Electronic Supplemental Information (ESI)

Transition metal and base free synthesis of 2-aryl-2-oxazolines from aldehydes with β-amino alcohols catalyzed by Potassium Iodide

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Table of contents

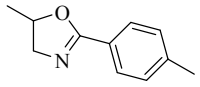
General Information

All chemicals were purchased from Sigma-Aldrich and S.D Fine Chemicals, Pvt. Ltd. India and used as received. ACME silica gel (100–200 mesh) was used for column chromatography and thin-layer chromatography was performed on Merck-precoated silica gel 60-F_{254} plates. All the other chemicals and solvents were obtained from commercial sources and purified using standard methods. The ^1H spectra were recorded on a Varian-Gemini 200 MHz, Bruker-Avance 300 MHz Spectrometer. Chemical shifts (δ) are reported in ppm, using TMS (δ =0) as an internal standard in $CDCl_3$. GC were recorded on Shimadzu-2014 using BP-01 (30M X 0.25 mm X 1.0 μm) column. GC-MS spectra were recorded on Thermo Trace DSQ GC-MS spectrometer using BP-01 (30M X 0.25 mm X 1.0 μm) column.

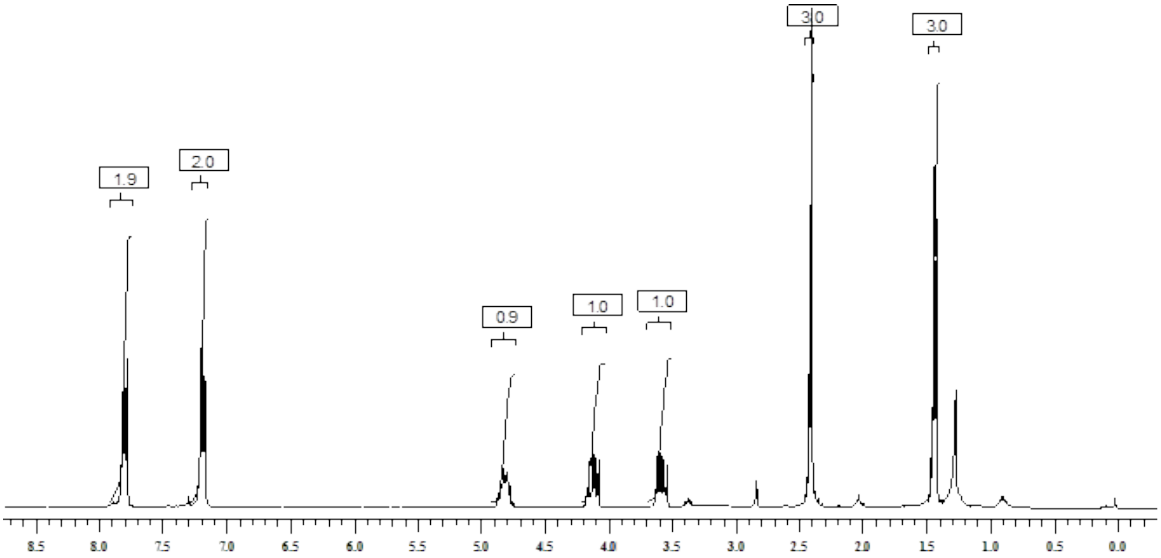
Typical experimental procedure for synthesis of 2-oxazoline from aldehyde and amino alcohol: To a solution of aldehyde (1.0 mmol), potassium iodide (0.2 mmol) and amino-alcohol (1.2 mmol) in 3 mL of CH_2Cl_2, a solution of 70% aqueous TBHP (3.0 mmol) was added drop-wise over a period of 30 min and stirred at room temperature. The mixture was quenched with saturated aqueous $Na_2S_2O_3$ after 8h, washed with brine, extracted with ethyl acetate and dried over anhydrous Na_2SO_4. Removal of the solvent under vacuum afforded the crude product, which was further purified by column chromatography using hexane / ethyl acetate mixture and was analyzed by ^1H NMR, GC and GC-MS. Similar procedure was followed for the synthesis of chiral oxazolines from chiral amino alcohols and benzaldehyde and multi-scale synthesis of chiral 2-Oxazoline **2p.**

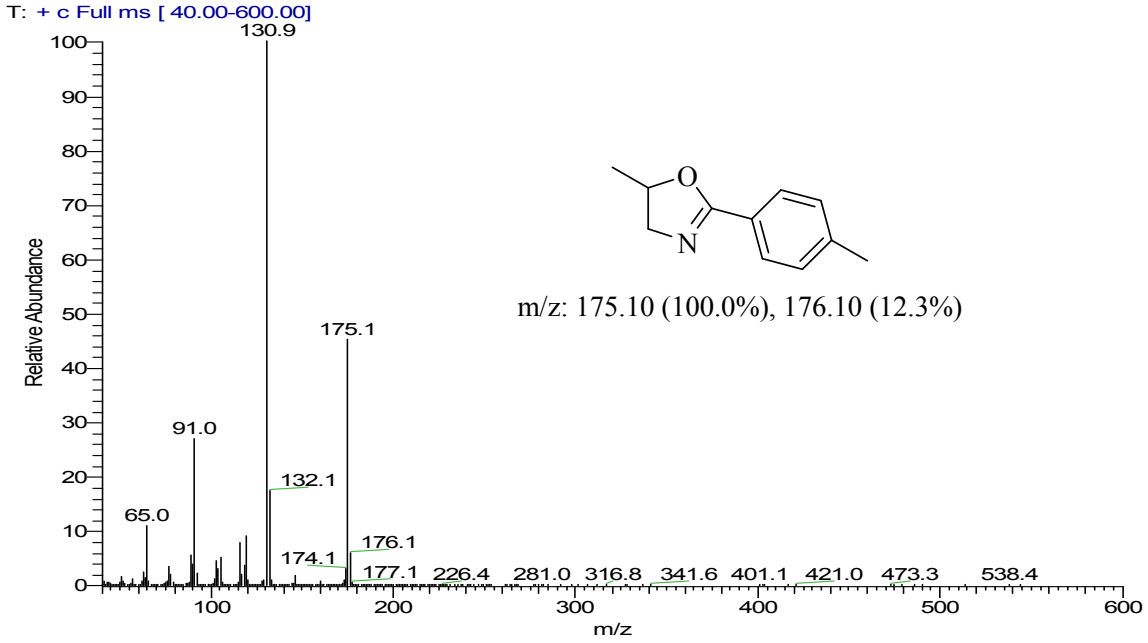
Products 3a [1], 3c [2], 3d [3], 3h [4], 3k [5], 3m [6], 3n [7], 3p [6], 3q [8], 3r [8] and 3t [9] have been described in the literature previously. Characterization data for all compounds are given below.

5-methyl-2-p-tolyl-4,5-dihydrooxazole (**3a**,Table 2, Entry 1) [1]



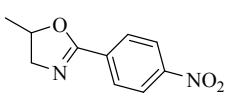
Isolated yield = 61%; ^{1}H NMR δ (300 MHz, $CDCl_3$) 7.80 (d, J = 7.9 Hz, Ar, 2H), 7.18 (d, J = 7.9 Hz, Ar, 2H), 4.77 – 4.87 (m, 1H), 4.11 (dd, J = 9.3 Hz, 9.2 Hz, 1H), 3.57 (dd, J = 7.4 Hz, 7.2 Hz), 2.4 (s, -CH_3, 3H), 1.43 (d, J = 6.0Hz, -CH_3, 3H). **GC-MS** m/z 175.1 (M^+ peak),130.9, 91.0, 65.0 .



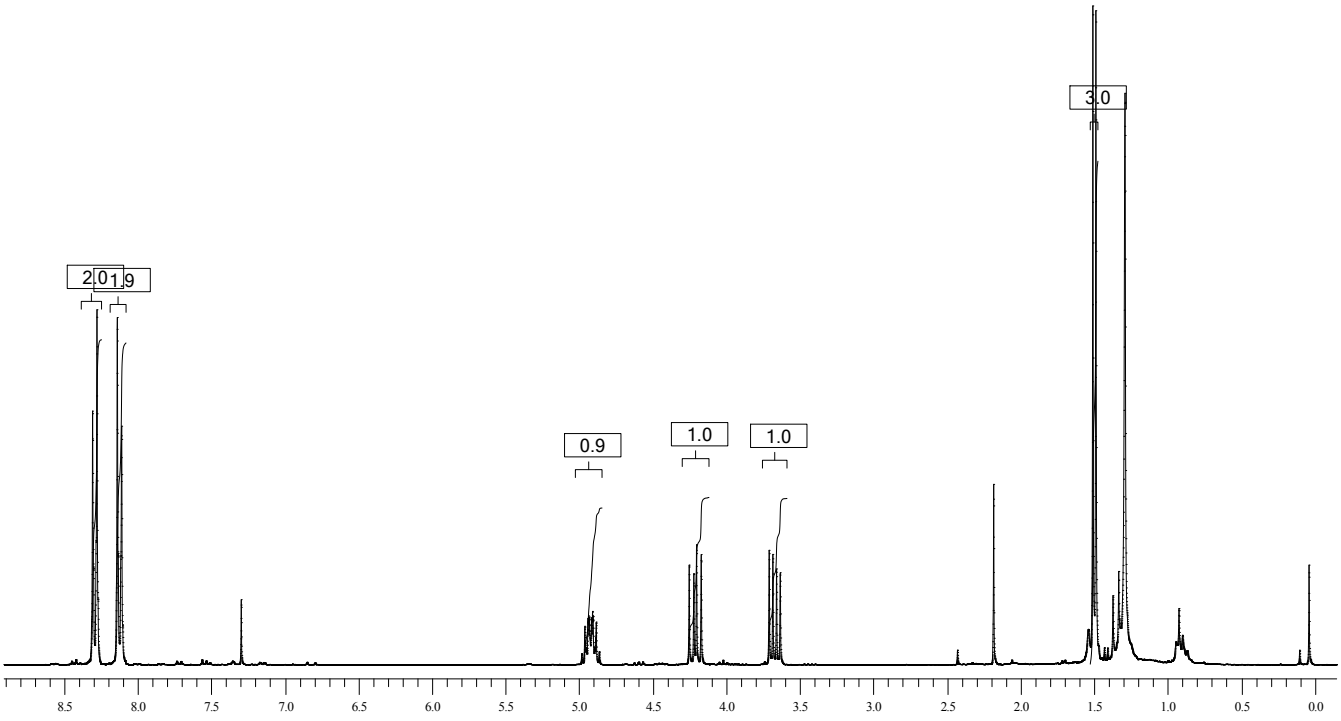


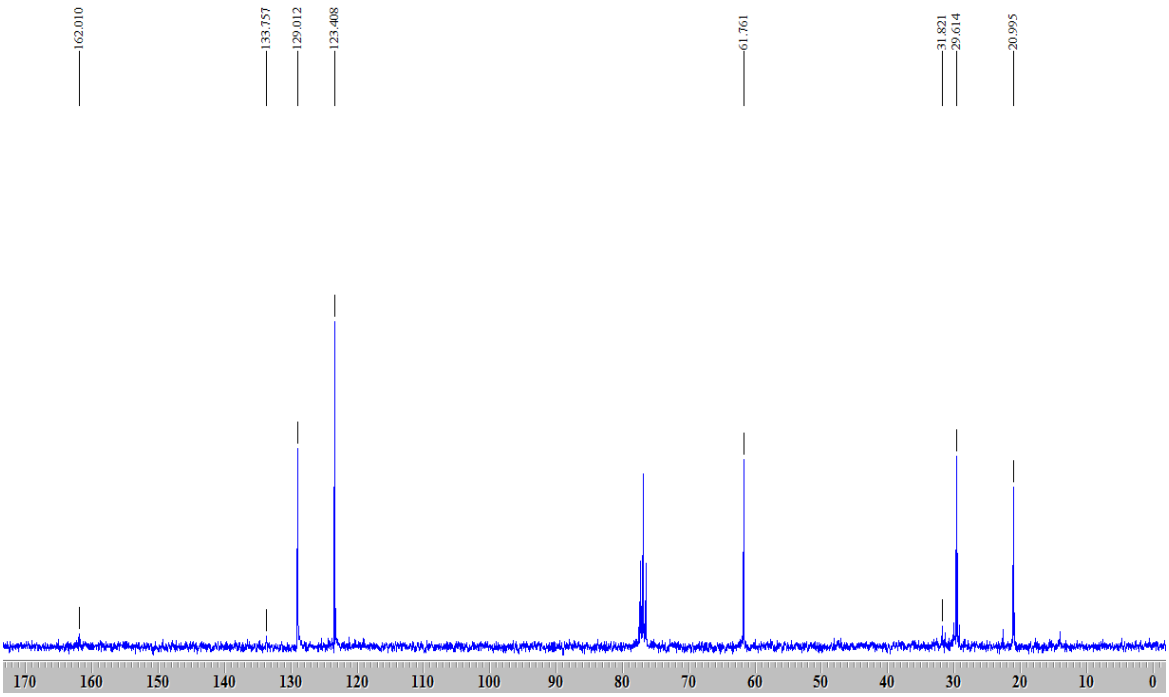
m/z: 175.10 (100.0%), 176.10 (12.3%)

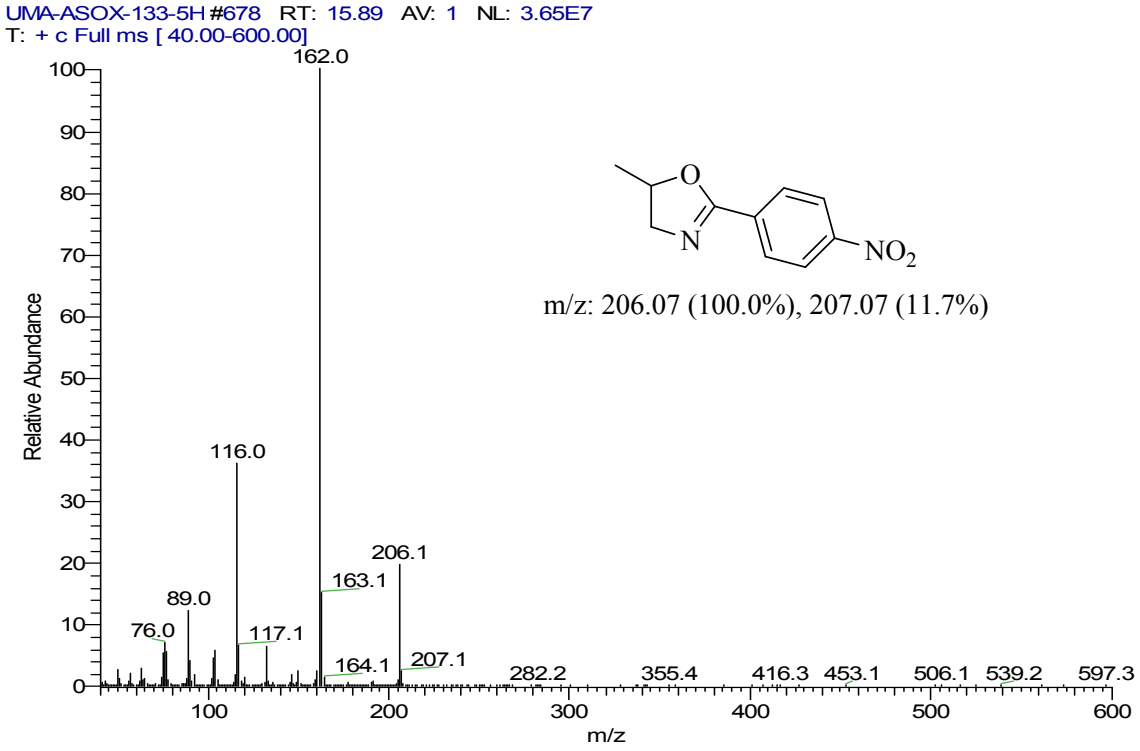
5-methyl-2-(4-nitrophenyl)-4,5-dihydrooxazole (**3b**, Table 2, Entry 2)



Isolated yield = 96%; yellow solid; mp 122-124 ^{o}C. IR (KBr) cm^{-1}: 2927, 2877, 1726, 1647, 1597, 1525, 1343, 1111, 957, 850, 705. ^{1}H NMR δ (300 MHz, $CDCl_3$) 8.29 (d, J = 9.1 Hz, Ar, 2H), 8.12 (d, J = 8.9 Hz, Ar, 2H), 4.86 – 4.98 (m, 1H), 4.21 (dd, J = 9.4 Hz, 9.2 Hz, 1H), 3.67 (dd, J = 7.5 Hz, 7.5 Hz), 1.50 (d, J = 6.2Hz, -CH_3, 3H). ^{13}C NMR (75 MHz, $CDCl_3$): 162.0, 133.8, 129.0, 123.4, 61.8, 31.8, 29.6, 20.9. **GC-MS** m/z 206.1 (M^+ peak), 162.0, 117.1, 116.0, 89.0, 76.0 .

