Electronic Supplementary Material (ESI) for Organic Chemistry Frontiers.

Efficient Construction of Pyrrolo[1',2':1,2]azocino[4,5-*c*]quinolines via Cascade Cycloaddition and Annulation Reaction

Wen-Tao Wu, Ying Han*, Jing Sun, and Chao-Guo Yan[a]*

Supporting Information

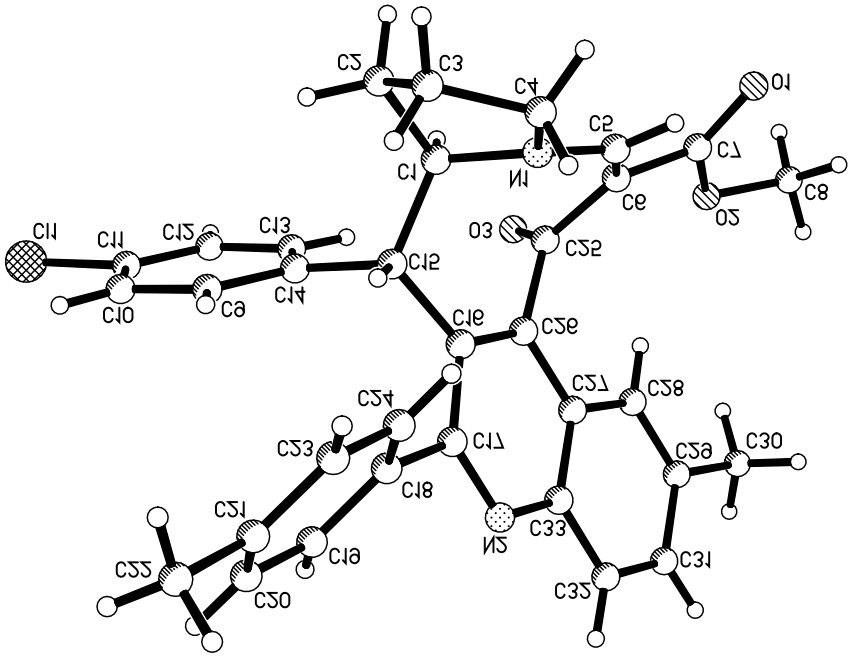


Fig. 1 The single crystal structure of the compound **1e**

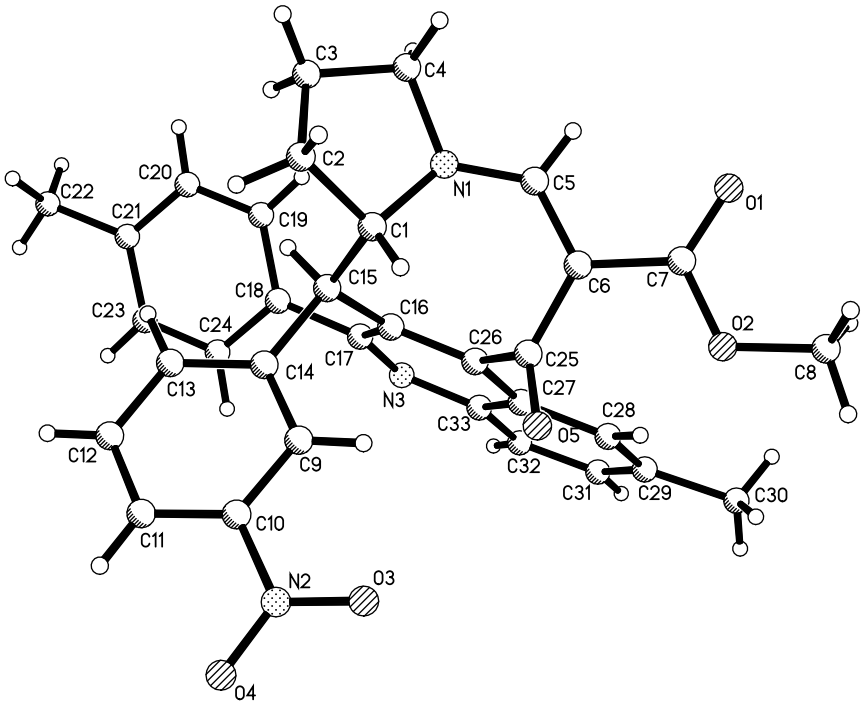


Fig. 2 The single crystal structure of the compound **1i**

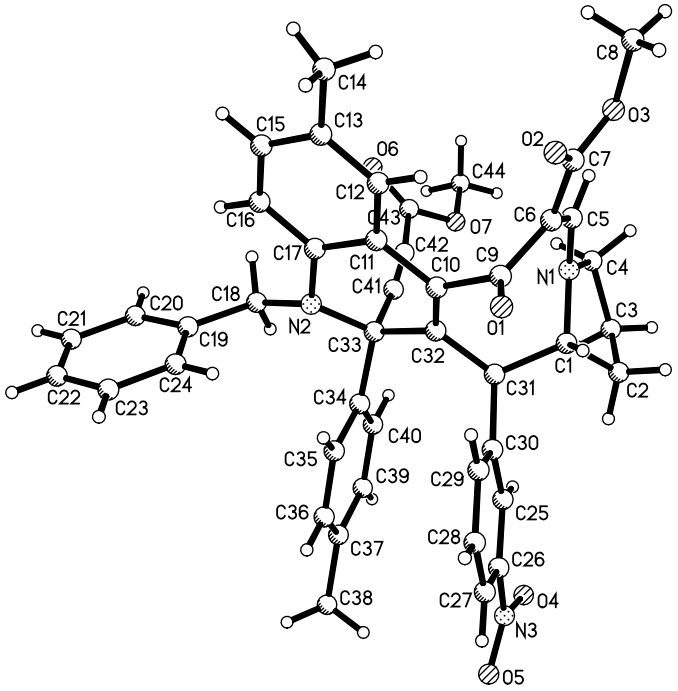


Fig. 3 The single crystal structure of the compound **2f**

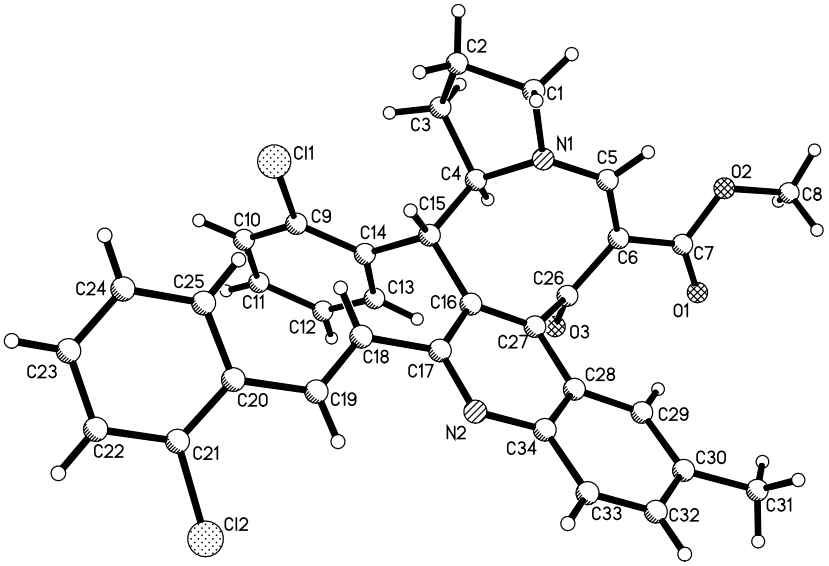


Fig. 3 The single crystal structure of the compound **3f**

Experimental section

1. General procedure for the preparation of hexahydropyrrolo[1',2':1,2]azocino-[4,5-*c*]quinolines 1a-1k: To a round flask was added L-proline (0.5 mmol), isatin (0.5 mmol), chalcone (0.5 mmol), and methanol (10.0 mL). The mixture was refluxed for two hours. The solvent was removed by rotatory evaporation at reduced pressure. Then, methyl propiolate (0.6 mmol) and acetonitrile (10.0 mL) was added. The mixture was refluxed for eight hours. After removing the solvent, the residue was subjected to column chromatography with light petroleum and ethyl acetate (V/V = 5:1) as eluent to give the pure product for analysis.

2. General procedure for the preparation of octahydropyrrolo[1',2':1,2]azocino[4,5-*c*]-quinolines 2a-2p: To a round flask was added L-proline (0.5 mmol), isatin (0.5 mmol), chalcone (0.5 mmol), and methanol (10.0 mL). The mixture was refluxed for two hours. The solvent was removed by rotatory evaporation at reduced pressure. Then, methyl propiolate (1.2 mmol) and acetonitrile (10.0 mL) was added. The mixture was refluxed for twenty-four hours. After removing the solvent, the residue was subjected to column chromatography with light petroleum and ethyl acetate (V/V = 5:1) as eluent to give the pure product for analysis.

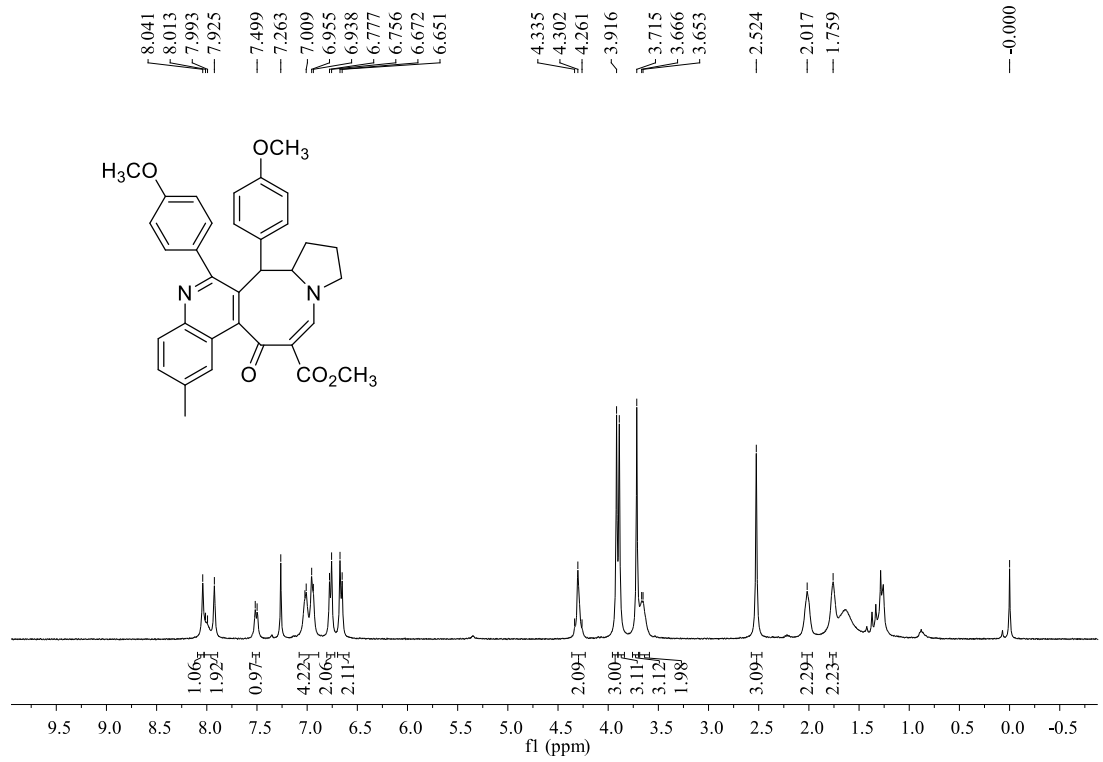
3. General procedure for the preparation of hexahydropyrrolo[1',2':1,2]azocino[4,5-*c*]-quinolines 3a-3h: To a round flask was added L-proline (0.5 mmol), isatin (0.5 mmol), bis-chalcone (0.5 mmol), and methanol (10.0 mL). The mixture was refluxed for two hours. The solvent was removed by rotatory evaporation at reduced pressure. Then, methyl propiolate (0.6 mmol) and acetonitrile (10.0 mL) was added. The mixture was refluxed for eight hours. After removing the solvent, the residue was subjected to column chromatography with light petroleum

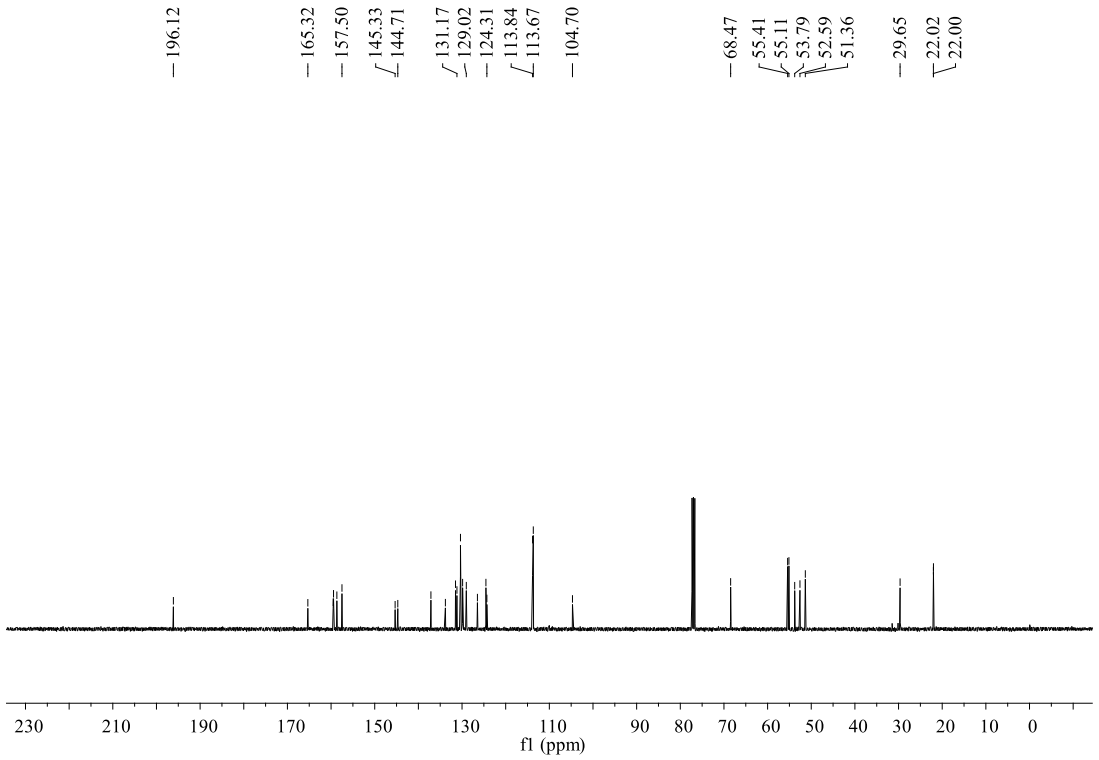
and ethyl acetate (V/V = 5:1) as eluent to give the pure product for analysis.

Methyl

(*E*)-1,14-bis(4-methoxyphenyl)-5-methyl-7-oxo-7,11,12,13,13a,14-hexahydropyrrolo[1',2':1,2]azocino[4,5-*c*]quinoline-8-carboxylate (1a):

yellow solid, 70%, m.p. 295~297℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.04 (s, 1H, CH), 8.01~7.92 (m, 2H, ArH), 7.51 (d, *J* = 8.0 Hz, 1H, ArH), 7.02~6.94 (m,4H, ArH), 6.76 (d, *J* = 8.4 Hz, 2H, ArH), 6.66 (d, *J* = 8.4 Hz, 2H, ArH), 4.26~4.34 (m, 2H, CH), 3.92 (s, 3H, OCH_3), 3.89 (s, 3H, OCH_3), 3.72(s, 3H, OCH_3), 3.66 (d, *J* = 6.8 Hz, 2H, CH_2), 2.52 (s, 3H, CH_3), 2.02 (s, 2H, CH_2), 1.76 (s, 2H, CH_2); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 196.0, 165.2, 159.5, 159.4, 158.6, 157.5, 145.3,144.6, 137.1, 133.7, 131.5, 131.1, 130.3, 129.8, 128.9, 126.5, 124.5, 124.3, 113.8, 113.6, 110.0, 104.6, 68.4, 55.4, 55.1, 53.7, 52.5, 51.3, 31.3, 29.6, 22.0; IR (KBr) υ: 3300, 2951, 2840, 1737, 1704, 1681, 1649, 1606, 1577, 1512, 1460, 1344, 1271, 1179, 1149, 1063, 1032, 947, 885, 840, 806, 760 cm^{-1}; MS (*m*/*z*): HRMS (ESI) Calcd. for $C_{34}H_{33}N_2O_5$ ($[M+H]^+$): 549.2384, found: 549.2394.

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53.79
52.59
51.36
29.65
22.02
22.00
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90
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50
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30
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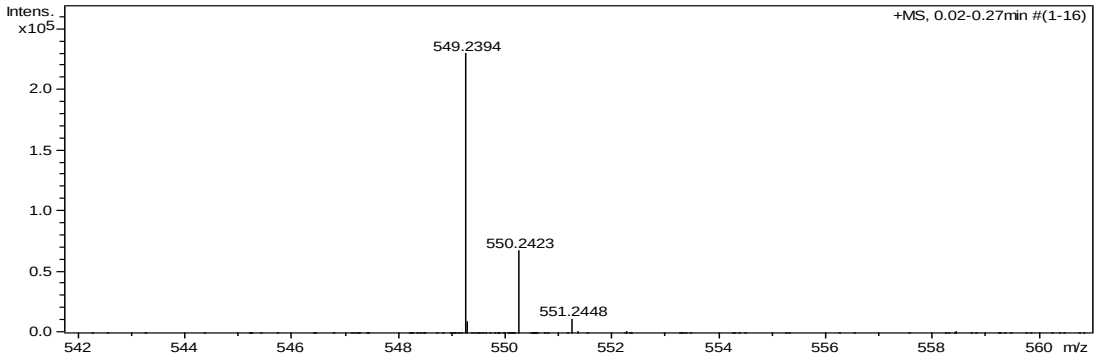
10
0
f1 (ppm)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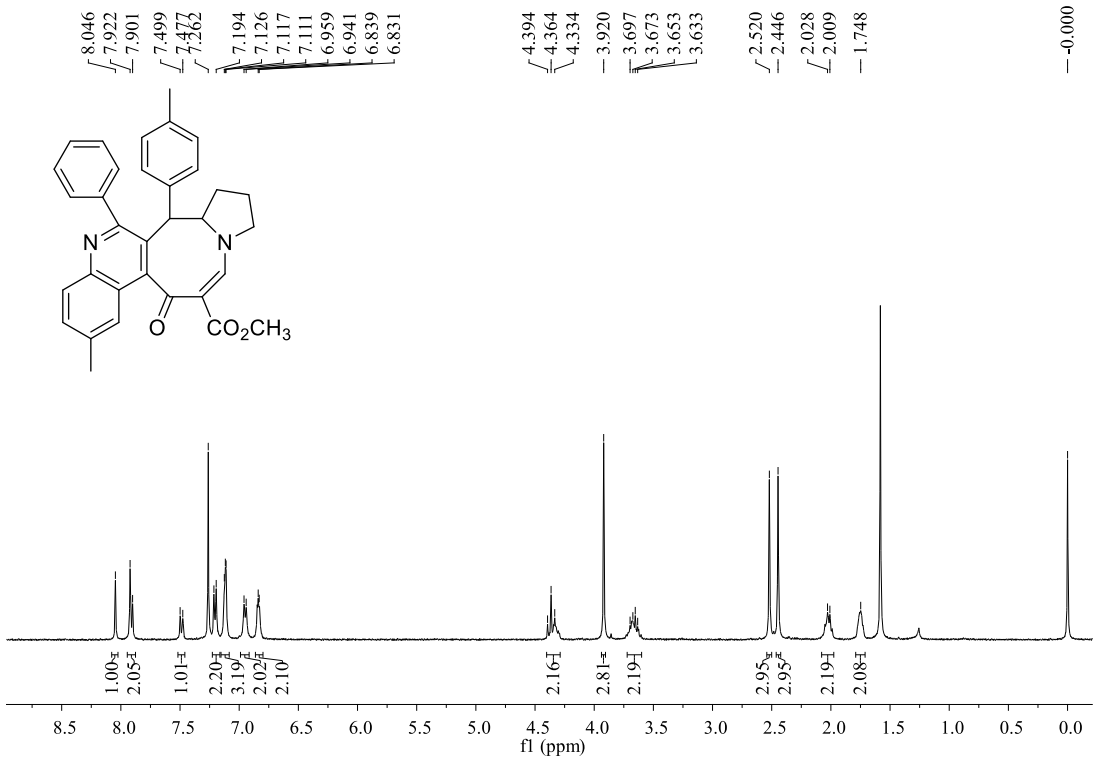
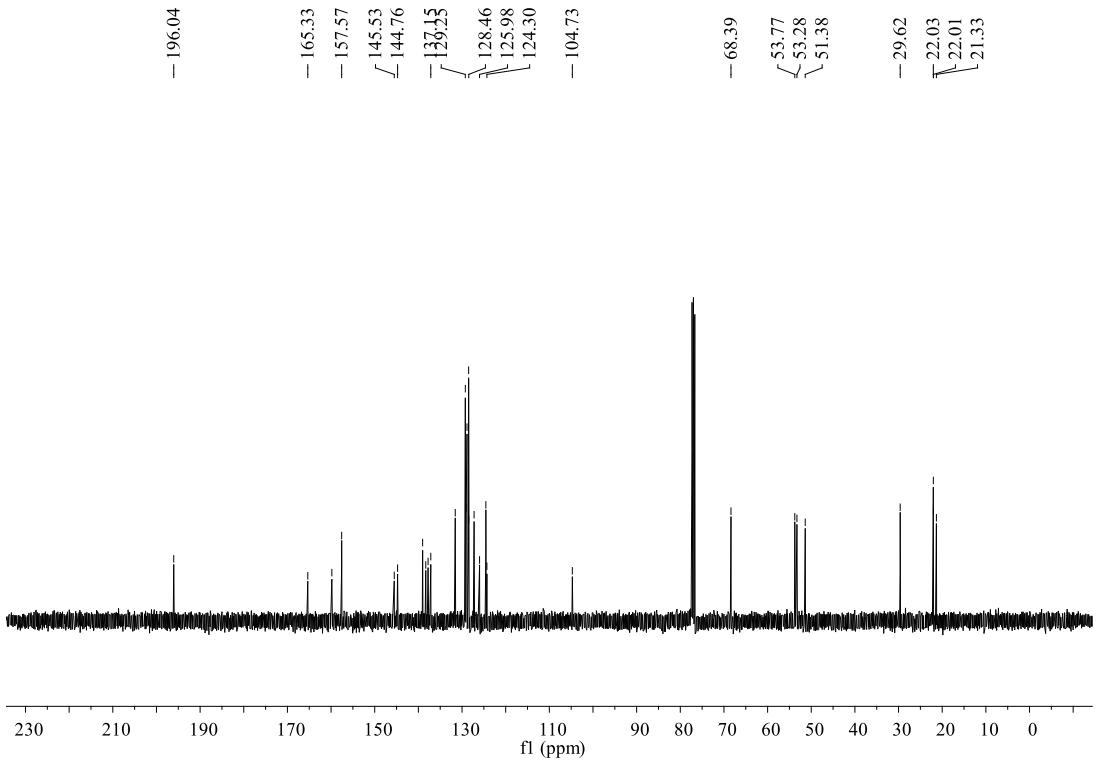
1.5
1.0
0.5
0.0
542
544
546
548
550
552
554
556
558
560
m/z

Methyl

(*E*)-5-methyl-7-oxo-1-phenyl-14-(*p*-tolyl)-7,11,12,13,13a,14-hexahydropyrrolo[1',2':1,2]azocino[4,5-*c*]quinoline-8-carboxylate (1b):

yellow solid, 72%, m.p. 287~289℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.05 (s, 1H, CH), 7.91 (d, *J* = 8.4 Hz, 2H, ArH), 7.49 (d, *J* = 8.8 Hz, 1H, ArH), 7.20 (d, *J* = 8.0 Hz, 2H, ArH), 7.15~7.08 (m, 3H, ArH), 6.95 (d, *J* = 7.2 Hz, 2H, ArH), 6.84~6.94 (m, 2H, ArH), 4.36 (m, 2H, CH), 3.92 (s, 3H, OCH_3), 3.66 (m, 2H, CH_2), 2.52 (s, 3H, CH_3), 2.45 (s, 3H, CH_3), 2.02 (m, 2H,CH_2), 1.75 (m, 2H, CH_2); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 196.0, 165.3, 159.8, 157.5, 145.5, 144.7, 139.0, 138.3, 137.7, 137.1, 131.5, 129.2, 129.0, 128.8, 128.5, 128.4, 127.2, 125.9, 124.5, 124.3, 104.7, 68.3, 53.7, 53.2, 51.3, 29., 22.0, 22.0, 21.3; IR(KBr) υ: 3298, 2953,1703, 1585, 1493, 1451, 1409, 1358, 1321, 1272, 1186, 1148, 1059, 980, 944, 912, 885, 824, 807, 758,703 cm^{-1}; MS (*m*/*z*): HRMS (ESI) Calcd. For $C_{33}H_{30}N_2NaO_3$ ($[M+Na]^+$): 525.2149, found: 525.2084.

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125.98
124.30
104.73
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51.38
29.62
22.03
22.01
21.33
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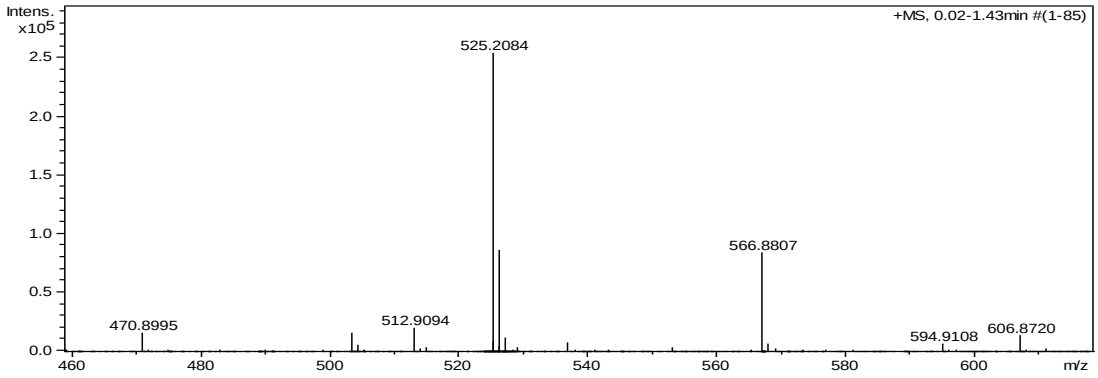
f1 (ppm)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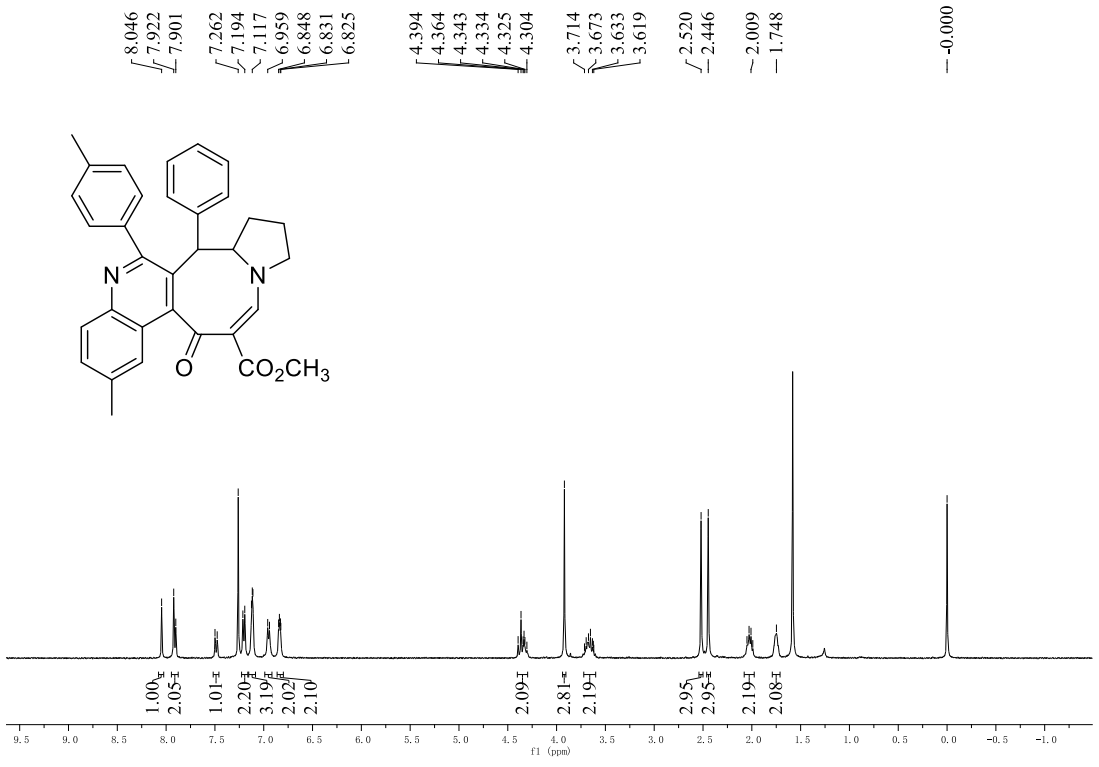
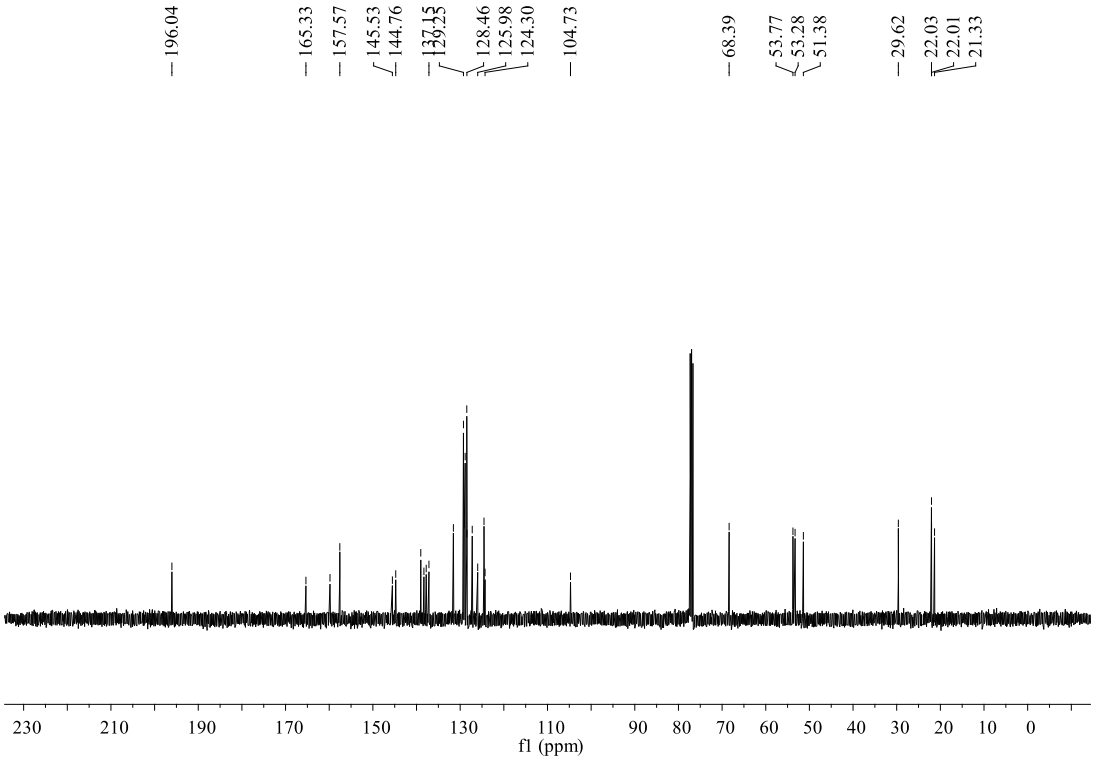
Methyl

(*E*)-5-methyl-7-oxo-14-phenyl-1-(*p*-tolyl)-7,11,12,13,13a,14-hexahydropyrrolo[1',2':1,2]azocino[4,5-*c*]quinoline-8-carboxylate (1c):

yellow solid, 43%, m.p. 293~297℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.05 (s, 1H, CH), 7.91 (d, *J* = 8.4 Hz, 2H, ArH), 7.49 (d, *J* = 8.8 Hz, 1H, ArH), 7.20 (d, *J* = 7.8 Hz, 2H, ArH), 7.15~7.08 (m, 3H, ArH), 6.95 (d, *J* = 7.2 Hz, 2H, ArH), 6.85~ 6.82(m, 2H, ArH), 4.369~4.32(m, 2H, CH), 3.92 (s, 3H, CH_3), 3.71~3.62 (m, 2H, CH_2), 2.52 (s, 3H, CH_3), 2.45 (s, 3H, CH_3), 2.05~1.99 (m, 2H, CH_2), 1.75 (s, 2H, CH_2). ^{13}C NMR (101 MHz, $CDCl_3$) δ 196.0, 165.3, 159.8, 157.5, 145.5, 144.7, 139.0, 138.3, 137.7, 137.1, 131.5, 129.2, 129.0, 128.8, 128.4, 128.4, 127.2, 125.98, 124.5, 124.3, 104.7, 68.3, 53.7, 53.2, 51.3, 29.6, 22.0, 22.0, 21.3; IR (KBr) υ: 3298, 2954, 1703, 1586, 1494, 1451, 1410, 1359, 1321, 1272, 1186, 1149, 1060, 980, 944, 912 885, 825, 807, 759, 703 cm^{-1}; MS (*m*/*z*): HRMS (ESI) Calcd. For $C_{33}H_{30}N_2NaO_3$ ([M+Na]$^+$): 525.2149, found: 525.2084.

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137.15
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124.30
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51.38
29.62
22.03
22.01
21.33
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50
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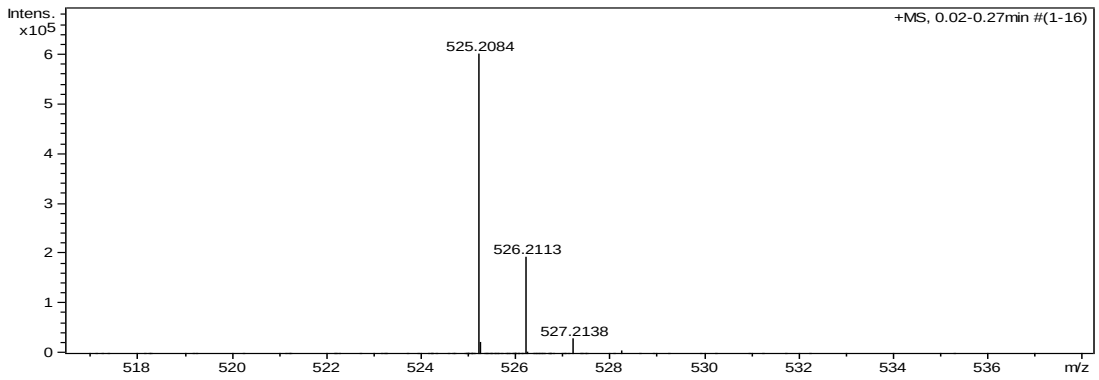
f1 (ppm)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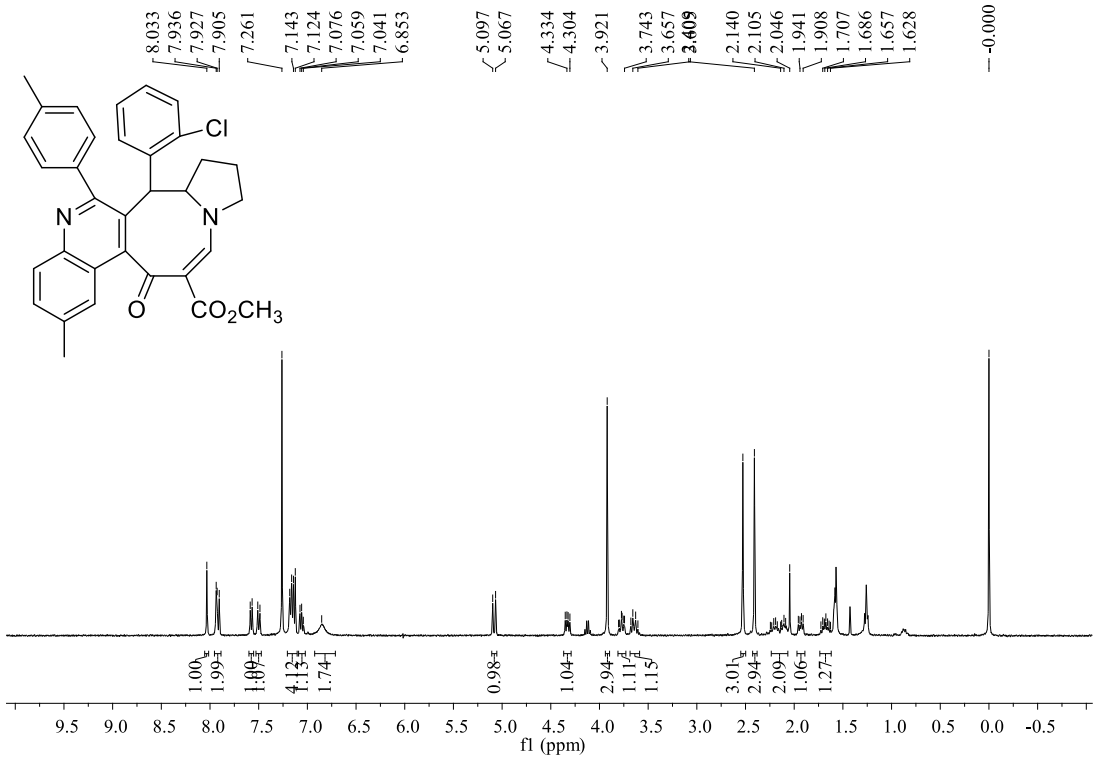
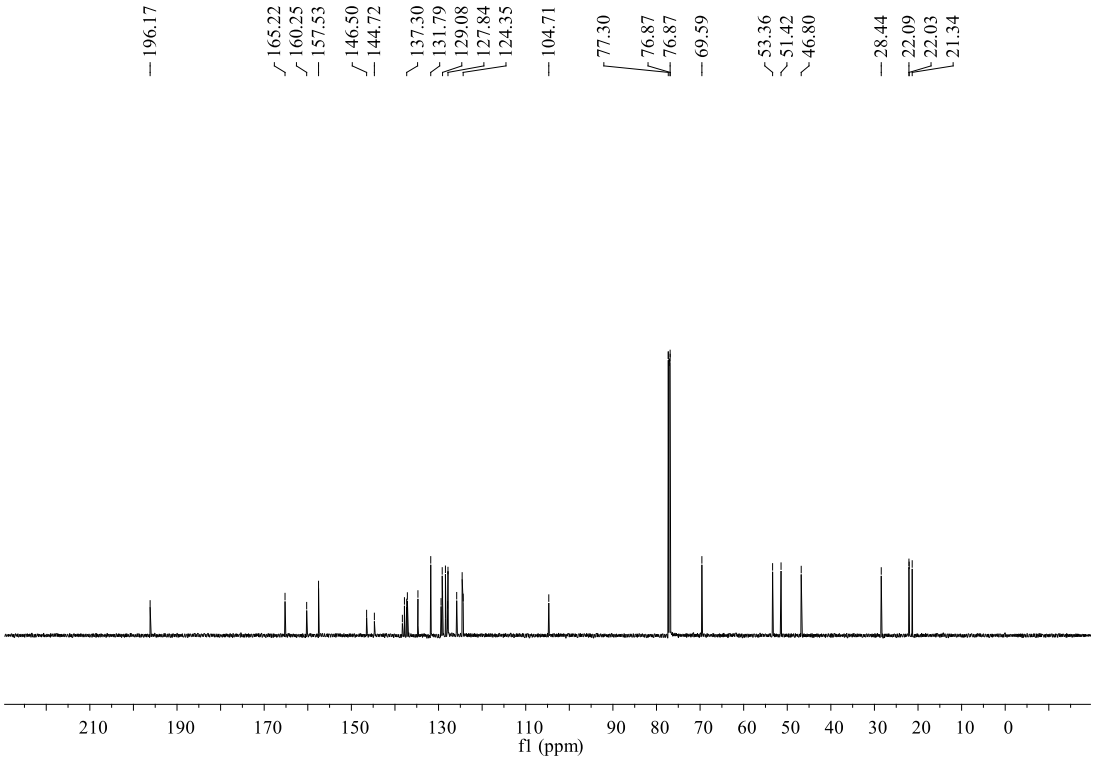
518
520
522
524
526
528
530
532
534
536
m/z

Methyl

(*E*)-14-(3-chlorophenyl)-5-methyl-7-oxo-1-(*p*-tolyl)-7,11,12,13,13a,14-hexahydropyrrolo[1',2':1,2]azocino[4,5-*c*]quinoline-8-carboxylate (1d):

yellow solid, 55%, m.p. 300~302℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.03 (s, 1H, CH), 7.95~7.89 (m, 2H, ArH), 7.58 (d, J = 8.0 Hz, 1H, ArH), 7.50 (d, J = 8.8 Hz, 1H, ArH), 7.15 (dd, J_1= 15.2 Hz, J_2= 7.6 Hz, 4H, ArH), 7.09~7.02 (m, 1H, ArH), 6.85 (s, 2H, ArH), 5.08 (d, J = 12.0 Hz, 1H, CH), 4.33 (dd, J_1= 12.0 Hz, J_2= 7.2 Hz, 1H, CH), 3.92 (s, 3H, OCH_3), 3.80~3.74 (m, 1H, CH), 3.64 (dd, J_1= 20.0 Hz, J_2= 8.0 Hz , 1H, CH_2), 2.53 (s, 3H, CH_3), 2.41 (s, 3H, CH3), 2.28~2.08 (m, 2H, CH_2), 1.93 (m, 1H, CH_2), 1.72~1.62 (m, 1H, CH_2); ^{13}C NMR (151 MHz, $CDCl_3$) δ: 196.2, 165.2, 160.2, 157.5, 146.5, 144.7, 138.3, 137.8, 137.3, 137.1, 134.7, 131.8, 129.4, 129.1, 129.0, 128.4, 127.9, 127.8, 125.8, 124.5, 124.3, 104.7, 69.5, 53.3, 51.4, 46.8, 28.4, 22.0, 22.0, 21.3; IR (KBr) υ: 3301, 3061, 3019, 2981, 1680, 1639, 1568, 1512, 1473, 1442, 1350, 1320, 1276, 1188, 1152, 1062, 1047, 1032, 980, 961, 912, 883, 863, 821, 795, 761 cm^{-1}; MS (*m*/*z*): HRMS (ESI) Calcd. for $C_{33}H_{29}ClN_2NaO_3$ ($[M+Na]^+$): 559.1759, found: 559.1771.

