Electronic Supplementary Material (ESI) for Chemical Communications

Supporting Information

Regioselective Palladium-Catalyzed Direct Cross-Coupling of Coumarins with Simple Arenes

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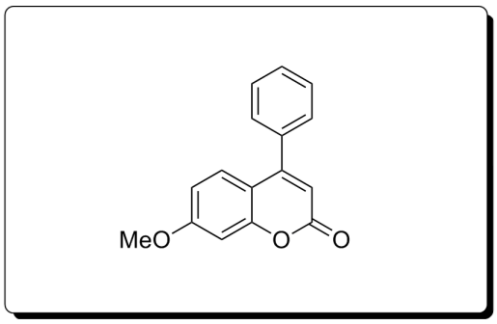
I. General Methods and Materials. Unless stated otherwise, reactions were performed in flame-dried glassware under a positive pressure of nitrogen. Analytical thin layer chromatography (TLC) was performed on precoated silica gel 60 F_{254} plates and visualization on TLC was achieved by UV light (254 and 354nm). Flash column chromatography was undertaken on silica gel (400-630 mesh). ^{1}H NMR was recorded on 400 MHz or 300 MHz and chemical shifts were quoted in parts per million (ppm) referenced to the appropriate solvent peak or 0.0 ppm for tetramethylsilane. The following abbreviations were used to describe peak splitting patterns when appropriate: br = broad, s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet, dd = doublet of doublet. Coupling constants, *J*, were reported in hertz unit (Hz). ^{13}C NMR was recorded on 75 MHz and was fully decoupled by broad band proton decoupling. Chemical shifts were reported in ppm referenced to the center line of a triplet at 77.0 ppm of chloroform-*d*. Mass spectral data were obtained from the KAIST Basic Science Institute by using EI method. Commercial grade reagents and solvents were used without further purification except as indicated below. Dichloromethane was distilled from calcium hydride. Unless otherwise stated, all commercial reagents and solvents were used without additional purification.

II. Experimental Procedures

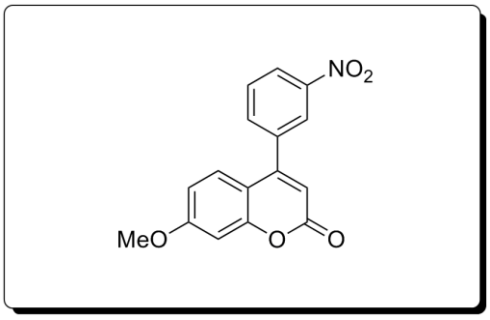
General Procedure for Coumarin Arylation:

Coumarin derivative (0.1 mmol), Arene (0.5 mL), $Pd(OPiv)_2$ (0.2 eq), AgOPiv (3.0 eq), and CsOPiv (3.0 eq) were combined in PivOH (0.7 mL) in a cap test tube. The reaction mixture was heated to 100 ^{o}C. The reaction was stirred for 6–12 h until the staring material, oumarin derivative disappeared (monitored by TLC using methylene chloride and ethyl acetate : *n*-hexane = 1 : 1 : 6 as the mobile phase. The reaction mixture was diluted with CH_2Cl_2 and the excess $NaHCO_3$ was added to neutralize PivOH. After stirring the mixture for 10 min, the residue was washed with sequentially aqueous $NaHCO_3$ and NH_4Cl. The organic layer was dried over $MgSO_4$. After removal of solvent, the residue was purified by flash chromatography on silica gel to give desired product.

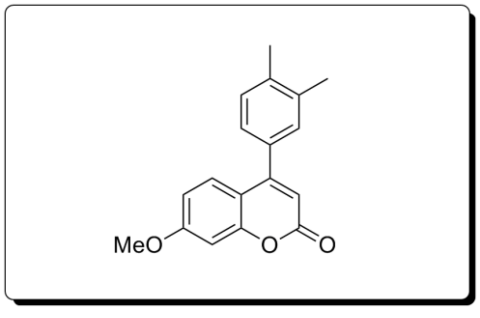
Compound Characterizations:



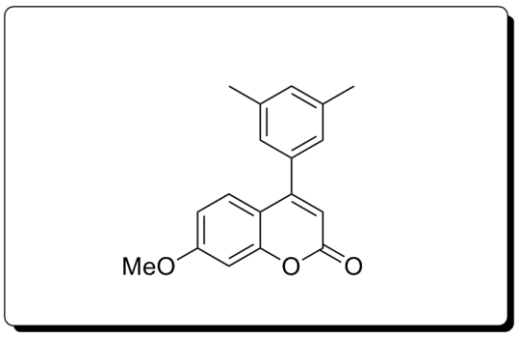
7-methoxy-4-phenyl-2H-chromen-2-one (2a). Yield 83% (20.7 mg). mp 106–107 °C. IR: *v* = 1727, 1607, 1377, 1282 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.53 – 7.46 (m, 3H), 7.44 – 7.39 (m, 2H), 7.36 (d, *J* = 8.9 Hz, 1H), 6.87 (d, *J* = 2.5 Hz, 1H), 6.77 (dd, *J* = 8.9, 2.6 Hz, 1H), 6.19 (s, 1H), 3.86 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.8, 161.2, 156.0, 155.8, 135.6, 129.6, 128.8, 128.3, 127.9, 112.5, 112.3, 111.9, 101.1, 55.8. [Ref]. *J. Org. Chem.* **2012**, *77*, 2053.



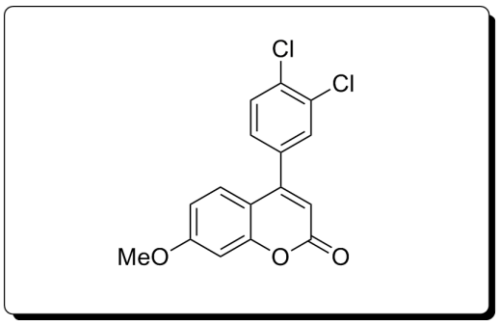
7-methoxy-4-(3-nitrophenyl)-2H-chromen-2-one (2b). Yield 52% (15.4 mg). mp 191–194 °C. IR: *v* = 1714, 1598, 1526, 1345 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.39 – 8.35 (m, 1H), 8.32 – 8.29 (m, 1H), 7.78 – 7.69 (m, 2H), 7.21 (d, *J* = 8.9 Hz, 1H), 6.90 (d, *J* = 2.5 Hz, 1H), 6.81 (dd, *J* = 8.9, 2.5 Hz, 1H), 6.23 (s, 1H), 3.88 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.3, 160.4, 156.1, 153.1, 148.4, 137.1, 134.2, 130.2, 127.2, 124.4, 123.4, 112.8, 112.7, 111.7, 101.4, 55.9. HRMS (ESI+) m/z calcd. for $C_{16}H_{11}NNaO_5^+$ $[M+Na]^+$: 320.0529, found: 320.0528.



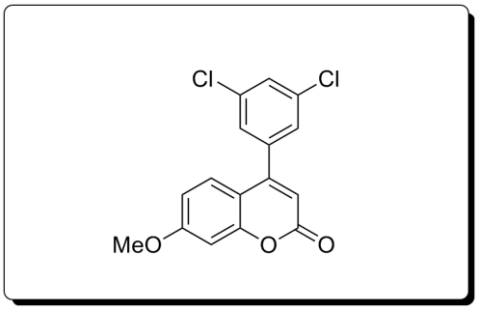
4-(3,4-dimethylphenyl)-7-methoxy-2H-chromen-2-one (2c). Yield 82% (22.9 mg). mp 115–117 °C. IR: *v* = 1714, 1603, 1363, 814 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.41 (d, *J* = 8.9 Hz, 1H), 7.24 (d, *J* = 7.7 Hz, 1H), 7.20 – 7.13 (m, 2H), 6.86 (d, *J* = 2.5 Hz, 1H), 6.77 (dd, *J* = 8.9, 2.5 Hz, 1H), 6.17 (s, 1H), 3.86 (s, 3H), 2.33 (s, 3H), 2.32 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.7, 161.3, 156.0, 155.9, 138.4, 137.2, 133.1, 129.9, 129.4, 128.1, 125.8, 112.7, 112.2, 111.5, 101.0, 55.7, 19.8, 19.6. HRMS (ESI+) m/z calcd. for $C_{18}H_{16}NaO_3^+$ $[M+Na]^+$: 303.0992, found: 303.0986.



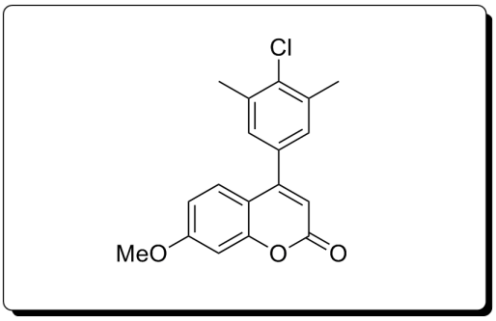
4-(3,5-dimethylphenyl)-7-methoxy-2H-chromen-2-one (2d). Yield 85% (23.8 mg). mp 97–100 °C. IR: *v* = 1714, 1610, 1594, 1255 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.38 (d, *J* = 8.9 Hz, 1H), 7.11 (s, 1H), 7.01 (s, 2H), 6.86 (d, *J* = 2.5 Hz, 1H), 6.77 (dd, *J* = 8.9, 2.5 Hz, 1H), 6.16 (s, 1H), 3.86 (s, 3H), 2.37 (s, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.7, 161.3, 156.2, 155.9, 138.4, 135.5, 131.1, 128.1, 126.1, 112.7, 112.2, 111.6, 101.0, 55.7, 21.3. HRMS (ESI+) m/z calcd. for $C_{18}H_{16}NaO_3^+$ $[M+Na]^+$: 303.0992, found: 303.0987.



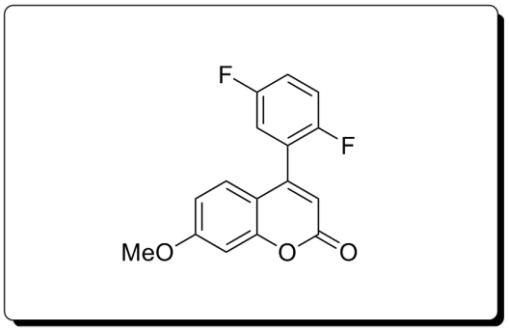
4-(3,4-dichlorophenyl)-7-methoxy-2H-chromen-2-one (2e). Yield 83% (26.5 mg). mp 155–157 °C. IR: *v* = 1723, 1716, 1611, 1542, 1295 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.58 (d, *J* = 8.3 Hz, 1H), 7.52 (d, *J* = 1.8 Hz, 1H), *7*.29 – 7.24 (m, 2H), 6.87 (d, *J* = 2.5 Hz, 1H), 6.80 (ddd, *J* = 8.9, 2.5, 0.6 Hz, 1H), 6.16 (s, 1H), 3.87 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.1, 160.6, 156.0, 153.2, 135.4, 134.1, 133.3, 130.9, 130.2, 127.6, 127.4, 112.6, 112.3, 111.8, 101.3, 55.9. HRMS (ESI+) m/z calcd. for $C_{16}H_{10}Cl_2NaO_3^+$ $[M+Na]^+$: 342.9899, found: 342.9894.



4-(3,5-dichlorophenyl)-7-methoxy-2H-chromen-2-one (2f). Yield 73% (23.2 mg). mp 178–179 °C. IR: *v* = 1717, 1619, 1603, 1365 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.49 (t, *J* = 1.9 Hz, 1H), 7.30 (d, *J* = 1.9 Hz, 2H), 7.25 (d, *J* = 9.0 Hz, 1H), 6.88 (d, *J* = 2.5 Hz, 1H), 6.81 (dd, *J* = 8.9, 2.5 Hz, 1H), 6.17 (s, 1H), 3.87 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.2, 160.4, 156.0, 152.8, 138.3, 135.7, 129.6, 127.3, 126.7, 112.7, 112.4, 111.7, 101.3, 55.8. HRMS (ESI+) m/z calcd. for $C_{16}H_{10}Cl_2NaO_3^+$ $[M+Na]^+$: 342.9899, found: 342.9901.

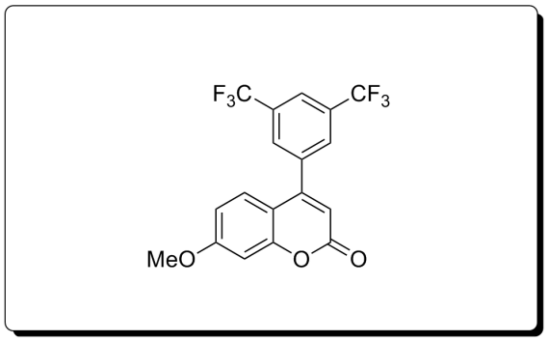


4-(4-chloro-3,5-dimethylphenyl)-7-methoxy-2H-chromen-2-one (2g). Yield 66% (20.6 mg). mp 210–212 °C. IR: *v* = 1724, 1617, 1605, 1363 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.35 (d, *J* = 8.9 Hz, 1H), 7.13 (s, 2H), 6.86 (d, *J* = 2.5 Hz, 1H), 6.78 (dd, *J* = 8.9, 2.6 Hz, 1H), 6.15 (s, 1H), 3.86 (s, 3H), 2.43 (s, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.8, 161.1, 156.0, 155.0, 137.0, 136.2, 133.3, 128.2, 127.9, 112.4, 112.3, 111.7, 101.1, 55.8, 20.8. HRMS (ESI+) m/z calcd. for $C_{18}H_{15}ClNaO_3^+$ $[M+Na]^+$: 337.0602, found: 337.0594.

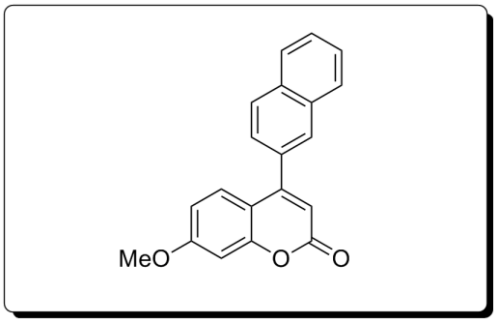


4-(2,5-difluorophenyl)-7-methoxy-2H-chromen-2-one (2h). Yield 71% (20.4 mg). mp 154–157 °C. IR: *v* = 1716, 1601, 1484, 1428 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.20 – 7.15 (m, 2H), 7.12 (dd, *J* = 8.9, 2.4 Hz, 1H), 7.08 – 7.02 (m, 1H), 6.87 (d, *J* = 2.5 Hz, 1H), 6.78 (dd, *J* = 8.9, 2.5 Hz, 1H), 6.22 (s, 1H), 3.86 (s, 3H). ^{13}C NMR (100

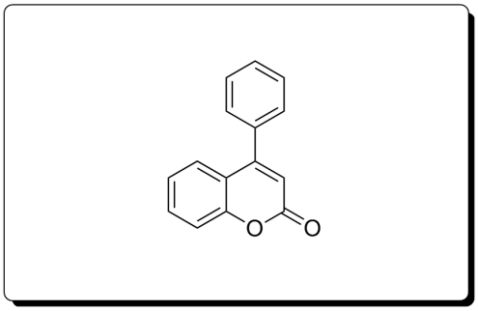
MHz, $CDCl_3$) δ 163.1, 160.5, 158.6 (dd, *J* = 245.0, 2.4 Hz), 155.7, 155.1 (dd, *J* = 245.8, 2.6 Hz), 149.1, 127.4, 127.4, 124.3 (dd, *J* = 18.5, 8.2 Hz), 118.1, 118.0, 117.8, 117.8, 117.7, 117.6, 117.5, 117.4, 117.1, 117.1, 116.8, 116.8, 113.7, 112.6, 111.8, 101.0, 55.8. HRMS (ESI+) m/z calcd. for $C_{16}H_{10}F_2NaO_3^+$ $[M+Na]^+$: 311.0490, found: 311.0490.



