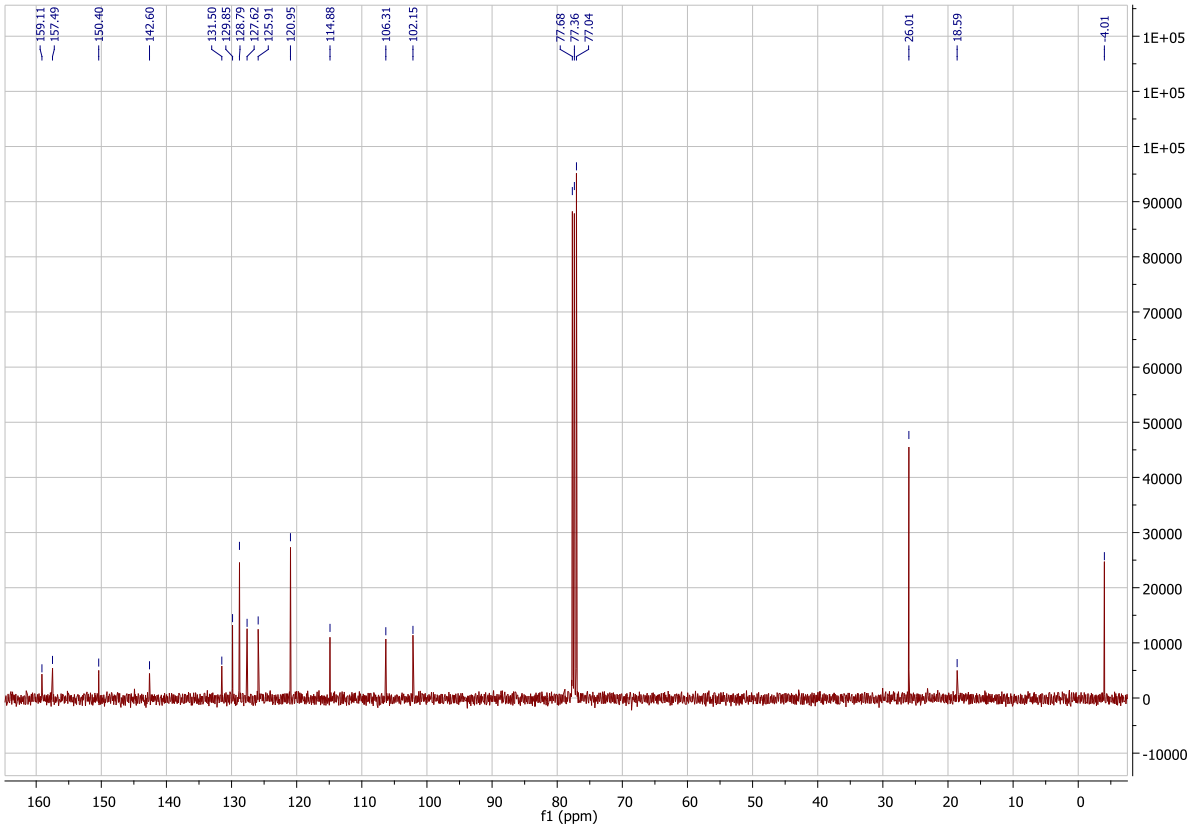


**Compound 3m: 2-(4-((*tert*-Butyldimethylsilyl)oxy)phenyl)-4*H*-quinolizin-4-one**

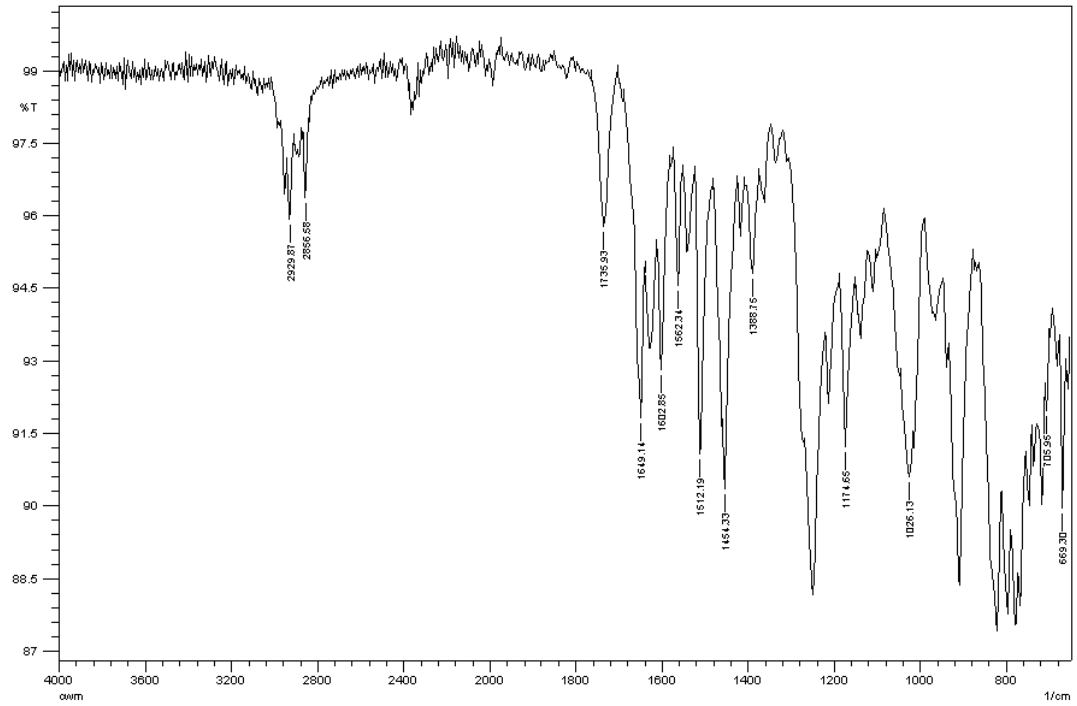
**$^{1}$H NMR:**



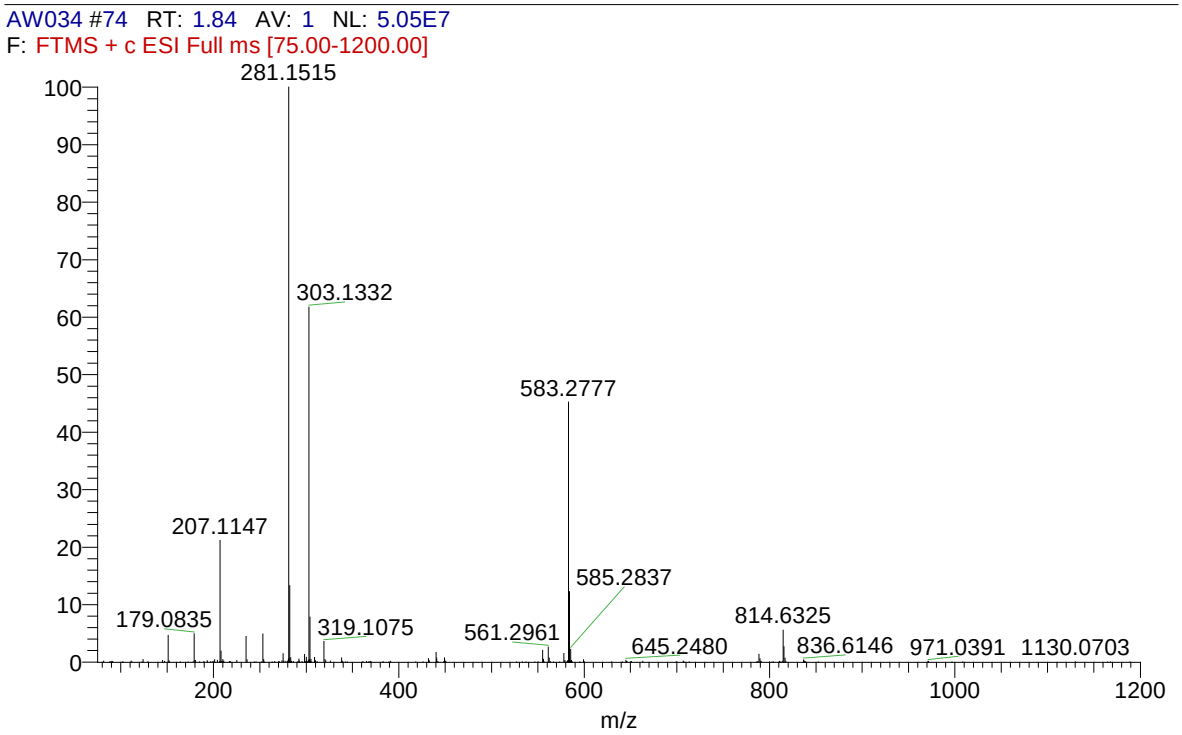

**$^{13}$C NMR:**



**FTIR:**

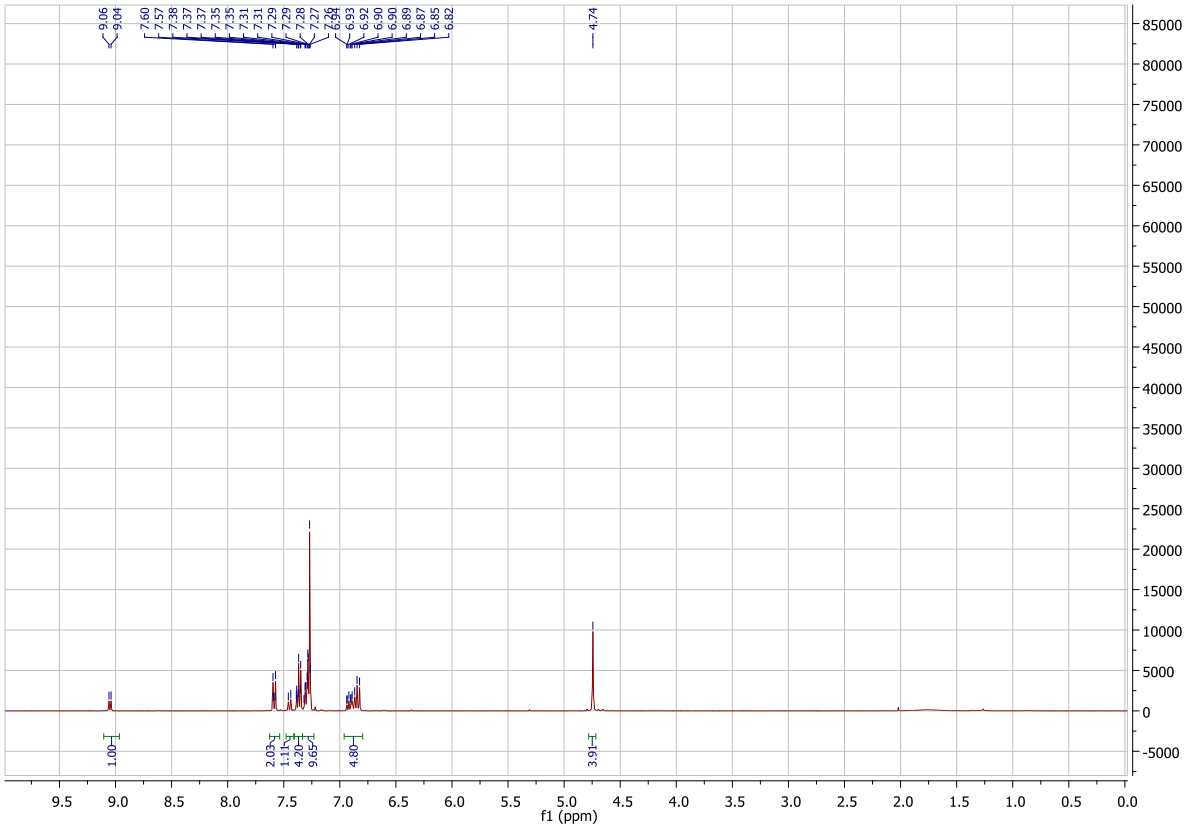



**HRMS:**

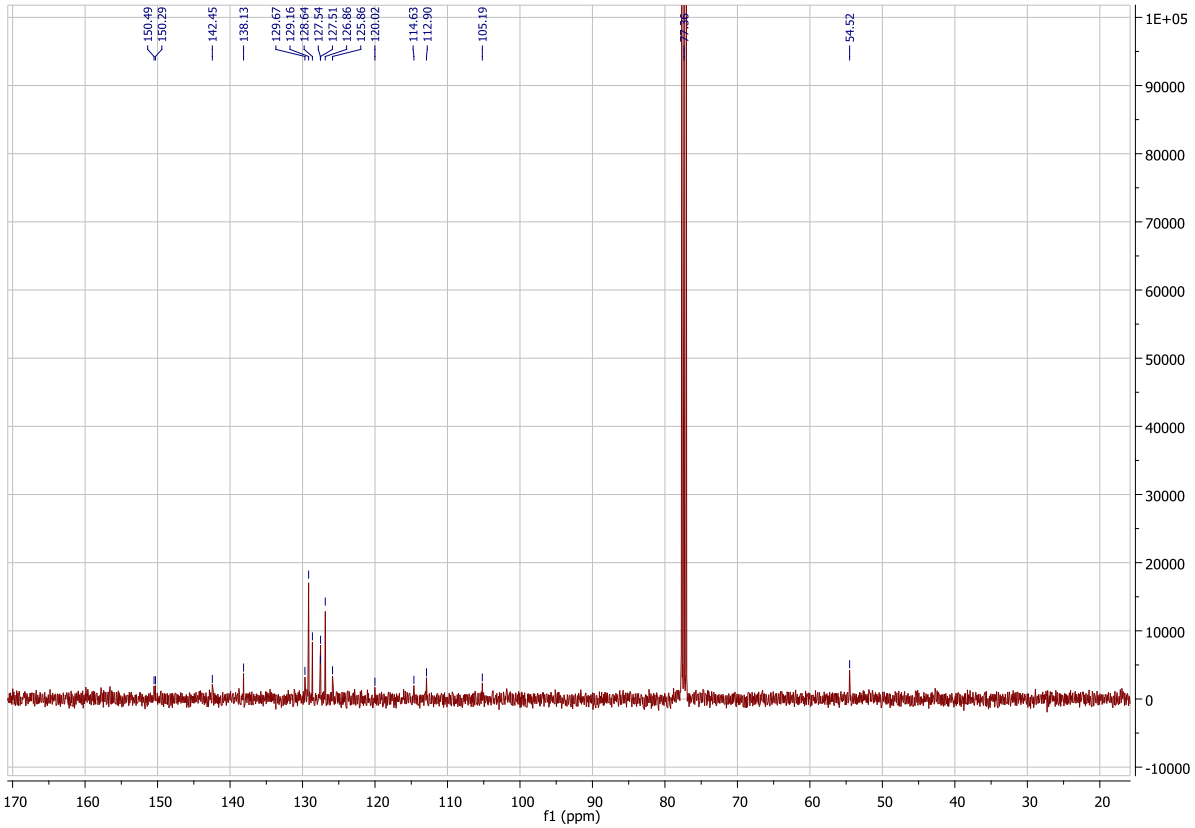


**Compound 3n: 2-(4-(Dibenzylamino)phenyl)-4*H*-quinolizin-4-one**

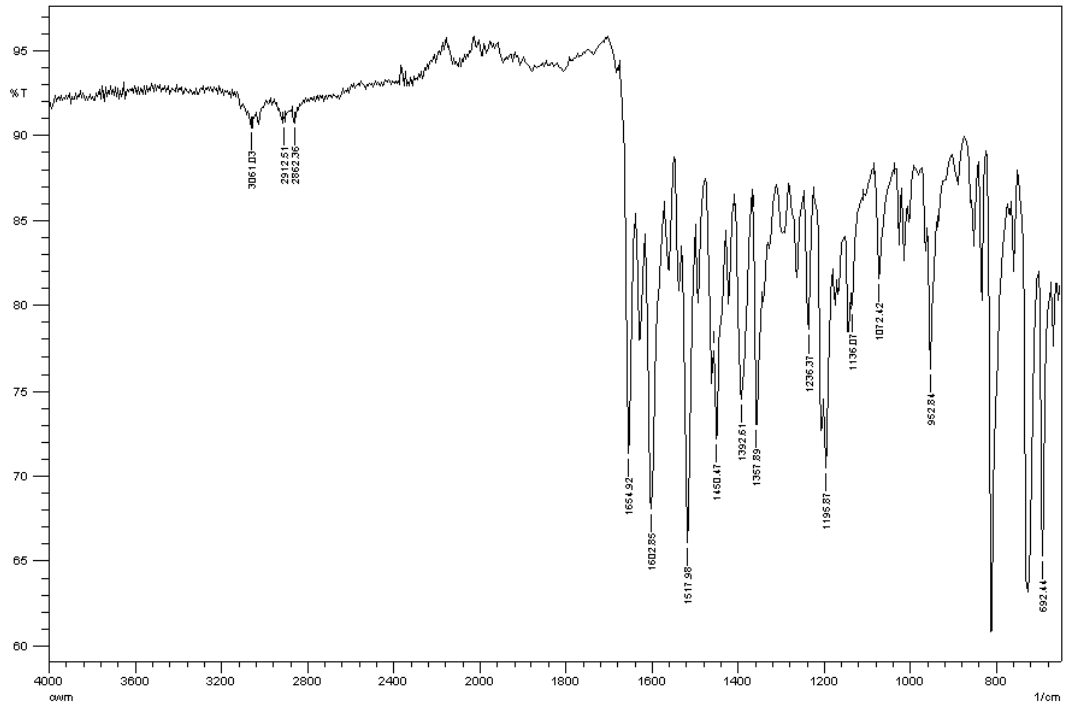
**$^{1}$H NMR:**



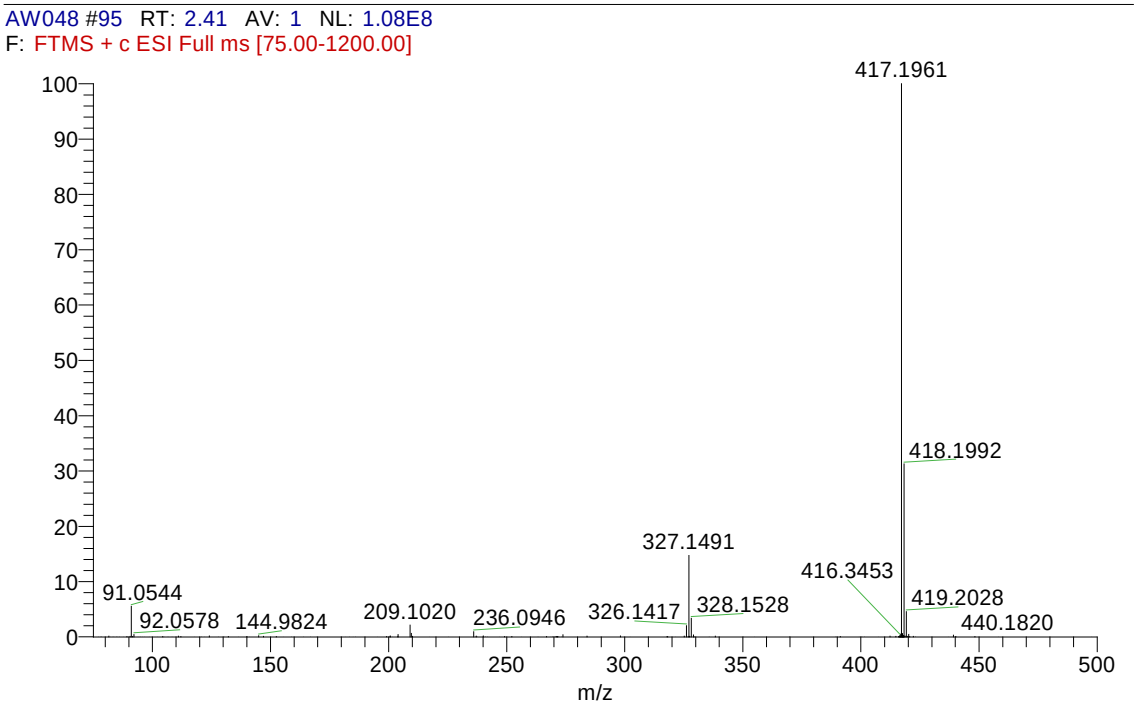

**$^{13}$C NMR:**



**FTIR:**

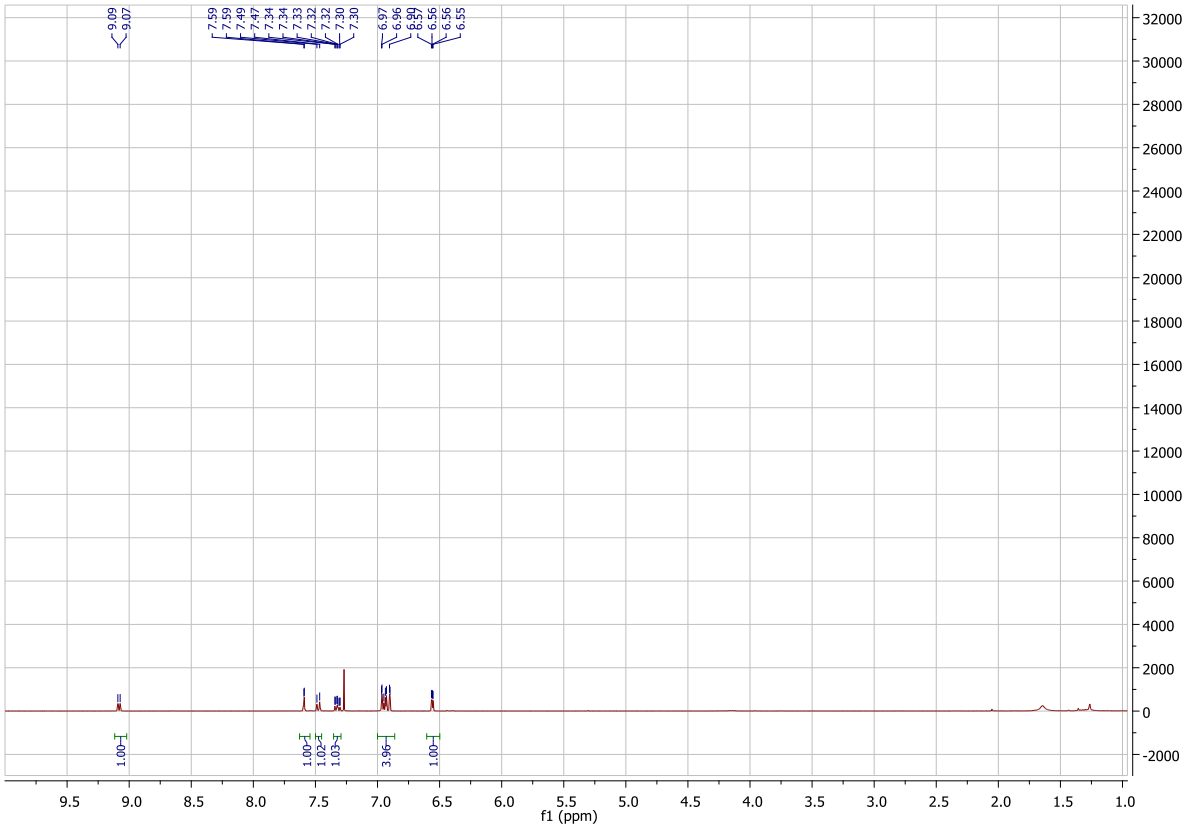



**HRMS:**

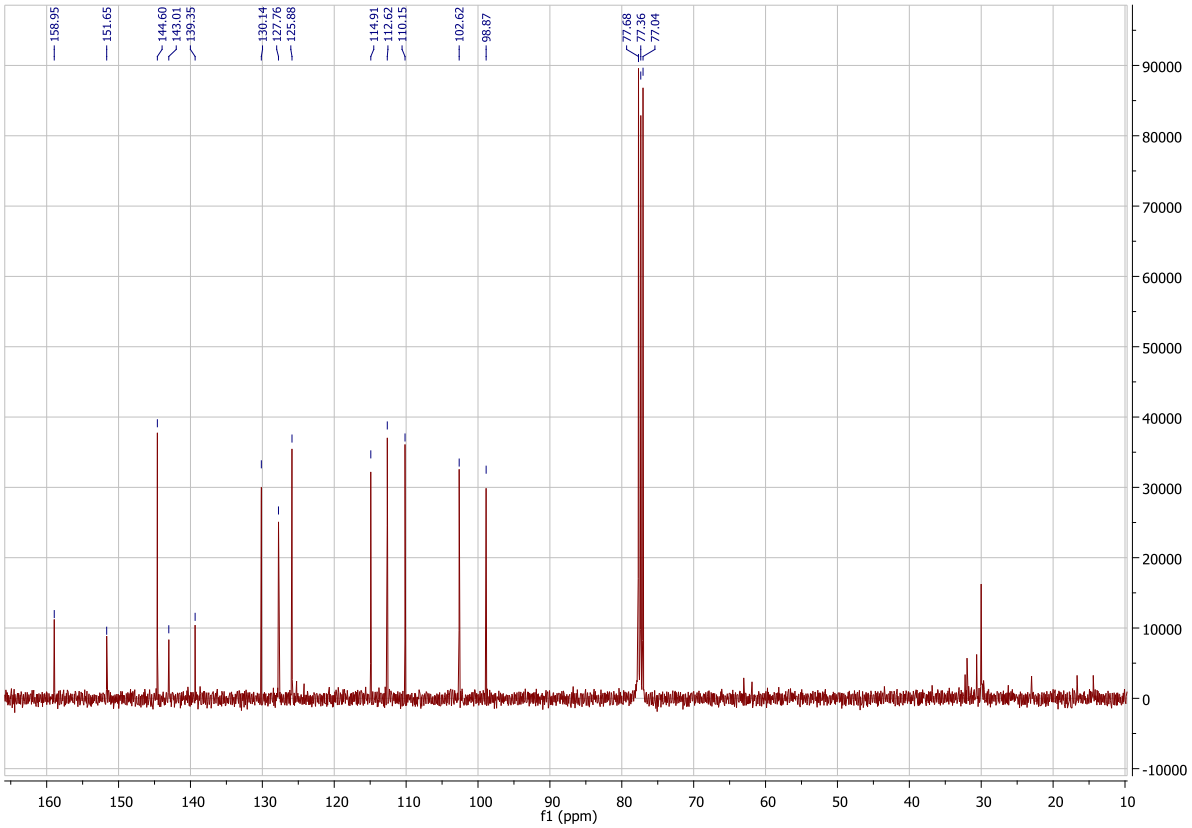