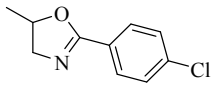






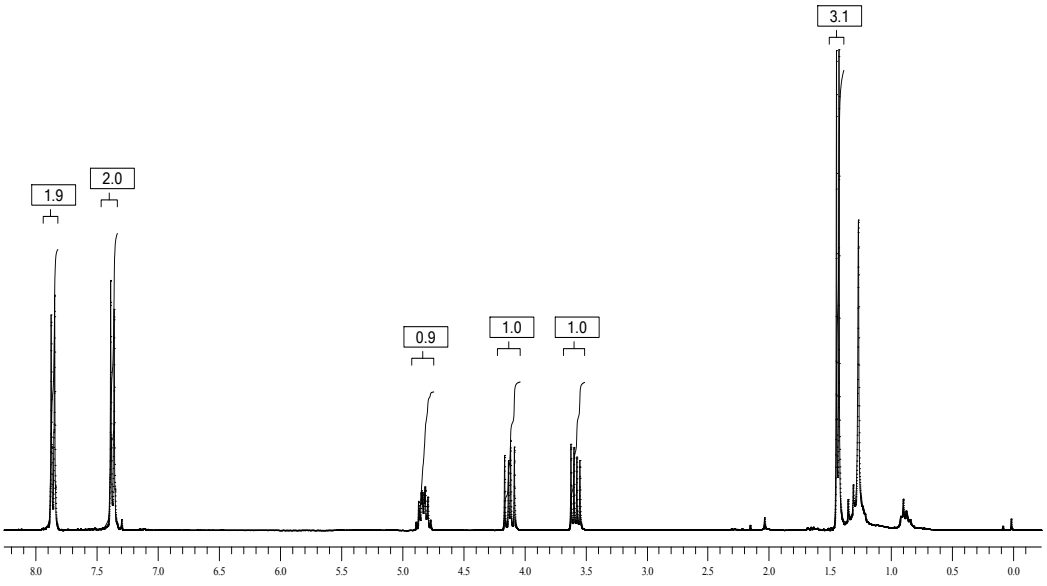
m/z: 206.07 (100.0%), 207.07 (11.7%)

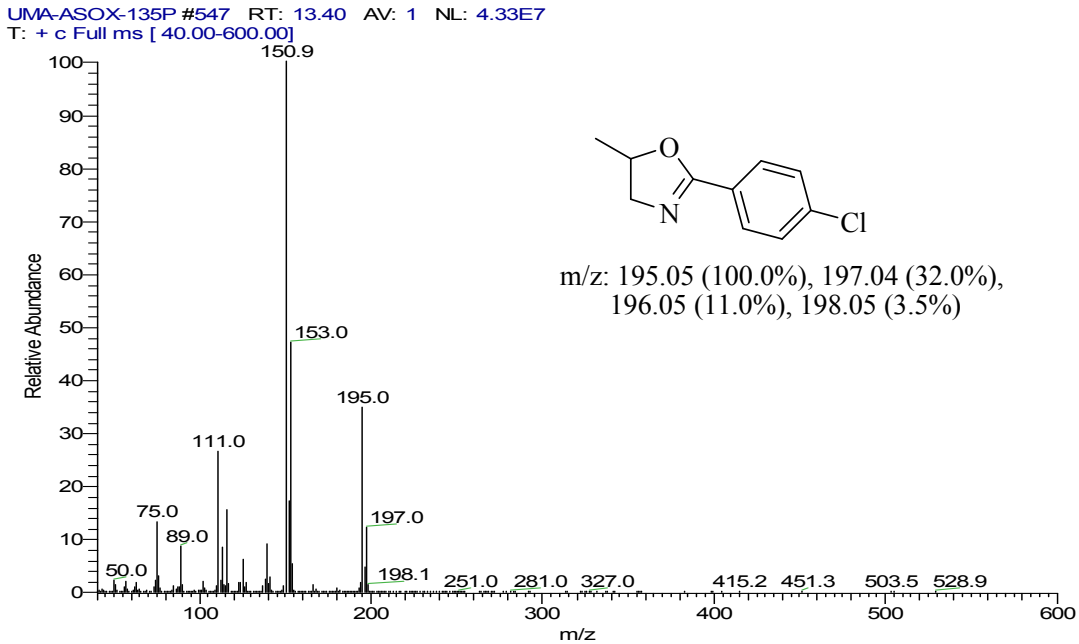
2-(4-chlorophenyl)-5-methyl-4,5-dihydrooxazole (**3c**, Table 2, Entry 3) [2]



Isolated yield = 86%; ^{1}H NMR δ(300 MHz, $CDCl_3$) 7.86 (d, J = 8.5 Hz, Ar, 2H), 7.37 (d, J = 8.5 Hz, Ar, 2H), 4.77 – 4.89 (m, 1H), 4.12 (dd, J = 9.4 Hz, 9.4 Hz, 1H), 3.58 (dd, J = 7.3 Hz, 7.5 Hz), 1.43 (d, J =6.2Hz, -CH_3, 3H).

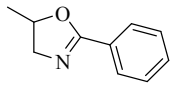
GC-MS m/z 195.0, 153.0, 150.9, 111.0, 89.0, 75.0 .



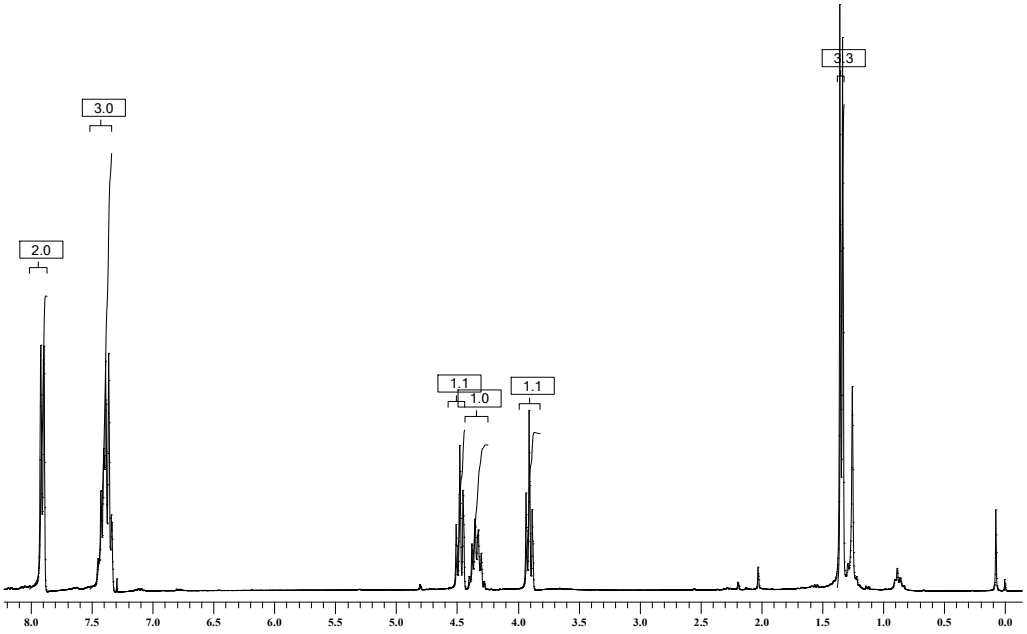


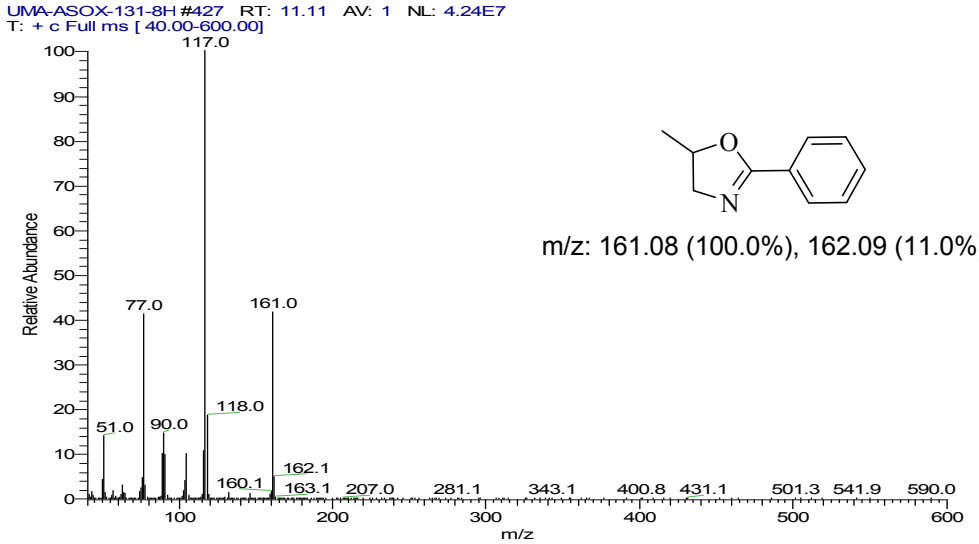
m/z: 195.05 (100.0%), 197.04 (32.0%), 196.05 (11.0%), 198.05 (3.5%)

5-methyl-2-phenyl-4,5-dihydrooxazole (**3d**, Table 2, Entry 4) [3]



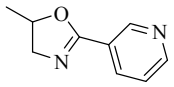
Isolated yield = 83%; ^{1}H NMR δ(300 MHz, $CDCl_3$) 7.86 (d, J = 8.5 Hz, Ar, 2H), 7.54 (d, J = 8.2 Hz, 1H), 7.37 (d, J = 8.5 Hz, Ar, 2H), 4.70 – 4.85 (m, 1H), 4.05 (dd, J = 9.3 Hz, 9.3 Hz, 1H), 3.52 (dd, J = 7.4 Hz, 7.4 Hz), 1.37 (d, J =6.1Hz, -CH_3, 3H). **GC-MS** m/z 161.0, 117.0, 90.0, 77.0, 51.0 .



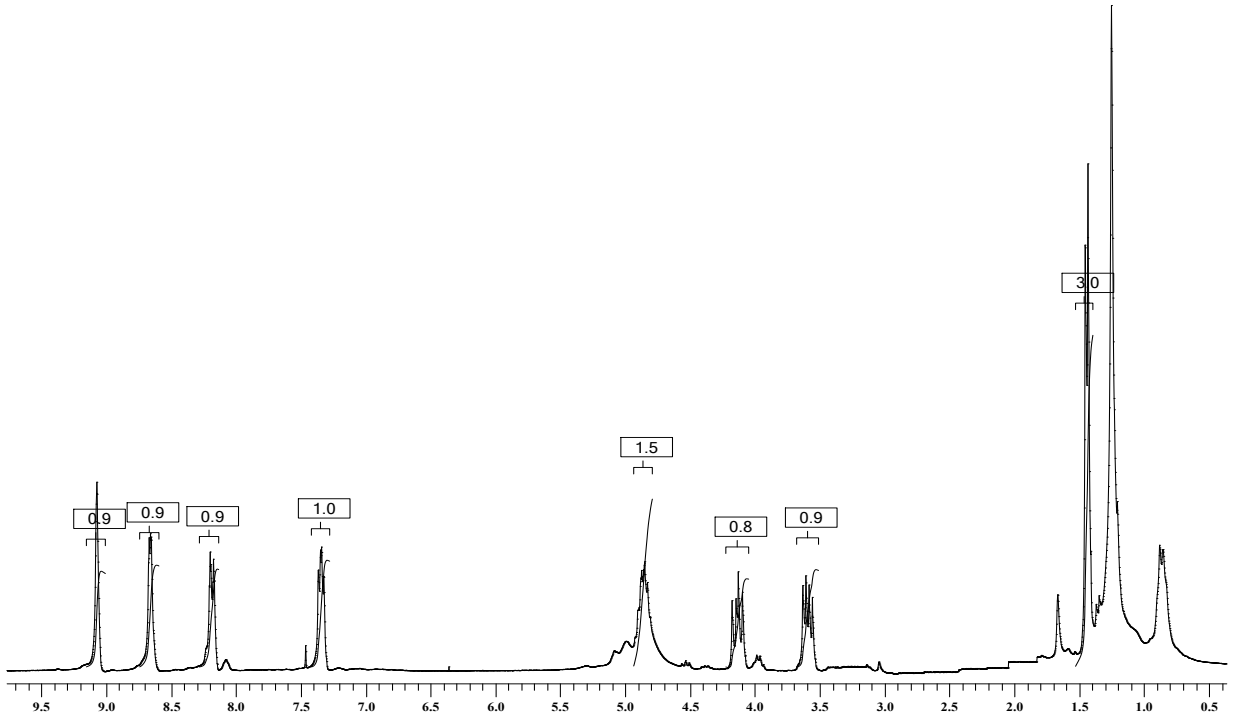


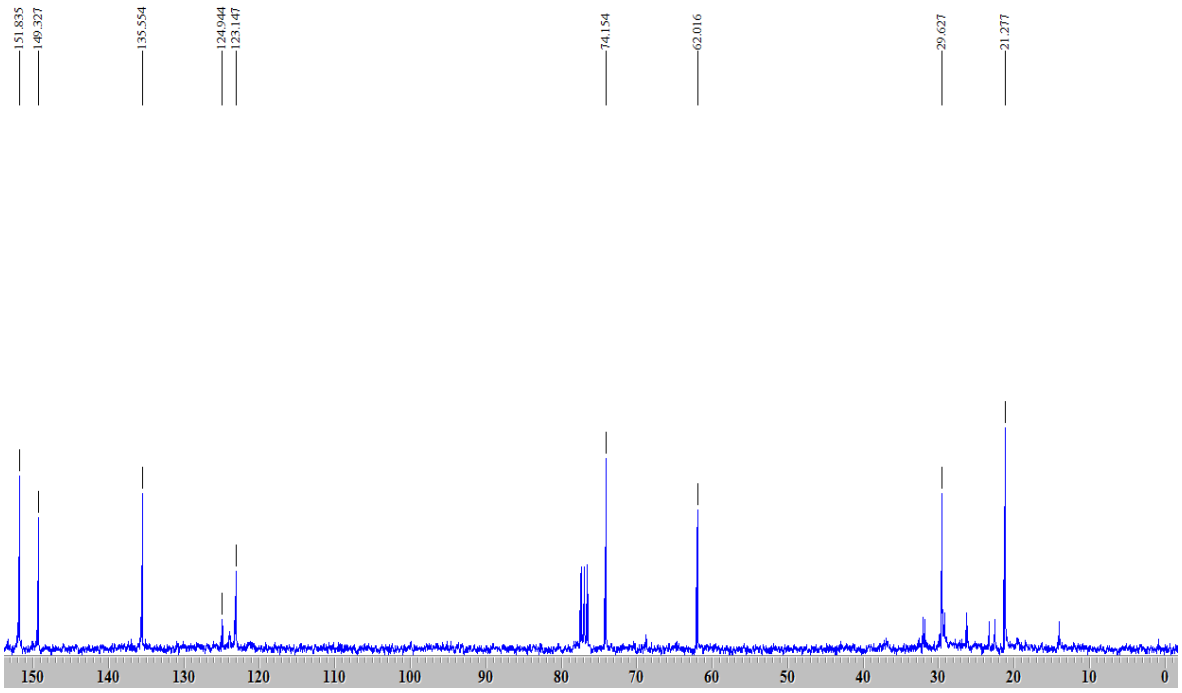
m/z: 161.08 (100.0%), 162.09 (11.0%)