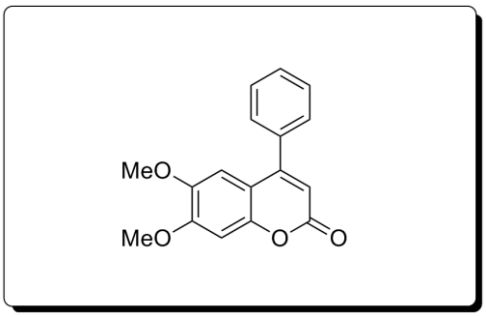
4-(3,5-bis(trifluoromethyl)phenyl)-7-methoxy-2H-chromen-2-one (2i). Yield 55% (21.2 mg). mp 151–154 °C. IR: *v* = 1706, 1601, 1279 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ 8.02 (s, 1H), 7.88 (s, 2H), 7.13 (d, *J* = 8.9 Hz, 1H), 6.91 (d, *J* = 2.5 Hz, 1H), 6.83 (dd, *J* = 8.9, 2.5 Hz, 1H), 6.23 (s, 1H), 3.89 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.4, 160.1, 156.1, 152.4, 137.6, 132.6 (q, *J* = 33.9 Hz), 128.5, 128.5, 126.9, 123.4 (hept, *J* = 4.0 Hz), 122.8 (q, *J* = 271.0 Hz), 113.0, 112.9, 111.5, 101.5, 55.9. HRMS (ESI+) m/z calcd. for $C_{18}H_{10}F_6NaO_3^+$ $[M+Na]^+$: 411.0426, found: 411.0428.



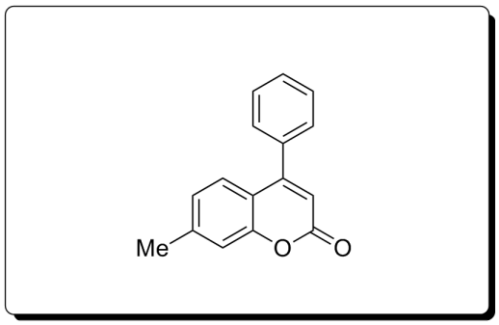
7-methoxy-4-(naphthalen-2-yl)-2H-chromen-2-one (2j). Yield 60% (18.1 mg). mp 147–150 °C. IR: *v* = 1721, 1603, 1504, 1142 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ 7.96 (d, *J* = 8.4 Hz, 1H), 7.93 – 7.88 (m, 3H), 7.59 – 7.54 (m, 2H), 7.50 (dd, *J* = 8.4, 1.8 Hz, 1H), 7.41 (d, *J* = 8.9 Hz, 1H), 6.90 (d, *J* = 2.5 Hz, 1H), 6.78 (dd, *J* = 8.9, 2.5 Hz, 1H), 6.30 (s, 1H), 3.87 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.8, 161.2, 156.1, 155.8, 133.5, 133.0, 133.0, 128.6, 128.3, 128.1, 128.0, 127.8, 127.2, 127.0, 125.7, 112.7, 112.4, 112.2, 101.2, 55.8. HRMS (ESI+) m/z calcd. for $C_{20}H_{14}NaO_3^+$ $[M+Na]^+$: 325.0835, found: 325.0836.



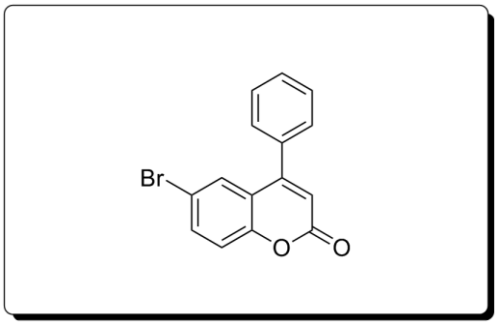
4-phenyl-2H-chromen-2-one (2k). Yield 66% (14.6 mg). IR: ν = 1718, 1603, 1369 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.56 – 7.37 (m, 8H), 7.21 (ddd, J = 8.2, 7.2, 1.2 Hz, 1H), 6.36 (s, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 160.7, 155.6, 154.2, 135.2, 131.9, 129.7, 128.8, 128.4, 127.0, 124.1, 119.0, 117.3, 115.2. [Ref]. *J. Org. Chem.* **2012**, *77*, 2053.



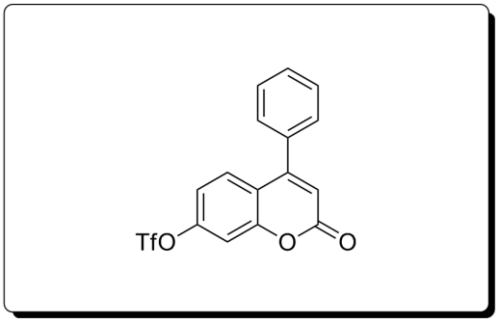
6,7-dimethoxy-4-phenyl-2H-chromen-2-one (2l). Yield 84% (23.7 mg). mp 140–142 °C. IR: ν = 1713, 1510, 1259 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.53 – 7.41 (m, 5H), 6.89 (s, 1H), 6.84 (s, 1H), 6.21 (s, 1H), 3.94 (s, 3H), 3.73 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.3, 155.6, 152.9, 150.1, 146.1, 135.7, 129.6, 128.9, 128.2, 112.3, 111.3, 107.4, 100.3, 56.4, 56.3. HRMS (ESI+) m/z calcd. for $C_{17}H_{14}NaO_4^+$ $[M+Na]^+$: 305.0784, found: 305.0775. [Ref]. *Eur. J. Org. Chem.* **2010**, *21*, 4130.



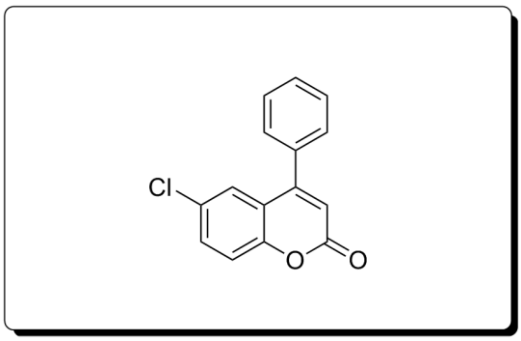
7-methyl-4-phenyl-2H-chromen-2-one (2m). Yield 74% (17.4 mg). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.51 – 7.48 (m, 3H), 7.44 – 7.40 (m, 2H), 7.34 (d, J = 8.1 Hz, 1H), 7.19 (s, 1H), 7.02 (d, J = 8.1 Hz, 1H), 6.29 (s, 1H), 2.44 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.0, 155.6, 154.3, 143.2, 135.4, 129.6, 128.8, 128.4, 126.6, 125.3, 117.4, 116.5, 114.0, 21.6. [Ref]. *Eur. J. Org. Chem.* **2010**, *20*, 3945-3955.



6-bromo-4-phenyl-2H-chromen-2-one (2n). Yield 44% (13.2 mg). mp 152–155 °C. IR: v = 1763, 1718, 1595, 1550 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ 7.62 (dd, J = 8.7, 2.4 Hz, 1H), 7.57 (d, J = 2.3 Hz, 1H), 7.55 – 7.52 (m, 3H), 7.44 – 7.40 (m, 2H), 7.28 (d, J = 8.8 Hz, 1H), 6.38 (s, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.9, 154.5, 153.1, 134.7, 134.5, 130.0, 129.3, 129.1, 128.3, 120.6, 119.0, 117.0, 116.1. HRMS (ESI+) m/z calcd. for $C_{15}H_9BrNaO_2^+$ $[M+Na]^+$: 322.9678, found: 322.9669.

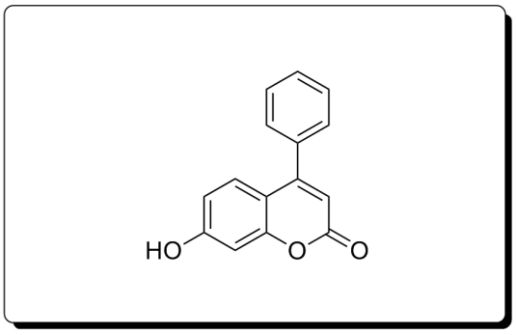


2-oxo-4-phenyl-2H-chromen-7-yl trifluoromethanesulfonate (2o). Yield 51% (18.8 mg). Colorless oil. IR: v = 1731, 1608, 1418, 1205 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ 7.58 (d, J = 8.9 Hz, 1H), 7.55 – 7.52 (m, 3H), 7.43 – 7.40 (m, 2H), 7.33 (d, J = 2.5 Hz, 1H), 7.14 (dd, J = 8.9, 2.5 Hz, 1H), 6.41 (s, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.4, 154.7, 154.6, 150.8, 134.4, 130.1, 129.1, 128.8, 128.3, 120.3, 119.1, 117.3, 117.1, 115.9, 110.7. HRMS (ESI+) m/z calcd. for $C_{16}H_9F_3NaO_5S^+$ $[M+Na]^+$: 393.0015, found: 393.0012.

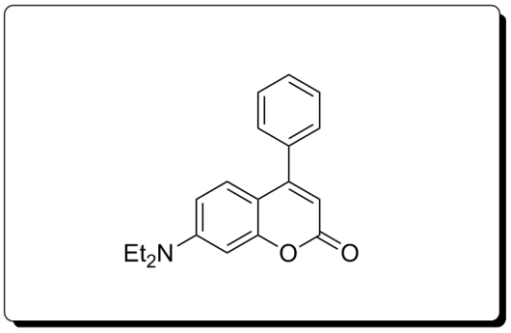


6-chloro-4-phenyl-2H-chromen-2-one (2p). Yield 72% (18.3 mg). IR: v = 1727, 1554, 1354 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ 7.55 – 7.52 (m, 3H), 7.48 (dd, J = 8.8, 2.5 Hz, 1H), 7.44 – 7.40 (m, 3H), 7.34 (dd, J = 8.8, 0.4 Hz,

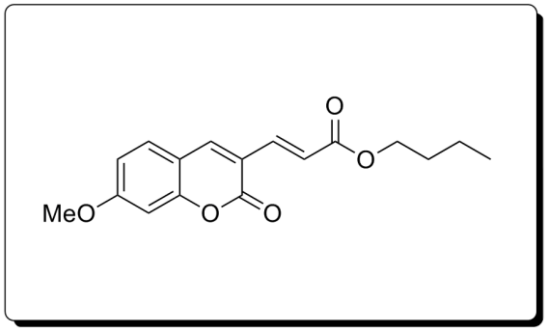
1H), 6.39 (s, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 160.0, 154.6, 152.6, 134.5, 131.9, 130.0 , 129.7, 129.1, 128.3, 126.3, 120.2, 118.7, 116.1. [Ref]. *J. Org. Chem.* **2012**, *77*, 2053.



7-hydroxy-4-phenyl-2H-chromen-2-one (2q). Yield 41% (9.7 mg). ^{1}H NMR (400 MHz, DMSO-d_6) δ 10.65 (s, 1H), 7.59 – 7.48 (m, 5H), 7.27 (d, *J* = 8.6 Hz, 1H), 6.80 (dd, *J* = 6.3, 2.2 Hz, 1H), 6.77 (d, *J* = 2.4 Hz, 1H), 6.15 (s, 1H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 161.4, 160.1, 155.5, 155.4, 135.2, 129.5, 128.8, 128.4, 128.1, 113.2, 110.7, 110.3, 102.7. [Ref]. *J. Org. Chem.* **2012**, *77*, 2053.



7-(diethylamino)-4-phenyl-2H-chromen-2-one (2r). Yield 53% (15.5 mg). Orange oil. IR: *v* = 1729, 1703, 1585, 1520, 1405 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.49 – 7.39 (m, 5H), 7.23 (d, *J* = 9.0 Hz, 1H), 6.55 (d, *J* = 2.6 Hz, 1H), 6.49 (dd, *J* = 9.1, 2.6 Hz, 1H), 5.99 (s, 1H), 3.39 (q, *J* = 7.1 Hz, 4H), 1.19 (t, *J* = 7.1 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.1, 156.8, 156.1, 150.6, 136.2, 129.2, 128.6, 128.3, 127.9, 108.5, 108.3, 107.9, 97.9, 44.8, 12.4. [Ref]. *J. Org. Chem.* **2012**, *77*, 2053.



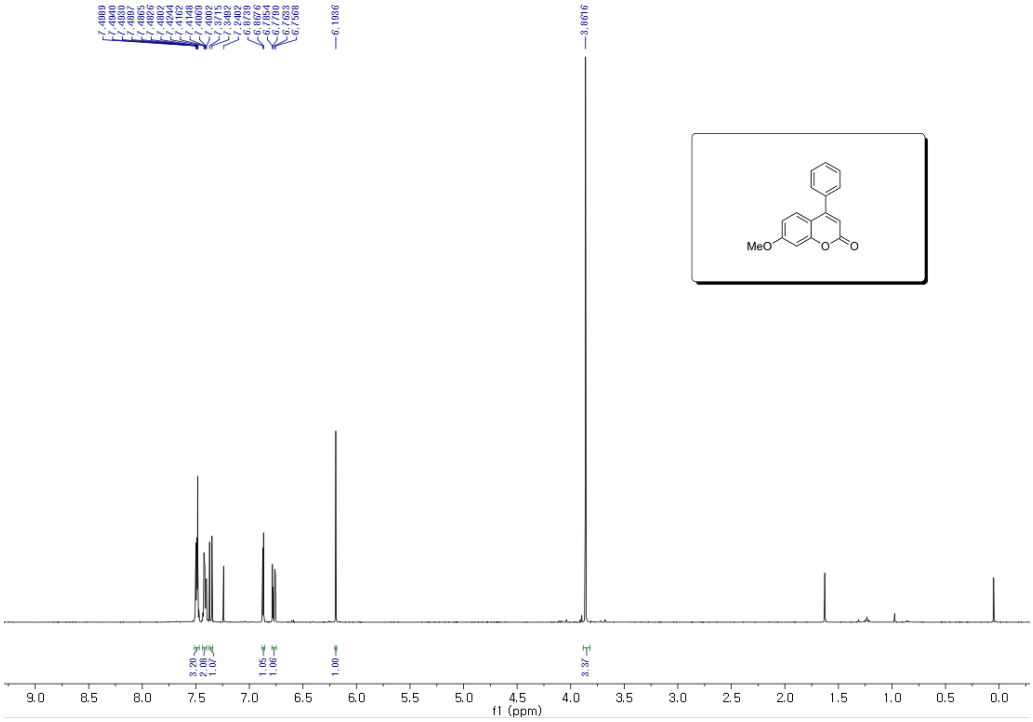
(*E*)-butyl 3-(7-methoxy-2-oxo-2H-chromen-3-yl)acrylate (4). Yield 63% (18.9 mg). mp 120–122 ^{o}C. IR: ν = 1723, 1706, 1601, 1156 cm^{-1}. δ 7.79 (s, 1H), 7.51 (dd, *J* = 15.9, 0.6 Hz, 1H), 7.42 (d, *J* = 8.6 Hz, 1H), 7.02 (d, *J* = 15.8 Hz, 1H), 6.86 (dd, *J* = 8.6, 2.4 Hz, 1H), 6.81 (d, *J* = 2.5 Hz, 1H), 4.18 (t, *J* = 6.6 Hz, 2H), 3.88 (s, 3H), 1.70 – 1.62 (m, 2H), 1.46 – 1.36 (m, 2H), 0.94 (t, *J* = 7.4 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 167.3, 163.9, 159.3, 155.6, 143.7, 138.2, 129.6, 122.3, 118.9, 113.4, 112.7, 100.5, 64.5, 55.9, 30.8, 19.2, 13.7. HRMS (ESI+) m/z calcd. for $C_{17}H_{18}NaO_5^+$ $[M+Na]^+$: 325.1046, found: 325.1048.

