Supplementary Material (ESI)

Direct Michael Addition/Decarboxylation Reaction of Coumarin-3-Carboxylic Acid to Cyclic 1,3-Diketones by Copper Ferrite Oxide Nanoparticles Immobilized on Microcrystalline Cellulose

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Table of contents

Experimental Section

1. General Experimental Details

All commercially available chemicals were used without further purification. Field Emission Scanning Electron Microscope (FESEM) (Carl Ziess Merlin compact equipped with Oxford X-max^{n}), High-resolution Transmission Electron Microscopy (HR-TEM) of JEOL model JEM 2100 TEM HR LaB6 and X-ray diffraction (XRD) of Bruker D8 Advance X-ray diffractometer were used for the characterization of Cu_2O immobilized on microcrystalline cellulose (Cu_2O@MCC). The thermal stability of the catalyst was analyzed using TG/DTA 7300 of EXSTAR. Brunauer–Emmett–Teller (BET) analysis was carried out to examine the surface area of composite material by using Bel**sorp**$_{max}$ of Microtrac BEL Corp. Detection of copper was measured from inductively coupled plasma (ICP) emission spectroscopy of 7300 DV, Perkin Elmer. ^{1}H NMR spectra were obtained on Bruker 500 MHz NMR and 400, 600 MHz JEOL NMR spectrometers.^{13}C NMR spectra were recorded at 100, 125, and 150 MHz. Chemical shifts are reported relative to the TMS signal. Multiplicity is indicated as follows: s (singlet); bs (broad singlet); d (doublet); t (triplet); q (quartet); m (multiplet); dd (doublet of doublets), etc. TOF and quadrupole mass analyzer types are used for the HRMS measurements. FT-IR spectrometer (Shimadzu) in the range of 400–4000 cm^{-1}. The melting point of organic molecules was observed from the melting point apparatus. Thin Layer Chromatography (TLC) was performed by using silica gel 60 F_{254} plates (Merck).