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22.09
22.03
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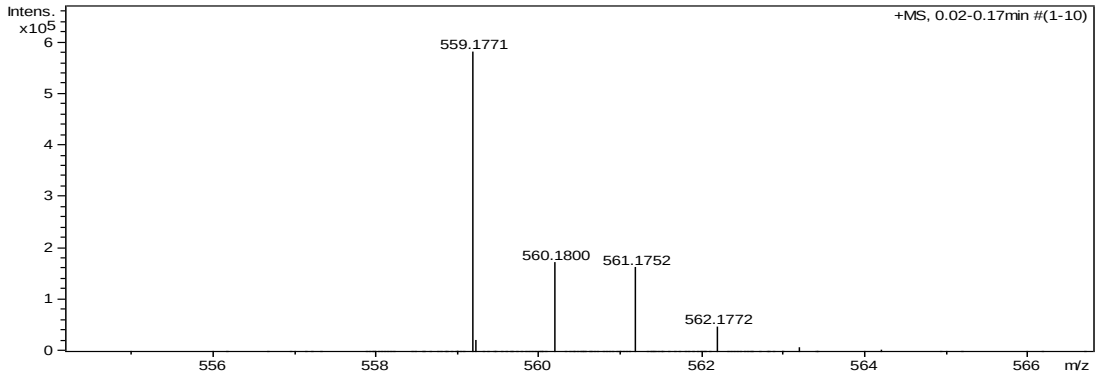
f1 (ppm)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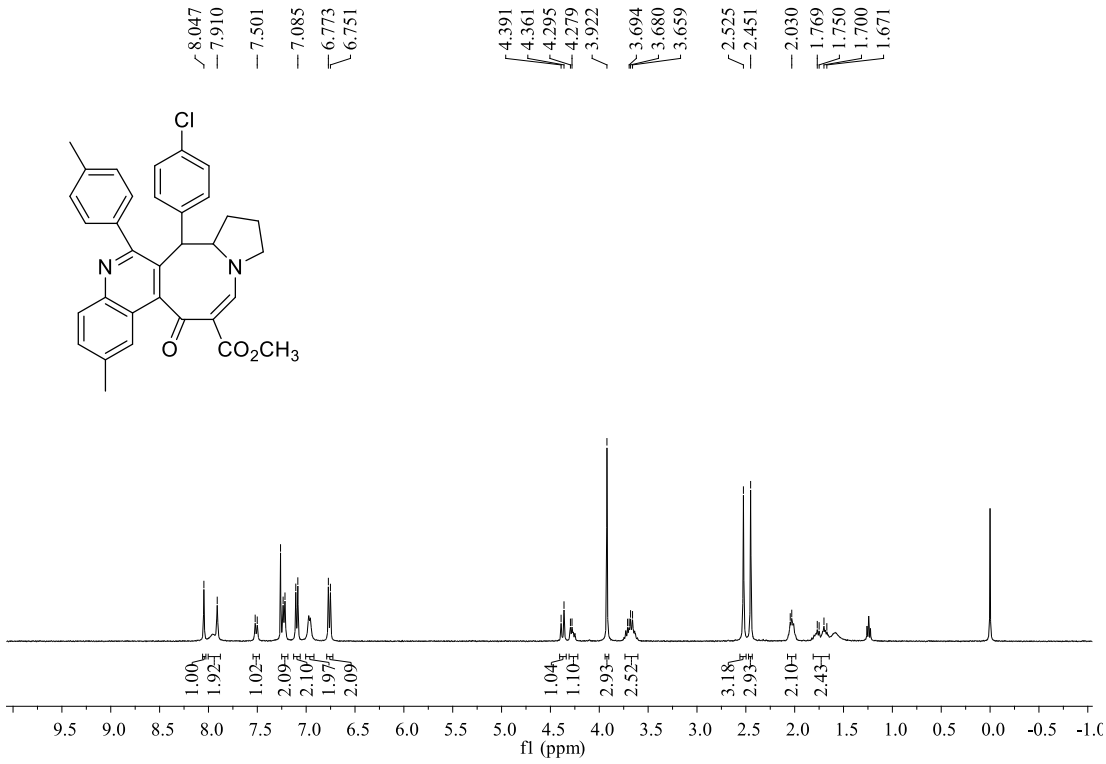
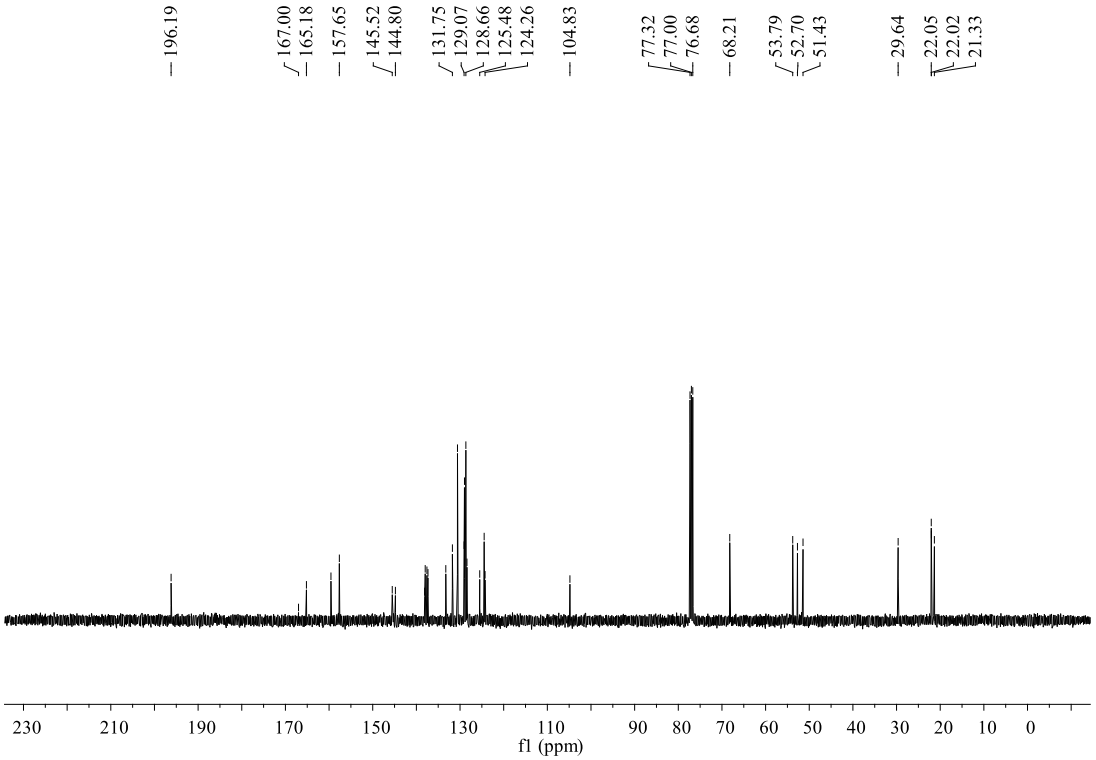
562.1772
556
558
560
562
564
566
m/z

Methyl

(*E*)-14-(4-chlorophenyl)-5-methyl-7-oxo-1-(*p*-tolyl)-7,11,12,13,13a,14-hexahydropyrrolo[1',2':1,2]azocino[4,5-*c*]quinoline-8-carboxylate (1e):

yellow solid, 59%, m.p. 290~292℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.05 (s, 1H, CH), 7.91 (s, 2H, ArH), 7.51 (d, *J* = 8.4 Hz, 1H, ArH), 7.23 (d, *J* = 7.6 Hz, 2H, ArH), 7.10 (d, *J* = 8.4 Hz, 2H, ArH), 6.97 (d, *J* = 6.4 Hz, 2H, ArH), 6.76 (d, *J* = 8.5 Hz, 2H, ArH), 4.38 (d, *J* = 12.0 Hz, 1H, CH), 4.31~4.22 (m, 1H, CH), 3.92 (s, 3H, OCH_3), 3.72~3.60 (m, 2H, CH_2), 2.52 (s, 3H, CH_3), 2.45 (s, 3H, CH_3), 2.06~1.99 (m, 2H, CH_2), 1.82~1.66 (m, 2H, CH_2); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 196.2, 165.2, 159.5, 157.6, 145.5, 144.8, 138.1, 137.9, 137.5, 137.3, 133.2, 131.7, 130.5, 129.0, 128.9, 128.6, 128.4, 125.4, 124.4, 124.2, 104.8, 68.2, 53.7, 52.7, 51.4, 29.6, 22.0, 22.0, 21.3; IR (KBr) υ: 3299, 2951, 1688, 1647, 1573, 1492, 1457, 1345, 1323, 1271, 1201, 1149, 1089, 1062, 1046, 1015, 949, 885, 827, 805, 760 cm^{-1}; MS (*m*/*z*): HRMS (ESI) Calcd. for $C_{33}H_{29}ClN_2NaO_3$ ($[M+Na]^+$): 559.1759, found: 559.1774.

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77.00
76.68
68.21
53.79
52.70
51.43
29.64
22.05
22.02
21.33
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90
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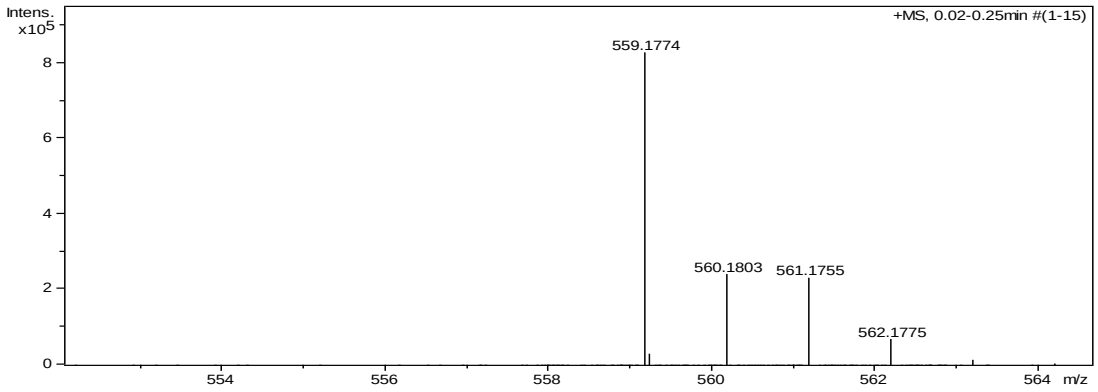
50
40
30
20
10
0
f1 (ppm)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x10^5
+MS, 0.02-0.25min #(1-15)
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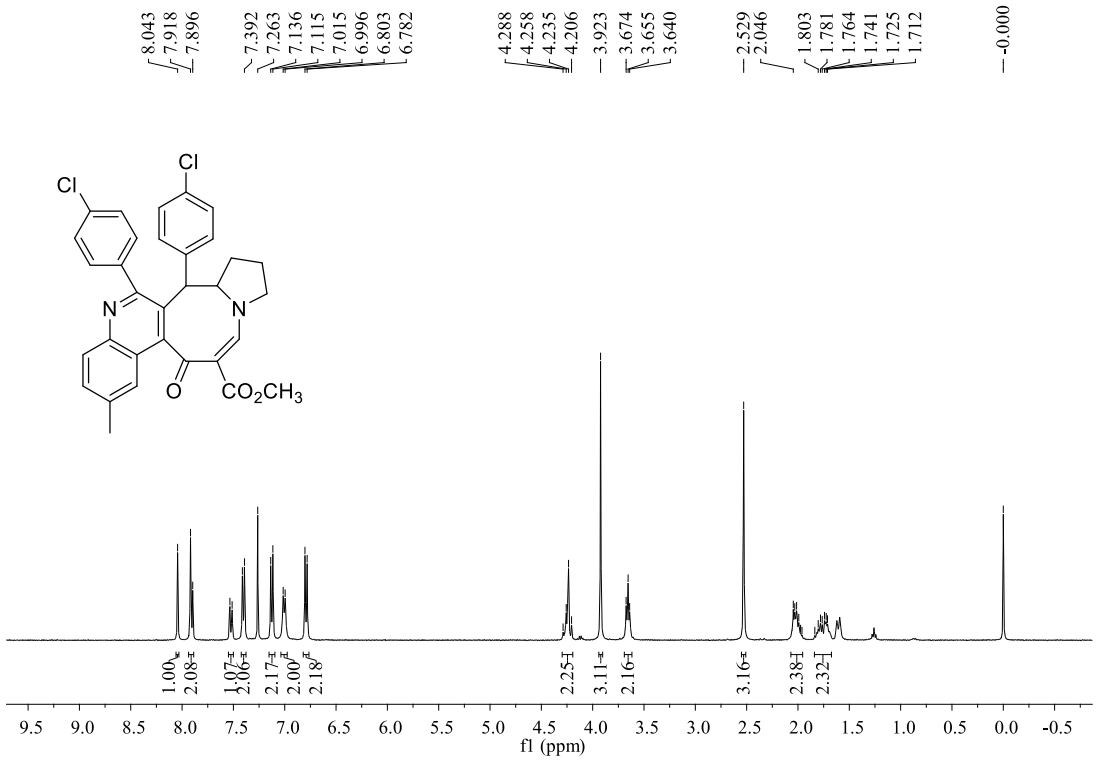
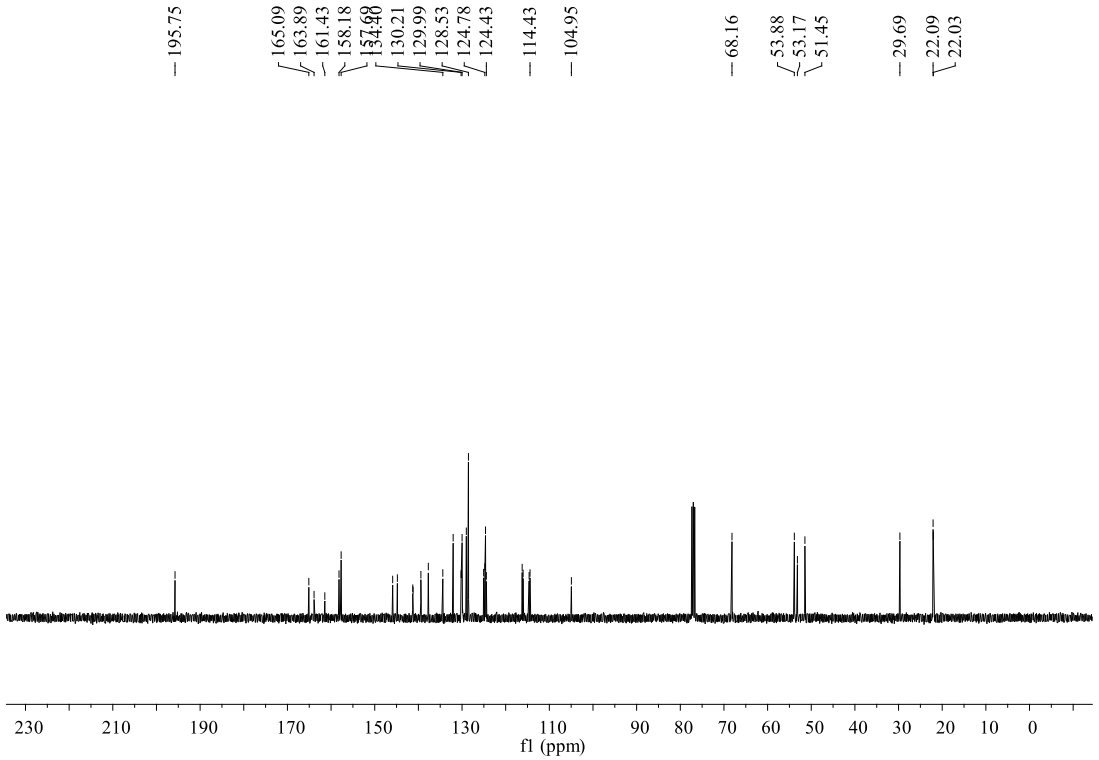
560.1803
561.1755
562.1775
554
556
558
560
562
564
m/z

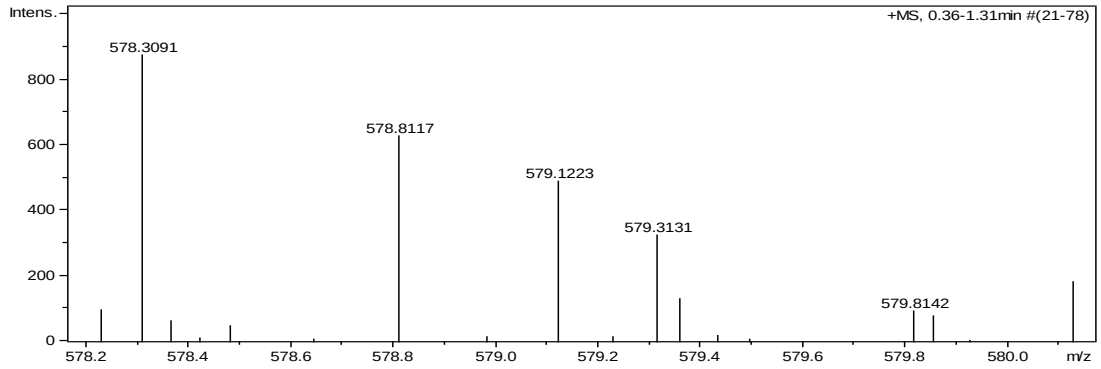
Methyl

(*E*)-1,14-bis(4-chlorophenyl)-5-methyl-7-oxo-7,11,12,13,13a,14-hexahydropyrrolo[1',2':1,2]azocino[4,5-*c*]quinoline-8-carboxylate (1f):

yellow solid, 43%, m.p. 312~314℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.04 (s, 1H, CH), 7.91 (d, *J* = 8.8 Hz, 2H, ArH), 7.52 (d, *J* = 8.8 Hz, 1H, ArH), 7.40 (d, *J* = 8.4 Hz, 2H, ArH), 7.13 (d, *J* = 8.4 Hz, 2H, ArH), 7.01 (d, *J* = 7.6 Hz, 2H, ArH), 6.79 (d, *J* = 8.4 Hz, 2H), ArH, 4.28~4.20 (m, 2H, CH), 3.92 (s, 3H, OCH_3), 3.66 (t, *J* = 6.9 Hz, 2H, CH), 2.53 (s, 3H, CH_3), 2.04~1.96 (m, 2H, CH_2), 1.84~1.67 (m, 2H, CH_2); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 195.7, 165.0, 163.8, 161.4, 158.1, 157.6, 145.8, 144.1, 141.2, 141.2, 139.4, 137.7, 134.4, 132.0, 130.2, 130.1, 129.9, 129.0, 128.5, 125.0, 124.7, 124.6, 124.4, 116.2, 116.0, 114.6, 114.4, 104.9, 68.1, 53.8, 53.1, 51.4, 29.6, 22.9, 22.0; IR (KBr) υ: 3295, 3066, 2952, 1683, 1641, 1574, 1491, 1444, 1354, 1320, 1275, 1220, 1190, 1153, 1087, 1047, 1014, 961, 891, 859, 827, 789, 760 cm^{-1}; MS (*m*/*z*): HRMS (ESI) Calcd. for $C_{32}H_{26}Cl_2N_2NaO_3$ ($[M+Na]^+$): 579.1213, found: 579.1223.



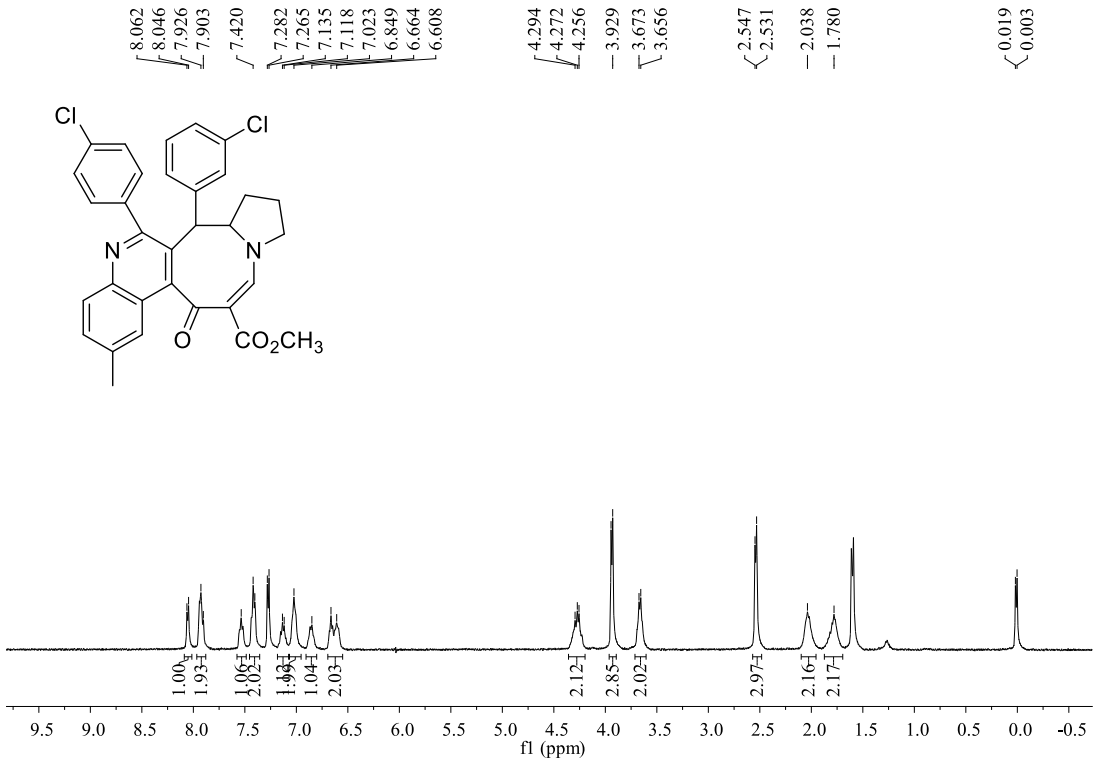

195.75
165.09
163.89
161.43
158.18
137.69
134.40
130.21
129.99
128.53
124.78
124.43
114.43
104.95
68.16
53.88
53.17
51.45
29.69
22.09
22.03
230
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

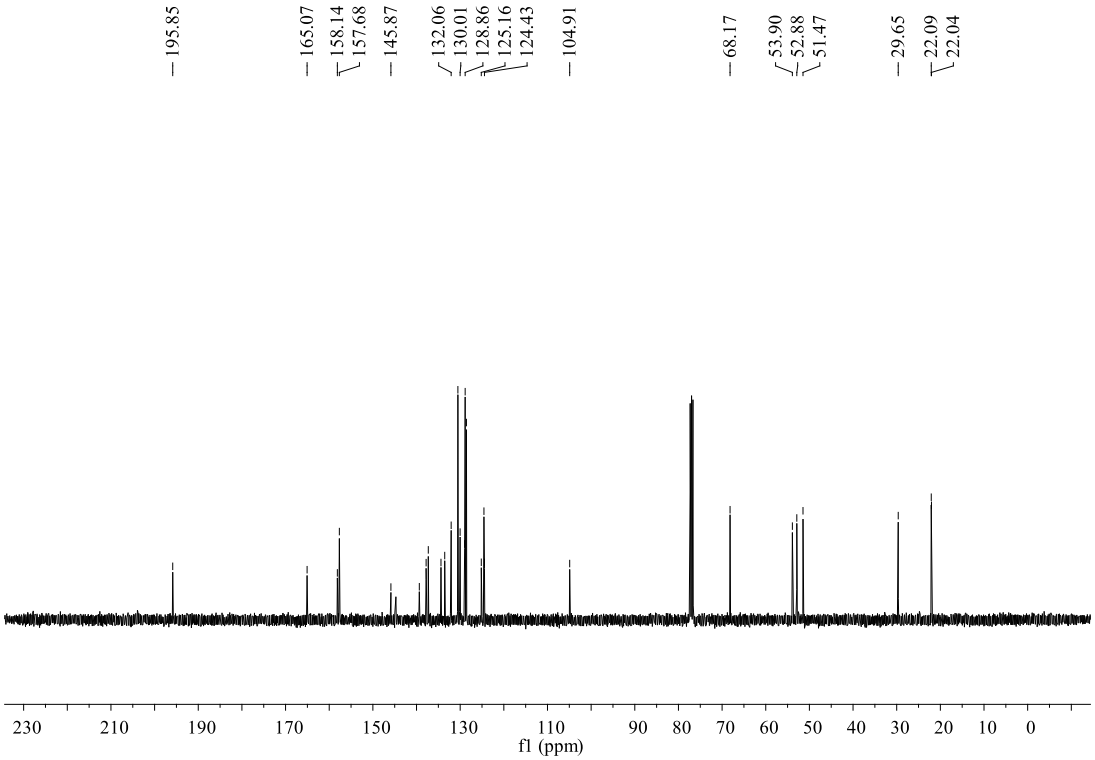

Intens.
+MS, 0.36-1.31min #(21-78)
578.3091
578.8117
579.1223
579.3131
579.8142
800
600
400
200
0
578.2
578.4
578.6
578.8
579.0
579.2
579.4
579.6
579.8
580.0
m/z

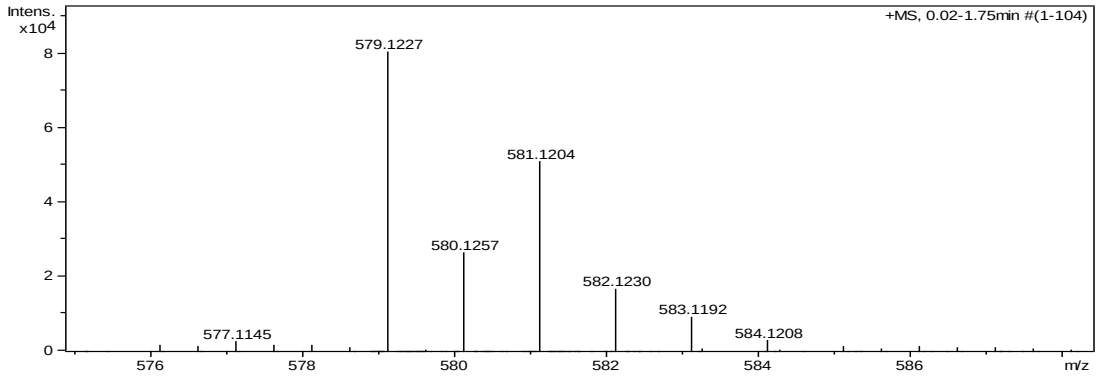
Methyl

(*E*)-14-(3-chlorophenyl)-1-(4-chlorophenyl)-5-methyl-7-oxo-7,11,12,13,13a,14-hexahydropyrrolo[1',2':1,2]azocino[4,5-*c*]quinoline-8-carboxylate (1g):

yellow solid, 40%, m.p. 288~290℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.05 (d, *J* = 6.4 Hz, 1H), 7.94~7.90(m, 2H, ArH), 7.54 (s, 1H, ArH), 7.41 (d, *J* = 6.6 Hz, 2H, ArH), 7.13 (d, *J* = 6.6 Hz, 1H, ArH), 7.02 (s, 2H, ArH), 6.85 (s, 1H, ArH), 6.64 (d, *J* = 22.2 Hz, 2H, ArH), 4.36~4.20 (m, 2H, CH), 3.94 (s, 3H, OCH_3), 3.66 (d, *J* = 6.9 Hz, 2H, CH_2), 2.54 (s, 3H, CH_3), 2.04 (s, 2H, CH_2), 1.78 (s, 2H, CH_2); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 195.8, 165.0, 158.1, 157.6, 145.8, 139.3, 137.8, 137.3, 134.4, 133.5, 132.0, 130.5, 130.0, 128.9, 128.8, 128.5, 125.1, 124.5, 124.4, 104.9, 68.1, 53.9, 52.8, 51.4, 29.6, 22.0, 22.0; IR (KBr) υ: 3439, 3297, 3021, 2950, 1684, 1573, 1492, 1460, 1357, 1321, 1273, 1189, 1150, 1090, 1047, 1014, 981, 885, 838, 806, 760 cm^{-1}; MS (*m*/*z*): HRMS (ESI) Calcd. for $C_{32}H_{26}Cl_2N_2NaO_3$ ($[M+Na]^+$): 579.1213, found: 579.1227.



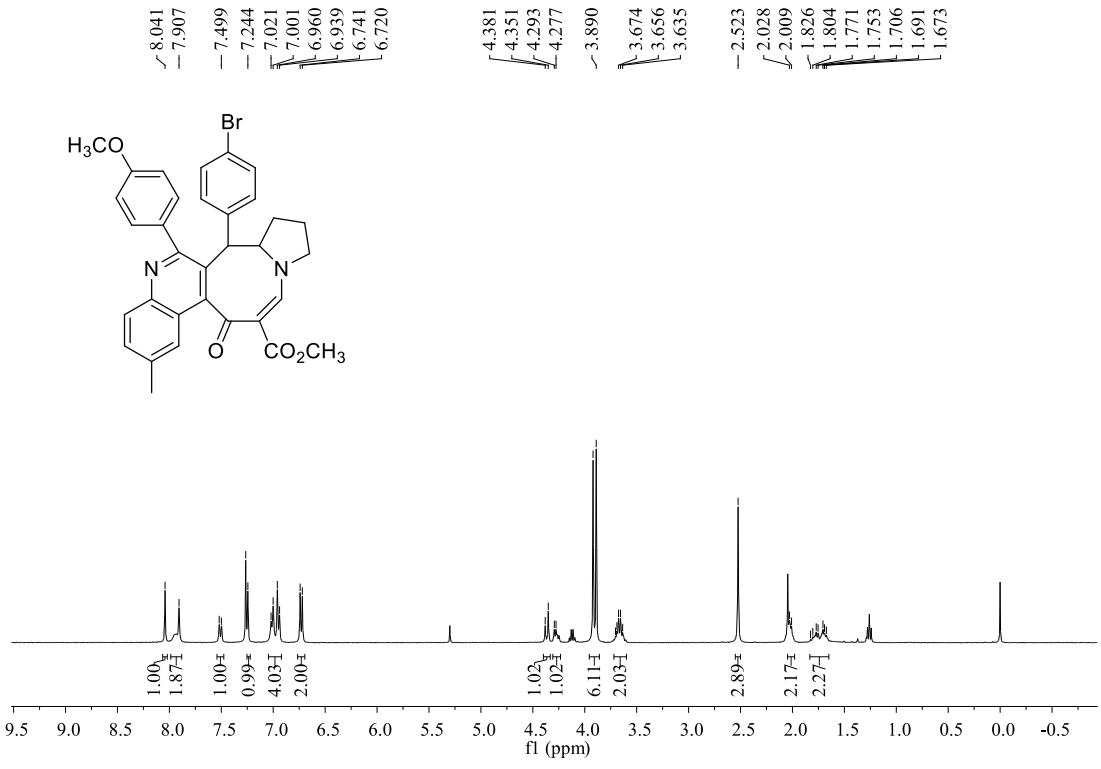

195.85
165.07
158.14
157.68
145.87
132.06
130.01
128.86
125.16
124.43
104.91
68.17
53.90
52.88
51.47
29.65
22.09
22.04
230
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

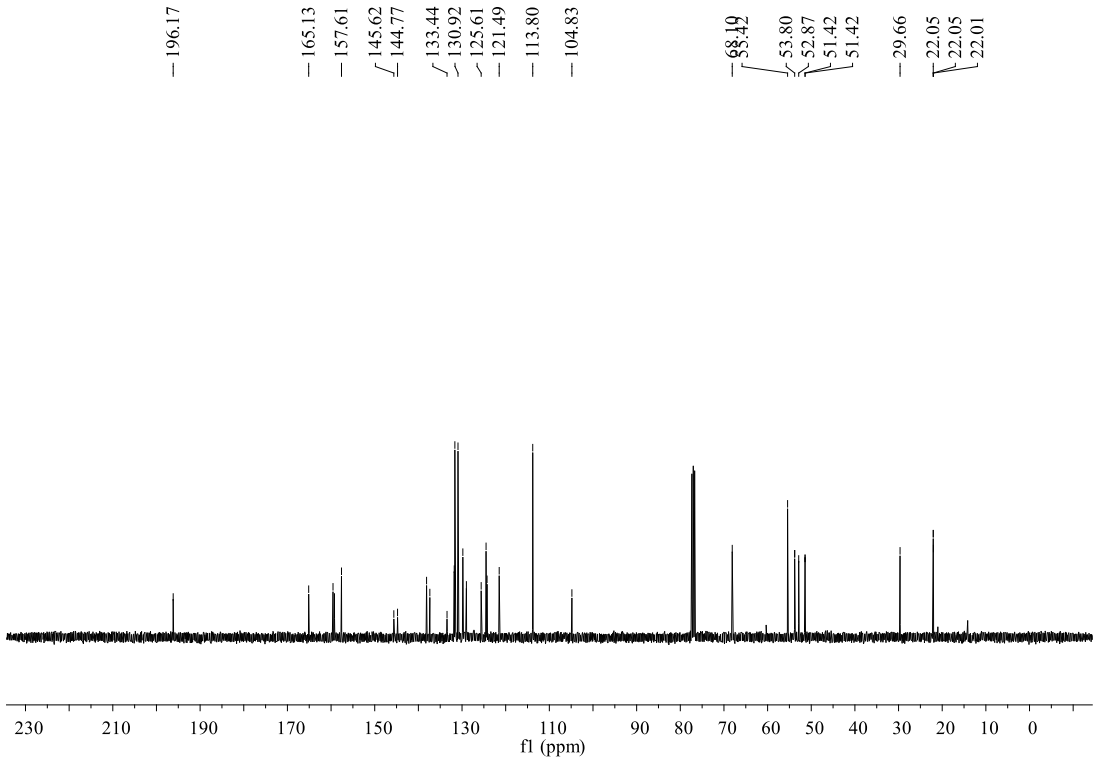

Intens.
x10^4
+MS, 0.02-1.75min #(1-104)
579.1227
581.1204
580.1257
582.1230
583.1192
584.1208
577.1145
576
578
580
582
584
586
m/z

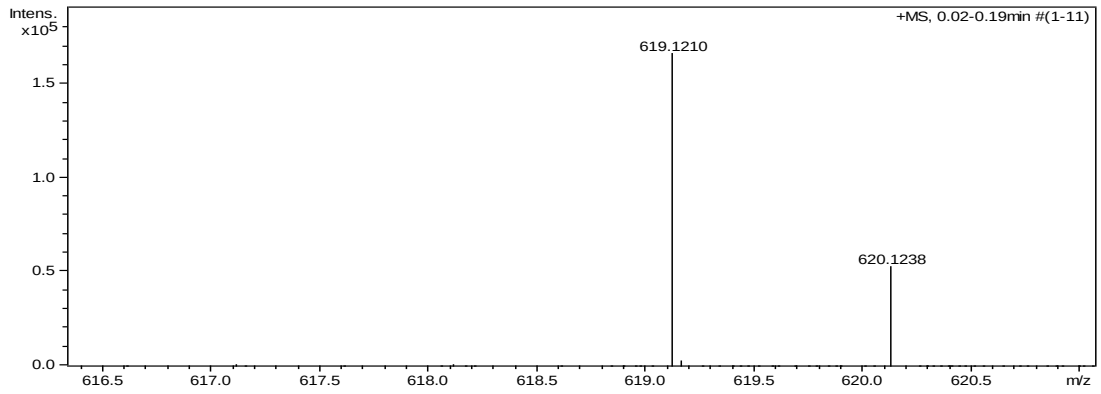
Methyl

(*E*)-14-(4-bromophenyl)-1-(4-methoxyphenyl)-5-methyl-7-oxo-7,11,12,13,13a,14-hexahydropyrrolo[1',2':1,2]azocino[4,5-*c*]quinoline-8-carboxylate (1h):

yellow solid, 67%, m.p. 289~291℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.04 (s, 1H, CH), 7.92 (s, 2H, ArH), 7.51 (d, *J* = 8.4 Hz, 1H, ArH), 7.24 (s, 1H, ArH), 7.02~76.94 (m, 4H, ArH), 6.73 (d, *J* = 8.4 Hz, 2H, ArH), 4.37 (d, *J* = 12.0 Hz, 1H,CH), 4.3~4.23 (m, 1H, CH), 3.90 (s, 6H, OCH_3), 3.72~3.60 (m, 2H, CH_2), 2.52 (s, 3H, CH_3), 2.05~1.98 (m, 2H, CH_2), 1.83~1.65 (m, 2H, CH_2). ^{13}C NMR (101 MHz, $CDCl_3$) δ 196.1, 165.1, 159.5, 159.2, 157.6, 145.6, 144.7, 138.1, 137.3, 133.4, 131.7, 131.6, 130.9, 129.8, 129.0, 125.6, 124.5, 124.2, 121.4, 113.8, 104.8, 68.1, 55.4, 53.8, 52.87, 51.4, 29.6, 22.0, 22.0; IR (KBr) υ: 3299, 2951, 1739, 1686, 1647, 1575, 1511, 1489, 1459, 1345, 1322, 1271, 1188, 1149, 1064, 1030, 1009, 949, 885, 839, 804, 760 cm^{-1}; MS (*m*/*z*): HRMS (ESI) Calcd. for $C_{33}H_{29}BrN_2NaO_4$ ([M+Na]$^+$): 619.1203, found: 619.1210.



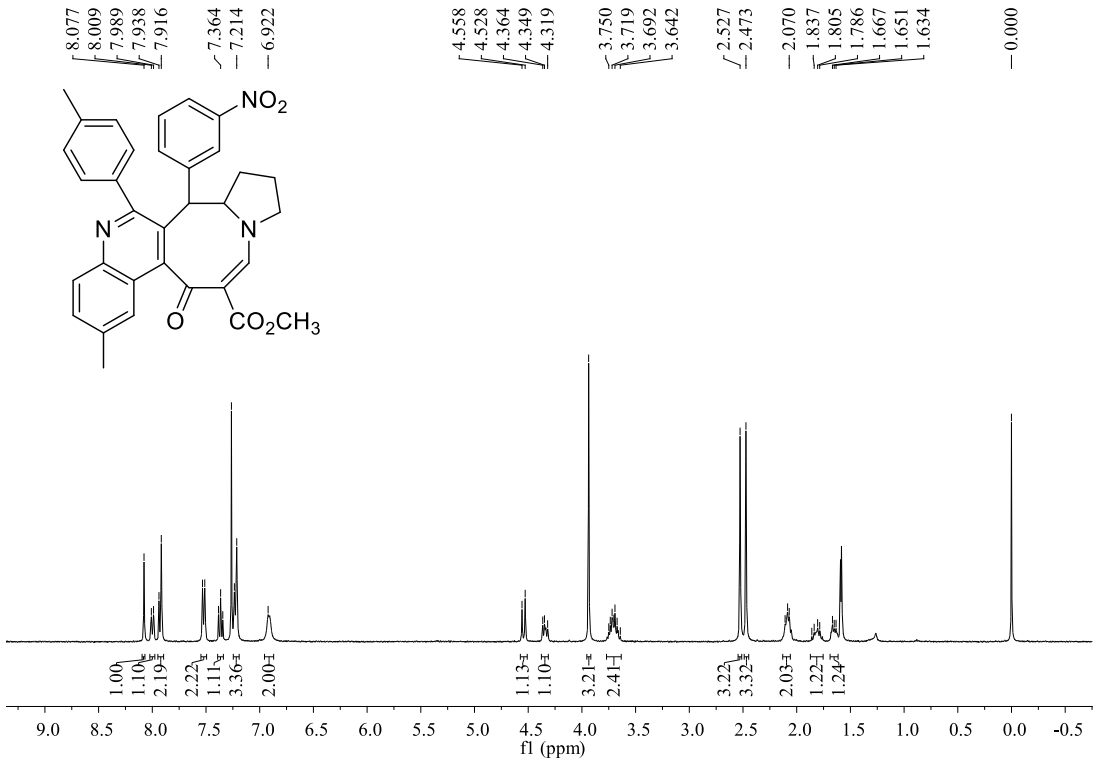

196.17
165.13
157.61
145.62
144.77
133.44
130.92
125.61
121.49
113.80
104.83
68.10
55.42
53.80
52.87
51.42
51.42
29.66
22.05
22.05
22.01
230
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

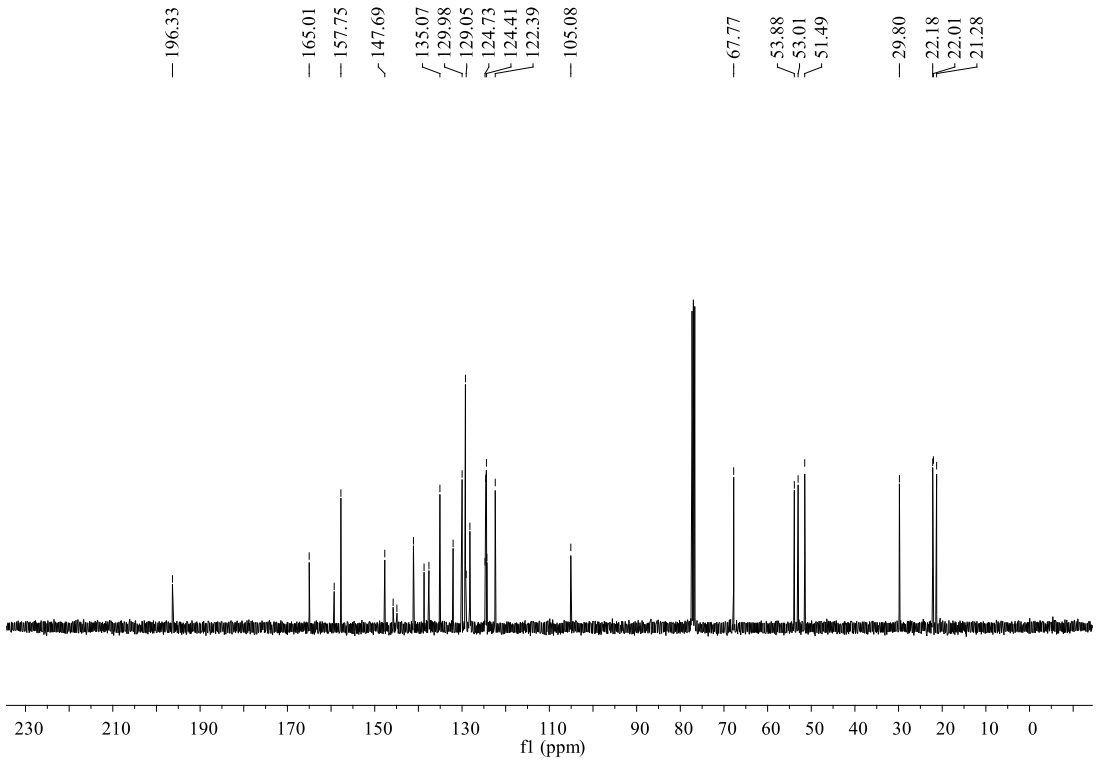

Intens.
x10^5
+MS, 0.02-0.19min #(1-11)
619.1210
620.1238
1.5
1.0
0.5
0.0
616.5
617.0
617.5
618.0
618.5
619.0
619.5
620.0
620.5
m/z

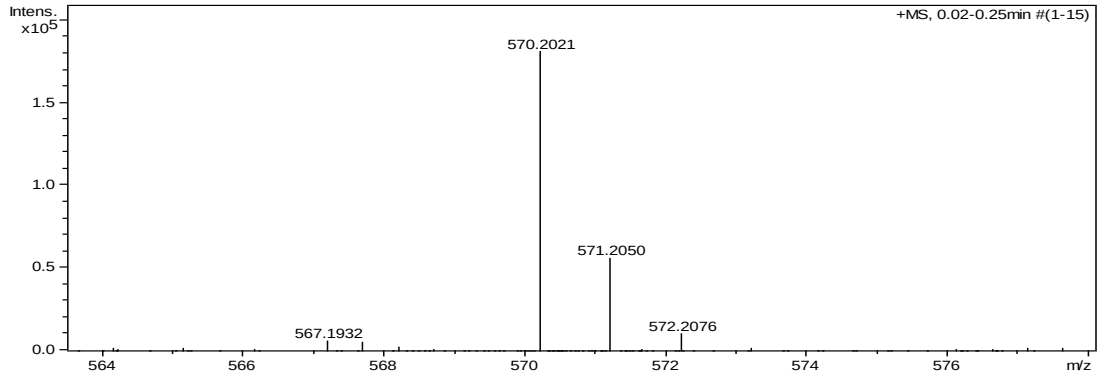
Methyl

(*E*)-5-methyl-14-(3-nitrophenyl)-7-oxo-1-(*p*-tolyl)-7,11,12,13,13a,14-hexahydropyrrolo[1',2':1,2]azocino[4,5-*c*]quinoline-8-carboxylate (1i):

yellow solid, 61%, m.p. 310~312℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.08 (s, 1H, CH), 8.00 (d, *J* = 8.0 Hz, 1H, ArH), 7.99~7.93 (m, 2H, ArH), 7.52 (d, *J* = 8.4 Hz, 2H,ArH), 7.36 (t, *J* = 8.0 Hz, 1H, ArH), 7.24~7.21 (m, 3H, ArH), 6.92 (s, 2H, ArH), 4.54 (d, *J* = 12.0 Hz, 1H, CH), 4.38~4.31 (m, 1H, CH), 3.94 (s, 3H, OCH_3), 3.77~3.63 (m, 2H, CH_2), 2.53 (s, 3H, CH_3), 2.47 (s, 3H, CH_3), 2.13~2.04 (m, 2H, CH_2), 2.12~2.07 (m, 1H, CH_2), 1.69~1.61 (m, 1H, CH_2); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 196.3, 165.0, 159.2, 157.7, 147.7, 145.7, 144.9, 141.1, 138.7, 137.5, 135.0, 132.0, 129.9, 129.2, 129.0, 128.2, 124.7, 124.5, 124.4, 124.3, 122.4, 105.1, 67.7, 53.9, 53.0, 51.4, 29.8, 22.2, 22.0, 21.3; IR (KBr) υ: 3302, 2923, 1684, 1652, 1579, 1531, 1459, 1436, 1350, 1270, 1188, 1151, 1063, 1047, 988, 958, 905, 877, 857,829, 806, 758, 734 cm^{-1}; MS (*m*/*z*): HRMS (ESI) Calcd. for $C_{33}H_{29}N_3NaO_5$ ($[M+Na]^+$): 570.1999, found: 570.2021.