Appendix I

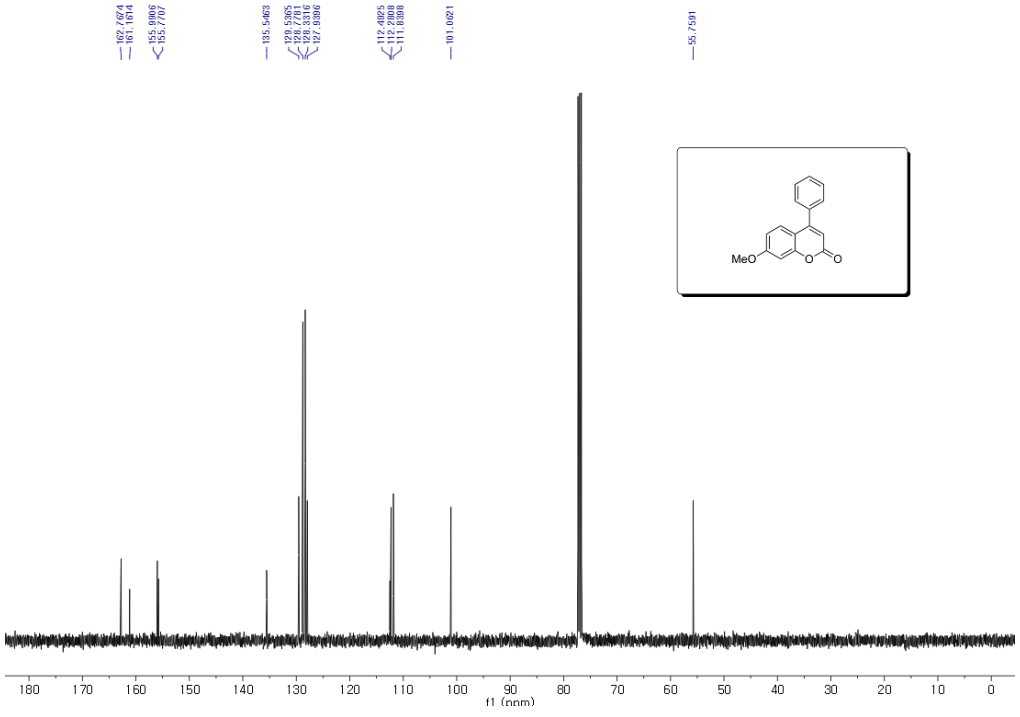
Spectral Copies of ^{1}H and ^{13}C NMR Data

Obtained in this Study

7-methoxy-4-phenyl-2H-chromen-2-one (2a).

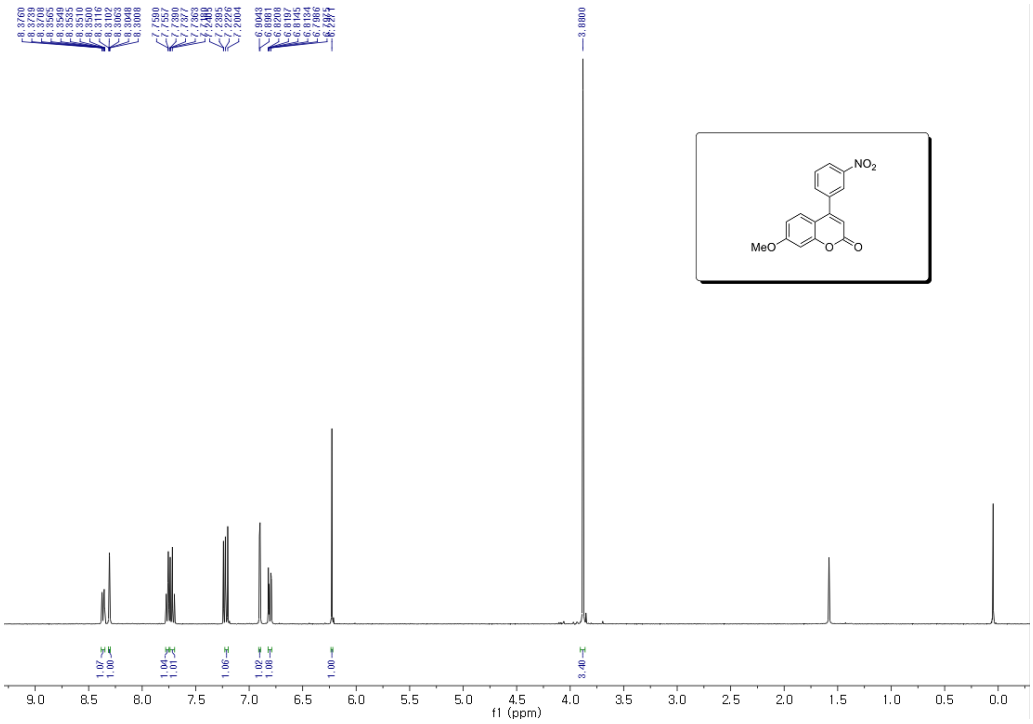


400 MHz, ^{1}H NMR in $CDCl_3$

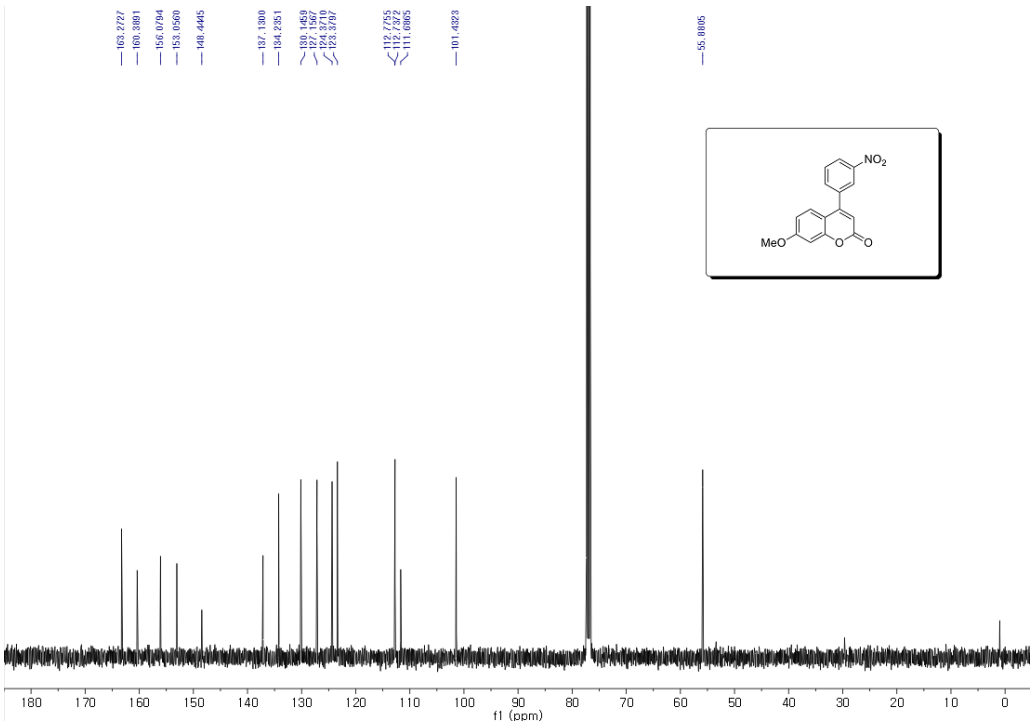


100 MHz, ^{13}C NMR in $CDCl_3$

7-methoxy-4-(3-nitrophenyl)-2H-chromen-2-one (2b).

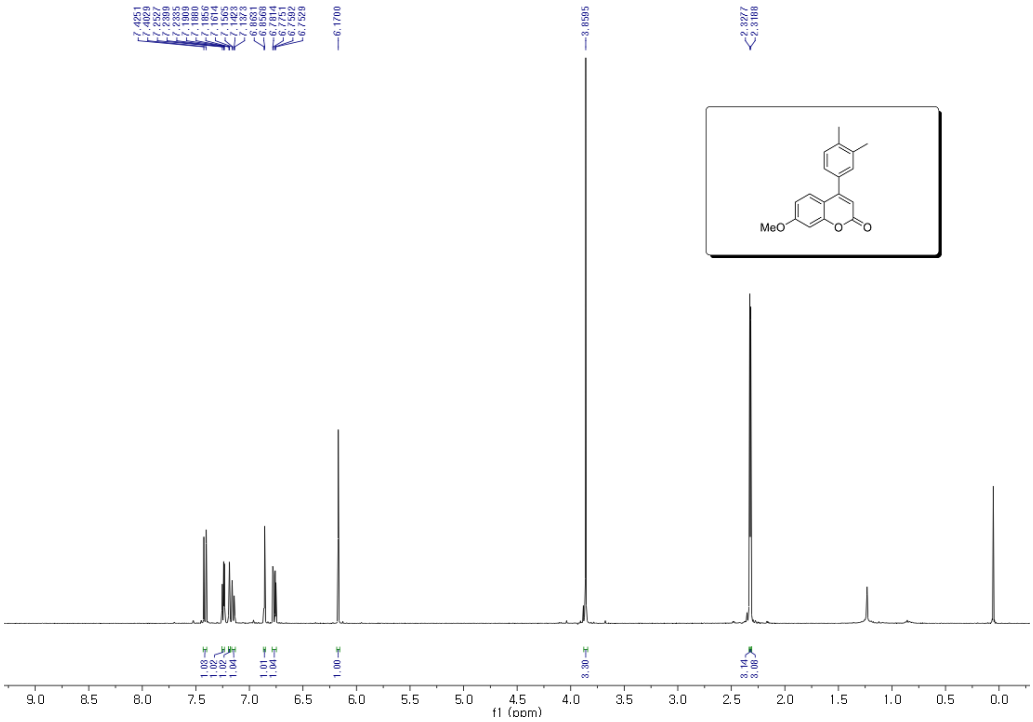


400 MHz, ^{1}H NMR in $CDCl_3$

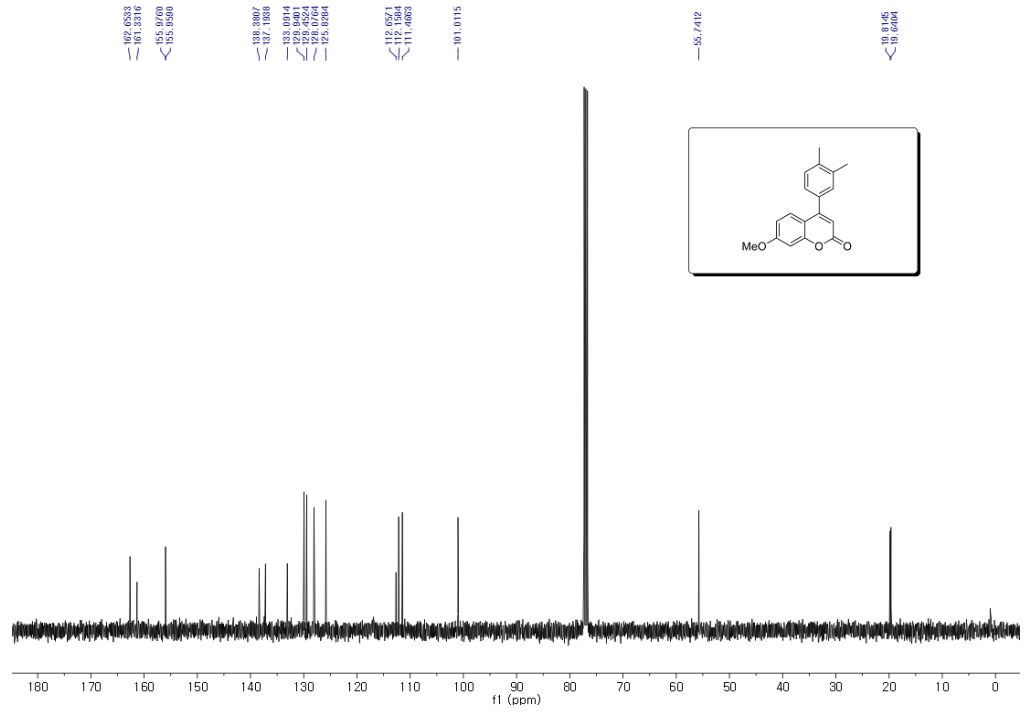


100 MHz, ^{13}C NMR in $CDCl_3$

4-(3,4-dimethylphenyl)-7-methoxy-2H-chromen-2-one (2c).