2. DTG of $CuFe_2O_4$@MCC nanocomposite

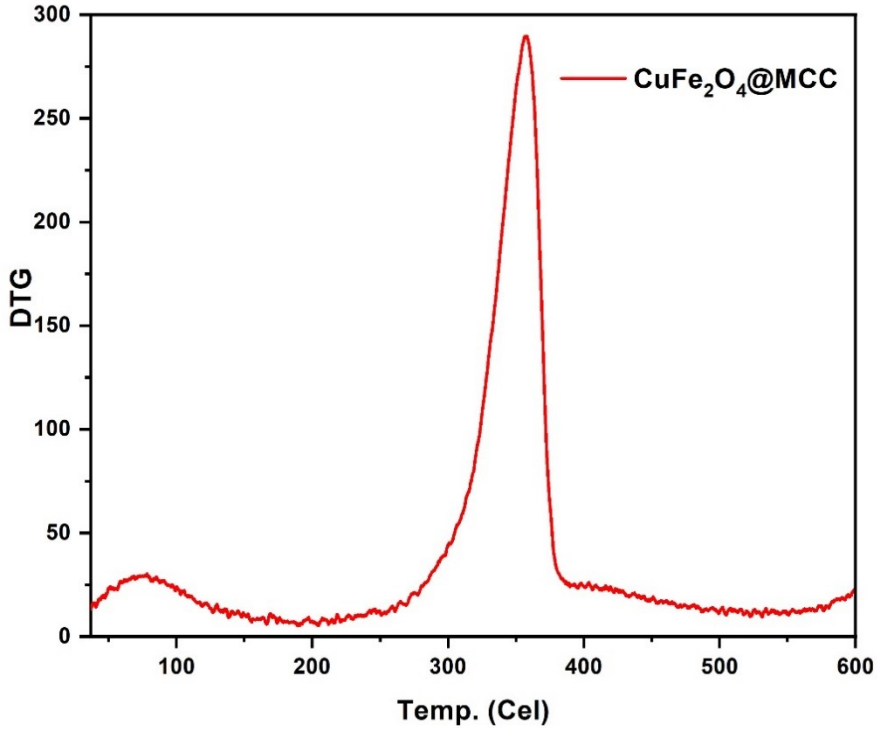


Figure: *SI.1:- DTG of* $CuFe_2O_4$@MCC

3. Brunauer–Emmett–Teller (BET) Analysis of $CuFe_2O_4$@MCC

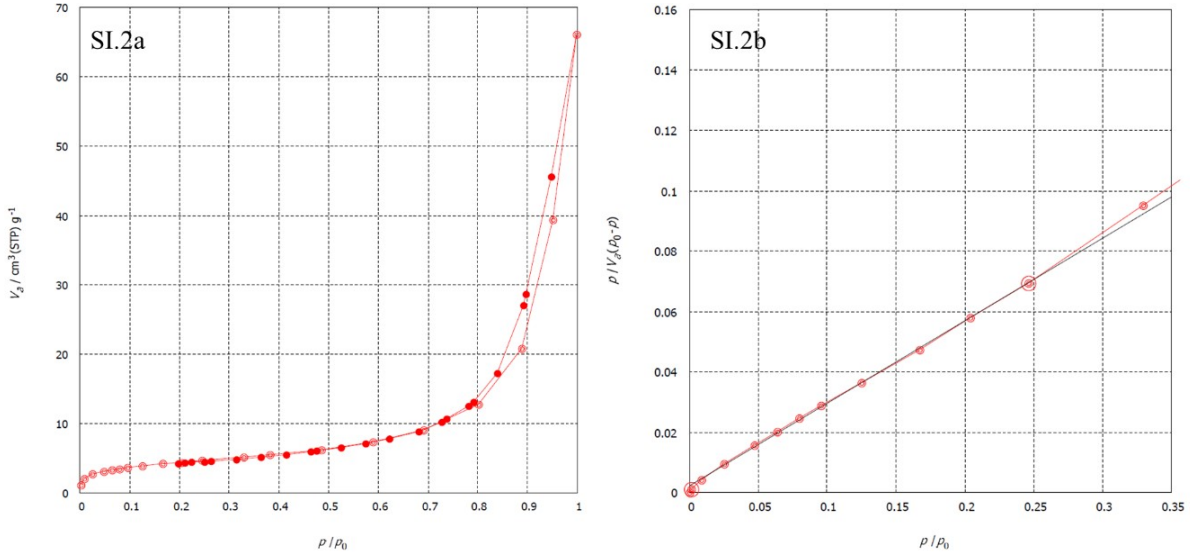


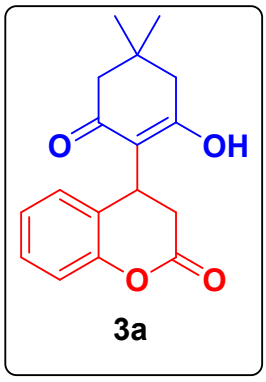
Figure: *SI.2a and 2b:- Adsorption-desorption isotherm & BET plot*

Composite	Surface area (m^2/g)	Average Pore Diameter (Å)
$CuFe_2O_4$@MCC	15.77	28.186

4. General Procedure for Michael Addition/decarboxylation of 1,3 diketone cyclohexanone with 1mmol coumarin 3-carboxylic acid

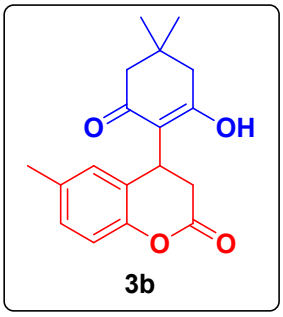
In a 10ml round bottom flask 1mmol of dimedone **(1a)** with 1mmol coumarin 3-carboxylic acid **(2a)** in DMSO: H_2O (1:1) 3 ml with catalyst (20mg) was stirred for 7 hours at 60°C. The progress of the reaction was examined by thin-layer chromatography (TLC). After completion of the reaction, 10 ml of water was added and extracted with ethyl acetate (3 X 10 ml). A combined organic layer passed through filter paper for removing the catalyst. The organic layer was washed with brine(20 ml), dried over anhydrous Na_2SO_4(10 gm), and concentrated under reduced pressure. Thus, obtained crude was washed with diethyl ether (3 ml) to remove nonpolar impurities**.** Further purification was done by recrystallization in ethyl acetate if necessary.

5. Spectral data for products (3a-p)



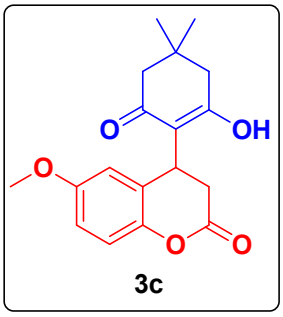
3a

4-(2-hydroxy-4,4-dimethyl-6-oxocyclohex-1-en-1-yl)chroman-2-one (3a): White solid; 86% yield; Melting Point: 178-180 ˚C; IR (KBr) u_{max} (cm^{-1}): 2947, 1758, 1558, 1373, 1288, 1226, 1180, 1041, 933, 756, 609; ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.19 (dd, *J* = 14.0, 3.0 Hz, 1H), 7.04 – 7.00 (m, 1H), 6.97 (d, *J* = 8.0 Hz, 1H), 4.57 (dd, *J* = 8.5, 4.9 Hz, 1H), 2.95 (dd, *J* = 16.6, 8.5 Hz, 1H), 2.68 (dd, *J* = 16.6 Hz, 1H), 2.32 – 2.15 (m, 4H), 0.97 (s, 6H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 167.88, 151.67, 128.20, 127.94, 125.39, 124.34, 116.64, 115.39, 33.61, 32.17, 28.44, 28.31. HRMS(ESI+): m/z calculated for $C_{17}H_{19}O_4$ $[M+H]^+$ 287.1283; Found: 287.1318.



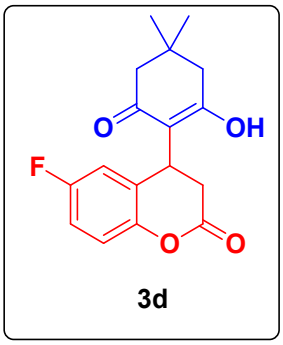
3b

4-(2-hydroxy-4,4-dimethyl-6-oxocyclohex-1-en-1-yl)-6-methylchroman-2-one (3b): White solid; 82% yield; Melting Point: 182-184˚C; IR (KBr) u_{max} (cm^{-1}): 2954, 1743, 1566, 1481, 1365, 1249, 1226, 1157, 1041, 879, 817, 663, 609; ^{1}H NMR (500 MHz, DMSO-d_6) δ 6.98 (d, *J* = 7.1 Hz, 1H), 6.85 (d, *J* = 8.2 Hz, 1H), 6.80 (s, 1H), 4.53 (dd, *J* = 8.4, 4.8 Hz, 1H), 2.91 (dd, *J* = 16.6, 8.6 Hz, 1H), 2.65 (dd, *J* = 16.6, 4.8 Hz, 1H), 2.24 (s, 4H), 2.19 (s, 3H), 0.97 (s, 6H). ^{13}C NMR (126 MHz, DMSO-d_6) δ 172.72, 154.38, 144.65, 137.84, 133.09, 129.72, 121.08, 120.09, 111.52, 61.82, 38.41, 36.85, 33.11, 33.00, 25.54, 12.12. HRMS(ESI+): m/z calculated for $C_{18}H_{21}O_4$ $[M+H]^+$ 301.1440; Found: 301.1479.