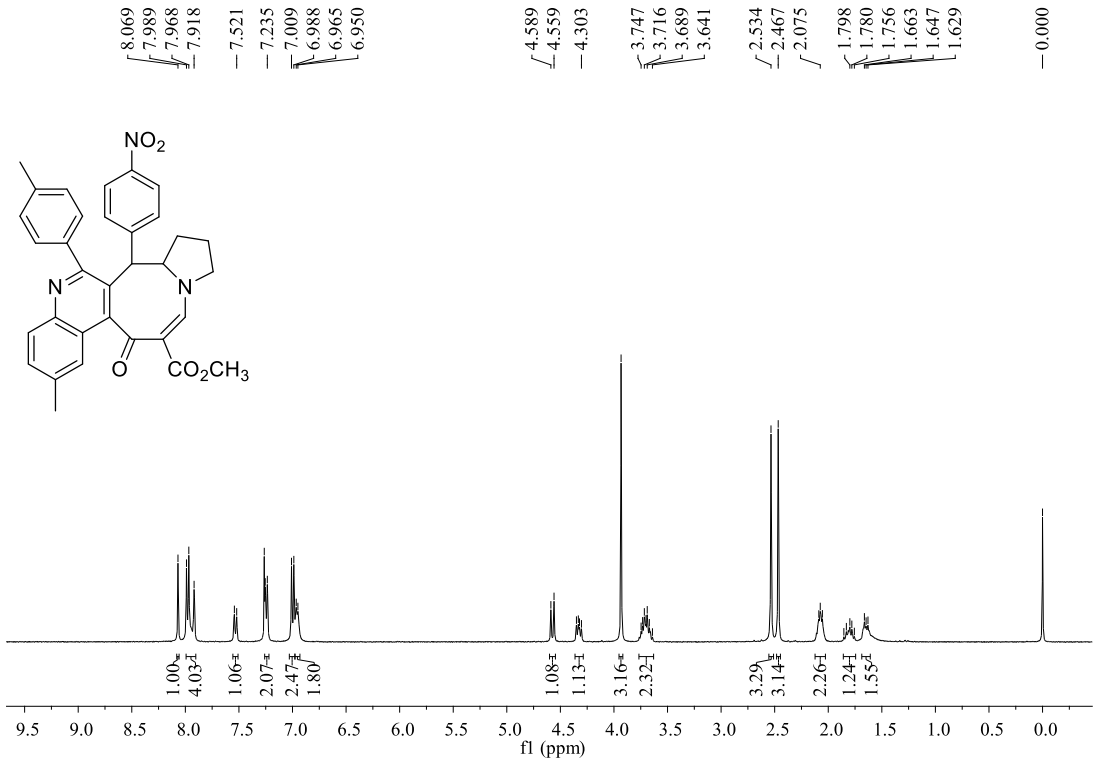

196.33
165.01
157.75
147.69
135.07
129.98
129.05
124.73
124.41
122.39
105.08
67.77
53.88
53.01
51.49
29.80
22.18
22.01
21.28
230
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

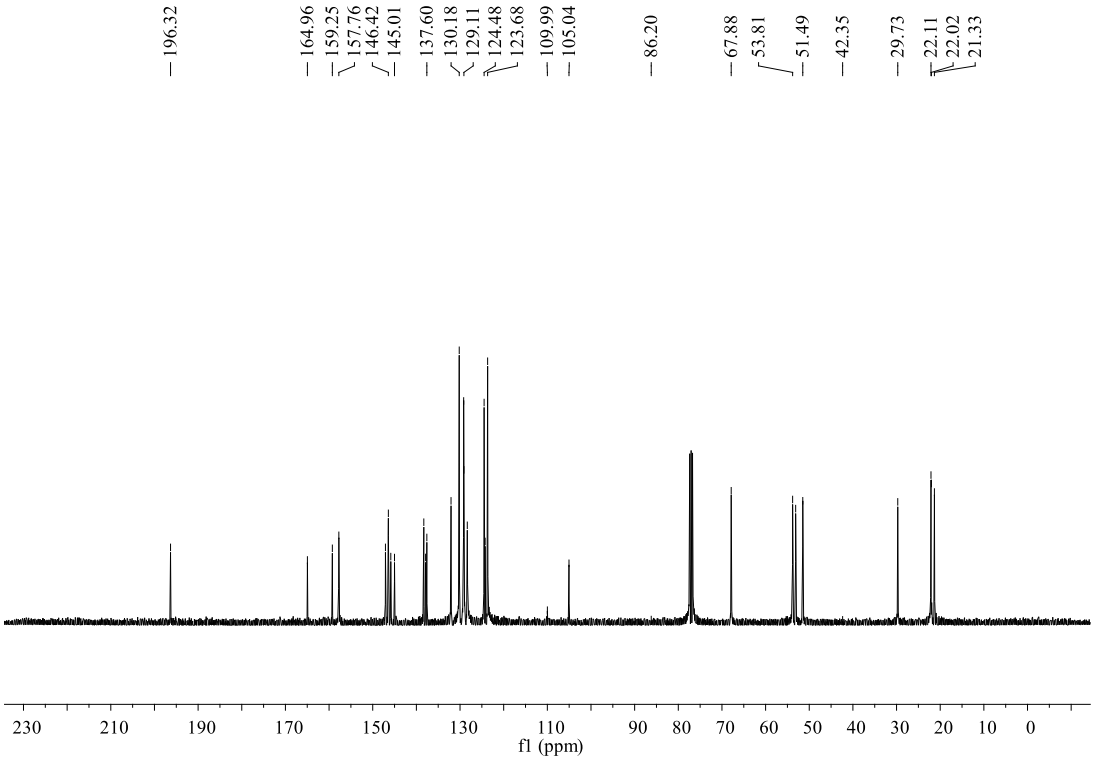

Intens.
x10^5
+MS, 0.02-0.25min #(1-15)
570.2021
571.2050
572.2076
567.1932
1.5
1.0
0.5
0.0
564
566
568
570
572
574
576
m/z

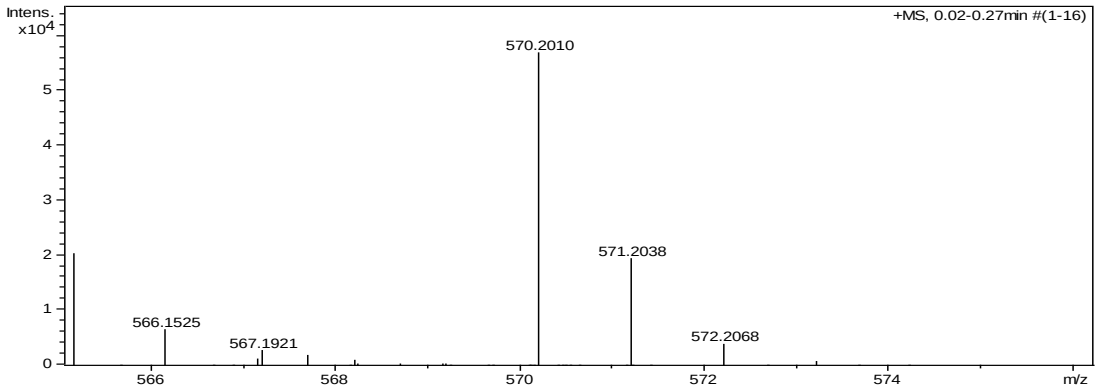
Methyl

(*E*)-5-methyl-14-(4-nitrophenyl)-7-oxo-1-(*p*-tolyl)-7,11,12,13,13a,14-hexahydropyrrolo[1',2':1,2]azocino[4,5-*c*]quinoline-8-carboxylate (1j):

yellow solid, 65%, m.p. 298~300℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.07 (s, 1H, CH), 7.99~7.90 (m, 4H, ArH), 7.53 (d, *J* = 8.4 Hz, 1H, ArH), 7.00 (d, *J* = 8.4 Hz, 2H, ArH), 7.24 (d, *J* = 8.0 Hz, 2H ArH), 6.96 (d, *J* = 6.0 Hz, 2H , ArH), 4.57 (d, *J* = 12.0 Hz, 1H, CH), 4.33 (dd, J_1 = 11.2 Hz, J_2 = 7.2 Hz, 1H, CH), 3.93 (s, 3H, OCH_3), 3.77~3.63 (m, 2H, CH_2), 2.53 (s, 3H, CH_3), 2.47 (s, 3H, CH_3), 2.12~2.03 (m, 2H, CH_2), 1.86~1.74 (m, 1H, CH_2), 1.69~1.61 (m, 2H, CH_2); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 196.3, 164.9, 159.2, 157.7, 147.0, 146.4, 145.8, 145.0, 138.2, 137.8, 137.6, 132.0, 130.1, 129.1, 129.1, 128.3, 124.4, 124.2, 123.6, 109.9, 105.0, 67.8, 53.8, 53.1, 51.4, 29.7, 22.1, 22.0, 21.3; IR (KBr) υ: 3440, 3298, 2948, 1710, 1584, 1523, 1460, 1433, 1346, 1324, 1272, 1188, 1150, 1063, 1019, 946, 889, 827, 810, 744 cm^{-1}; MS (*m*/*z*): HRMS (ESI) Calcd. for $C_{33}H_{29}N_3NaO_5$ ($[M+Na]^+$): 570.1999, found: 570.2010.



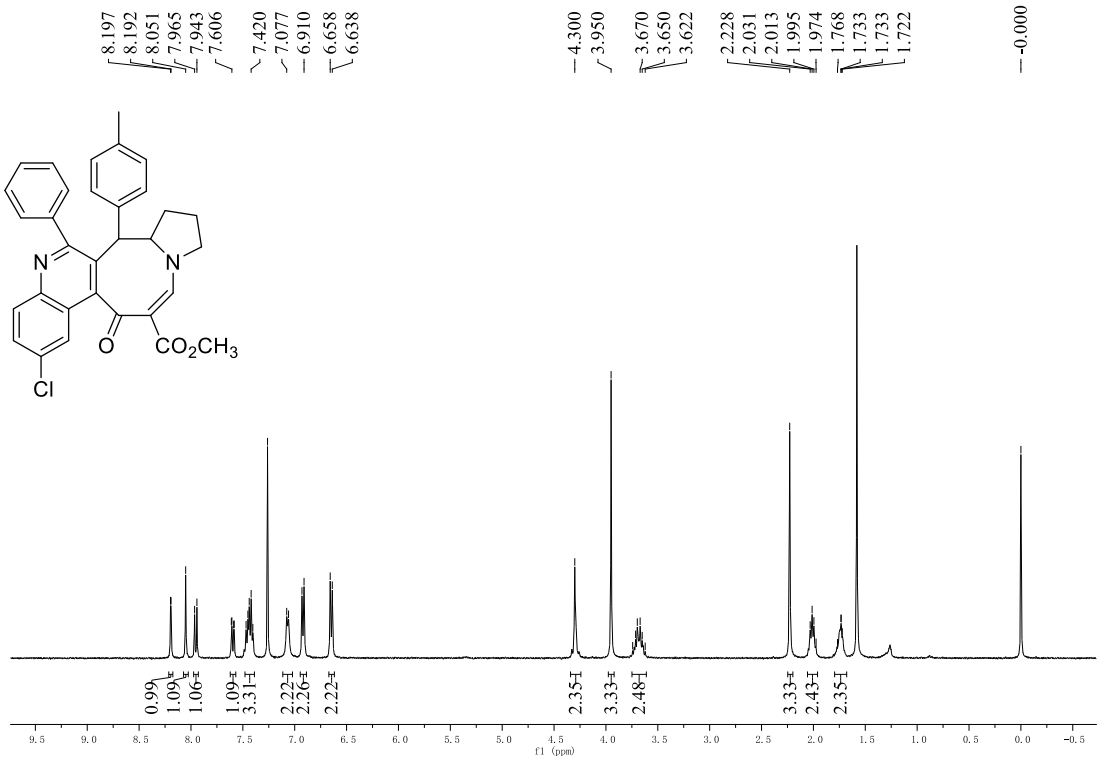

196.32
164.96
159.25
157.76
146.42
145.01
137.60
130.18
129.11
124.48
123.68
109.99
105.04
86.20
67.88
53.81
51.49
42.35
29.73
22.11
22.02
21.33
230
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

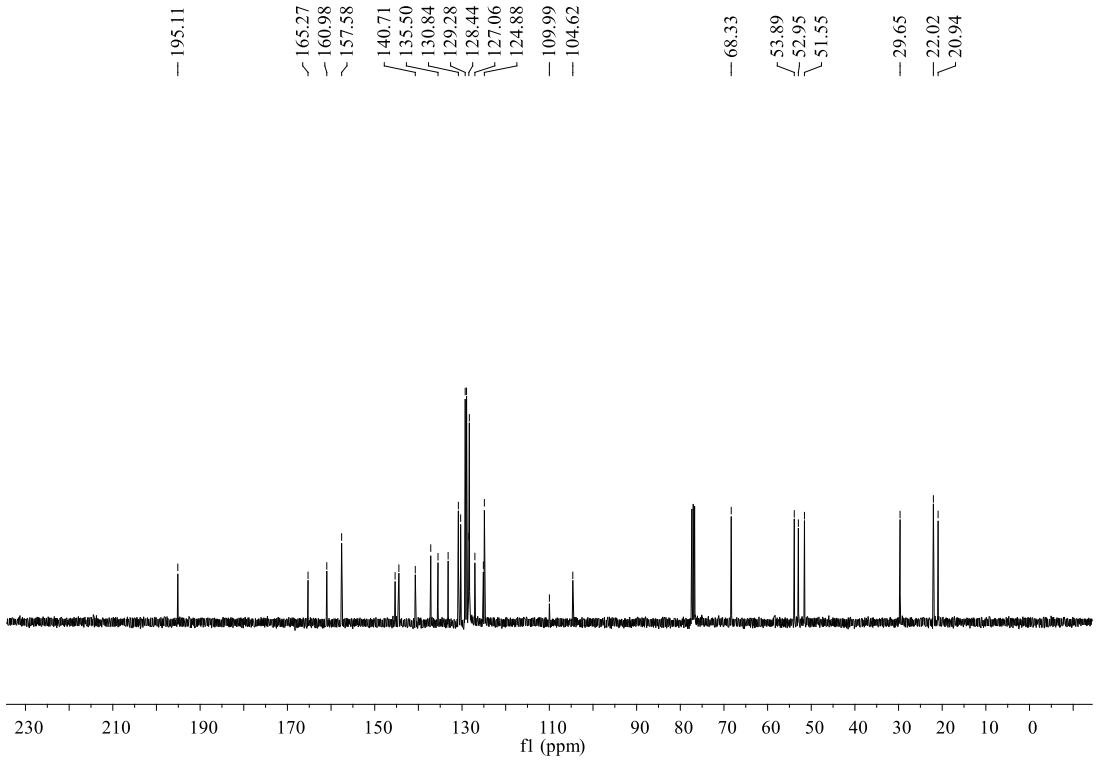

Intens.
x10^4
+MS, 0.02-0.27min #(1-16)
570.2010
571.2038
566.1525
567.1921
572.2068
566
568
570
572
574
m/z

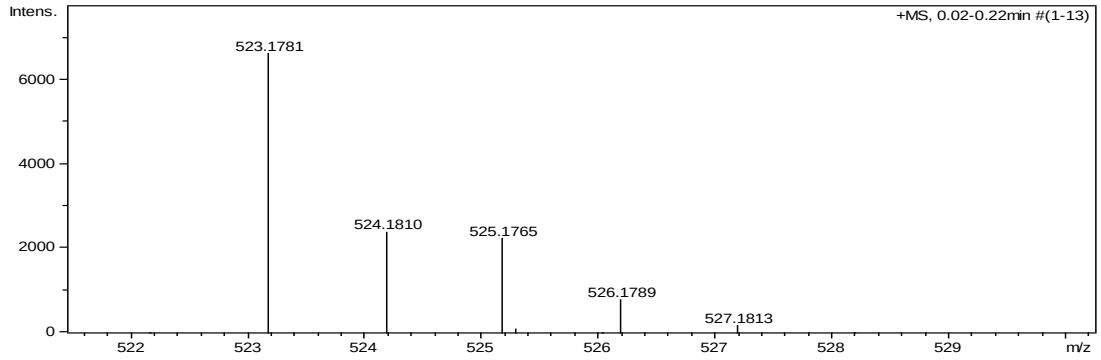
Methyl

(*E*)-5-chloro-7-oxo-1-phenyl-14-(*p*-tolyl)-7,11,12,13,13a,14-hexahydropyrrolo[1',2':1,2]azocino[4,5-*c*]quinoline-8-carboxylate (1k):

yellow solid, 55%, m.p. 231~233℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.19 (d, *J* = 2.0 Hz, 1H, ArH), 8.05 (s, 1H, CH), 7.95 (d, *J* = 8.8 Hz, 1H, ArH), 7.60 (dd, J_1 = 8.8 Hz, J_2 = 2.0 Hz, 1H, ArH), 7.45~7.40 (m, 3H, ArH), 7.07 (d, *J* = 7.2 Hz, 2H, ArH), 6.92 (d, *J* = 8.0 Hz, 2H, ArH), 6.65 (d, *J* = 8.0 Hz, 2H, ArH), 4.30 (s, 2H, CH), 3.95 (s, 3H ,OCH_3), 3.75~3.61 (m, 2H, CH_2), 2.23 (s, 3H , CH_3), 2.06~1.96 (m, 2H, CH_2), 1.77~1.72 (m, 2H, CH_2); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 195.1, 165.2, 160.9, 157.5, 145.3, 144.4, 140.7, 137.1, 135.5, 133.1, 130.8, 130.3, 129.2, 128.9, 128.4, 128.3, 127.0, 125.1, 124.8, 109.9, 104.6, 68.3, 53.8, 52.9, 51.5, 29.6, 22.0, 20.9; IR (KBr) υ: 3296, 2948, 2883, 1699, 1658, 1577, 1514, 1480, 1438, 1348, 1323, 1271, 1192, 1153, 1061, 1028, 981, 950, 886, 834, 807, 766, 728, 705 cm^{-1}; MS (*m*/*z*): HRMS (ESI) Calcd. for $C_{32}H_{28}ClN_2O_3$ ($[M+H]^+$): 523.1783, found: 523.1781.



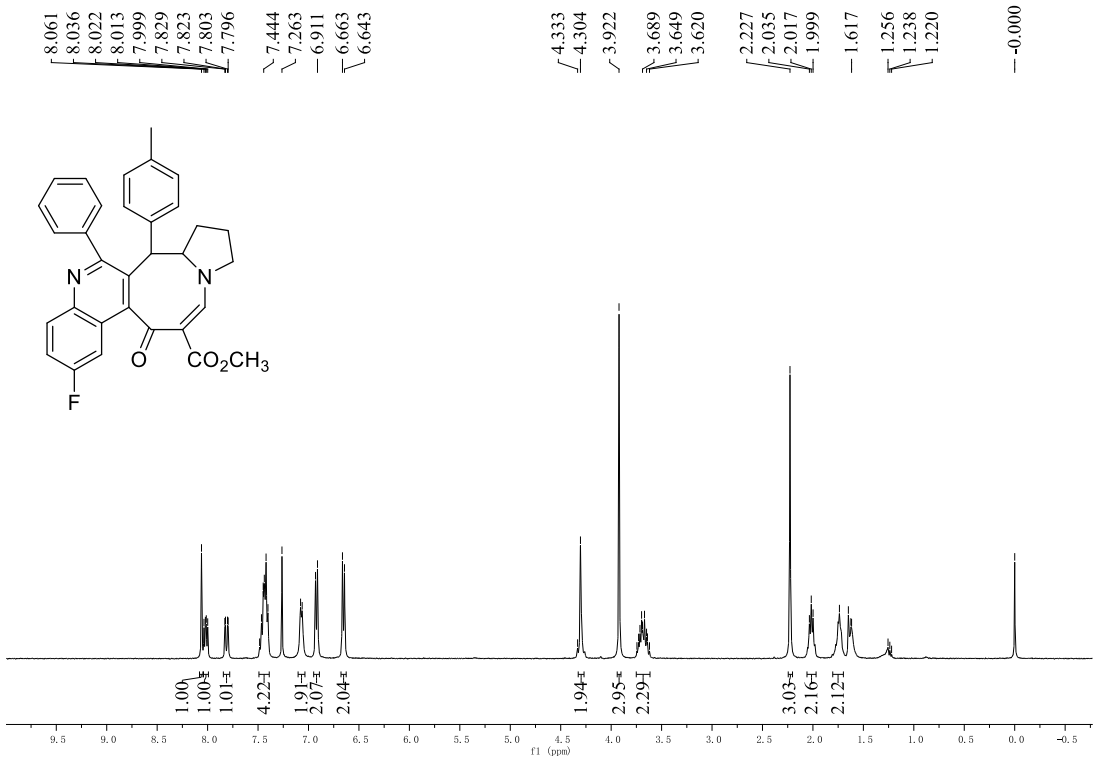

195.11
165.27
160.98
157.58
140.71
135.50
130.84
129.28
128.44
127.06
124.88
109.99
104.62
68.33
53.89
52.95
51.55
29.65
22.02
20.94
230
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

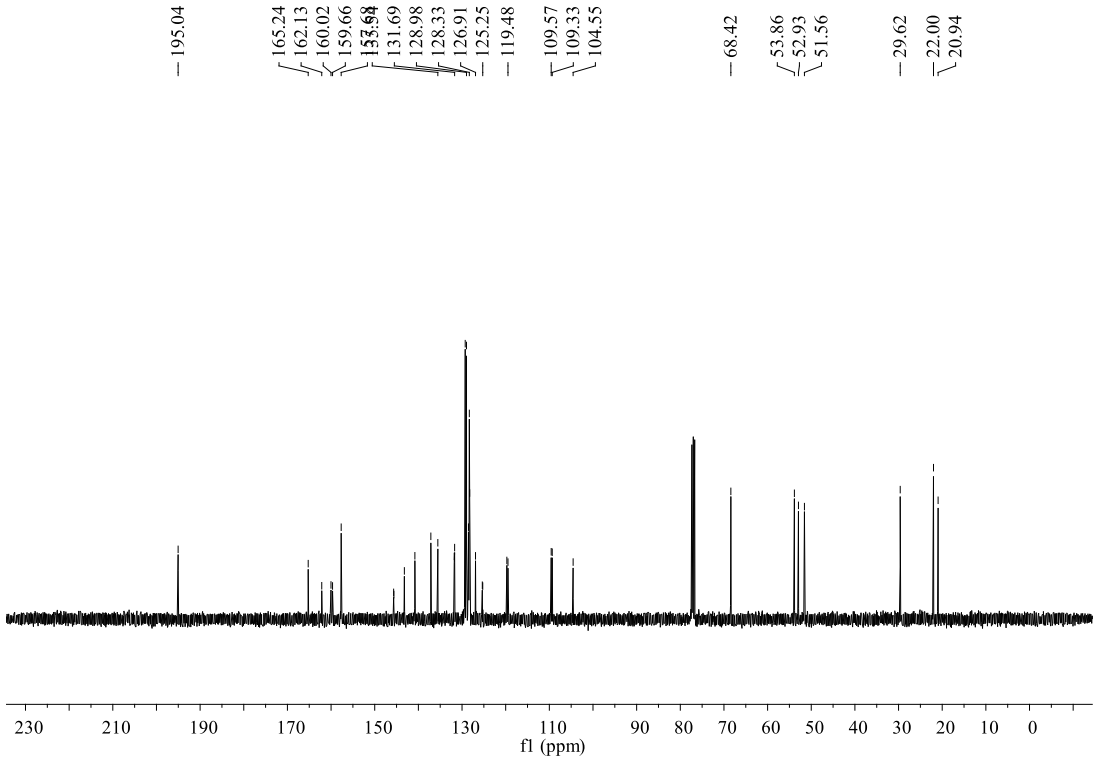

Intens.
+MS, 0.02-0.22min #(1-13)
523.1781
524.1810
525.1765
526.1789
527.1813
6000
4000
2000
0
522
523
524
525
526
527
528
529
m/z

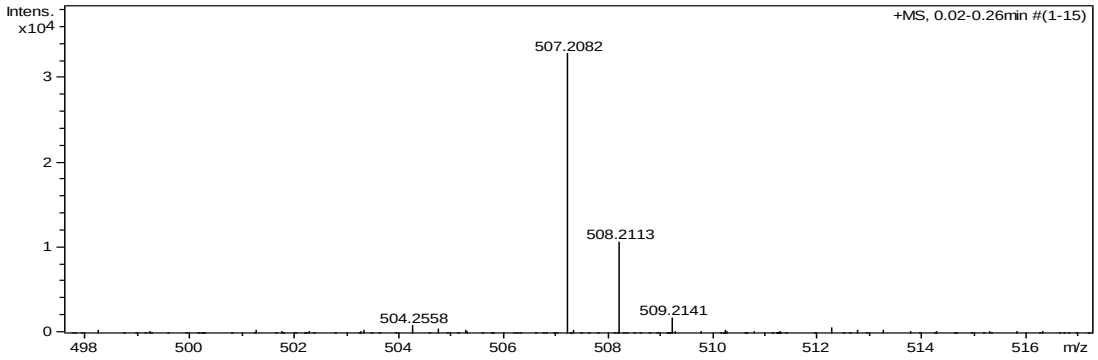
Methyl

(*E*)-5-fluoro-7-oxo-1-phenyl-14-(*p*-tolyl)-7,11,12,13,13a,14-hexahydropyrrolo[1',2':1,2]azocino[4,5-*c*]quinoline-8-carboxylate (1l):

yellow solid, 55%, m.p. 253~255℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.06 (s, 1H, CH), 8.02 (dd, *J* = 9.2 Hz, *J* = 5.6 Hz, 1H, ArH), 7.81 (dd, *J* = 10.4 Hz, *J* = 2.4 Hz, 1H, ArH), 7.49~7.39 (m, 4H, ArH), 7.07 (d, *J* = 6.4 Hz, 2H, ArH), 6.92 (d, *J* = 7.6 Hz, 2H, ArH), 6.65 (d, *J* = 8.0 Hz, 2H, ArH), 4.32 (d, *J* = 11.3 Hz, 2H, CH), 3.92 (s, 3H, OCH_3), 3.75~3.61 (m, 2H, CH_2), 2.23 (s, 3H, CH_3), 2.06~1.97 (m, 2H, CH_2), 1.74 (s, 2H, CH_2); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 195.0, 165.2, 162.1, 160.0, 159.6, 157.6, 145.6, 145.6, 143.2, 140.8, 137.1, 135.5, 131.7, 131.6, 129.2, 128.9, 128.5, 128.3, 128.2, 126.9, 125.3, 125.2, 119.7, 119.4, 109.5, 109.3, 104.5, 68.4, 53.8, 52.9, 51.5, 29.6, 22.0, 20.9; IR (KBr) υ: 3440, 3299, 3059, 2950, 1702, 1648, 1625, 1587, 1558, 1495, 1436, 1414, 1360, 1318, 1271, 1235, 1202, 1151, 1064, 1047, 1030, 983, 951, 916, 886, 834, 810, 761 cm^{-1}; MS (*m*/*z*): HRMS (ESI) Calcd. for $C_{32}H_{28}FN_2O_3$ ($[M+H]^+$): 507.2084, found: 507.2082.



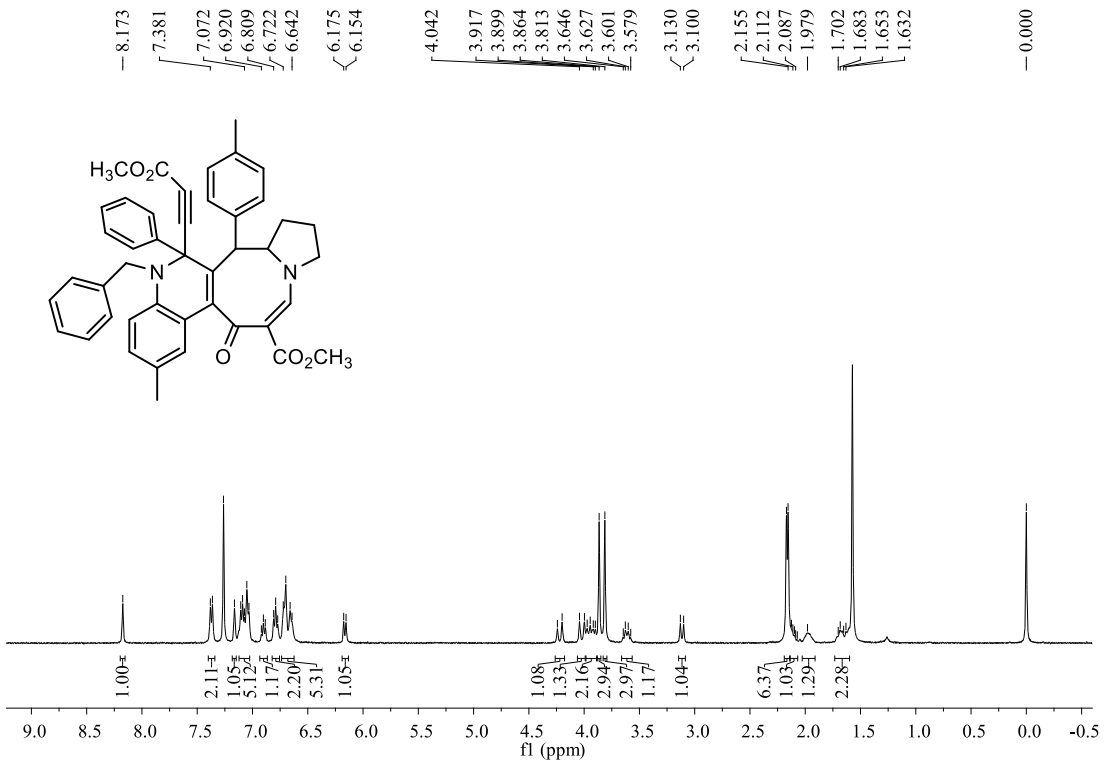

195.04
165.24
162.13
160.02
159.66
131.69
128.98
128.33
126.91
125.25
119.48
109.57
109.33
104.55
68.42
53.86
52.93
51.56
29.62
22.00
20.94
230
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

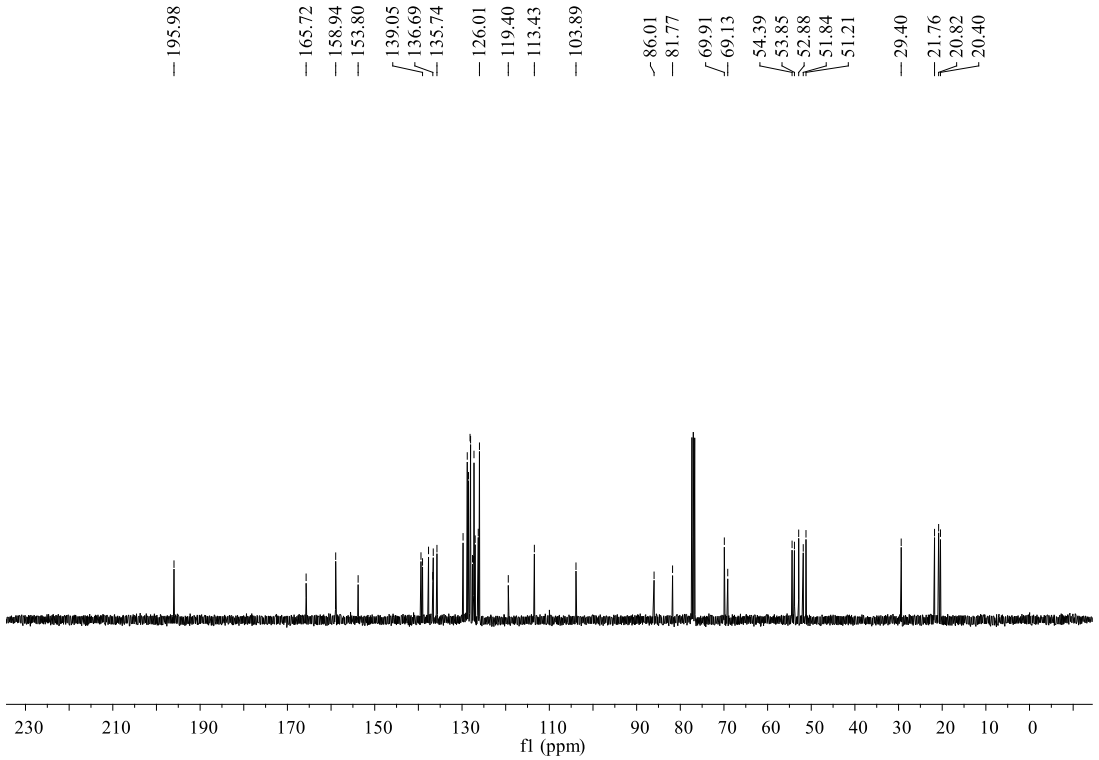

Intens.
x10^4
+MS, 0.02-0.26min #(1-15)
507.2082
508.2113
509.2141
504.2558
498
500
502
504
506
508
510
512
514
516
m/z

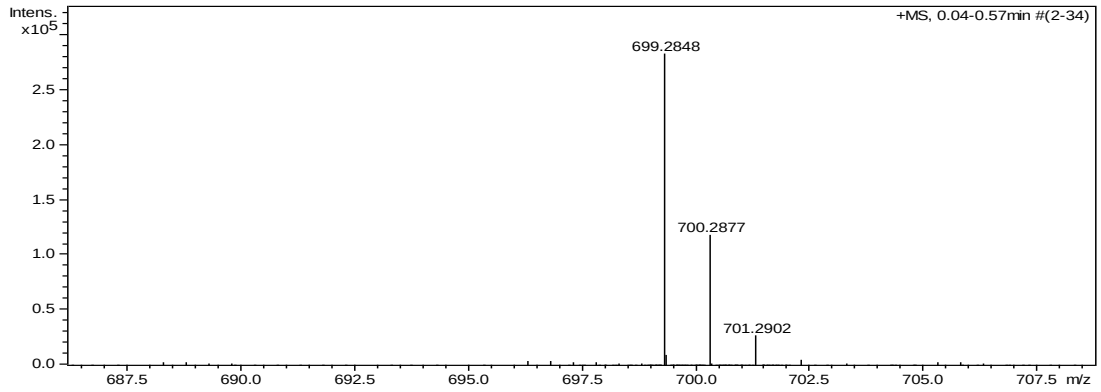
Methyl

(*E*)-2-benzyl-1-(3-methoxy-3-oxoprop-1-yn-1-yl)-5-methyl-7-oxo-1-phenyl-14-(*p*-tolyl)-1,2,7,11,12,13,13a,14-octahydropyrrolo[1',2':1,2]azocino[4,5-*c*]quinoline-8-carboxylate (2a):

yellow solid, 78%, m.p. 171~173℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.17 (s, 1H, CH), 7.37 (d, *J* = 7.6 Hz, 2H, ArH), 7.16 (s, 1H, ArH), 7.12~7.03 (m, 5H, ArH), 6.89 (t, *J* = 7.2 Hz, 1H, ArH), 6.79 (t, *J* = 7. 2 Hz, 2H, ArH), 6.72~6.64 (m, 5H, ArH), 6.16 (d, *J* = 8.4 Hz, 1H, ArH), 4.22 (d, *J* = 17.2 Hz, 1H, CH_2), 4.02 (d, *J* = 18.0 Hz, 1H, CH_2), 3.97~3.89 (m, 2H, CH_2), 3.86 (s, 3H, OCH_3), 3.81 (s, 3H, OCH_3), 3.61 (dd, J_1 = 19.0 Hz, J_2 = 8.6 Hz, 1H, CH), 3.11 (d, *J* = 12.0 Hz, 1H, CH), 2.16 (s, 6H, CH_3), 2.112~2.07(m, 1H, CH_2), 1.98 (s, 1H, CH_2), 1.70-1.63 (m, 2H, CH_2); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 195.9, 165.7, 158.9, 153.8, 139.4, 139.0, 137.6, 136.6, 136.5, 135.7, 129.7, 128.8, 128.5, 128.1, 128.0, 127.6, 127.3, 127.2, 126.9, 126.2, 126.0, 119.4, 113.4, 103.9, 86.0, 81.7, 69.9, 69.1, 54.39, 53.8, 52.8, 51.8, 51.2, 29.4, 21.7, 20.8, 20.4; IR (KBr) υ: 3302, 3002, 2949, 2218, 1711, 1683, 1646, 1606, 1568, 1506, 1456, 1433, 1347, 1249, 1175, 1146, 1118, 1028, 946, 865, 835, 799, 786, 744, 723 cm^{-1}; MS (*m*/*z*): HRMS (ESI) Calcd. for $C_{44}H_{40}N_2NaO_5$ ($[M+Na]^+$): 699.2829, found: 699.2848.