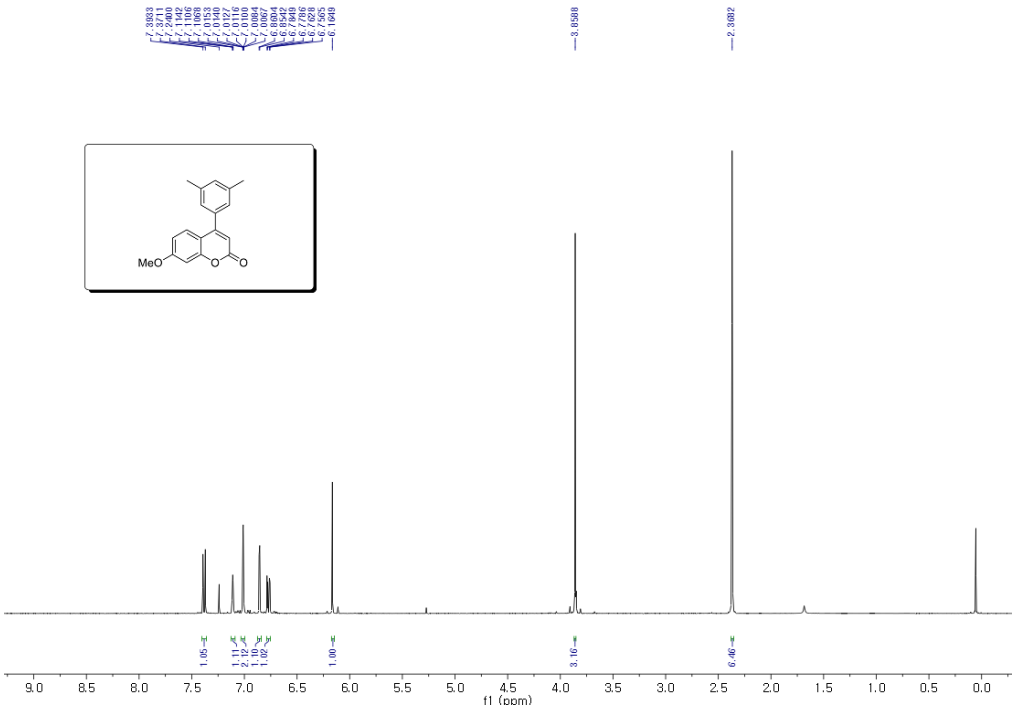


400 MHz, ^{1}H NMR in $CDCl_3$

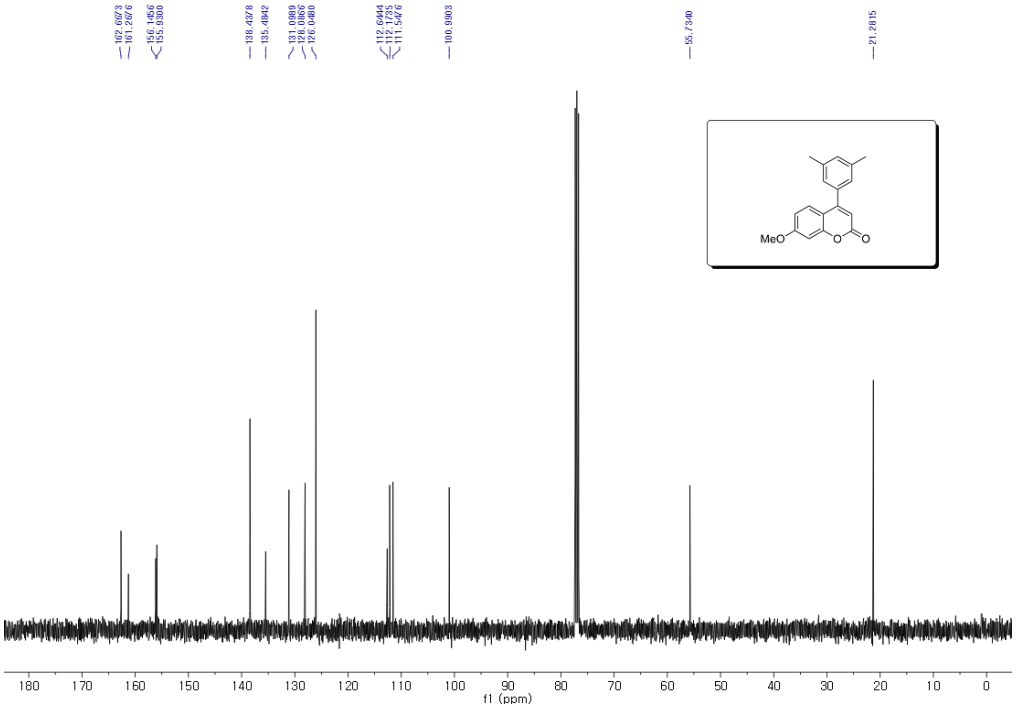


100 MHz, ^{13}C NMR in $CDCl_3$

4-(3,5-dimethylphenyl)-7-methoxy-2H-chromen-2-one (2d).

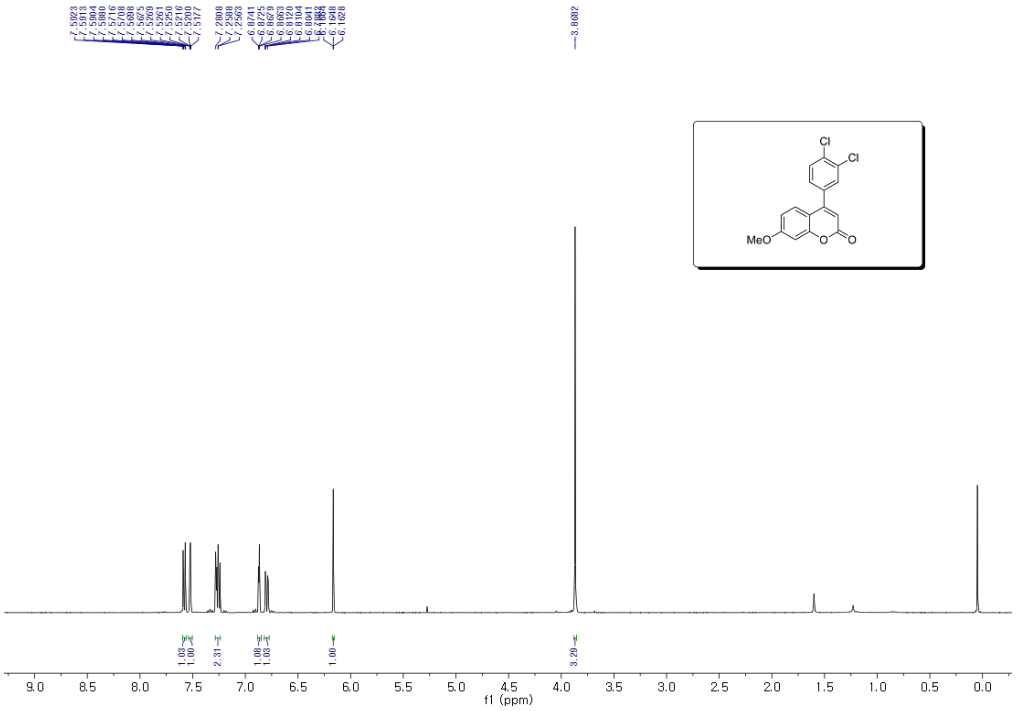


400 MHz, ^{1}H NMR in $CDCl_3$

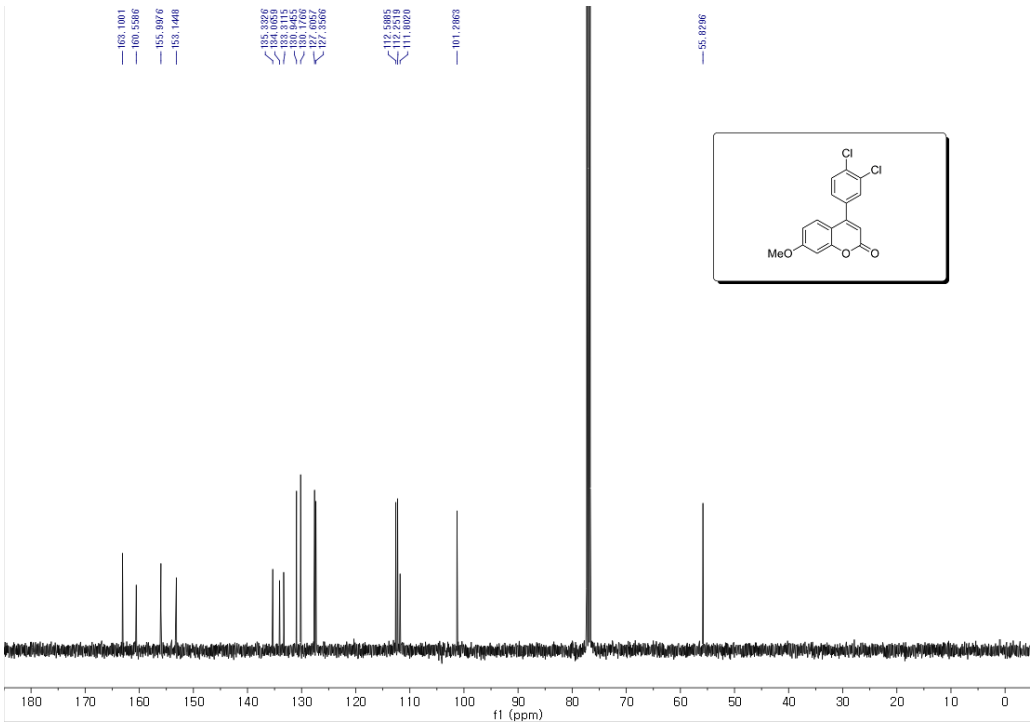


100 MHz, ^{13}C NMR in $CDCl_3$

4-(3,4-dichlorophenyl)-7-methoxy-2H-chromen-2-one (2e).

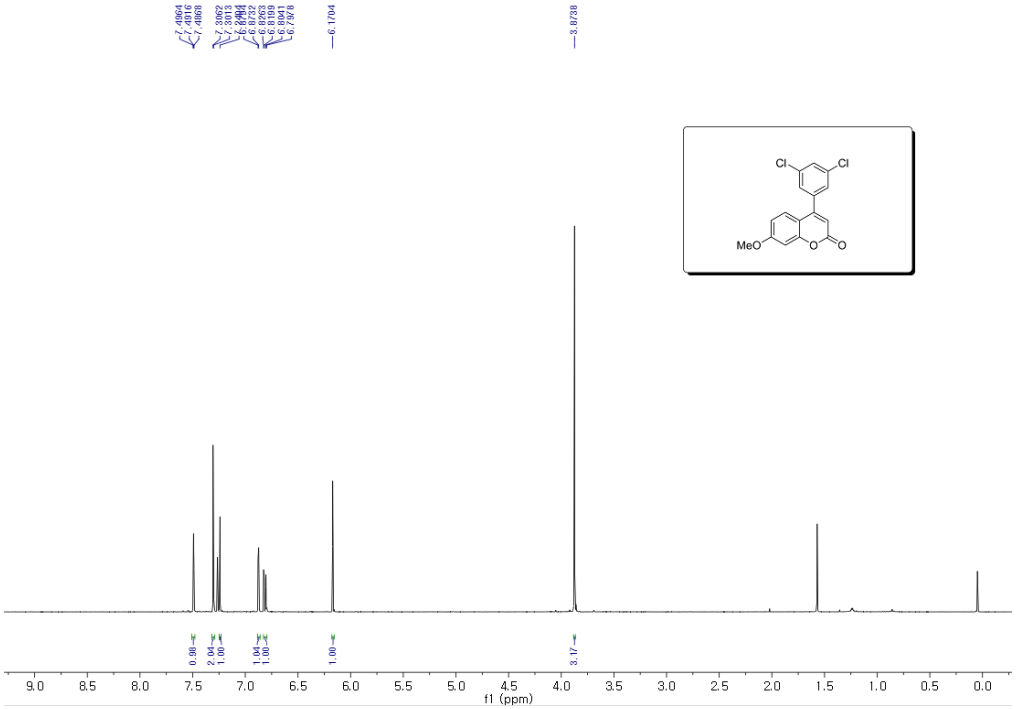


400 MHz, ^{1}H NMR in $CDCl_3$

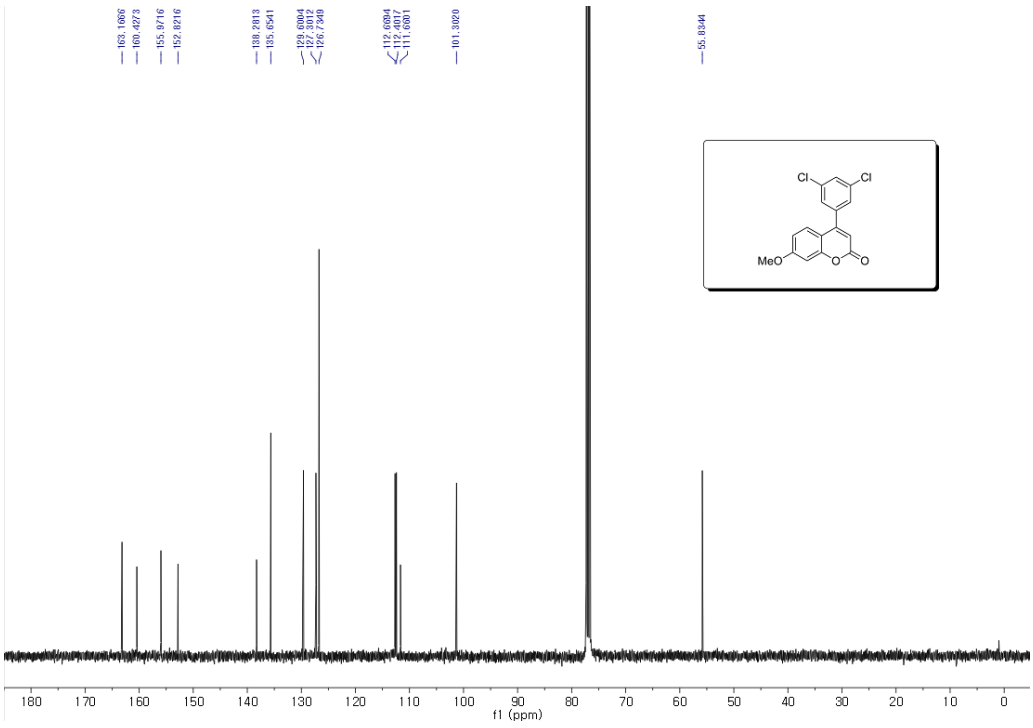


100 MHz, ^{13}C NMR in $CDCl_3$

4-(3,5-dichlorophenyl)-7-methoxy-2H-chromen-2-one (2f).

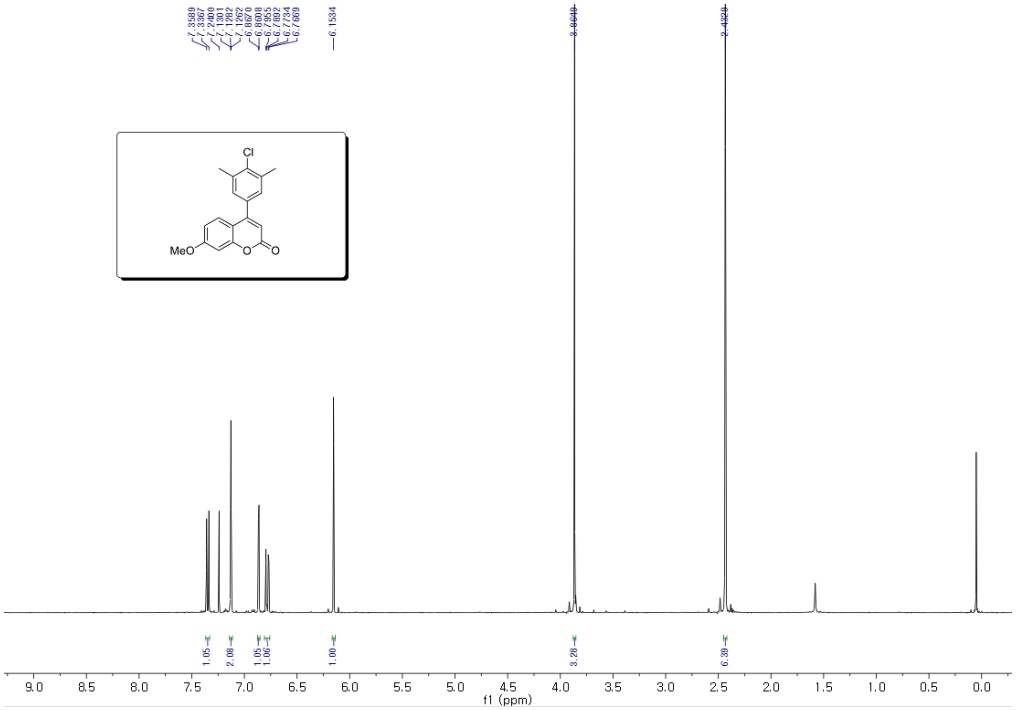


400 MHz, ^{1}H NMR in $CDCl_3$

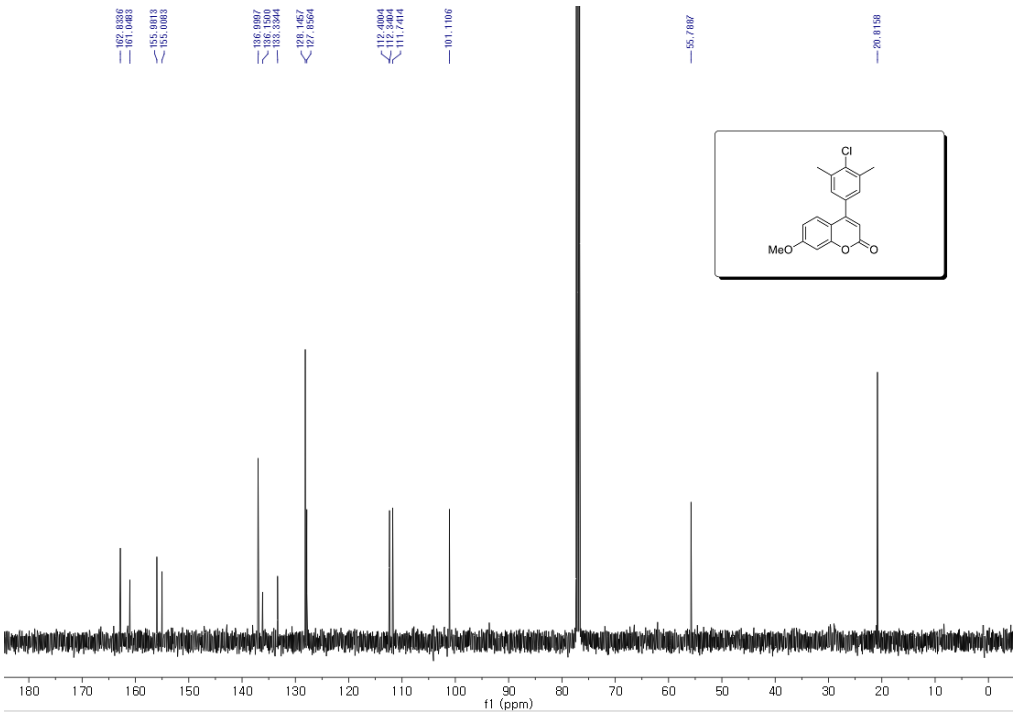


100 MHz, ^{13}C NMR in $CDCl_3$

4-(4-chloro-3,5-dimethylphenyl)-7-methoxy-2H-chromen-2-one (2g).