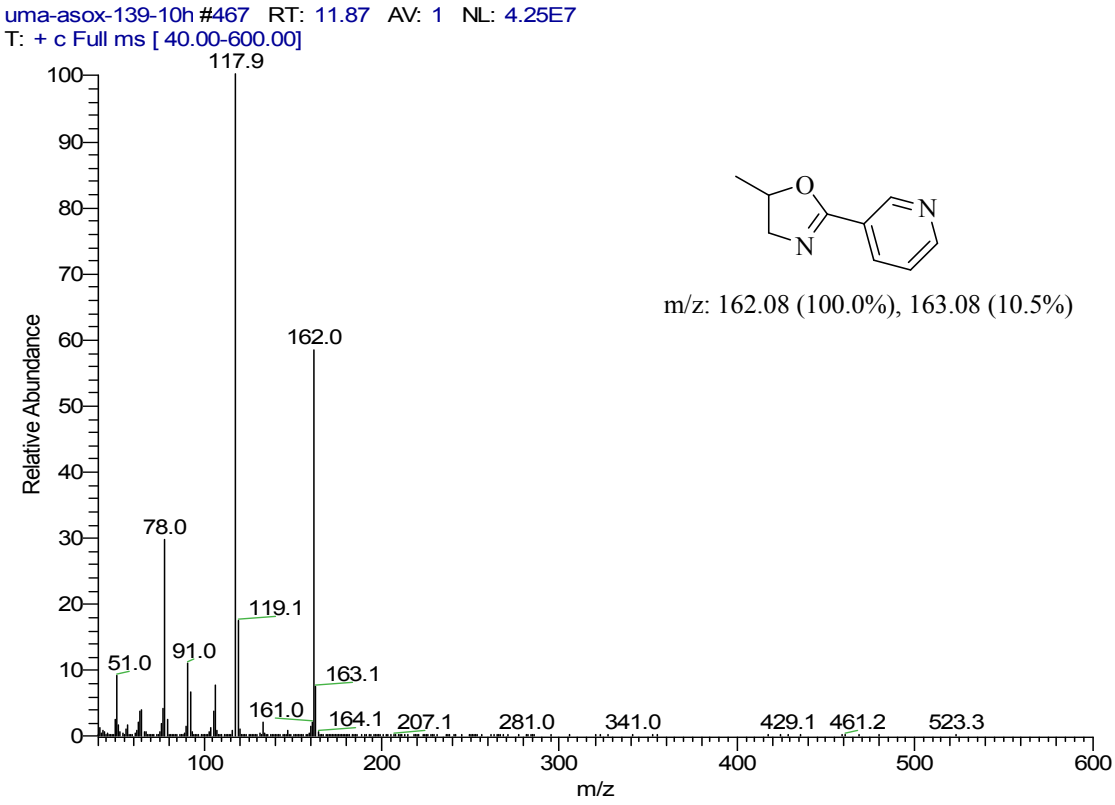
5-methyl-2-(pyridin-3-yl)-4,5-dihydrooxazole (**3e**, Table 2, Entry 5)



Isolated yield = 61%; yellow liquid; IR (KBr) cm^{-1}: 2924, 2854, 1730, 1652, 1458, 1377, 1278, 1114, 965, 811. ^{1}H NMR δ(300 MHz, $CDCl_3$) 9.1 (s, Ar, 1H), 8.69 (s, Ar, 1H), 8.27 (d, J = 8.1 Hz, Ar, 1H), 7.32 (d, J = 8.1, Ar, 1H), 4.90 – 4.72 (m, 1H), 4.11 (dd, J = 9.4 Hz, 7.4 Hz, 1H), 3.58 (dd, J = 7.5 Hz, 9.5 Hz), 1.39 (d, J =6.3Hz, -CH_3, 3H). ^{13} C NMR (75 MHz, $CDCl_3$): 151.8, 149.3, 135.6, 124.9, 123.1, 74.2, 62.0, 29.6, 21.3. GC-MS m/z 162.0, 117.9, 91.0, 78.0, 51.0 .

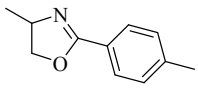




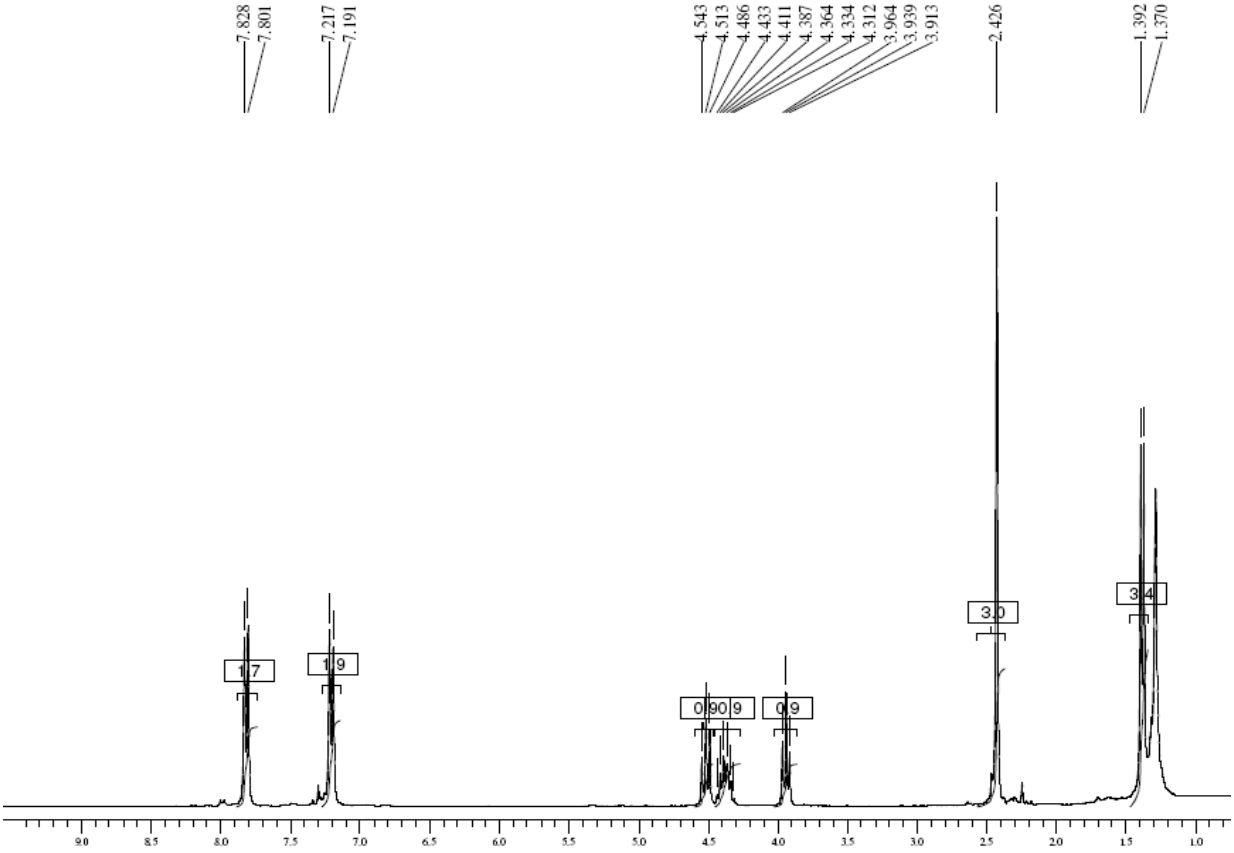


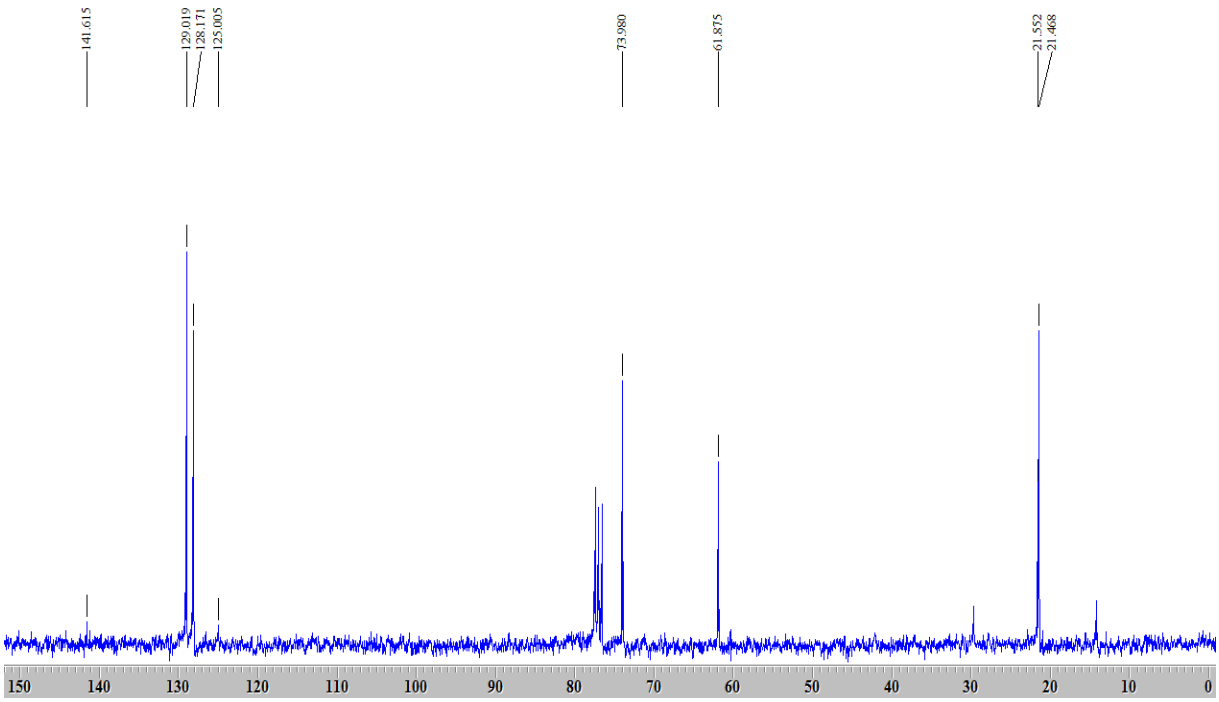
m/z: 162.08 (100.0%), 163.08 (10.5%)

4-methyl-2-p-tolyl-4,5-dihydrooxazole (**3f**, Table 2, Entry 6)



Isolated yield = 77%; yellow liquid; IR (KBr) cm^{-1}: 2956, 2923, 2855, 1724, 1647, 1457, 1350, 1264, 1178, 1108, 1062, 1021, 972, 829, 728. ^{1}H NMR δ(300 MHz, $CDCl_3$) 7.81 (d, J = 7.9 Hz,Ar, 2H), 7.20 (d, J = 7.9 Hz, Ar, 2H), 4.51 (t, J = 9.0 Hz, 8.1 Hz, 1H), 4.31- 4.43 (m, 1H), 3.94 (t, J = 7.5 Hz, 7.7 Hz, 1H), 2.42(s, $-CH_3$, 3H), 1.38 (d, J = 6.6 $-CH_3$, 3H). ^{13}C NMR (75 MHz, $CDCl_3$): 151.8, 149.3, 135.6, 124.9, 123.1, 74.2, 62.0, 29.6, 21.3. GC-MS m/z 175.1 (M^+ peak), 160.0, 132.1, 105.0, 91.0, 65.0 .





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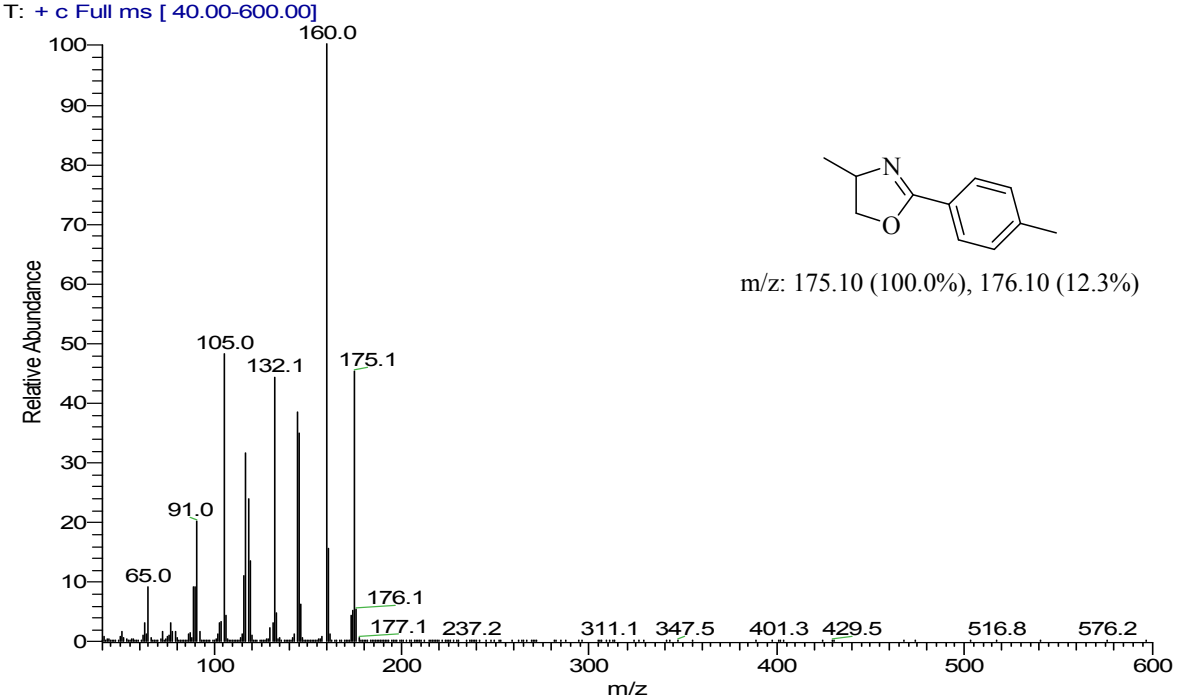
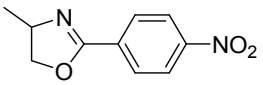
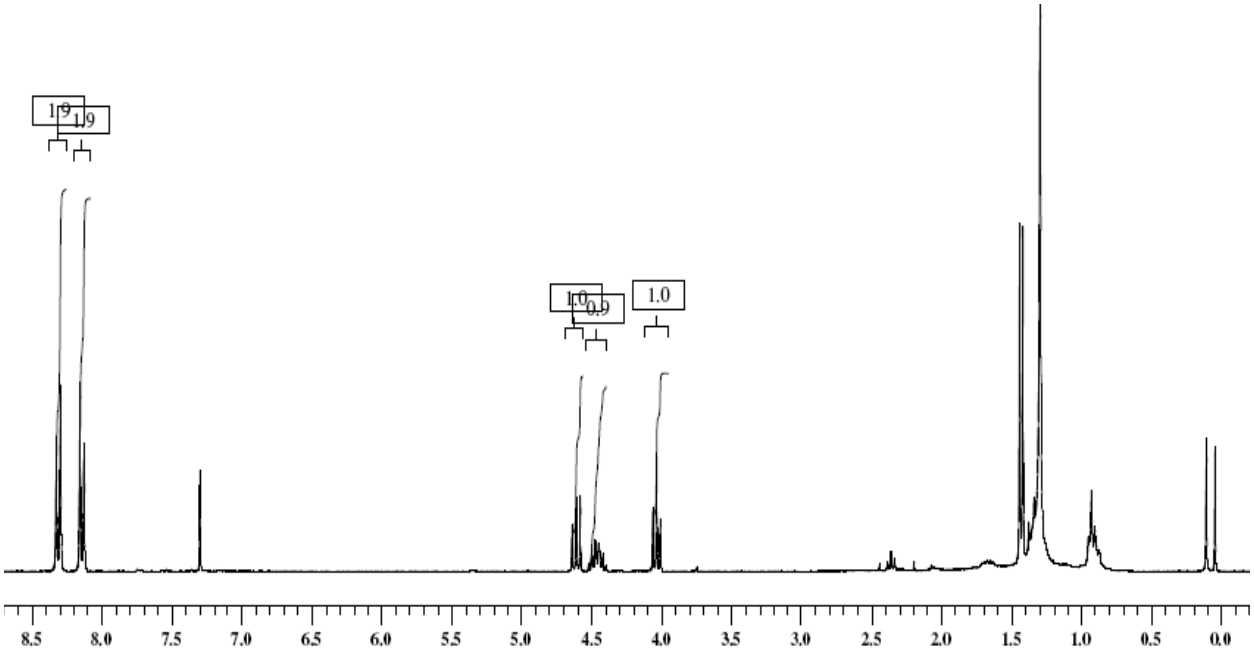