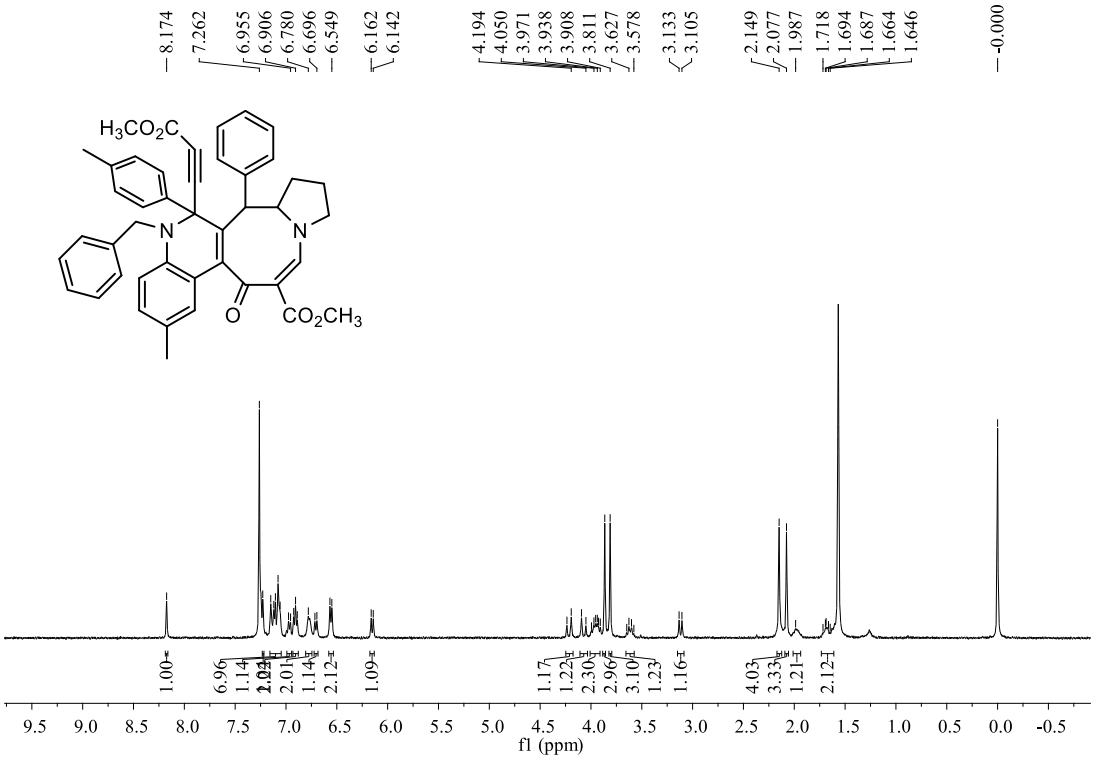

195.98
165.72
158.94
153.80
139.05
136.69
135.74
126.01
119.40
113.43
103.89
86.01
81.77
69.91
69.13
54.39
53.85
52.88
51.84
51.21
29.40
21.76
20.82
20.40
230
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

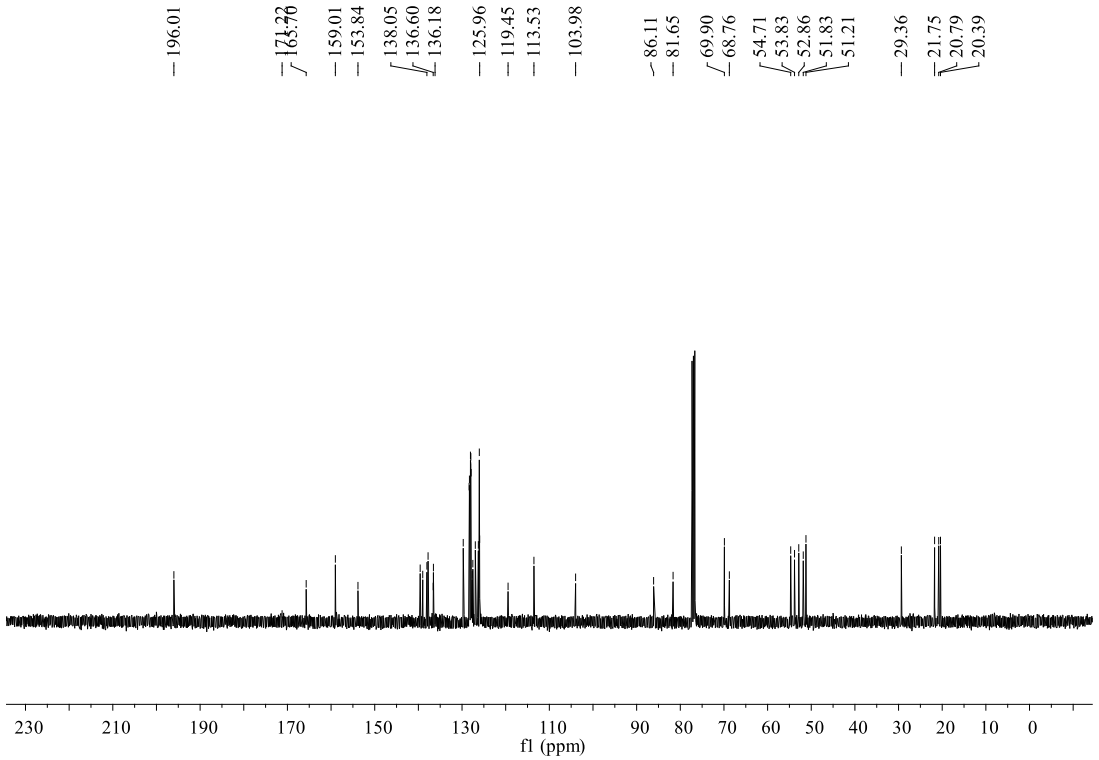

Intens.
x10^5
+MS, 0.04-0.57min #(2-34)
699.2848
700.2877
701.2902
2.5
2.0
1.5
1.0
0.5
0.0
687.5
690.0
692.5
695.0
697.5
700.0
702.5
705.0
707.5
m/z

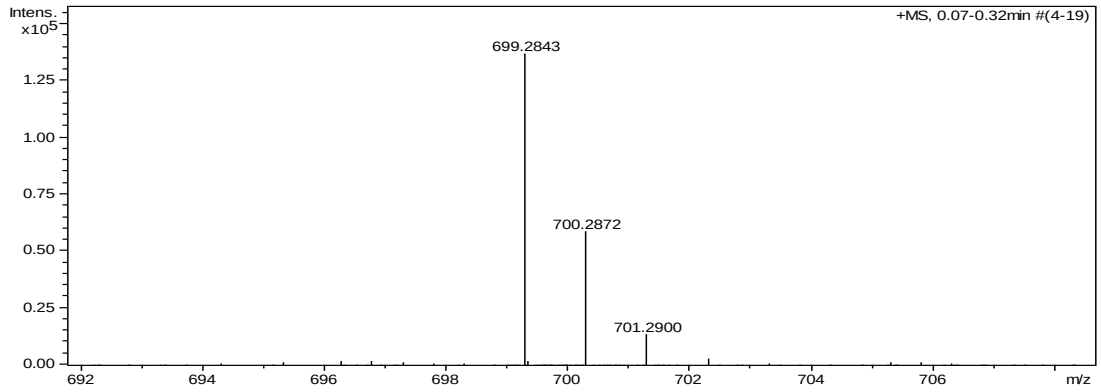
Methyl

(*E*)-2-benzyl-1-(3-methoxy-3-oxoprop-1-yn-1-yl)-5-methyl-7-oxo-14-phenyl-1-(*p*-tolyl)-1,2,7,11,12,13,13a,14-octahydropyrrolo[1',2':1,2]azocino[4,5-*c*]quinoline-8-carboxylate (2b):

yellow solid, 82%, m.p. 170~172℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.17 (s, 1H, CH), 7.23 (s, 1H, ArH), 7.15~7.06 (m, 7H, ArH), 6.97 (d, *J* = 8.0 Hz, 1H, ArH), 6.91 (t, *J* = 7.2 Hz, 2H, ArH), 6.78 (s, 2H, ArH), 6.71 (d, *J* = 8.0 Hz, 1H, ArH), 6.56 (d, *J* = 7.6 Hz, 2H, ArH), 6.15 (d, *J* = 8.0 Hz, 1H, ArH), 4.22 (d, *J* = 16.8 Hz, 1H, CH_2), 4.07 (d, *J* = 17.2 Hz, 1H, CH_2), 4.01~3.90 (m, 2H, CH_2), 3.86 (s, 3H, OCH_3), 3.81 (s, 3H, OCH_3), 3.61 (dd, J_1 = 19.1, J_2 = 9.0 Hz, 1H, CH), 3.12 (d, *J* = 11.2 Hz, 1H, CH), 2.15 (s, 4H, CH_3, CH_2), 2.08 (s, 3H, CH_2), 1.99 (s, 1H, CH_2), 1.72~1.65(m, 2H, CH_2); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 196.0, 171.2, 165.7, 162.8, 159.0, 153.8, 139.5, 139.0, 138.0, 137.7, 136.6, 136.5, 136.1, 129.7, 128.3, 128.3, 128.0, 127.9, 127.9, 127.6, 127.5, 126.9, 126.2, 126.0, 125.9, 119.4, 113.5, 103.9, 86.1, 81.6, 69.9, 68.7, 54.7, 53.8, 52.8, 51.8, 51.2, 29.3, 21.7, 20.7, 20.3; IR (KBr) υ: 3300, 2951, 2221, 1735, 1710, 1681, 1575, 1502, 1437, 1348, 1247, 1193, 1149, 1043, 1021, 944, 918, 810, 786, 747 cm^{-1}; MS (*m*/*z*): HRMS (ESI) Calcd. for $C_{44}H_{40}N_2NaO_5$ ($[M+Na]^+$): 699.2829, found: 699.2843.



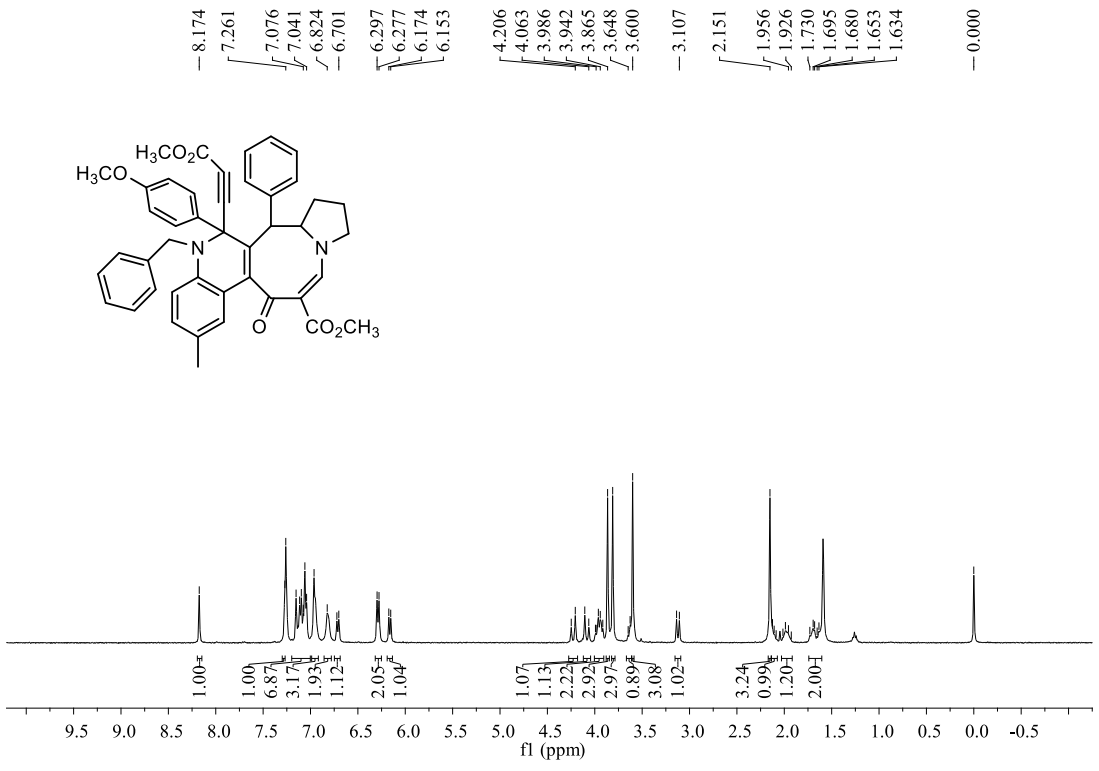

196.01
171.22
165.70
159.01
153.84
138.05
136.60
136.18
125.96
119.45
113.53
103.98
86.11
81.65
69.90
68.76
54.71
53.83
52.86
51.83
51.21
29.36
21.75
20.79
20.39
230
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

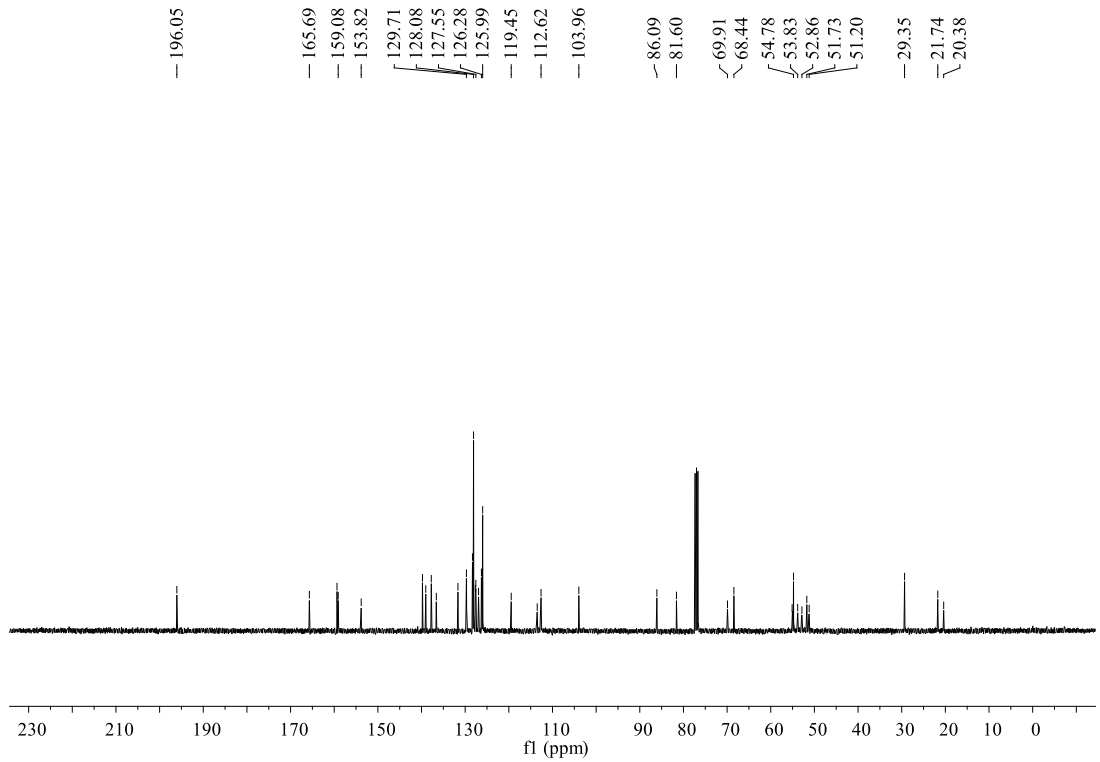

Intens.
x10^5
+MS, 0.07-0.32min #(4-19)
699.2843
700.2872
701.2900
1.25
1.00
0.75
0.50
0.25
0.00
692
694
696
698
700
702
704
706
m/z

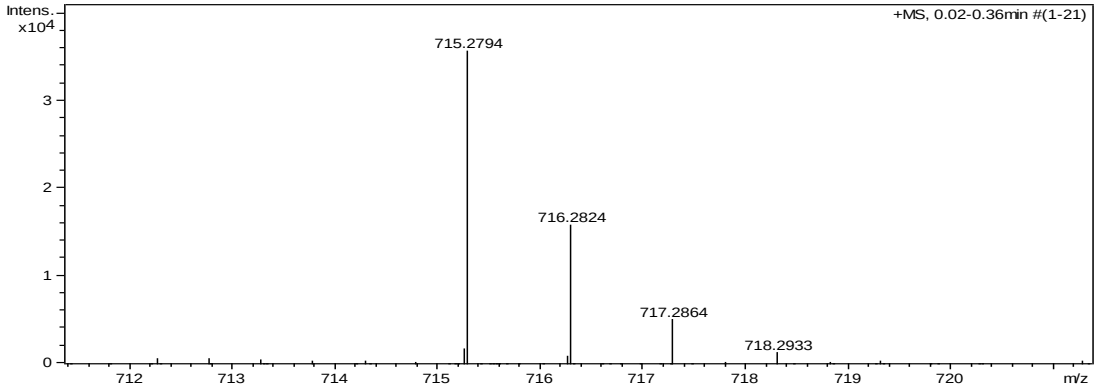
Methyl

(*E*)-2-benzyl-1-(3-methoxy-3-oxoprop-1-yn-1-yl)-1-(4-methoxyphenyl)-5-methyl-7-oxo-14-phenyl-1,2,7,11,12,13,13a,14-octahydropyrrolo[1',2':1,2]azocino[4,5-*c*]quinoline-8-carboxylate (2c):

yellow solid, 84%, m.p. 233~235℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.17 (s, 1H, CH), 7.27 (s, 1H, ArH), 7.20~7.00 (m, 7H, ArH), 6.96 (s, 3H, ArH), 6.82 (s, 2H, ArH), 6.71 (d, *J* = 8.4 Hz, 1H, ArH), 6.29 (d, *J* = 8.0 Hz, 2H, ArH), 6.16 (d, *J* = 8.4 Hz, 1H, ArH), 4.23 (d, *J* = 16.8 Hz, 1H, CH_2), 4.08 (d, *J* = 16.8 Hz, 1H, CH_2), 4.00~3.90 (m, 2H, CH_2), 3.86 (s, 3H, OCH_3), 3.81 (s, 3H, OCH_3), 3.65~3.63 (m, 1H, CH), 3.60 (s, 3H, OCH_3), 3.12 (d, *J* = 12.0 Hz, 1H, CH), 2.15 (s, 3H, CH_3), 2.14~2.07 (m, 1H, CH_2), 2.04~1.94 (m, 1H, CH_2), 1.74~1.60 (m, 1H, CH_2); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 196.0, 165.6, 159.3, 159.0, 153.8, 139.7, 139.0, 137.7, 136.6, 131.6, 129.7, 128.3, 128.1, 127.7, 127.5, 126.9, 126.2, 126.1, 125.9, 119.5, 113.5, 112.6, 103.9, 86.0, 81.6, 69.9, 68.4, 55.1, 54.8, 53.8, 52.8, 51.7, 51.2, 29.3, 21.7, 20.3; IR (KBr) υ: 3299, 3084, 2222, 1712, 1571, 1502, 1454, 1347, 1259, 1194, 1145, 1043, 944, 822, 751 cm^{-1}; MS (*m*/*z*): HRMS (ESI) Calcd. for $C_{45}H_{42}N_2NaO_6$ ($[M+Na]^+$): 715.2779, found: 715.2794.



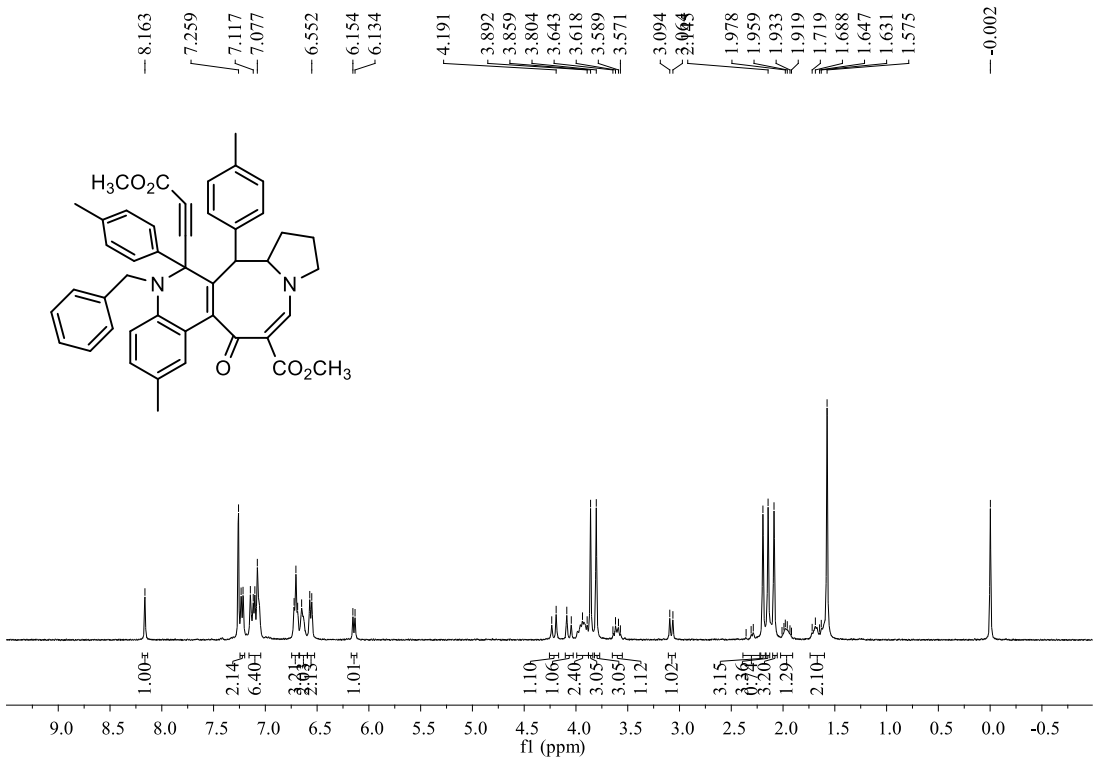

196.05
165.69
159.08
153.82
129.71
128.08
127.55
126.28
125.99
119.45
112.62
103.96
86.09
81.60
69.91
68.44
54.78
53.83
52.86
51.73
51.20
29.35
21.74
20.38
230
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

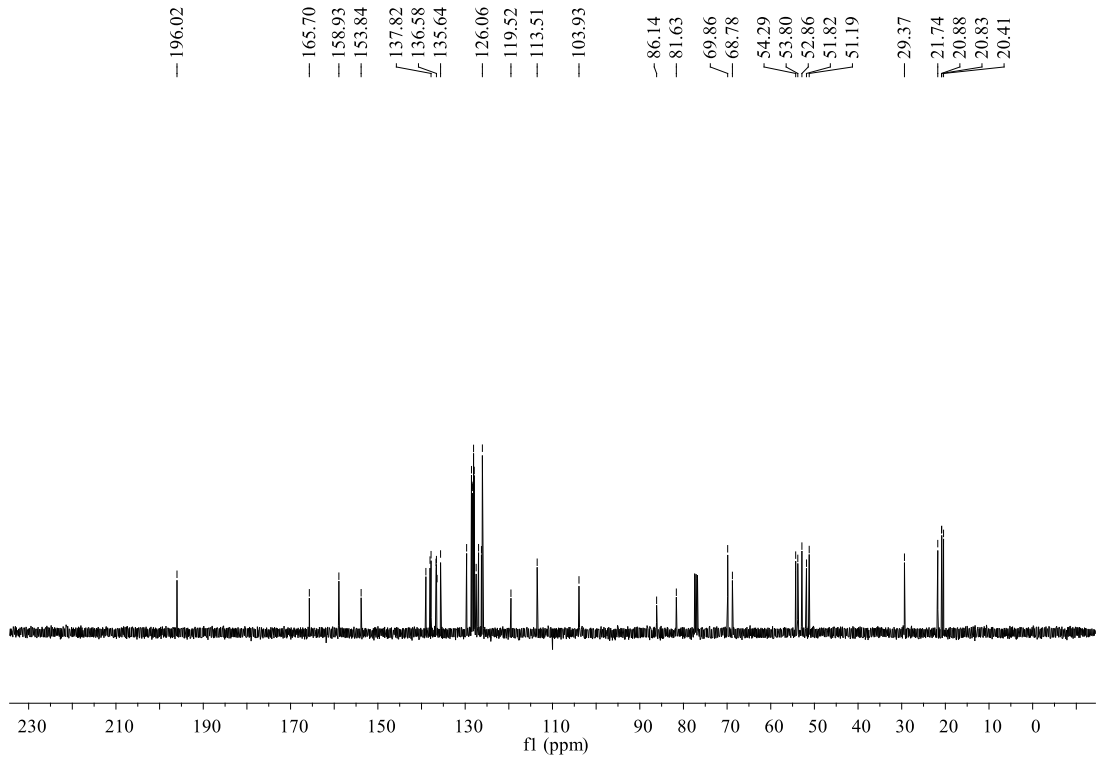

Intens.
x10^4
+MS, 0.02-0.36min #(1-21)
715.2794
716.2824
717.2864
718.2933
0
1
2
3
712
713
714
715
716
717
718
719
720
m/z

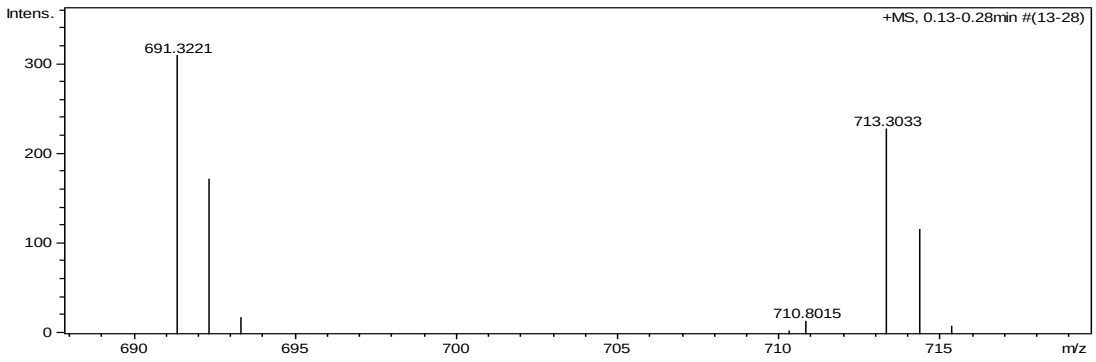
Methyl

(*E*)-2-benzyl-1-(3-methoxy-3-oxoprop-1-yn-1-yl)-5-methyl-7-oxo-1,14-di-p-tolyl-1,2,7,11,12,13,13a,14-octahydropyrrolo[1',2':1,2]azocino[4,5-*c*]quinoline-8-carboxylate (2d):

yellow solid, 70%, m.p. 165~167℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.16 (s, 1H, CH), 7.22 (d, *J* = 7.6 Hz, 2H, ArH), 7.14~7.08 (m, 6H, ArH), 6.71 (t, J= 6.8 Hz, 3H, ArH), 6.65 (s, 2H, ArH), 6.56 (d, *J* = 7.6 Hz, 2H), 6.14 (d, *J* = 8.0 Hz, 1H, ArH), 4.21 (d, *J* = 17.2 Hz, 1H, CH_2), 4.07 (d, *J* = 17.6 Hz, 1H, CH_2), 3.98~3.86 (m, 2H, CH_2), 3.86 (s, 3H, OCH_3), 3.80 (s, 3H, OCH_3), 3.64~3.57 (m, 1H, CH), 3.08 (d, *J* = 12.0 Hz, 1H, CH), 2.36~2.29 (m, 1H, CH_2), 2.19 (s, 3H, CH_3), 2.14 (s, 3H, CH_3), 2.09 (s, 3H, CH_3), 2.01~1.92 (m, 1H, CH_2), 1.72~1.57 (m, 1H, CH_2); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 196.0, 165.7, 159.0, 153.8, 138.9, 138.0, 137.82, 136.6, 136.5, 136.4, 135.6, 129.6, 128.5, 128.3, 128.2, 128.1, 127.9, 127.8, 127.5, 126.9, 126.3, 126.0, 119.5, 113.5, 109.9,103.9, 86.1, 81.6, 69.9, 68.7, 54.2, 53.8, 52.9, 51.8, 51.2, 29.3, 21.7, 20.9, 20.8, 20.4; IR (KBr) υ: 3550, 3480, 3415, 2945, 2217, 1709, 1579, 1503, 1425, 1332, 1261, 1149, 1037, 948, 885, 803, 753, 723 cm^{-1}; MS (*m*/*z*): HRMS (ESI) Calcd. for $C_{45}H_{42}N_2NaO_5$ ($[M+Na]^+$): 713.2986, found: 713.3033.




196.02
165.70
158.93
153.84
137.82
136.58
135.64
126.06
119.52
113.51
103.93
86.14
81.63
69.86
68.78
54.29
53.80
52.86
51.82
51.19
29.37
21.74
20.88
20.83
20.41
230
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

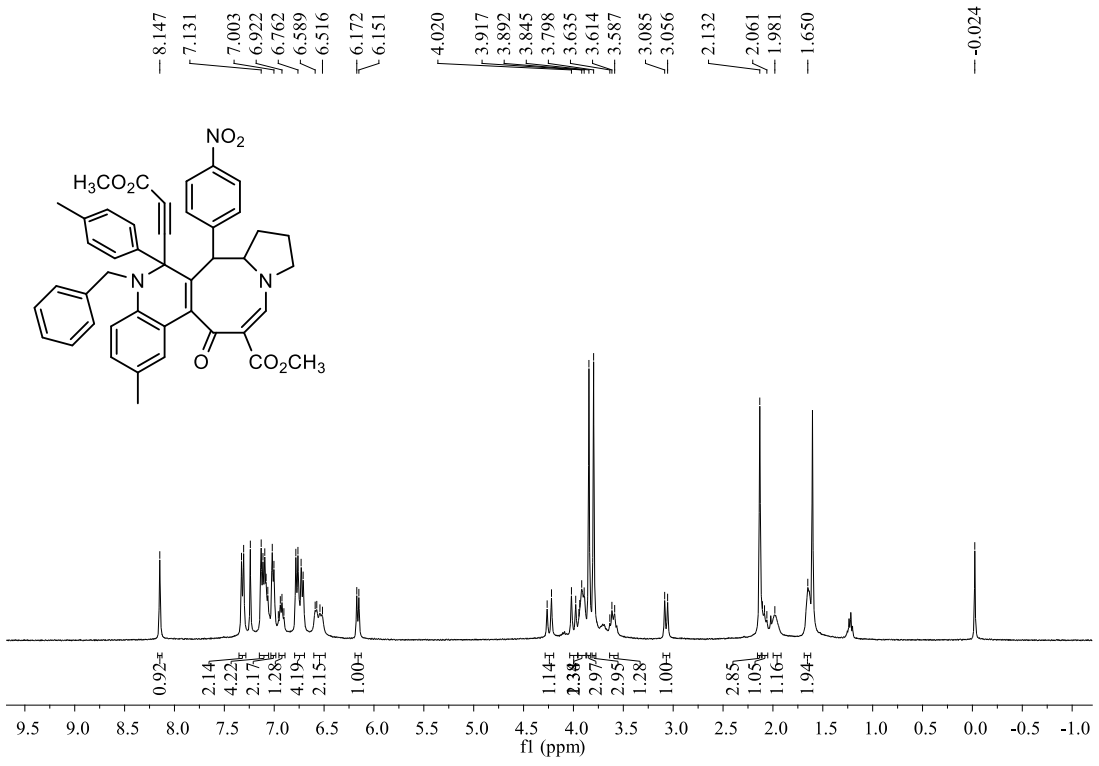

Intens.
+MS, 0.13-0.28min #(13-28)
691.3221
713.3033
710.8015
300
200
100
0
690
695
700
705
710
715
m/z

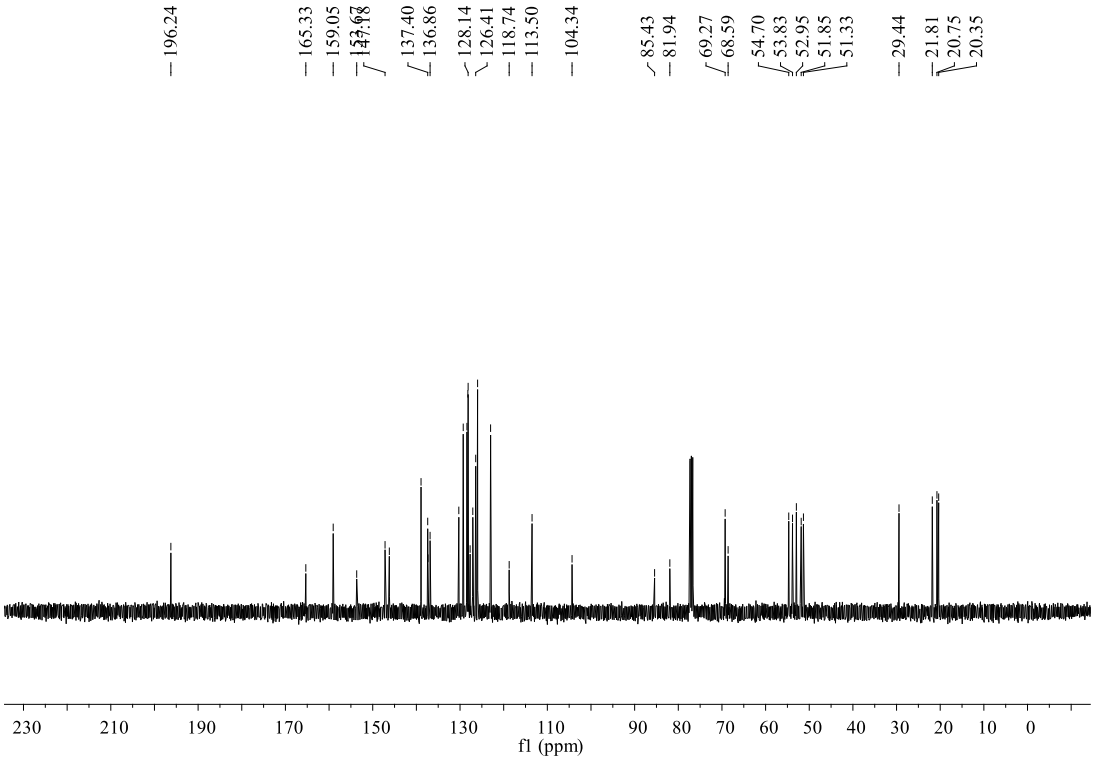
Methyl

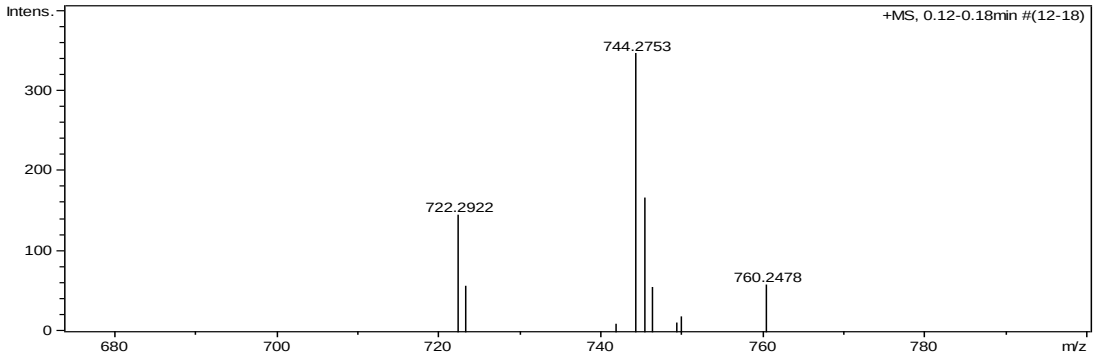
(*E*)-2-benzyl-1-(3-methoxy-3-oxoprop-1-yn-1-yl)-5-methyl-14-(4-nitrophenyl)-7-oxo-1-(*p*-toly l)-1,2,7,11,12,13,13a,14-octahydropyrrolo[1',2':1,2]azocino[4,5-*c*]quinoline-8-carboxylate

(2e):

yellow solid, 59%, m.p. 232~234℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.15 (s, 1H, CH), 7.32 (d, *J* = 8.8 Hz, 2H, ArH), 7.13~7.06 (m, 4H, ArH), 7.01 (d, *J* = 6.8 Hz, 2H, ArH), 6.95~6.89 (m, 1H, ArH), 6.75 (dd, *J* = 16.8 Hz, *J* = 8.0 Hz, 4H, ArH), 6.60-6.52 (m, 2H, ArH), 6.16 (d, *J* = 8.4 Hz, 1H, ArH), 4.24 (d, *J* = 17.6 Hz, 1H, CH_2), 4.00 (d, *J* = 17.2 Hz, 1H, CH_2), 3.92 (s, 2H, CH_2), 3.84 (s, 3H, OCH_3), 3.80 (s, 3H, OCH_3), 3.64~3.55 (m, 1H, CH), 3.07 (d, *J* = 11.6 Hz, 1H, CH), 2.13 (s, 3H, CH_3), 2.11~2.05 (m, 1H, CH_2), 1.98 (s, 1H, CH_2), 1.65 (s, 2H, CH_2); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 196.2, 165.3, 159.0, 153.6, 147.1, 146.2, 138.9, 137.4, 137.3, 136.8, 130.2, 129.2, 128.4, 128.2, 128.1, 127.6, 127.0, 126.4, 125.9, 123.0, 118.7, 113.5, 104.3, 85.4, 81.9, 69.2, 68.5, 54.70, 53.8, 52.9, 51.8, 51.3, 29.4, 21.8, 20.7, 20.3; IR (KBr) υ: 3549, 3477, 3412, 2950, 2879, 2227, 1913, 1711, 1648, 1580, 1514, 1416, 1350, 1252, 1176, 1138, 1036, 943, 854, 811, 753, 731 cm^{-1}; MS (*m*/*z*): HRMS (ESI) Calcd. for $C_{44}H_{39}N_3NaO_7$ ([M+Na]$^+$): 744.2680, found: 744.2753.




196.24
165.33
159.05
153.67
147.18
137.40
136.86
128.14
126.41
118.74
113.50
104.34
85.43
81.94
69.27
68.59
54.70
53.83
52.95
51.85
51.33
29.44
21.81
20.75
20.35
230
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

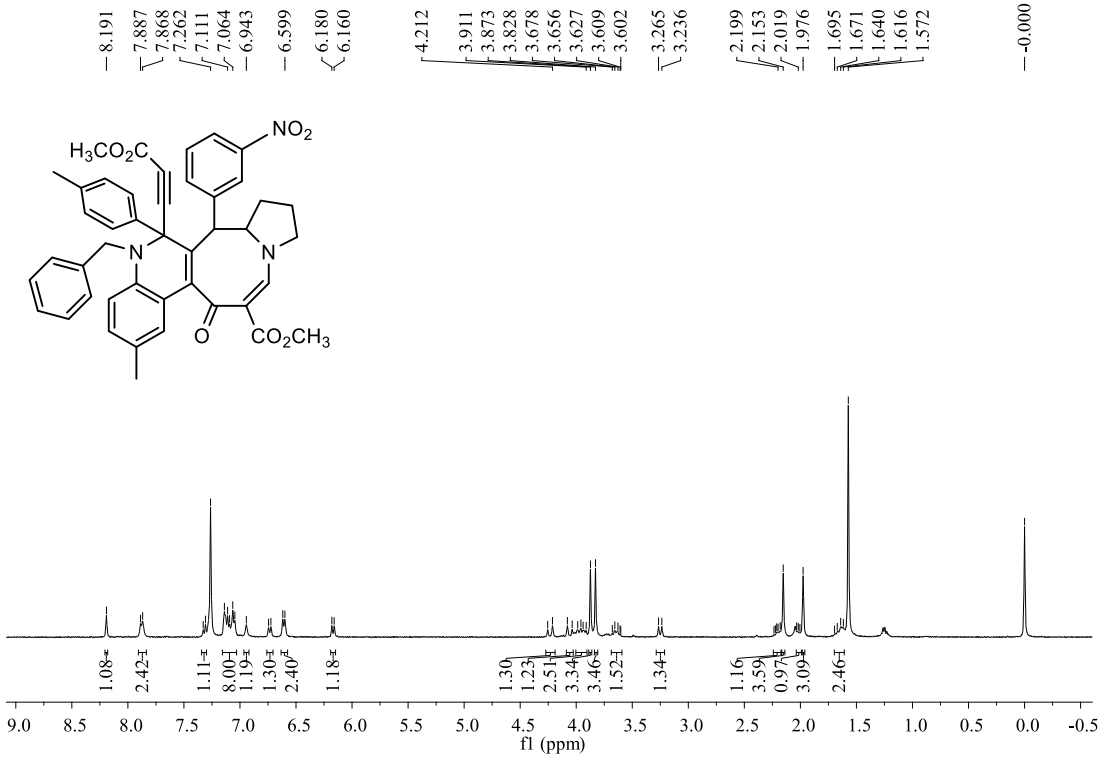

Intens.
+MS, 0.12-0.18min #(12-18)
744.2753
722.2922
760.2478
300
200
100
0
680
700
720
740
760
780
m/z

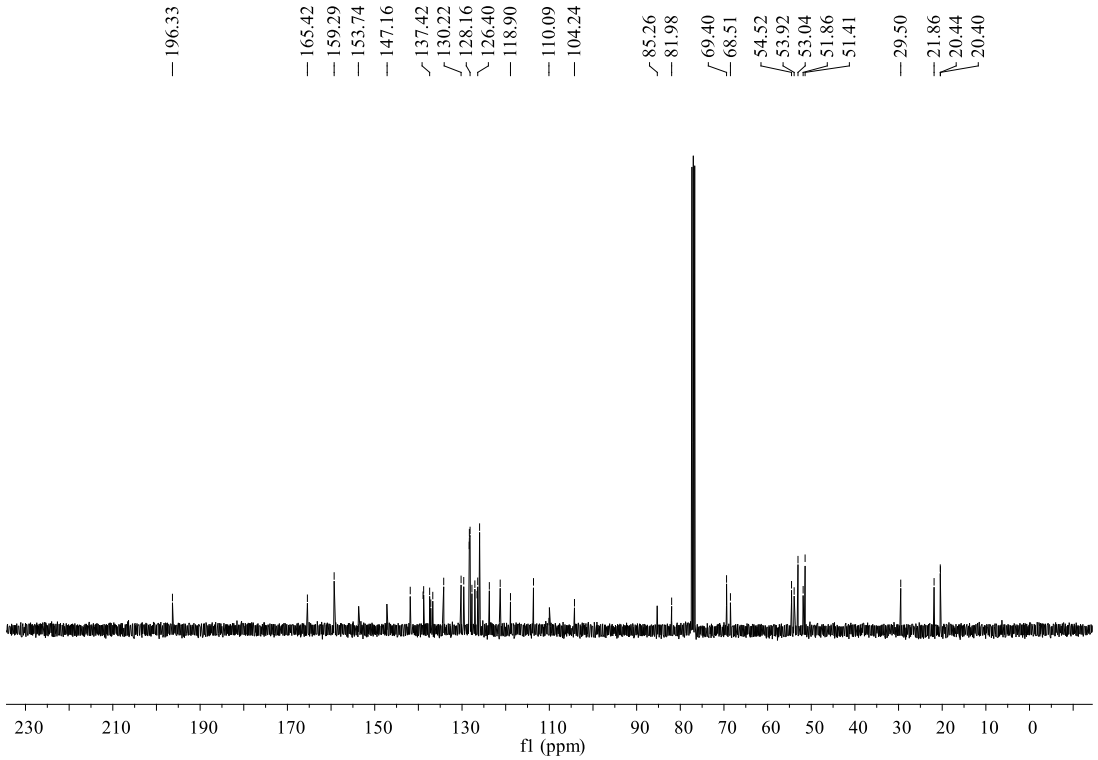
Methyl

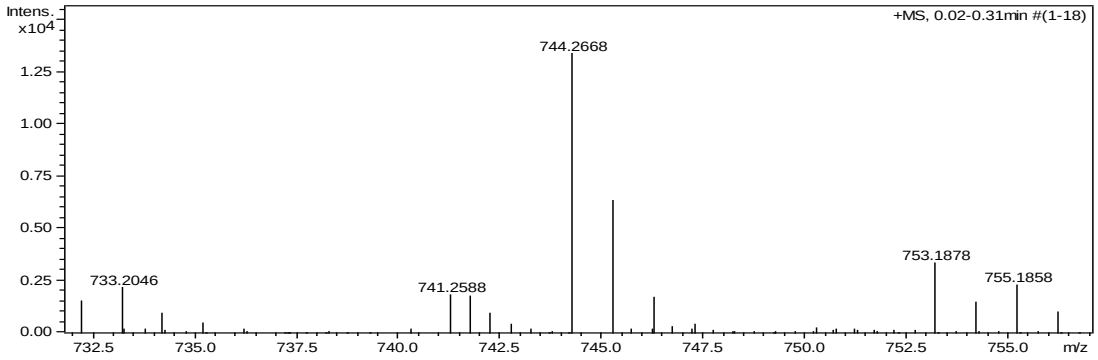
(*E*)-2-benzyl-1-(3-methoxy-3-oxoprop-1-yn-1-yl)-5-methyl-14-(3-nitrophenyl)-7-oxo-1-(*p*-toly l)-1,2,7,11,12,13,13a,14-octahydropyrrolo[1',2':1,2]azocino[4,5-*c*]quinoline-8-carboxylate

(2f):

yellow solid, 69%, m.p. 215~217℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.19 (s, 1H, CH), 7.88 (d, *J* = 7.6 Hz, 2H, ArH), 7.32 (d, *J* = 8.0 Hz, 1H, ArH), 7.17~7.02 (m, 8H, ArH), 6.94 (s, 1H, ArH), 6.73 (d, *J* = 8.2 Hz, 1H, ArH), 6.61 (d, *J* = 7.6 Hz, 2H, ArH), 6.17 (d, *J* = 8.0 Hz, 1H, ArH), 4.23 (d, *J* = 17.2 Hz, 1H, CH_2), 4.06 (d, *J* = 17.2 Hz, 1H, CH_2), 3.95-3.91 (m, 2H, CH_2), 3.87 (s, 3H, OCH_3), 3.83 (s, 3H, OCH_3), 3.68~3.60 (m, 1H, CH), 3.25 (d, *J* = 11.6 Hz, 1H, CH), 2.25~2.18 (m, 1H, CH_2), 2.15 (s, 3H, CH_3), 2.05 (s, 1H, CH_2), 2.03~2.00(m, 1H, CH_2), 1.98 (s, 3H, CH_3), 1.69~1.57 (m, 2H, CH_2); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 196.3, 165.4, 159.2, 153.7, 147.1, 141.8, 138.9, 138.7, 137.4, 137.1, 136.7, 134.1, 130.2, 129.6, 128.3, 128.3, 128.1, 127.7, 127.0, 126.5, 126.4, 125.9, 123.7, 121.2, 118.9, 113.6, 110.0, 104.2, 85.2, 81.9, 69.4, 68.5, 54.5, 53.9, 53.0, 51.8, 51.4, 29.5, 21.8, 20.5, 20.4; IR (KBr) υ: 3549, 3477, 3412, 2950, 2879, 2227, 1913, 1711, 1648, 1580, 1514, 1416, 1350, 1252, 1176, 1138, 1036, 943, 854, 811, 753, 731 cm^{-1}; MS (*m*/*z*): HRMS (ESI) Calcd. for $C_{43}H_{39}N_3NaO_7$ ($[M+Na]^+$): 744.2680, found: 744.2668.