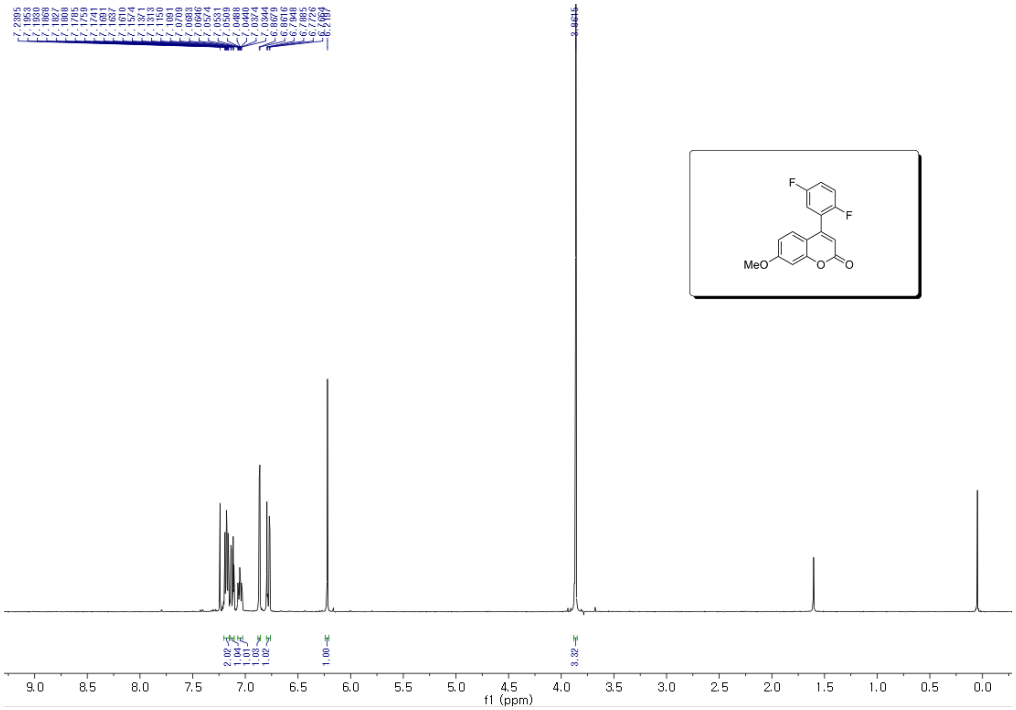


400 MHz, ^{1}H NMR in $CDCl_3$

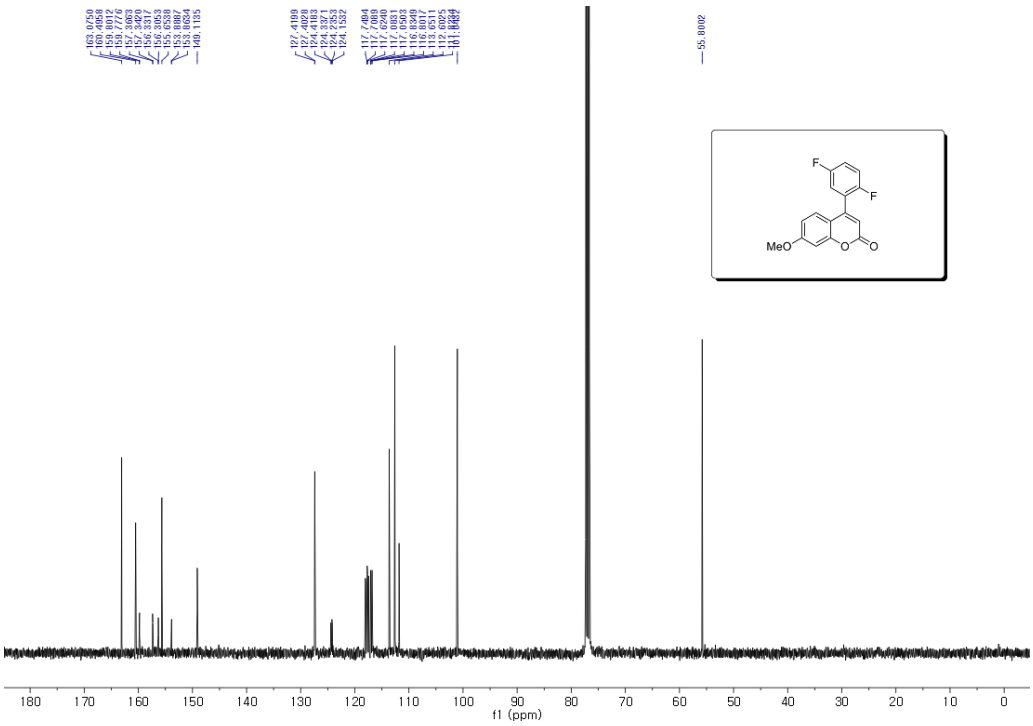


100 MHz, ^{13}C NMR in $CDCl_3$

4-(2,5-difluorophenyl)-7-methoxy-2H-chromen-2-one (2h).

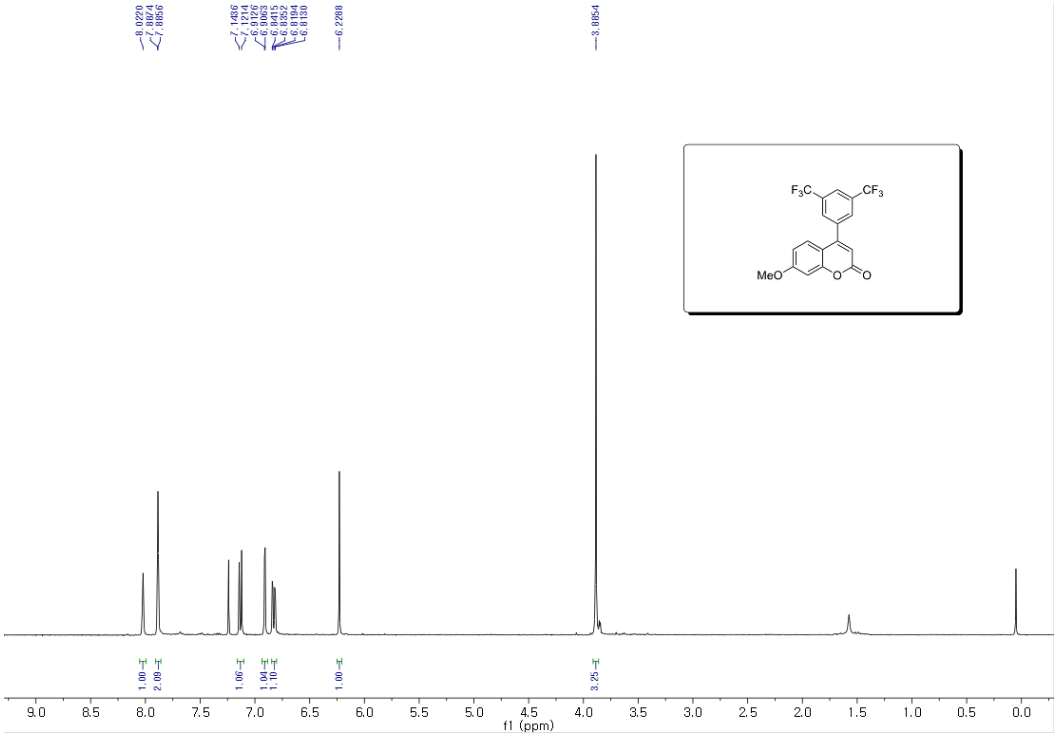


400 MHz, ^{1}H NMR in $CDCl_3$

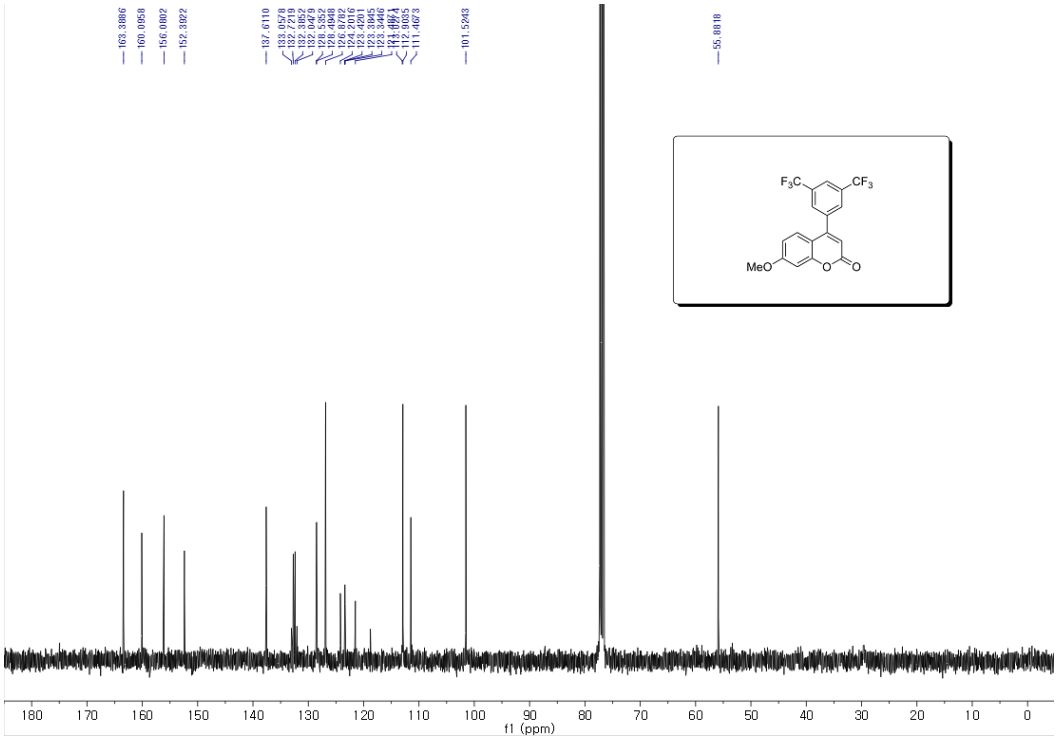


100 MHz, ^{13}C NMR in $CDCl_3$

4-(3,5-bis(trifluoromethyl)phenyl)-7-methoxy-2H-chromen-2-one (2i).

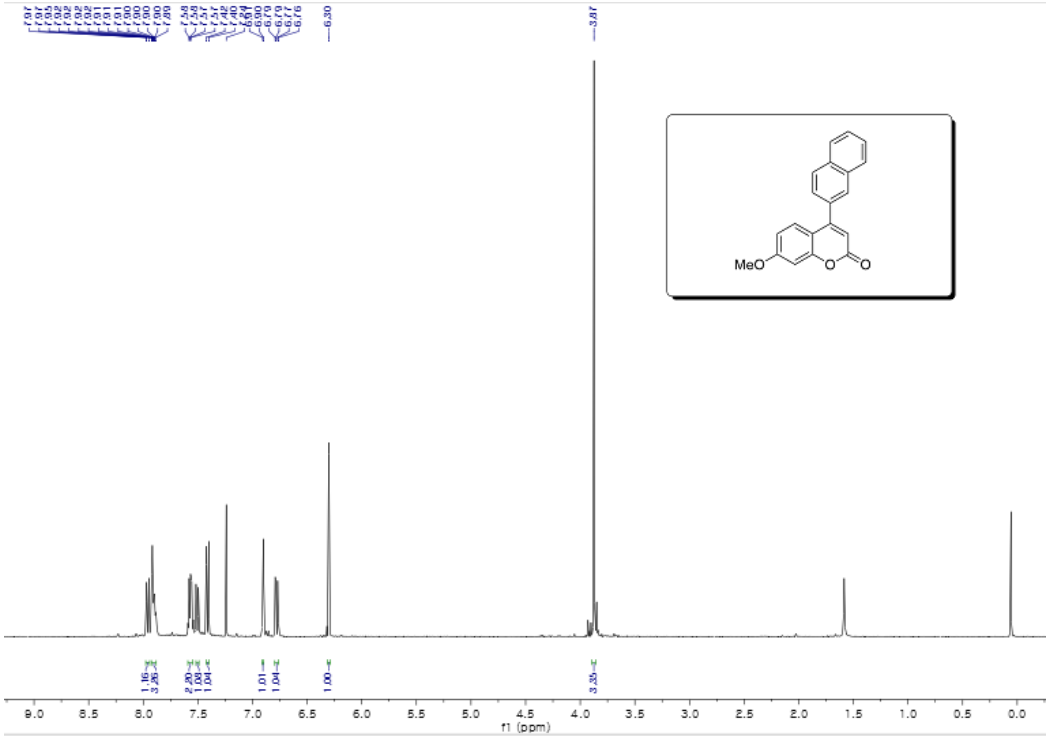


400 MHz, ^{1}H NMR in $CDCl_3$

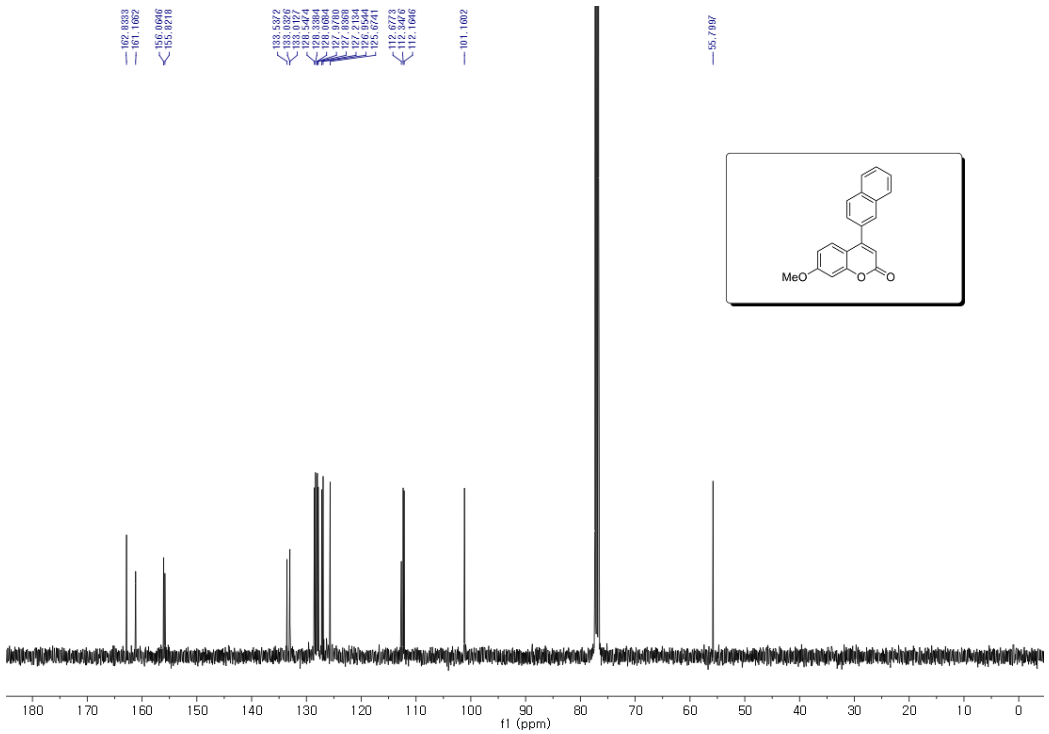


100 MHz, ^{13}C NMR in $CDCl_3$

7-methoxy-4-(naphthalen-2-yl)-2H-chromen-2-one (2j).