## Compound 3o: 2-(Furan-2-yl)-4*H*-quinolizin-4-one

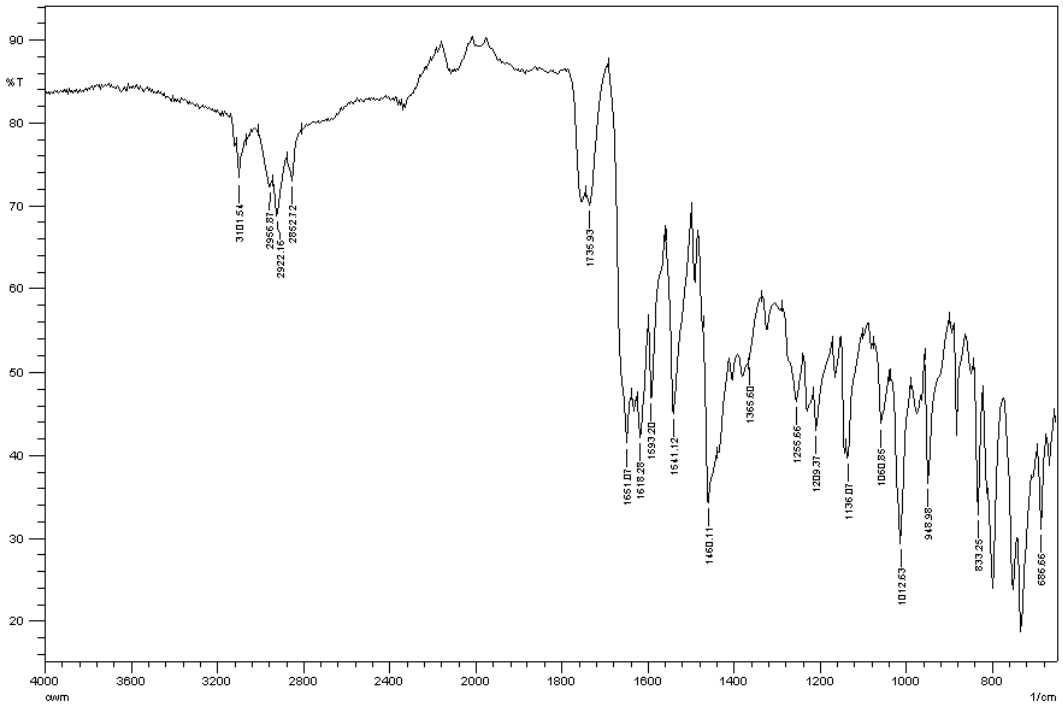
**$^{1}$H NMR:**



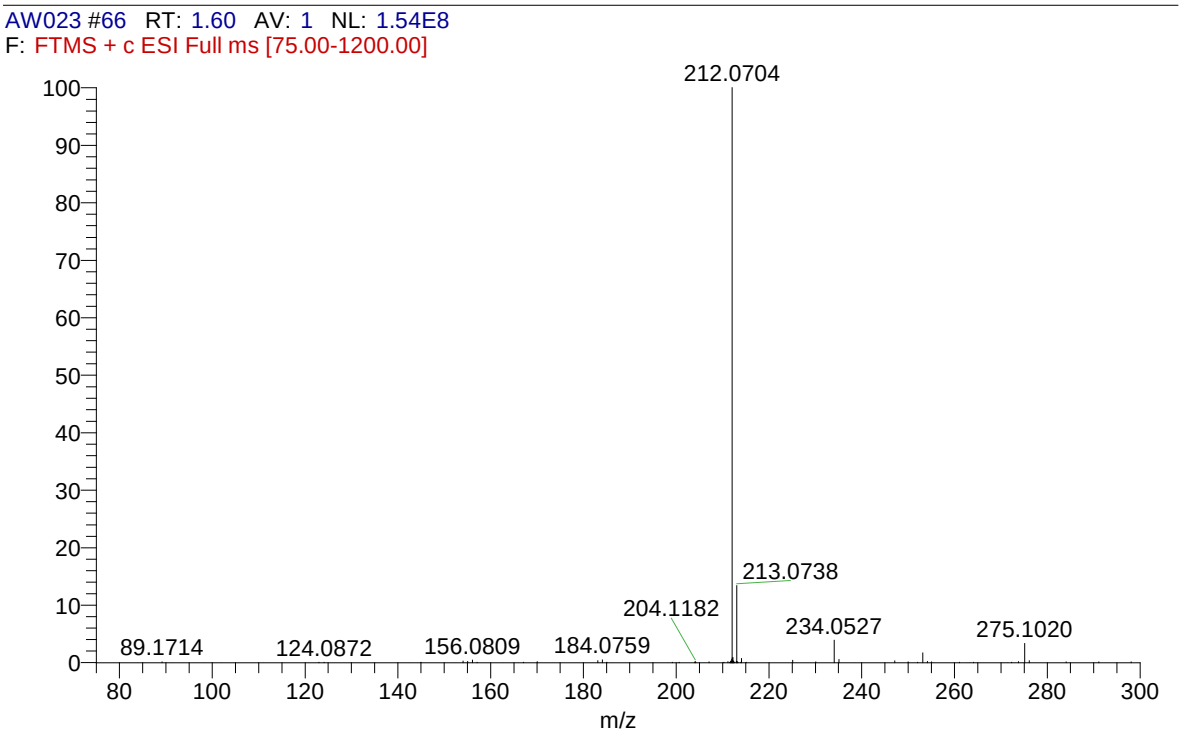

**$^{13}$C NMR:**



**FTIR:**

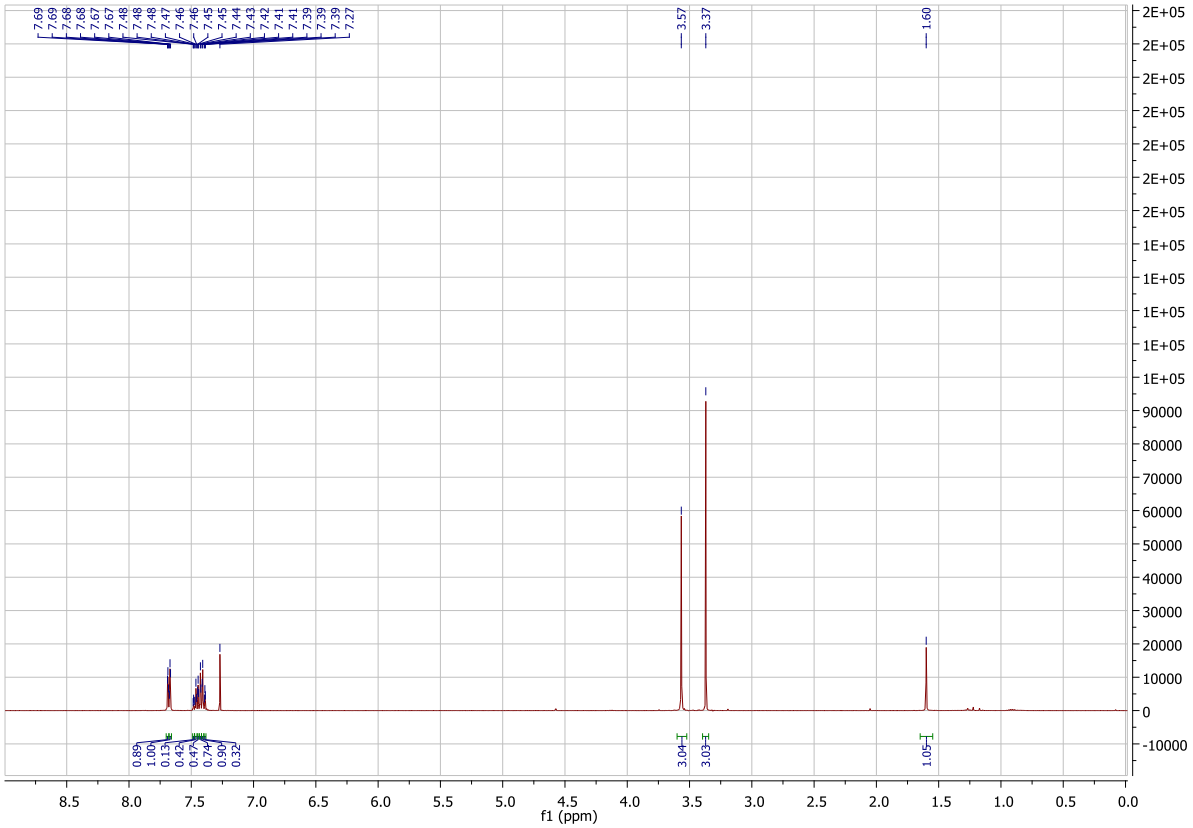



**HRMS:**

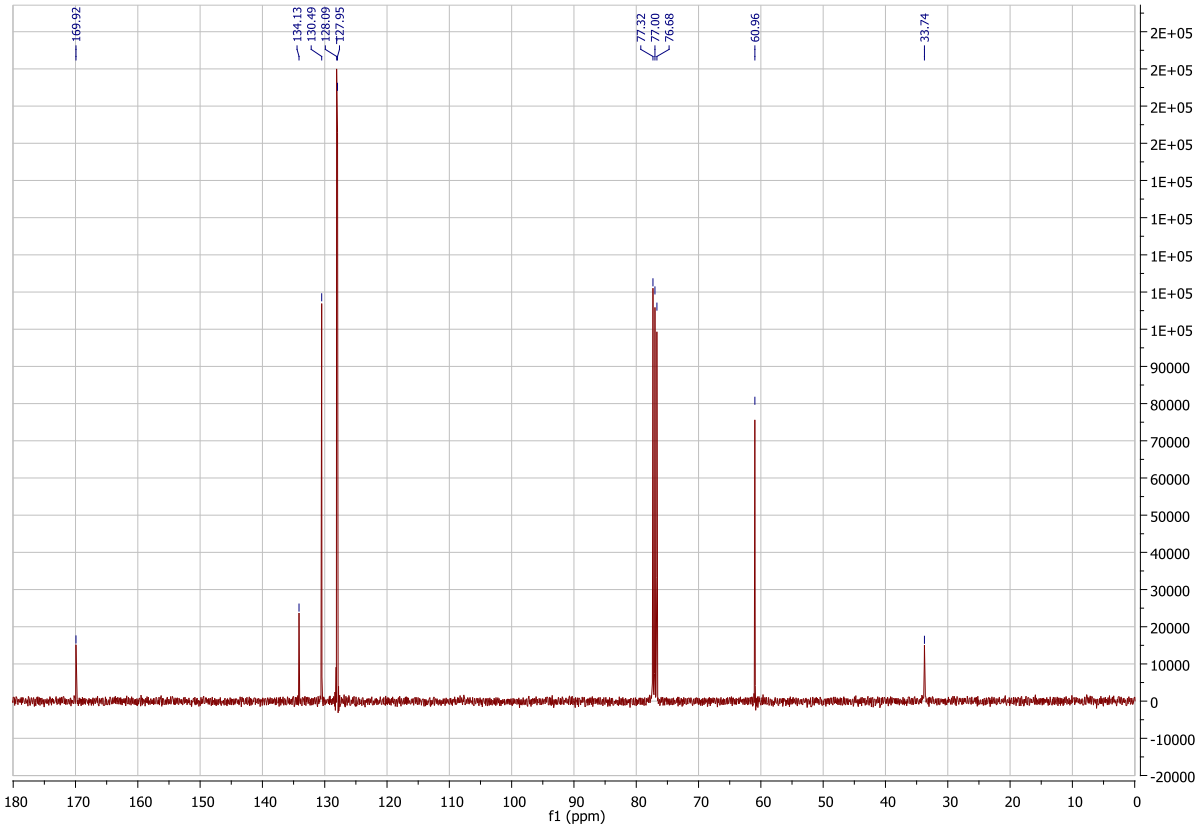


## Compound 5a: *N*-Methoxy-*N*-methylbenzamide

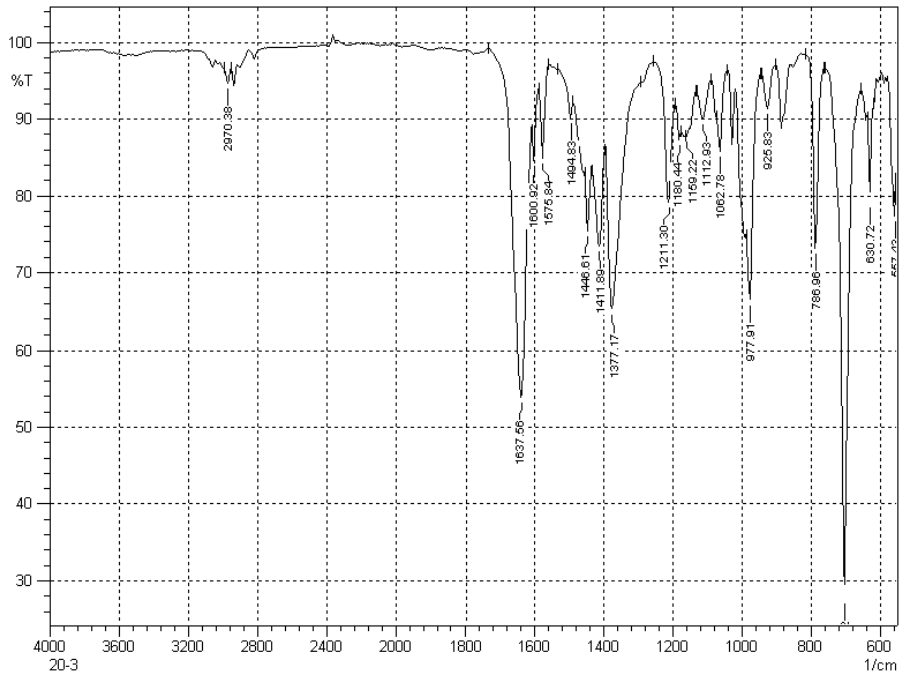
**$^{1}$H NMR:**



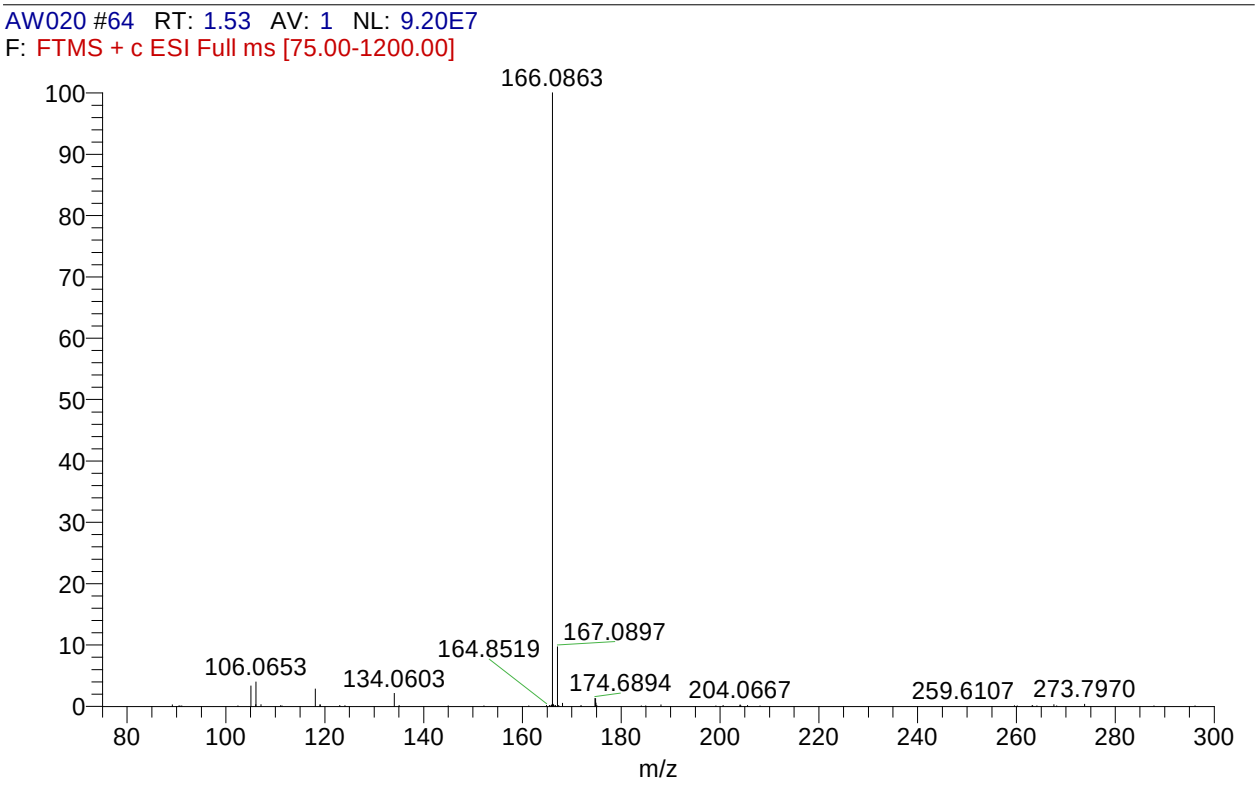

**$^{13}$C NMR:**



**FTIR:**

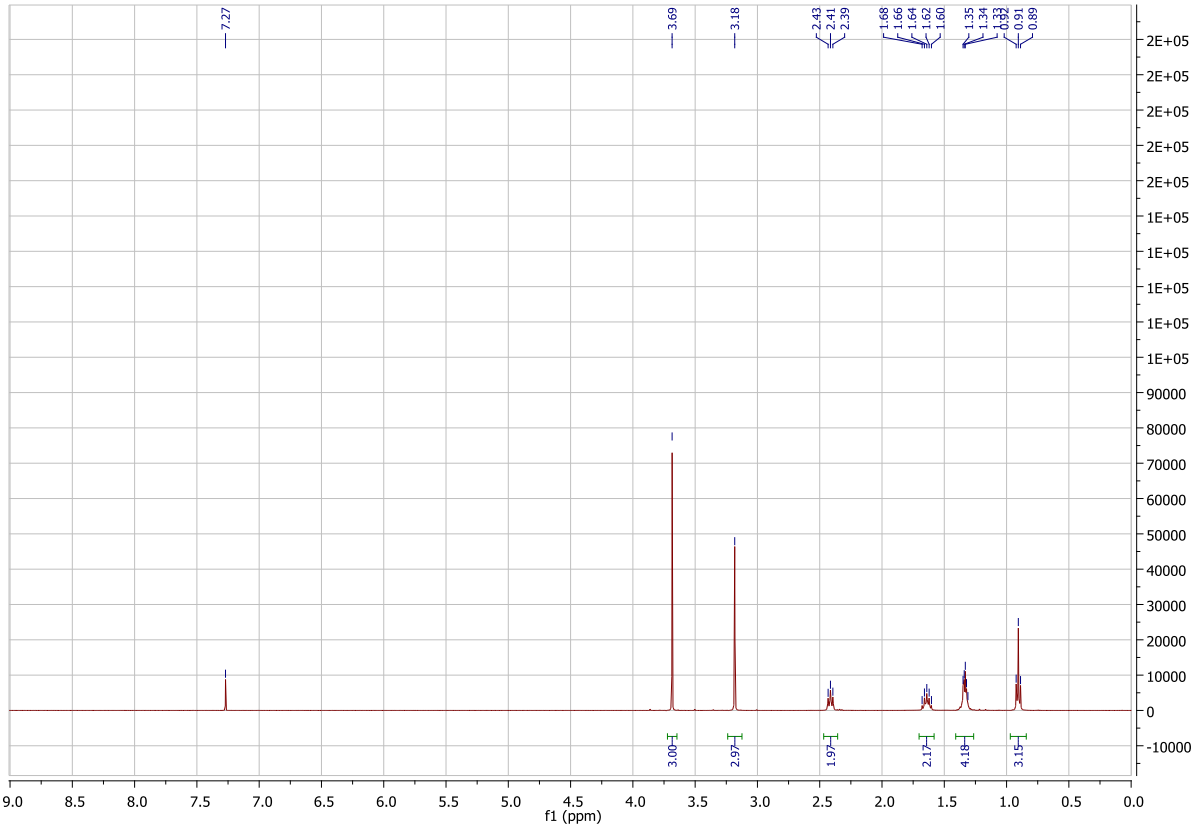



**HRMS:**

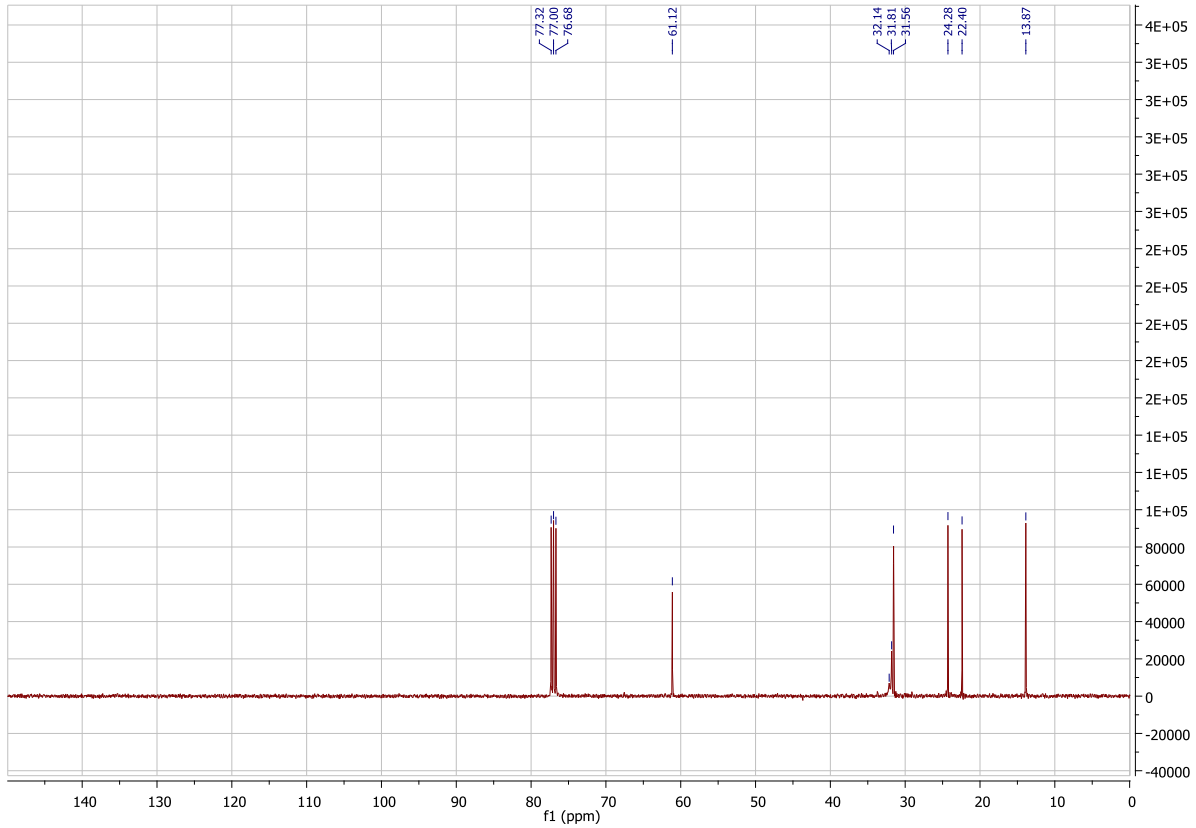


## Compound 5b: *N*-Methoxy-*N*-methylhexanamide

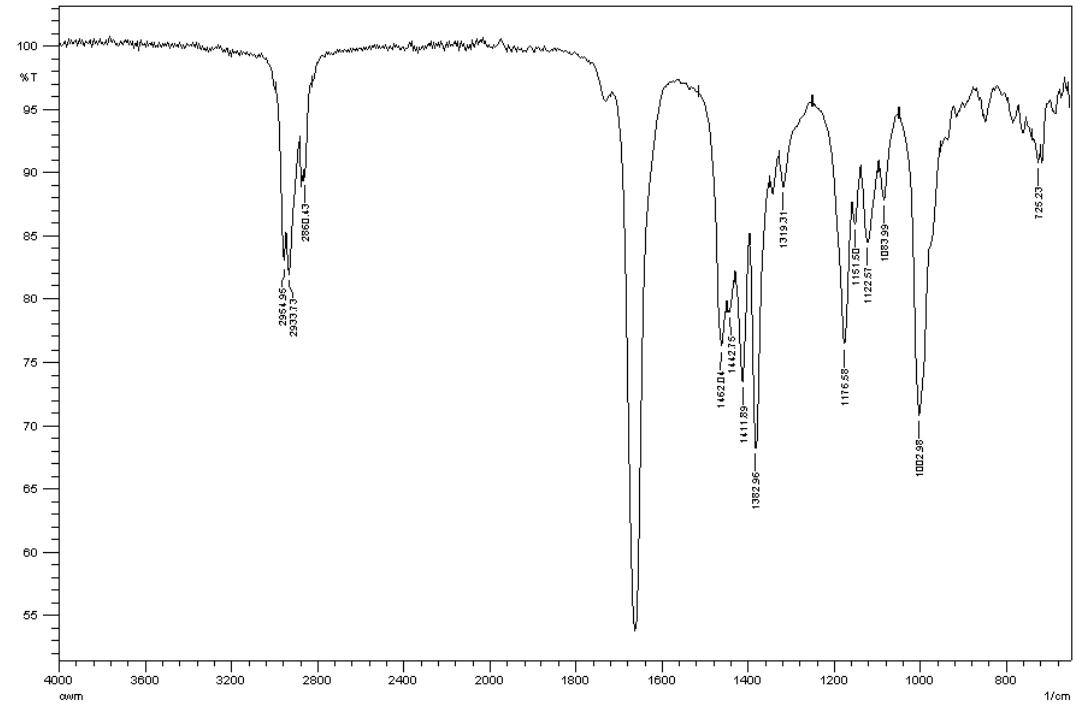
### $^{1}$H NMR:



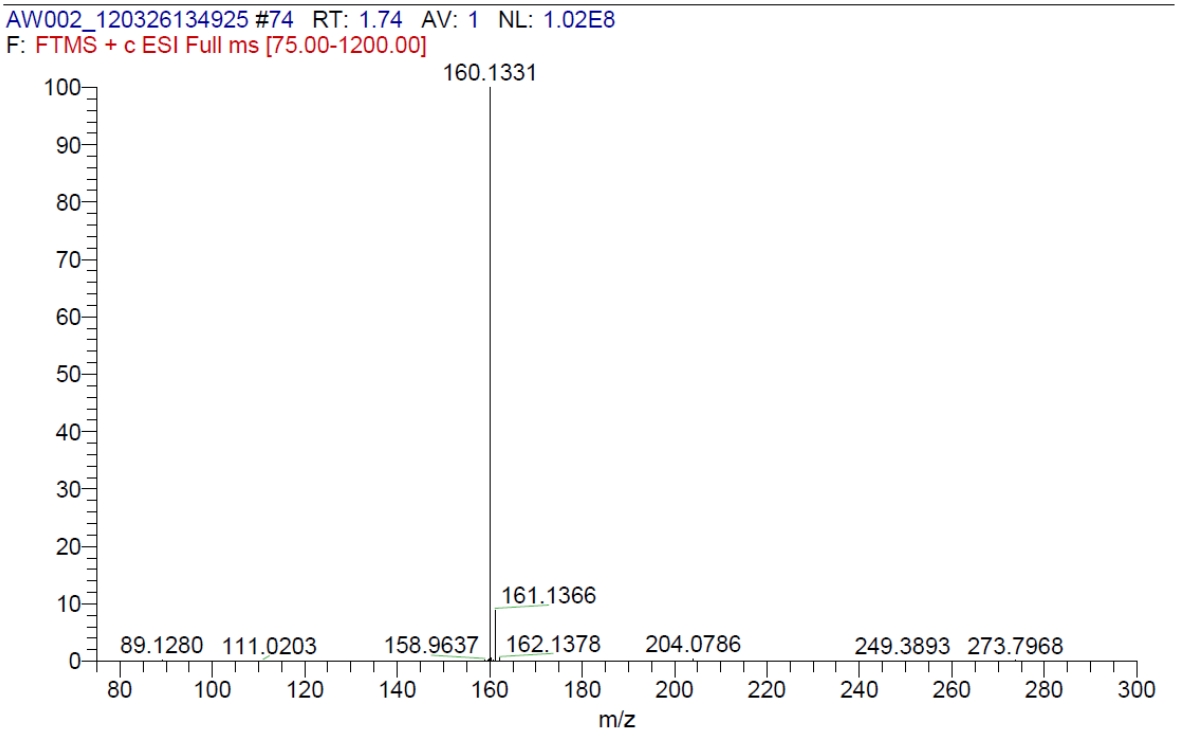

### $^{13}$C NMR:



**FTIR:**

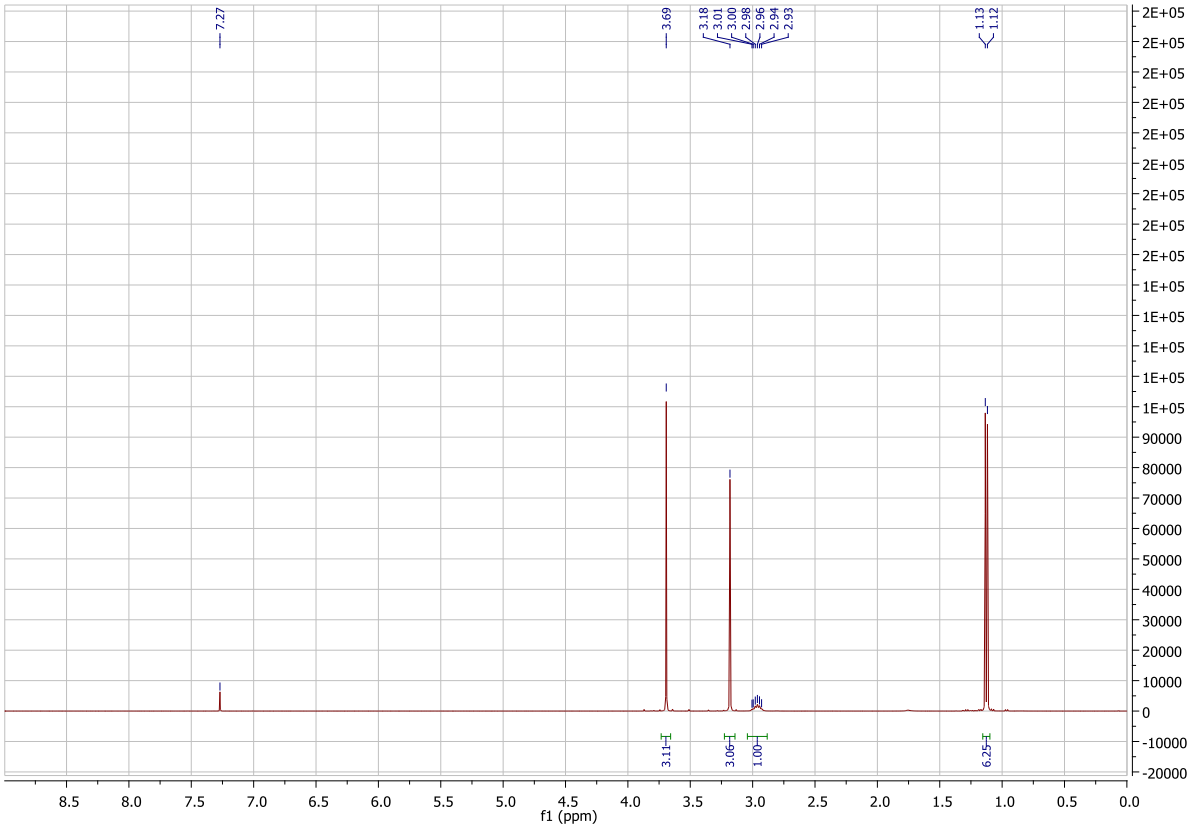



**HRMS:**

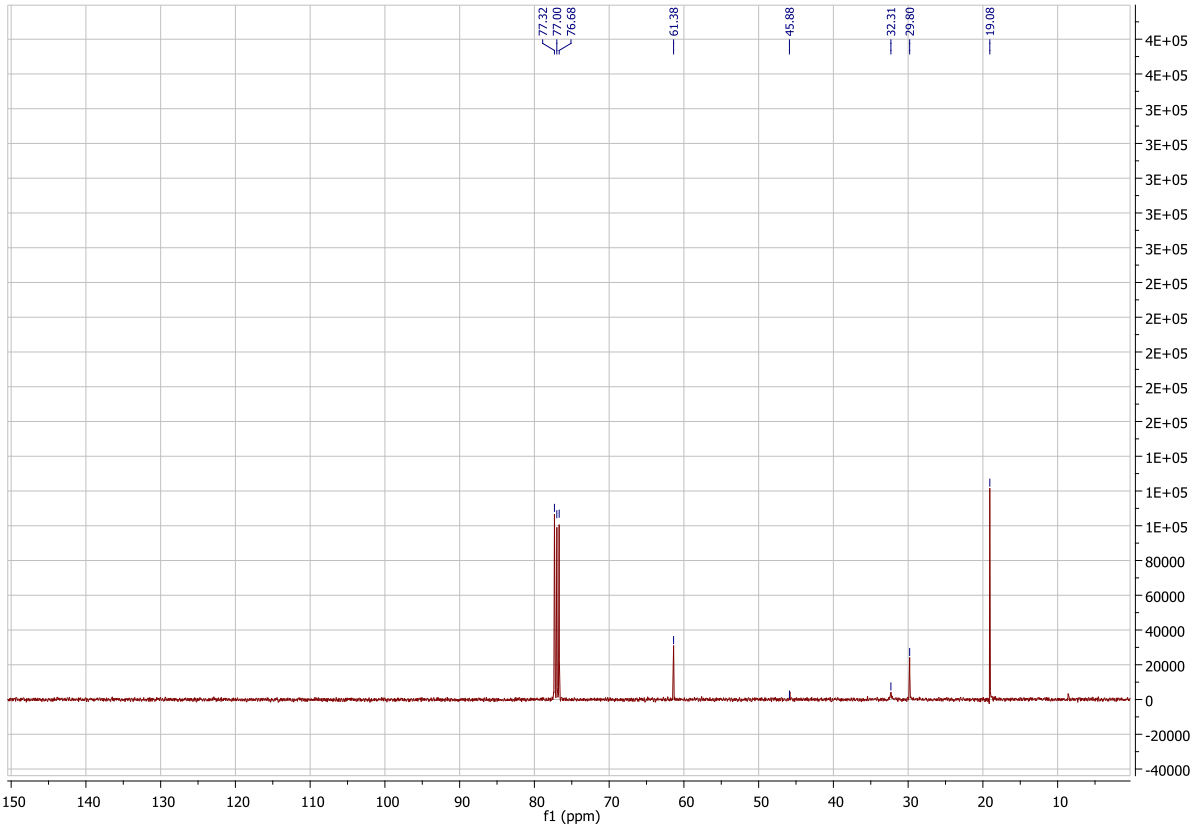


## Compound 5c: *N*-Methoxy-*N*-methylisobutyramide

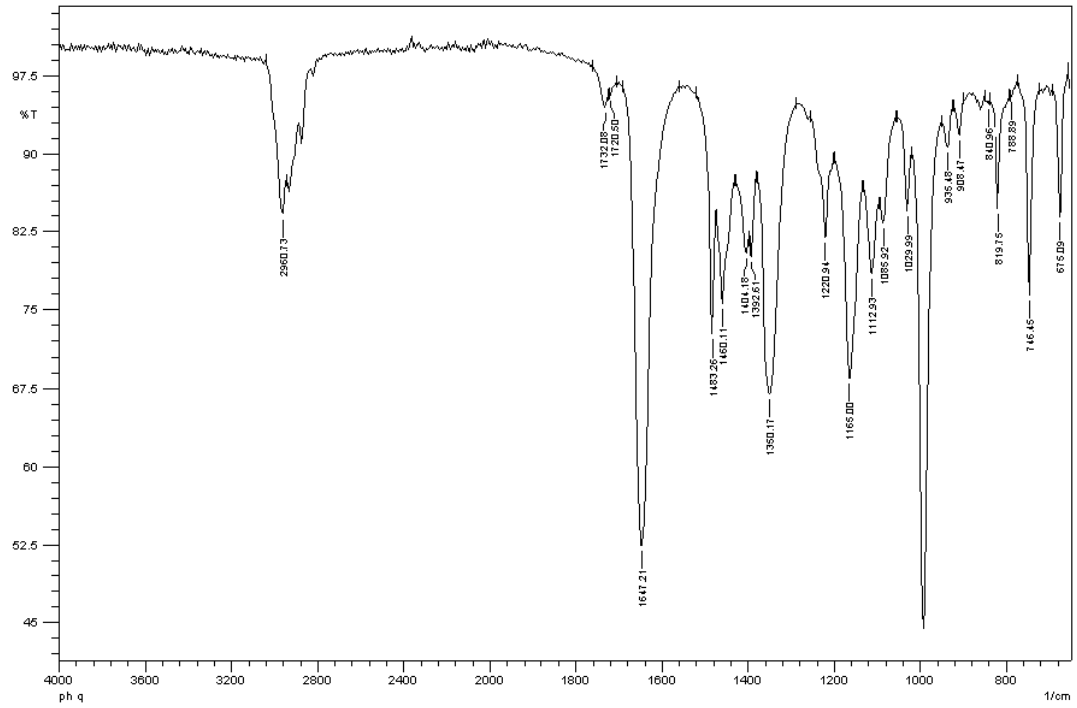
### $^{1}$H NMR:



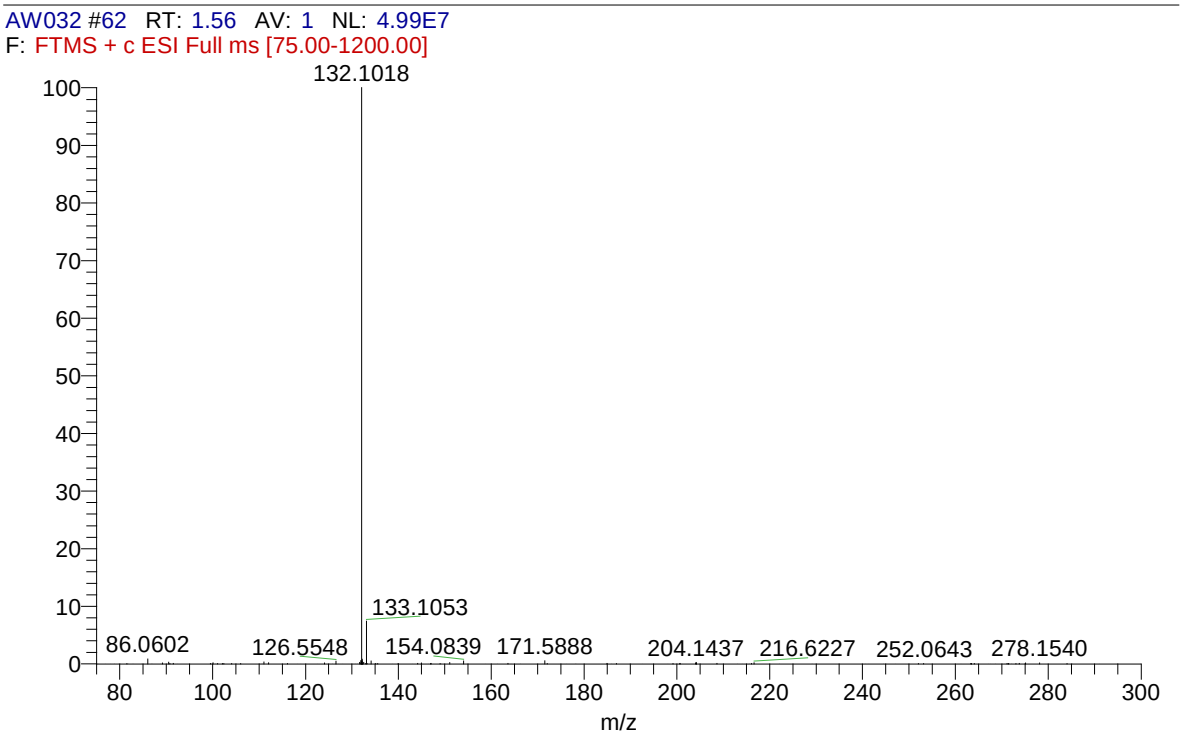

### $^{13}$C NMR:



**FTIR:**

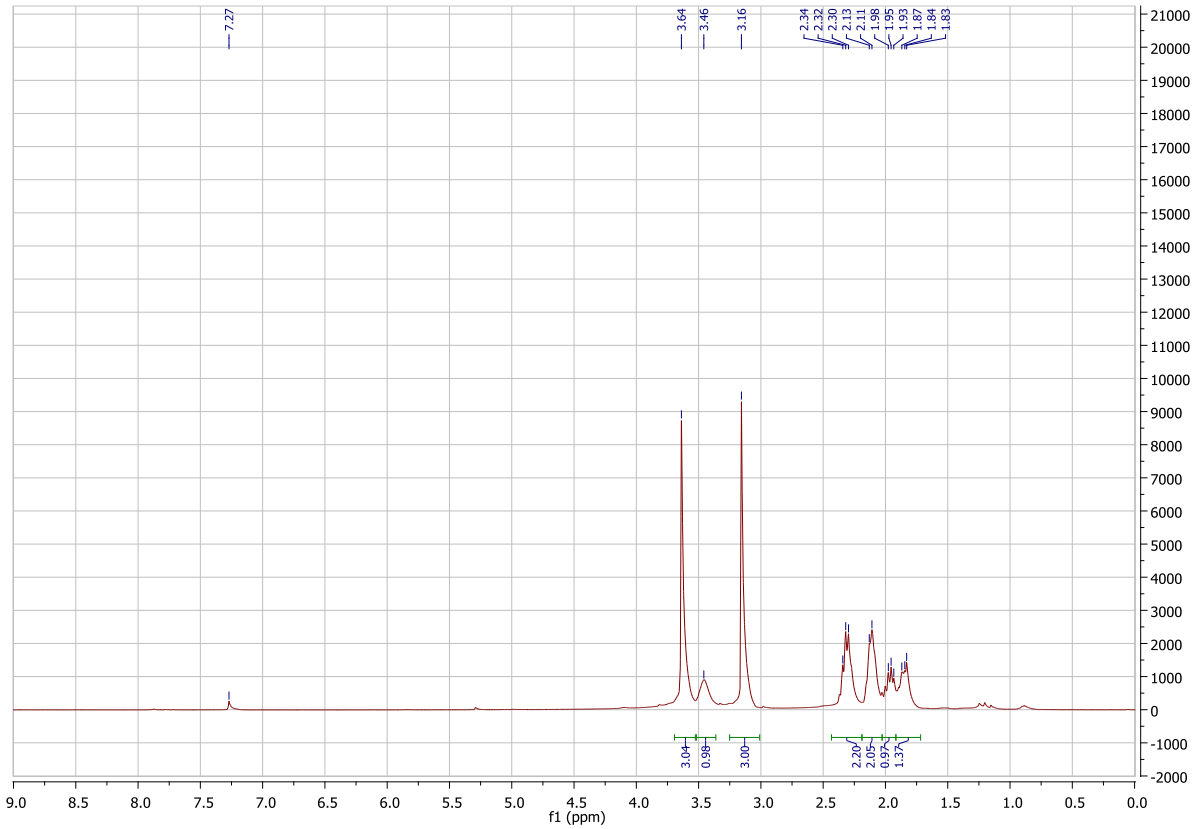



**HRMS:**

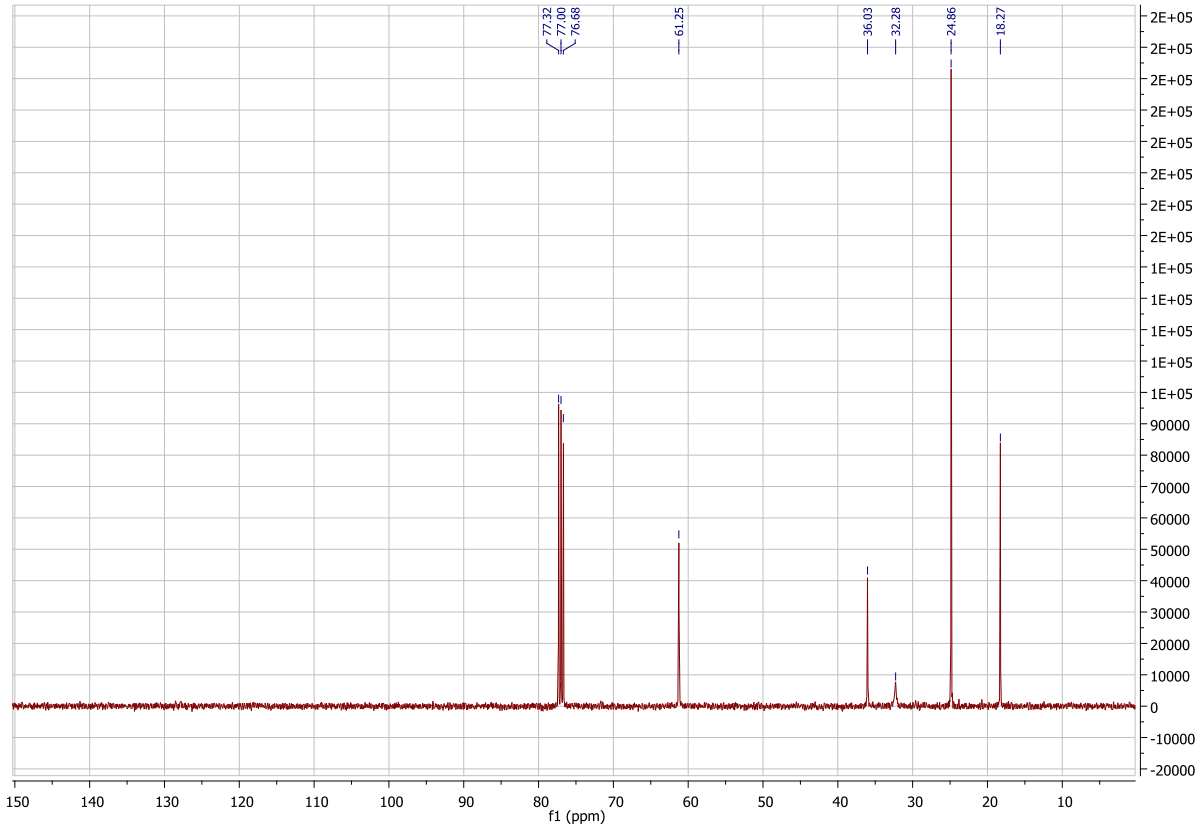


## Compound 5d: *N*-Methoxy-*N*-methylcyclobutanecarboxamide

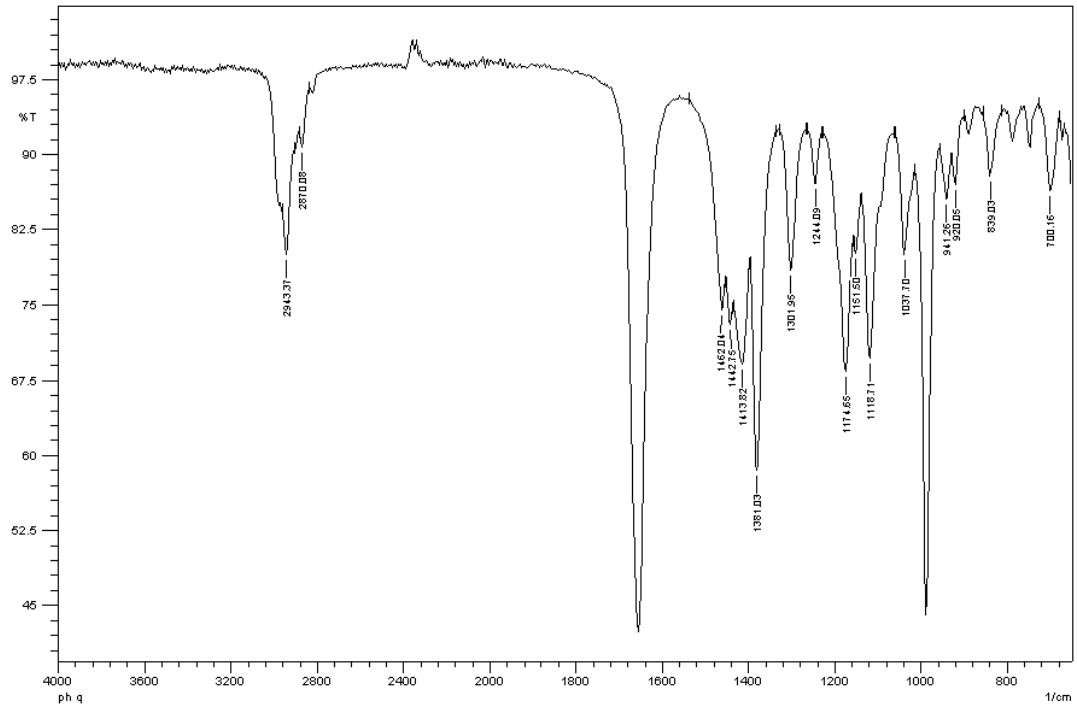
### $^{1}$H NMR:



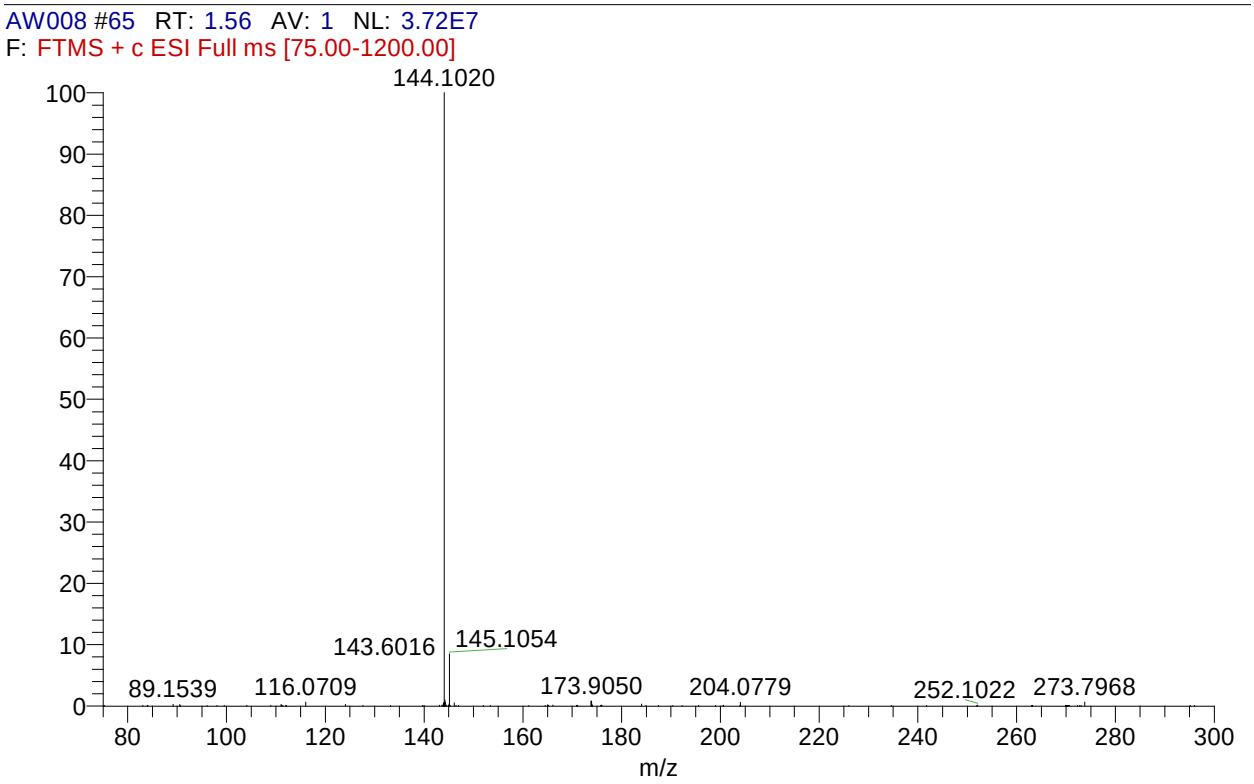

### $^{13}$C NMR:



**FTIR:**

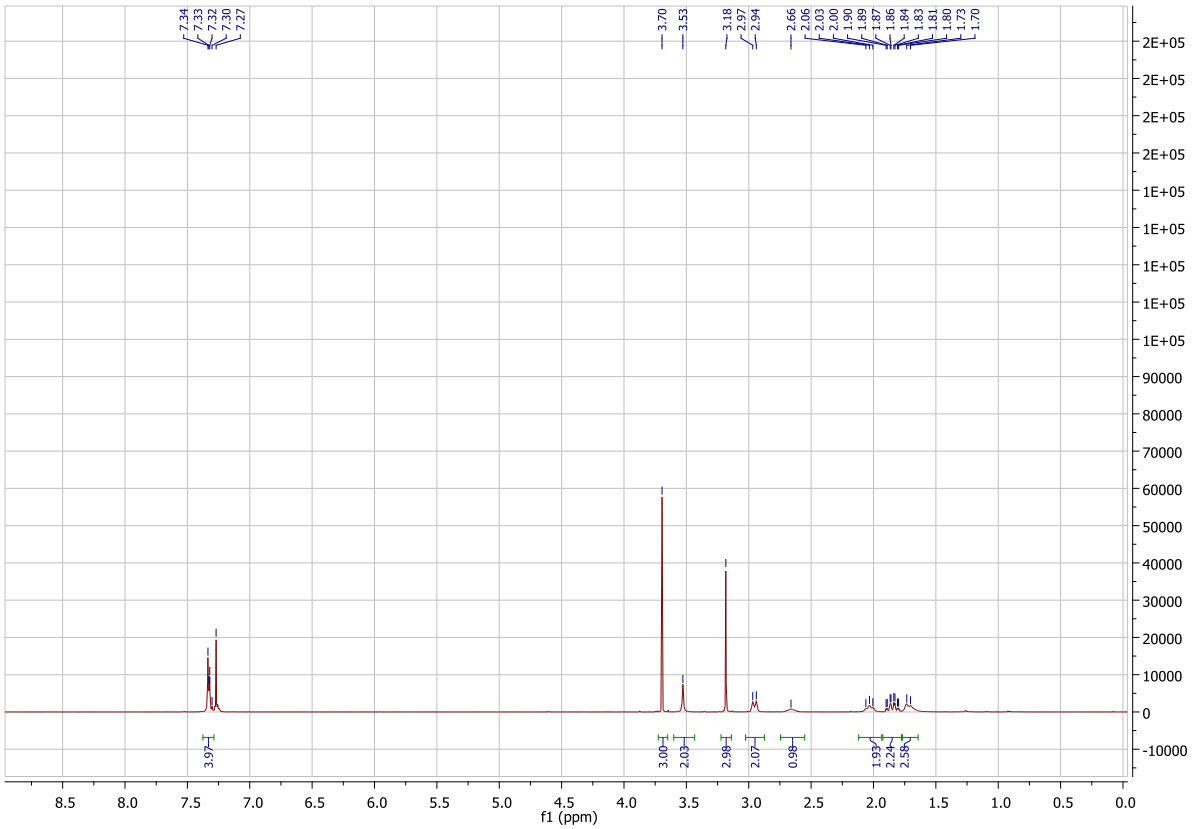



**HRMS:**

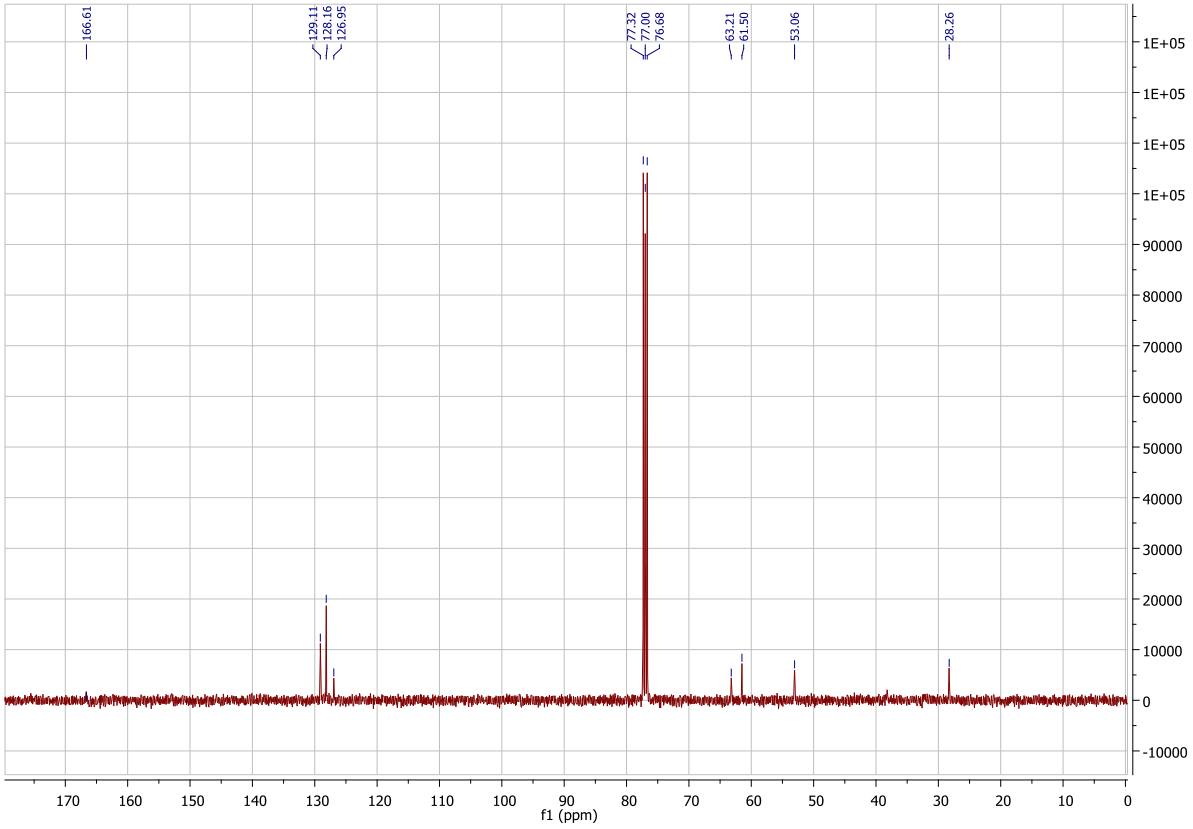


**Compound 5e: 1-Benzyl-*N*-methoxy-*N*-methylpiperidine-4-carboxamide**

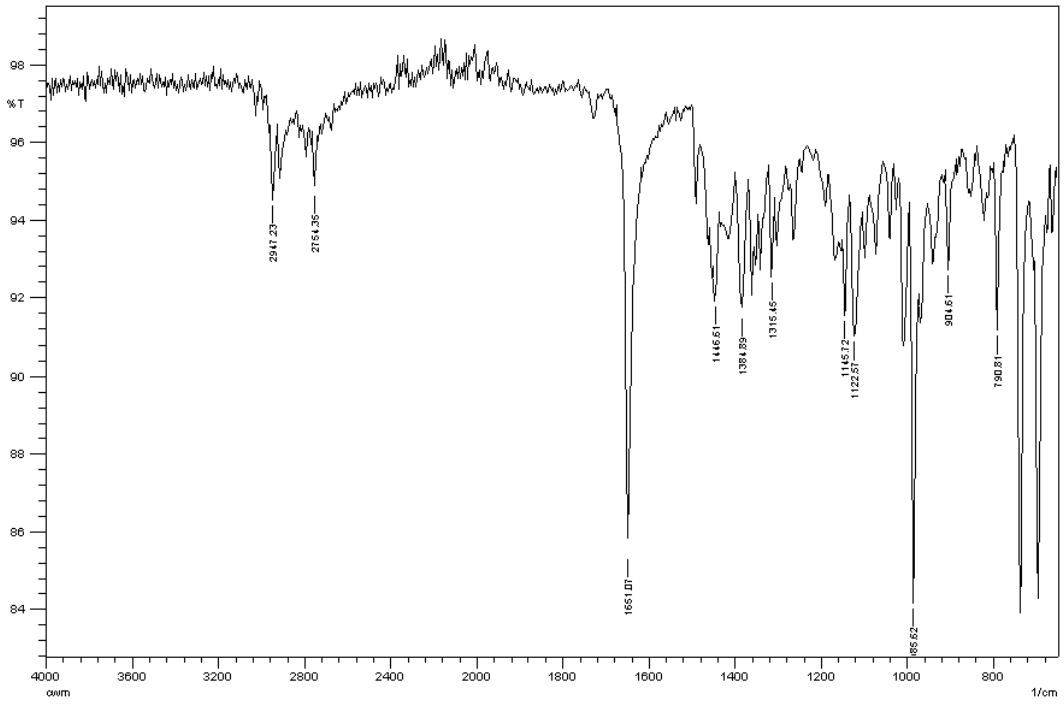
**$^{1}$H NMR:**



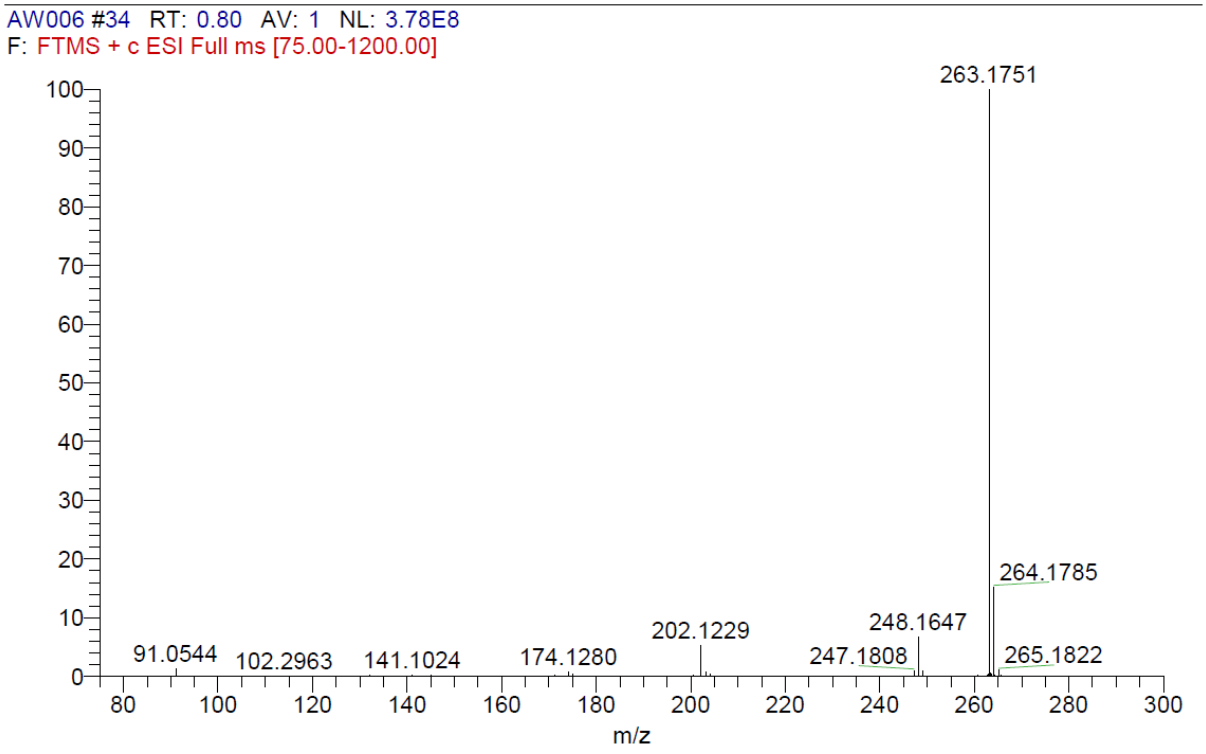

**$^{13}$C NMR:**



**FTIR:**

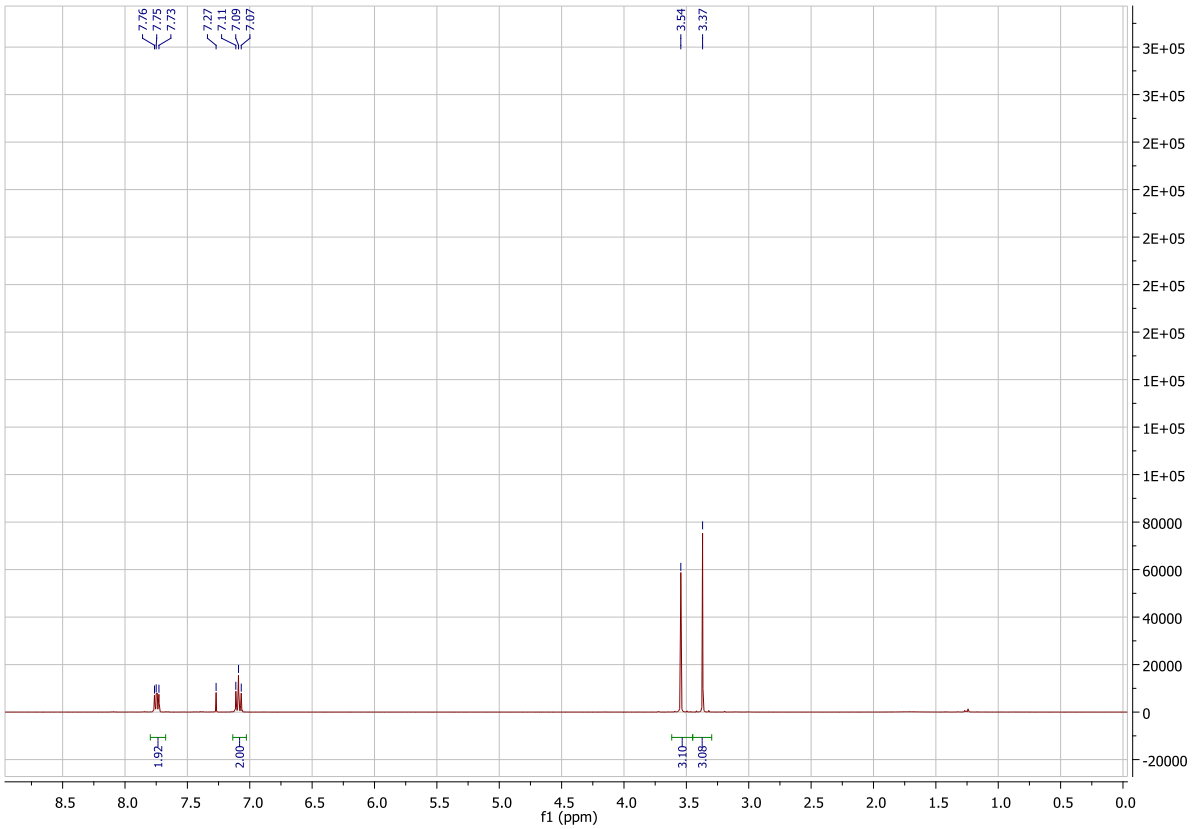

%T
98
96
94
92
90
88
86
84
2947.23
2764.35
1651.07
1446.61
1384.89
1315.45
1145.72
1122.57
985.62
904.61
790.81
4000
3600
3200
2800
2400
2000
1800
1600
1400
1200
1000
800
cm
1/cm

**HRMS:**

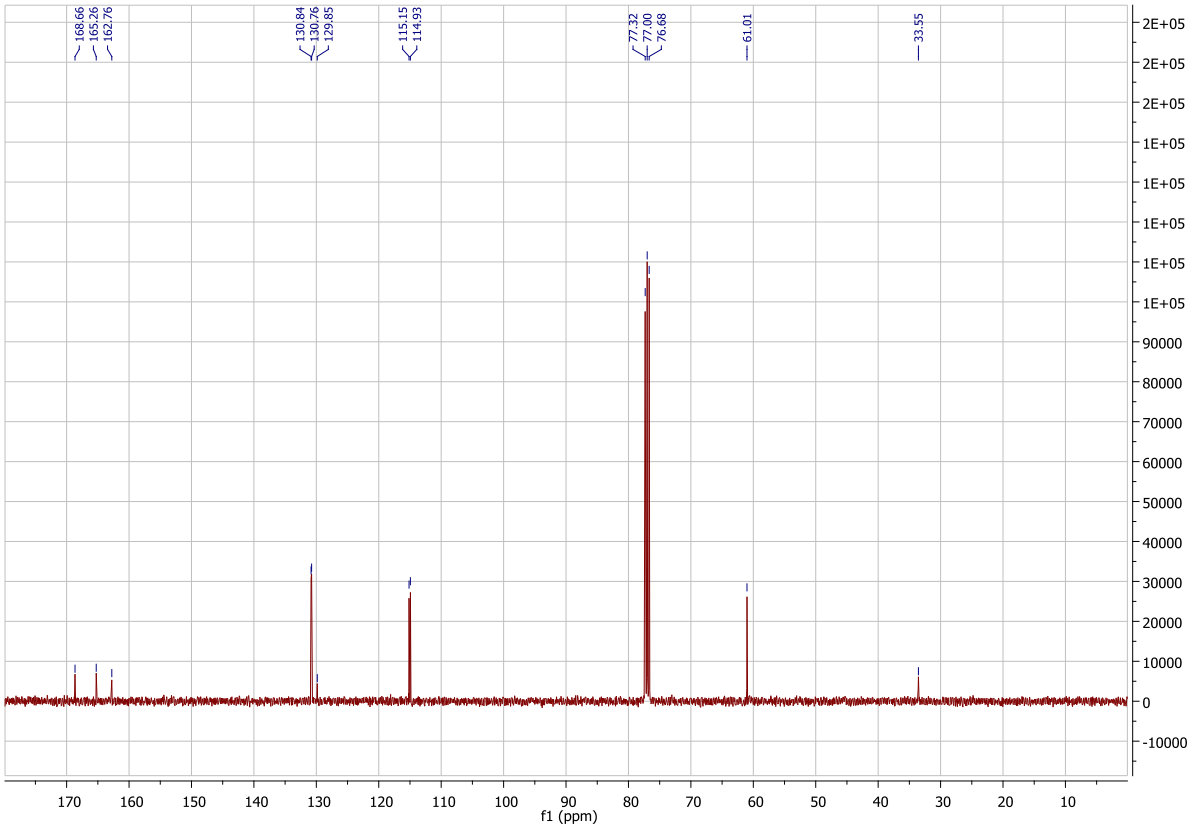

AW006 #34 RT: 0.80 AV: 1 NL: 3.78E8
F: FTMS + c ESI Full ms [75.00-1200.00]
263.1751
264.1785
248.1647
202.1229
91.0544
102.2963
141.1024
174.1280
247.1808
265.1822
100
90
80
70
60
50
40
30
20
10
0
80
100
120
140
160
180
200
220
240
260
280
300
m/z