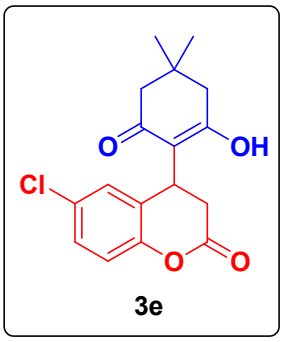
3c

4-(2-hydroxy-4,4-dimethyl-6-oxocyclohex-1-en-1-yl)-6-methoxychroman-2-one (3c): White solid; 79% yield; Melting Point: 180-182˚C; IR (KBr) u_{max} (cm^{-1}): 2954, 1765, 1563, 1365, 1248, 1268, 1176, 1048, 1020, 879, 814, 673, 609; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.07 (d, *J* = 8.8 Hz, 1H), 6.92 (dd, *J* = 8.8, 3.0 Hz, 1H), 6.65 (d, *J* = 2.8 Hz, 1H), 4.67 (dd, *J* = 8.0, 5.9 Hz, 1H), 3.80 (s, 3H), 3.02 (dd, *J* = 16.6, 8.3 Hz, 1H), 2.85 (dd, *J* = 16.6, 5.7 Hz, 1H), 2.52 – 2.27 (m, 4H), 1.12 (s, 6H). ^{13}C NMR (126 MHz, DMSO) δ 168.09, 155.84, 145.66, 126.52, 117.33, 114.79, 112.93, 112.88, 55.75, 33.39, 32.14, 28.74, 28.28.



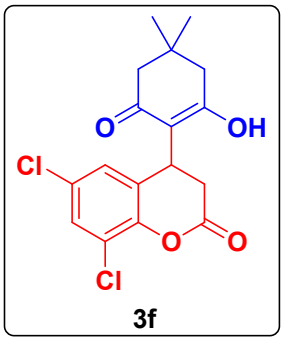
3d

6-fluoro-4-(2-hydroxy-4,4-dimethyl-6-oxocyclohex-1-en-1-yl)chroman-2-one (3d): White solid; 83% yield; Melting Point: 184-186˚C; IR (KBr) u_{max} (cm^{-1}): 2954, 1766, 1558, 1373, 1296, 1249, 1180, 1041, 925, 879, 810, 694, 617; ^{1}H NMR (600 MHz, $CDCl_3$ + DMSO-d_6) δ 7.75 – 7.68 (m), 7.14 (d, *J* = 8.4 Hz, 1H), 7.05 (s, 1H), 6.95 – 6.91 (m, 1H), 4.69 (t, *J* = 6.9 Hz, 1H), 2.99 (dd, *J* = 16.5, 8.7 Hz, 1H), 2.83 (dd, *J* = 16.4 Hz, 1H), 2.31 (d, *J* = 6.9 Hz, 4H), 1.07 (s, 6H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 168.03, 149.69, 133.15, 128.39 (d, J_{C-F} = 2.7 Hz), 125.02, 116.40, 115.44, 33.72, 32.18, 28.41, 28.31, 20.86. ^{19}F NMR (500 MHz, $CDCl_3$ + DMSO-d_6) δ -114.90. HRMS(ESI+): m/z calculated for $C_{17}H_{18}FO_4$ $[M+H]^+$ 305.1189; Found: 305.1227.



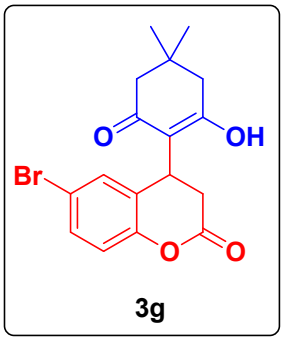
3e

6-chloro-4-(2-hydroxy-4,4-dimethyl-6-oxocyclohex-1-en-1-yl)chroman-2-one (3e): White solid; 83% yield; Melting Point: 172-174˚C; IR (KBr) u_{max} (cm^{-1}): 2954, 1728, 1581, 1488, 1373, 1257, 1141, 871, 802, 756, 686, 609; ^{1}H NMR (500 MHz, DMSO) δ 7.27 (dd, *J* = 8.7, 2.5 Hz, 1H), 7.05 (d, *J* = 8.7 Hz, 1H), 7.00 (d, *J* = 2.1 Hz, 1H), 4.59 (dd, *J* = 8.5, 4.8 Hz, 1H), 2.99 (dd, *J* = 16.7, 8.7 Hz, 1H), 2.69 (dd, *J* = 16.7, 4.8 Hz, 1H), 2.37 – 2.18 (m, 4H), 0.99 (s, 6H). ^{13}C NMR (126 MHz, DMSO) δ 167.26, 150.53, 127.88, 127.80, 127.64, 127.54, 118.59, 114.85, 33.12, 32.16, 28.51, 28.25. HRMS(ESI+): m/z calculated for $C_{17}H_{18}ClO_4$ $[M+H]^+$ 321.0894; Found: 321.0934.