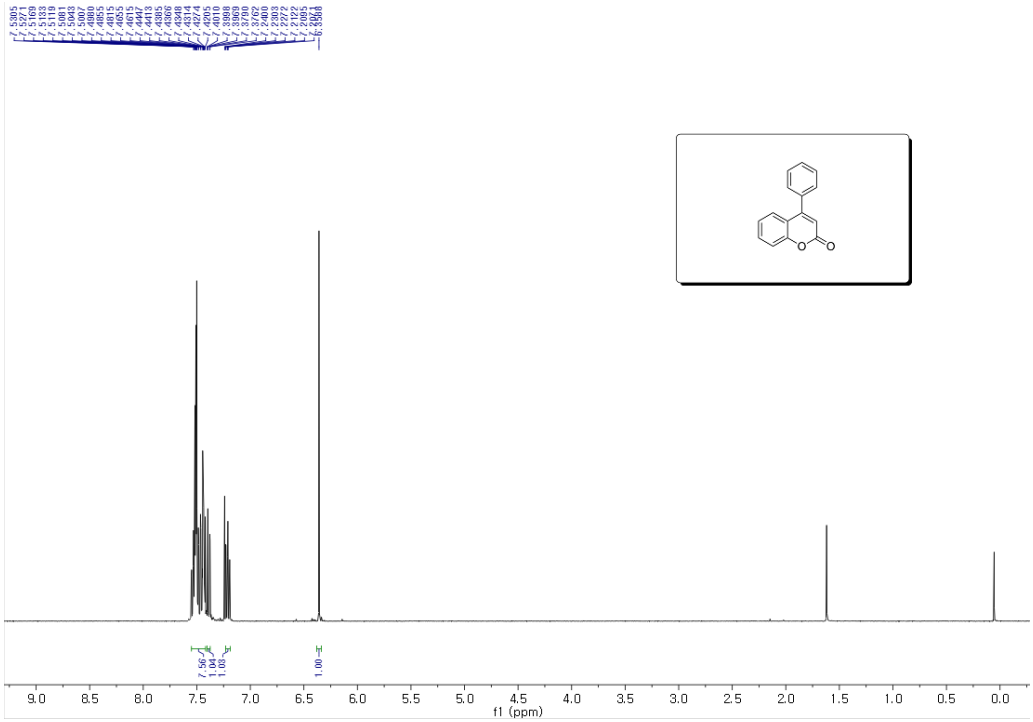


400 MHz, ^{1}H NMR in $CDCl_3$

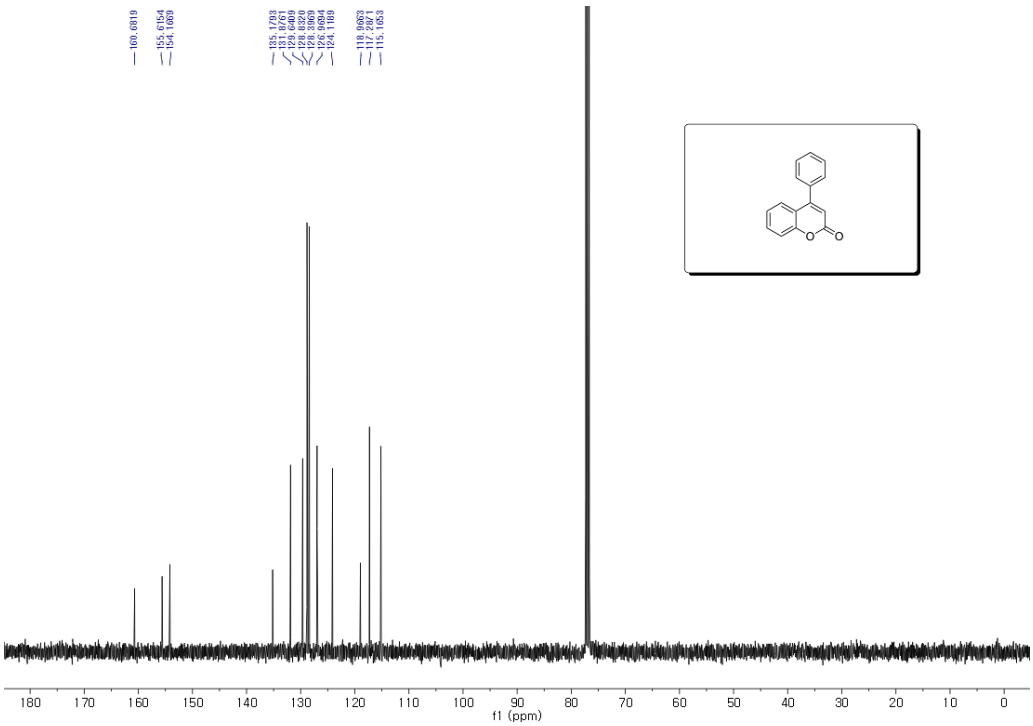


100 MHz, ^{13}C NMR in $CDCl_3$

4-phenyl-2H-chromen-2-one (2k).

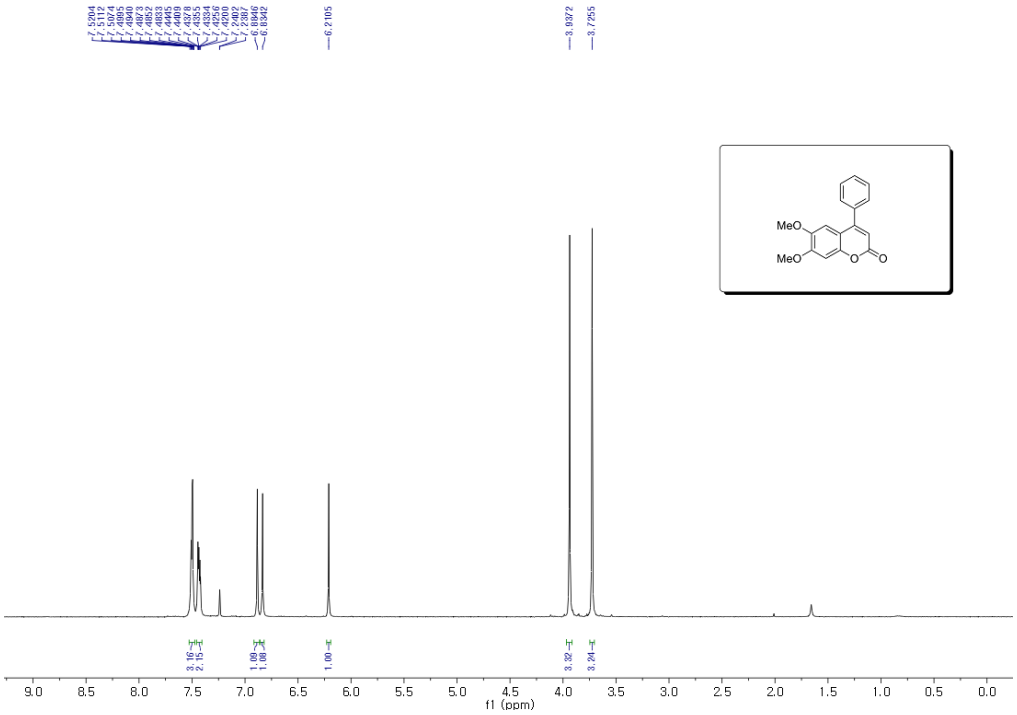


400 MHz, ^{1}H NMR in $CDCl_3$

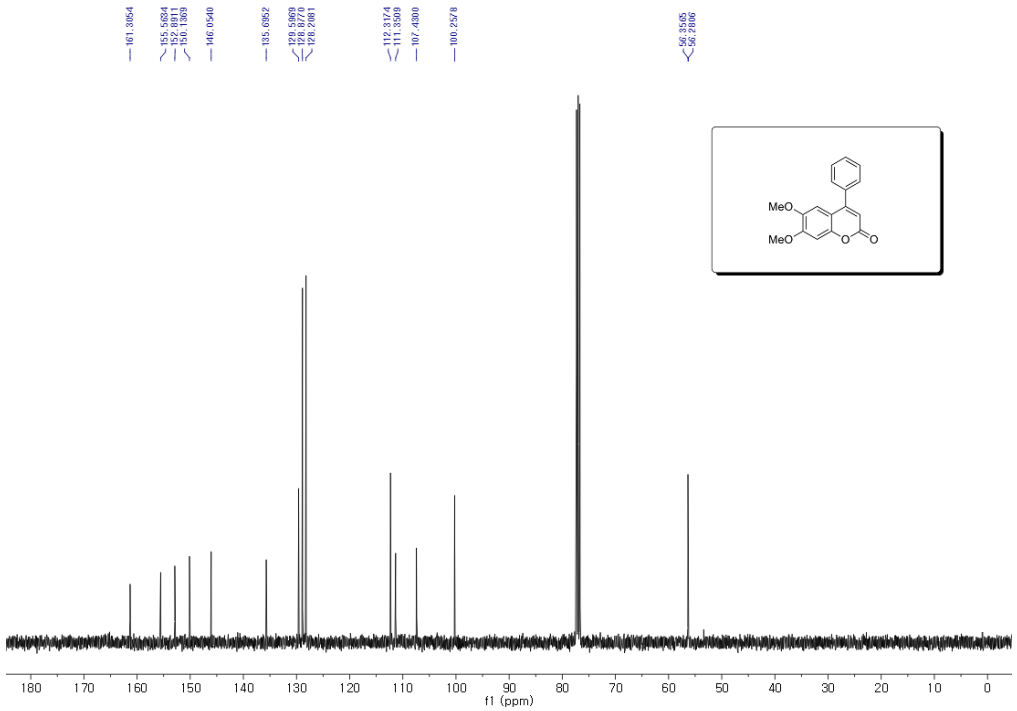


100 MHz, ^{13}C NMR in $CDCl_3$

6,7-dimethoxy-4-phenyl-2H-chromen-2-one (2l).

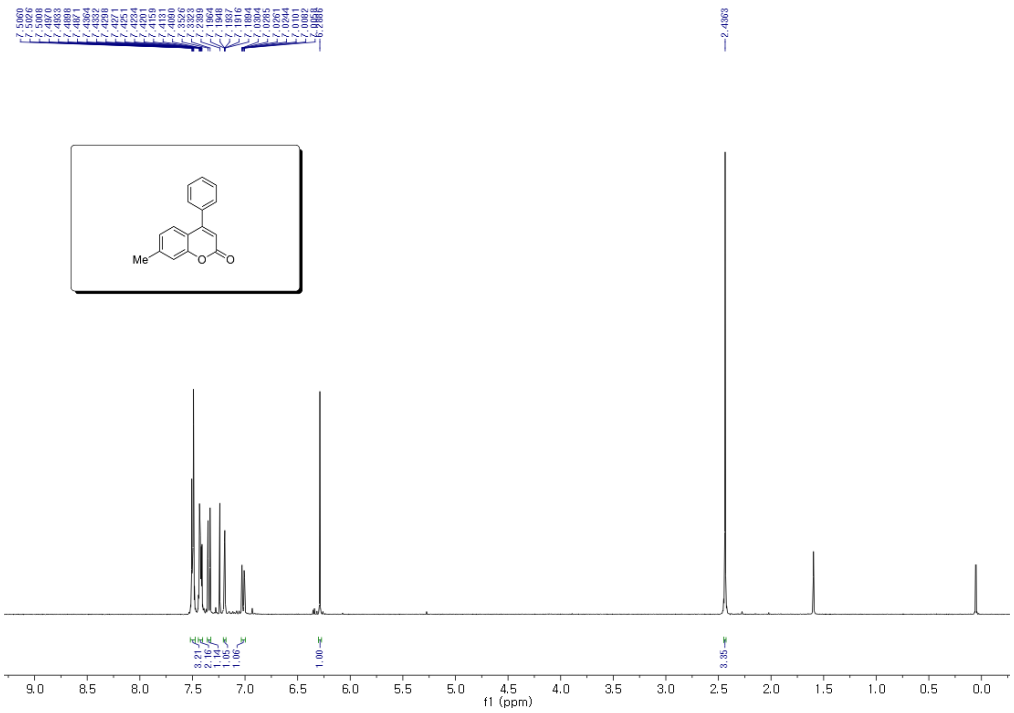


400 MHz, ^{1}H NMR in $CDCl_3$

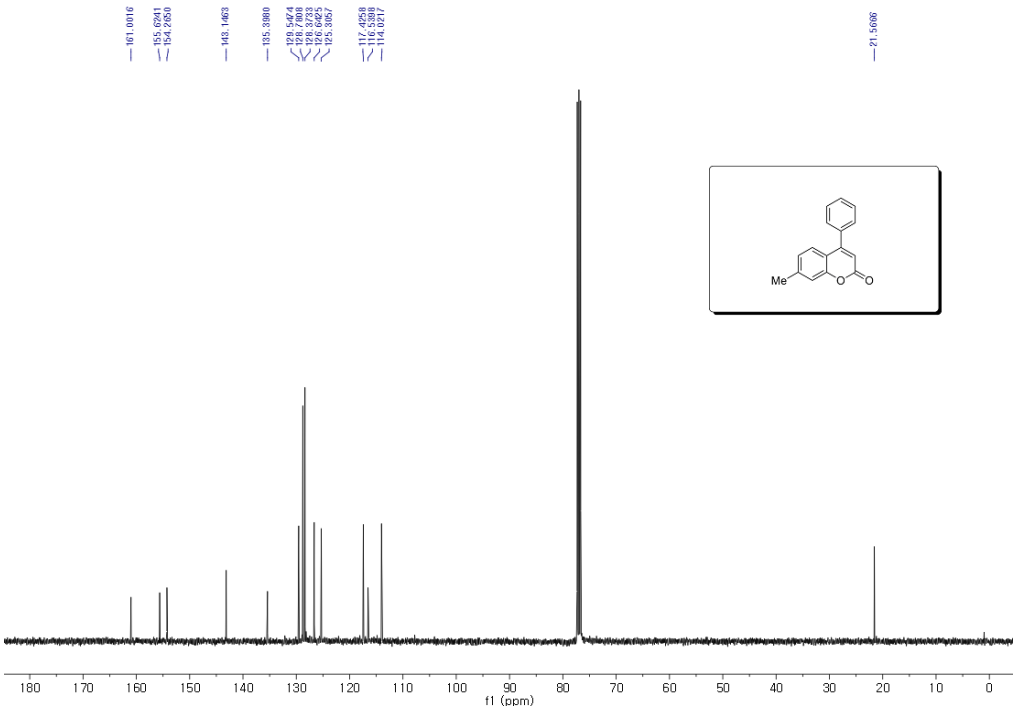


100 MHz, ^{13}C NMR in $CDCl_3$

7-methyl-4-phenyl-2H-chromen-2-one (2m).