## Compound 5f: 4-Fluoro-*N*-methoxy-*N*-methylbenzamide

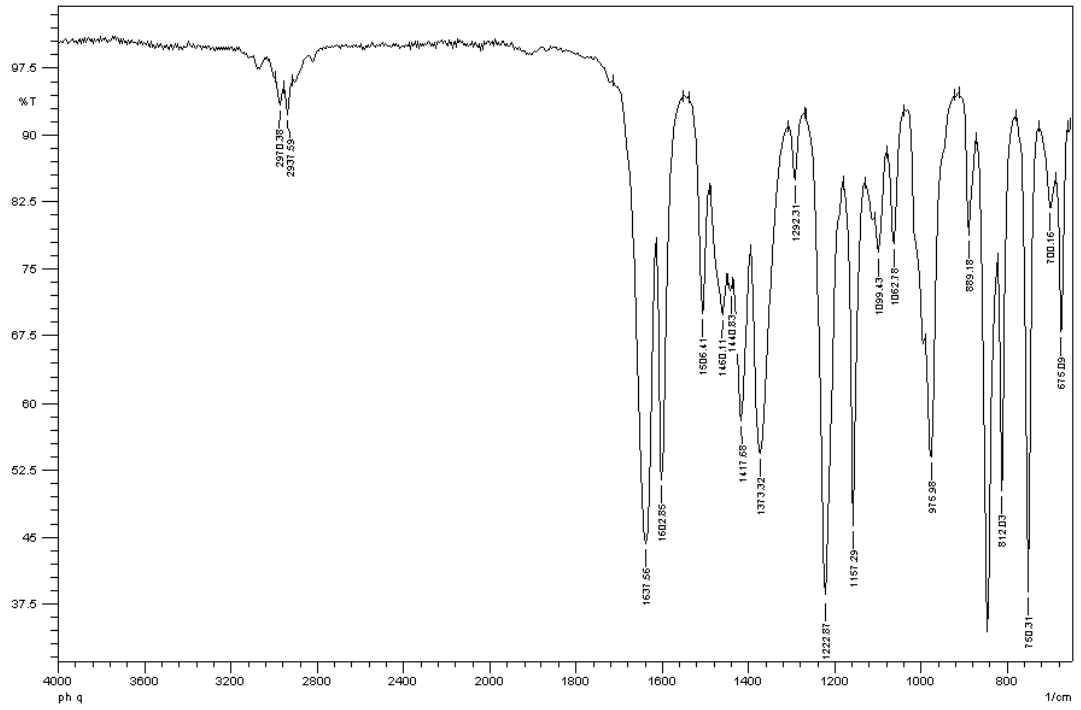
**$^{1}$H NMR:**



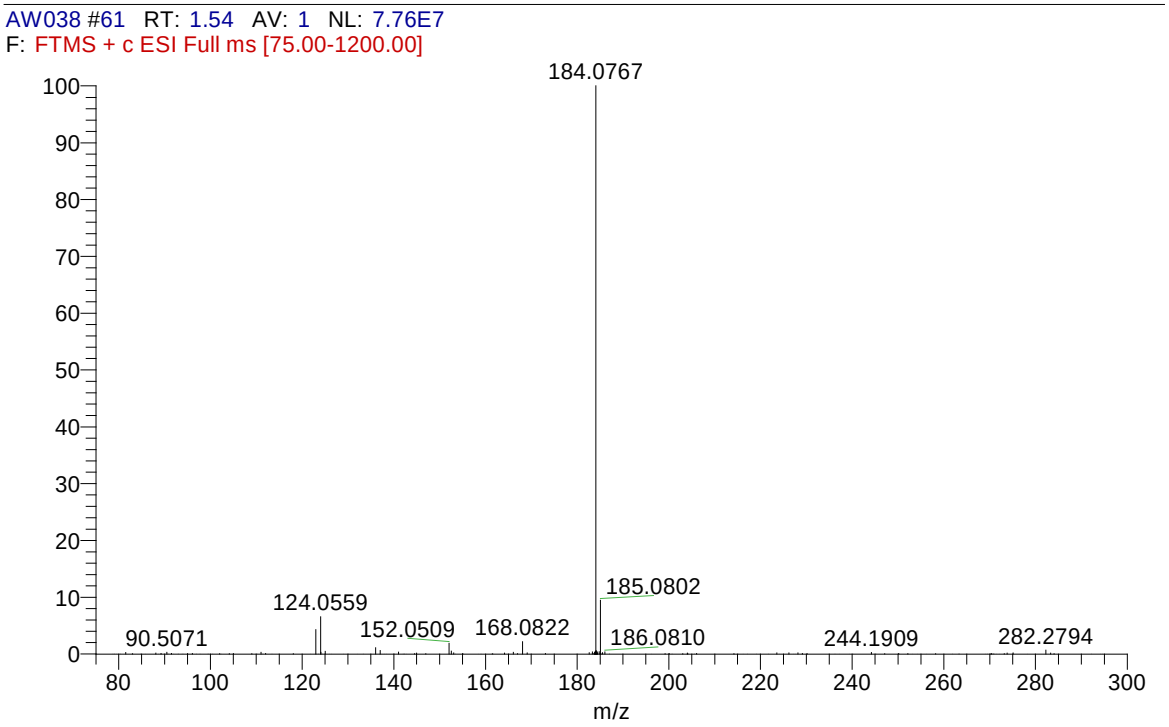

**$^{13}$C NMR:**



**FTIR:**

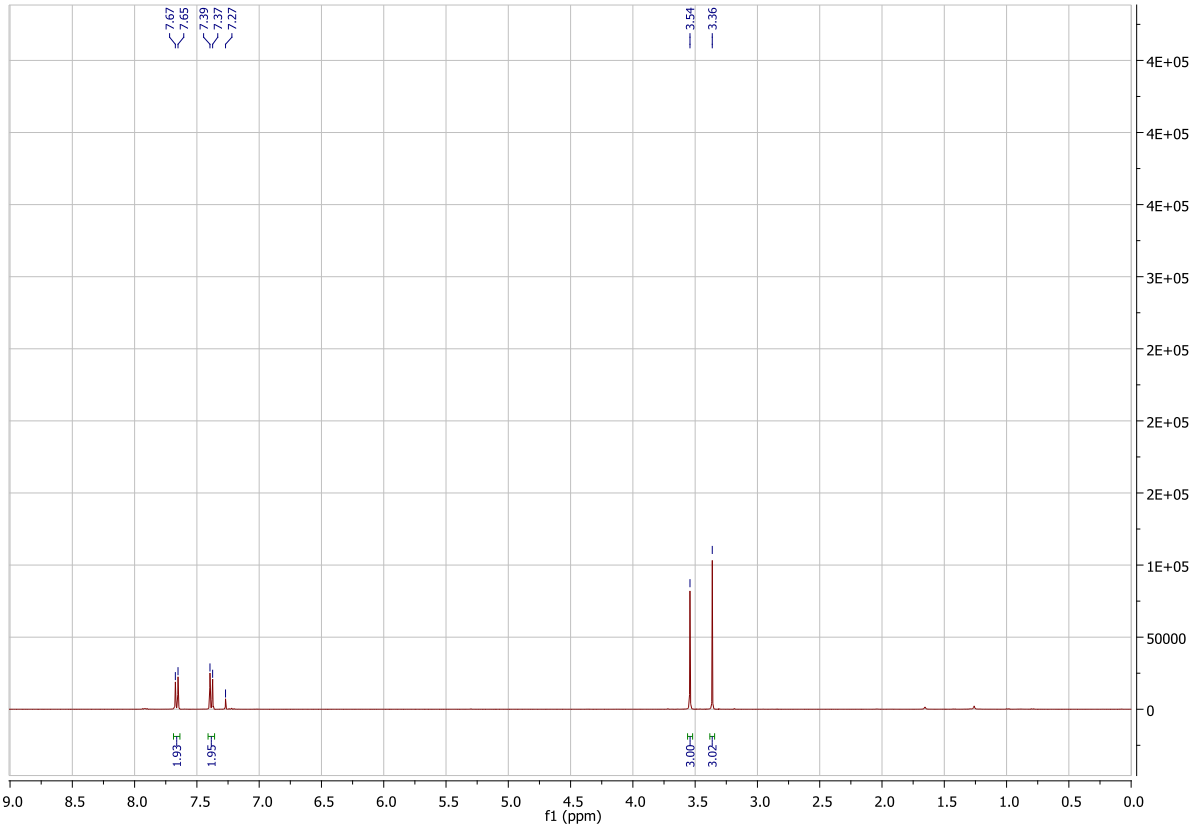



**HRMS:**

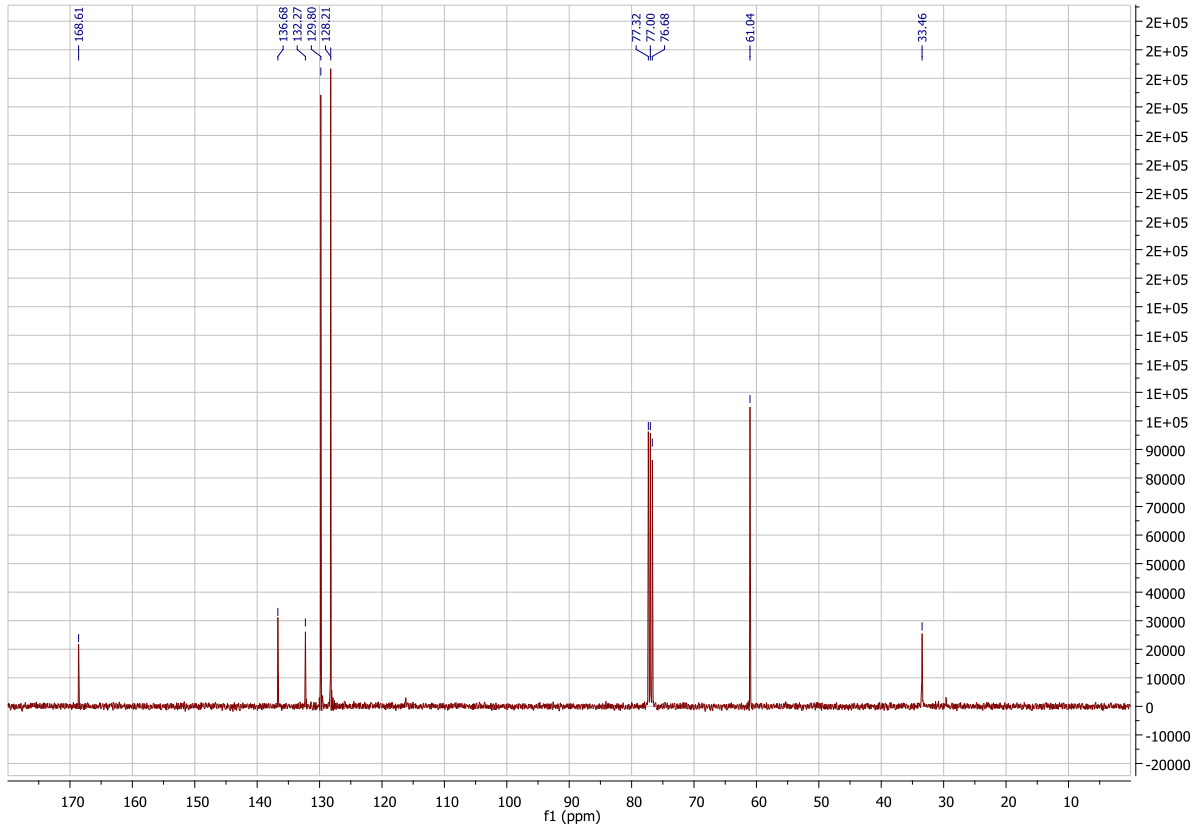


**Compound 5g: 4-Chloro-*N*-methoxy-*N*-methylbenzamide**

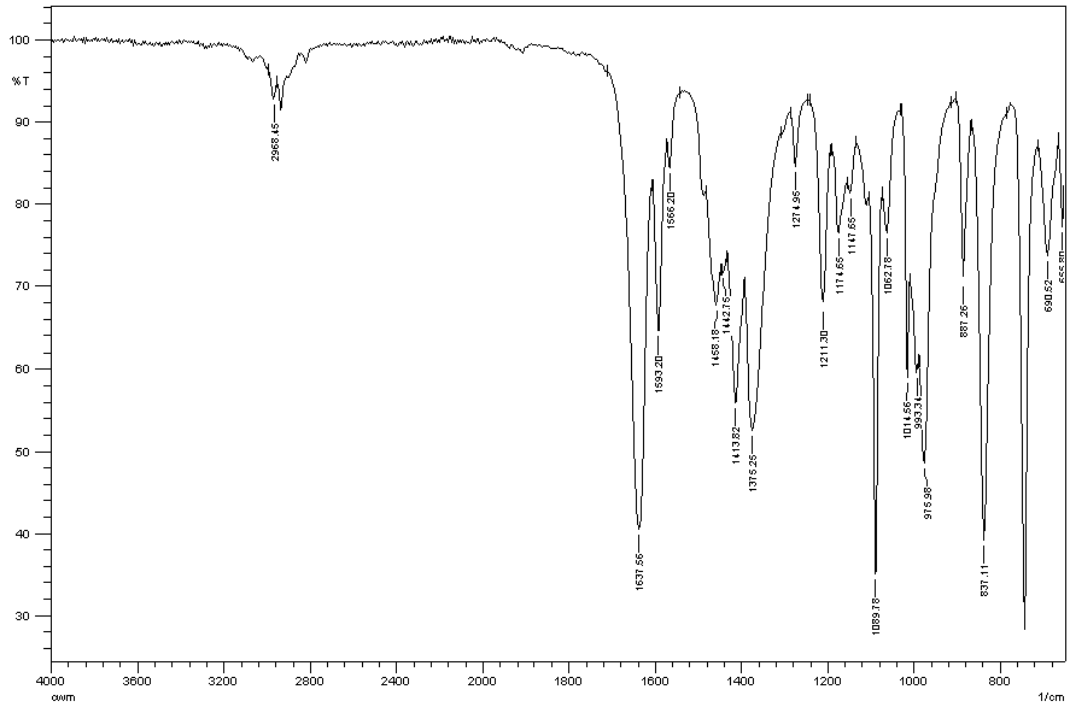
**$^{1}$H NMR:**



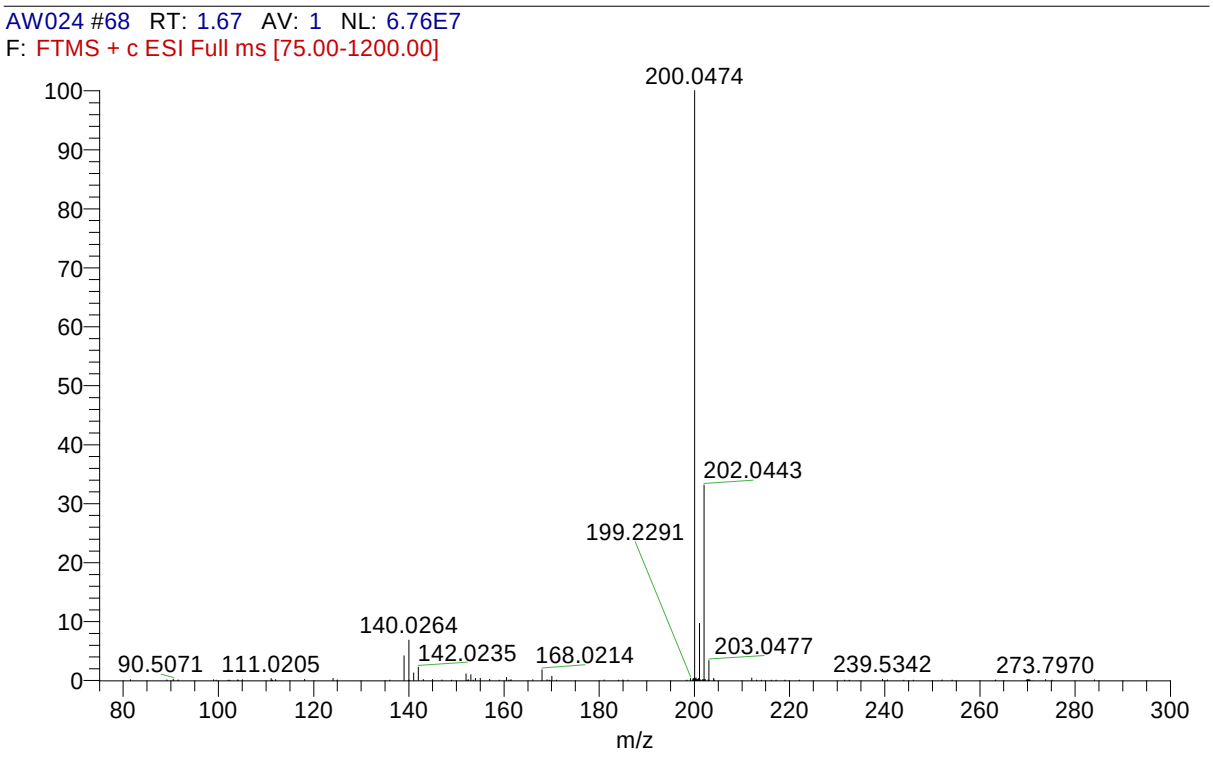

**$^{13}$C NMR:**



**FTIR:**

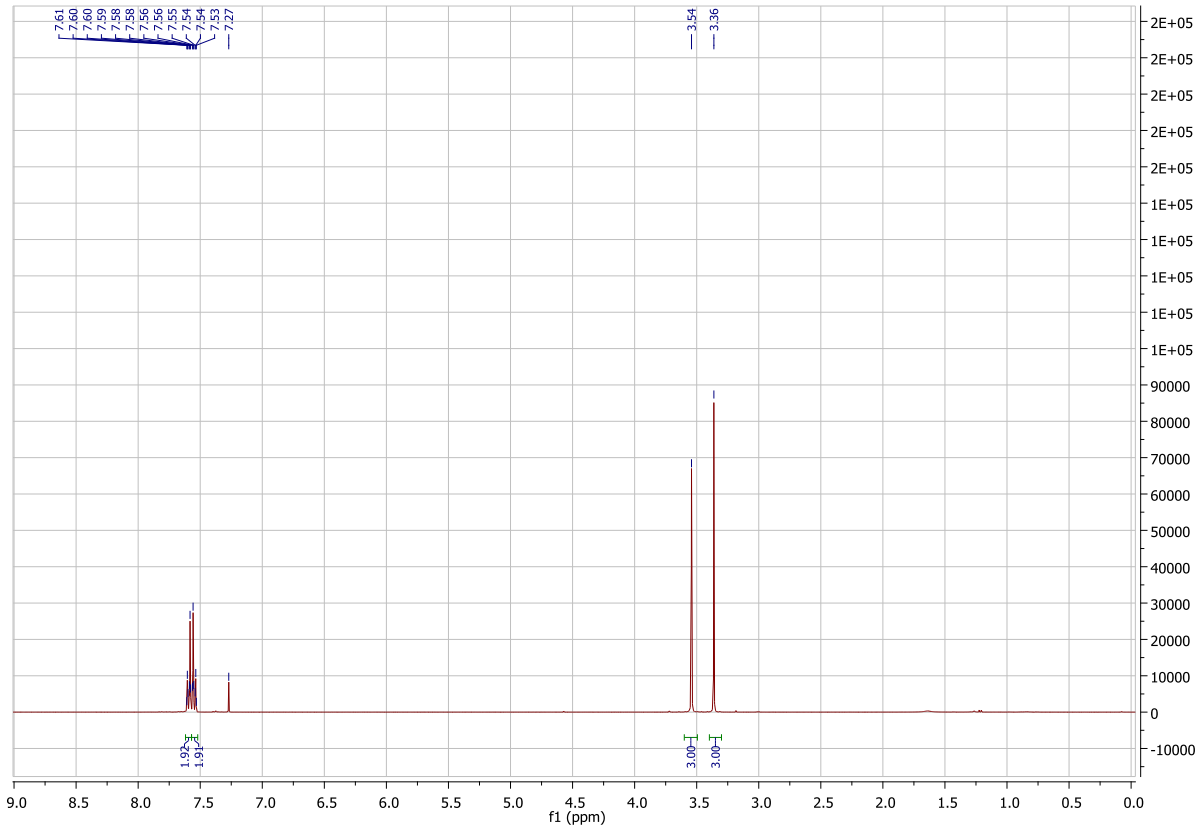



**HRMS:**

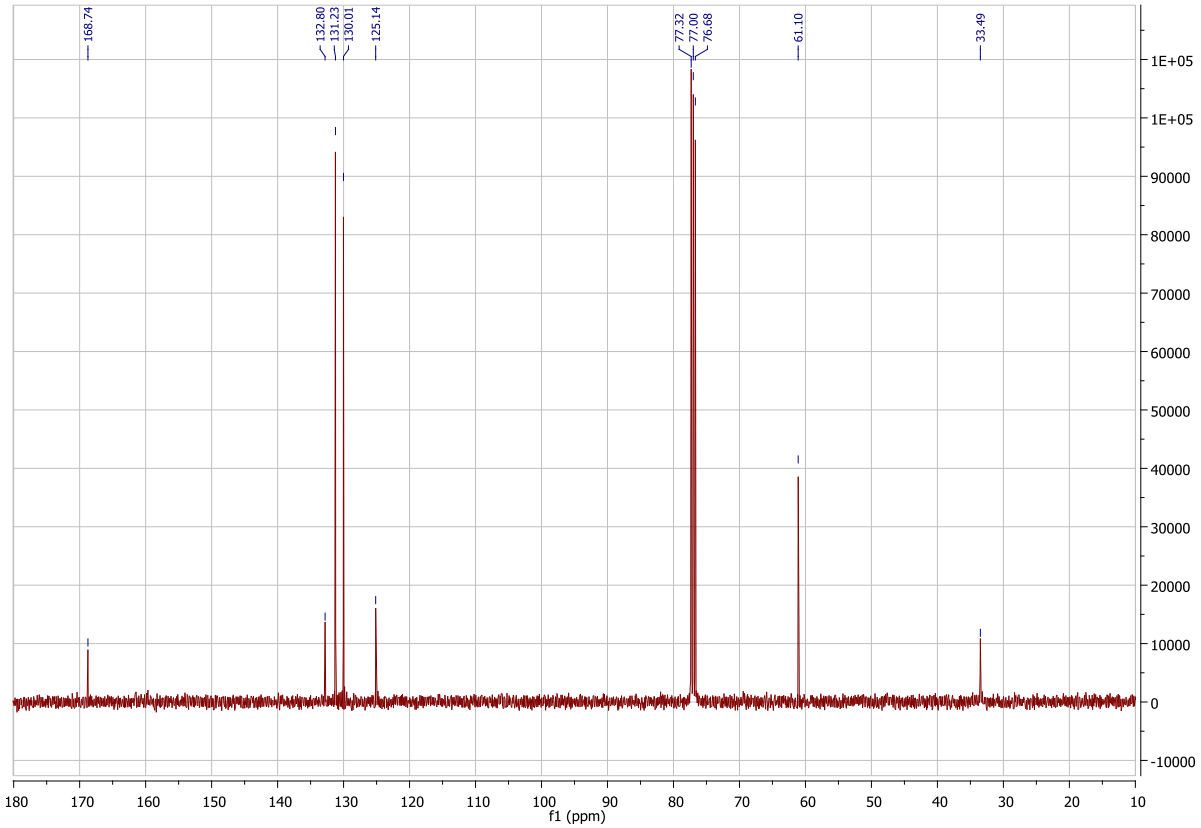


## Compound 5h: 4-Bromo-*N*-methoxy-*N*-methylbenzamide

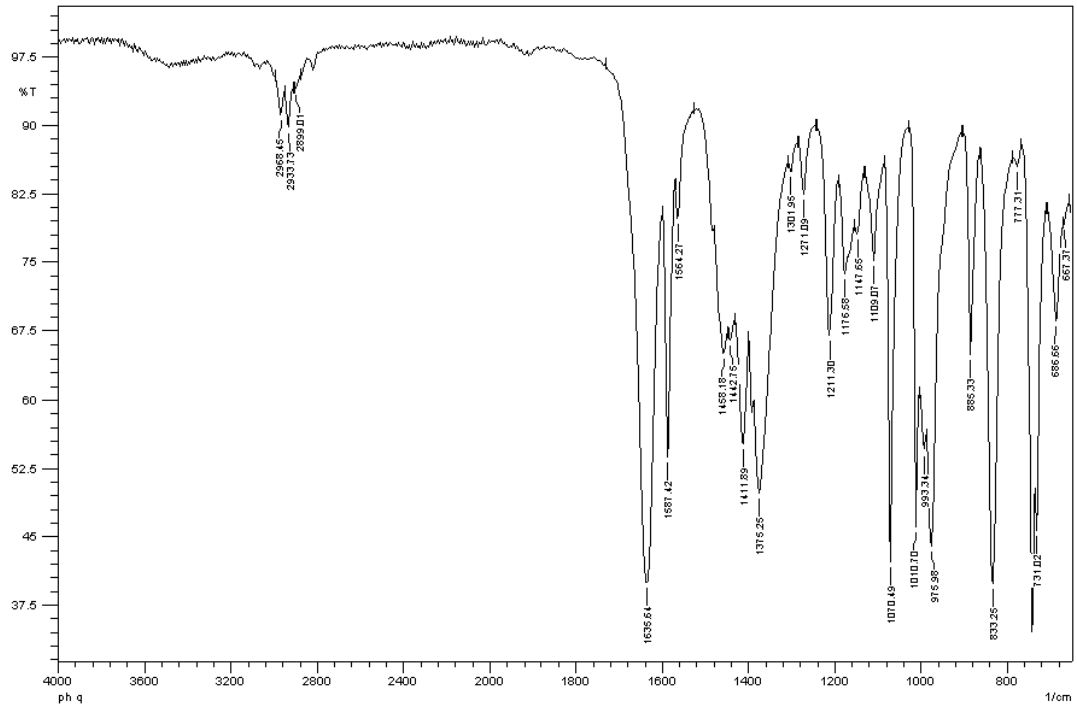
**$^{1}$H NMR:**



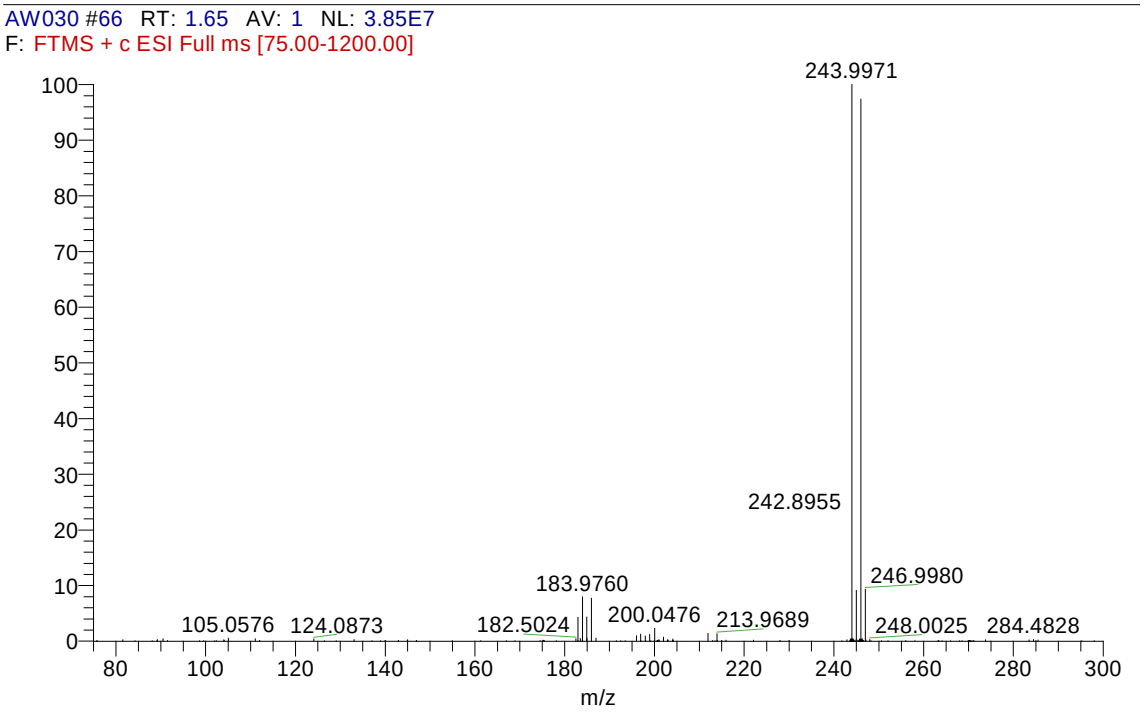

**$^{13}$C NMR:**



**FTIR:**

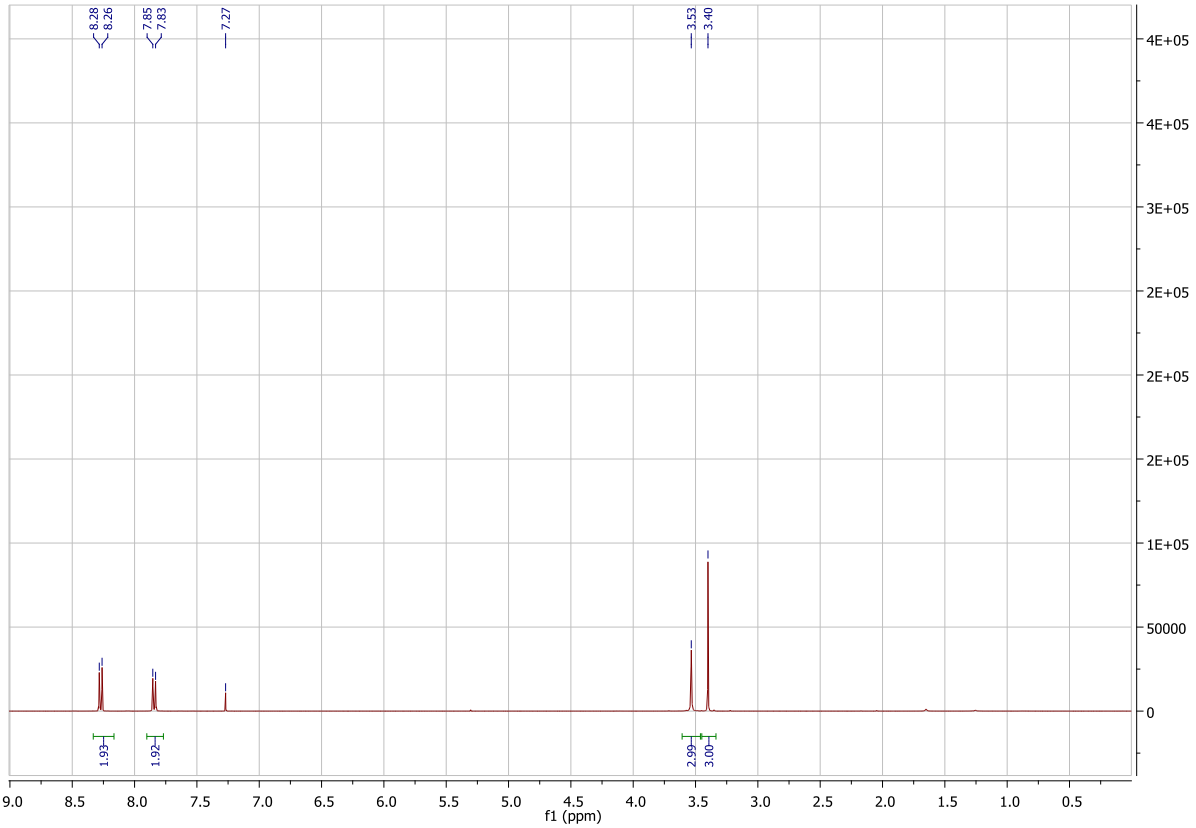



**HRMS:**

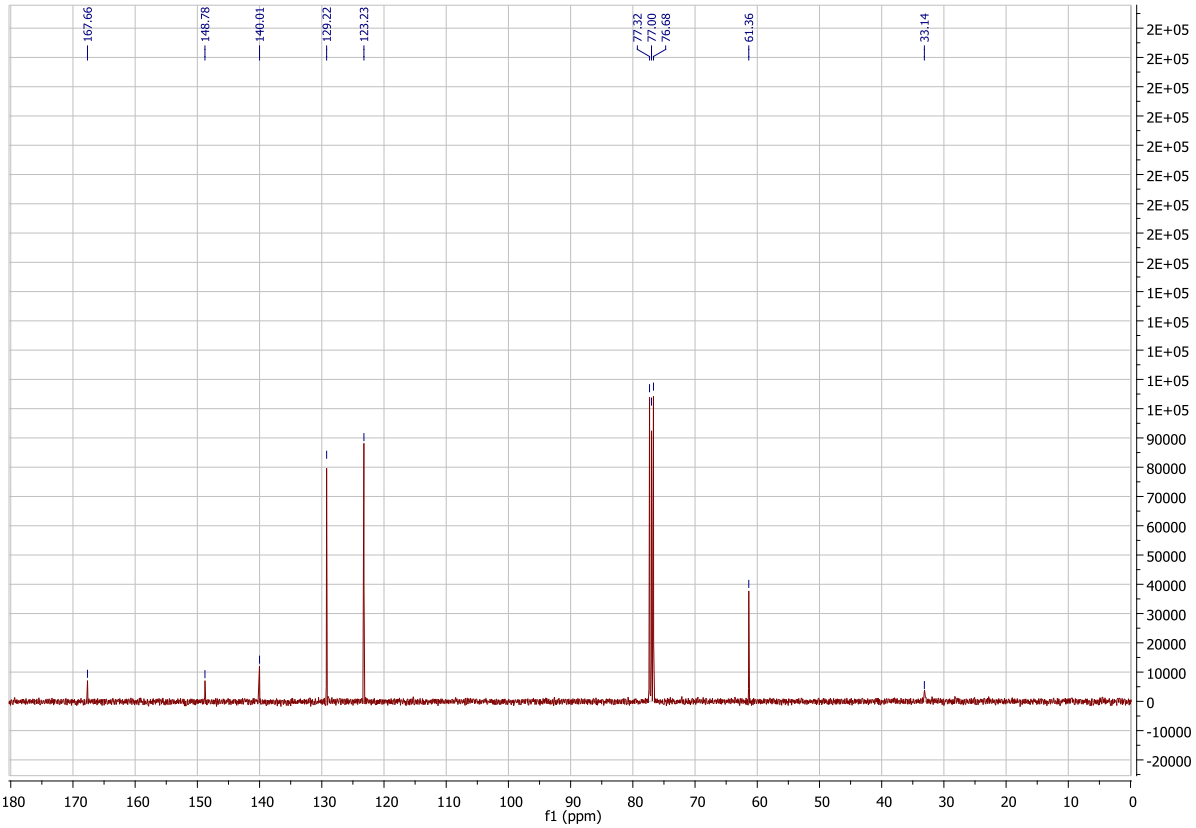


**Compound 5i: *N*-Methoxy-*N*-methyl-4-nitrobenzamide**

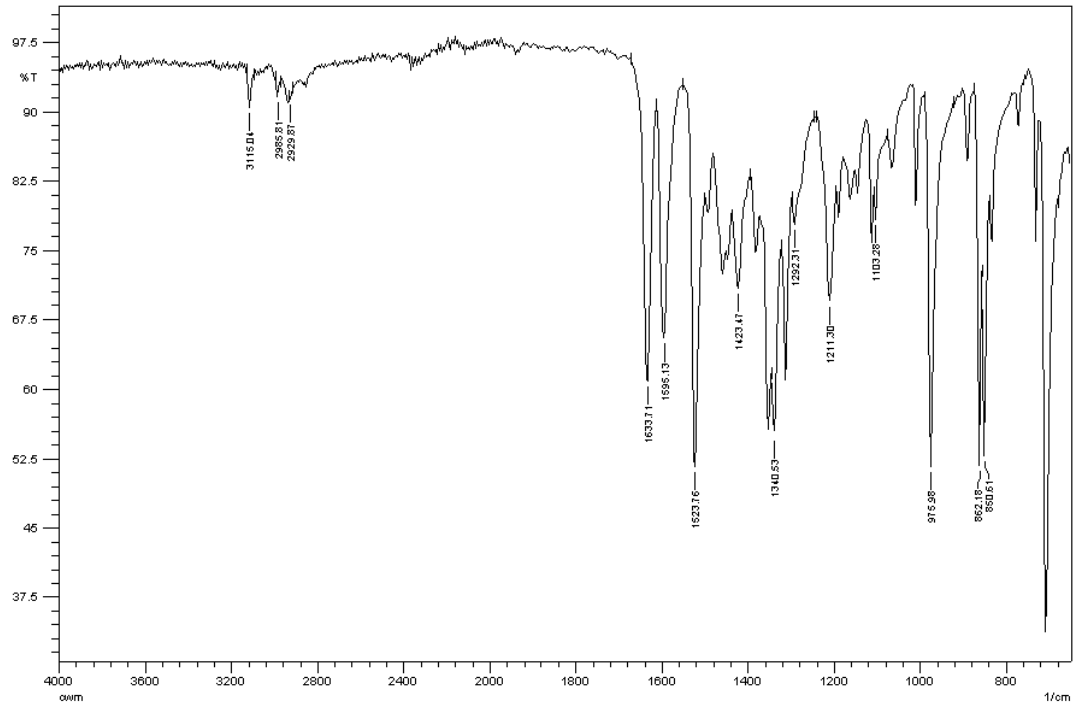
**$^{1}$H NMR:**



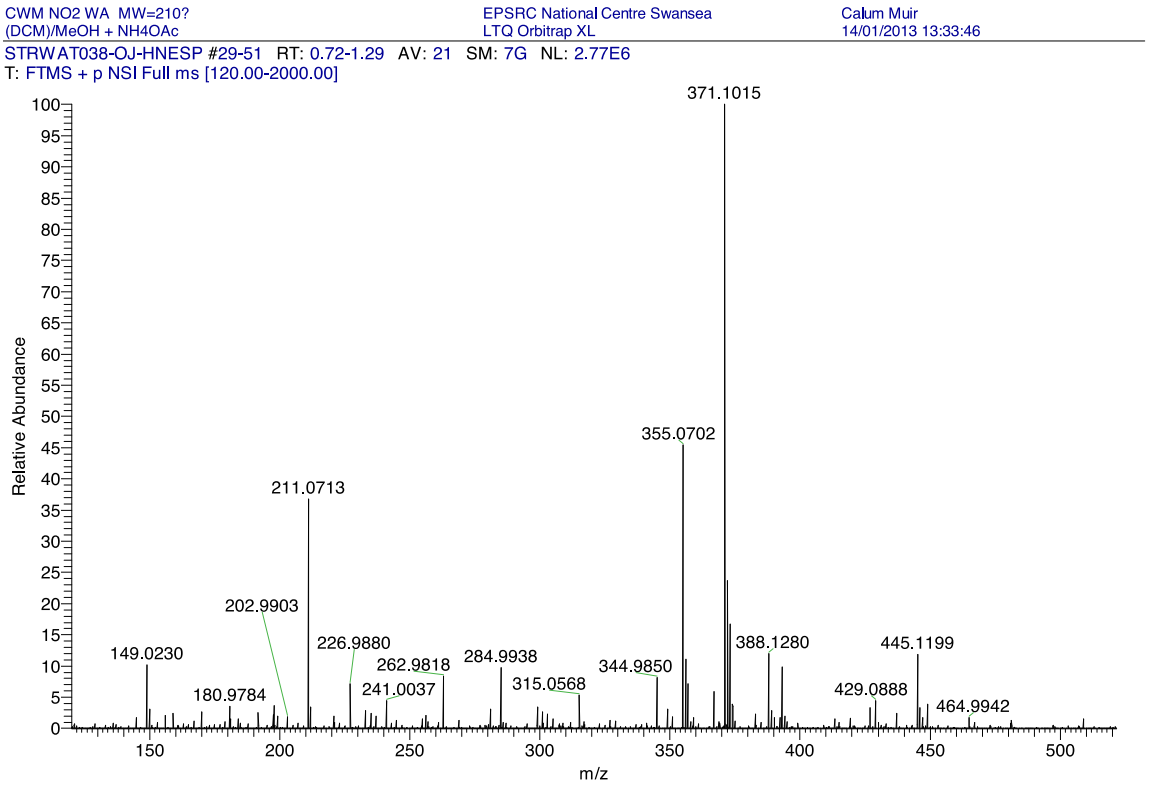

**$^{13}$C NMR:**



**FTIR:**

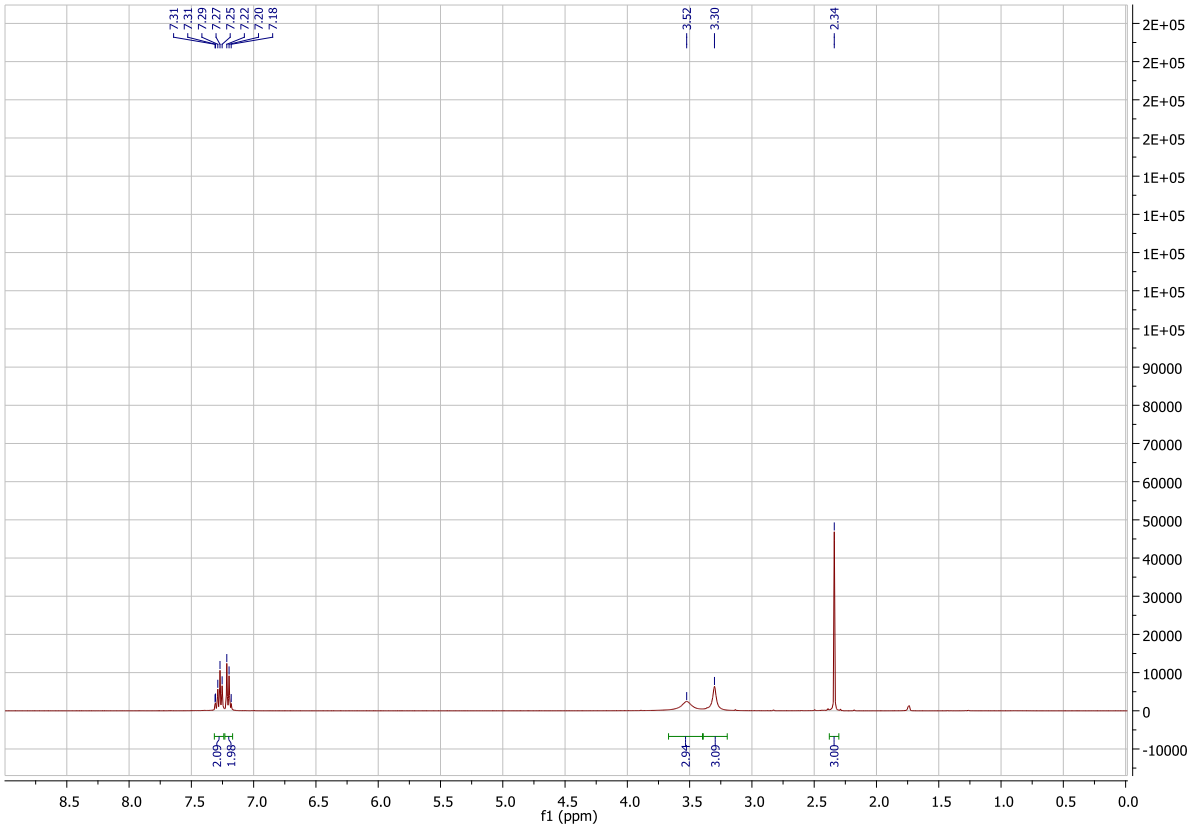

97.5
%T
90
82.5
75
67.5
60
52.5
45
37.5
3115.04
2965.81
2929.01
1633.71
1595.13
1523.76
1423.47
1340.53
1292.31
1211.30
1103.28
975.98
862.15
830.61
4000
3600
3200
2800
2400
2000
1800
1600
1400
1200
1000
800
cwm
1/cm