196.33
165.42
159.29
153.74
147.16
137.42
130.22
128.16
126.40
118.90
110.09
104.24
85.26
81.98
69.40
68.51
54.52
53.92
53.04
51.86
51.41
29.50
21.86
20.44
20.40
230
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

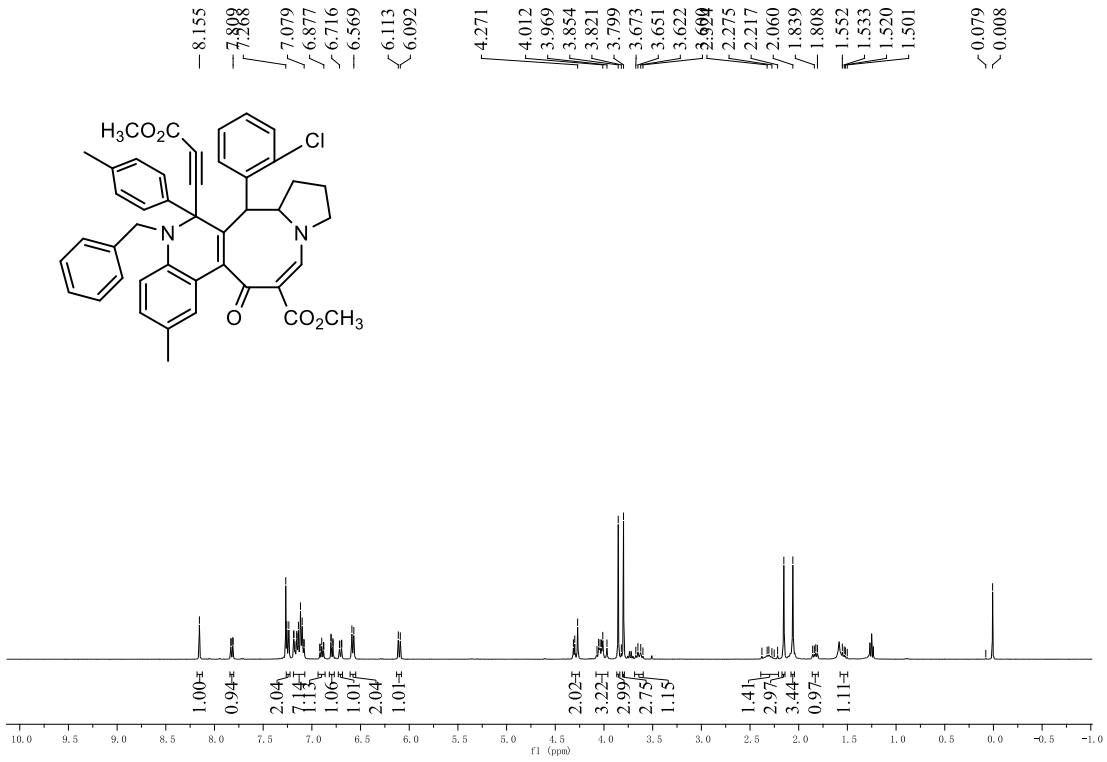

Intens.
x10^4
+MS, 0.02-0.31min #(1-18)
744.2668
753.1878
755.1858
733.2046
741.2588
1.25
1.00
0.75
0.50
0.25
0.00
732.5
735.0
737.5
740.0
742.5
745.0
747.5
750.0
752.5
755.0
m/z

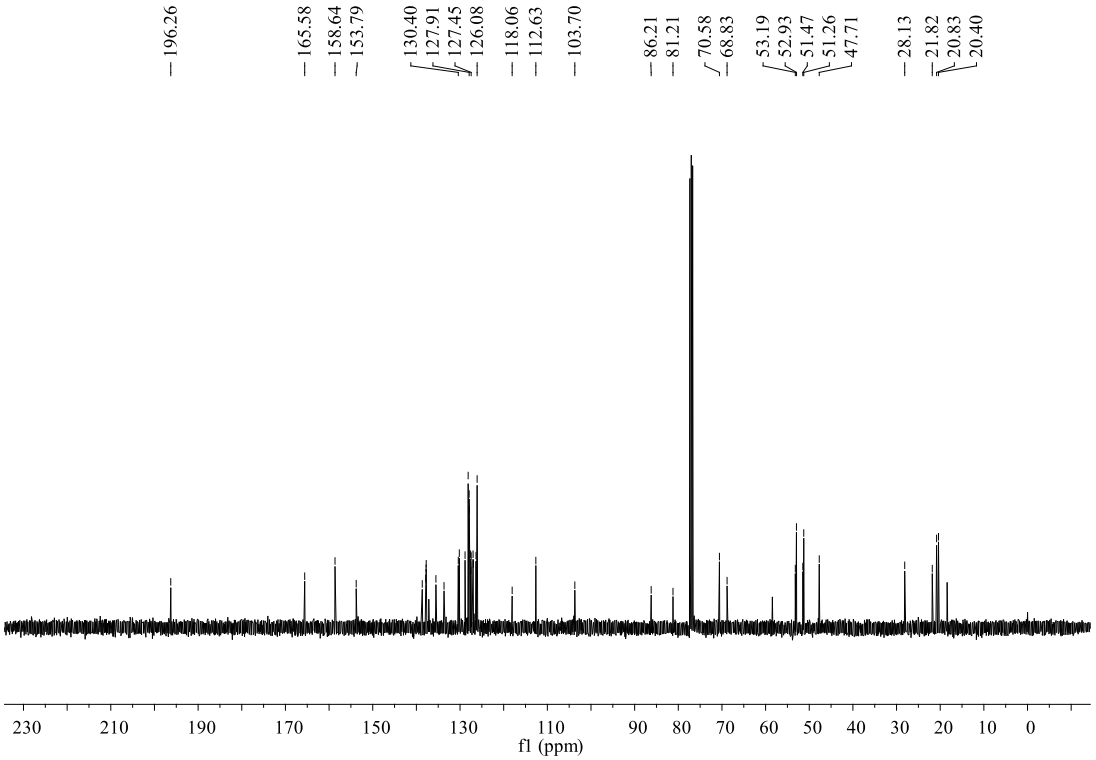
Methyl

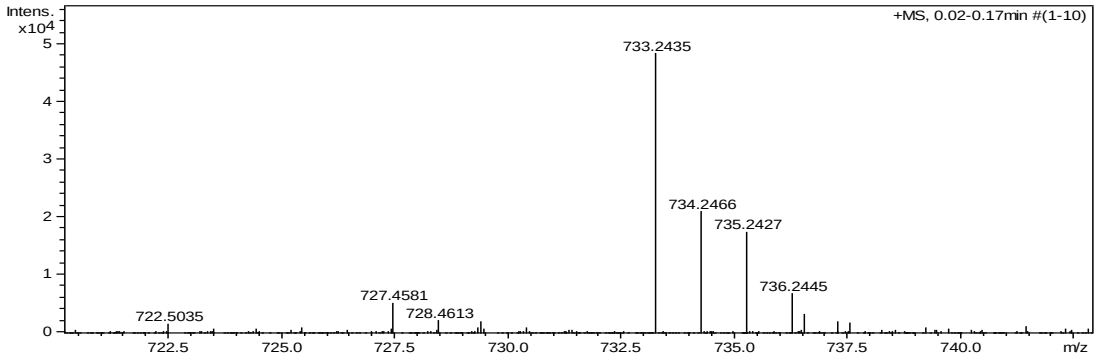
(*E*)-2-benzyl-14-(2-chlorophenyl)-1-(3-methoxy-3-oxoprop-1-yn-1-yl)-5-methyl-7-oxo-1-(*p*-tolyl)-1,2,7,11,12,13,13a,14-octahydropyrrolo[1',2':1,2]azocino[4,5-*c*]quinoline-8-carboxylate

(2g):

yellow solid, 71%, m.p. 173~175℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.15 (s, 1H), 7.81 (d, *J* = 6.8 Hz, 1H, ArH), 7.24 (d, *J* = 8.1 Hz, 2H, ArH), 7.12 (d, *J* = 13.4, 7.9 Hz, 8H, ArH), 6.89 (t, *J* = 7.6 Hz, 1H, ArH), 6.78 (d, *J* = 7.8 Hz, 1H, ArH), 6.70 (d, *J* = 7.2 Hz, 1H, ArH), 6.57 (d, *J* = 7.8 Hz, 2H, ArH), 6.09 (d, *J* = 8.3 Hz, 1H, ArH), 4.29 (d, *J* = 6.7 Hz, 1H, CH_2), 4.26 (s, 1H, CH_2), 4.04~3.96 (m, 3H, CH_2), 3.85 (s, 3H, OCH_3), 3.79 (s, 3H, OCH_3), 3.63 (dd, J_1 = 20.4 Hz, J_2 = 8.8 Hz, 1H), 2.42~2.18 (m, 2H, CH_2), 2.14 (s, 3H, CH_3), 2.09 (d, *J* = 7.2 Hz, 1H, CH_2), 2.05 (s, 3H, CH_3), 1.86~1.81 (m, 1H, CH_2), 1.56~1.50 (m, 1H, CH_2); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 196.2, 165.5, 158.6, 153.7, 138.6, 137.8, 137.7, 137.7, 135.5, 133.6, 130.4, 130.1, 128.8, 128.1, 127.9, 127.8, 127.5, 127.5, 127.4, 127.0, 126.9, 126.3, 126.0, 118.0, 112.6, 103.7, 86.2, 81.2, 70.5, 68.8, 53.1, 52.9, 51.4, 51.2, 47.7, 28.1, 21.8, 20.8, 20.4; IR (KBr) υ: 3479, 3415, 2950, 2219, 1710, 1579, 1527, 1434, 1350, 1266 1154, 1038, 953, 896, 809, 734 cm^{-1}; MS (*m*/*z*): HRMS (ESI) Calcd. for $C_{43}H_{39}ClN_2NaO_5$ ($[M+Na]^+$): 733.2440, found: 733.2435.



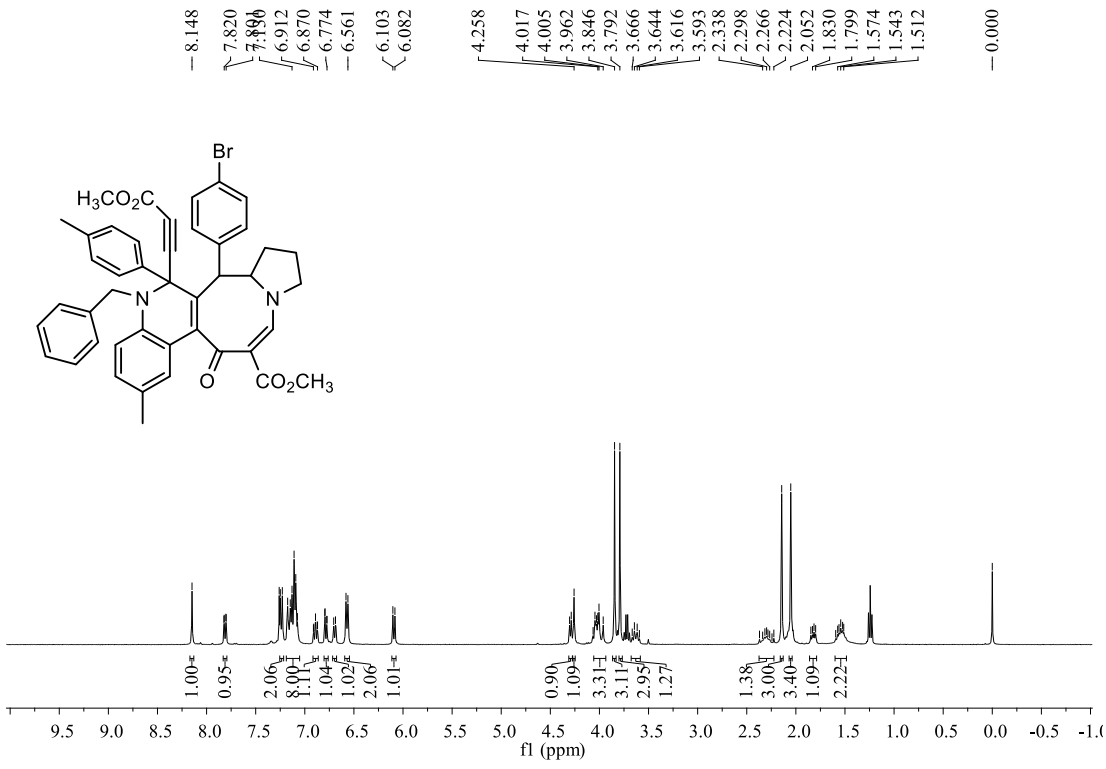

196.26
165.58
158.64
153.79
130.40
127.91
127.45
126.08
118.06
112.63
103.70
86.21
81.21
70.58
68.83
53.19
52.93
51.47
51.26
47.71
28.13
21.82
20.83
20.40
230 210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

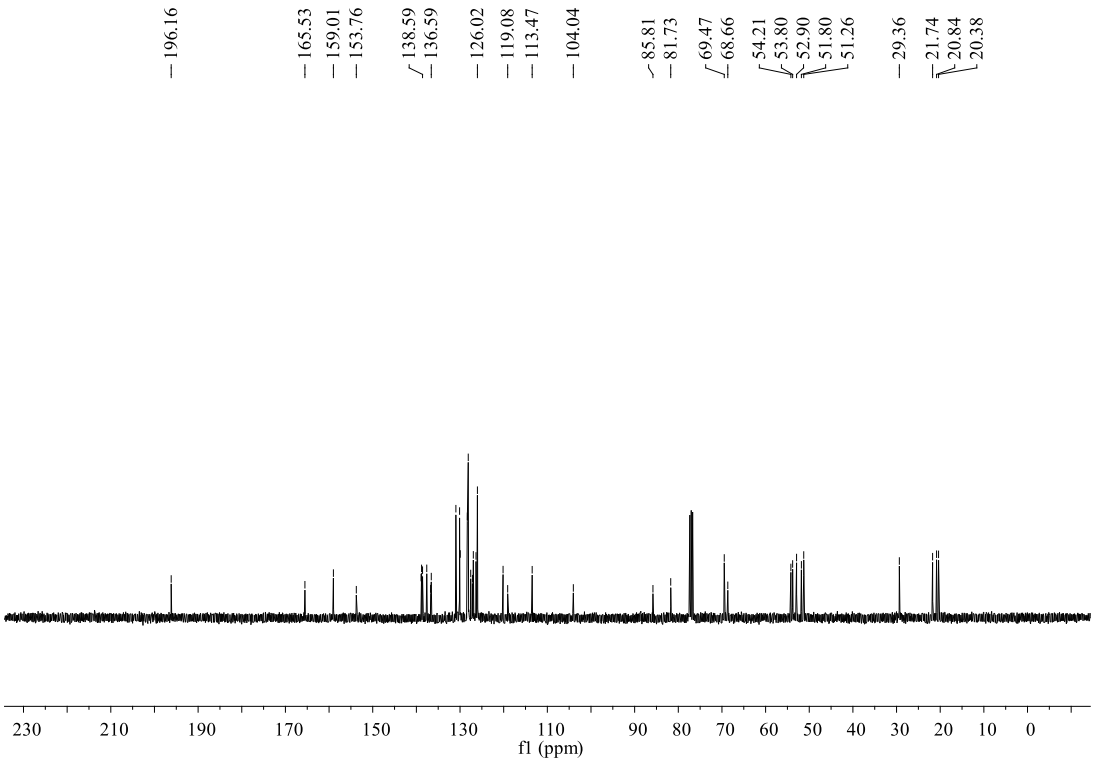

Intens.
x10^4
+MS, 0.02-0.17min #(1-10)
733.2435
734.2466
735.2427
736.2445
727.4581
728.4613
722.5035
722.5 725.0 727.5 730.0 732.5 735.0 737.5 740.0
m/z

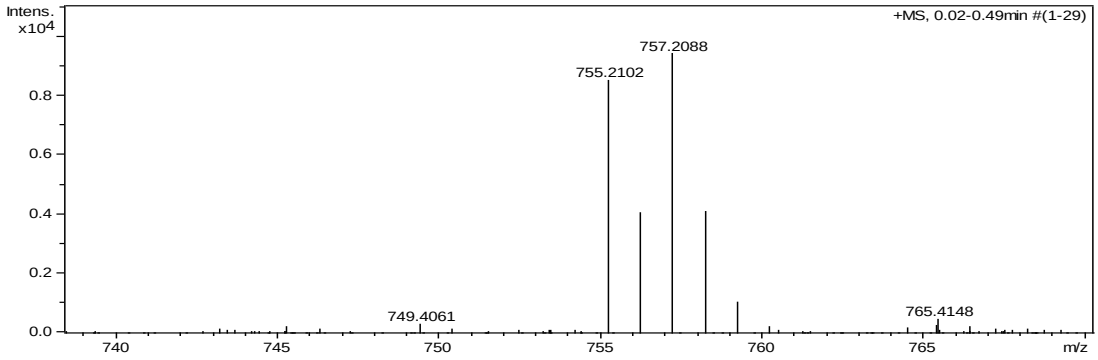
Methyl

(*E*)-2-benzyl-14-(4-bromophenyl)-1-(3-methoxy-3-oxoprop-1-yn-1-yl)-5-methyl-7-oxo-1-(*p*-tolyl)-1,2,7,11,12,13,13a,14-octahydropyrrolo[1',2':1,2]azocino[4,5-*c*]quinoline-8-carboxylate (2h):

yellow solid, 50%, m.p. 170~172℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.15 (s, 1H), 7.83–7.79 (m, 1H, ArH), 7.23 (d, *J* = 8.0 Hz, 1H, ArH), 7.12 (m, 8H, ArH), 6.91-6.87 (m, 1H, ArH), 6.80~6.76 (m, 1H, ArH), 6.70 (d, *J* = 7.6 Hz, 1H, ArH), 6.57 (d, *J* = 8.0 Hz, 2H, ArH), 6.09 (d, *J* = 8.4 Hz, 1H, ArH), 4.30 (d, *J* = 6.8 Hz, 1H, CH_2), 4.26 (s, 1H, CH_2), 4.02 (m, 3H, CH_2, CH), 3.85 (s, 3H, OCH_3), 3.79 (s, 3H, OCH_3), 3.63 (dd, J_1 = 20.0, J_2 = 9.0 Hz, 1H, CH), 2.37~2.22 (m, 1H, CH_2), 2.14 (s, 3H, CH_3), 2.05 (s, 3H, CH_3), 1.82 (dd, *J* = 12.8, *J* = 6.8 Hz, 1H, CH_2), 1.60~1.49 (m, 2H, CH_2); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 196.2, 165.5, 159.0, 153.7, 138.9, 138.8, 138.5, 137.6, 136.7, 136.5, 130.9, 130.1, 129.9, 128.3, 128.1, 127.5, 127.1, 126.9, 126.3, 126.0, 120.1, 119.1, 113.5, 104.0, 85.8, 81.7, 69.4, 68.6, 54.2, 53.8, 52.9, 51.8, 51.2, 29.3, 21.7, 20.8, 20.3; IR (KBr) υ: 3530, 3415, 2958, 2881, 2229, 1711, 1653, 1578, 1501, 1444, 1345, 1252, 1156, 1036, 948, 874, 797, 755 cm^{-1}; MS (*m*/*z*): HRMS (ESI) Calcd. for $C_{43}H_{40}BrN_2O_5$ ($[M+H]^+$): 755.2115, found: 755.2102.



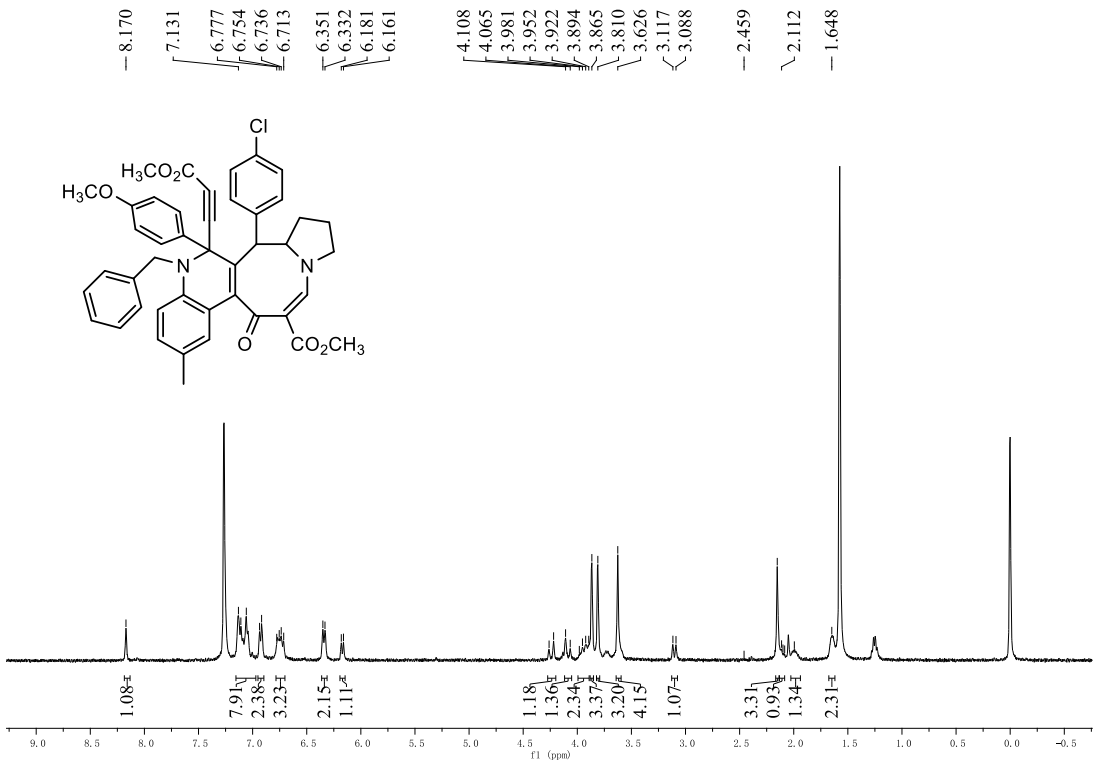

196.16
165.53
159.01
153.76
138.59
136.59
126.02
119.08
113.47
104.04
85.81
81.73
69.47
68.66
54.21
53.80
52.90
51.80
51.26
29.36
21.74
20.84
20.38
230
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

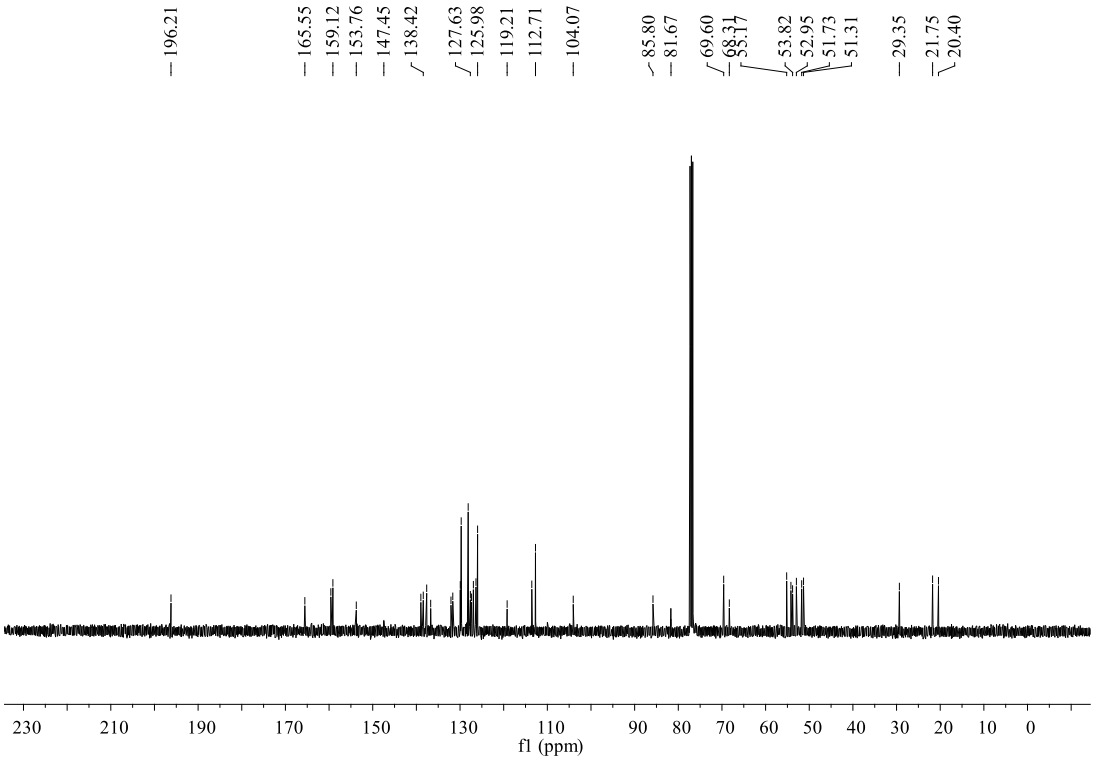

Intens.
x10^4
+MS, 0.02-0.49min #(1-29)
757.2088
755.2102
749.4061
765.4148
0.0
0.2
0.4
0.6
0.8
740
745
750
755
760
765
m/z

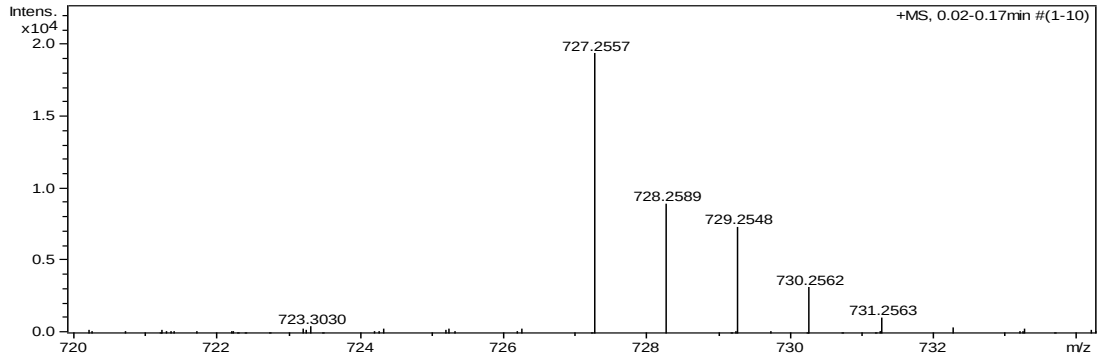
Methyl

(*E*)-2-benzyl-14-(4-chlorophenyl)-1-(3-methoxy-3-oxoprop-1-yn-1-yl)-1-(4-methoxyphenyl)-5-methyl-7-oxo-1,2,7,11,12,13,13a,14-octahydropyrrolo[1',2':1,2]azocino[4,5-*c*]quinoline-8-carboxylate (2i):

yellow solid, 74%, m.p. 169~171℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.17 (s, 1H, CH), 7.15~7.02 (m, 8H, ArH), 6.93 (d, *J* = 7.6 Hz, 2H, ArH), 6.8-6.7 (m, 3H, ArH), 6.34 (d, *J* = 7.6 Hz, 2H, ArH), 6.17 (d, *J* = 8.0 Hz, 1H, ArH), 4.24 (d, *J* = 16.8 Hz, 1H, CH_2), 4.09 (d, *J* = 17.2 Hz, 2H, CH_2), 4.0~3.9 (m, 2H, CH_2), 3.87 (s, 3H, OCH_3), 3.81 (s, 3H, OCH_3), 3.63 (s, 1H, OCH_3, CH), 3.10 (d, *J* = 11.6 Hz, 1H, CH), 2.15 (s, 3H, CH_3), 2.1~2.0 (m, 1H, CH_2), 1.99 (s, 1H, CH_2), 1.65 (s, 2H, CH_2); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 196.2, 165.5, 159.5, 159.1, 153.7, 147.4, 138.9, 138.4, 137.6, 136.7, 132.0, 131.6, 129.9, 129.7, 128.1, 127.6, 127.3, 126.9, 126.3, 125.9, 119.2, 113.5, 112.7, 104.0, 85.8, 81.6, 69.6, 68.3, 55.1, 54.2, 53.8, 52.9, 51.7, 51.3, 29.3, 21.7, 20.4; IR (KBr) υ: 3553, 3477, 3414, 3237, 2949, 2220, 2028, 1711, 1623, 1578, 1501, 1427, 1252, 1155, 1034, 950, 807, 736 cm^{-1}; MS (*m*/*z*): HRMS (ESI) Calcd. for $C_{44}H_{40}ClN_2O_6$ ($[M+H]^+$): 727.2569, found: 727.2557.



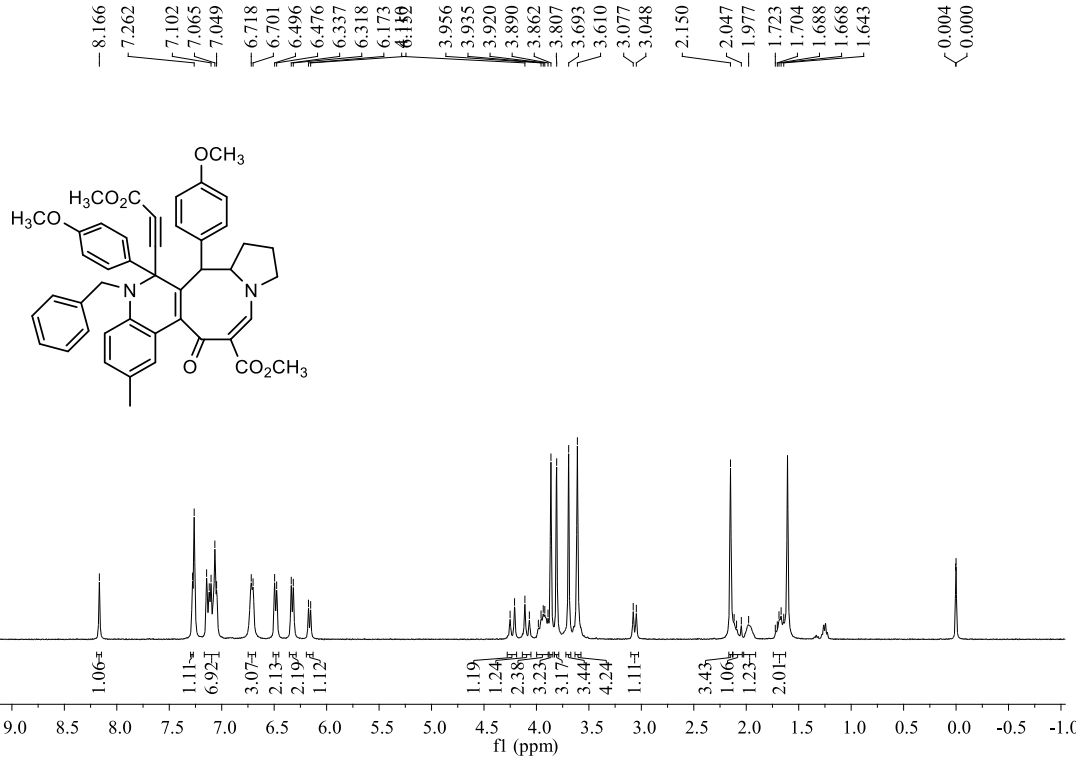

196.21
165.55
159.12
153.76
147.45
138.42
127.63
125.98
119.21
112.71
104.07
85.80
81.67
69.60
68.31
55.17
53.82
52.95
51.73
51.31
29.35
21.75
20.40
230
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

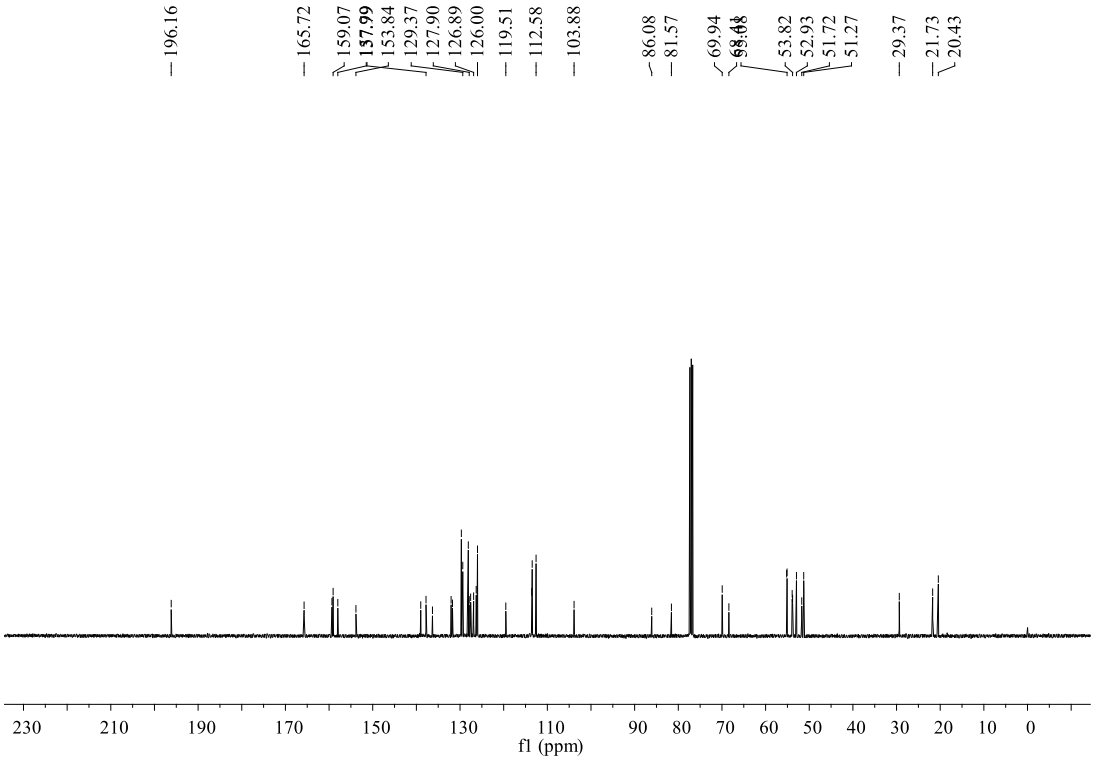

Intens.
x10^4
2.0
1.5
1.0
0.5
0.0
+MS, 0.02-0.17min #(1-10)
727.2557
728.2589
729.2548
730.2562
731.2563
723.3030
720
722
724
726
728
730
732
m/z

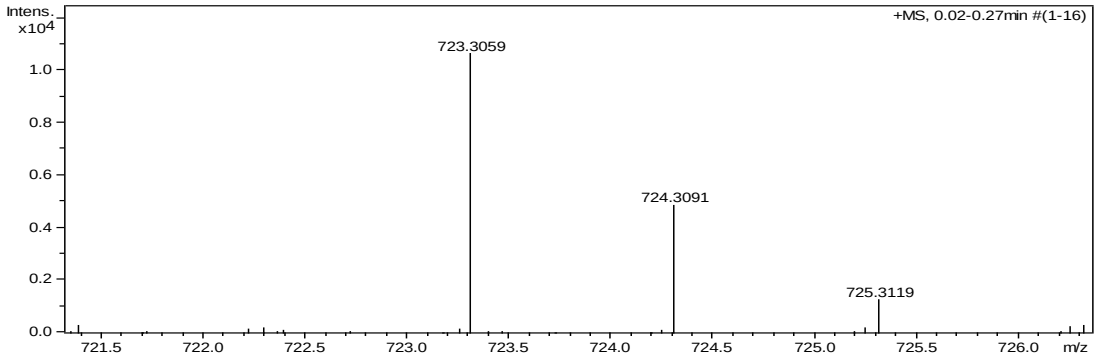
Methyl

(*E*)-2-benzyl-1-(3-methoxy-3-oxoprop-1-yn-1-yl)-1,14-bis(4-methoxyphenyl)-5-methyl-7-oxo-1,2,7,11,12,13,13a,14-octahydropyrrolo[1',2':1,2]azocino[4,5-*c*]quinoline-8-carboxylate (2j):

yellow solid, 73%, m.p. 165~167℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.17 (s, 1H, CH), 7.28 (s, 1H, ArH), 7.17~7.01 (m, 7H, ArH), 6.71 (d, *J* = 2.8 Hz, 3H, ArH), 6.49 (d, *J* = 8.0 Hz, 2H, ArH), 6.33 (d, *J* = 7.6 Hz, 2H, ArH), 6.16 (d, *J* = 8.4 Hz, 1H, ArH), 4.23 (d, *J* = 16.8 Hz, 1H, CH_2), 4.09 (d, *J* = 17.2 Hz, 1H, CH_2), 4.00~3.89 (m, 2H, CH_2), 3.86 (s, 3H, OCH_3), 3.81 (s, 3H, OCH_3), 3.69 (s, 4H, OCH_3), 3.61 (s, 1H, CH), 3.06 (d, *J* = 11.6 Hz, 1H, CH_2), 2.15 (s, 3H, CH_3), 2.16~2.05(m, 1H, CH_2), 1.98 (s, 1H, CH_2), 1.74~1.62 (m, 2H, CH_2); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 196.1, 165.7, 159.3, 159.0, 157.9, 153.8, 139.0, 137.7, 136.3, 132.0, 131.7, 129.7, 129.3, 128.1, 127.9, 127.5, 126.8, 126.2, 126.0, 119.5, 113.5, 113.4, 112.5, 103.8, 86.0, 81.5, 69.9, 68.4, 55.1, 55.0, 53.9, 53.8, 52.9, 51.7, 51.2, 29.3, 21.7, 20.4; IR (KBr) υ: 3551, 3412, 2962, 2889, 2214, 1711, 1653, 1578, 1506, 1433, 1245, 1156, 1113, 1076, 1032, 953, 887, 839, 746 cm^{-1}; MS (*m*/*z*): HRMS (ESI) Calcd. for $C_{45}H_{43}N_2O_7$ ([M+H]$^+$): 723.3065, found: 723.3059.