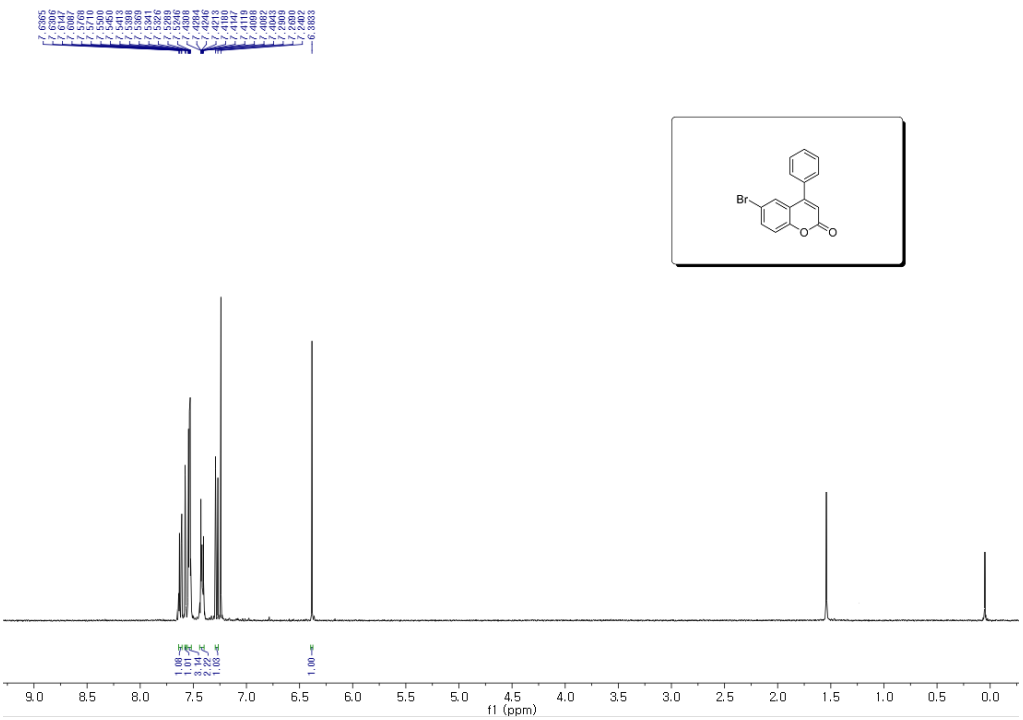


400 MHz, ^{1}H NMR in $CDCl_3$

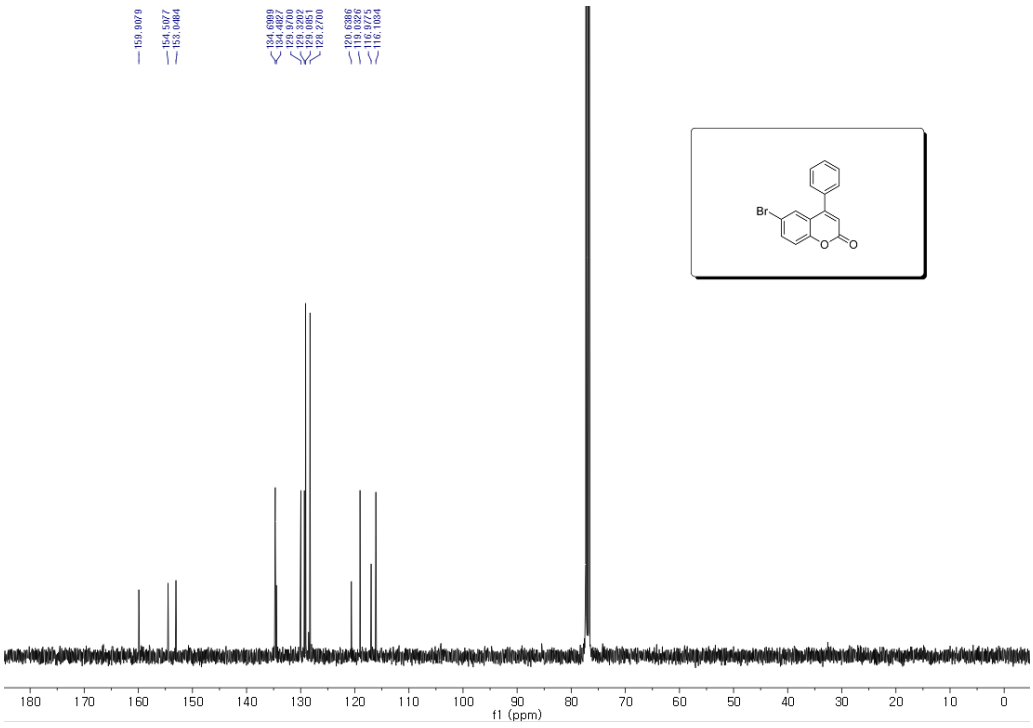


100 MHz, ^{13}C NMR in $CDCl_3$

6-bromo-4-phenyl-2H-chromen-2-one (2n).

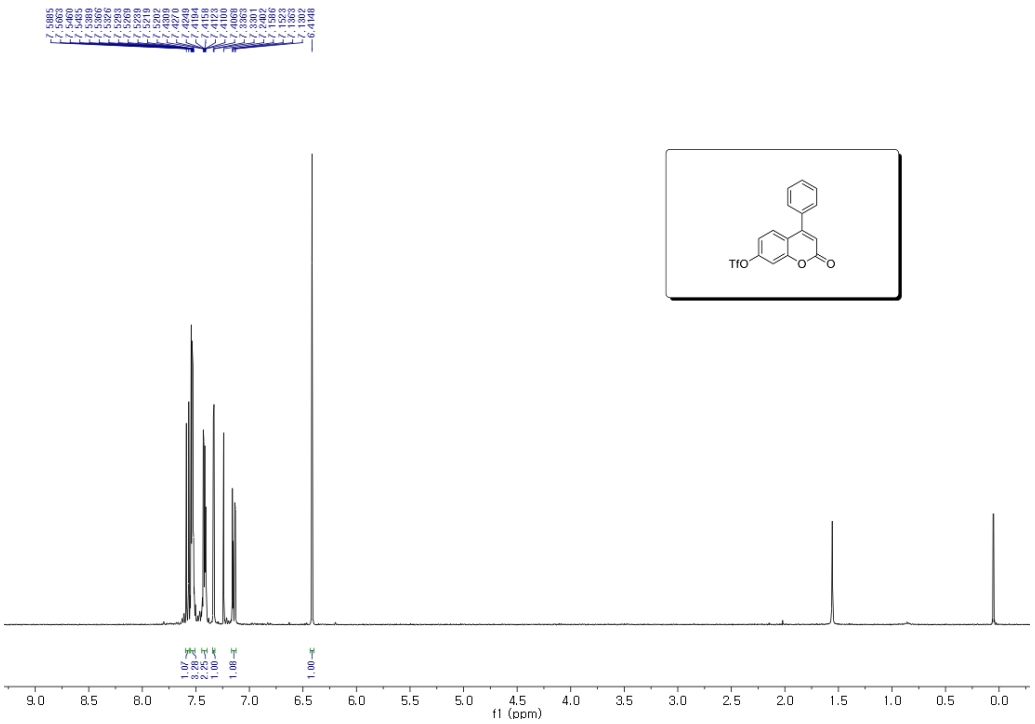


400 MHz, ^{1}H NMR in $CDCl_3$

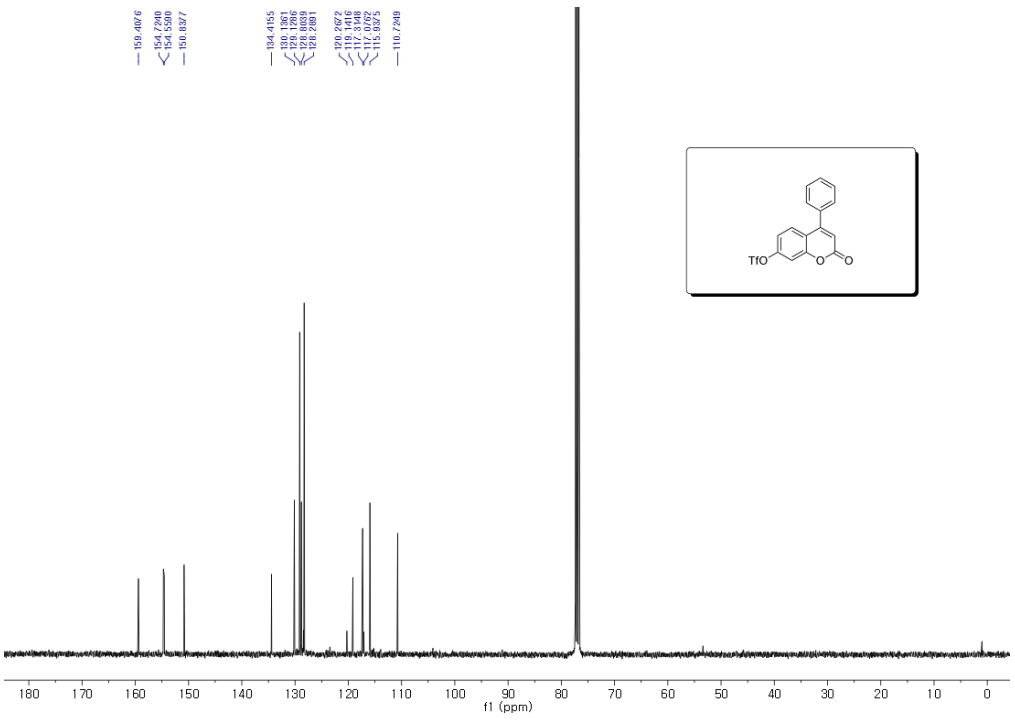


100 MHz, ^{13}C NMR in $CDCl_3$

2-oxo-4-phenyl-2H-chromen-7-yl trifluoromethanesulfonate (2o).

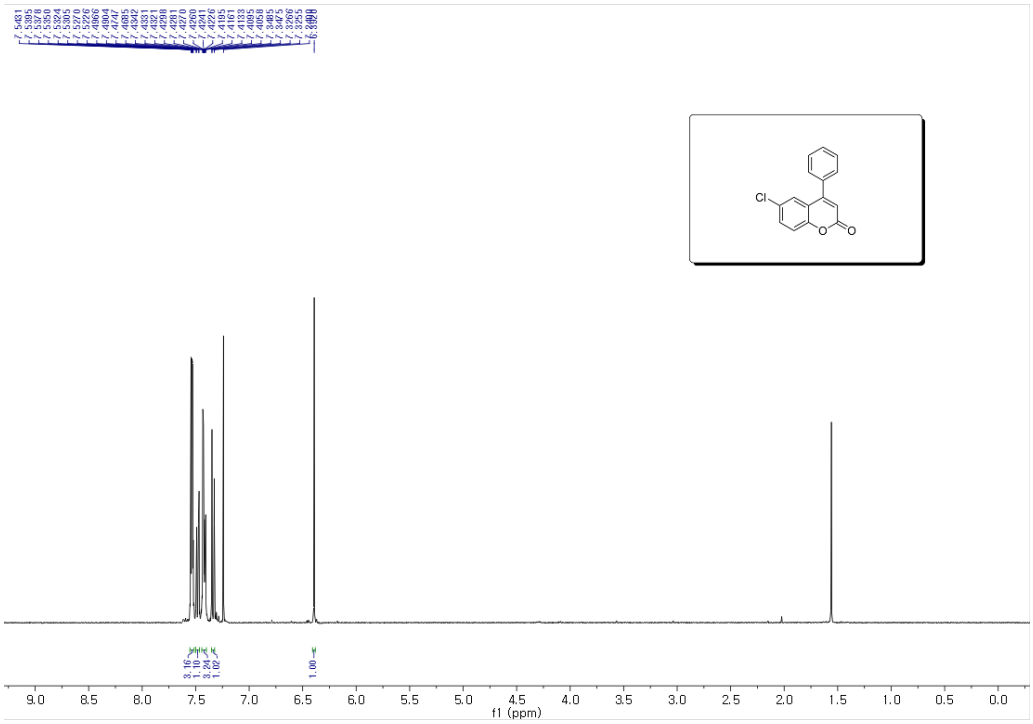


400 MHz, ^{1}H NMR in $CDCl_3$

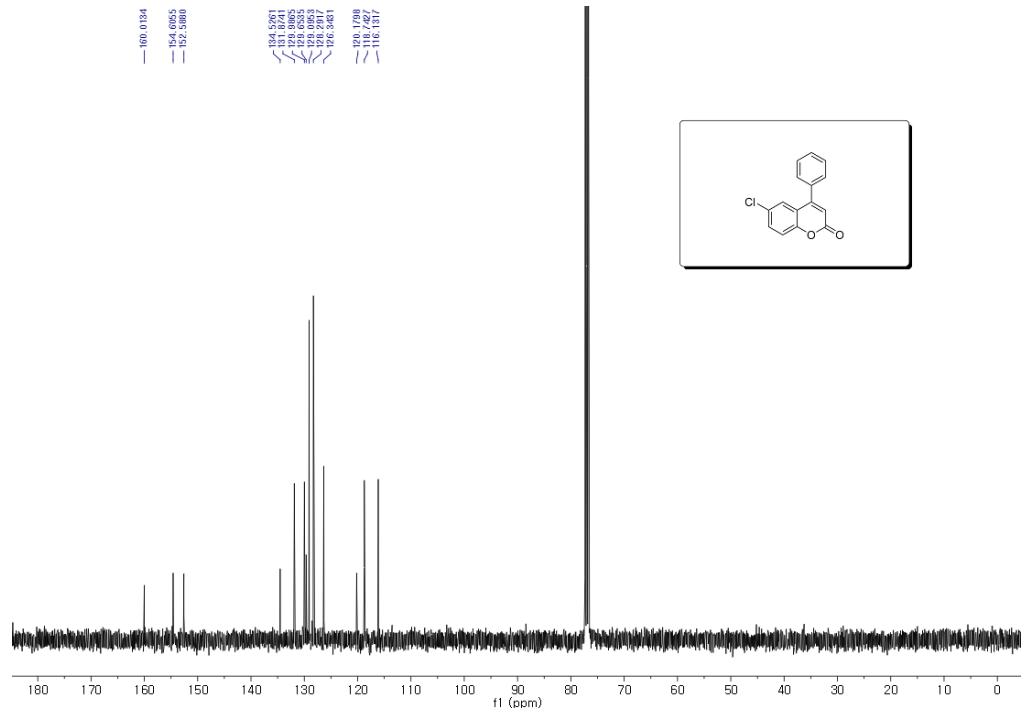


100 MHz, ^{13}C NMR in $CDCl_3$

6-chloro-4-phenyl-2H-chromen-2-one (2p).