**HRMS:**

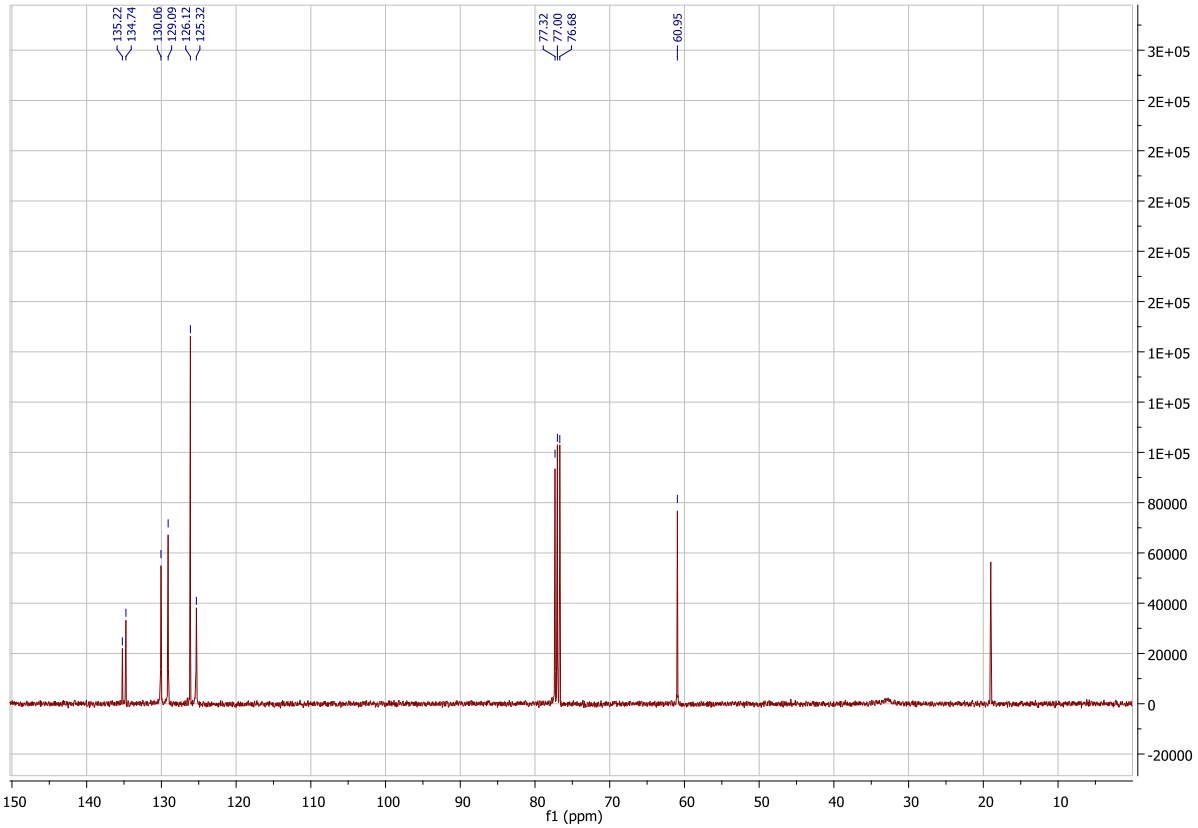

CWM NO2 WA MW=210?
(DCM)/MeOH + NH4OAc
EPSRC National Centre Swansea
LTQ Orbitrap XL
Calum Muir
14/01/2013 13:33:46
STRWAT038-OJ-HNESP #29-51 RT: 0.72-1.29 AV: 21 SM: 7G NL: 2.77E6
T: FTMS + p NSI Full ms [120.00-2000.00]
Relative Abundance
m/z
371.1015
355.0702
211.0713
202.9903
149.0230
226.9880
262.9818
284.9938
344.9850
315.0568
241.0037
180.9784
388.1280
445.1199
429.0888
464.9942