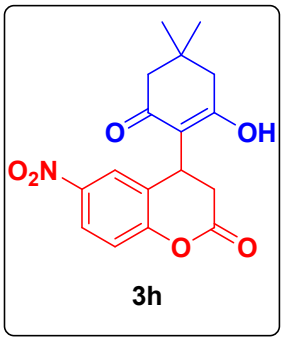
3f

6,8-dichloro-4-(2-hydroxy-4,4-dimethyl-6-oxocyclohex-1-en-1-yl)chroman-2-one (3f): White solid; 80% yield; Melting Point: 178-180˚C; IR (KBr) u_{max} (cm^{-1}): 2955, 1734, 1424, 1558, 1448, 1373, 1248, 1158, 1041, 874, 612; ^{1}H NMR (500 MHz, DMSO) δ 7.72 (d, *J* = 2.4 Hz, 1H), 7.64 (d, *J* = 2.2 Hz, 1H), 4.23 (t, *J* = 4.4 Hz, 1H), 2.76 (t, *J* = 10.3 Hz, 3H), 2.60 (d, *J* = 17.6 Hz, 1H), 2.50 (d, *J* = 16.1 Hz, 1H), 2.34 (d, *J* = 16.1 Hz, 1H), 1.22 (s, 3H), 1.19 (s, 3H). ^{13}C NMR (126 MHz, DMSO-d_6) δ 196.88, 172.65, 165.82, 145.41, 128.59, 128.32, 128.05, 121.67, 111.01, 50.58, 32.22, 29.47, 28.80, 26.62.HRMS(ESI+): m/z calculated for $C_{17}H_{18}NO_6$ $[M+H]^+$ 355.0504; Found: 355.0501.



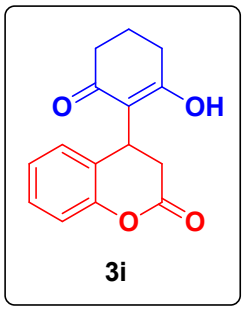
3g

6-bromo-4-(2-hydroxy-4,4-dimethyl-6-oxocyclohex-1-en-1-yl)chroman-2-one (3g): White solid; 81% yield; Melting Point: 174-176 ˚C; IR (KBr) u_{max} (cm^{-1}): 2954, 1766, 1558, 1342, 1257, 1226,1157, 1041, 871, 601; ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.38 (dd, *J* = 8.6, 2.4 Hz, 1H), 7.12 (d, *J* = 2.2 Hz, 1H), 6.98 (d, *J* = 8.6 Hz, 1H), 4.58 (dd, *J* = 8.6, 4.7 Hz, 1H), 2.98 (dd, *J* = 16.7, 8.7 Hz, 1H), 2.67 (dd, *J* = 16.7, 4.8 Hz, 1H), 2.46 – 1.97 (m, 4H), 0.98 (s, 6H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 167.22, 151.01, 130.71, 130.49, 128.06, 119.04, 115.80, 114.99, 33.15, 32.19, 28.46, 28.25. HRMS(ESI+): m/z calculated for $C_{17}H_{18}BrO_4$ $[M+H]^+$ 365.0461; Found: 365.0448.



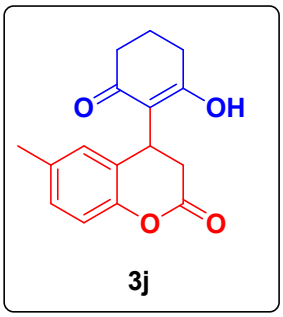
3h

4-(2-hydroxy-4,4-dimethyl-6-oxocyclohex-1-en-1-yl)-6-nitrochroman-2-one (3h): White solid; 80% yield; Melting Point: 184-186°C; IR (KBr) u_{max} (cm^{-1}): 2954, 1712, 1620, 1527, 1388, 1342, 1234, 1203, 1157, 1033, 925, 833, 794, 748, 671, 648, 594; ^1H NMR (500 MHz, DMSO-d_6) δ 8.30 (d, *J* = 2.6 Hz, 1H), 8.11 (dd, *J* = 9.0, 2.7 Hz, 1H), 8.07 (s, 1H), 7.22 (d, *J* = 9.0 Hz, 1H), 4.24 (s, 1H), 2.65 (t, *J* = 5.8 Hz, 1H), 2.60 – 2.58 (m, 1H), 2.50 (d, *J* = 17.6 Hz, 1H), 2.34 (d, *J* = 16.1 Hz, 1H), 2.27 (d, *J* = 16.1 Hz, 1H), 1.12 (d, *J* = 8.0 Hz, 6H).^{13}C NMR (126 MHz, DMSO-d_6) δ 194.66, 170.69, 163.65, 153.02, 142.38, 138.05, 124.28, 109.31, 104.92, 55.22, 48.82, 30.27, 27.53, 26.47, 25.15, 5.52. HRMS(ESI+): m/z calculated for $C_{17}H_{18}NO_6$ $[M+H]^+$ 332.1134; Found: 332.1133.



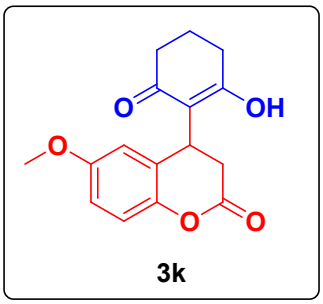
3i

4-(2-hydroxy-6-oxocyclohex-1-en-1-yl)chroman-2-one (3i): White solid; 85% yield; Melting Point: 176-178°C; IR (KBr) u_{max} (cm^{-1}): 3440, 2561, 1766, 1635, 1550, 1488, 1450, 1365, 1296, 1172, 1103, 1072, 995, 945, 925, 864, 756, 709, 648; ^1H NMR (400 MHz, DMSO-d_6) δ 7.22 – 7.16 (m, 1H), 7.02 (d, *J* = 6.2 Hz, 2H), 6.96 (d, *J* = 7.9 Hz, 1H), 4.63 – 4.53 (m, 1H), 2.91 (dd, *J* = 16.6, 8.4 Hz, 1H), 2.85 (dd, *J* = 16.6, 5.3 Hz, 1H), 2.35 (m, 4H), 1.91 – 1.80 (m, 2H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 167.90, 151.71, 128.30, 127.90, 125.51, 124.32, 116.57, 116.45, 33.63, 28.56, 20.86. HRMS(ESI+): m/z calculated for $C_{15}H_{15}O_4$ $[M+H]^+$ 259.0970; Found: 259.0972.