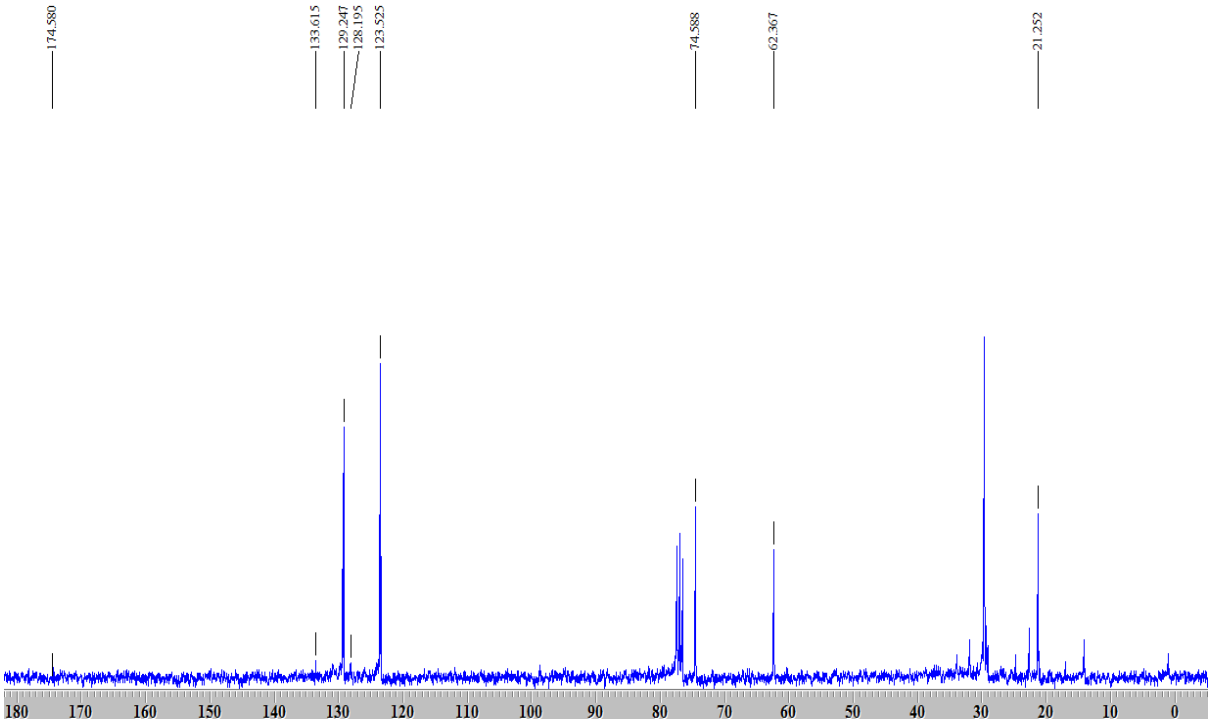
m/z: 175.10 (100.0%), 176.10 (12.3%)

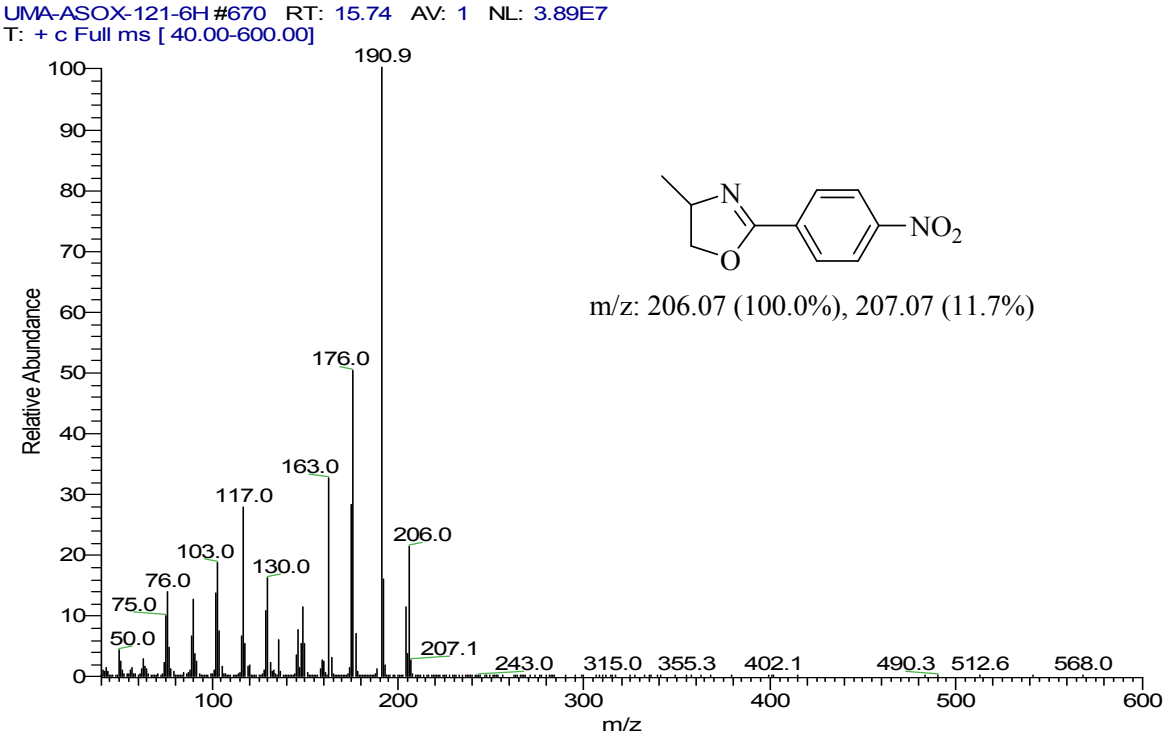
4-methyl-2-(4-nitrophenyl)-4,5-dihydrooxazole (**3g**, Table 2, Entry 7)



Isolated yield = 63%; pale yellow solid; mp 89-91 ^{o}C; IR (KBr) cm^{-1}: 2923, 2855, 1645, 1522, 1344, 1069, 963, 856, 706. ^{1}H NMR δ(300 MHz, $CDCl_3$) 8.21 (d, J = 8.8 Hz, Ar, 2H), 8.10 (d, J = 8.1 Hz, Ar, 2H), 4.53 (t, J = 8.1 Hz, 1H), 4.31- 4.37 (m, 1H), 3.94 (t, J = 7.8 Hz, 1H), 1.42 (d, J = 6.7, -CH_3, 3H). ^{13}C NMR (75 MHz, $CDCl_3$): 162.6, 137.4, 129.5, 128.6, 126.3, 74.2, 62.0, 21.4. GC-MS m/z 206.0 (M^+ peak), 190.9, 176.0, 163.0, 130.0, 117.0, 103.0, 76.0.

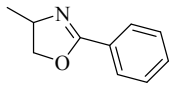




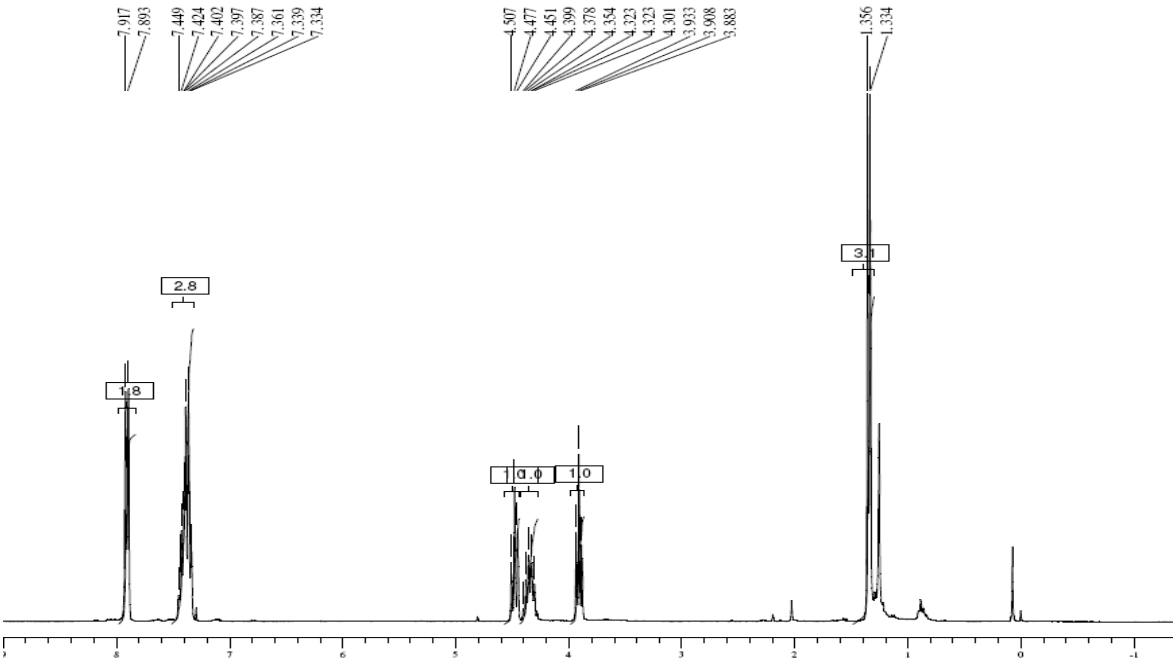


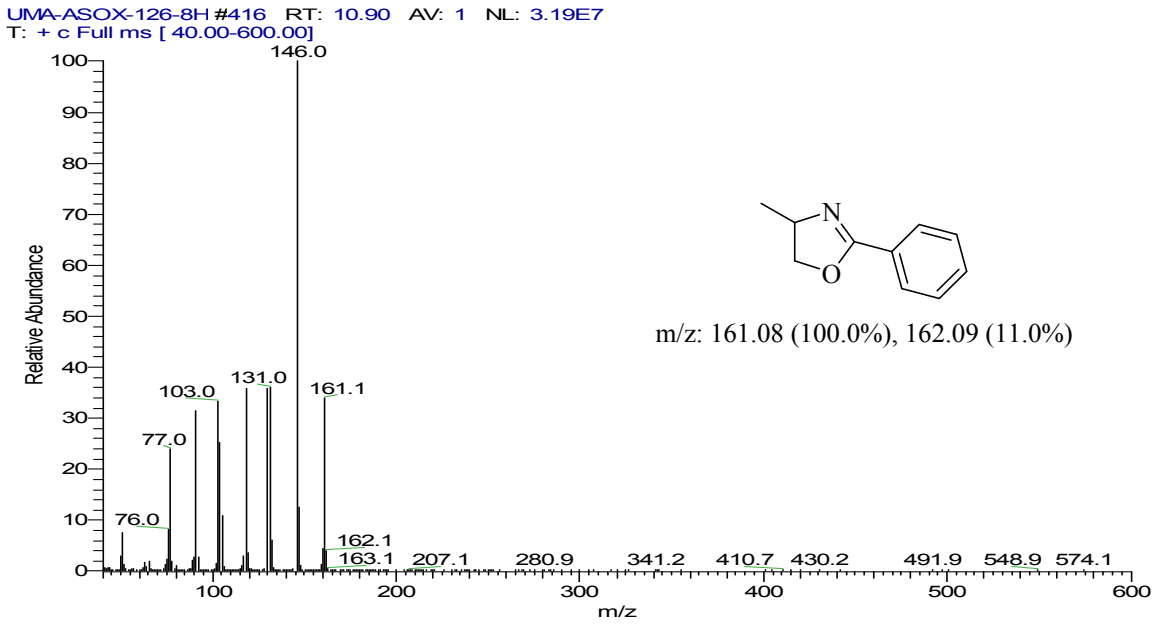
m/z: 206.07 (100.0%), 207.07 (11.7%)

4-methyl-2-phenyl-4,5-dihydrooxazole (**3h**, table 2, Entry 8) [4]



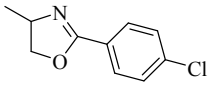
Isolated yield = 78%; ^{1}H NMR δ(300 MHz, $CDCl_3$) 7.90 (d, J = 7.5 Hz, Ar, 2H), 7.33 – 7.44 (m, Ar, 3H), 4.47 (t, J = 9.0 Hz, 7.5 Hz, 1H), 4.30- 4.40 (m, 1H), 3.91 (t, J = 7.5 Hz, 7.5 Hz, 1H), 1.34 (d, J = 6.8 -CH_3, 3H). **GC-MS** m/z 161.1 (M^+ peak), 146.0, 131.0, 103.0,77.0.





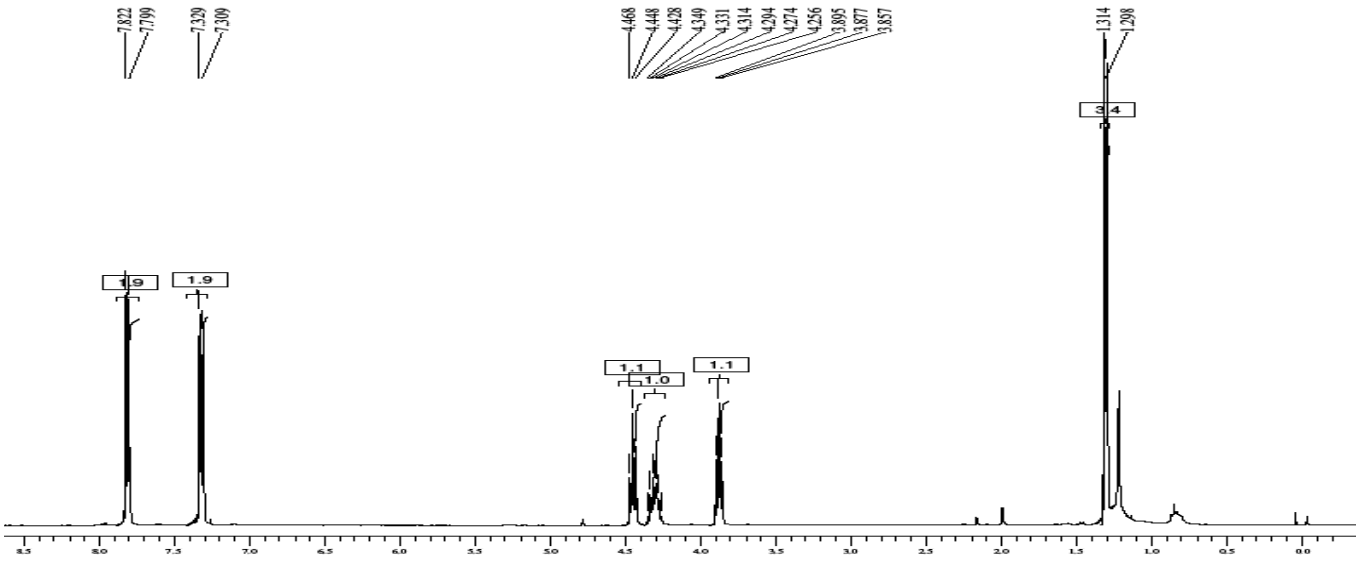
m/z: 161.08 (100.0%), 162.09 (11.0%)

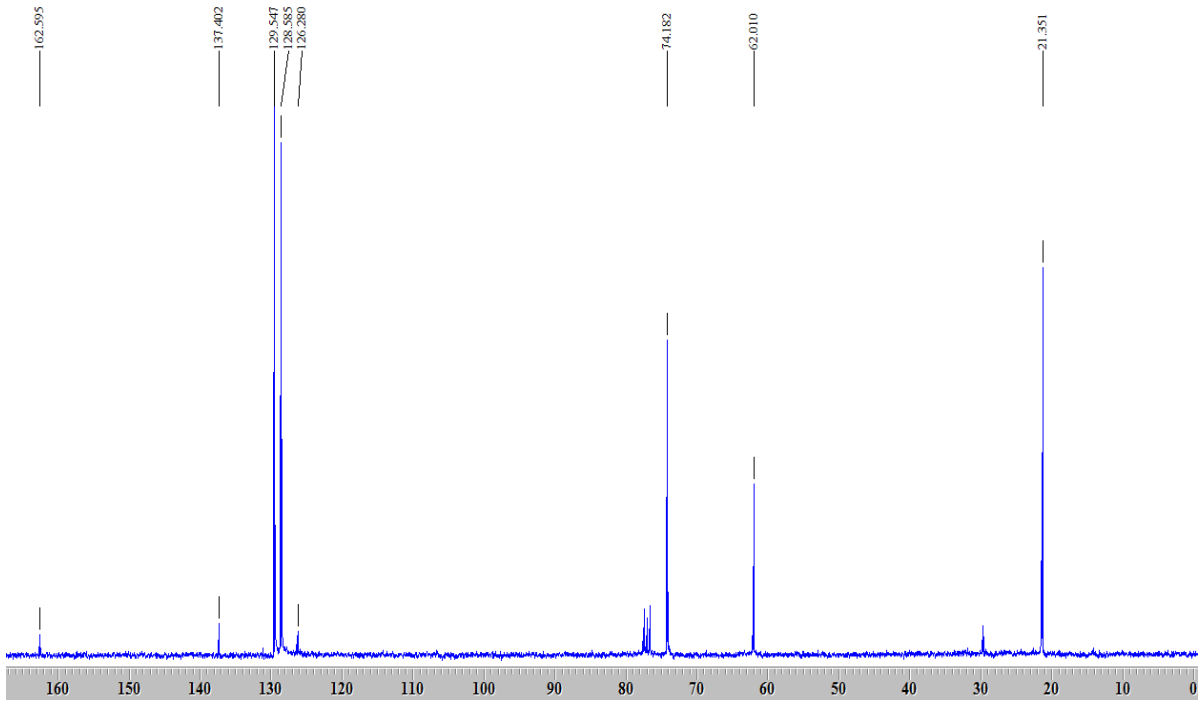
2-(4-chlorophenyl)-4-methyl-4,5-dihydrooxazole (**3i**, Table 2, Entry 9)



Isolated yield = 65%; yellow liquid; IR (KBr) cm^{-1}: 3064, 3030, 2966, 2924, 1720, 1648, 1491, 1451, 1356, 1269, 1170, 1060, 1021, 969, 841, 701. ^{1}H NMR δ(300 MHz, $CDCl_3$) 7.81 (d, *J* = 8.8 Hz, Ar, 2H), 7.32 (d, *J* = 8.1 Hz, Ar, 2H), 4.45 (t, *J* = 8.1 Hz, 1H), 4.26- 4.35 (m, 1H), 3.88 (t, J = 7.3 Hz,8.1 Hz, 1H), 2.42(s, $-CH_3$, 3H), 1.38 (d, *J* = 6.6 $-CH_3$, 3H). ^{13}C NMR (75 MHz, $CDCl_3$): 162.6, 137.4, 129.5, 128.6, 126.3, 74.2, 62.0, 21.4.