**Compound 5j: *N*-Methoxy-*N*,2-dimethylbenzamide**

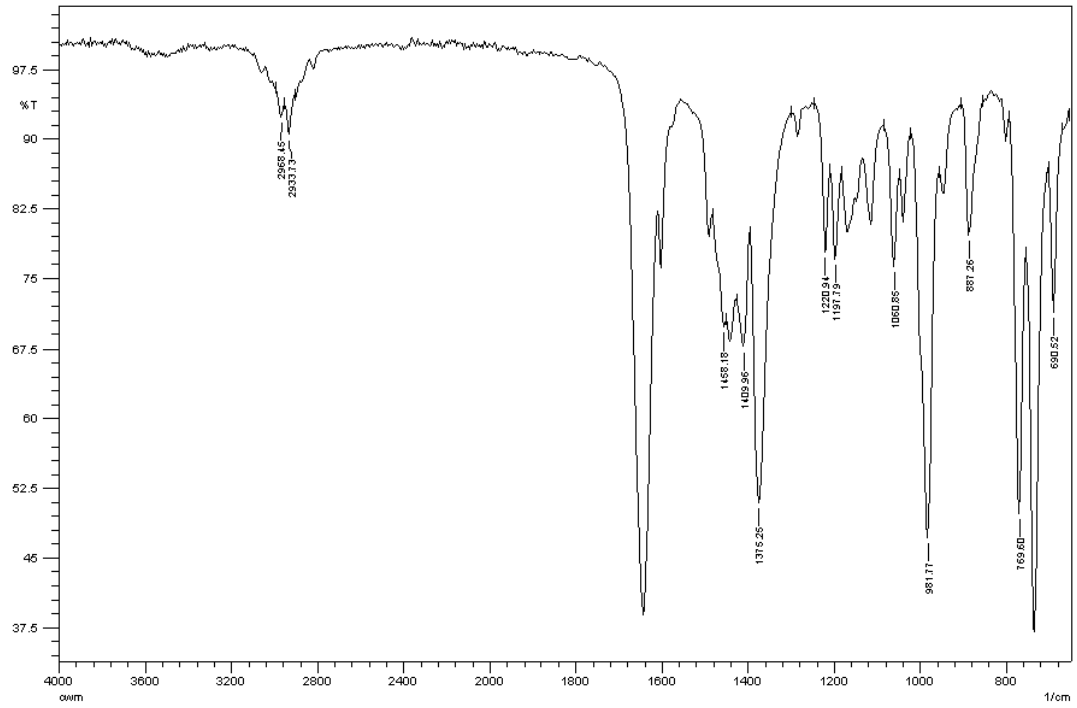
**$^{1}$H NMR:**



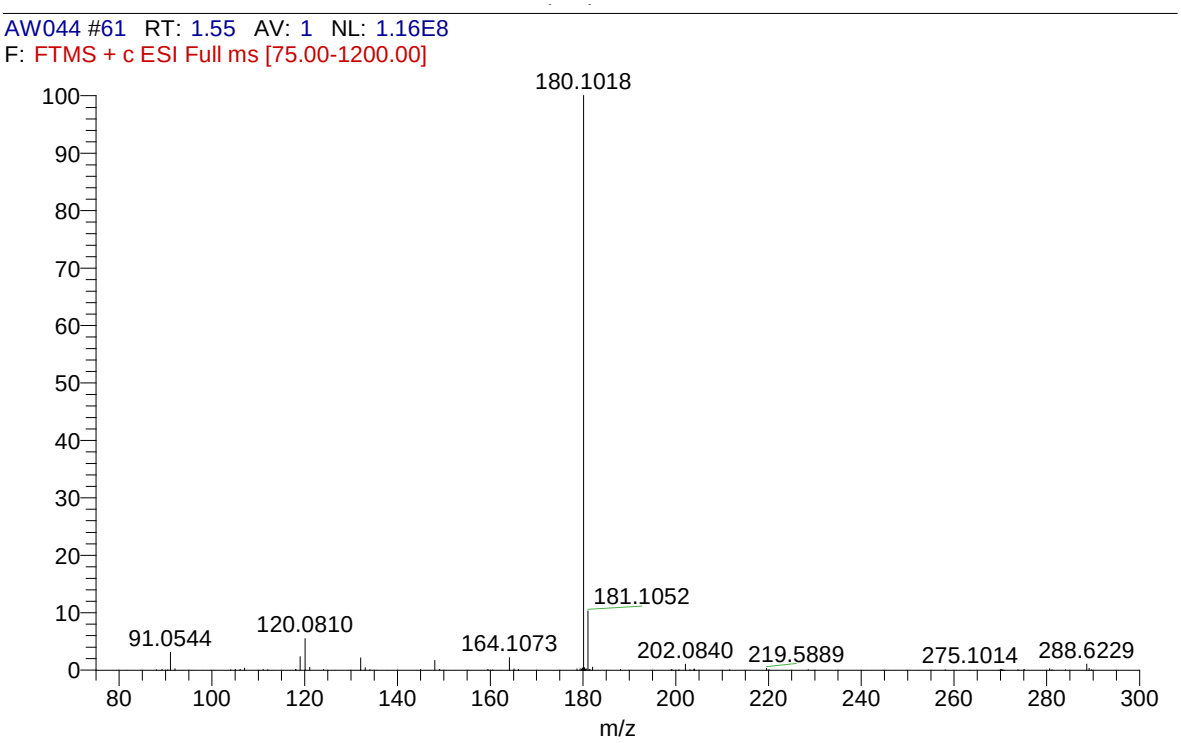

**$^{13}$C NMR:**



**FTIR:**

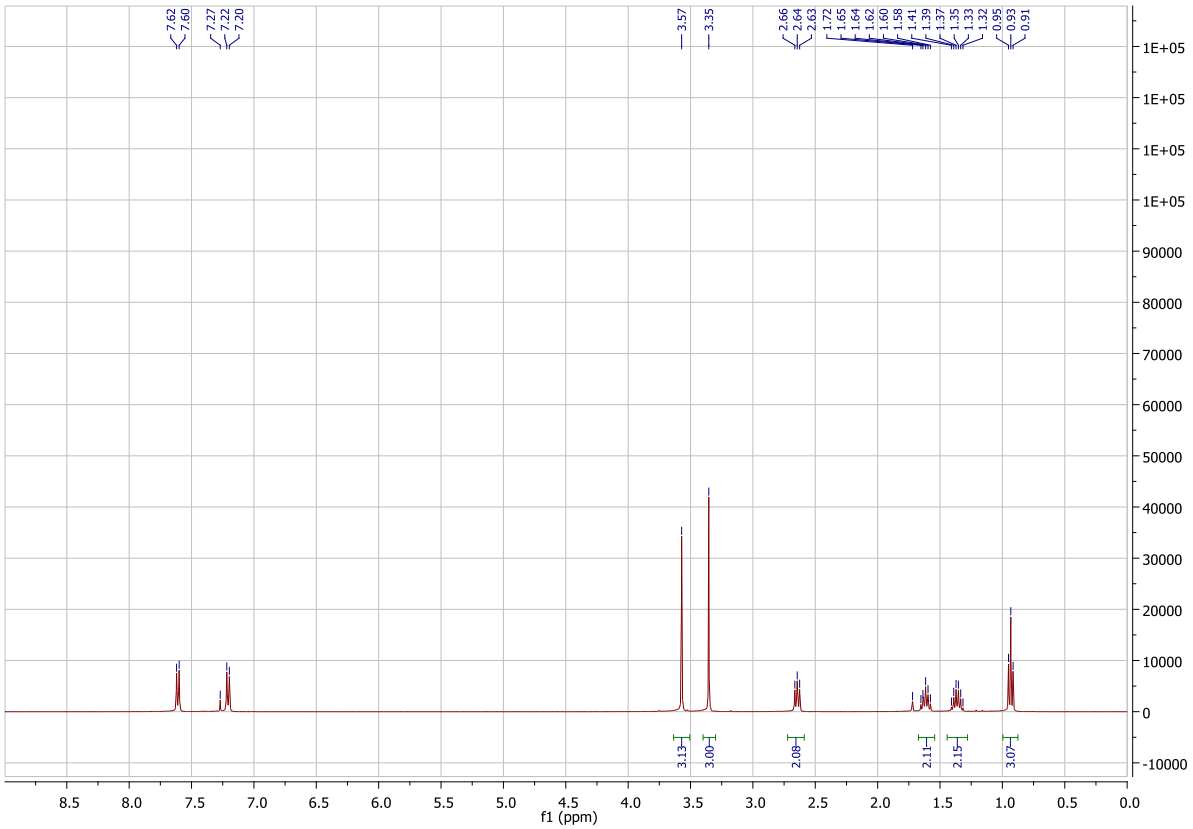



**HRMS:**

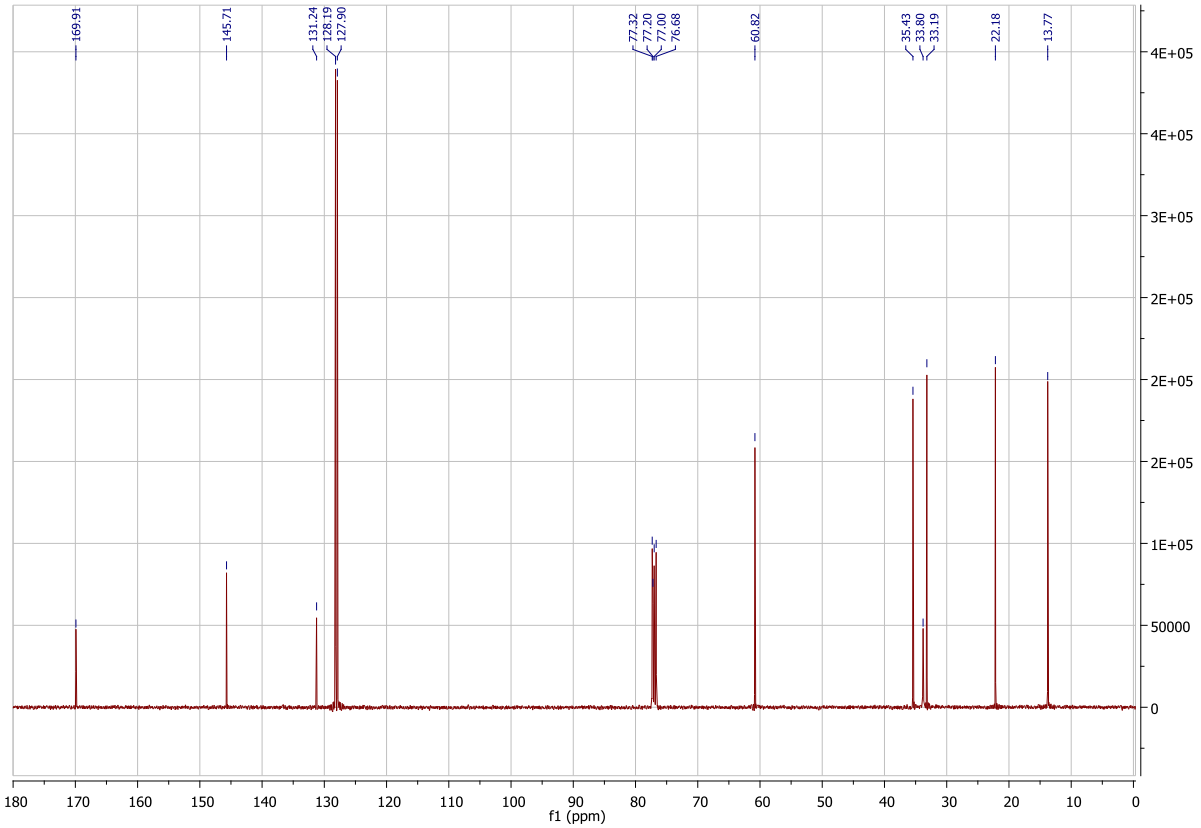


**Compound 5k: 4-(*n*-Butyl)-*N*-methoxy-*N*-methylbenzamide**

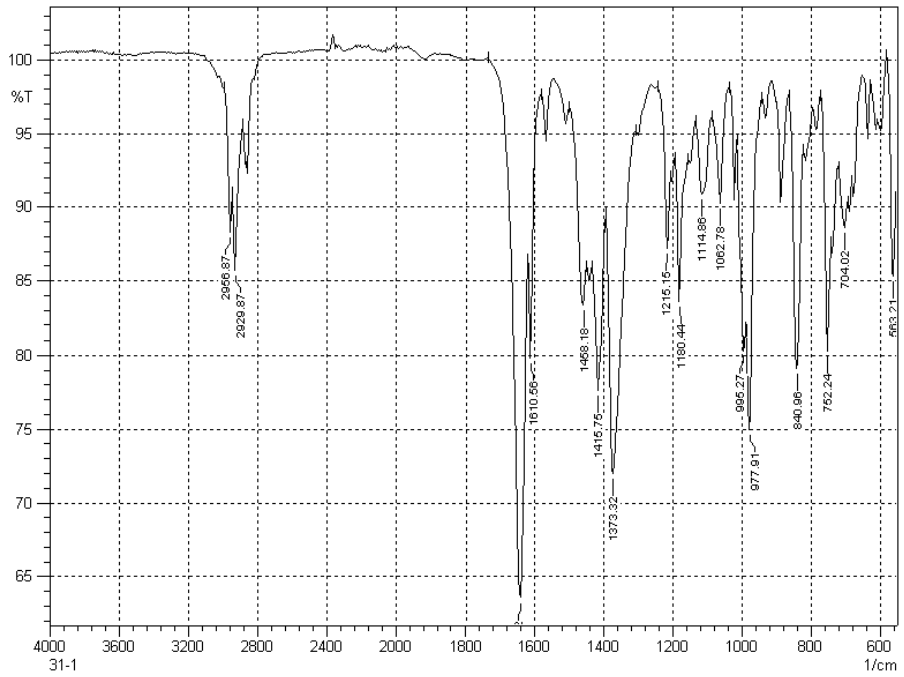
**$^{1}$H NMR:**



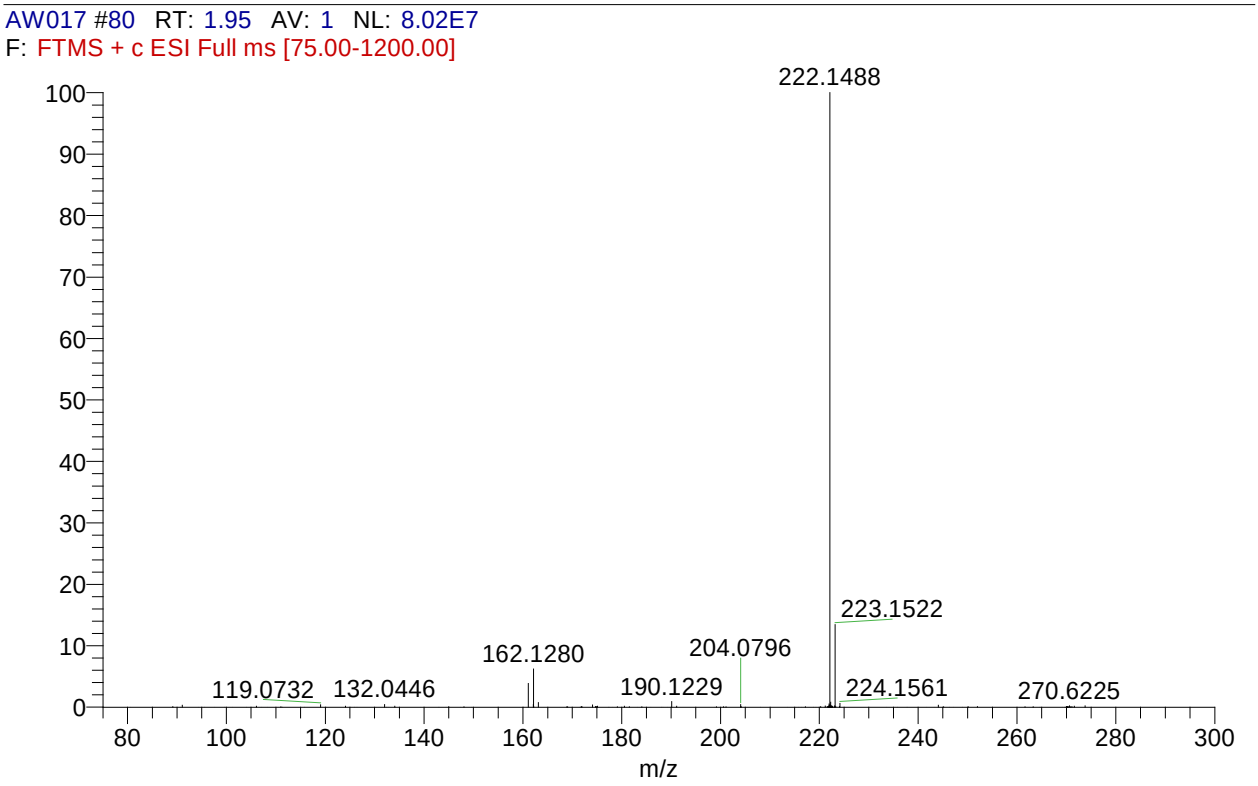

**$^{13}$C NMR:**



**FTIR:**

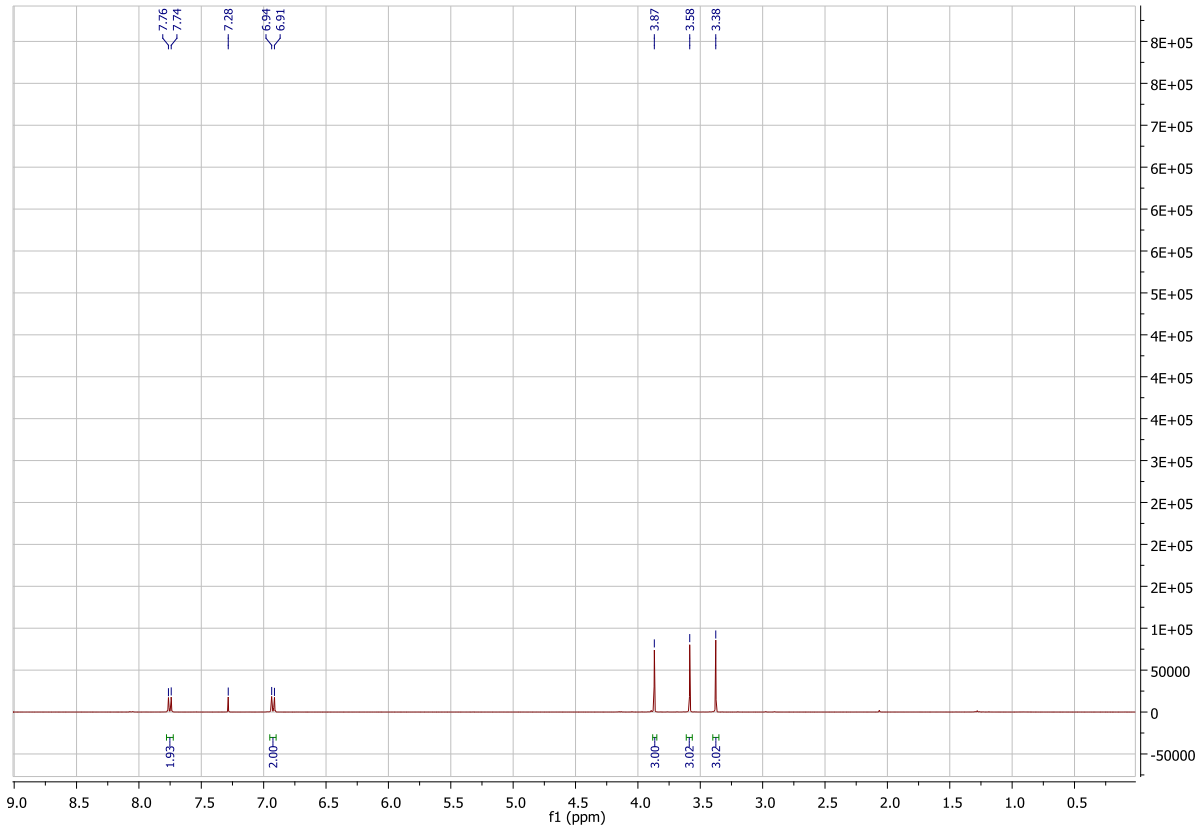



**HRMS:**

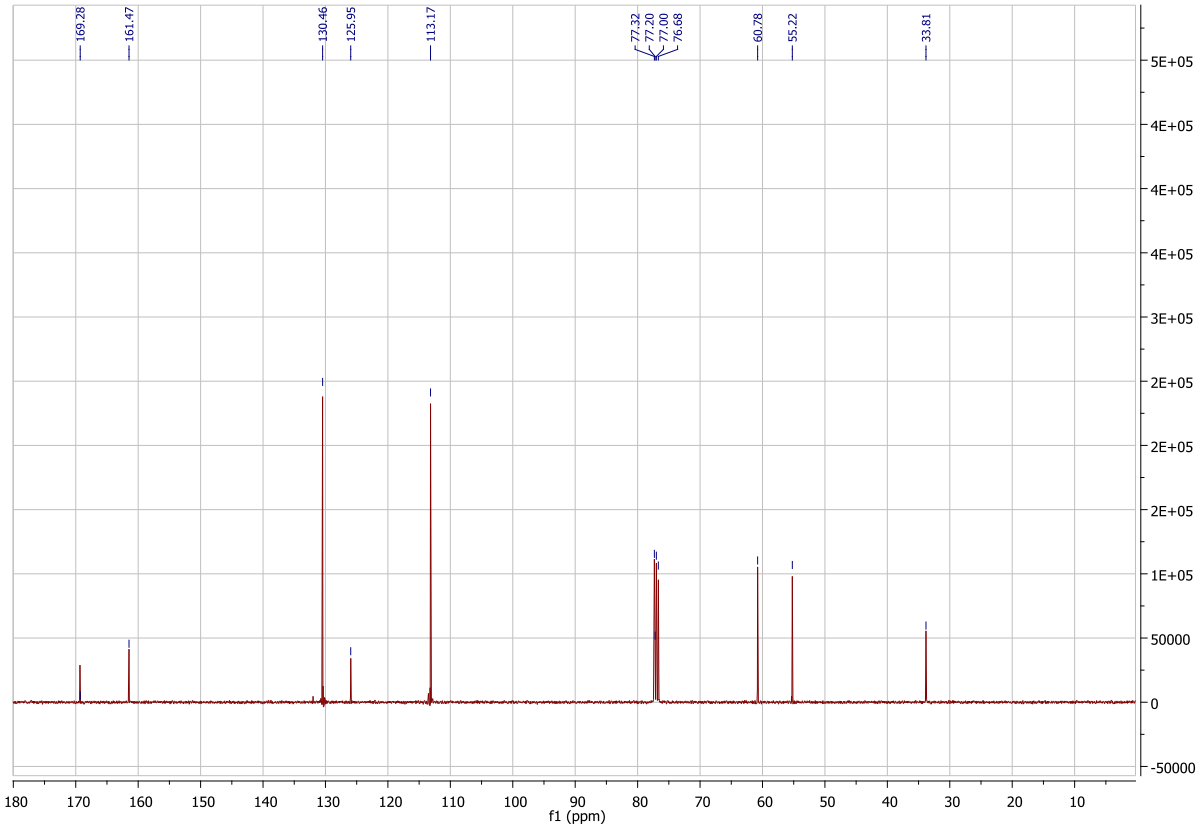


## Compound 5l: 4-Methoxy-*N*-methoxy-*N*-methylbenzamide

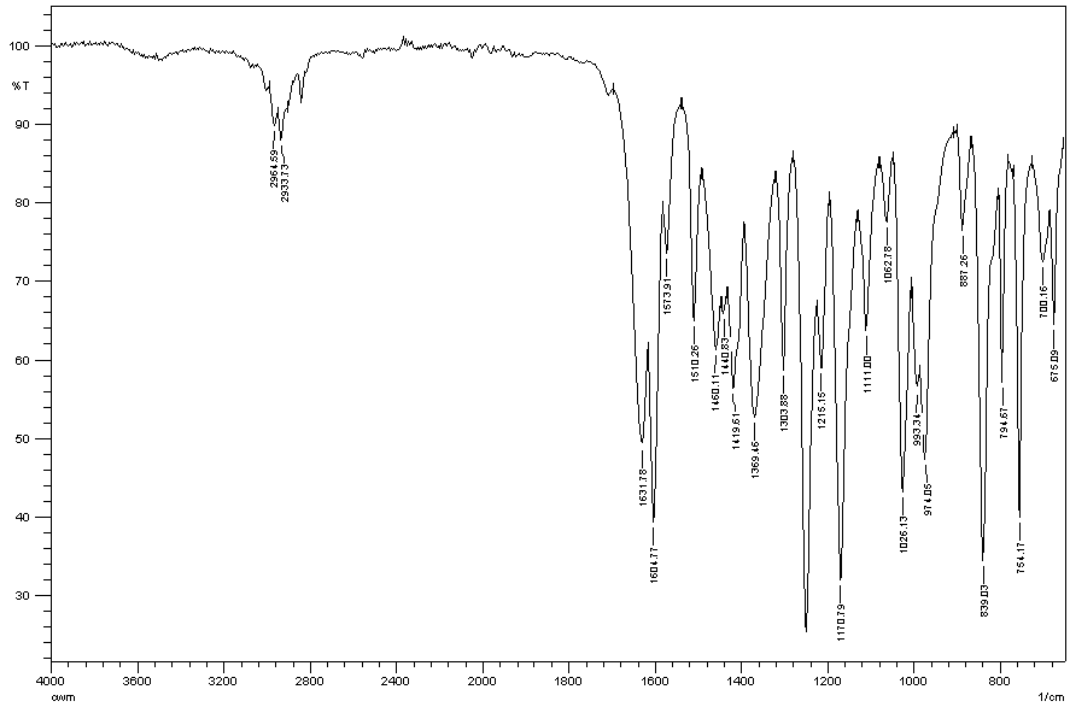
**$^{1}$H NMR:**



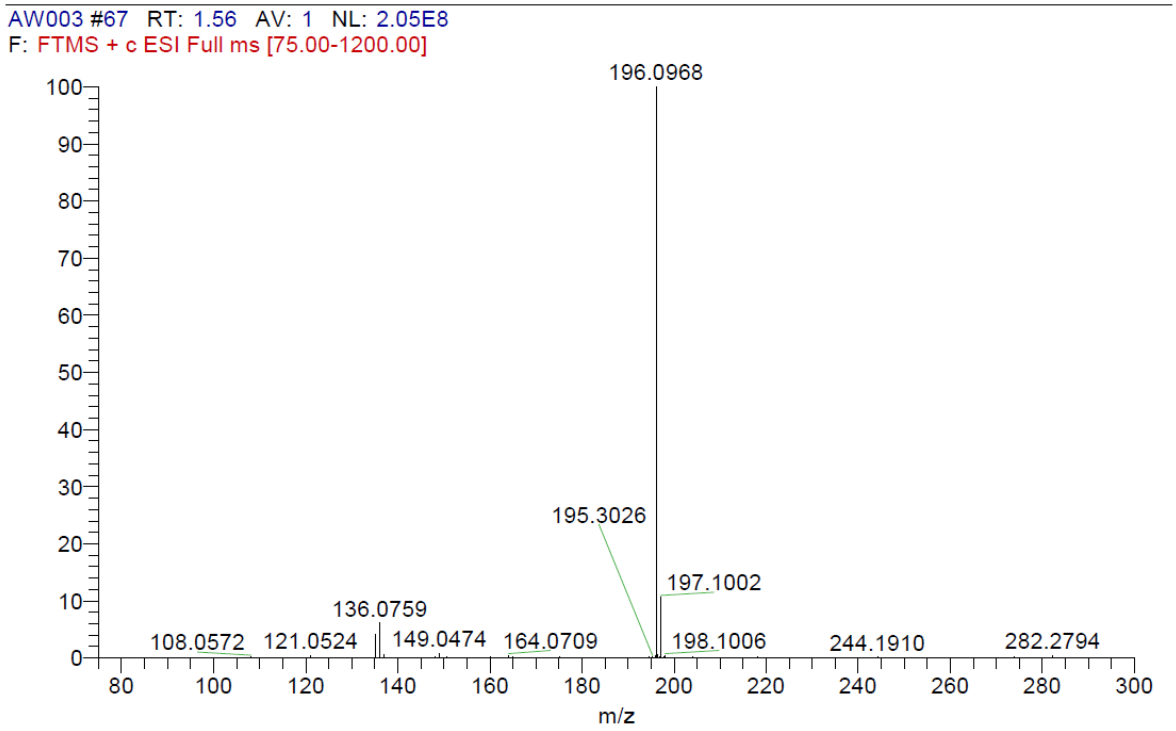

**$^{13}$C NMR:**



**FTIR:**

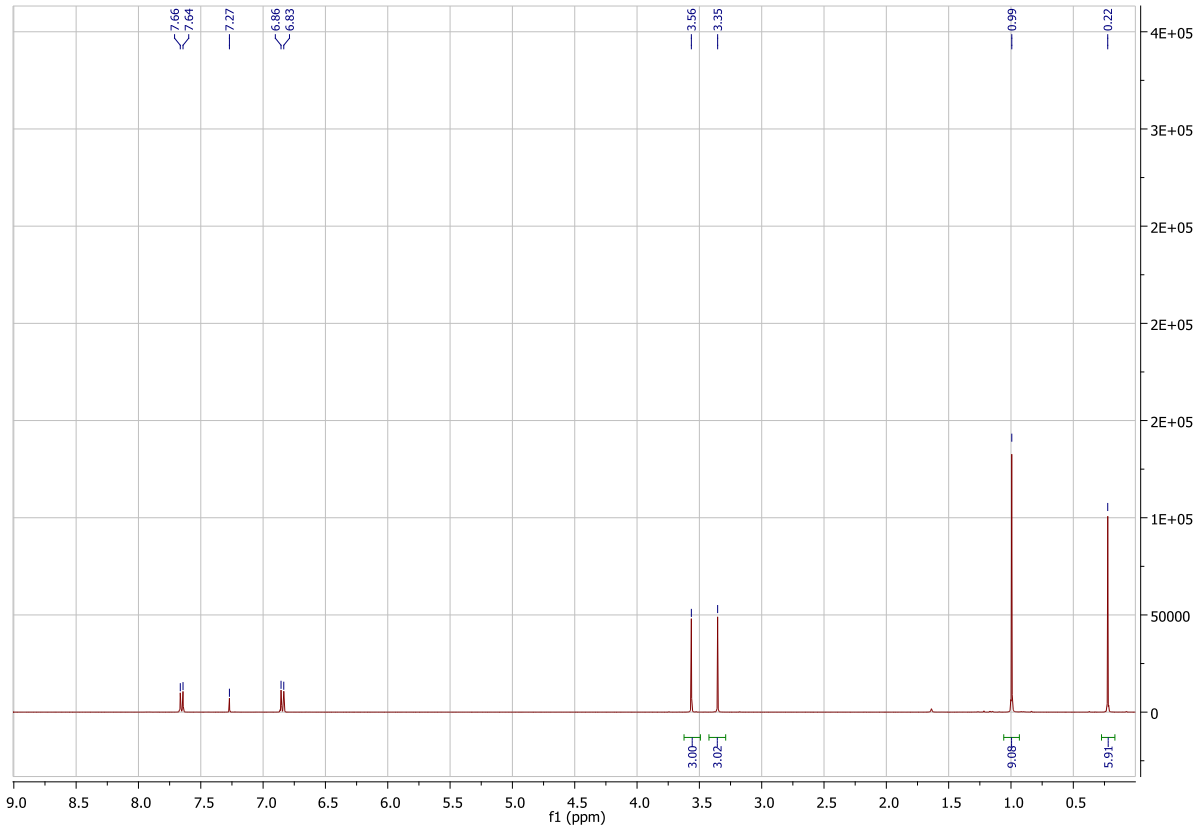

100
%T
90
80
70
60
50
40
30
2964.59
2933.13
1631.18
1604.77
1513.91
1510.26
1460.11
1440.83
1419.61
1369.46
1303.88
1215.15
1110.79
1111.00
1062.78
1026.13
993.34
914.05
839.03
887.26
794.67
764.17
700.16
676.09
4000
3600
3200
2800
2400
2000
1800
1600
1400
1200
1000
800
cm
1/cm

**HRMS:**

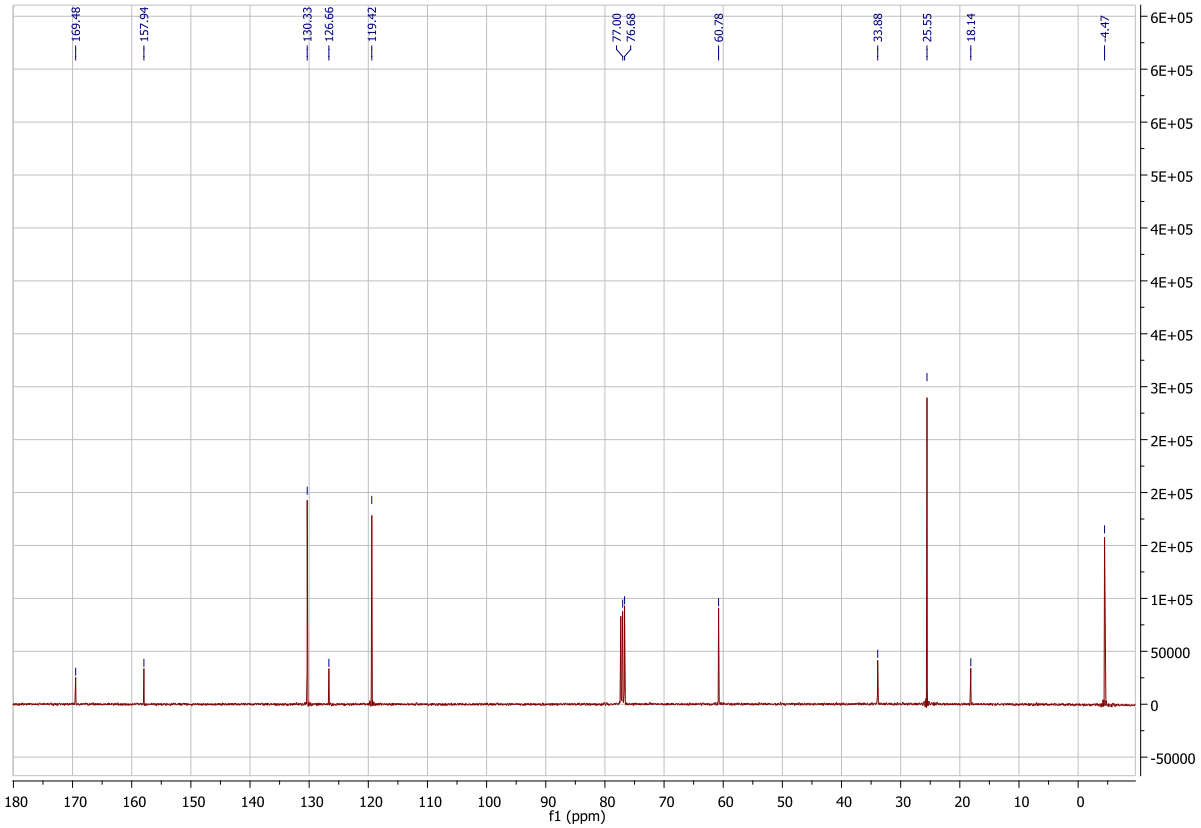

AW003 #67 RT: 1.56 AV: 1 NL: 2.05E8
F: FTMS + c ESI Full ms [75.00-1200.00]
196.0968
195.3026
197.1002
136.0759
108.0572
121.0524
149.0474
164.0709
198.1006
244.1910
282.2794
100
90
80
70
60
50
40
30
20
10
0
80
100
120
140
160
180
200
220
240
260
280
300
m/z