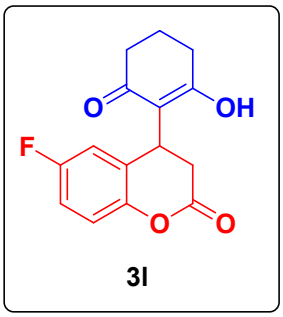
3j

4-(2-hydroxy-6-oxocyclohex-1-en-1-yl)-6-methylchroman-2-one (3j): White solid; 82% yield; Melting Point: 176-178˚C; IR (KBr) u_{max} (cm^{-1}): 3433, 2368, 1743, 1589, 1488, 1380, 1296, 1172, 1195, 1103, 1056, 894, 817, 709, 663; ^{1}H NMR (400 MHz,) δ 6.98 (dd, *J* = 8.2, 2.1 Hz, 1H), 6.84 (d, *J* = 8.2 Hz), 6.82 (d, *J* = 1.6 Hz), 4.52 (dd, *J* = 8.4, 4.9 Hz, 1H), 2.88 (dd, *J* = 16.6, 8.6 Hz, 1H), 2.65 (dd, *J* = 16.6, 4.9 Hz, 1H), 2.34 (m, 4H), 2.20 (s, 3H)1.83 (m, 2H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 168.04, 149.72, 133.16, 128.48, 128.39, 125.07, 116.66, 116.34, 33.75, 28.51, 20.86. HRMS(ESI+): m/z calculated for $C_{15}H_{14}FO_4$ $[M+H]^+$ 273.1127; Found: 273.1121.



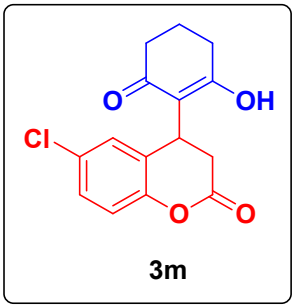
3k

4-(2-hydroxy-6-oxocyclohex-1-en-1-yl)-6-methoxychroman-2-one (3k): White solid; 78% yield; Melting Point: 178-180˚C; IR (KBr) u_{max} (cm^{-1}): 3440, 2947, 1735, 1585, 1365, 1248, 1145, 1157, 1084, 1019, 977, 889, 813, 794, 663, 609; ^{1}H NMR (500 MHz, DMSO) δ 7.06 (d, *J* = 8.8 Hz, 1H), 6.91 (dd, *J* = 8.8, 3.0 Hz, 1H), 6.66 (d, *J* = 2.9 Hz, 1H), 4.66 (dd, *J* = 8.2, 5.6 Hz, 1H), 3.81 (s, 3H), 3.00 (dd, *J* = 16.6, 8.3 Hz, 1H), 2.83 (dd, *J* = 16.6, 5.5 Hz, 1H), 2.66 – 2.64 (m, 4H), 2.00 – 1.96 (m, 2H). ^{13}C NMR (126 MHz, DMSO-d_6) δ 168.07, 155.83, 145.67, 126.48, 117.23, 116.11, 113.20, 112.74, 55.76, 33.41, 28.80, 20.82. HRMS(ESI+): m/z calculated for $C_{15}H_{14}O_5$ $[M+H]^+$ 289.1076; Found: 289.1075.



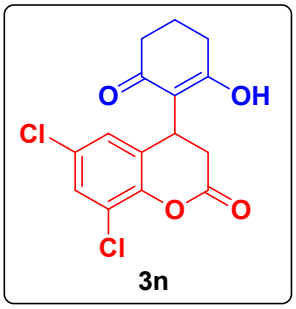
3l

6-fluoro-4-(2-hydroxy-6-oxocyclohex-1-en-1-yl)chroman-2-one (3l): White solid; 83% yield; Melting Point: 180-182˚C; IR (KBr) u_{max} (cm^{-1}): 3438, 3047, 1735, 1589, 1373, 1250, 1149, 1150, 1080, 1002, 972, 887, 817, 810, 663, 609; ^{1}H NMR (500 MHz, DMSO) δ 7.24 (d, *J* = 8.5 Hz, 1H), 7.05 – 6.99 (m, 2H), 4.55 (t, *J* = 7.5 Hz 1H), 2.99 – 2.88 (m, 1H), 2.66 (d, *J* = 16.6 Hz, 1H), 2.35 (m, 4H), 1.83 (s, 2H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 172.04, 155.30, 132.65, 132.55, 132.42 (d, J_{C-F} = 5.3 Hz), 123.28, 120.86, 37.90, 33.35, 25.52. ^{19}F NMR (500 MHz, $CDCl_3$ + DMSO-d_6) δ -115.20. HRMS(ESI+): m/z calculated for $C_{15}H_{14}FO_4$ $[M+H]^+$ 273.0876; Found: 293.0873.