GC-MS m/z 195.0 (M^+ peak), 180.0, 125.0, 111.0, 75.0 .

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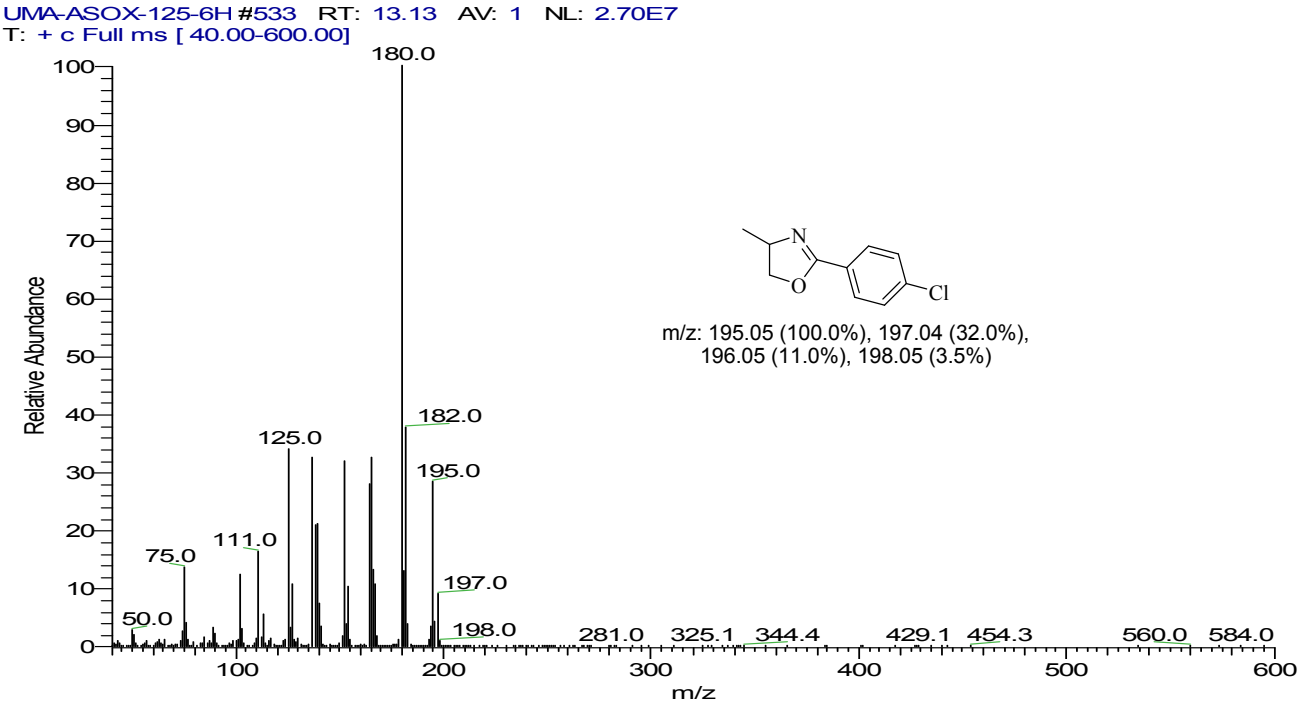
129.547
128.585
126.280
74.182
62.010
21.351
160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0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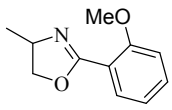
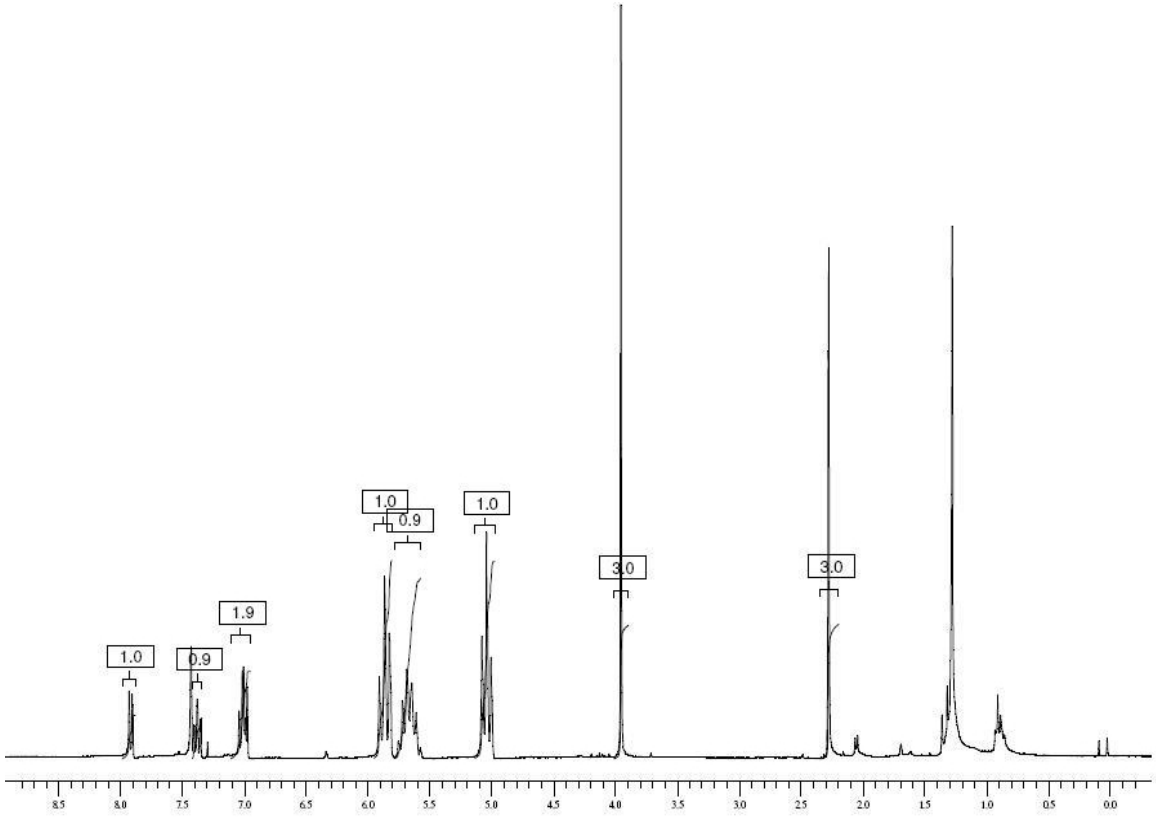
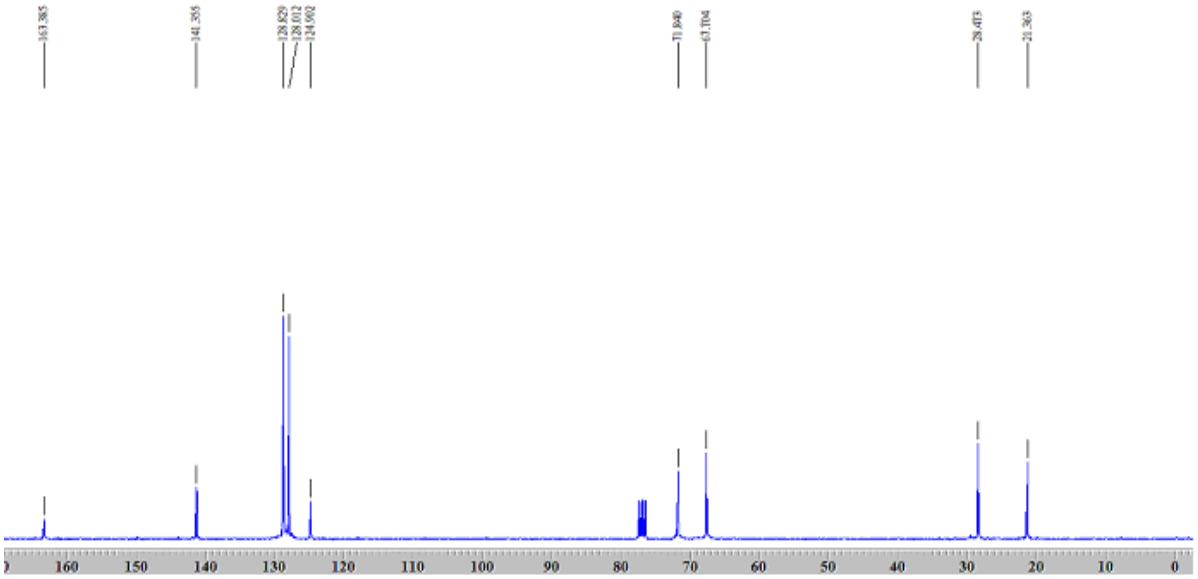
T: + c Full ms [40.00-600.00]
Relative Abundance
m/z
180.0
182.0
125.0
195.0
111.0
75.0
197.0
50.0
198.0
281.0
325.1
344.4
429.1
454.3
560.0
584.0
N
O
Cl
m/z: 195.05 (100.0%), 197.04 (32.0%),
196.05 (11.0%), 198.05 (3.5%)

4-methyl-2-p-tolyl-4,5-dihydrooxazole (**3j**, Table 2, Entry 10)

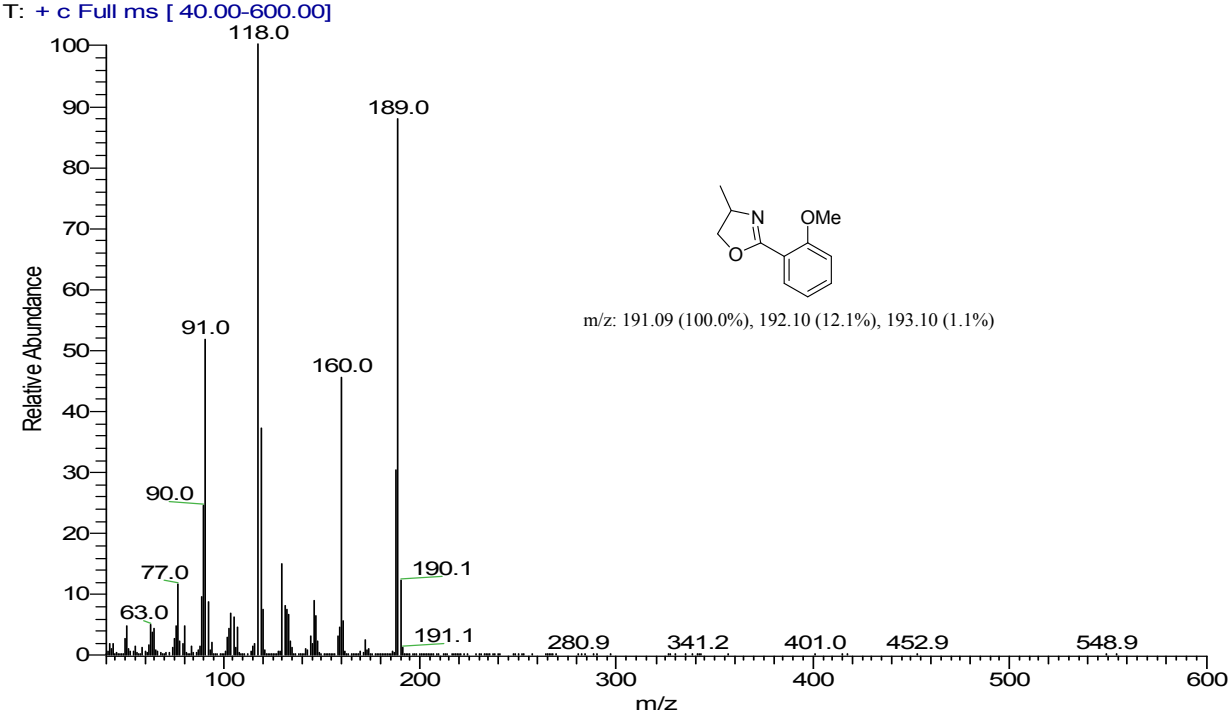


Isolated yield = 83%; pale yellow solid; IR (KBr) cm^{-1}: 2928, 2846, 1719, 1598, 1466, 1380, 1253, 1175, 1102, 1023, 936, 752; ^{1}H NMR δ(300 MHz,$CDCl_3$) 7.95 (d, J = 8.1 Hz, Ar, 1H), 7.30-7.50 (m, Ar, 1H), 6.97-7.04 (m, Ar, 1H), 5.90 (t, J = 9.0 Hz, 8.1 Hz, 1H), 5.60-5.80 (m, 1H), 5.15 (t, J = 9.0 Hz, 8.1 Hz, 1H), 3.95 (s, -CH_3, 3H), 2.27 (d, J = 5.3, -CH_3, 3H). ^{13} C NMR (75 MHz, $CDCl_3$): 163.4, 141.4, 128.8, 128.0, 124.9, 71.8, 67.7, 28.5, 21.4. **GC-MS** m/z 190.1 (M^+ peak), 189.0, 160.0, 118.0, 91.0, 77.0, 63.0. .



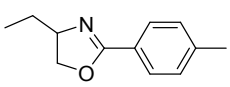


UMA-ASOX-127-8H #560 RT: 13.64 AV: 1 NL: 2.59E7
T: + c Full ms [40.00-600.00]