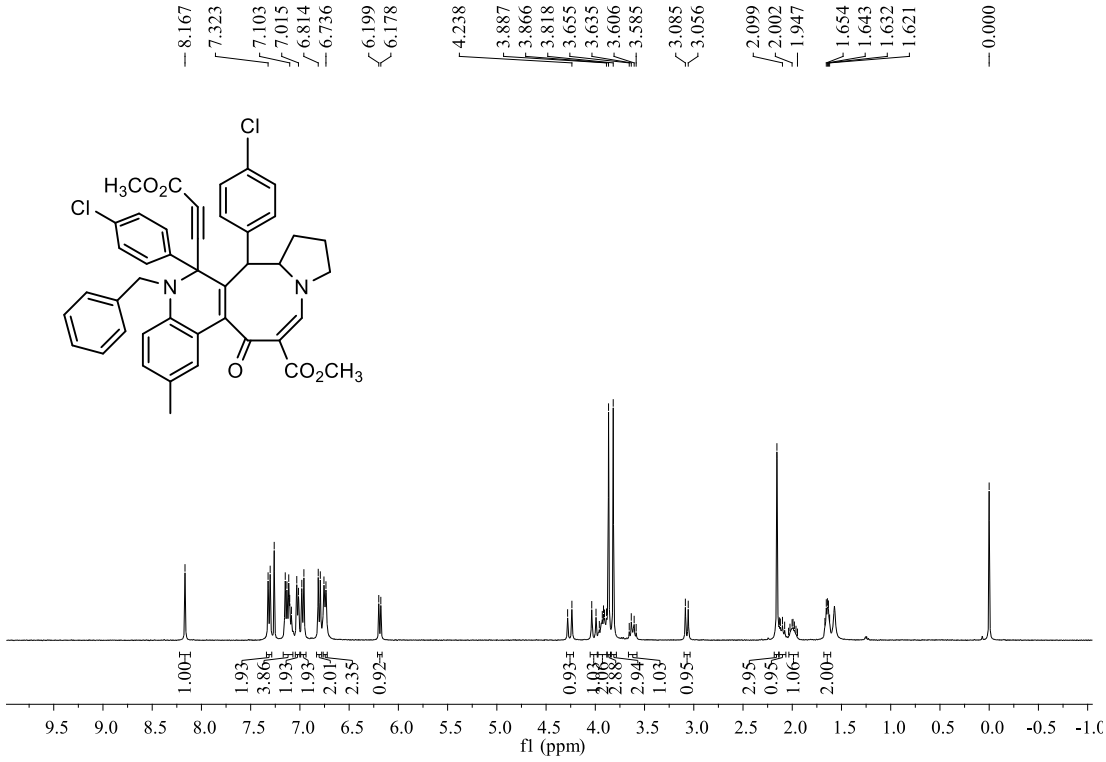

196.16
165.72
159.07
137.99
153.84
129.37
127.90
126.89
126.00
119.51
112.58
103.88
86.08
81.57
69.94
53.82
52.93
51.72
51.27
29.37
21.73
20.43
230
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

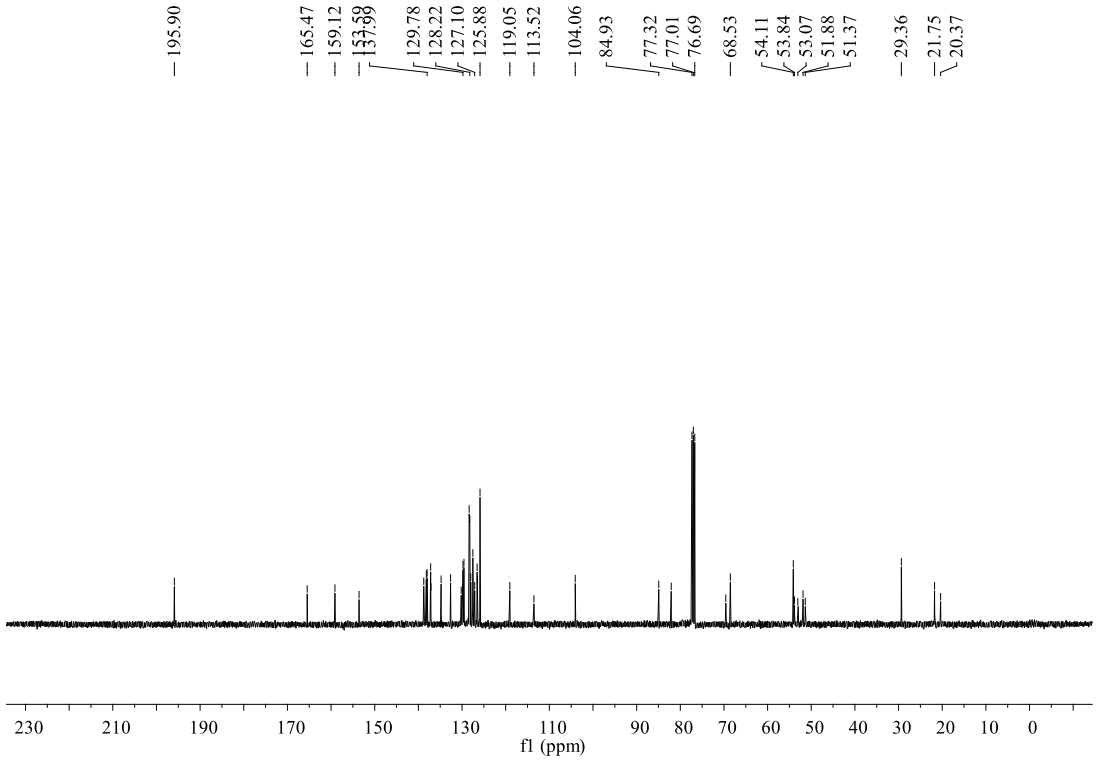

Intens.
x10^4
+MS, 0.02-0.27min #(1-16)
723.3059
724.3091
725.3119
1.0
0.8
0.6
0.4
0.2
0.0
721.5
722.0
722.5
723.0
723.5
724.0
724.5
725.0
725.5
726.0
m/z

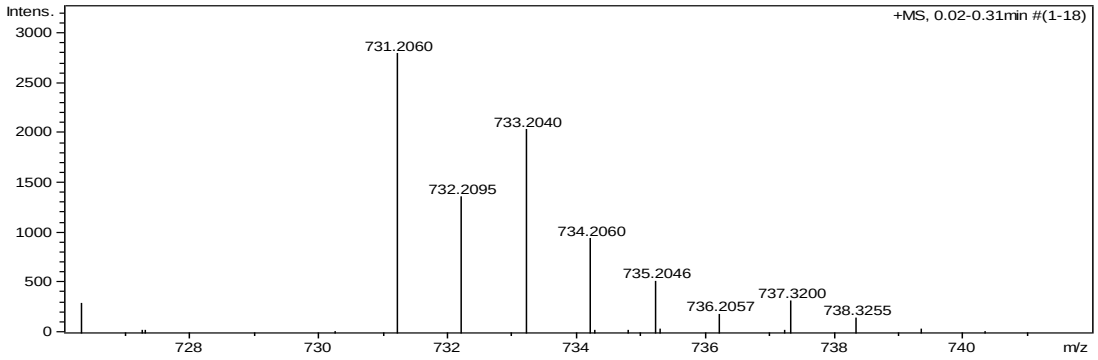
Methyl

(*E*)-2-benzyl-1,14-bis(4-chlorophenyl)-1-(3-methoxy-3-oxoprop-1-yn-1-yl)-5-methyl-7-oxo-1, 2,7,11,12,13,13a,14-octahydropyrrolo[1',2':1,2]azocino[4,5-*c*]quinoline-8-carboxylate (2k):

yellow solid, 48%, m.p. 174~176℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.17 (s, 1H, CH), 7.31 (d, *J* = 8.4 Hz, 2H, ArH), 7.17~7.07 (m, 4H, ArH), 7.02 (d, *J* = 6.8 Hz, 2H, ArH), 6.97 (d, *J* = 8.8 Hz, 2H, ArH), 6.80 (d, *J* = 8.4 Hz, 2H, ArH), 6.75 (d, *J* = 8.4 Hz, 3H, ArH), 6.19 (d, *J* = 8.4 Hz, 1H, ArH), 4.26 (d, *J* = 17.2 Hz, 1H, CH_2), 4.01 (d, *J* = 17.2 Hz, 1H,CH_2), 3.97~3.88 (m, 2H, CH_2), 3.87 (s, 3H, OCH_3), 3.82 (s, 3H, OCH_3), 3.66~3.59 (m, 1H, CH), 3.07 (d, *J* = 11.6 Hz, 1H, CH), 2.16 (s, 3H, CH_3), 2.12~2.07 (m, 1H, CH_2), 2.04~1.95 (m, 1H, CH_2), 1.68~1.61 (m, 2H, CH_2); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 195.9, 165.4, 159.1, 153.5, 138.7, 138.1, 137.9, 137.1, 137.1, 134.7, 132.6, 130.1, 129.7, 129.5, 128.3, 128.2, 128.0, 127.5, 127.1, 126.5, 126.4, 125.8, 119.0, 113.5, 104.0, 84.9, 82.0, 69.5, 68.5, 54.1, 53.8, 53.0, 51.8, 51.3, 29.3, 21.7; IR (KBr) υ: 3478, 3415, 2953, 2218, 1707, 1625, 1579, 1499, 1424, 1357, 1261, 1152, 1040, 950, 885, 810, 754, 731 cm^{-1}; MS (*m*/*z*): HRMS (ESI) Calcd. for $C_{43}H_{37}Cl_2N_2O_5$ ($[M+H]^+$): 731.2074, found: 731.2060.



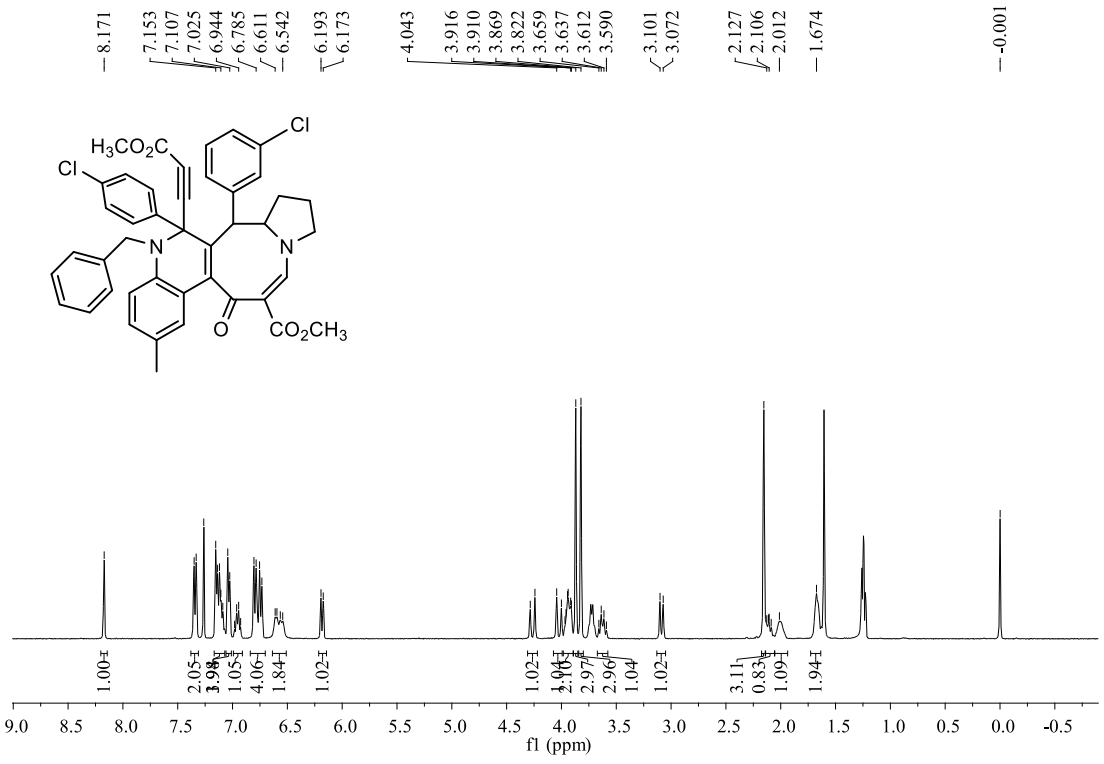

195.90
165.47
159.12
153.59
137.99
129.78
128.22
127.10
125.88
119.05
113.52
104.06
84.93
77.32
77.01
76.69
68.53
54.11
53.84
53.07
51.88
51.37
29.36
21.75
20.37
230
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

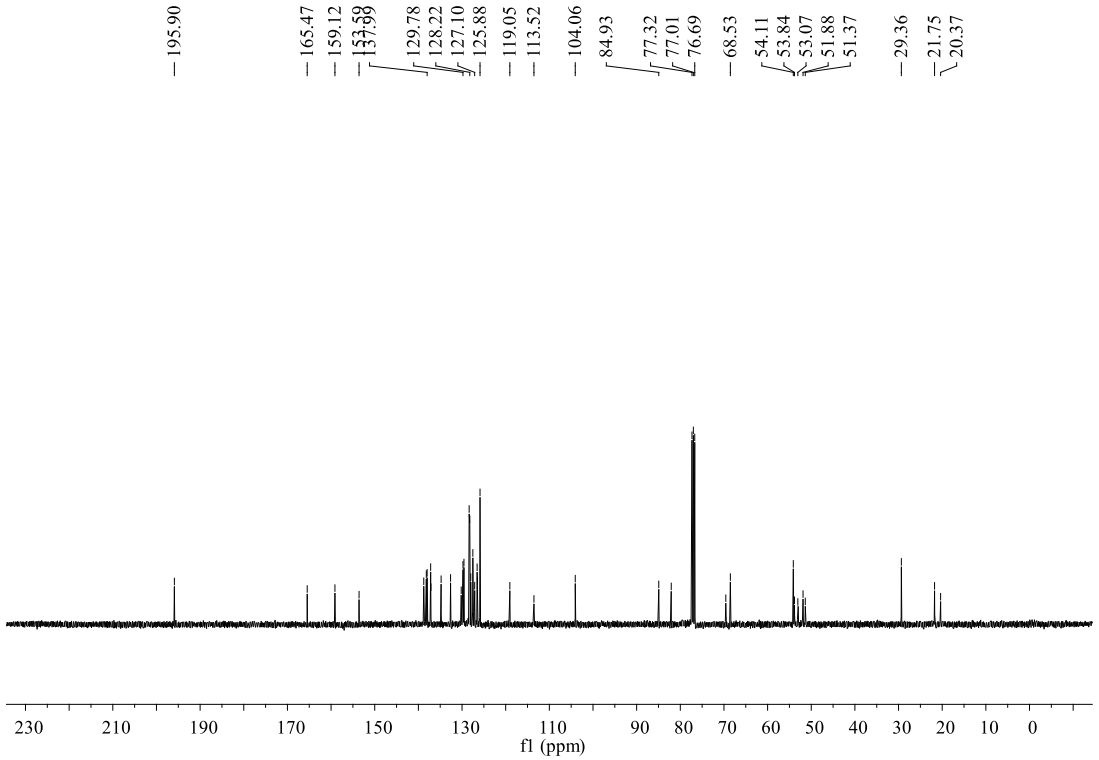

Intens.
+MS, 0.02-0.31min #(1-18)
3000
2500
2000
1500
1000
500
0
731.2060
733.2040
732.2095
734.2060
735.2046
736.2057
737.3200
738.3255
728
730
732
734
736
738
740
m/z

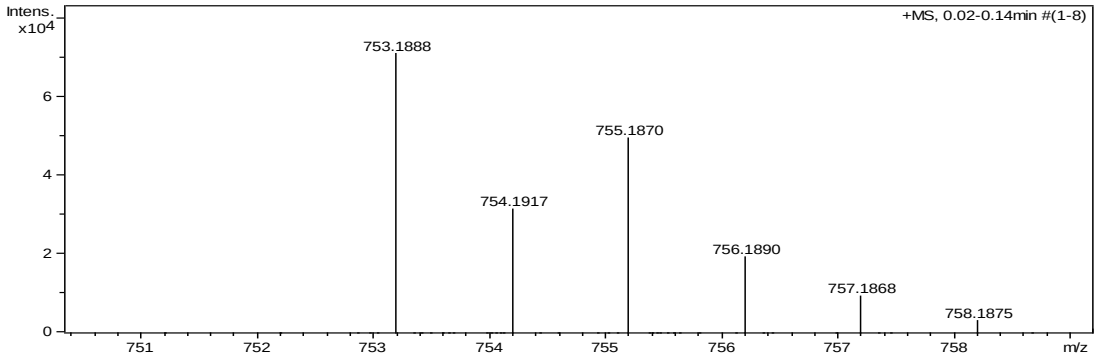
Methyl

(*E*)-2-benzyl-14-(3-chlorophenyl)-1-(4-chlorophenyl)-1-(3-methoxy-3-oxoprop-1-yn-1-yl)-5-methyl-7-oxo-1,2,7,11,12,13,13a,14-octahydropyrrolo[1',2':1,2]azocino[4,5-*c*]quinoline-8-carboxylate (2l):

yellow solid, 47%, m.p. 170~172℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.17 (s, 1H, CH), 7.34 (d, *J* = 7.2 Hz, 2H, ArH), 7.15~7.09 (m, 4H, ArH), 7.03(d, *J* =7.6 Hz, 2H, ArH), 6.98~6.92 (dd, *J1* = 14.8 Hz, *J* 2= 7.2 Hz, 1H, ArH), 6.81~6.73 (m, 4H, ArH), 6.61~6.54 (m, 2H, ArH), 6.18 (d, *J* = 8.0 Hz, 1H, ArH), 4.26 (d, *J* = 16.8 Hz, 1H, CH_2), 4.02 (d, *J* = 17.2 Hz, 1H, CH_2), 3.97~3.91 (m, 2H, CH_2), 3.87 (s, 3H, OCH_3), 3.82 (s, 3H, OCH_3), 3.62 (dd, J_1 = 18.8 Hz, J_2 = 8.0 Hz, 1H, CH), 3.09 (d, *J* = 11.6 Hz, 1H, CH), 2.15 (s, 3H, CH_3), 2.16~2.09 (m, 1H, CH_2), 2.01 (s, 1H, CH_2), 1.67 (s, 2H, CH_2); ^{13}C NMR (101 MHz, $CDCl_3$) δ 195.9, 165.4, 159.1, 153.5, 138.7, 138.1, 137.9, 137.1, 137.1, 134.7, 132.6, 130.1, 129.7, 129.5, 128.3, 128.2, 128.0, 127.5, 127.1, 126.5, 126.4, 125.8, 119.0, 113.5, 104.0, 84.9, 82.0, 69.5, 68.5, 54.1, 53.8, 53.0, 51.8, 51.3, 29.3, 21.7; IR (KBr) υ: 3478, 3415, 2953, 2218, 1707, 1625, 1579, 1499, 1424, 1357, 1261, 1152, 1040, 950, 885, 810, 754, 731 cm^{-1}; MS (*m*/*z*): HRMS (ESI) Calcd. for $C_{43}H_{36}Cl_2N_2NaO_5$ ($[M+Na]^+$): 753.1893, found: 753.1888.

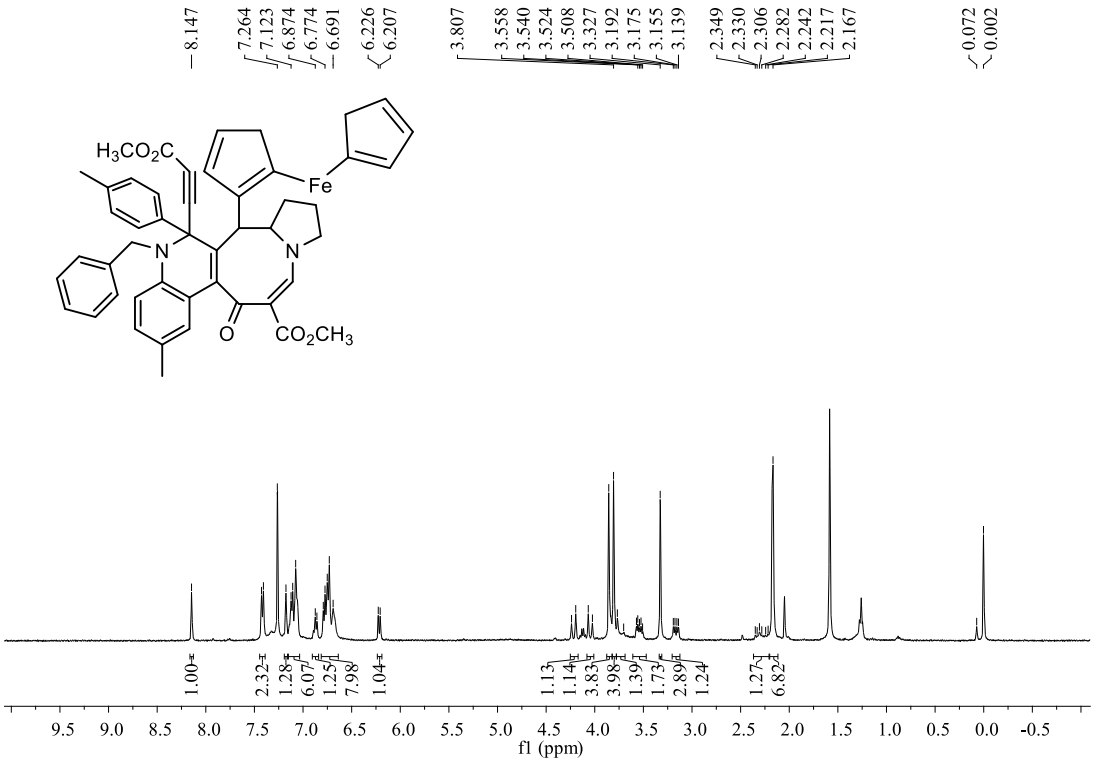


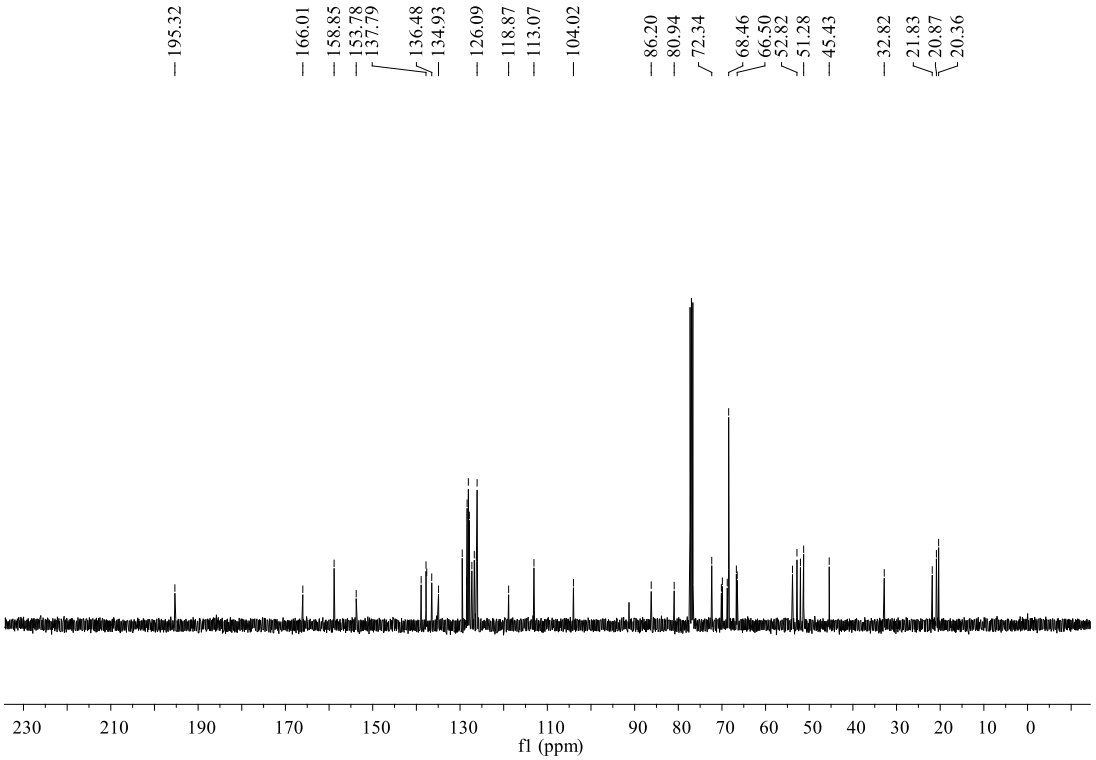

195.90
165.47
159.12
153.59
137.69
129.78
128.22
127.10
125.88
119.05
113.52
104.06
84.93
77.32
77.01
76.69
68.53
54.11
53.84
53.07
51.88
51.37
29.36
21.75
20.37
230
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

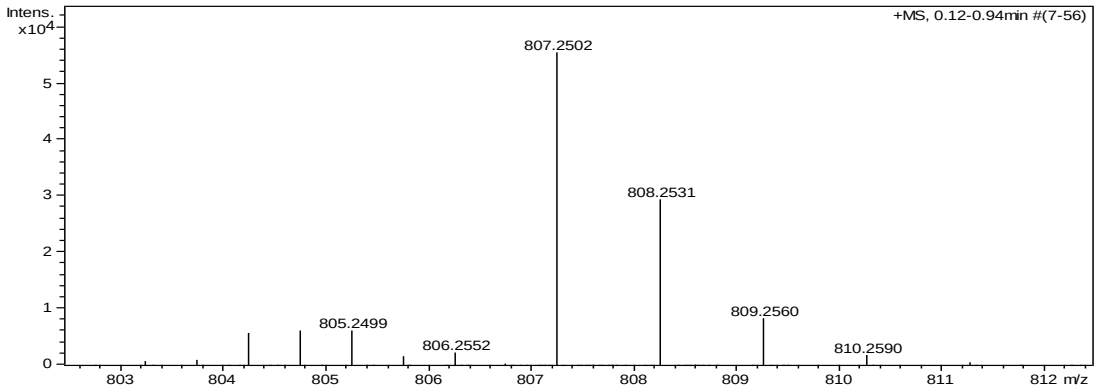

Intens.
x10^4
+MS, 0.02-0.14min #(1-8)
753.1888
755.1870
754.1917
756.1890
757.1868
758.1875
0
2
4
6
751
752
753
754
755
756
757
758
m/z

(*E*)-(2-(2-benzyl-1-(3-methoxy-3-oxoprop-1-yn-1-yl)-8-(methoxycarbonyl)-5-methyl-7-oxo-1-(*p*-tolyl)-1,2,7,11,12,13,13a,14-octahydropyrrolo[1',2':1,2]azocino[4,5-*c*]quinolin-14-yl)cyclopenta-1,3-dien-1-yl)(cyclopenta-1,3-dien-1-yl)iron (2m):

yellow solid, 50%, m.p. 260~262℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.15 (s, 1H, CH), 7.42 (d, *J* = 7.6 Hz, 2H, ArH), 7.18 (s, 1H, ArH), 7.15 ~7.04 (m, 6H, ArH), 6.87 (d, *J* = 6.6 Hz, 1H, ArH), 6.81 ~6.64 (m, 8H, ArH, CH), 6.22 (d, *J* = 8.0 Hz, 1H, CH), 4.22 (d, *J* = 17.2 Hz, 1H, CH_2), 4.05 (d, *J* = 17.2 Hz, 1H, CH_2), 3.86 (s, 3H, OCH_3), 3.81 (s, 4H, OCH_3, CH), 3.77 (s, 1H, CH), 3.57 ~3.51(m, 2H, CH_2), 3.33 (s, 3H, CH_3), 3.17 (dd, J_1 = 14.6, J_2 = 6.7 Hz, 1H, CH_2), 2.37 ~2.21 (m, 1H, CH_2), 2.17 (s, 6H, CH_3); ^{13}C NMR (101 MHz, CDCl3) δ: 195.3, 166.0, 158.8, 153.8, 138.9, 137.8, 137.6, 136.4, 134.9, 129.5, 128.4, 128.3, 128.0, 127.8, 127.2, 126.7, 126.2, 126.0, 118.8, 113.0, 104.0, 86.2, 80.9, 72.3, 70.1, 69.9, 68.7, 68.4, 66.7, 66.5, 53.8, 52.8, 52.0, 51.2, 45.4, 32.8, 21.8, 20.8, 20.3; IR (KBr) υ: 3300, 3085, 2220, 1710, 1685, 1649, 1571, 1498, 1455, 1435, 1350, 1277, 1253, 1201, 1149, 1037, 950, 877, 799, 745 cm^{-1}; MS (*m*/*z*): HRMS (ESI) Calcd. for $C_{48}H_{44}FeN_2NaO_5$ ($[M+Na]^+$): 807.2492, found: 807.2502.



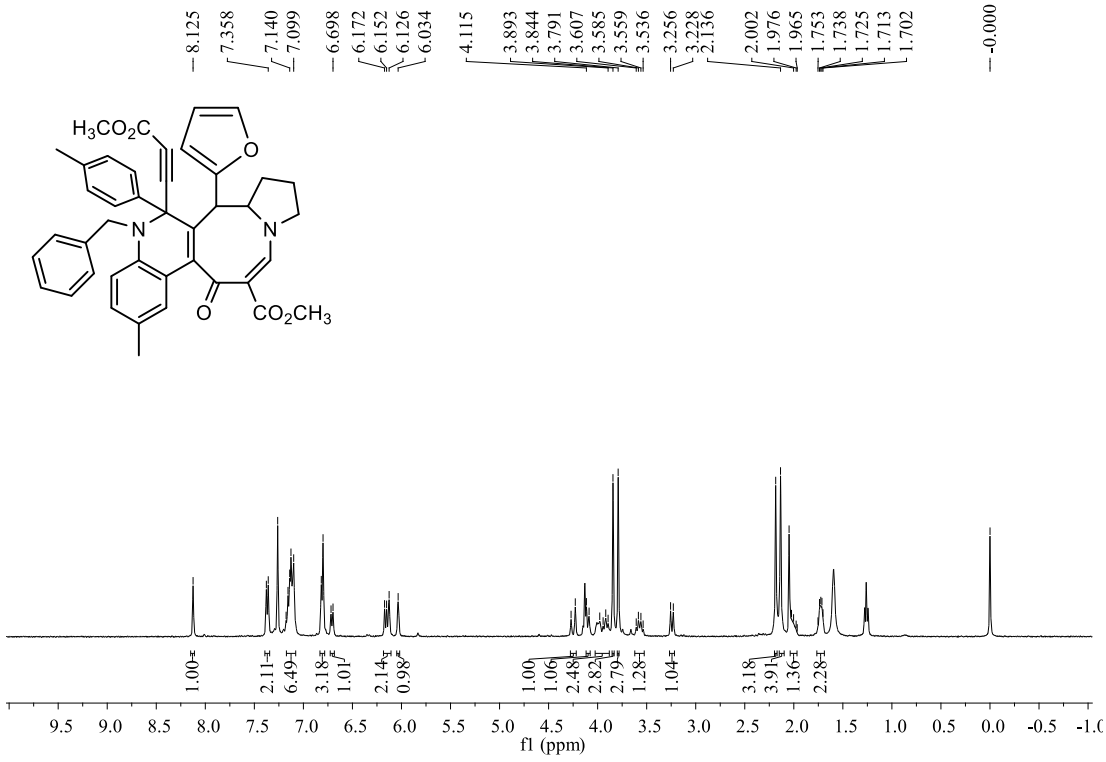

195.32
166.01
158.85
153.78
137.79
136.48
134.93
126.09
118.87
113.07
104.02
86.20
80.94
72.34
68.46
66.50
52.82
51.28
45.43
32.82
21.83
20.87
20.36
230
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

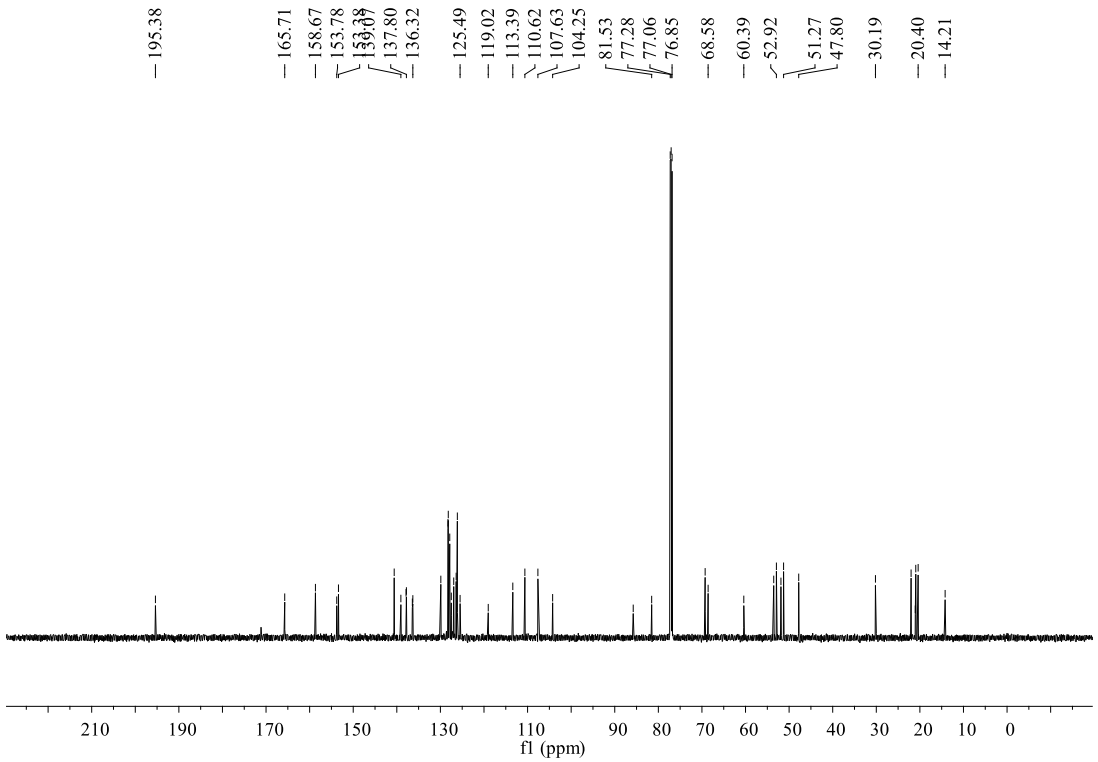

Intens.
x10^4
+MS, 0.12-0.94min #(7-56)
807.2502
808.2531
805.2499
809.2560
806.2552
810.2590
803
804
805
806
807
808
809
810
811
812 m/z

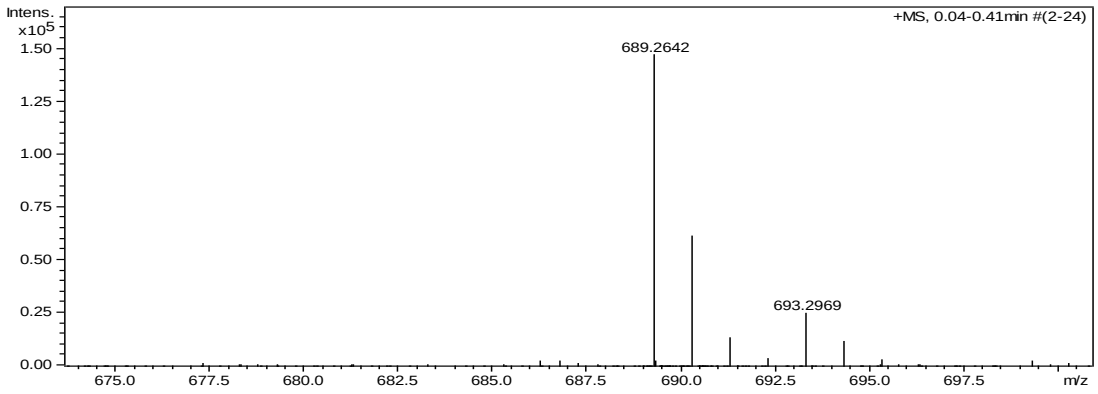
Methyl

(*E*)-2-benzyl-14-(furan-2-yl)-1-(3-methoxy-3-oxoprop-1-yn-1-yl)-5-methyl-7-oxo-1-(*p*-tolyl)-1,2,7,11,12,13,13a,14-octahydropyrrolo[1',2':1,2]azocino[4,5-*c*]quinoline-8-carboxylate(2n):

yellow solid, 85%, m.p. 190~192℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.12 (s, 1H, CH), 7.37 (d, *J* = 8.0 Hz, 2H, ArH), 7.13 (m, 6H, ArH), 6.82~6.80 (m, 3H, ArH), 6.71 (d, *J* = 8.0 Hz, 1H, ArH), 6.18~6.11 (m, 2H, ArH), 6.03 (s, 1H, ArH), 4.25 (d, *J* = 17.2 Hz, 1H, CH_2), 4.10 (d, *J* = 10.8 Hz, 1H, CH_2), 3.93 (m, 2H, CH_2), 3.84 (s, 3H, CH_2), 3.79 (s, 3H, OCH_3), 3.57 (dd, J_1 = 19.2 Hz, J_2 = 8.9 Hz, 1H, CH), 3.24 (d, *J* = 11.2 Hz, 1H, CH), 2.18 (s, 3H, CH_3), 2.14 (s, 4H, CH_3, CH_2), 2.04~1.97 (m, 1H, CH_2), 1.77~1.69 (m, 2H, CH_2); ^{13}C NMR (151 MHz, $CDCl_3$) δ: 195.3, 165.7, 158.6, 153.7, 153.3, 140.6, 139.0, 137.8, 137.8, 136.4, 136.3, 129.9, 128.2, 128.2, 127.8, 127.5, 126.9, 126.3, 126.1, 125.4, 119.0, 113.4, 110.6, 107.6, 104.2, 85.7, 81.5, 77.2, 77.0, 76.8, 69.2, 68.5, 53.5, 52.9, 51.8, 51.2, 47.8, 30.1, 22.0, 21.0, 20.9, 20.4; IR (KBr) υ: 3299, 2951, 2218, 1711, 1685, 1647, 1571, 1493, 1455, 1434, 1349, 1272, 1251, 1189, 1146, 1036, 946, 867 823, 799, 746. cm^{-1}; MS (*m*/*z*): HRMS (ESI) Calcd. for $C_{42}H_{38}N_2NaO_6$ ([M+Na]$^+$): 689.2622, found: 689.2642.



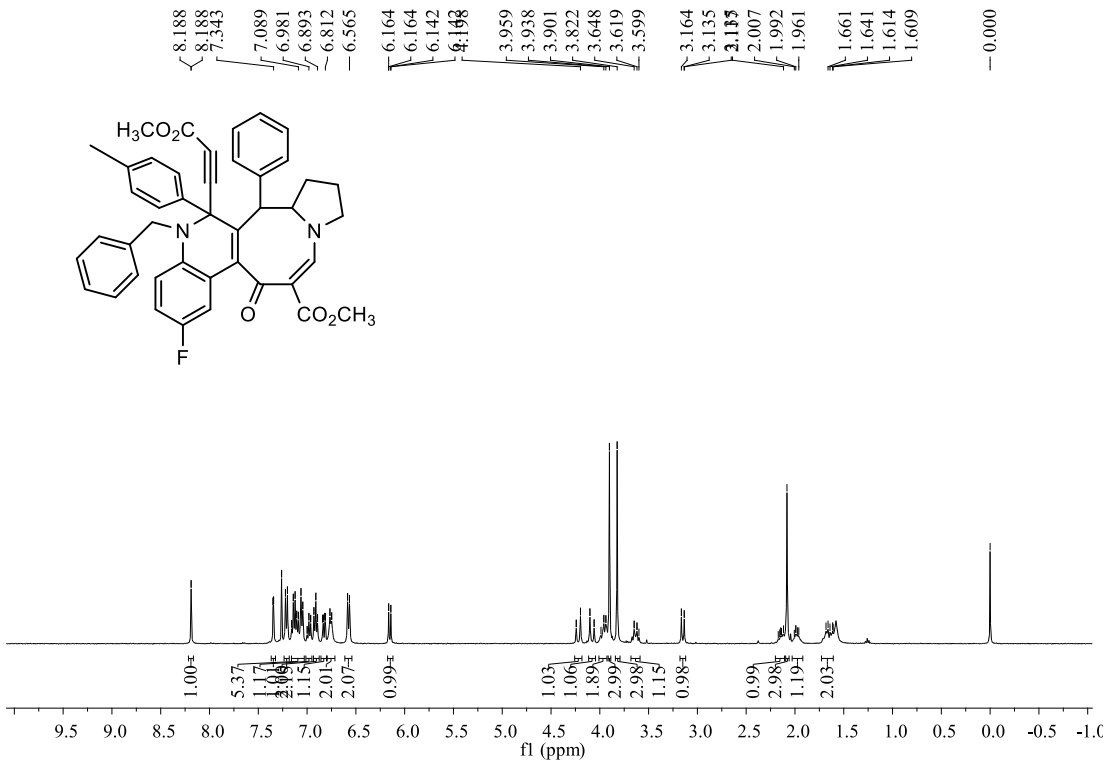

195.38
165.71
158.67
153.78
153.38
137.80
136.32
125.49
119.02
113.39
110.62
107.63
104.25
81.53
77.28
77.06
76.85
68.58
60.39
52.92
51.27
47.80
30.19
20.40
14.21
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

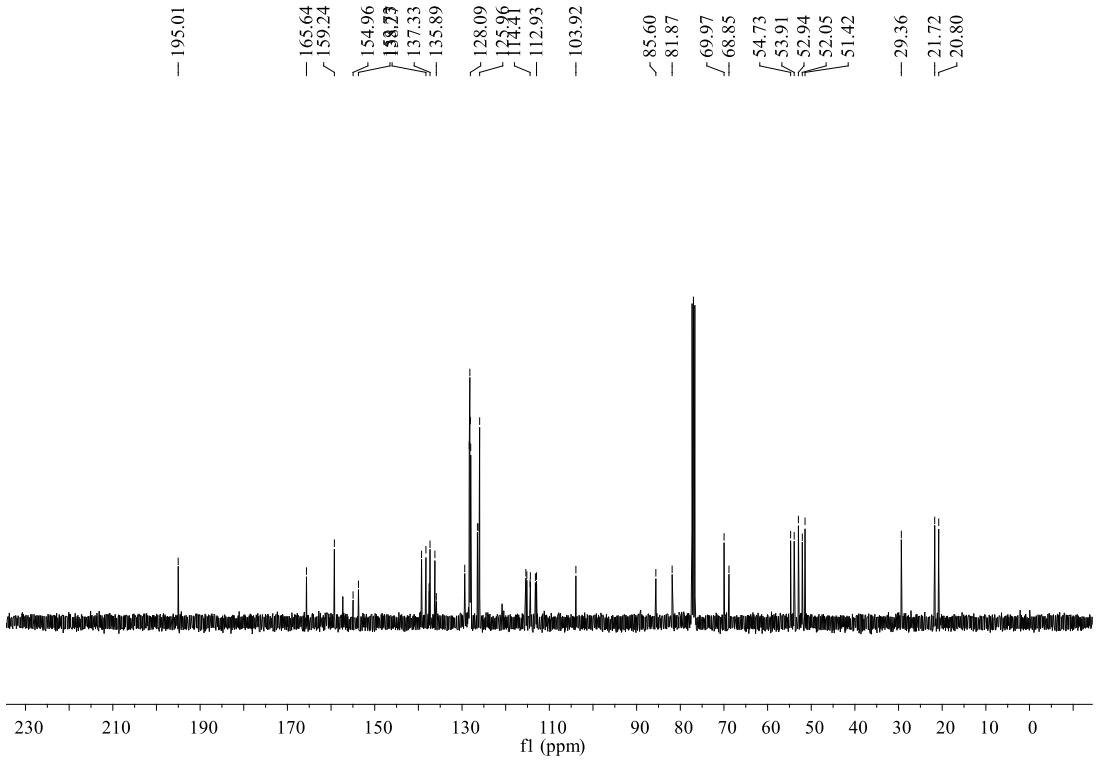

Intens.
x10^5
1.50
1.25
1.00
0.75
0.50
0.25
0.00
+MS, 0.04-0.41min #(2-24)
689.2642
693.2969
675.0
677.5
680.0
682.5
685.0
687.5
690.0
692.5
695.0
697.5
m/z

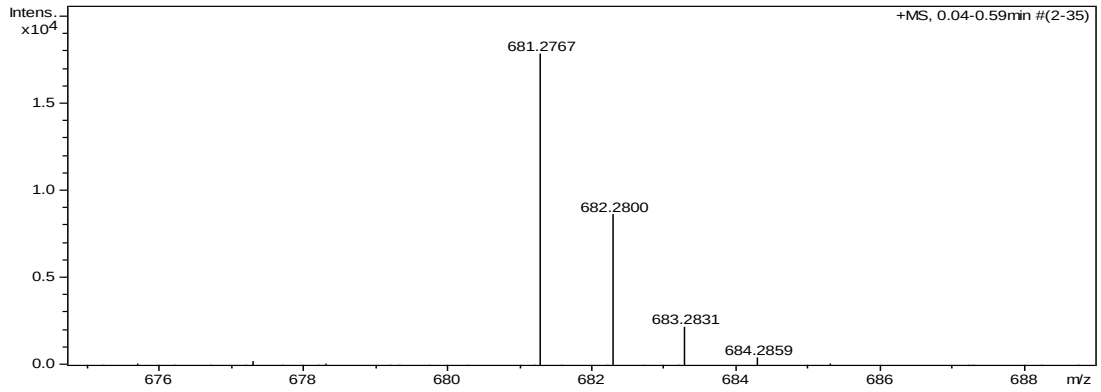
Methyl

(*E*)-2-benzyl-5-fluoro-1-(3-methoxy-3-oxoprop-1-yn-1-yl)-7-oxo-14-phenyl-1-(*p*-tolyl)-1,2,7,11,12,13,13a,14-octahydropyrrolo[1',2':1,2]azocino[4,5-*c*]quinoline-8-carboxylate (2o):

yellow solid, 64%, m.p. 259~261℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.19 (s, 1H, CH), 7.35 (d, *J* = 2.3 Hz, 1H, ArH), 7.21 (d, *J* = 8.1 Hz, 2H, ArH), 7.16~7.03 (m, 6H, ArH), 6.98 (t, *J* = 7.2 Hz, 1H, ArH), 6.91 (t, *J* = 7.4 Hz, 2H, ArH), 6.83 (dd, J_1 = 8.8 Hz, J_2 =2.4 Hz, 1H, ArH), 6.76 (d, *J* = 7.1 Hz, 2H, ArH), 6.58 (d, *J* = 7.8 Hz, 2H, ArH), 6.15 (d, *J* = 8.8 Hz, 1H, ArH), 4.22 (d, *J* = 17.3 Hz, 1H, CH_2), 4.08 (d, *J* = 17.2 Hz, 1H, CH_2), 4.01~3.92 (m, 2H, CH_2), 3.90 (s, 3H, OCH_3), 3.82 (s, 3H, OCH_3), 3.67~3.60 (m, 1H, CH), 3.15 (d, *J* = 11.6 Hz, 1H, CH), 2.18~2.11 (m, 1H, CH_2), 2.08 (s, 3H, CH_3), 1.99 (s, 1H, CH_2), 1.656~1.61 (m, 2H, CH_2); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 195.0, 165.6, 159.2, 157.36, 154.9, 153.7, 139.2, 138.2, 137.5, 137.3, 136.2, 135.9, 129.3, 128.3, 128.2, 128.0, 128.0, 126.4, 126.1, 125.9, 115.3, 115.1, 114.4, 114.3, 113.1, 112.9, 103.9, 85.6, 81.8, 69.9, 68.8, 54.7, 53.9, 52.9, 52.0, 51.4, 29.3, 21.72, 20.8; IR (KBr) υ: 3298, 2959, 1688, 1658, 1581, 1514, 1438, 1346, 1272, 1191, 1151, 1064, 1032, 953, 887, 851, 830, 808, 766, 706 cm^{-1}; MS (*m*/*z*): HRMS (ESI) Calcd. for $C_{43}H_{38}FN_2O_5$ ([M+H]$^+$): 681.2759, found: 681.2767.