**Compound 5m: 4-((*tert*-Butyldimethylsilyl)oxy)-*N*-methoxy-*N*-methylbenzamide**

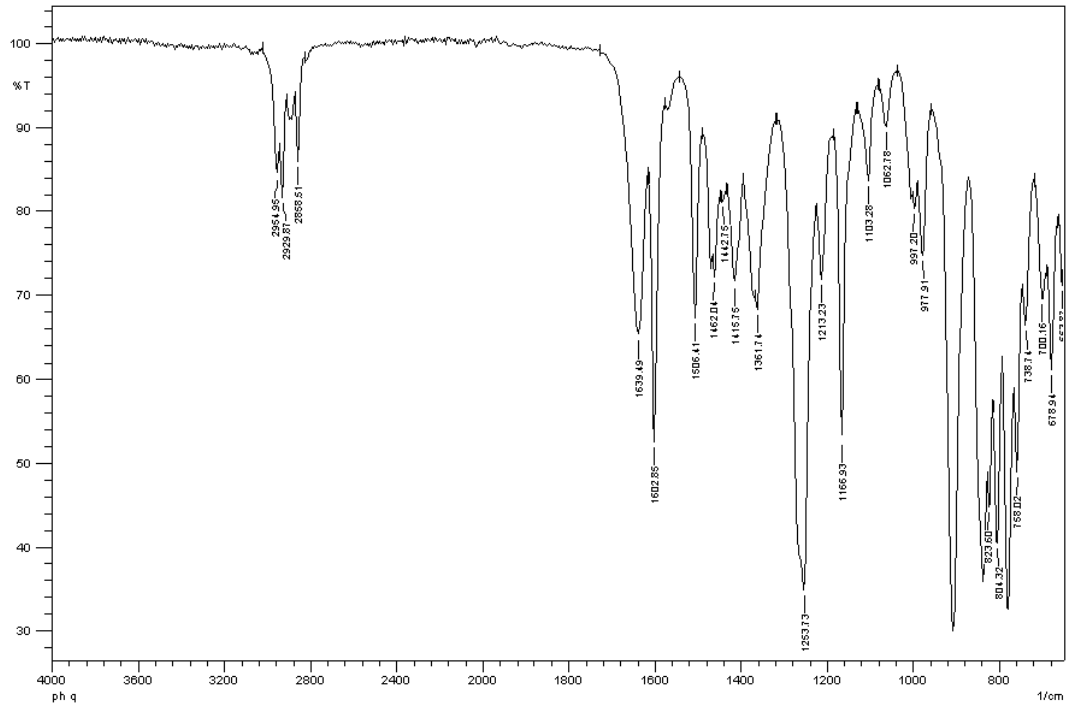
**$^{1}$H NMR:**



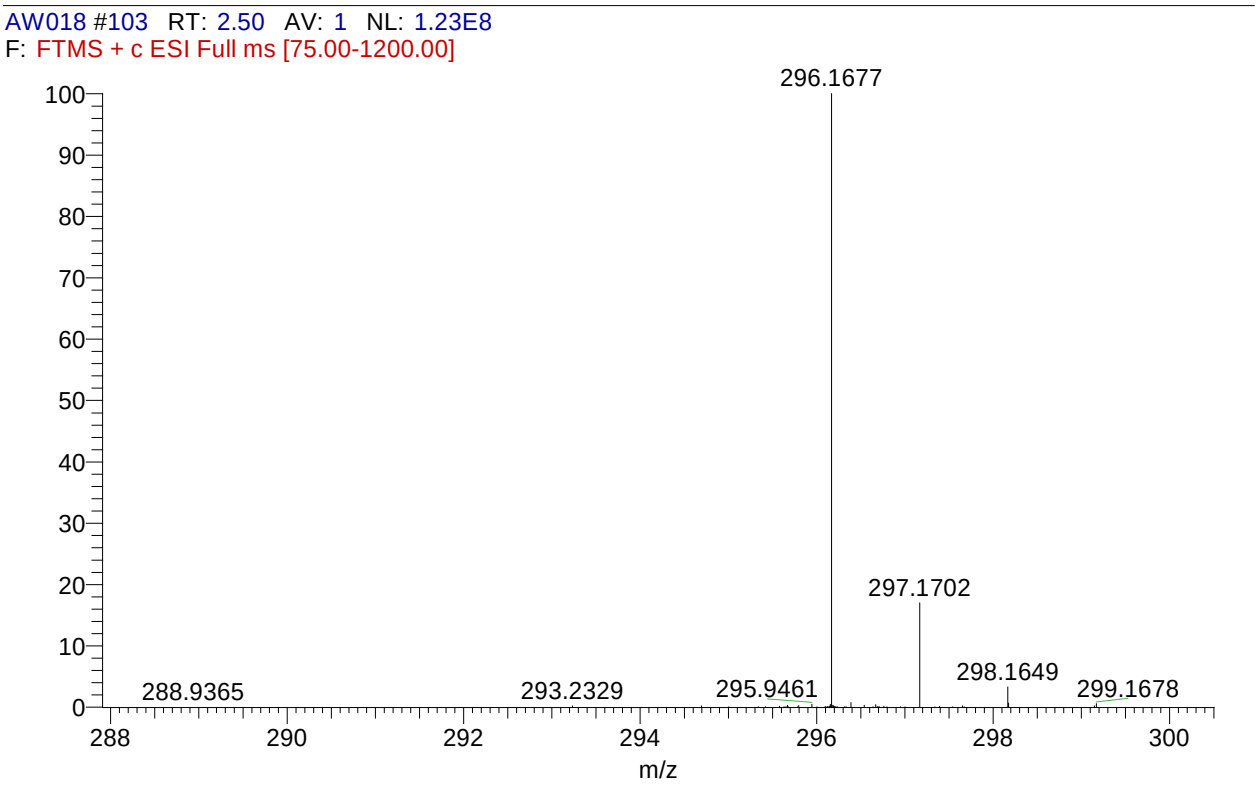

**$^{13}$C NMR:**



**FTIR:**

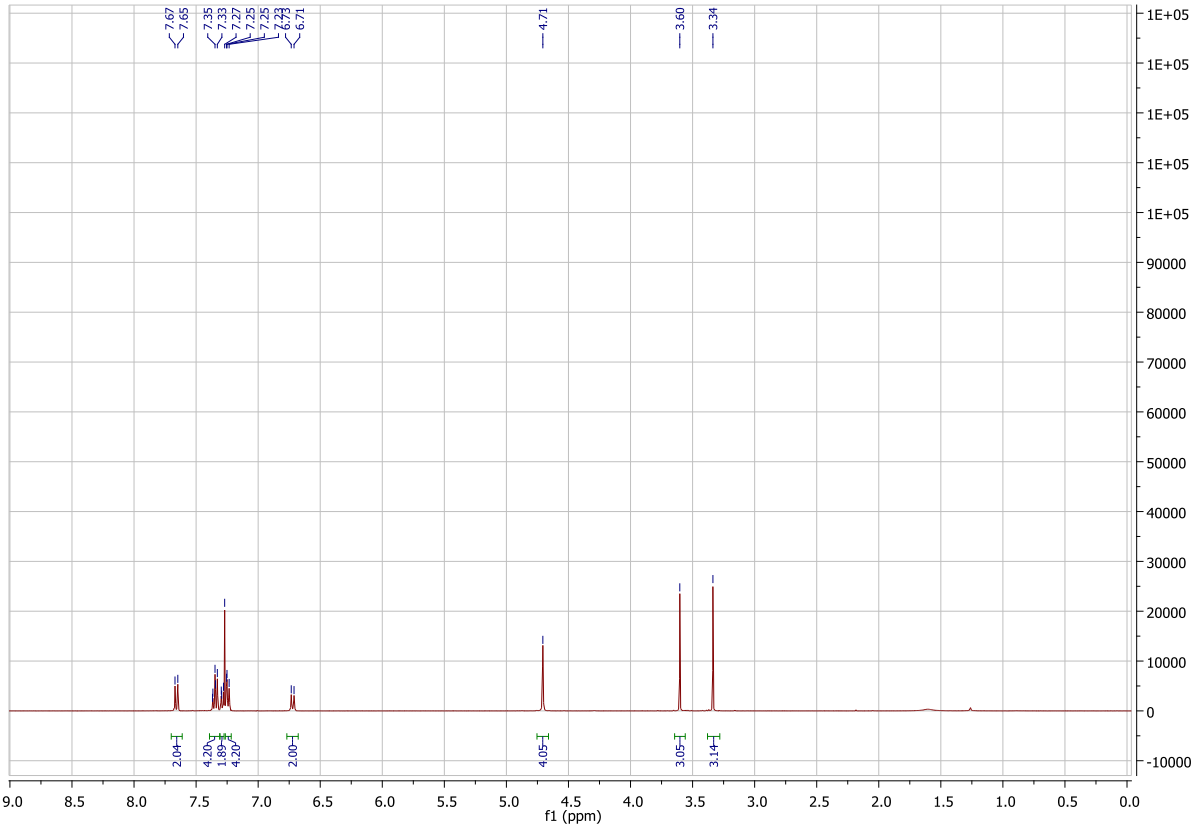



**HRMS:**

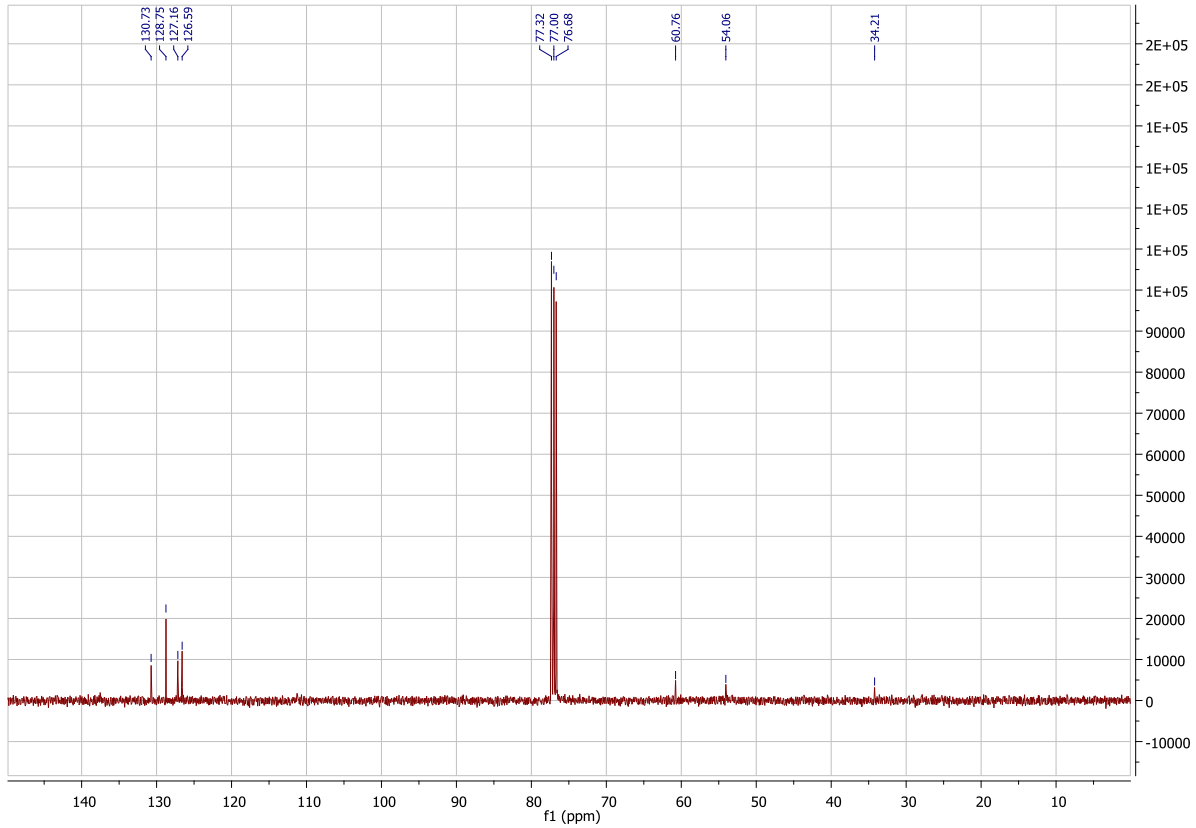


**Compound 5n: 4-(Dibenzylamino)-*N*-methoxy-*N*-methylbenzamide**

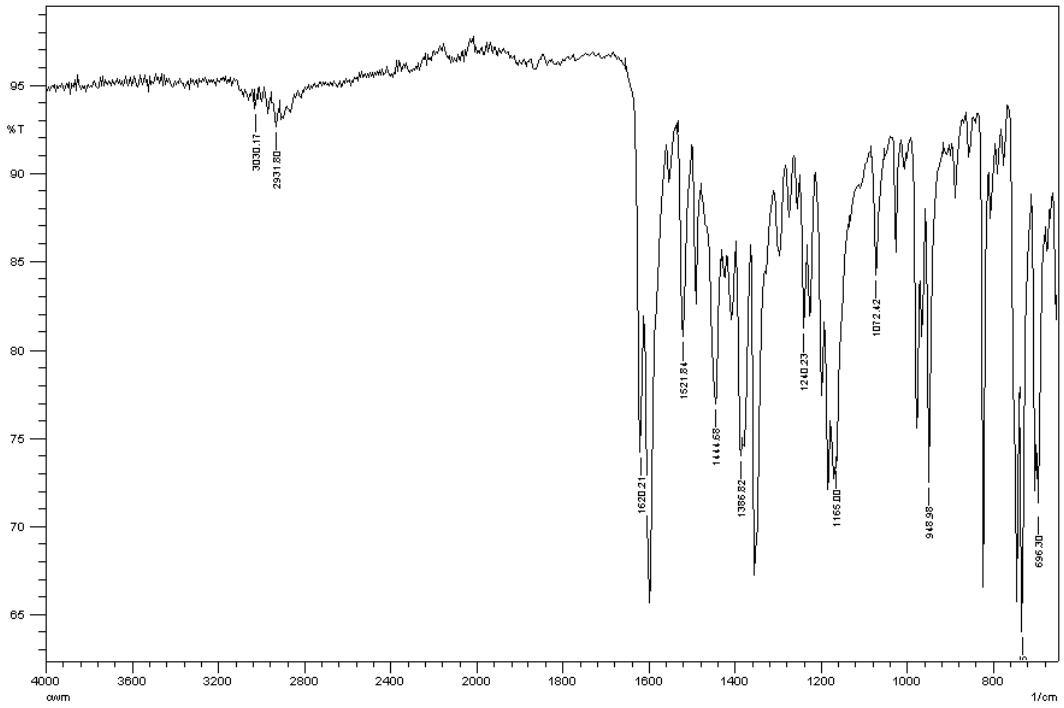
**$^{1}$H NMR:**



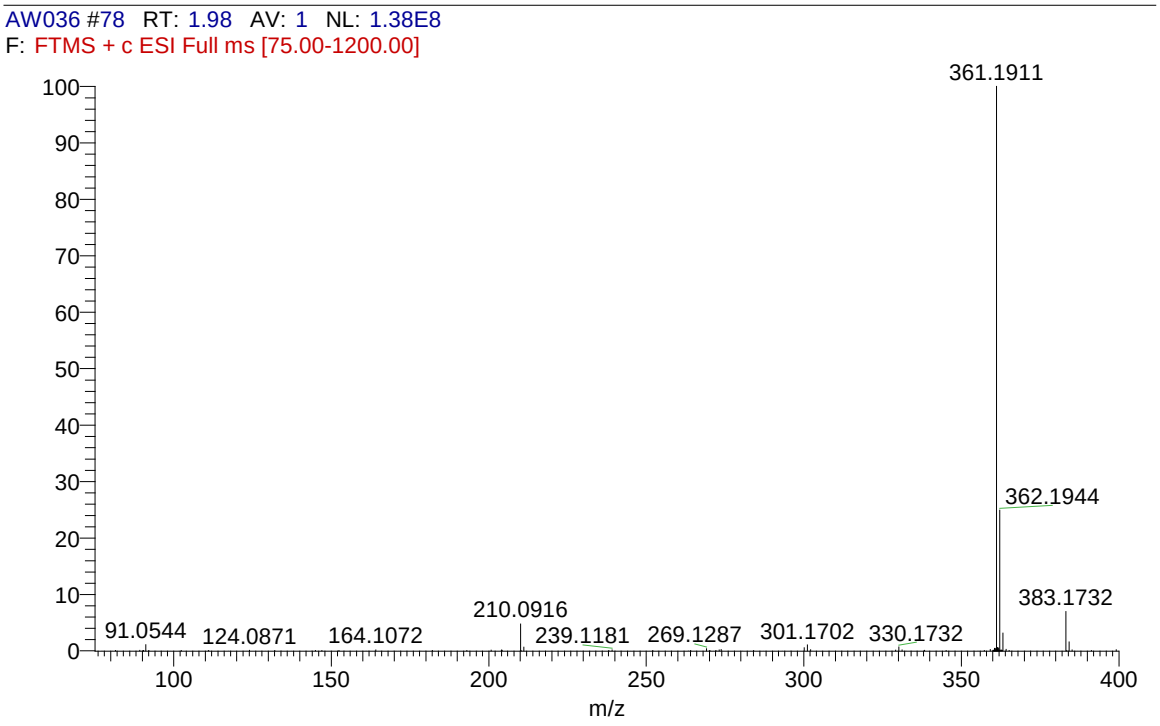

**$^{13}$C NMR:**



**FTIR:**

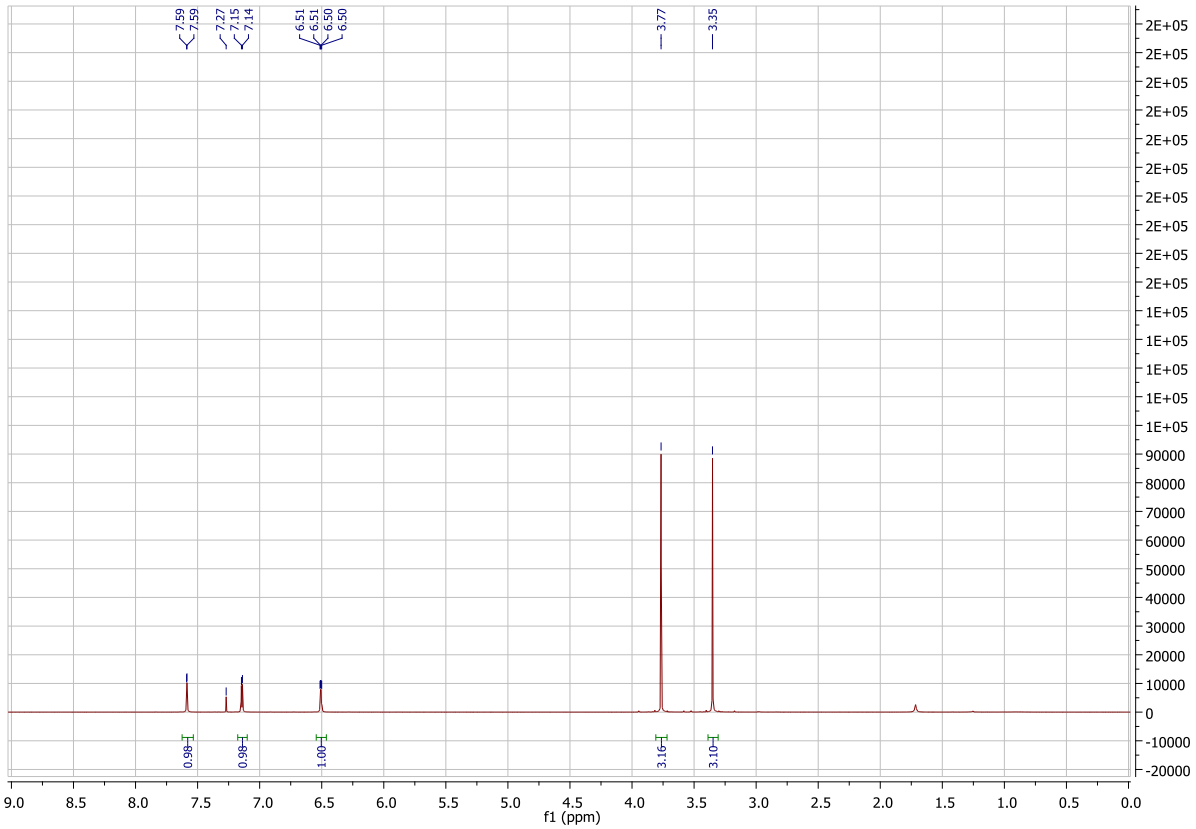



**HRMS:**

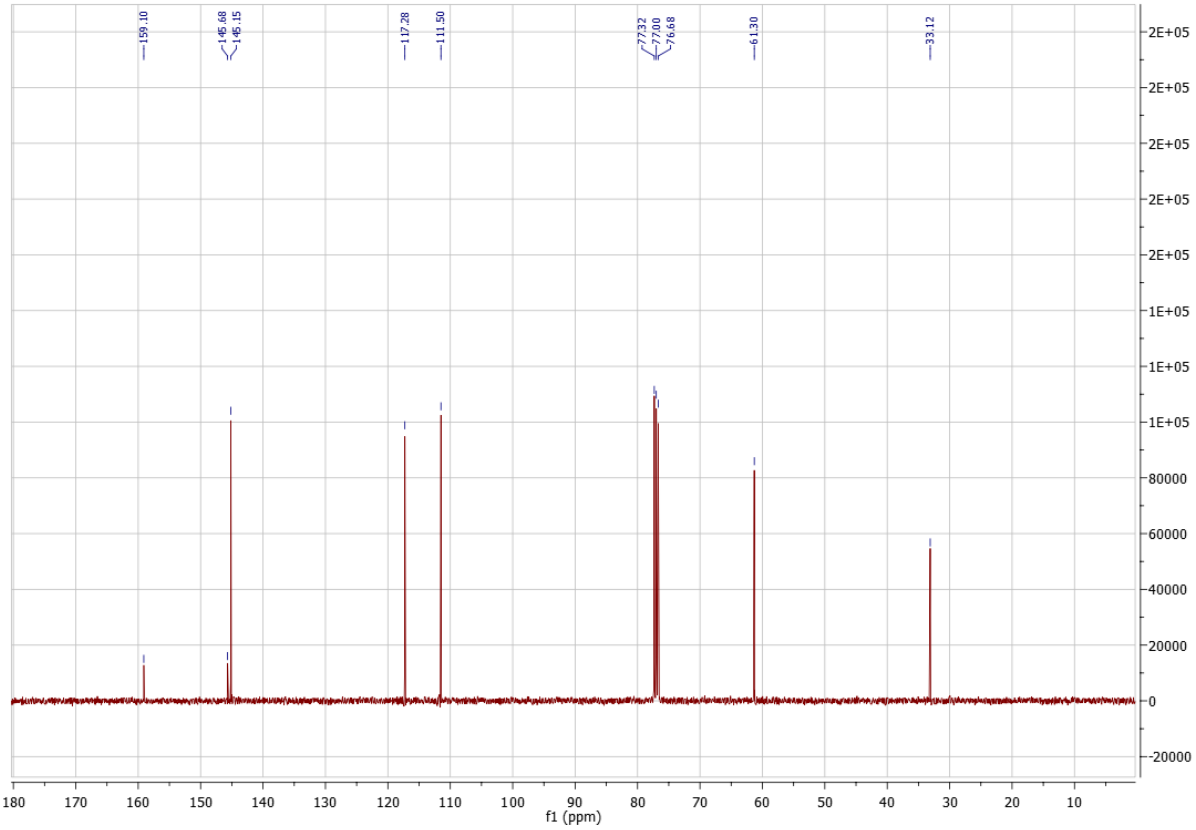


**Compound 5o: *N*-Methoxy-*N*-methylfuran-2-carboxamide**

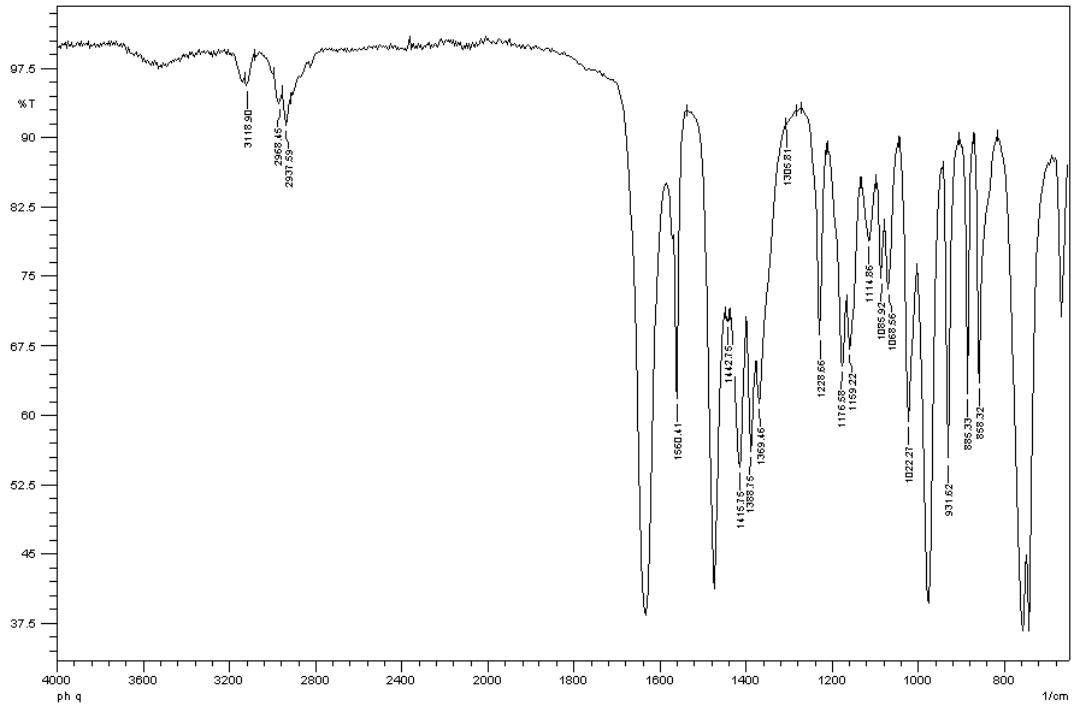
**$^{1}$H NMR:**



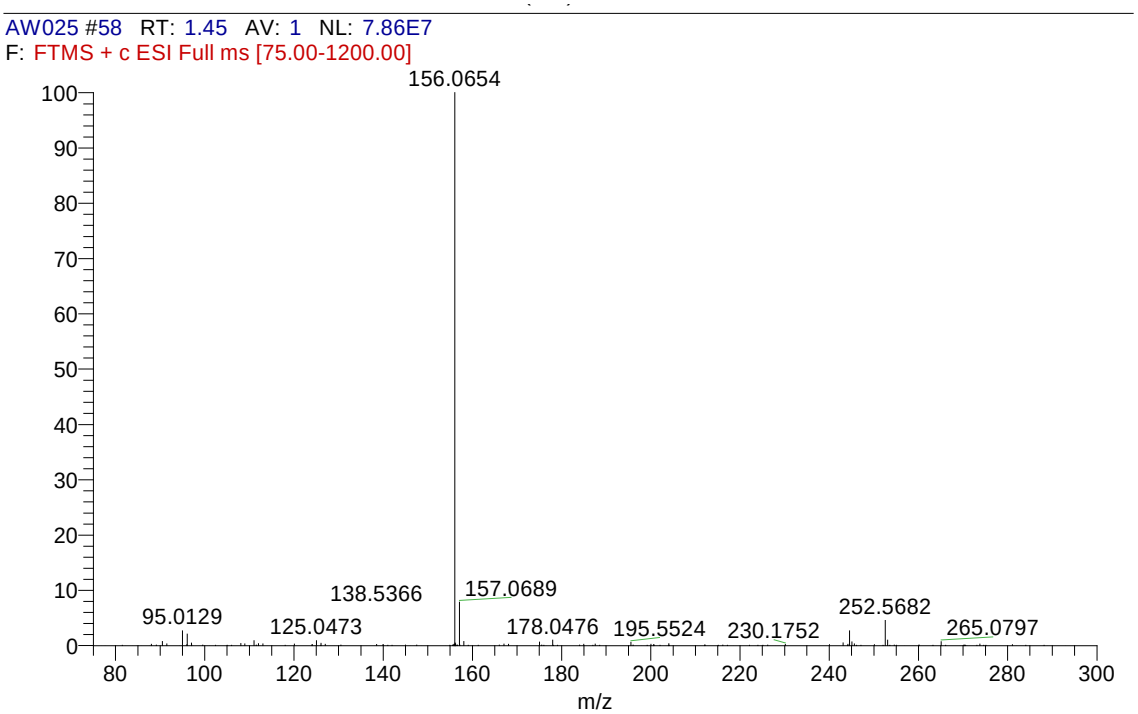

**$^{13}$C NMR:**



**FTIR:**




**HRMS:**



### 3.6 Crystal Structure Data for 3a

#### 3.6.1 General

Crystal data for **3a** ($C_{15}H_{11}NO$, MW = 221.25) were measured at 123 K using an Oxford Diffraction Xcalibur E instrument and MoKα radiation, λ = 0.71073 Å. Found monoclinic, space group P21/c, a = 9.0140(5), b= 10.7721(5), c= 11.3234(7) Å, β = 101.481(6)˚, V = 1077.50(10) Å3, Z = 4, μ = 0.086 mm-1, 2θmax = 54˚, 4957 reflections, 2347 unique, Rint 0.0276; final refinement to convergence on F2 gave R = 0.0475 (F, 1703 obs. data only) and Rw = 0.1061 (F2, all data), GOF = 1.041. CCDC reference number 915082.

#### 3.6.2 CIF Check

## checkCIF/PLATON report (basic structural check)

No syntax errors found. CIF dictionary

Please wait while processing .... Interpreting this report

# Datablock: watson1

---

```
Bond precision:      C-C = 0.0021 A              Wavelength=0.71073
Cell:          a=9.0140(5)     b=10.7721(5)    c=11.3234(7)
               alpha=90        beta=101.481(6) gamma=90
Temperature: 123 K
                    Calculated                      Reported
Volume              1077.50(11)                     1077.50(10)
Space group         P 21/c                          P21/c
Hall group          -P 2ybc                         ?
Moiety formula      C15 H11 N O                     ?
Sum formula         C15 H11 N O                     C15 H11 N O
Mr                  221.25                          221.25
Dx,g cm-3           1.364                           1.364
Z                   4                               4
Mu (mm-1)           0.086                           0.086
F000                464.0                           464.0
F000'               464.19
h,k,lmax            11,13,14                        11,13,14
Nref                2349                            2347
Tmin,Tmax           0.980,0.983                     0.953,1.000
Tmin'               0.975
Correction method= MULTI-SCAN
Data completeness= 0.999        Theta(max)= 27.000
R(reflections)= 0.0475( 1703)      wR2(reflections)= 0.1061( 2347)
S = 1.041              Npar= 154
```

---

The following ALERTS were generated. Each ALERT has the format

**test-name_ALERT_alert-type_alert-level**.

Click on the hyperlinks for more details of the test.

---

## Alert level G

PLAT005_ALERT_5_G No _iucr_refine_instructions_details in the CIF ?

---

0 **ALERT level A** = Most likely a serious problem - resolve or explain
0 **ALERT level B** = A potentially serious problem, consider carefully
0 **ALERT level C** = Check. Ensure it is not caused by an omission or oversight
1 **ALERT level G** = General information/check it is not something unexpected

0 ALERT type 1 CIF construction/syntax error, inconsistent or missing data
0 ALERT type 2 Indicator that the structure model may be wrong or deficient
0 ALERT type 3 Indicator that the structure quality may be low
0 ALERT type 4 Improvement, methodology, query or suggestion
1 ALERT type 5 Informative message, check

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It is advisable to attempt to resolve as many as possible of the alerts in all categories. Often the minor alerts point to easily fixed oversights, errors and omissions in your CIF or refinement strategy, so attention to these fine details can be worthwhile. In order to resolve some of the more serious problems it may be necessary to carry out additional measurements or structure refinements. However, the purpose of your study may justify the reported deviations and the more serious of these should normally be commented upon in the discussion or experimental section of a paper or in the "special_details" fields of the CIF. checkCIF was carefully designed to identify outliers and unusual parameters, but every test has its limitations and alerts that are not important in a particular case may appear. Conversely, the absence of alerts does not guarantee there are no aspects of the results needing attention. It is up to the individual to critically assess their own results and, if necessary, seek expert advice.

**Publication of your CIF in IUCr journals**

A basic structural check has been run on your CIF. These basic checks will be run on all CIFs submitted for publication in IUCr journals (*Acta Crystallographica*, *Journal of Applied Crystallography*, *Journal of Synchrotron Radiation*); however, if you intend to submit to *Acta Crystallographica Section C* or *E*, you should make sure that full publication checks are run on the final version of your CIF prior to submission.

**Publication of your CIF in other journals**

Please refer to the *Notes for Authors* of the relevant journal for any special instructions relating to CIF submission.

### 3.6.3 Crystal Data and Structure Refinement for 3a.

Table 1. Crystal Data and Structure Refinement for 3a.

| | |
|---|---|
| Identification code | watson1 |
| Empirical formula | C15 H11 N O |
| Formula weight | 221.25 |
| Temperature | 123(2) K |
| Wavelength | 0.71073 Å |

| | | |
|---|---|---|
| Crystal system | Monoclinic | |
| Space group | $P2_1/c$ | |
| Unit cell dimensions | a = 9.0140(5) Å | □= 90°. |
| | b = 10.7721(5) Å | □= 101.481(6)°. |
| | c = 11.3234(7) Å | □ = 90°. |
| Volume | 1077.50(10) $Å^3$ | |
| Z | 4 | |
| Density (calculated) | 1.364 $Mg/m^3$ | |
| Absorption coefficient | 0.086 $mm^{-1}$ | |
| F(000) | 464 | |
| Crystal size | 0.30 x 0.20 x 0.20 $mm^3$ | |
| Theta range for data collection | 2.98 to 27.00°. | |
| Index ranges | -11<=h<=11, -13<=k<=13, -14<=l<=14 | |
| Reflections collected | 4957 | |
| Independent reflections | 2347 [R(int) = 0.0276] | |
| Completeness to theta = 27.00° | 99.9 % | |
| Absorption correction | Semi-empirical from equivalents | |
| Max. and min. transmission | 1.00000 and 0.95340 | |
| Refinement method | Full-matrix least-squares on $F^2$ | |
| Data / restraints / parameters | 2347 / 0 / 154 | |
| Goodness-of-fit on $F^2$ | 1.041 | |
| Final R indices [I>2sigma(I)] | R1 = 0.0475, wR2 = 0.0937 | |
| R indices (all data) | R1 = 0.0769, wR2 = 0.1061 | |
| Largest diff. peak and hole | 0.235 and -0.234 $e.Å^{-3}$ | |

Table 2. Atomic coordinates ($x10^4$) and equivalent isotropic displacement parameters ($Å^2x10^3$) for 3a. U(eq) is defined as one third of the trace of the orthogonalized $U^{ij}$ tensor.

| | x | y | z | U(eq) |
|---|---|---|---|---|
| O(1) | 1077(1) | 2359(1) | 416(1) | 28(1) |
| N(1) | 1440(2) | 4324(1) | 1213(1) | 18(1) |
| C(1) | 1520(2) | 3433(2) | 284(2) | 20(1) |
| C(2) | 2141(2) | 3880(2) | -676(1) | 19(1) |
| C(3) | 2645(2) | 5090(2) | -748(1) | 18(1) |
| C(4) | 2495(2) | 5923(2) | 167(1) | 19(1) |
| C(5) | 1910(2) | 5547(2) | 1148(1) | 18(1) |
| C(6) | 1781(2) | 6346(2) | 2125(1) | 21(1) |
| C(7) | 1299(2) | 5925(2) | 3107(2) | 23(1) |
| C(8) | 879(2) | 4661(2) | 3160(2) | 23(1) |
| C(9) | 937(2) | 3907(2) | 2223(1) | 21(1) |
| C(10) | 3374(2) | 5487(2) | -1754(1) | 19(1) |
| C(11) | 2966(2) | 4965(2) | -2904(2) | 22(1) |

| | | | | |
|---|---|---|---|---|
| C(12) | 3675(2) | 5335(2) | -3824(2) | 27(1) |
| C(13) | 4799(2) | 6231(2) | -3614(2) | 29(1) |
| C(14) | 5206(2) | 6764(2) | -2486(2) | 26(1) |
| C(15) | 4506(2) | 6392(2) | -1561(2) | 22(1) |

Table 3. Bond lengths [Å] and angles [°] for 3a.

| | |
|---|---|
| O(1)-C(1) | 1.2428(19) |
| N(1)-C(9) | 1.3857(19) |
| N(1)-C(5) | 1.391(2) |
| N(1)-C(1) | 1.436(2) |
| C(1)-C(2) | 1.403(2) |
| C(2)-C(3) | 1.388(2) |
| C(2)-H(2) | 0.9500 |
| C(3)-C(4) | 1.397(2) |
| C(3)-C(10) | 1.487(2) |
| C(4)-C(5) | 1.383(2) |
| C(4)-H(4) | 0.9500 |
| C(5)-C(6) | 1.424(2) |
| C(6)-C(7) | 1.350(2) |
| C(6)-H(6) | 0.9500 |
| C(7)-C(8) | 1.418(2) |
| C(7)-H(7) | 0.9500 |
| C(8)-C(9) | 1.346(2) |
| C(8)-H(8) | 0.9500 |
| C(9)-H(9) | 0.9500 |
| C(10)-C(15) | 1.396(2) |
| C(10)-C(11) | 1.399(2) |
| C(11)-C(12) | 1.384(2) |
| C(11)-H(11) | 0.9500 |
| C(12)-C(13) | 1.385(3) |
| C(12)-H(12) | 0.9500 |
| C(13)-C(14) | 1.382(2) |
| C(13)-H(13) | 0.9500 |
| C(14)-C(15) | 1.385(2) |
| C(14)-H(14) | 0.9500 |
| C(15)-H(15) | 0.9500 |

| | |
|---|---|
| C(9)-N(1)-C(5) | 120.24(14) |
| C(9)-N(1)-C(1) | 117.40(13) |
| C(5)-N(1)-C(1) | 122.29(13) |
| O(1)-C(1)-C(2) | 126.86(15) |
| O(1)-C(1)-N(1) | 118.00(14) |
| C(2)-C(1)-N(1) | 115.12(14) |
| C(3)-C(2)-C(1) | 123.58(15) |
| C(3)-C(2)-H(2) | 118.2 |
| C(1)-C(2)-H(2) | 118.2 |
| C(2)-C(3)-C(4) | 118.61(15) |

| | |
|---|---|
| C(2)-C(3)-C(10) | 121.02(14) |
| C(4)-C(3)-C(10) | 120.34(14) |
| C(5)-C(4)-C(3) | 121.11(15) |
| C(5)-C(4)-H(4) | 119.4 |
| C(3)-C(4)-H(4) | 119.4 |
| C(4)-C(5)-N(1) | 119.25(14) |
| C(4)-C(5)-C(6) | 123.43(15) |
| N(1)-C(5)-C(6) | 117.32(14) |
| C(7)-C(6)-C(5) | 121.73(16) |
| C(7)-C(6)-H(6) | 119.1 |
| C(5)-C(6)-H(6) | 119.1 |
| C(6)-C(7)-C(8) | 119.36(16) |
| C(6)-C(7)-H(7) | 120.3 |
| C(8)-C(7)-H(7) | 120.3 |
| C(9)-C(8)-C(7) | 119.56(16) |
| C(9)-C(8)-H(8) | 120.2 |
| C(7)-C(8)-H(8) | 120.2 |
| C(8)-C(9)-N(1) | 121.70(16) |
| C(8)-C(9)-H(9) | 119.2 |
| N(1)-C(9)-H(9) | 119.2 |
| C(15)-C(10)-C(11) | 118.34(15) |
| C(15)-C(10)-C(3) | 120.14(15) |
| C(11)-C(10)-C(3) | 121.52(15) |
| C(12)-C(11)-C(10) | 120.59(17) |
| C(12)-C(11)-H(11) | 119.7 |
| C(10)-C(11)-H(11) | 119.7 |
| C(11)-C(12)-C(13) | 120.24(17) |
| C(11)-C(12)-H(12) | 119.9 |
| C(13)-C(12)-H(12) | 119.9 |
| C(14)-C(13)-C(12) | 119.90(16) |
| C(14)-C(13)-H(13) | 120.0 |
| C(12)-C(13)-H(13) | 120.0 |
| C(13)-C(14)-C(15) | 120.07(17) |
| C(13)-C(14)-H(14) | 120.0 |
| C(15)-C(14)-H(14) | 120.0 |
| C(14)-C(15)-C(10) | 120.85(16) |
| C(14)-C(15)-H(15) | 119.6 |
| C(10)-C(15)-H(15) | 119.6 |

---

Symmetry transformations used to generate equivalent atoms:

Table 4. Anisotropic displacement parameters ($Å^2 x\ 10^3$)for watson1. The anisotropic displacement factor exponent takes the form: $-2\pi^2[\ h^2 a^{*2} U^{11} + ... + 2\ h\ k\ a^*\ b^*\ U^{12}\ ]$

| | $U^{11}$ | $U^{22}$ | $U^{33}$ | $U^{23}$ | $U^{13}$ | $U^{12}$ |
|---|---|---|---|---|---|---|
| O(1) | 38(1) | 16(1) | 31(1) | -1(1) | 12(1) | -3(1) |
| N(1) | 18(1) | 18(1) | 18(1) | 1(1) | 4(1) | 1(1) |
| C(1) | 20(1) | 16(1) | 24(1) | -2(1) | 2(1) | 2(1) |
| C(2) | 22(1) | 18(1) | 19(1) | -3(1) | 4(1) | 2(1) |
| C(3) | 16(1) | 19(1) | 18(1) | 0(1) | 0(1) | 3(1) |
| C(4) | 21(1) | 16(1) | 21(1) | 1(1) | 3(1) | -1(1) |
| C(5) | 17(1) | 16(1) | 20(1) | 0(1) | 1(1) | 1(1) |
| C(6) | 20(1) | 19(1) | 23(1) | -4(1) | 3(1) | 0(1) |
| C(7) | 22(1) | 28(1) | 20(1) | -4(1) | 3(1) | 4(1) |
| C(8) | 22(1) | 29(1) | 19(1) | 4(1) | 5(1) | 2(1) |
| C(9) | 20(1) | 20(1) | 25(1) | 6(1) | 6(1) | 2(1) |
| C(10) | 20(1) | 17(1) | 21(1) | 2(1) | 5(1) | 6(1) |
| C(11) | 22(1) | 22(1) | 24(1) | -1(1) | 4(1) | 4(1) |
| C(12) | 33(1) | 30(1) | 20(1) | 0(1) | 7(1) | 10(1) |
| C(13) | 33(1) | 31(1) | 28(1) | 9(1) | 16(1) | 10(1) |
| C(14) | 21(1) | 25(1) | 35(1) | 6(1) | 9(1) | 2(1) |
| C(15) | 21(1) | 22(1) | 22(1) | 2(1) | 4(1) | 3(1) |

Table 5. Hydrogen coordinates ($x10^4$) and isotropic displacement parameters ($Å^2x10^3$) for 3a.

| | x | y | z | U(eq) |
|---|---|---|---|---|
| H(2) | 2221 | 3324 | -1312 | 23 |
| H(4) | 2802 | 6761 | 113 | 23 |
| H(6) | 2041 | 7197 | 2085 | 25 |
| H(7) | 1242 | 6470 | 3755 | 28 |
| H(8) | 559 | 4349 | 3853 | 28 |
| H(9) | 626 | 3067 | 2254 | 26 |
| H(11) | 2195 | 4351 | -3056 | 27 |
| H(12) | 3390 | 4974 | -4601 | 33 |
| H(13) | 5289 | 6479 | -4245 | 35 |
| H(14) | 5967 | 7387 | -2344 | 32 |
| H(15) | 4800 | 6756 | -786 | 26 |

Table 6. Torsion angles [°] for 3a.

| | |
|---|---|
| C(9)-N(1)-C(1)-O(1) | 2.9(2) |
| C(5)-N(1)-C(1)-O(1) | 179.90(15) |

| | |
|---|---|
| C(9)-N(1)-C(1)-C(2) | -175.44(14) |
| C(5)-N(1)-C(1)-C(2) | 1.5(2) |
| O(1)-C(1)-C(2)-C(3) | -178.43(17) |
| N(1)-C(1)-C(2)-C(3) | -0.2(2) |
| C(1)-C(2)-C(3)-C(4) | -1.6(2) |
| C(1)-C(2)-C(3)-C(10) | 176.44(15) |
| C(2)-C(3)-C(4)-C(5) | 2.3(2) |
| C(10)-C(3)-C(4)-C(5) | -175.78(15) |
| C(3)-C(4)-C(5)-N(1) | -1.1(2) |
| C(3)-C(4)-C(5)-C(6) | 177.76(15) |
| C(9)-N(1)-C(5)-C(4) | 175.97(15) |
| C(1)-N(1)-C(5)-C(4) | -0.9(2) |
| C(9)-N(1)-C(5)-C(6) | -2.9(2) |
| C(1)-N(1)-C(5)-C(6) | -179.82(14) |
| C(4)-C(5)-C(6)-C(7) | -175.42(16) |
| N(1)-C(5)-C(6)-C(7) | 3.4(2) |
| C(5)-C(6)-C(7)-C(8) | -1.3(3) |
| C(6)-C(7)-C(8)-C(9) | -1.3(3) |
| C(7)-C(8)-C(9)-N(1) | 1.8(2) |
| C(5)-N(1)-C(9)-C(8) | 0.4(2) |
| C(1)-N(1)-C(9)-C(8) | 177.42(15) |
| C(2)-C(3)-C(10)-C(15) | -147.47(16) |
| C(4)-C(3)-C(10)-C(15) | 30.6(2) |
| C(2)-C(3)-C(10)-C(11) | 31.8(2) |
| C(4)-C(3)-C(10)-C(11) | -150.15(15) |
| C(15)-C(10)-C(11)-C(12) | 0.3(2) |
| C(3)-C(10)-C(11)-C(12) | -179.02(15) |
| C(10)-C(11)-C(12)-C(13) | -0.1(3) |
| C(11)-C(12)-C(13)-C(14) | -0.5(3) |
| C(12)-C(13)-C(14)-C(15) | 0.9(3) |
| C(13)-C(14)-C(15)-C(10) | -0.7(3) |
| C(11)-C(10)-C(15)-C(14) | 0.1(2) |
| C(3)-C(10)-C(15)-C(14) | 179.40(15) |

Symmetry transformations used to generate equivalent atoms:

**4. References**

1. W. L. F. Armarego and C. L. L. Chai, Purification of Laboratory Chemicals, 7th ed., Elsevier, Oxford, 2013.

2. The β-ketopyridines prepared exist as a mixture of enol and keto tautomers in various ratios. In addition, some of the enol tautomers exhibit *cis-trans* isomerism. As such, the $^{1}H$ and $^{13}C$ NMR spectra for these compounds are complicated and we have elected to provide the spectra, which can be found in the appendix.

3. J. M. Williams, R. B. Jobson, N. Yasuda, G. Marchesini, U. H. Dolling and E. J. J. Grabowski, *Tetrahedron Lett.*, 1995, **36**, 5461.