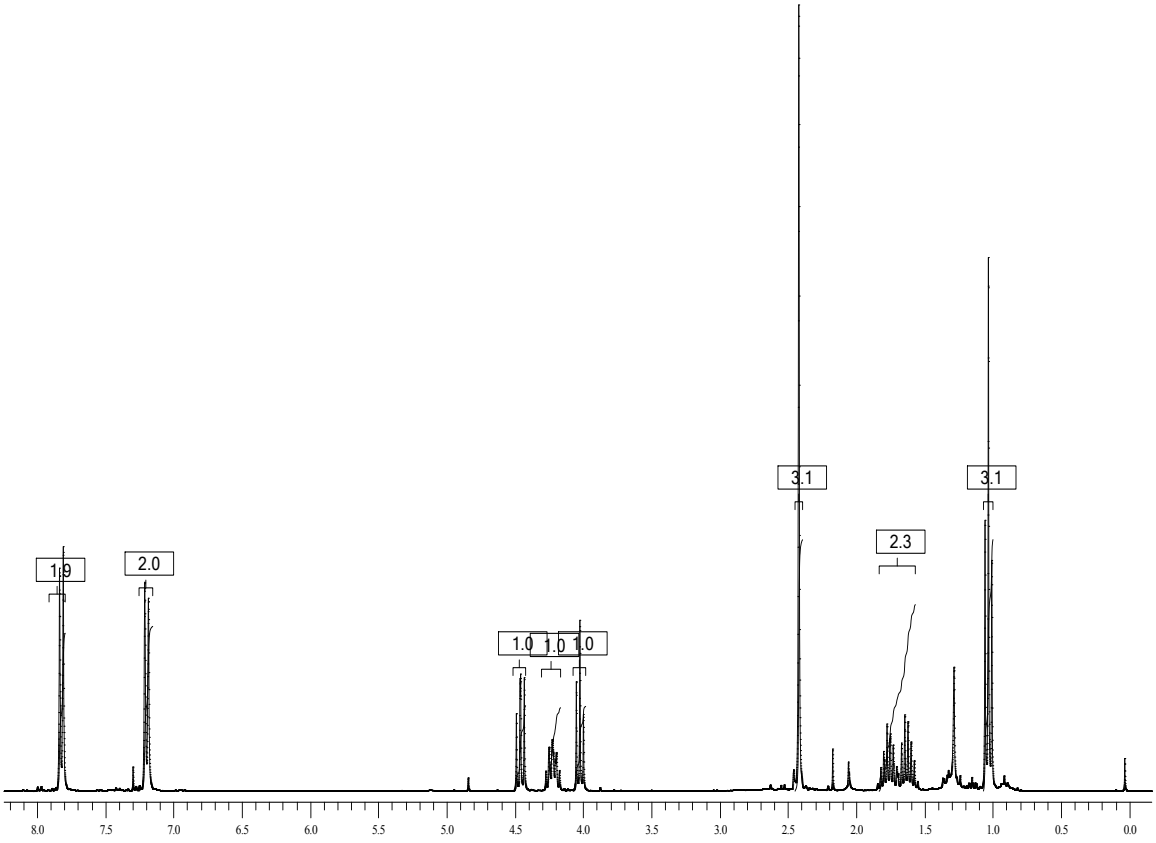


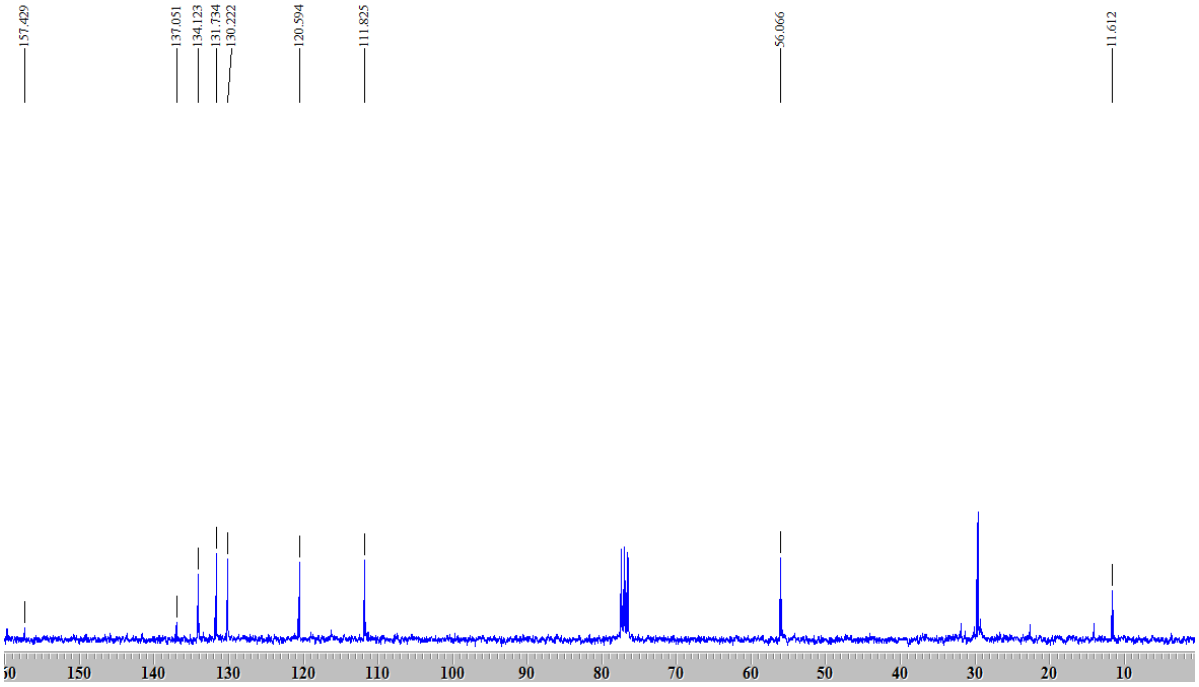
m/z: 191.09 (100.0%), 192.10 (12.1%), 193.10 (1.1%)

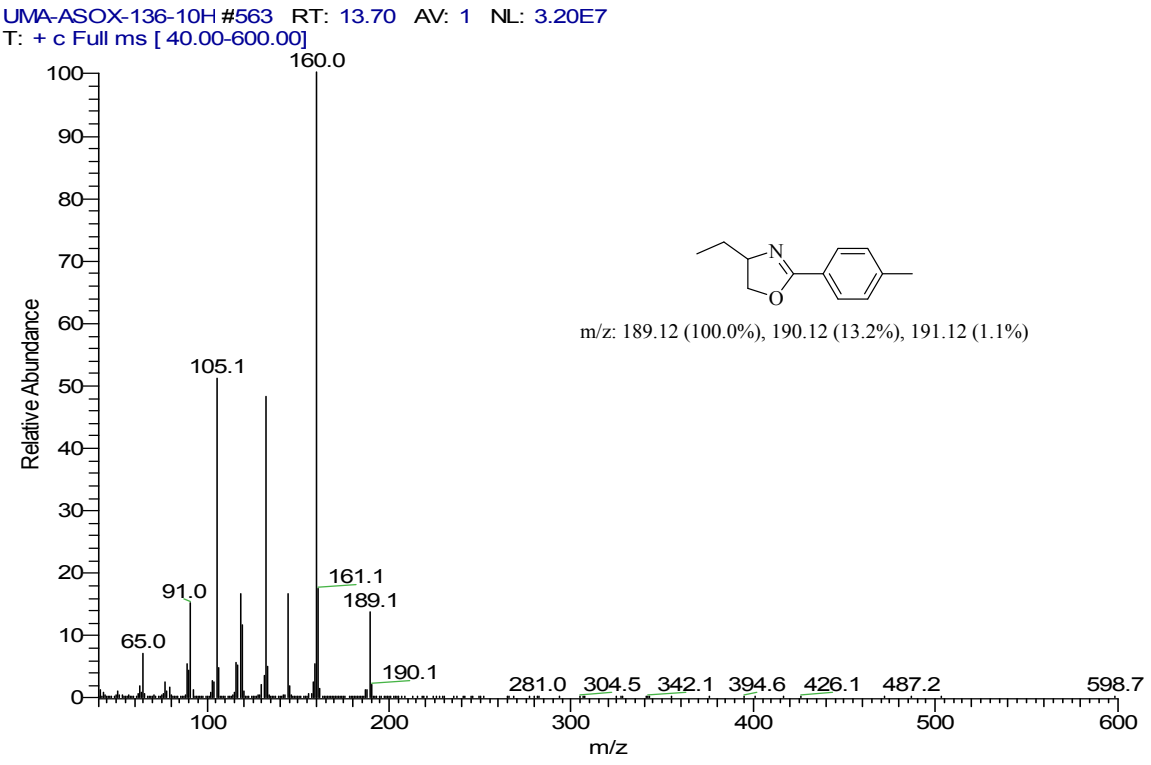
4-ethyl-2-p-tolyl-4,5-dihydrooxazole (**3k**, Table 2, Entry 11)



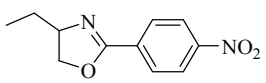
Isolated yield = 72%; yellow liquid; IR (KBr) cm^{-1}: 2963, 2897, 1648, 1512, 1461, 1355, 1178, 1065, 963, 828, 728. ^{1}H NMR δ(300 MHz, $CDCl_3$) 7.82 (d, J = 8.1 Hz, Ar, 2H), 7.20 (d, J = 7.9 Hz, Ar, 2H), 4.46 (t, J = 7.9 Hz, 1H), 4.17-4.43 (m, 1H), 4.02 (t, J = 7.9 Hz, 1H), 2.42 (s, $-CH_3$, 3H), 1.57 – 1.82 (m, 2H), 1.3 (t, J = 7.4 Hz, 7.4 Hz, 3H). ^{13} C NMR (75 MHz, $CDCl_3$): 157.4, 137.1, 134.1, 131.7, 130.2, 120.6, 111.8, 56.1, 11.6.**GC-MS** m/z 189.1 (M^+ peak), 160.0, 105.1, 91.0, 65.0 .



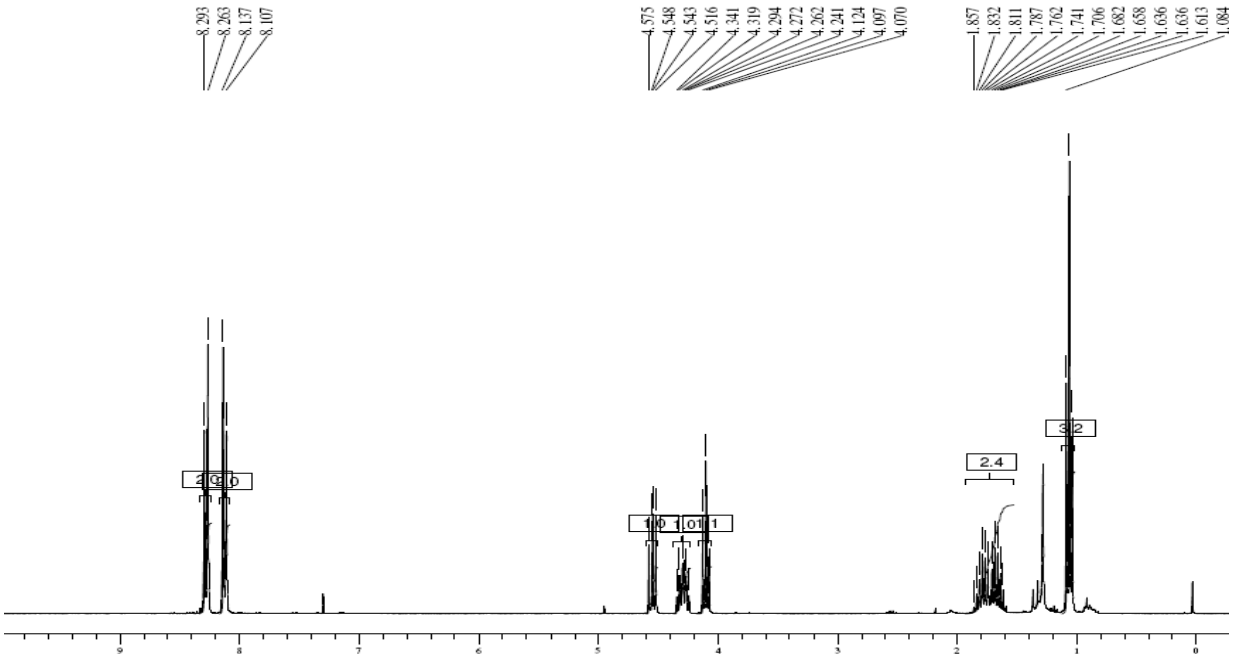

157.429
137.051
134.123
131.734
130.222
120.594
111.825
56.066
11.612
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10

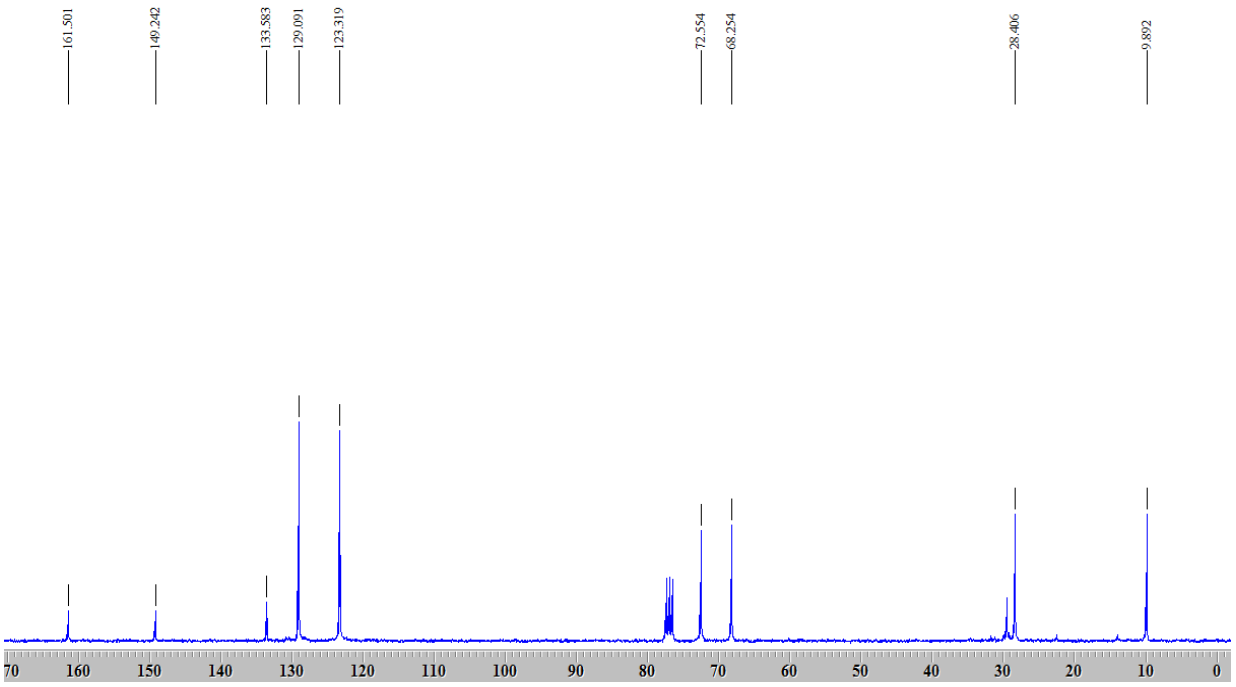

UMA-ASOX-136-10H #563 RT: 13.70 AV: 1 NL: 3.20E7
T: + c Full ms [40.00-600.00]
Relative Abundance
m/z
160.0
105.1
91.0
65.0
161.1
189.1
190.1
281.0
304.5
342.1
394.6
426.1
487.2
598.7
N
O
m/z: 189.12 (100.0%), 190.12 (13.2%), 191.12 (1.1%)

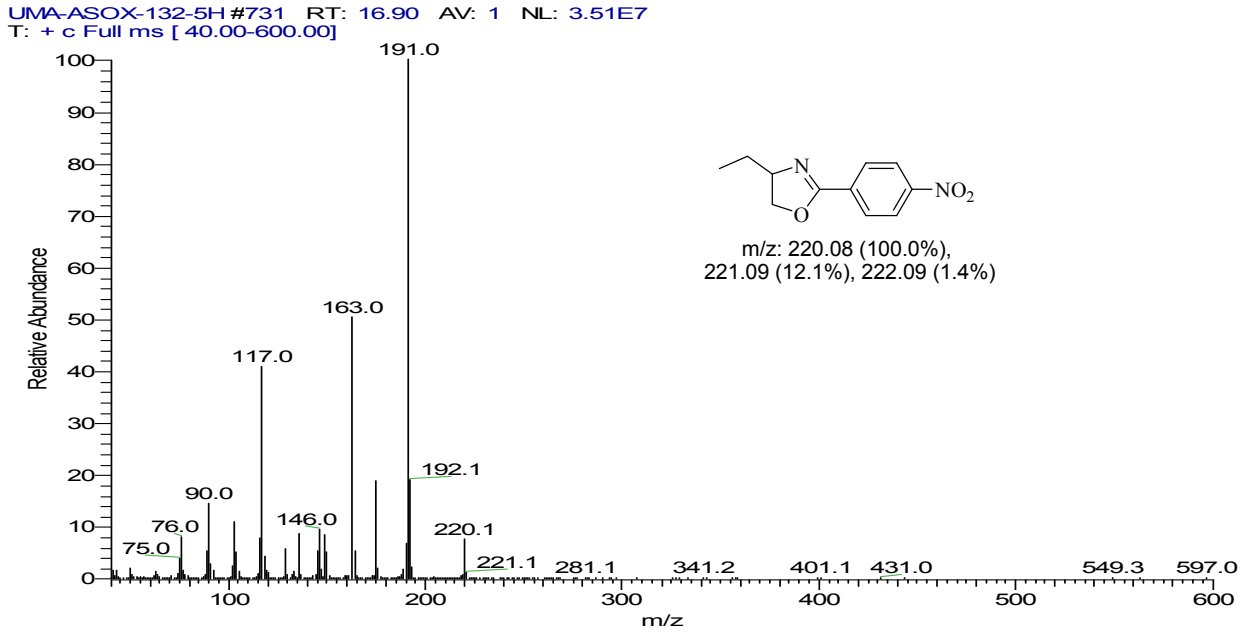
4-ethyl-2-(4-nitrophenyl)-4,5-dihydrooxazole (**3l**,Table 2, Entry 12) [6]



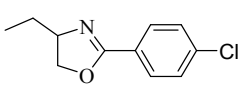
Isolated yield = 81%; ^{1}H NMR δ(300 MHz, $CDCl_3$) 8.28 (d, J = 8.8 Hz, Ar, 2H), 8.12 (d, J = 8.8 Hz, Ar, 2H), 4.54 (t, J = 8.1 Hz, 1H), 4.24- 4.34 (m, 1H), 4.10 (t, J = 7.9 Hz, 1H), 1.61 – 1.86 (m, 2H), 1.06 (d, J = 7.4 Hz, 3H). **GC-MS** m/z 220 (M^+ peak), 191.0, 163.0, 146.0, 117.0, 90.0, 76.0 .