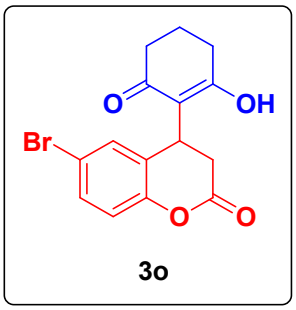
3m

6-chloro-4-(2-hydroxy-6-oxocyclohex-1-en-1-yl)chroman-2-one (3m): White solid; 83% yield; Melting Point: 174-176˚C; IR (KBr) u_{max} (cm^{-1}): 3456, 3047, 2345, 1743, 1589, 1481, 1411, 1373, 1249, 1211, 1149, 1080, 1002, 972, 877, 817, 794, 756, 663, 609; ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.43 (d, *J* = 2.5 Hz, 1H), 7.29 (dd, *J* = 8.7, 2.6 Hz, 1H), 7.12 (d, *J* = 8.7 Hz, 1H), 4.10 (dd, *J* = 6.8, 3.7 Hz, 1H), 2.61 – 2.54 (m, 2H), 2.48 – 2.31 (m, 4H), 2.03 – 1.81 (m, 2H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 197.06, 172.77, 168.00, 149.16, 128.99, 128.72, 128.39, 127.07, 118.49, 111.98, 41.91, 36.97, 28.37, 27.61, 20.61. HRMS(ESI+): m/z calculated for $C_{15}H_{14}ClO_4$ $[M+H]^+$ 293.0581; Found: 293.0581.



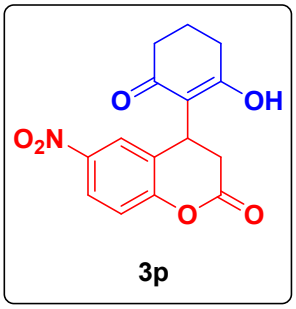
3n

6,8-dichloro-4-(2-hydroxy-6-oxocyclohex-1-en-1-yl)chroman-2-one (3n): White solid; 81% yield; Melting Point: 174-176˚C; IR (KBr) u_{max} (cm^{-1}): 3456, 2970, 1720, 1420, 1558, 1450, 1380, 1249, 1172, 1126, 1041, 918, 856, 632, 593; ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.57 (s, 1H), 7.46 (s, 1H), 4.12 (s, 1H), 2.63 (s, 2H), 2.38 (m, 4H), 1.95 (m, 2H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 197.00, 172.73, 167.42, 145.31, 128.71, 128.61, 128.37, 128.06, 121.76, 112.39, 36.91, 28.75, 27.45, 20.56. HRMS(ESI+): m/z calculated for $C_{16}H_{17}O_4$ $[M+H]^+$ 327.0191; Found: 327.0190.



3o

6-bromo-4-(2-hydroxy-6-oxocyclohex-1-en-1-yl)chroman-2-one (3o): White solid; 79% yield; Melting Point: 170-172˚C; IR (KBr) u_{max} (cm^{-1}): 3417, 2939, 2545, 1767, 1688, 1558, 1473, 1365, 1296, 1164, 1103, 1072, 1033, 987, 948, 871, 810, 748, 702, 640; ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.36 (dd, J = 8.6, 2.4 Hz, 1H), 7.14 (d, J = 2.3 Hz, 1H), 6.96 (d, J = 8.6 Hz, 1H), 4.57 (dd, J = 8.5, 4.7 Hz, 1H), 2.94 (dd, J = 16.7, 8.7 Hz, 1H), 2.66 (dd, J = 16.7, 4.8 Hz, 1H), 2.35 (m, 4H), 1.89 – 1.77 (m, 2H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 172.73, 167.24, 151.06, 130.69, 130.61, 128.18, 118.96, 116.23, 115.85, 33.24, 28.57, 20.82. HRMS(ESI+): m/z calculated for $C_{15}H_{14}BrO_4$ $[M+H]^+$ 337.0075; Found: 337.0075.