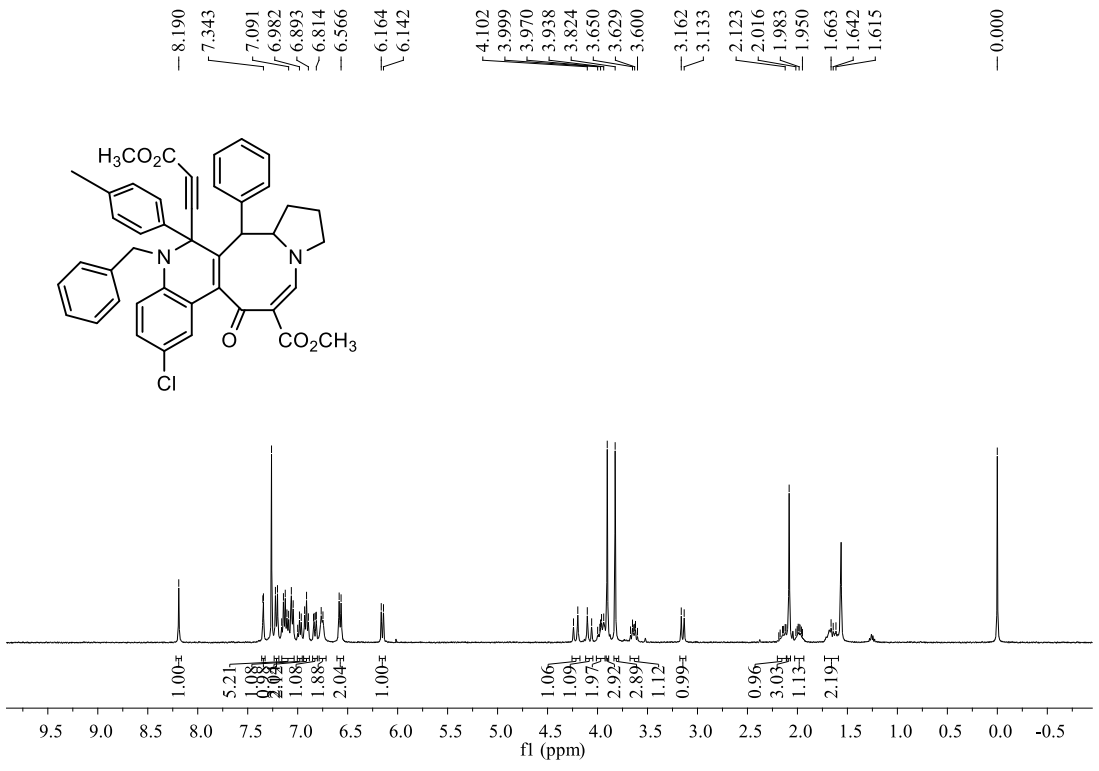

195.01
165.64
159.24
154.96
137.33
135.89
128.09
125.96
114.41
112.93
103.92
85.60
81.87
69.97
68.85
54.73
53.91
52.94
52.05
51.42
29.36
21.72
20.80
230
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

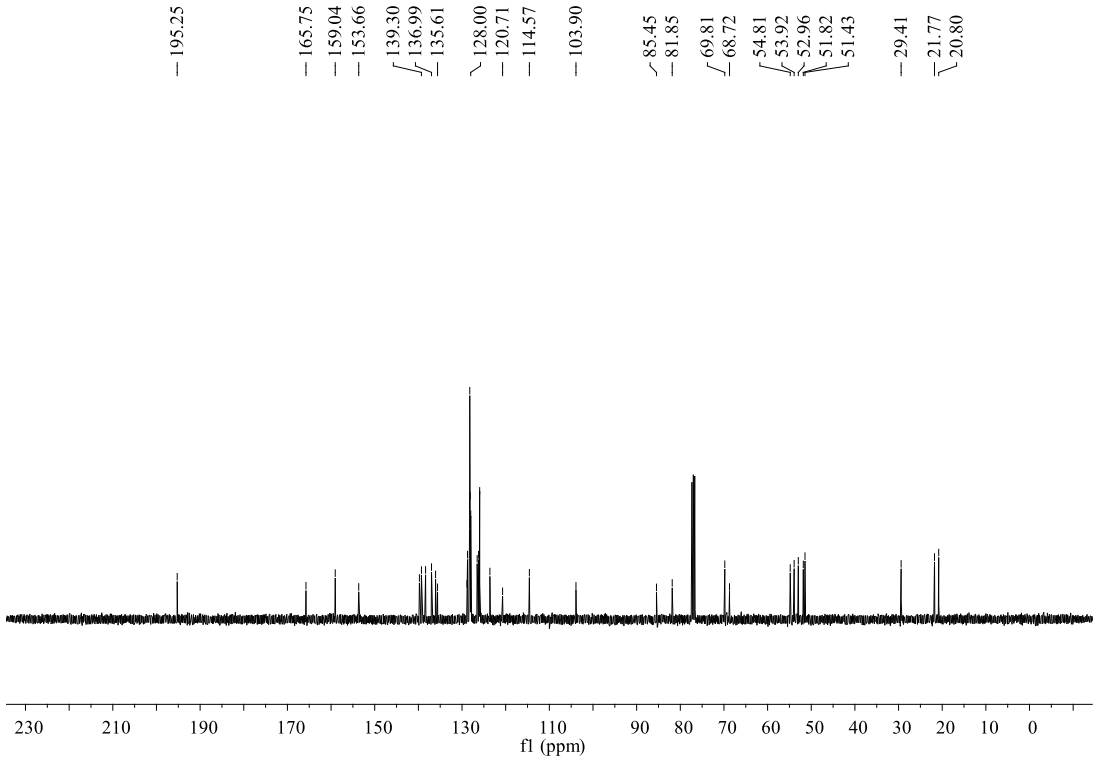

Intens.
x10^4
+MS, 0.04-0.59min #(2-35)
681.2767
682.2800
683.2831
684.2859
1.5
1.0
0.5
0.0
676
678
680
682
684
686
688
m/z

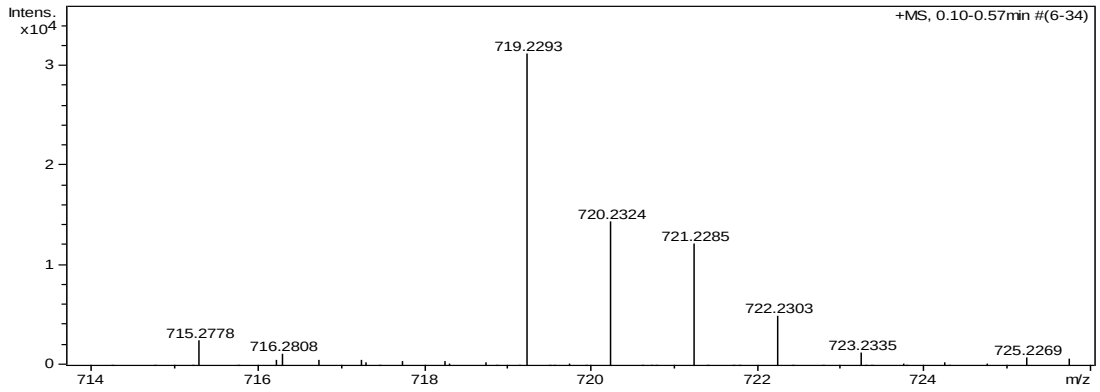
Methyl

(*E*)-2-benzyl-5-chloro-1-(3-methoxy-3-oxoprop-1-yn-1-yl)-7-oxo-14-phenyl-1-(*p*-tolyl)-1,2,7,11,12,13,13a,14-octahydropyrrolo[1',2':1,2]azocino[4,5-*c*]quinoline-8-carboxylate (2p):

yellow solid, 58%, m.p. 261~263℃; 1H NMR (400 MHz, CDCl3) δ: 8.19 (s, 1H, CH), 7.35 (d, *J* = 2.0 Hz, 1H, ArH), 7.21 (d, *J* = 8.4 Hz, 2H, ArH), 7.16~7.04 (m, 5H, ArH), 6.98 (t, *J* = 7.2 Hz, 1H, ArH), 6.91 (t, *J* = 7.6 Hz, 2H, ArH), 6.83 (dd, J_1 = 8.8, J_2 =2.4 Hz, 1H, ArH), 6.75(d, *J* = 7.2 Hz, 2H, ArH), 6.58 (d, *J* = 7.6 Hz, 2H, ArH), 6.15 (d, *J* = 8.8 Hz, 1H, ArH), 4.22 (d, *J* = 17.2 Hz, 1H, CH_2), 4.08 (d, *J* = 17.2 Hz, 1H, CH_2), 4.01~3.92 (m, 2H, CH_2), 3.90 (s, 3H, OCH_3), 3.82 (s, 3H, OCH_3), 3.67~3.64 (m, 1H), 3.15 (d, *J* = 11.6 Hz, 1H), 2.20~2.11 (m, 1H, CH_2), 2.08 (s, 3H, CH_3), 2.03~1.94 (m, 1H, CH_2), 1.73~1.59 (m, 2H, CH_2); ^{13}C NMR (101 MHz, $CDCl_3$) δ 195.2, 165.7, 159.0, 153.6, 139.7, 139.3, 138.3, 136.9, 136.0, 135.6, 128.8, 128.7, 128.2, 128.2, 128.1, 128.0, 126.5, 126.1, 126.1, 125.9, 123.6, 120.7, 114.5, 103.9, 85.4, 81.8, 69.8, 68.7, 54.8, 53.9, 52.9, 51.8, 51.4, 29.4, 21.7, 20.8; IR (KBr) υ: 3300, 2956, 2221, 1714, 1683, 1579, 1502, 1453, 1355, 1324, 1248, 1190, 1149, 1119, 1042, 951, 809, 750 cm^{-1}; MS (*m*/*z*): HRMS (ESI) Calcd. for $C_{43}H_{37}ClN_2NaO_5$ ($[M+Na]^+$): 719.2283, found: 719.2293.



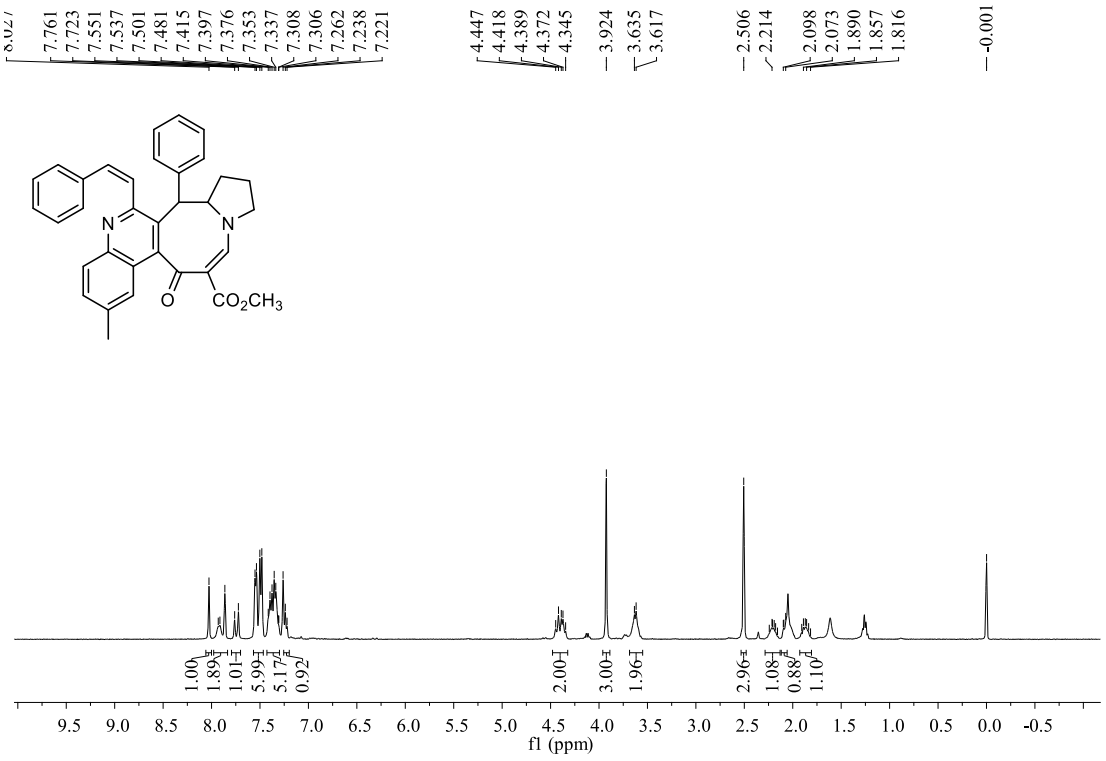

195.25
165.75
159.04
153.66
139.30
136.99
135.61
128.00
120.71
114.57
103.90
85.45
81.85
69.81
68.72
54.81
53.92
52.96
51.82
51.43
29.41
21.77
20.80
230
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

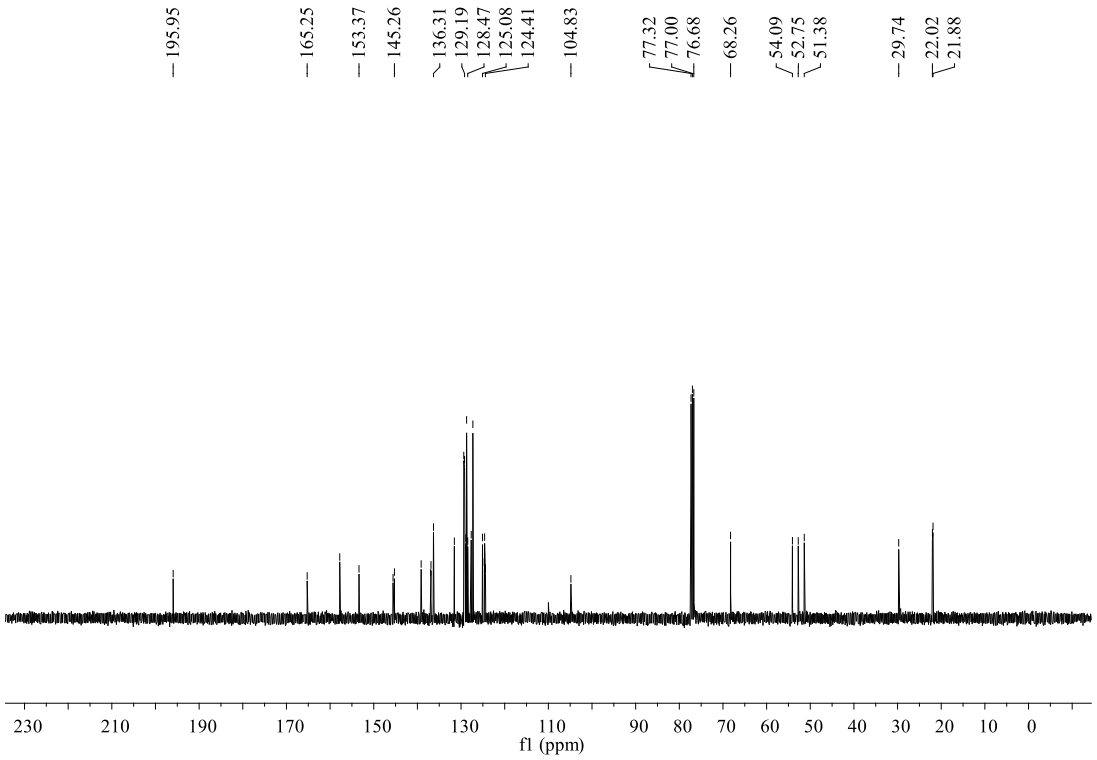

Intens.
x10^4
+MS, 0.10-0.57min #(6-34)
719.2293
720.2324
721.2285
722.2303
715.2778
716.2808
723.2335
725.2269
714
716
718
720
722
724
m/z

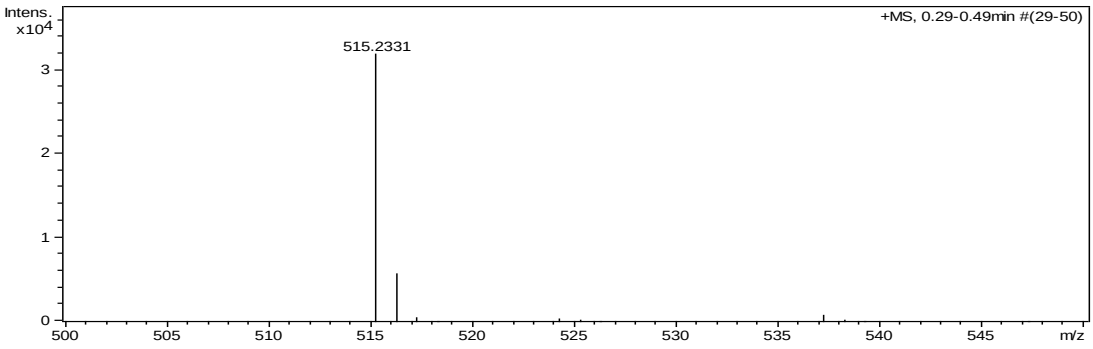
Methyl

(*E*)-5-methyl-7-oxo-14-phenyl-1-((*Z*)-styryl)-7,11,12,13,13a,14-hexahydropyrrolo[1',2':1,2]azocino[4,5-*c*]quinoline-8-carboxylate (3a):

yellow solid, 63%, m.p. 260~262℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.03 (s, 1H, CH), 7.93~7.86 (m, 2H, ArH), 7.74 (d, *J* = 15.2 Hz, 1H, ArH), 7.55~7.48 (m, 6H, ArH), 7.37 (m, 5H, ArH, CH), 7.23 (d, *J* = 6.8 Hz, 1H, CH), 4.48~4.32 (m, 2H, CH), 3.92 (s, 3H, OCH_3), 3.63 (d, *J* = 7.0 Hz, 2H, CH), 2.51 (s, 3H, CH_2), 2.24~2.15 (m, 1H, CH_2), 2.12~2.06 (m, 1H, CH_2), 1.93~1.81 (m, 1H, CH_2); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 195.9, 165.2, 157.8, 153.3, 139.1, 136.9, 136.4, 131.5, 129.37, 129.1, 128.8, 128.7, 128.5, 127.6, 127.3, 125.0, 124.6, 124.4, 104.7, 68.2, 54.1, 52.7, 51.3, 29.7, 22.0, 21.8; IR (KBr) υ: 2945, 1701, 1645, 1547, 1512, 1460, 1324, 1269, 1182, 1190, 1109, 1029, 968, 946, 908, 887 812, 780, 772, 746 cm^{-1}; MS (*m*/*z*): HRMS (ESI) Calcd. for $C_{34}H_{31}N_2O_3$ ($[M+H]^+$): 515.2335, found: 515.2331.



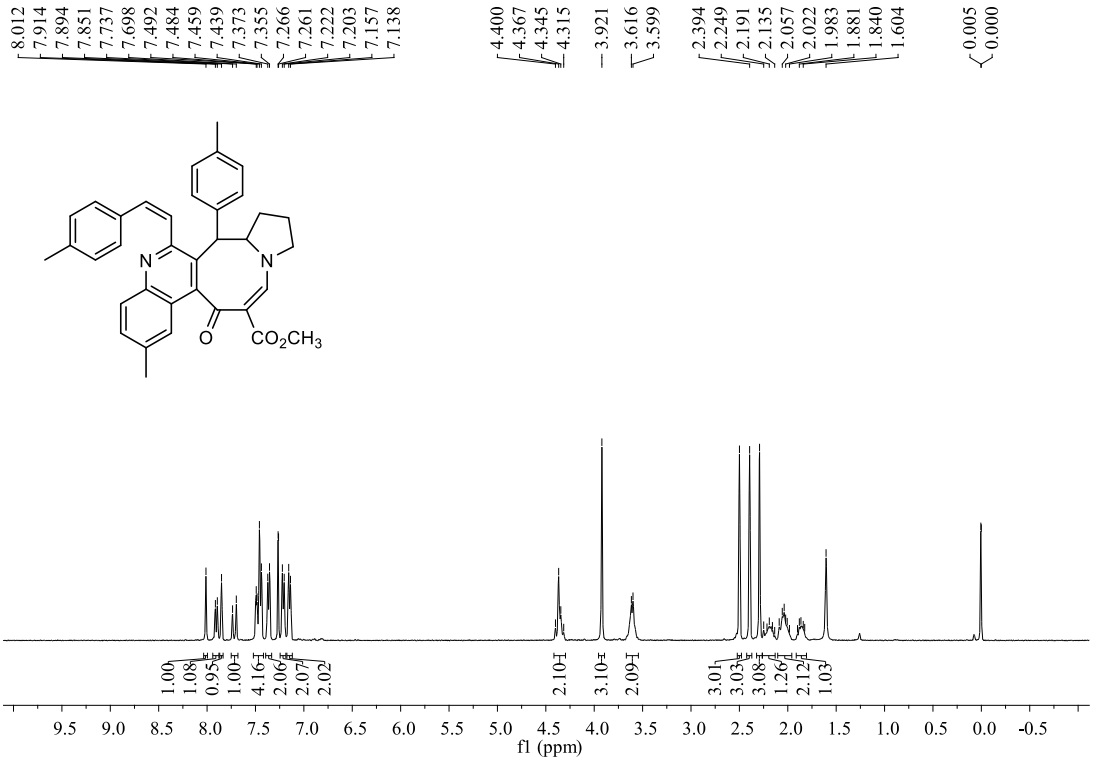

195.95
165.25
153.37
145.26
136.31
129.19
128.47
125.08
124.41
104.83
77.32
77.00
76.68
68.26
54.09
52.75
51.38
29.74
22.02
21.88
230
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

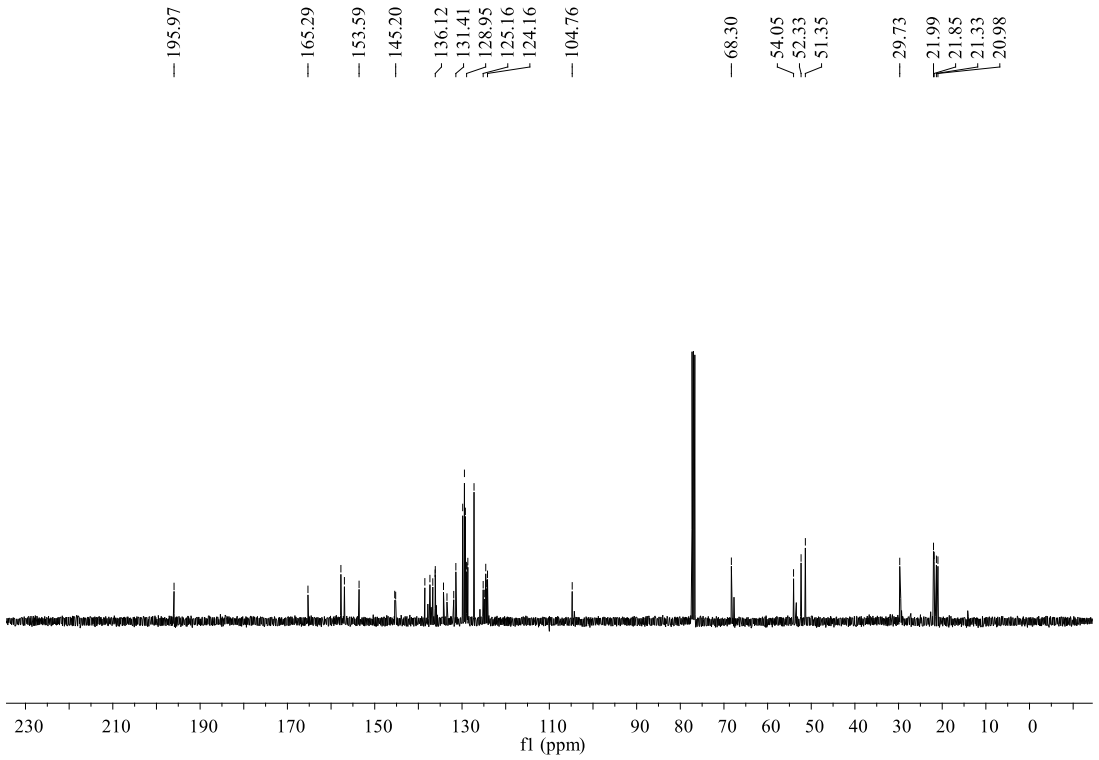

Intens.
x10^4
+MS, 0.29-0.49min #(29-50)
515.2331
3
2
1
0
500
505
510
515
520
525
530
535
540
545
m/z

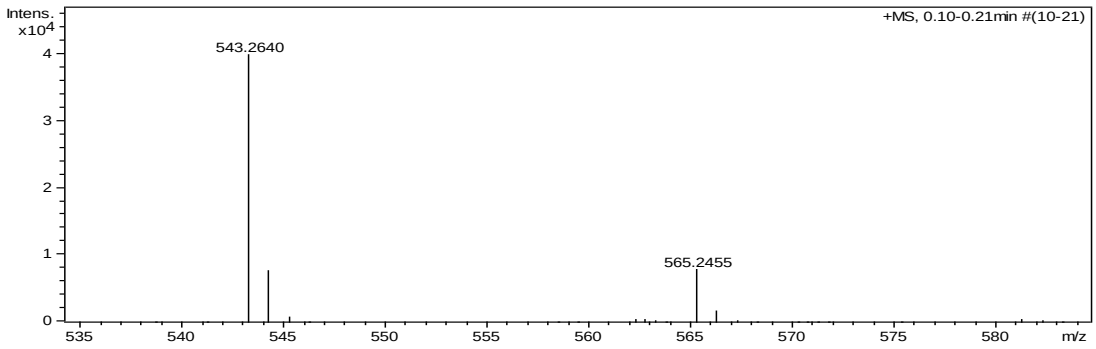
Methyl

(*E*)-5-methyl-1-((Z)-4-methylstyryl)-7-oxo-14-(*p*-tolyl)-7,11,12,13,13a,14-hexahydropyrrolo[1',2':1,2]azocino[4,5-*c*]quinoline-8-carboxylate (3b):

yellow solid, 70%, m.p. 293~295℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.01 (s, 1H, CH), 7.90 (d, *J* = 8.0 Hz, 1H, ArH), 7.85 (s, 1H), 7.72 (d, *J* = 15.4 Hz, 1H, ArH), 7.47 (dd, J_1 = 15.6 Hz, J_1 = 5.8 Hz, 4H, ArH), 7.36 (d, *J* = 7.2 Hz, 2H, ArH), 7.27 (s, 1H, ArH), 7.21 (d, *J* = 7.5 Hz, 2H, ArH), 7.15 (d, *J* = 7.3 Hz, 2H, CH), 4.42~4.30 (m, 2H, CH), 3.92 (s, 3H, OCH_3), 3.61 (d, *J* = 6.7 Hz, 2H, CH_2), 2.50 (s, 3H, CH_3), 2.39 (s, 3H, CH_3), 2.29 (s, 3H, CH_3), 2.22~2.13(m, 1H, CH_2), 2.09~1.98 (m, 2H, CH_2), 1.90~1.82 (m, 1H, CH_2); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 195.9, 165.3, 157.8, 153.6, 145.2, 138.5, 137.3, 136.2, 136.1, 136.4, 134.2, 129.8, 129.1, 128.9, 128.8, 128.6, 127.2, 125.2,124.8, 124.6, 124.3, 12.4.1, 104.7, 68.3, 54.0, 52.3, 51.3, 29.7, 22.0, 21.8, 21.3, 20.9; IR (KBr) υ: 2945, 1701, 1645, 1547, 1512, 1460, 1324, 1269, 1182, 1190, 1109, 1029, 968, 946, 908, 887, 812, 780, 772, 746 cm^{-1}; MS (*m*/*z*): HRMS (ESI) Calcd. for $C_{36}H_{35}N_2O_3$ ($[M+H]^+$): 543.2642, found: 543.2640.



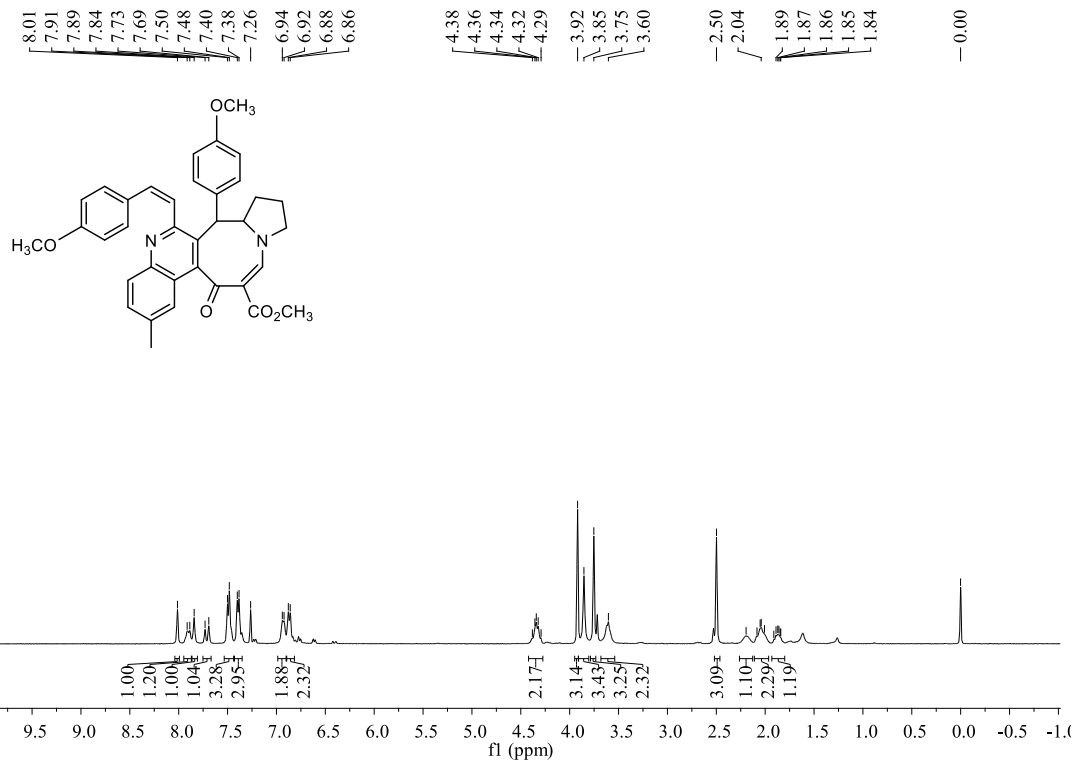

195.97
165.29
153.59
145.20
136.12
131.41
128.95
125.16
124.16
104.76
68.30
54.05
52.33
51.35
29.73
21.99
21.85
21.33
20.98
230
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

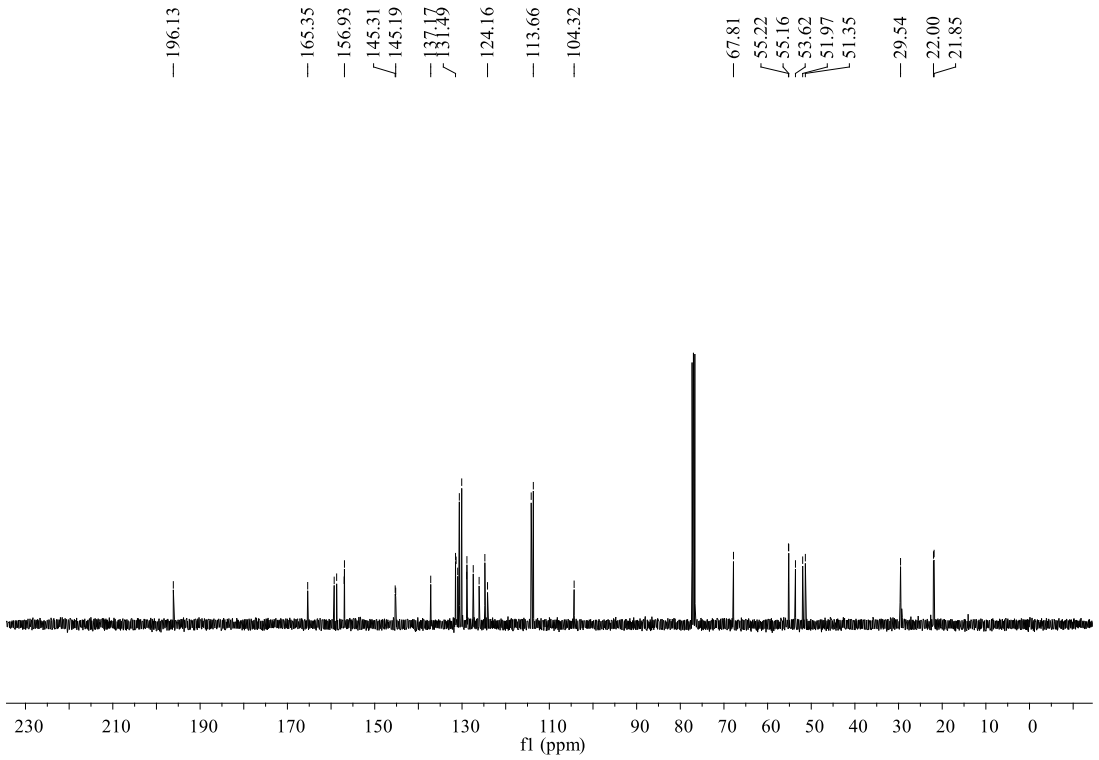

Intens.
x10^4
+MS, 0.10-0.21min #(10-21)
543.2640
565.2455
0
1
2
3
4
535
540
545
550
555
560
565
570
575
580
m/z

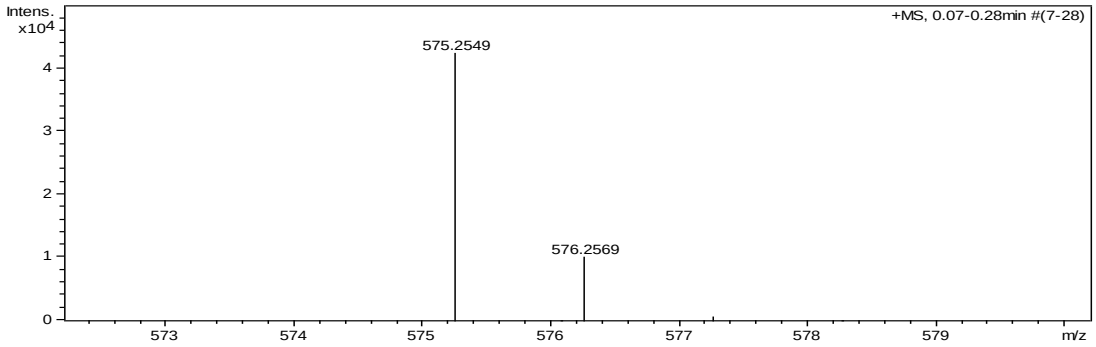
Methyl

(*E*)-14-(4-methoxyphenyl)-1-((*Z*)-4-methoxystyryl)-5-methyl-7-oxo-7,11,12,13,13a,14-hexahydropyrrolo[1',2':1,2]azocino[4,5-*c*]quinoline-8-carboxylate (3c):

yellow solid, 80%, m.p. 265~267℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.01 (s, 1H, CH, ArH), 7.90 (d, *J* = 10.8 Hz, 1H, ArH), 7.84 (s, 1H, ArH), 7.71 (d, *J* = 15.3 Hz, 1H, ArH), 7.49 (d, *J* = 7.4 Hz, 3H, ArH), 7.39 (d, *J* = 7.0 Hz, 3H, ArH), 6.93 (d, *J* = 7.0 Hz, 2H, ArH), 6.87 (d, *J* = 7.9 Hz, 2H, CH), 4.38~4.29 (m, 2H, CH), 3.92 (s, 3H, OCH_3), 3.85 (s, 3H), 3.75 (s, 3H, OCH_3), 3.60 (s, 2H, CH_2), 2.50 (s, 3H, CH_3), 2.20 (s, 1H, CH_2), 2.04 (s, 2H, CH_2), 1.91~1.84 (m, 1H, CH_2); ^{13}C NMR (101 MHz, $CDCl_3$) δ: ^{13}C NMR (101 MHz, $CDCl_3$) δ: 196.1, 165.2, 160.0, 158.7, 157.0, 156.9, 145.3, 145.2, 137.1, 131.5, 131.2, 131.0, 130.6, 130.0, 129.0, 128.9, 127.4, 126.1, 124.8, 124.2, 114.1, 113.7, 104.3, 67.8, 55.2, 55.1, 53.6, 52.0, 51.3, 29.5, 22.0, 21.8; IR (KBr) υ: 2948, 2836, 1706, 1637, 1604, 1583, 1548, 1511, 1460, 1423, 1357, 1325, 1302, 1253, 1176, 1150, 1111, 1034, 966, 823, 776 cm^{-1}; MS (*m*/*z*): HRMS (ESI) Calcd. for $C_{36}H_{35}N_2O_5$ ([M+H]$^+$): 575.2540, found: 575.2549.