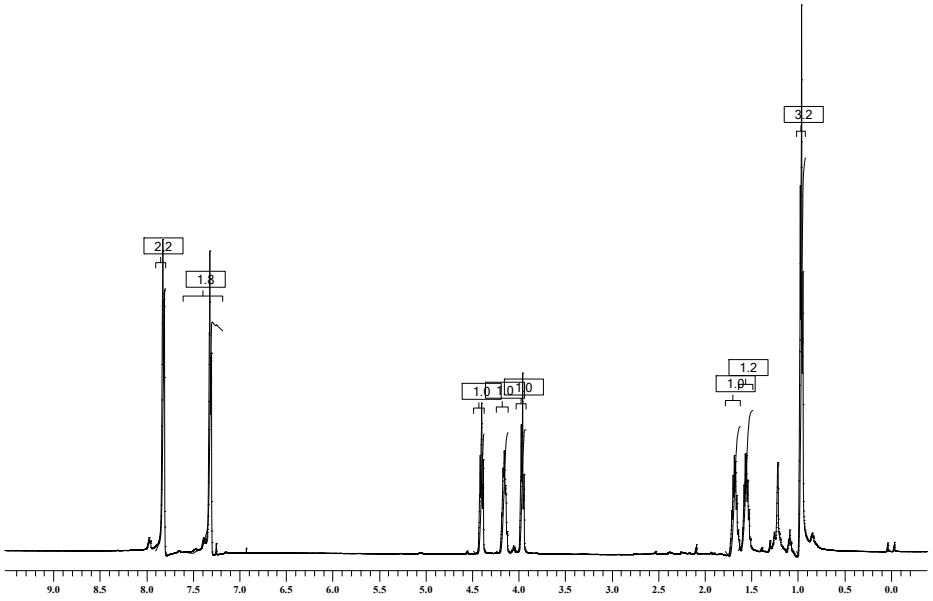

161.501
149.242
133.583
129.091
123.319
72.554
68.254
28.406
9.892
70 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0

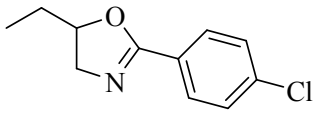

UMA-ASOX-132-5H #731 RT: 16.90 AV: 1 NL: 3.51E7
T: + c Full ms [40.00-600.00]
Relative Abundance
m/z
191.0
163.0
117.0
192.1
90.0
146.0
76.0
75.0
220.1
221.1
281.1
341.2
401.1
431.0
549.3
597.0
N
O
NO2
m/z: 220.08 (100.0%),
221.09 (12.1%), 222.09 (1.4%)

2-(4-chlorophenyl)-4-ethyl-4,5-dihydrooxazole (**3m**, Table 2, Entry 13) [7]



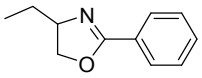
Isolated yield =83%; ^{1}H NMR δ(300 MHz, $CDCl_3$) 7.80 (d, J = 8.6 Hz, Ar, 2H), 7.32 (d, J = 8.6 Hz, Ar, 2H), 4.46 (t, J = 8.1 Hz, 1H), 4.21- 4.30 (m, 1H), 3.96 (t, J = 7.9 Hz, 1H), 1.72 – 1.80 (m, 2H), 1.04 (d, J = 7.7 Hz, 7.6 Hz, 3H). **GC-MS** m/z 209.1 (M^+ peak), 182.0,179.9, 125.0, 111.0, 75.0.



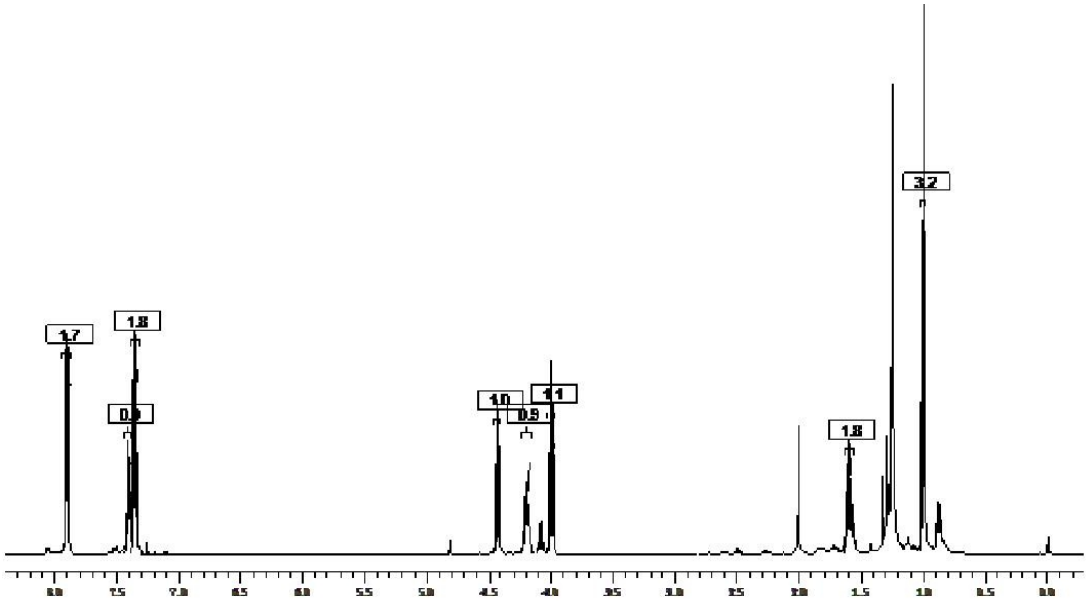


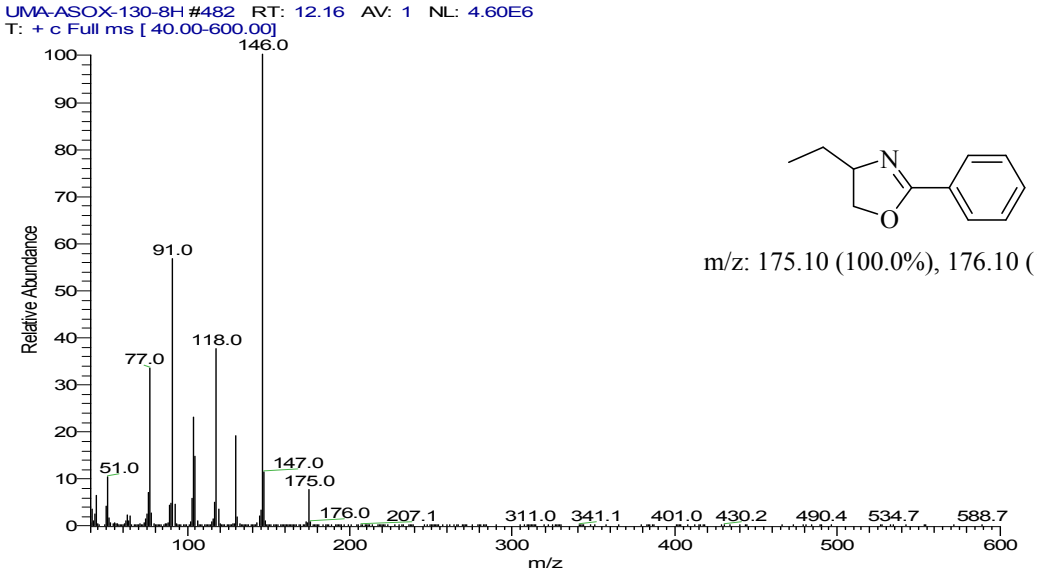
m/z: 209.06 (100.0%), 211.06 (32.2%), 210.06 (12.3%), 212.06 (3.9%)

4-ethyl-2-phenyl-4,5-dihydrooxazole (**3n**, Table 2, Entry 14) [5]



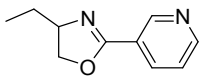
Isolated yield = 84%; ^{1}H NMR δ(300 MHz, $CDCl_3$) 7.82 (d, J = 8.1 Hz, Ar, 2H), 7.32 (d, J = 7.9 Hz, 1H), 7.20 (d, J = 7.9 Hz, Ar, 2H), 4.50 (t, J = 7.9 Hz, 1H), 4.27- 4.48 (m, 1H), 4.03 (t, J = 7.9 Hz, 1H), 1.62 – 1.91 (m, 2H), 1.0 (t, J = 7.4 Hz, 3H). **GC-MS** m/z 175.0 (M^+ peak), 146.0, 118.0, 91.0, 77.0.



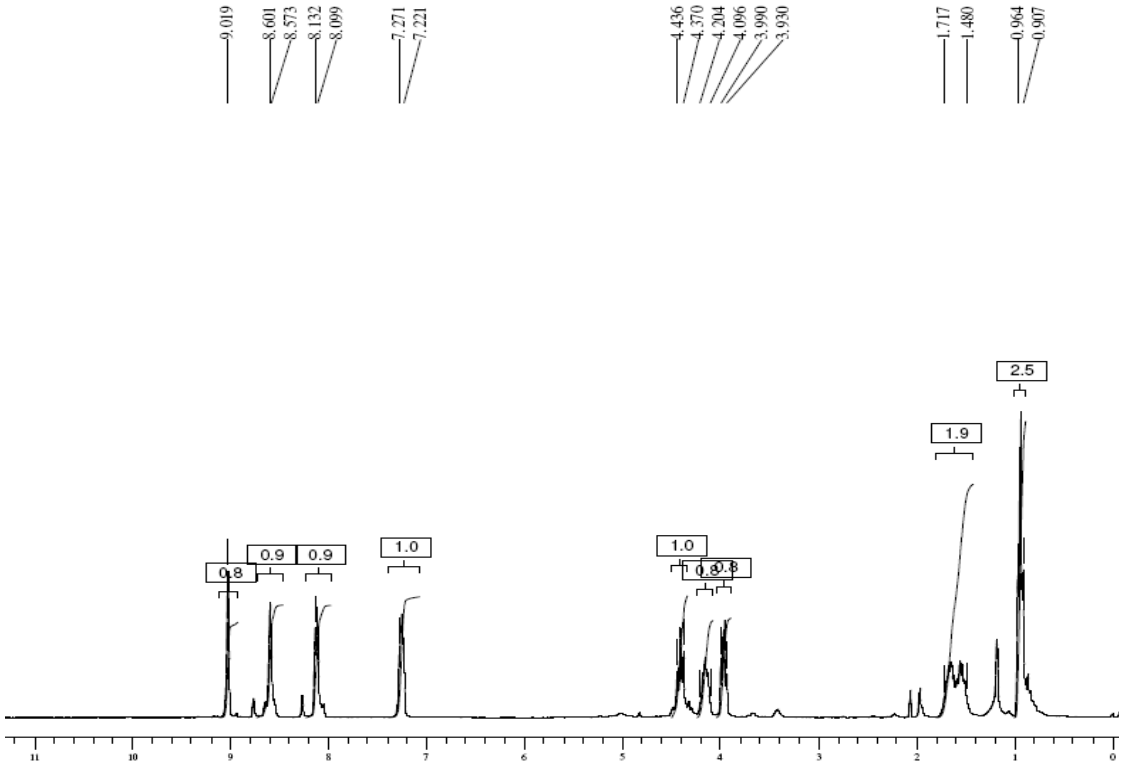


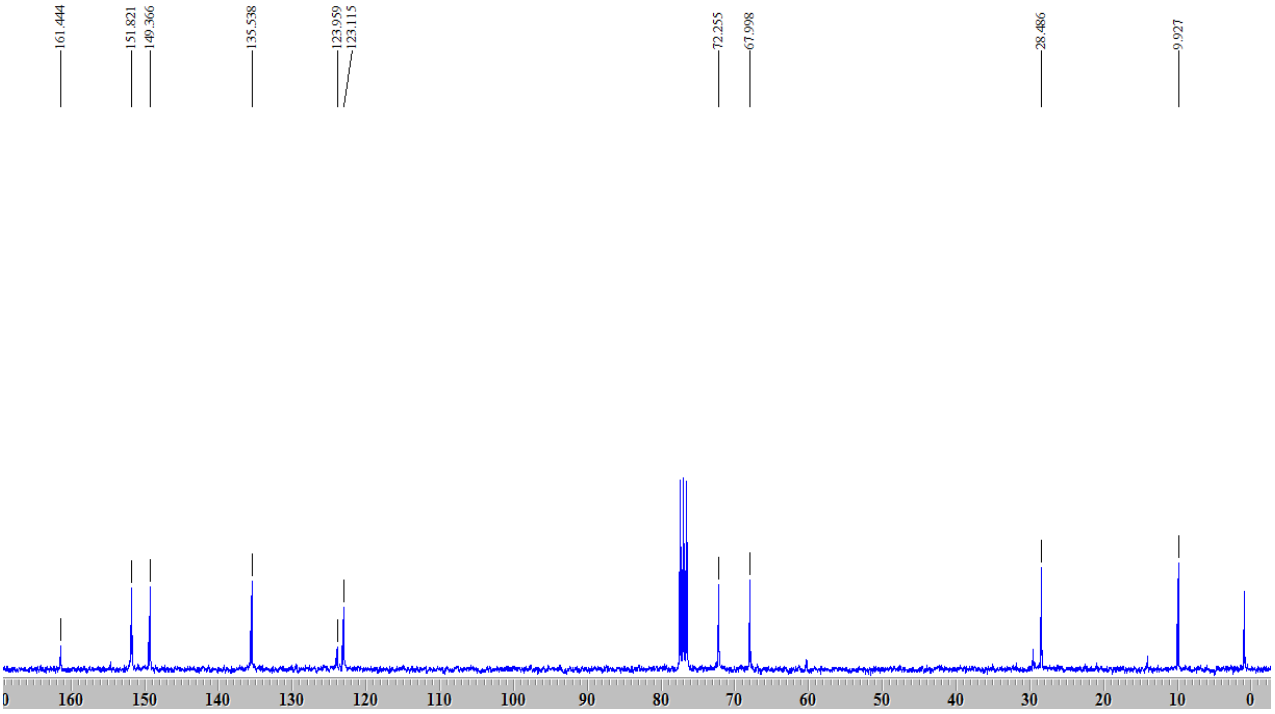
m/z: 175.10 (100.0%), 176.10 (12.3%)

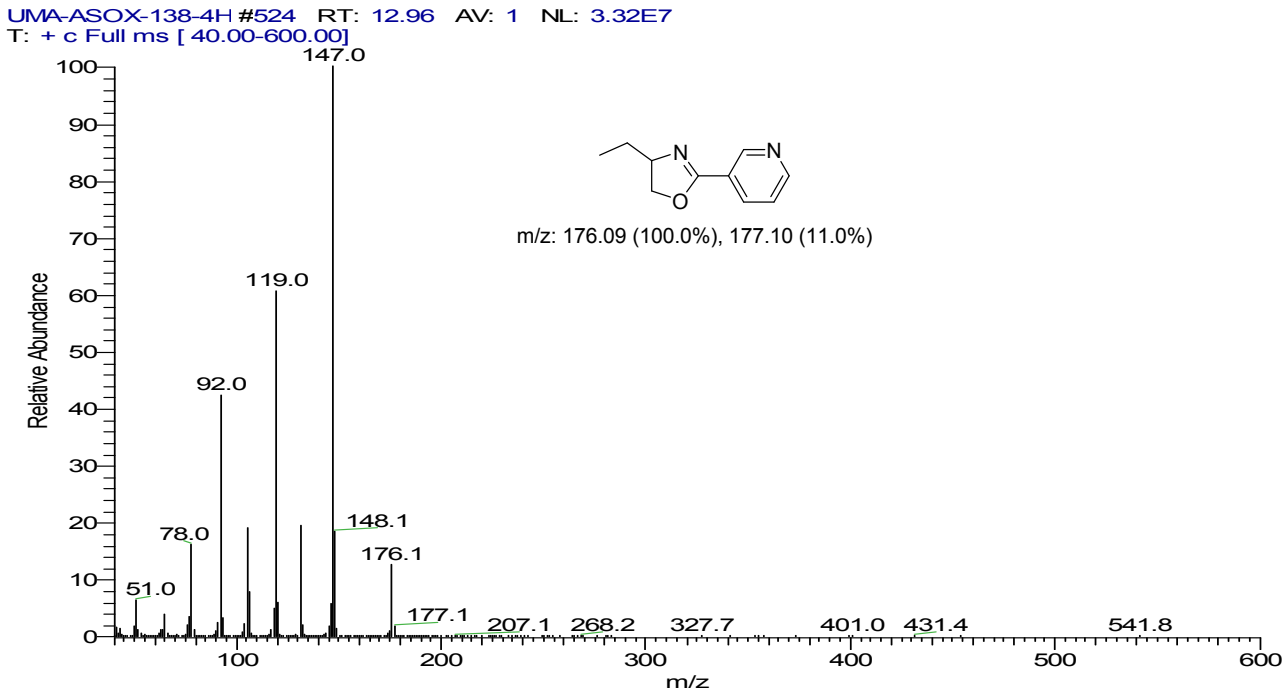
4-ethyl-2-(pyridin-3-yl)-4,5-dihydrooxazole (**3o**, Table 2, Entry15)



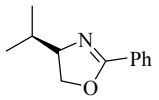
Isolated yield = 74%; yellow liquid; IR (KBr) cm^{-1}: 2962, 2926, 2875, 1728, 1653, 1571, 1529, 1416, 1359, 1260, 1077, 1022, 947, 797. ^{1}H NMR δ(300 MHz, $CDCl_3$) 9.02(s, Ar, 1H), 8.58 (d, J = 8.1 Hz, Ar, 1H), 8.11 (d, J = 8.1 Hz, 1H), 7.22 – 7.27 (m, Ar, 1H), 4.37 (t, J = 8.1 Hz, 1H), 4.17- 4.43 (m, 1H), 4.09 – 4.20 (m, 1H), 3.93 – 3.99 (m, 1H), 1.48 – 1.71 (m, 2H), 0.91 -0.96 (m, 3H). ^{13} C NMR (75 MHz, $CDCl_3$): 161.4, 151.8, 149.4, 135.5, 123.9, 123.1, 72.3, 67.9, 28.5, 9.9.**GC-MS** m/z 176.1 (M^+ peak), 147.0, 119.0, 92.0, 78.0.