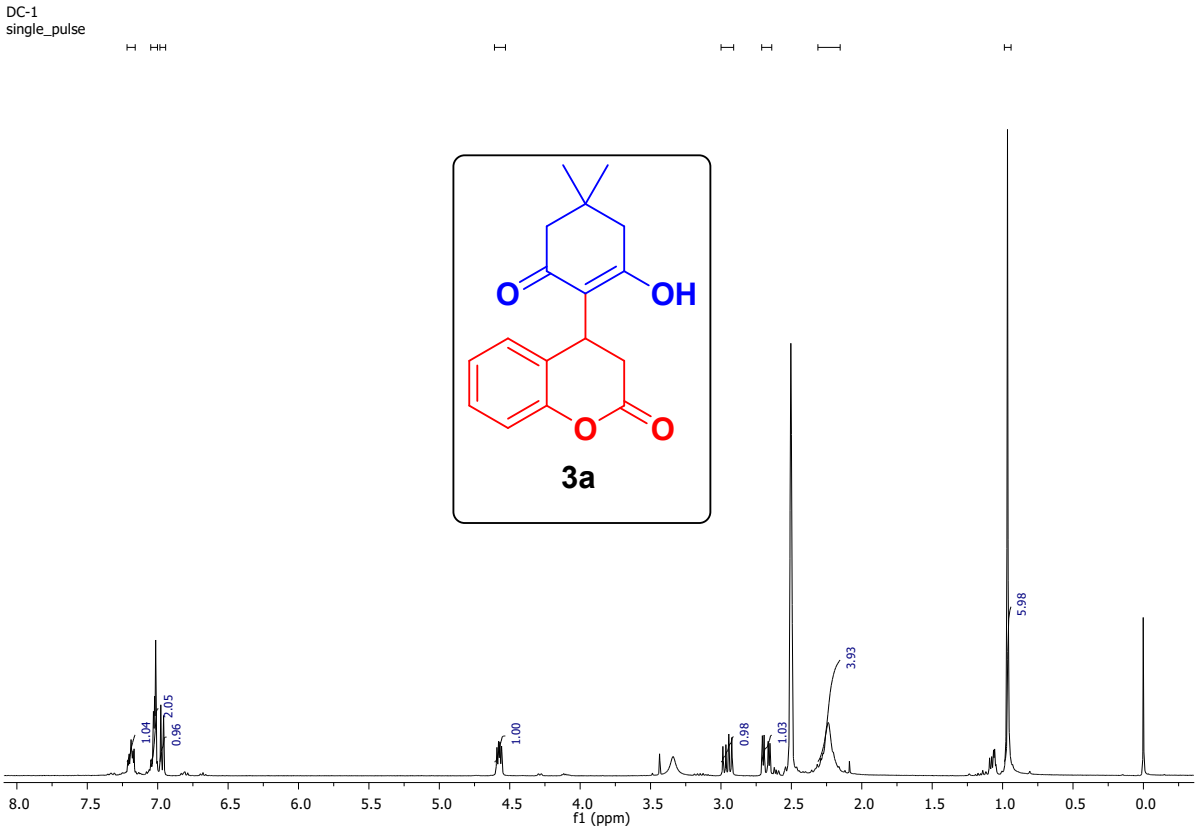


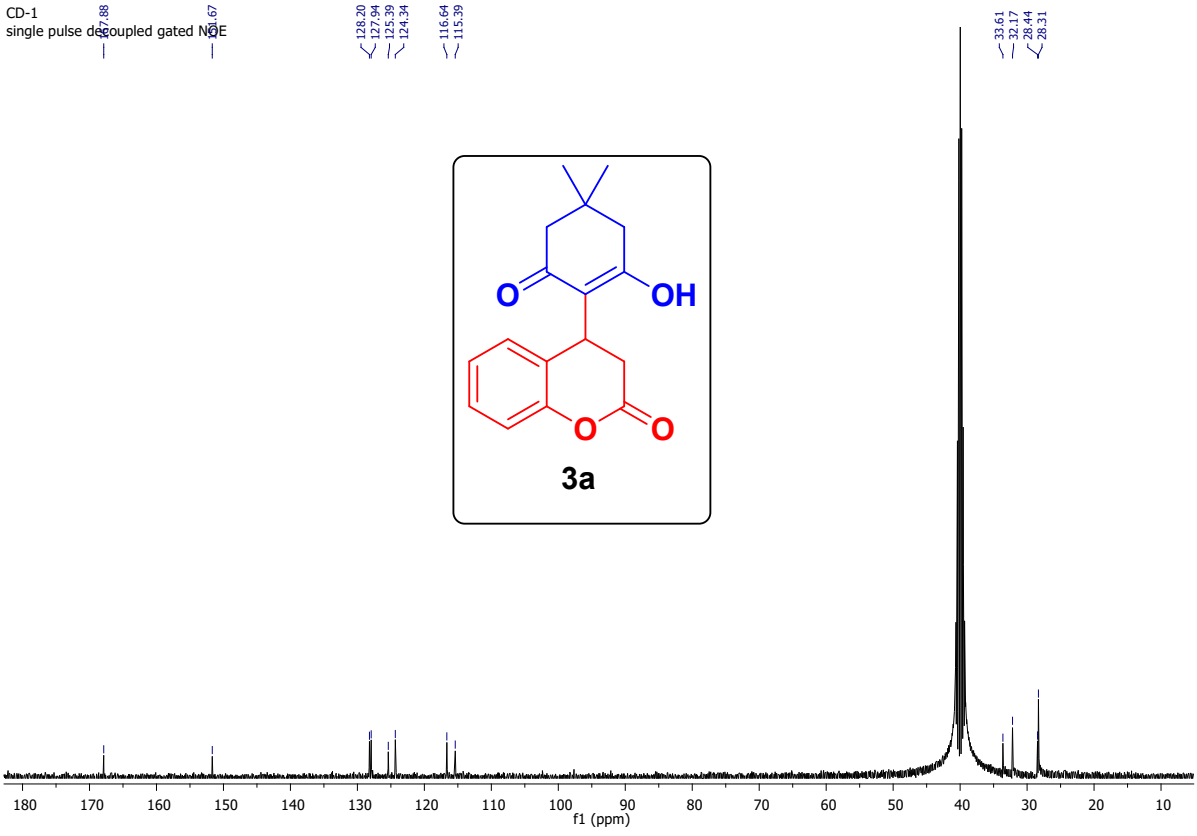
3p

4-(2-hydroxy-6-oxocyclohex-1-en-1-yl)-6-nitrochroman-2-one (3p): White solid; 76% yield; Melting Point: 176-178˚C; IR (KBr) υ_{max} (cm^{-1}): 3425, 2345, 1704, 1643, 1519, 1380, 1342, 1226, 1134, 1002, 910, 880, 748, 663, 632; ^{1}H NMR (400 MHz,) δ 8.33 (s, 1H), 8.12 (d, *J* = 8.7 Hz, 1H), 7.31 (d, *J* = 8.9 Hz, 1H), 4.25 – 4.16 (m, 1H), 2.61 (m, 4H), 2.40 (s, 2H), 2.09 – 1.89 (m, 2H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 197.09, 172.72, 167.45, 154.96, 144.30, 126.46, 125.47, 124.35, 117.86, 112.24, 41.77, 36.92, 28.28, 27.42, 20.53. HRMS(ESI+): m/z calculated for $C_{15}H_{14}NO_6$ $[M+H]^+$ 304.0821; Found: 304.0821