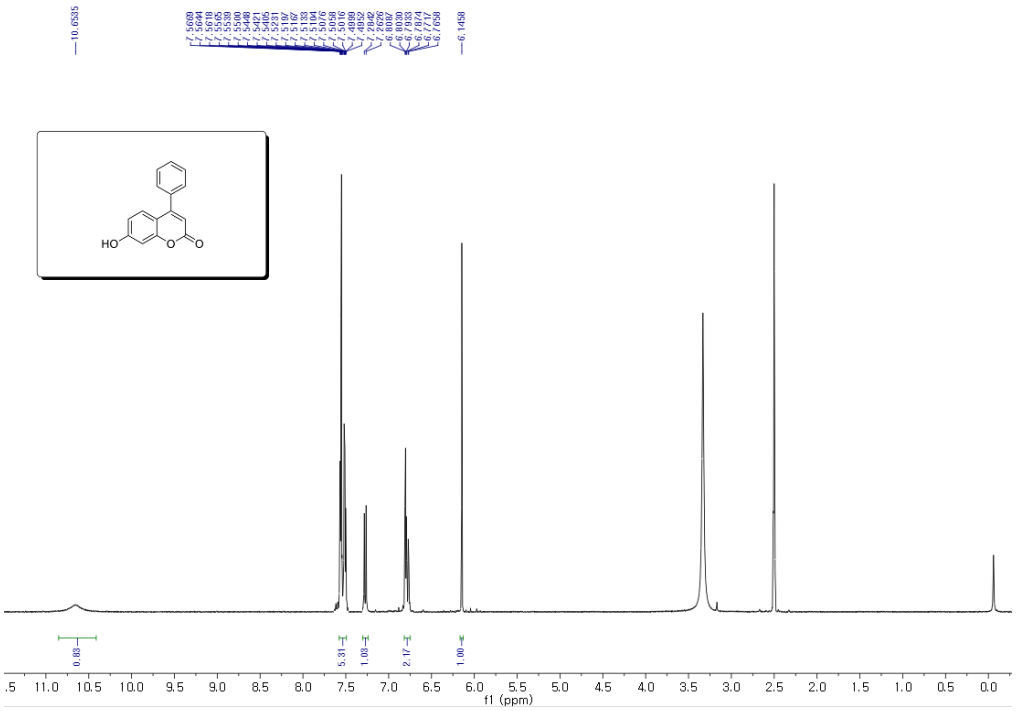


400 MHz, ^{1}H NMR in $CDCl_3$

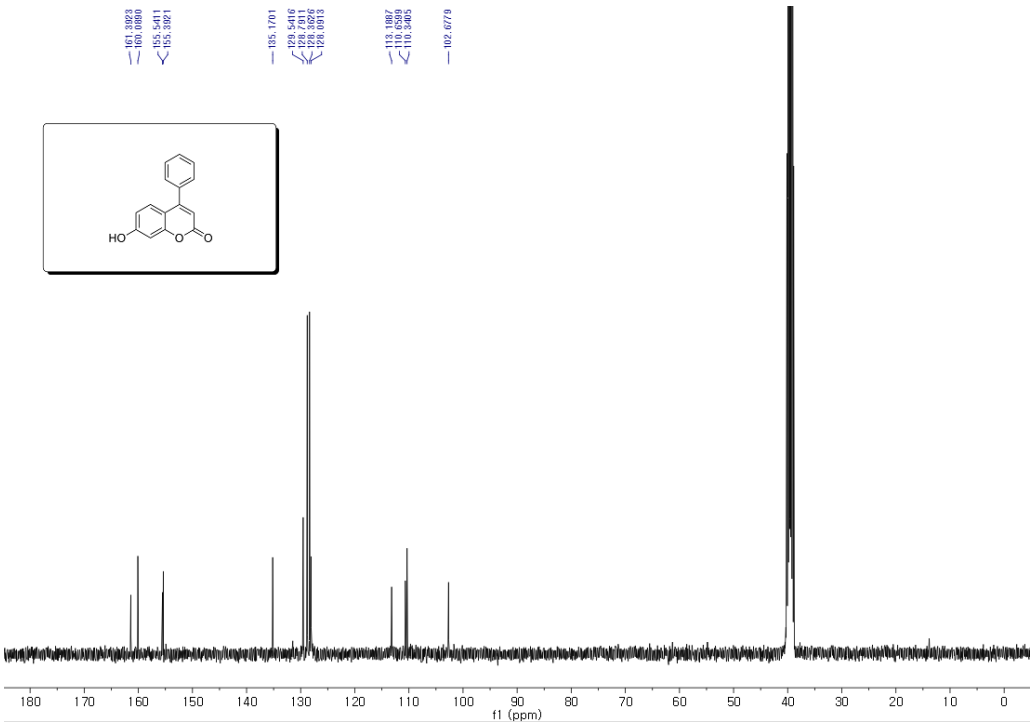


100 MHz, ^{13}C NMR in $CDCl_3$

7-hydroxy-4-phenyl-2H-chromen-2-one (2q).

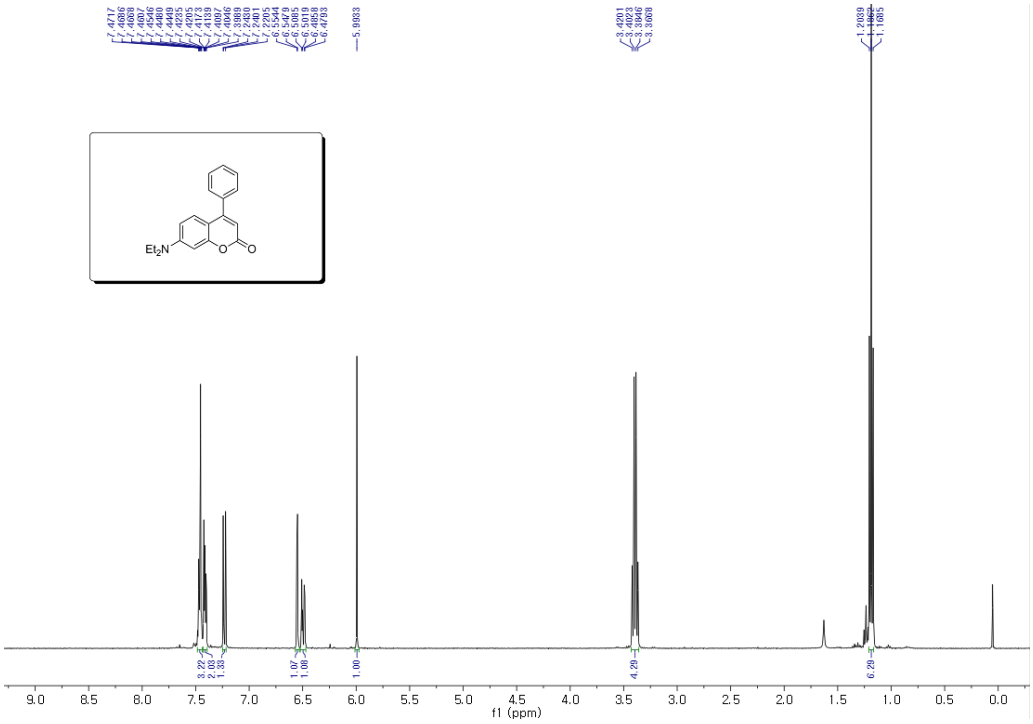


400 MHz, ^{1}H NMR in DMSO-d$_6$

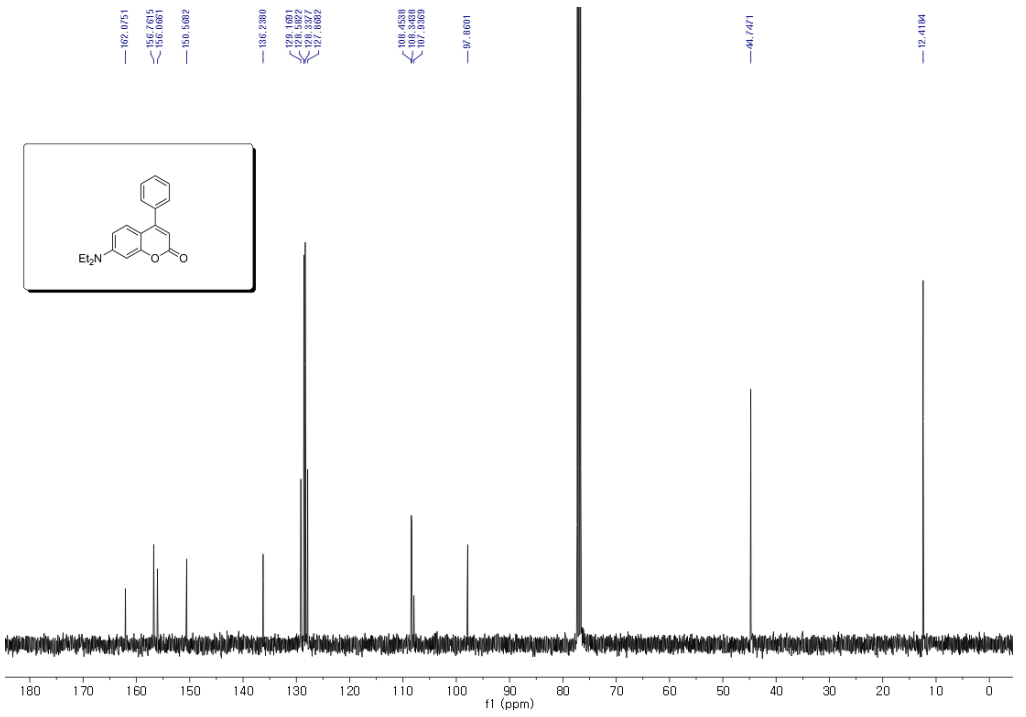


100 MHz, ^{13}C NMR in DMSO-d$_6$

7-(diethylamino)-4-phenyl-2H-chromen-2-one (2r).

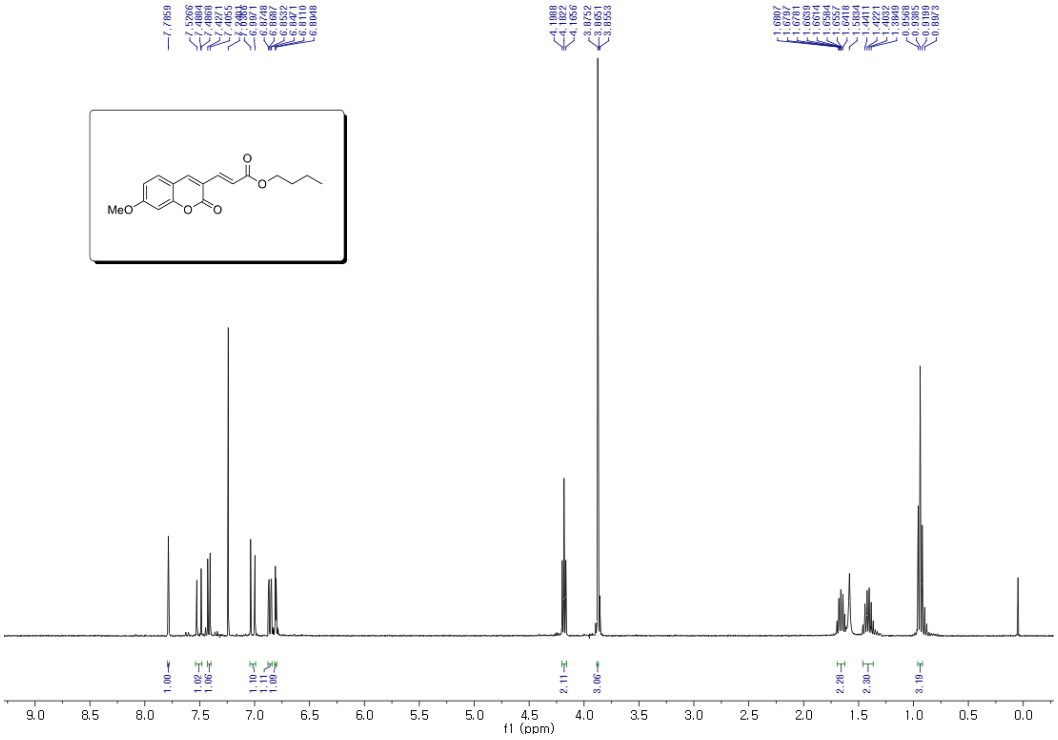


400 MHz, ^{1}H NMR in $CDCl_3$

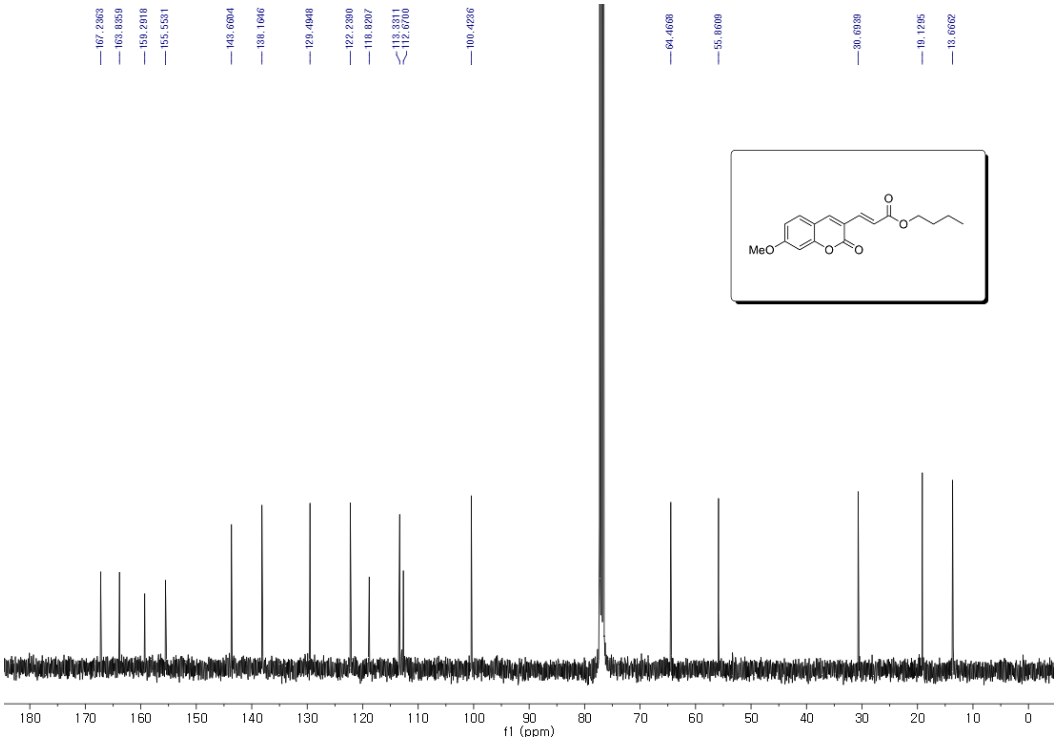


100 MHz, ^{13}C NMR in $CDCl_3$

(*E*)-butyl 3-(7-methoxy-2-oxo-2H-chromen-3-yl)acrylate (4).



400 MHz, ^{1}H NMR in $CDCl_3$



100 MHz, ^{13}C NMR in $CDCl_3$