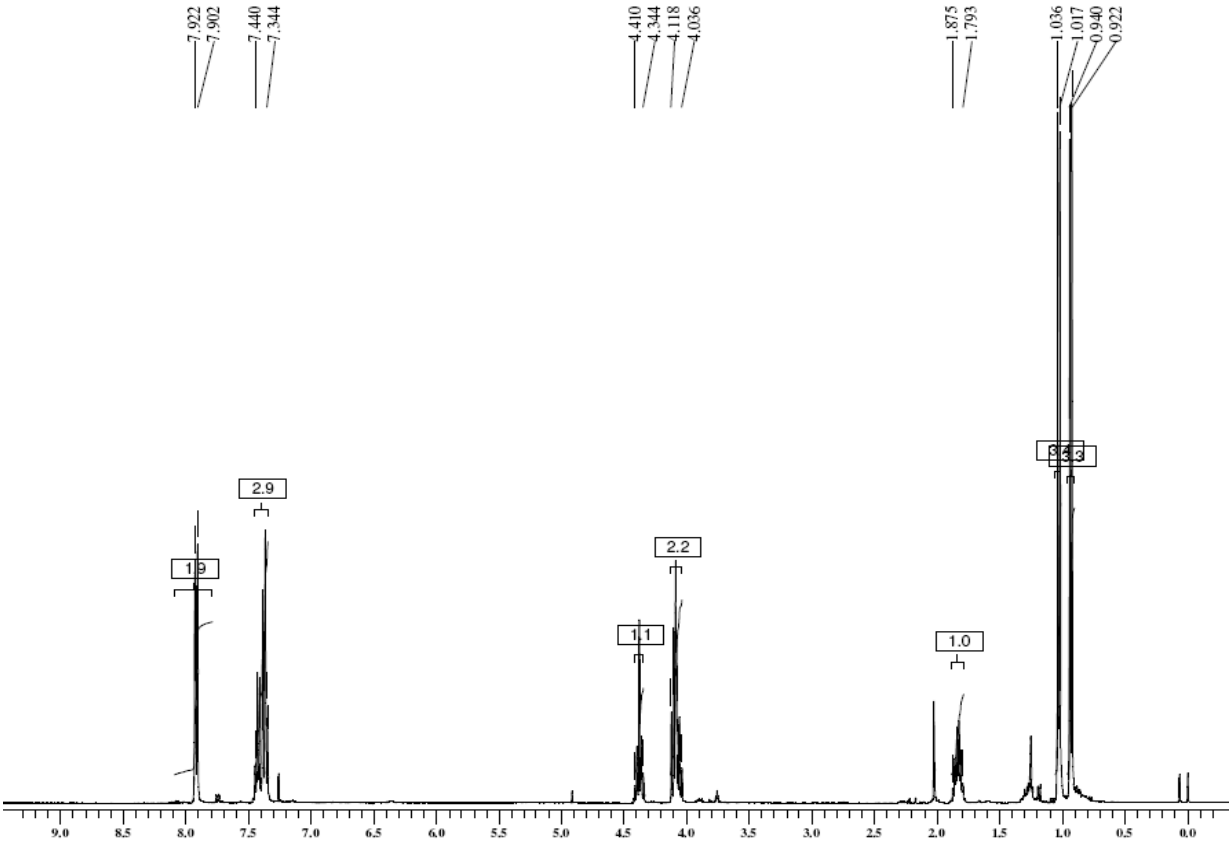

161.444
151.821
149.366
135.538
123.959
123.115
72.255
67.998
28.486
9.927
0
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

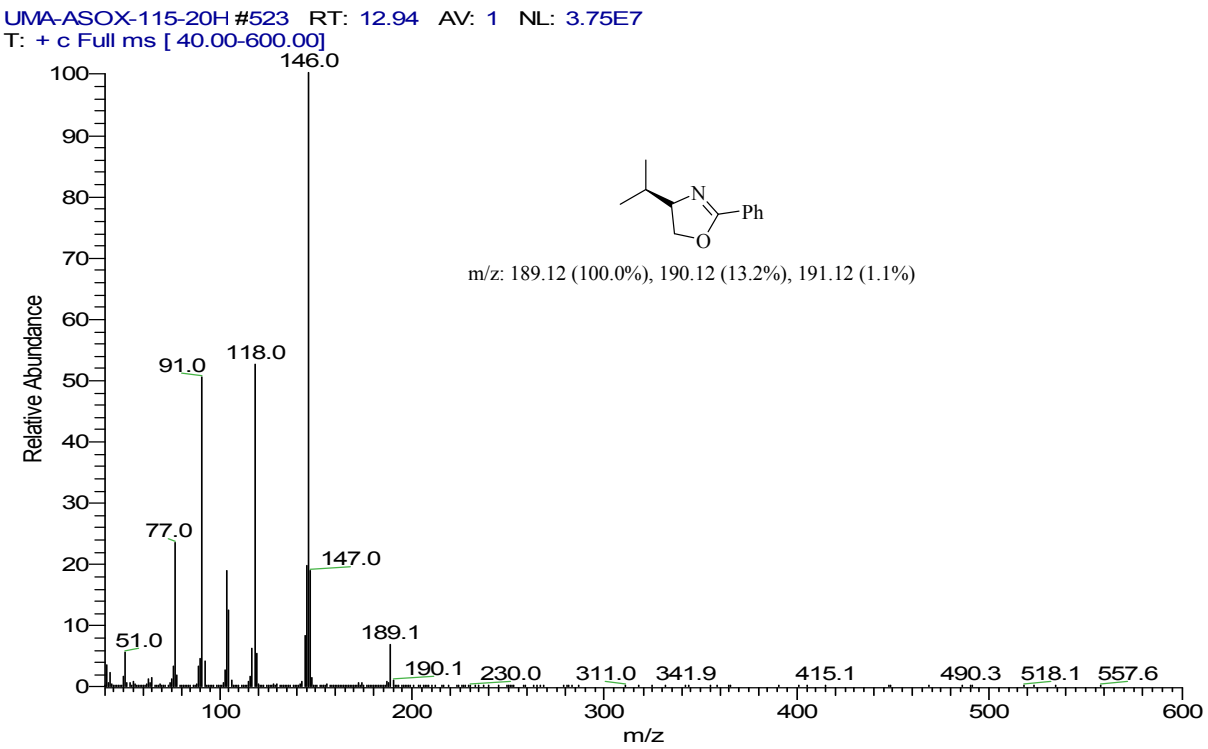

UMA-ASOX-138-4H #524 RT: 12.96 AV: 1 NL: 3.32E7
T: + c Full ms [40.00-600.00]
147.0
119.0
92.0
78.0
51.0
148.1
176.1
177.1
207.1
268.2
327.7
401.0
431.4
541.8
Relative Abundance
m/z
m/z: 176.09 (100.0%), 177.10 (11.0%)
N
N
O

(*S*)-4-isopropyl-2-phenyl-4,5-dihydrooxazole (**3p**, Table 3, Entry 1) [6]

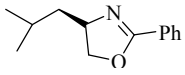


Isolated yield = 81%; ^{1}H NMR δ(300 MHz, $CDCl_3$) 7.91 (d, J = 8.1 Hz, Ar, 2H), 7.34-7.44 (m, Ar, 3H), 4.34-4.41 (m, -CH, 1H),4.04- 4.12 (m, -CH_2, 2H), 1.79-1.88 (m, -CH, 1H), 1.02 (d, J = 7.3 Hz, -CH_3, 3H), 0.93 (d, J = 7.3 Hz,-CH_3, 3H). **GC-MS** m/z 189.1, 146.0, 118.0, 91.0, 77.0, 51.0. Optical rotation: $[\alpha]_D^{22}$ = -76.4, (c =0.63 in $CHCl_3$) {Lit.[5] $[\alpha]_D^{22}$ -83 (c = 0.63, $CHCl_3$)}

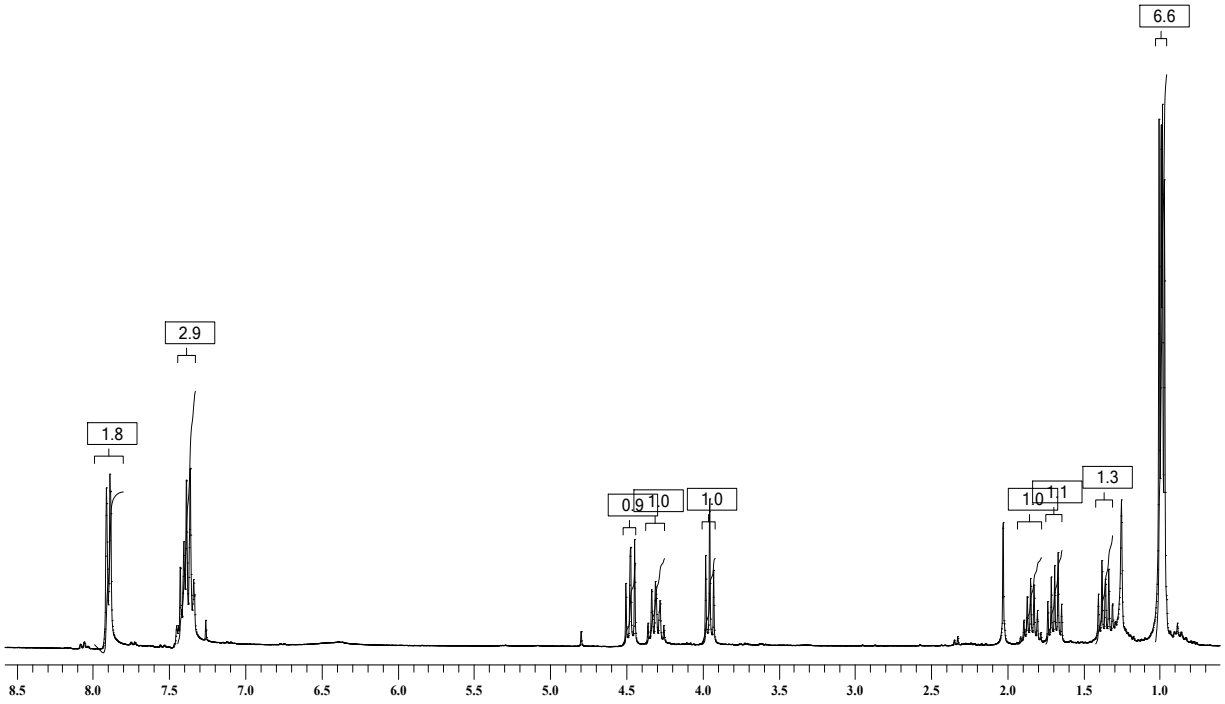




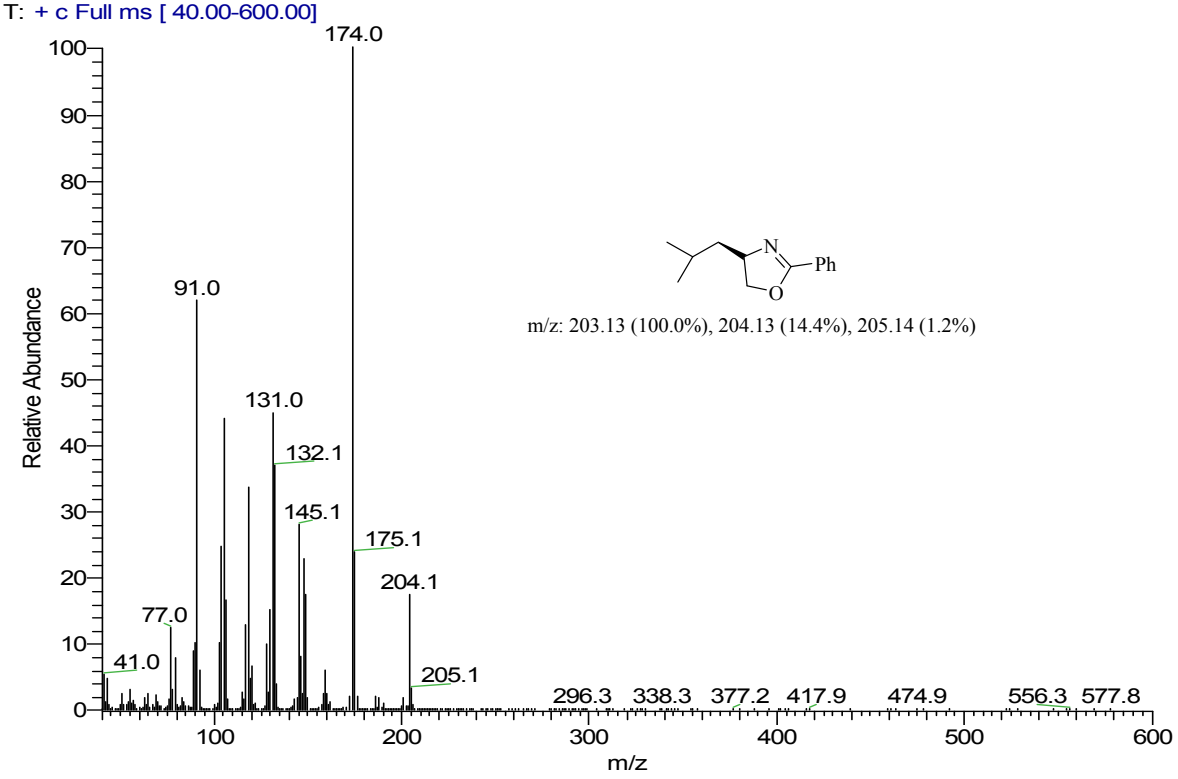
(*S*)-4-isobutyl-2-phenyl-4,5-dihydrooxazole (**3q**, Table 3, Entry 2) [8]



Isolated yield = 86%; ^{1}H NMR δ(300 MHz, $CDCl_3$) 7.89 (d, J = 8.3 Hz, Ar, 2H), 7.33- 7.45 (m, Ar, 3H), 4.47 (t, J = 9.8Hz, 7.5 Hz, 1H), 4.25- 4.36 (m, H), 3.95 (t, 7.5 Hz, 1H), 1.78 - 1.91 (m, 1H), 1.64 – 1.74 (m, 1H), 1.31 – 1.40 (m, 1H), 0.97 - 1.00 (m, -$(CH_3)_2$, 6H). **GC-MS** m/z 204.1 (M+1), 174.0, 145.1, 132.1, 131.0, 91.0, 77.0. Optical rotation: [α] = -66.1, c =1.0 in $CHCl_3$). {Lit.[7] $[\alpha]_D^{21}$ = -76.9 (*c* =1, $CHCl_3$)}

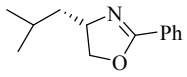


UMA-ASOX-110-6H #610 RT: 14.59 AV: 1 NL: 4.00E7
T: + c Full ms [40.00-600.00]



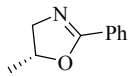
m/z: 203.13 (100.0%), 204.13 (14.4%), 205.14 (1.2%)

(*R*)-4-isobutyl-2-phenyl-4,5-dihydrooxazole (**3r**, Table 3, Entry 3) [8]



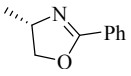
Optical rotation: [α] = +71.5, c =1.0 in $CHCl_3$). {Lit. [8] $[\alpha]_D^{21}$ = -76.9 for (*S*)-4-isobutyl-2-phenyl-4,5-dihydrooxazole (*c* = 1.0, $CHCl_3$)}

(*R*)-5-methyl-2-phenyl-4,5-dihydrooxazole (**3s**, Table 3, Entry 4) [9]



Optical rotation: [α] = -4.5, c =1.0 in MeOH). {Lit. [9] $[\alpha]_D^{25}$ = -5.1 (*c* = 1.0, MeOH)}

(*S*)-4-methyl-2-phenyl-4,5-dihydrooxazole (**3t**, Table 3, Entry 5) [9]



Optical rotation: [α] = -74.2, c =1.0 in EtOH). {Lit.[9] $[\alpha]_D^{25}$ = -79.8 (*c* = 1.0, EtOH)}

References:

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9. Dehmlow, E. V.; Pieper, St.; Neumann, B.; Stammler, H.-G. *Liebigs Ann. Chem*. **1997**, 1013.