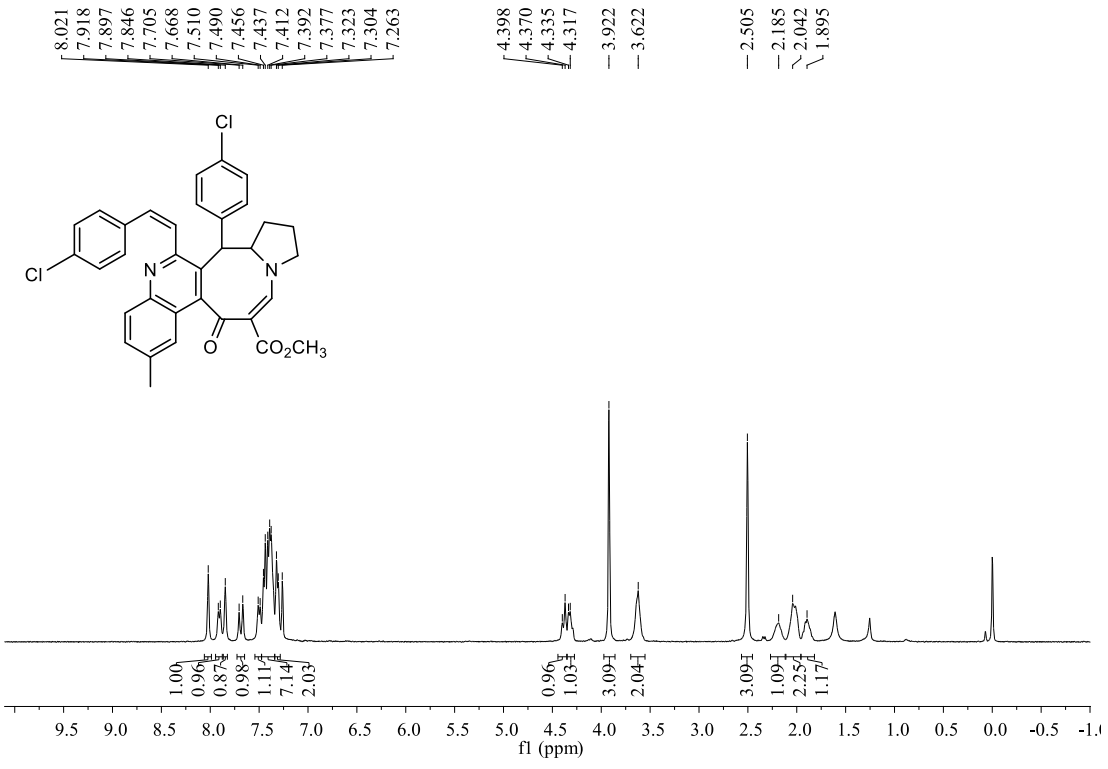

196.13
165.35
156.93
145.31
145.19
137.17
131.49
124.16
113.66
104.32
67.81
55.22
55.16
53.62
51.97
51.35
29.54
22.00
21.85
230
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

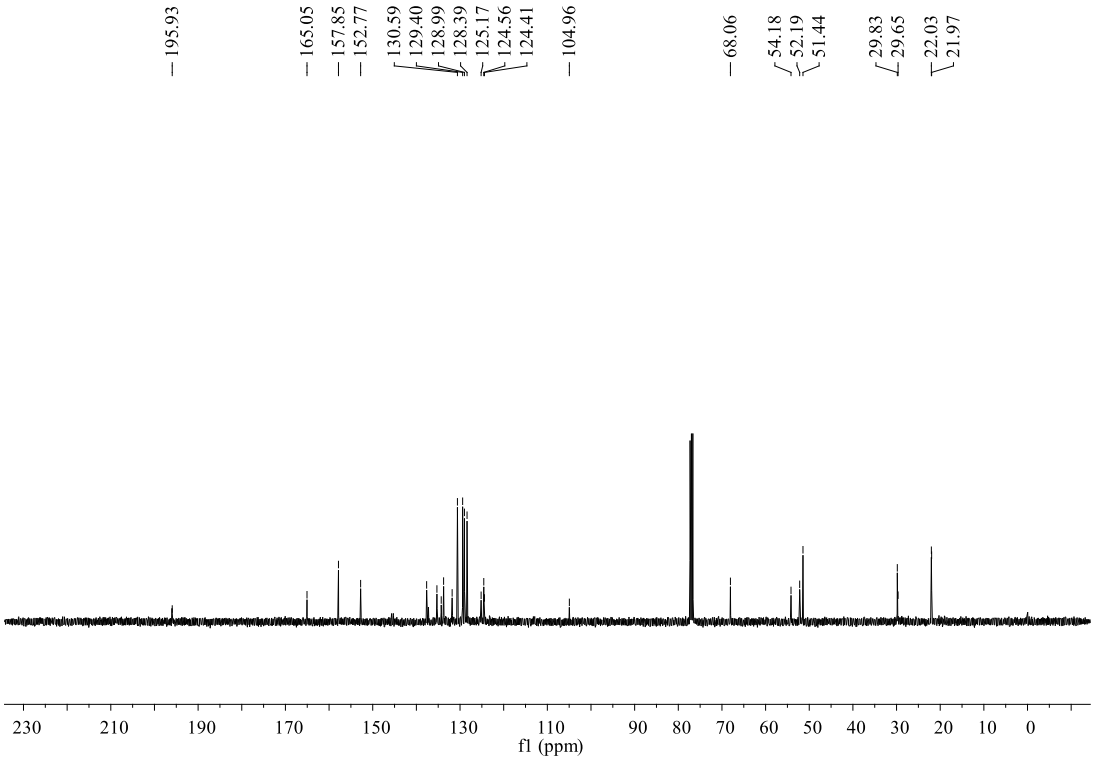

Intens.
x10^4
+MS, 0.07-0.28min #(7-28)
575.2549
576.2569
0
1
2
3
4
573
574
575
576
577
578
579
m/z

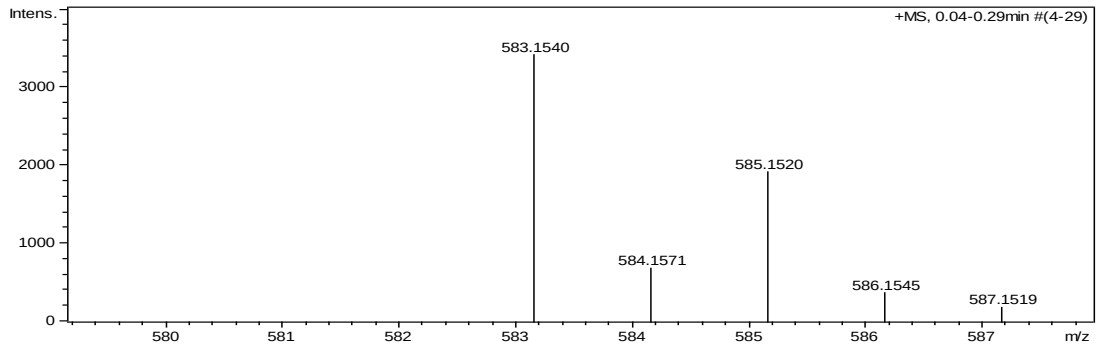
Methyl

(*E*)-14-(4-chlorophenyl)-1-((*Z*)-4-chlorostyryl)-5-methyl-7-oxo-7,11,12,13,13a,14-hexahydropyrrolo[1',2':1,2]azocino[4,5-*c*]quinoline-8-carboxylate (3d):

yellow solid, 52%, m.p. 265~267℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.02 (s, 1H, CH), 7.91 (d, *J* = 8.4 Hz, 1H, ArH), 7.85 (s, 1H, ArH), 7.69 (d, *J* = 14.8 Hz, 1H, ArH), 7.50 (d, *J* = 8.0 Hz, 1H, ArH), 7.48~7.34 (m, 7H, ArH), 7.31 (d, *J* = 7.6 Hz, 2H, CH), 4.38 (d, *J* = 11.4 Hz, 1H, CH), 4.34~4.28 (m, 1H, CH), 3.92 (s, 3H, OCH_3), 3.62 (s, 2H, CH_2), 2.51 (s, 3H, CH_3), 2.23~2.16 (m, 1H, CH_2), 2.04~2.01(m, 2H, CH_2), 1.94~1.84 (m, 1H, CH_2); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 195.9, 165.0, 157.8, 152.7, 137.6, 137.4, 135.3, 134.3, 133.7, 131.8, 130.5, 129.4, 128.9, 128.3, 125.1, 124.5, 124.4, 104.9, 68.0, 54.2, 52.2, 51.4, 29.8, 29.6, 22.0, 21.9; IR (KBr) υ: 2943, 1705, 1632, 1582, 1547, 1471, 1433, 1356, 1324, 1270, 1201, 1180, 1148, 1105, 1037, 1001, 968, 946, 908, 885, 833, 776, 755 cm^{-1}; MS (*m*/*z*): HRMS (ESI) Calcd. for $C_{34}H_{29}Cl_2N_2O_3$ ($[M+H]^+$): 583.1550, found: 583.1540.



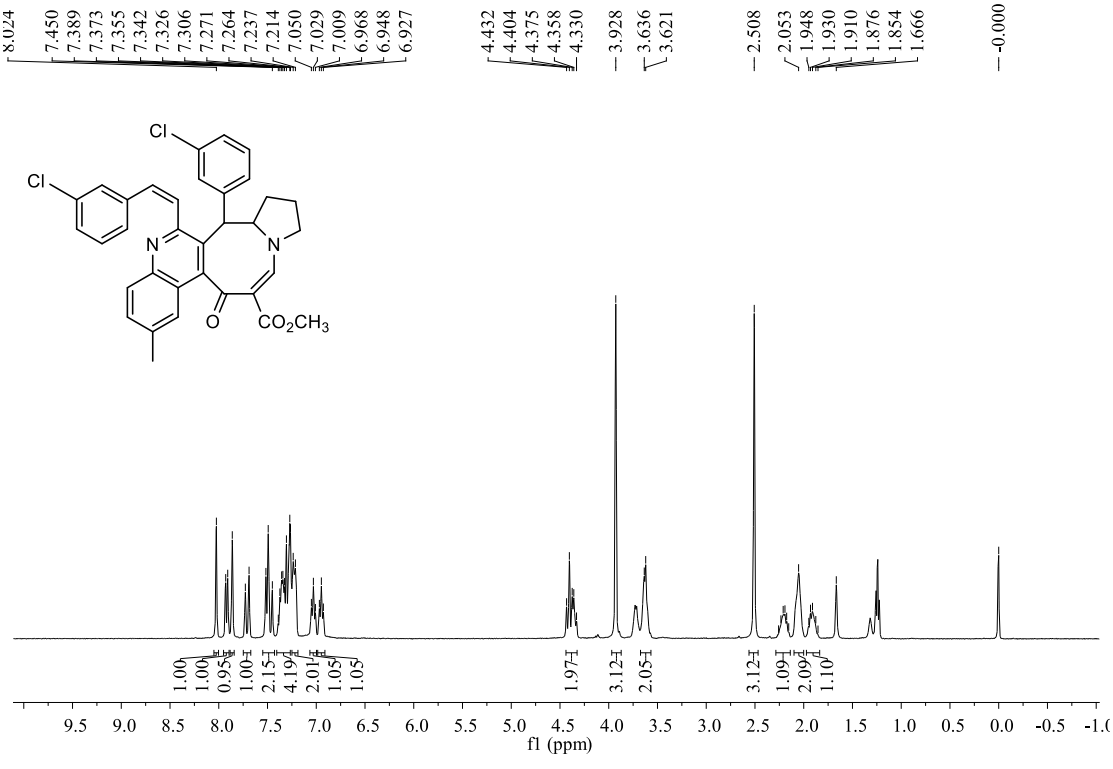

195.93
165.05
157.85
152.77
130.59
129.40
128.99
128.39
125.17
124.56
124.41
104.96
68.06
54.18
52.19
51.44
29.83
29.65
22.03
21.97
230
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

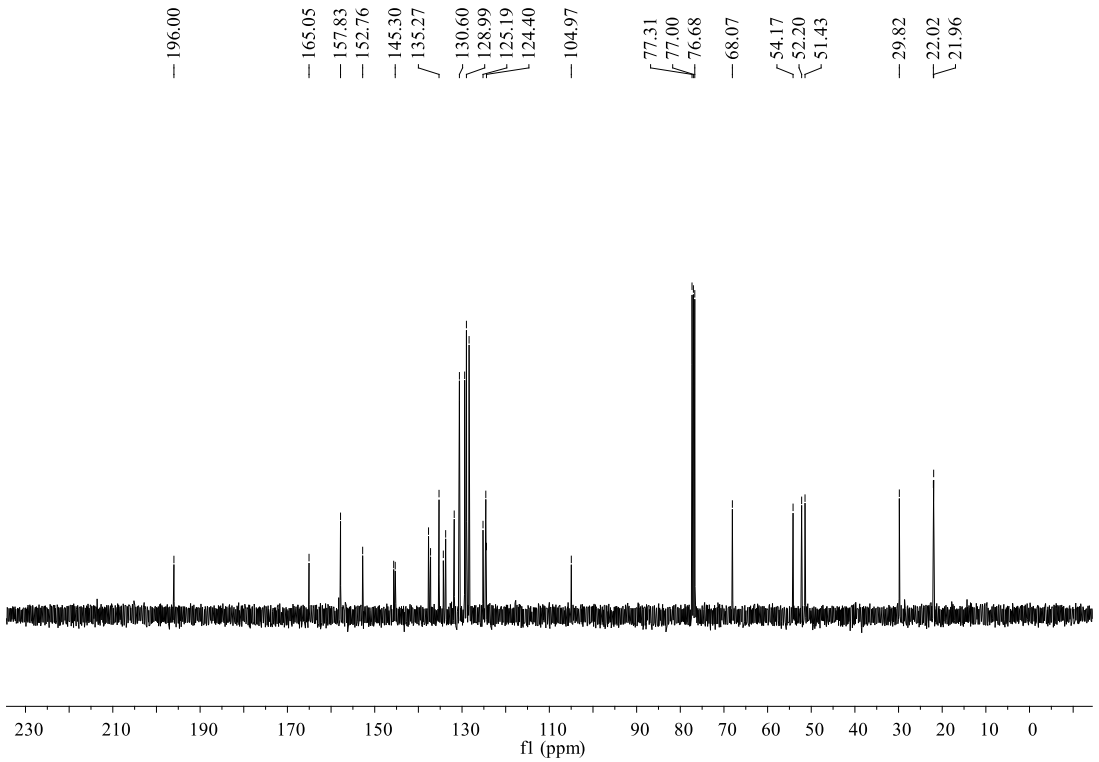

Intens.
+MS, 0.04-0.29min #(4-29)
583.1540
585.1520
584.1571
586.1545
587.1519
3000
2000
1000
0
580
581
582
583
584
585
586
587
m/z

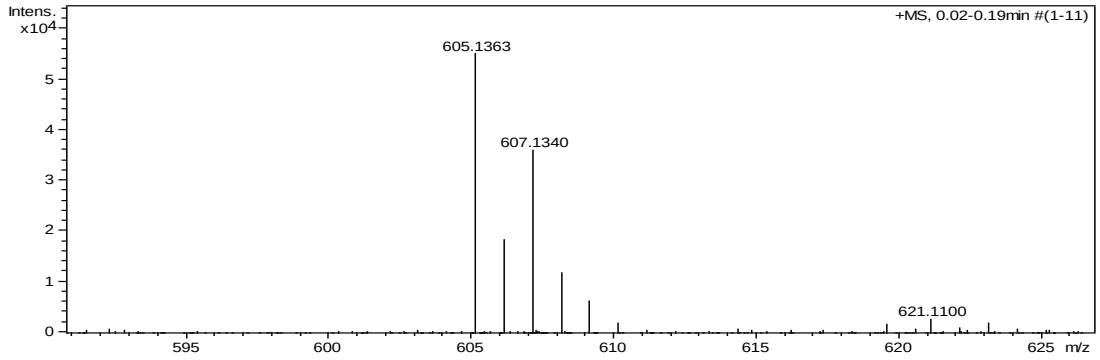
Methyl

(*E*)-14-(3-chlorophenyl)-1-((*Z*)-3-chlorostyryl)-5-methyl-7-oxo-7,11,12,13,13a,14-hexahydropyrrolo[1',2':1,2]azocino[4,5-*c*]quinoline-8-carboxylate (3e):

yellow solid, 48%, m.p. 265~267℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.02 (s, 1H, CH), 7.92 (d, *J* = 8.4 Hz, 1H, ArH), 7.86 (s, 1H, ArH), 7.71 (d, *J* = 15.2 Hz, 1H, ArH), 7.50~7.45 (m, 2H, ArH), 7.41~7.27 (m, 4H, ArH), 7.23 (d, *J* = 9.2 Hz, 2H, ArH), 7.03 (t, *J* = 8.2 Hz, 1H, CH), 6.95 (t, *J* = 8.2 Hz, 1H, CH), 4.44~4.32 (m, 2H, CH), 3.93 (s, 3H, OCH_3), 3.64~3.62 (m, 2H, CH_2), 2.51 (s, 3H, CH_3), 2.26~2.15(m, 1H, CH_2), 2.05 (s, 2H, CH_2), 1.95~1.85(m, 1H, CH_2); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 196.0, 165.0, 157.8, 152.7, 145.6, 145.3, 137.6, 137.2, 135.2, 134.2, 133.7, 131.7, 130.6, 129.4, 128.9, 128.3, 125.1, 124.5, 124.4, 104.9, 68.0, 54.1, 52.2, 51.4, 29.8, 22.0, 21.9; IR (KBr) υ: 2949, 1705, 1630, 1587, 1547, 1490, 1458, 1415, 1358, 1324, 1269, 1182, 1148, 1108, 1091, 1037, 1010, 962, 887, 812, 772 cm^{-1}; MS (*m*/*z*): HRMS (ESI) Calcd. for $C_{34}H_{28}Cl_2N_2NaO_3$ ($[M+Na]^+$): 605.1369, found: 605.1363.



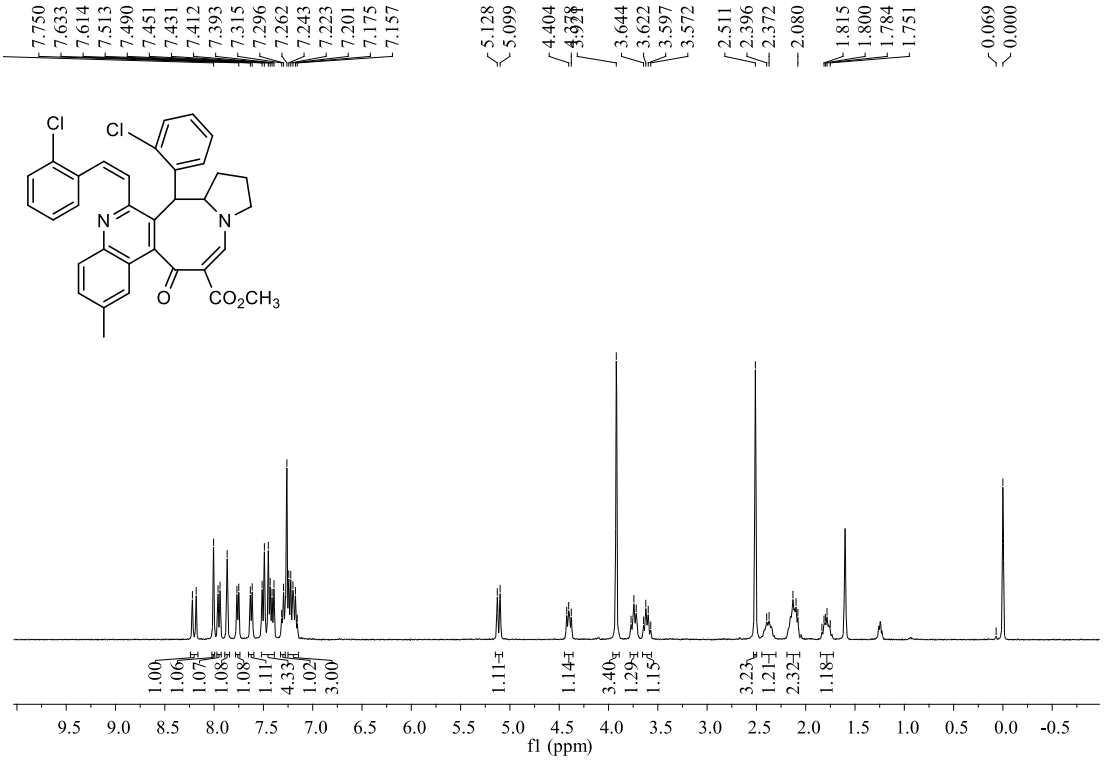

196.00
165.05
157.83
152.76
145.30
135.27
130.60
128.99
125.19
124.40
104.97
77.31
77.00
76.68
68.07
54.17
52.20
51.43
29.82
22.02
21.96
230
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

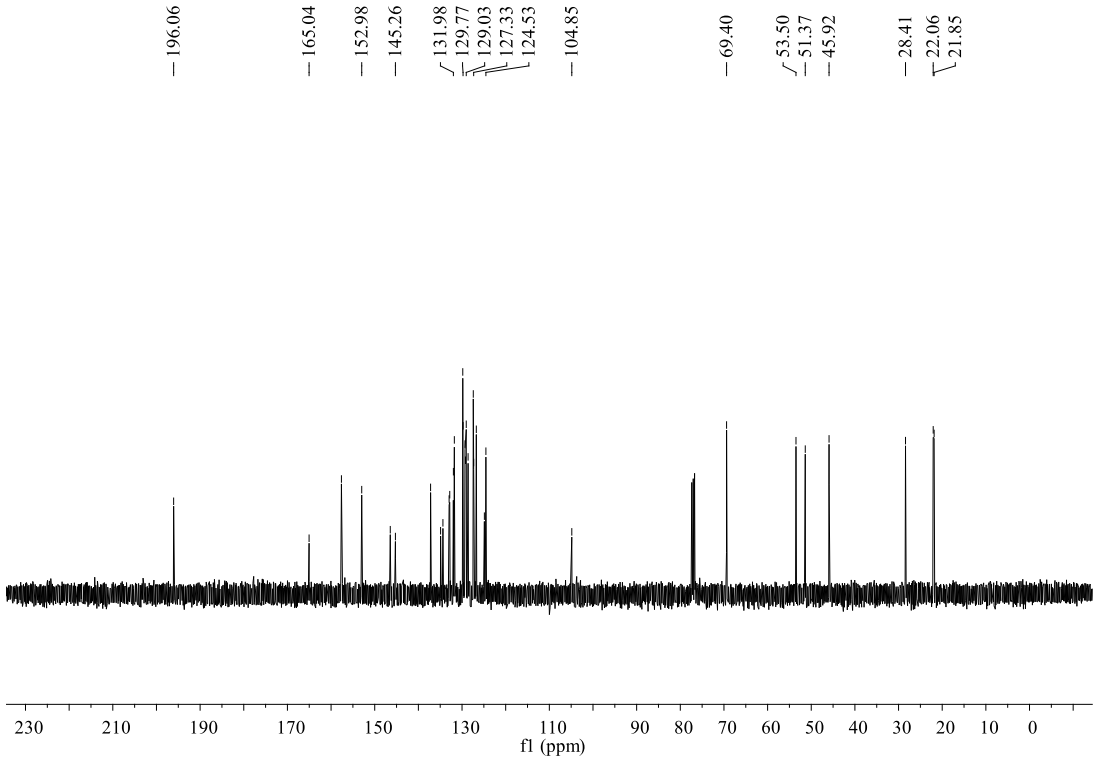

Intens.
x10^4
+MS, 0.02-0.19min #(1-11)
605.1363
607.1340
621.1100
595
600
605
610
615
620
625
m/z

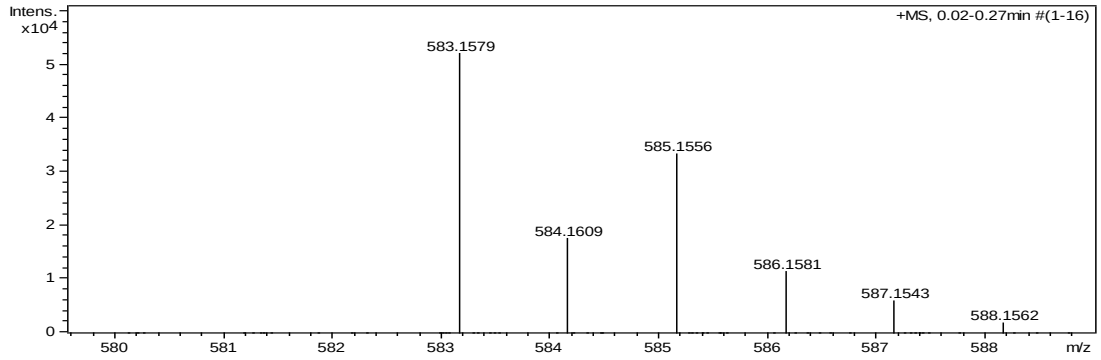
Methyl

(*E*)-14-(2-chlorophenyl)-1-((*Z*)-2-chlorostyryl)-5-methyl-7-oxo-7,11,12,13,13a,14-hexahydropyrrolo[1',2':1,2]azocino[4,5-*c*]quinoline-8-carboxylate (3f):

yellow solid, 53%, m.p. 262~264℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.20 (d, *J* = 15.2 Hz, 1H, ArH), 8.01 (s, 1H, CH), 7.95 (d, *J* = 8.0 Hz, 1H, ArH), 7.87 (s, 1H, ArH), 7.76 (d, *J* = 7.6 Hz, 1H, ArH), 7.62 (d, *J* = 7.6 Hz, 1H), 7.50~7.42 (m, 4H, ArH), 7.31 (d, *J* = 7.6 Hz, 1H, ArH), 7.25~7.14 (m, 3H, ArH, CH), 5.11 (d, *J* = 11.6 Hz, 1H, CH), 4.45~4.36 (m, 1H, CH), 3.92 (s, 3H, OCH_3), 3.77~3.72 (m, 1H, CH_2), 3.64~3.57 (m, 1H , CH_2), 2.51 (s, 3H, CH_3), 2.38 (d, *J* = 9.6 Hz, 1H, CH_2), 2.19~2.06 (m, 2H, CH_2), 1.81~1.75 (m, 1H, CH_2); ^{13}C NMR (101MHz, $CDCl_3$) δ: 196.0, 165.0, 157.6, 152.9, 146.4, 145.2, 137.2, 134.9, 134.3, 132.9, 132.8, 131.9, 131.7, 129.8, 129.7, 129.3, 129.2, 129.0, 128.6, 127.4, 127.3, 126.7, 124.8, 124.5, 104.8, 69.4, 53.5, 51.3, 45.9, 28.4, 22.0, 21.8; IR (KBr) υ: 2947, 1702, 1677, 1635, 1581, 1547, 1512, 1460, 1430, 1329, 1275, 1184, 1149, 1109, 1039, 999, 970, 824, 808, 760 cm^{-1}; MS (*m*/*z*): HRMS (ESI) Calcd. for $C_{34}H_{29}Cl_2N_2O_3$ ($[M+H]^+$): 583.1550, found: 583.1579.



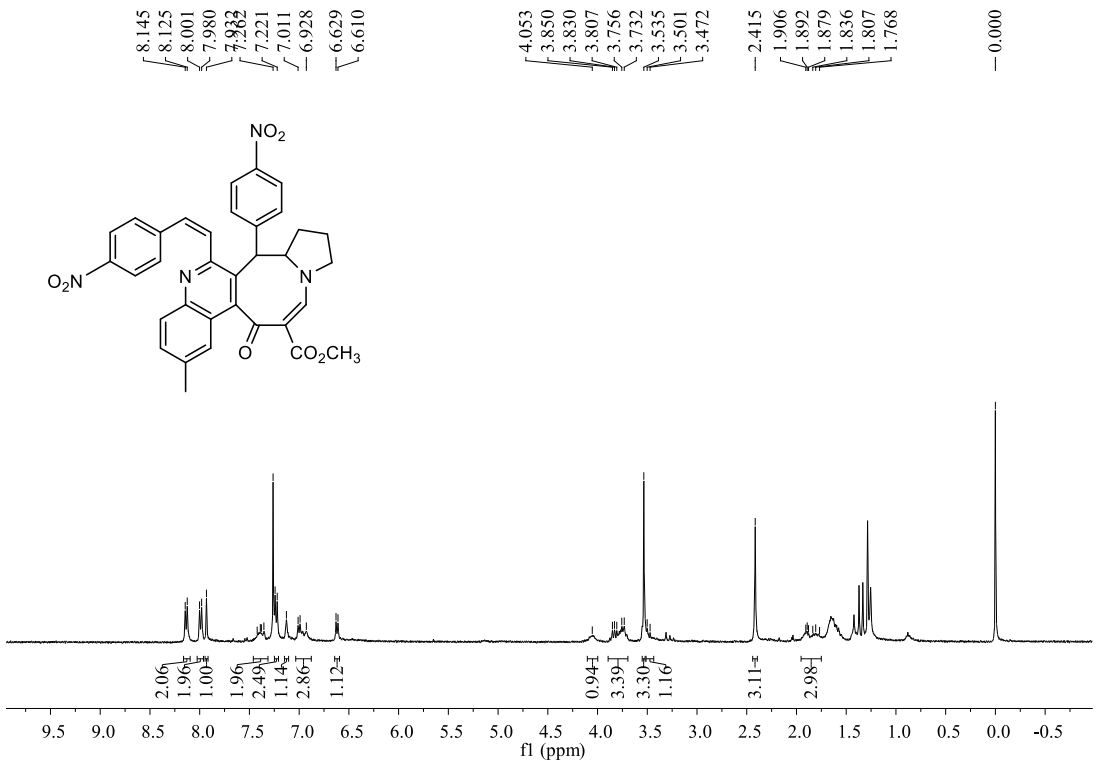

196.06
165.04
152.98
145.26
131.98
129.77
129.03
127.33
124.53
104.85
69.40
53.50
51.37
45.92
28.41
22.06
21.85
230
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

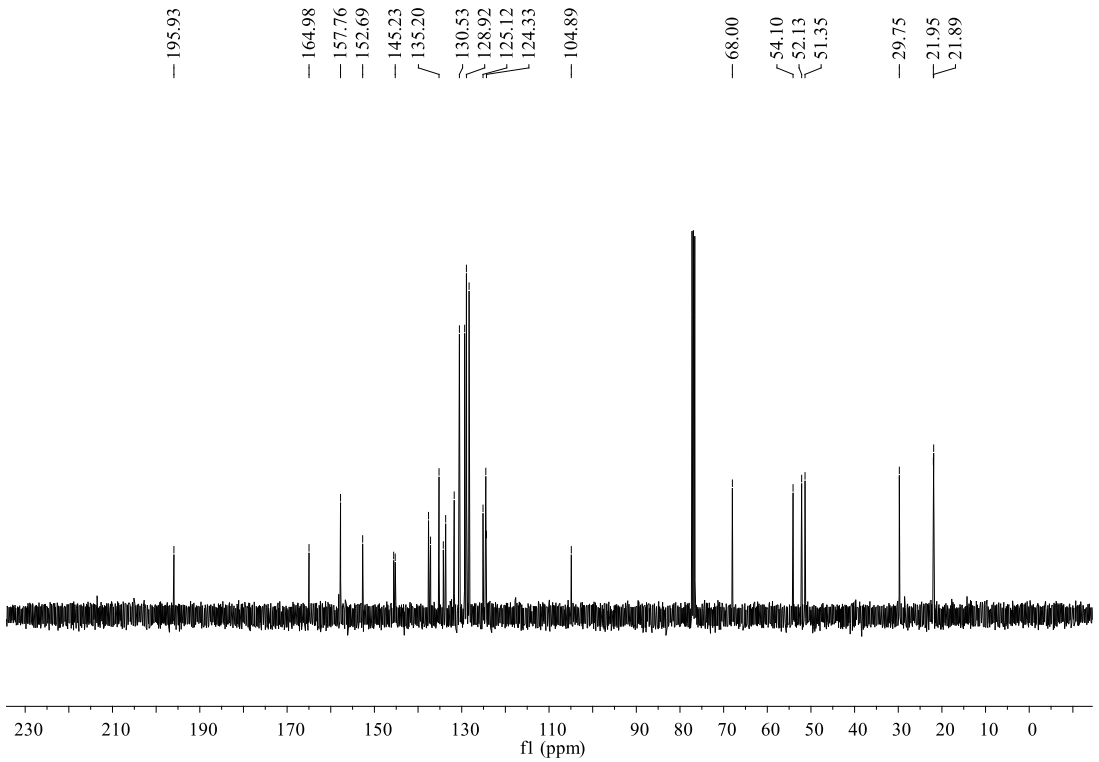

Intens.
x10^4
+MS, 0.02-0.27min #(1-16)
583.1579
585.1556
584.1609
586.1581
587.1543
588.1562
m/z

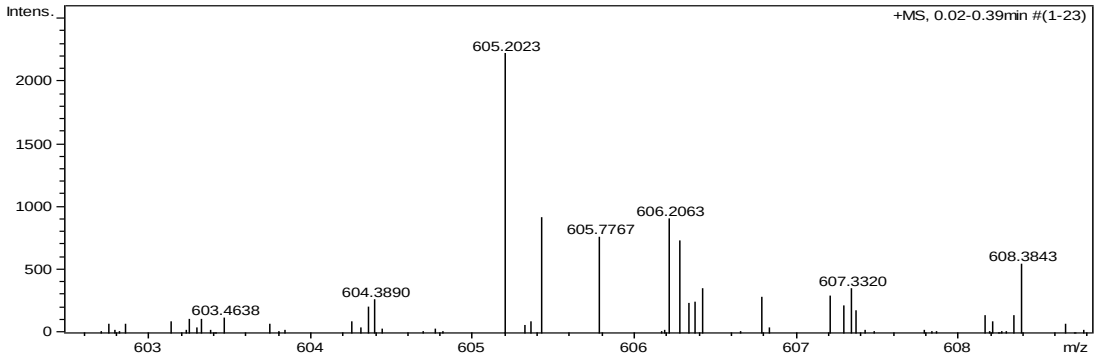
Methyl

(*E*)-5-methyl-14-(4-nitrophenyl)-1-((*Z*)-4-nitrostyryl)-7-oxo-7,11,12,13,13a,14-hexahydropyrrolo[1',2':1,2]azocino[4,5-*c*]quinoline-8-carboxylate (3g):

yellow solid, 50%, m.p. 278~280℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.14 (d, *J* = 8.2 Hz, 2H, ArH), 7.99 (d, *J* = 8.4 Hz, 2H, ArH), 7.93 (s, 1H, CH), 7.42~7.35 (m, 2H, ArH), 7.23 (d, *J* = 8.6 Hz, 2H, ArH), 7.13 (s, 1H, ArH), 7.03~6.88 (m, 3H, ArH, CH), 6.62 (d, *J* = 7.9 Hz, 1H, CH), 4.05 (s, 1H, CH), 3.89~ 3.69 (m, 3H, CH_2), 3.53 (s, 3H OCH_3), 3.49 (d, *J* = 11.8 Hz, 1H, CH_2), 2.41 (s, 3H CH_3), 1.95~1.75 (m, 3H, CH_2); ^{13}C NMR (101MHz, $CDCl_3$) δ: 195.9, 164.9, 157.7, 152.7, 145.6, 145.2, 137.6, 137.1, 135.2, 134.2, 133.7, 131.7, 130.5, 129.3, 128.9, 128.3, 125.1, 124.4, 124.3, 104.8, 68.0, 54.1, 52.1, 51.3, 29.7, 21.9, 21.8; IR (KBr) υ: 2951, 1717, 1614,1520, 1491, 1432, 1346, 1274, 1238, 1190, 1109, 1029, 976, 851, 779, 738, 701 cm^{-1}; MS (*m*/*z*): HRMS (ESI) Calcd. for $C_{34}H_{29}N_4O_7$ ([M+H]$^+$): 605.2031, found: 605.2023.



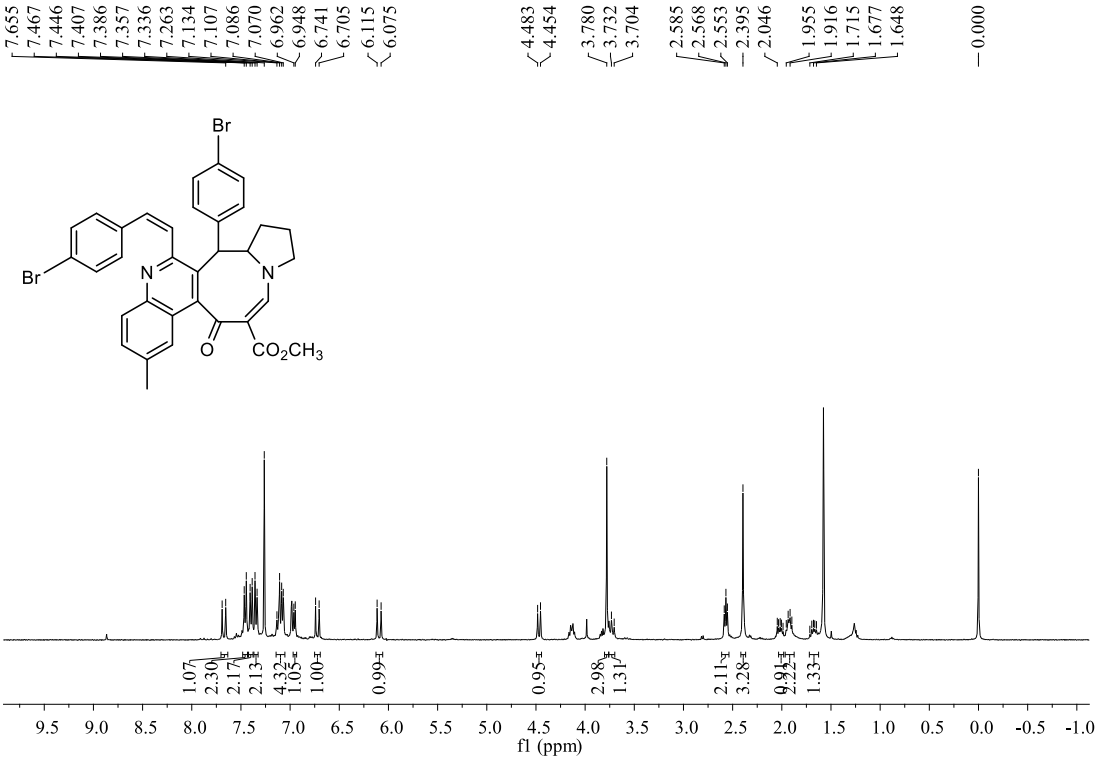

195.93
164.98
157.76
152.69
145.23
135.20
130.53
128.92
125.12
124.33
104.89
68.00
54.10
52.13
51.35
29.75
21.95
21.89
230
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

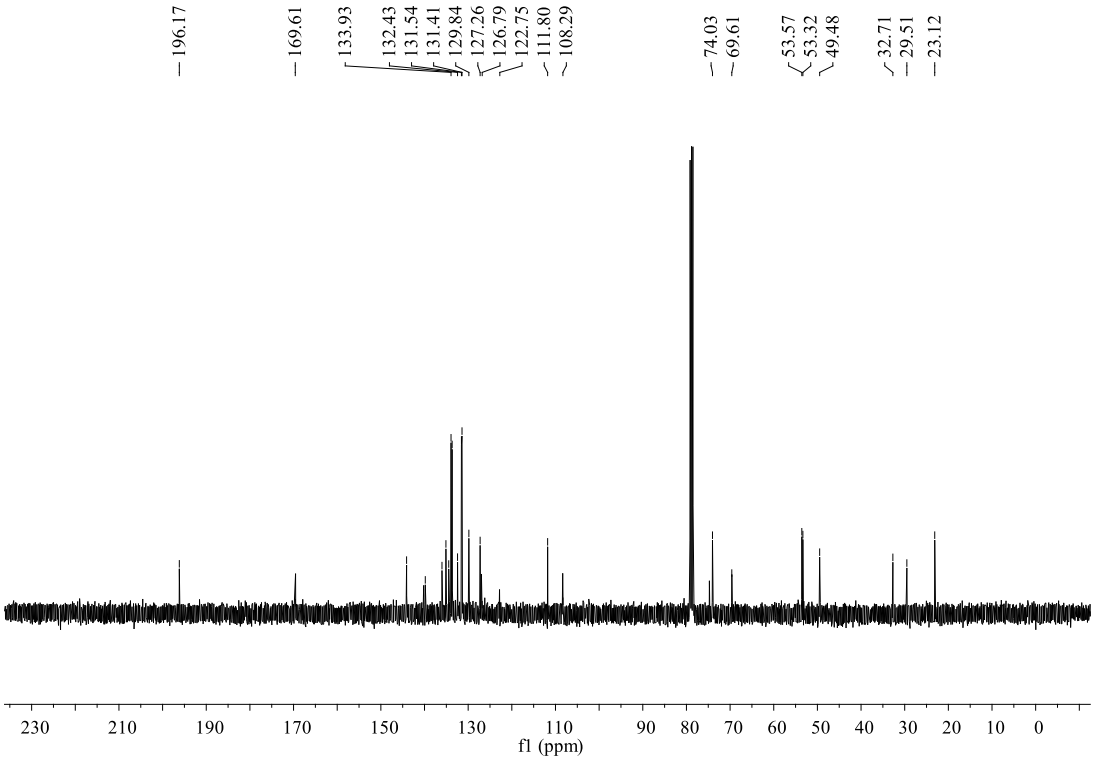

Intens.
+MS, 0.02-0.39min #(1-23)
605.2023
606.2063
605.7767
608.3843
607.3320
604.3890
603.4638
2000
1500
1000
500
0
603
604
605
606
607
608
m/z

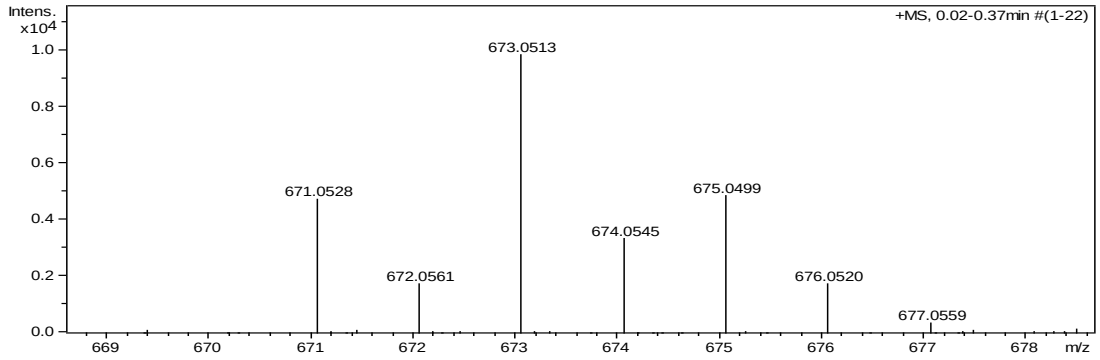
Methyl

(*E*)-14-(4-bromophenyl)-1-((*Z*)-4-bromostyryl)-5-methyl-7-oxo-7,11,12,13,13a,14-hexahydro pyrrolo[1',2':1,2]azocino[4,5-*c*]quinoline-8-carboxylate (3h):

yellow solid, 40%, m.p. 284~286℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.67 (d, *J* = 14.4 Hz, 1H, CH), 7.46 (d, *J* = 8.4 Hz, 2H, ArH), 7.40 (d, *J* = 8.4 Hz, 2H, ArH), 7.35 (d, *J* = 8.4 Hz, 2H, ArH), 7.11~7.07 (m, 4H, ArH), 6.95 (d, *J* = 5.6 Hz, 1H, ArH), 6.72 (d, *J* = 14.4 Hz, 1H, CH), 6.10 (d, *J* = 16.2 Hz, 1H, CH), 4.47 (d, *J* = 11.6 Hz, 1H, CH), 3.72 (s, 3H, OCH_3), 2.57 (t, *J* = 6.4 Hz, 2H, CH_2), 2.40 (s, 3H, CH_3), 2.03~1.98 (m, 1H, CH_2), 1.936~1.90(m, 2H, CH_2), 1.72~1.63 (m, 1H, CH_2); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 196.2, 169.6, 144.1, 140.2, 139.8, 136.0, 135.1, 134.4, 133.9, 133.6, 132.4, 131.5, 131.4, 129.8, 127.2, 126.7, 122.7, 111.8, 108.2, 74.0, 69.6, 53.5, 5.3, 49.4, 32.7, 29.5, 23.1; IR (KBr) υ: 945, 1710, 1684,1626, 1601, 1488, 1432, 1399, 1324, 1271, 1197, 1107,1071, 1008, 815, 760 cm^{-1}; MS (*m*/*z*): HRMS (ESI) Calcd. for $C_{34}H_{29}Br_2N_2O_3$ ($[M+H]^+$): 671.0539, found: 671.0528.




196.17
169.61
133.93
132.43
131.54
131.41
129.84
127.26
126.79
122.75
111.80
108.29
74.03
69.61
53.57
53.32
49.48
32.71
29.51
23.12
230
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


Intens.
x10^4
+MS, 0.02-0.37min #(1-22)
673.0513
671.0528
675.0499
674.0545
672.0561
676.0520
677.0559
669
670
671
672
673
674
675
676
677
678
m/z