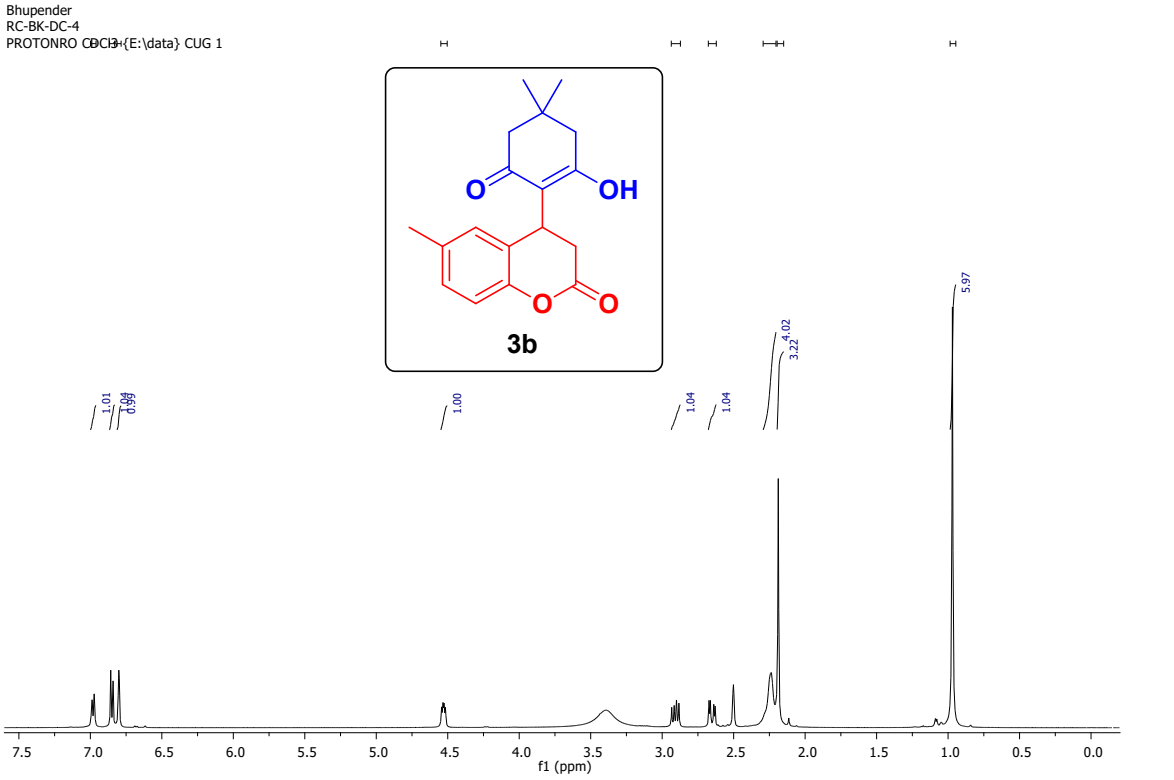
Copies of ^{1}H and ^{13}C NMR spectra of products(3a-p)

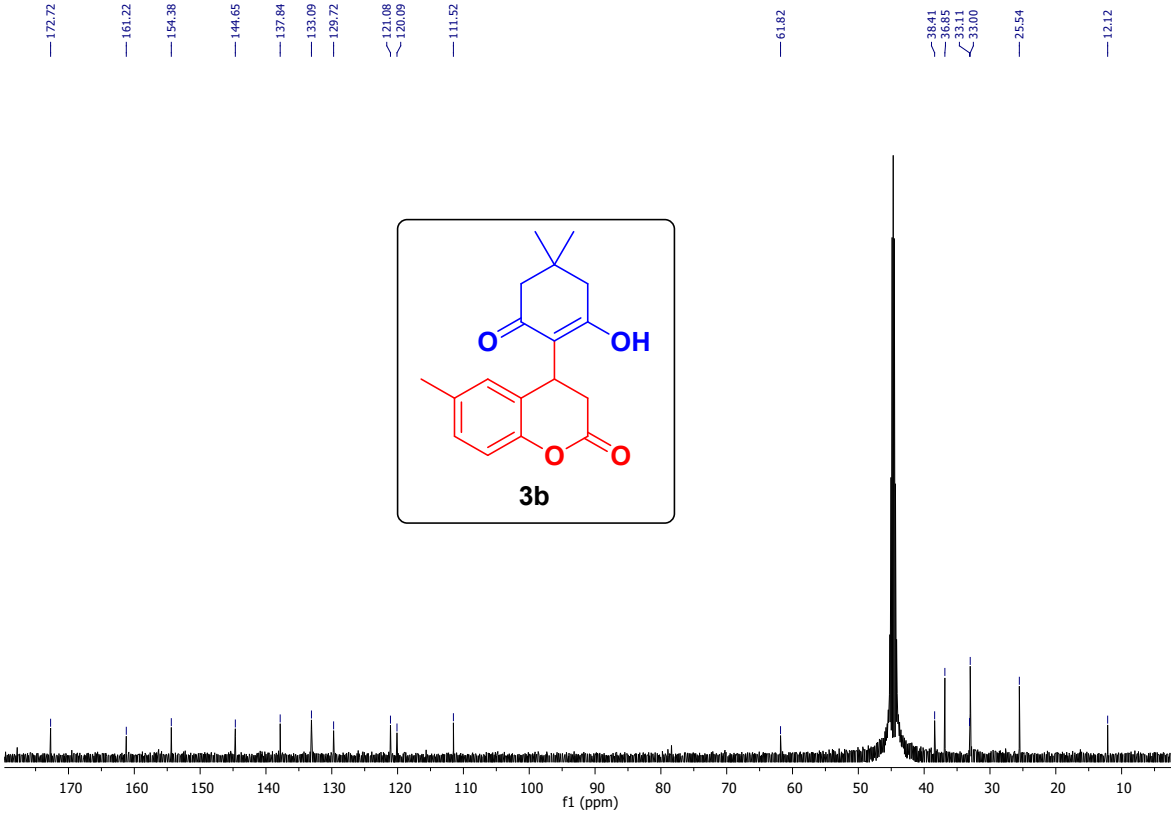
Copies of $^{1}HNMR$ and $^{13}CNMR$ spectra of **Compound 3a**



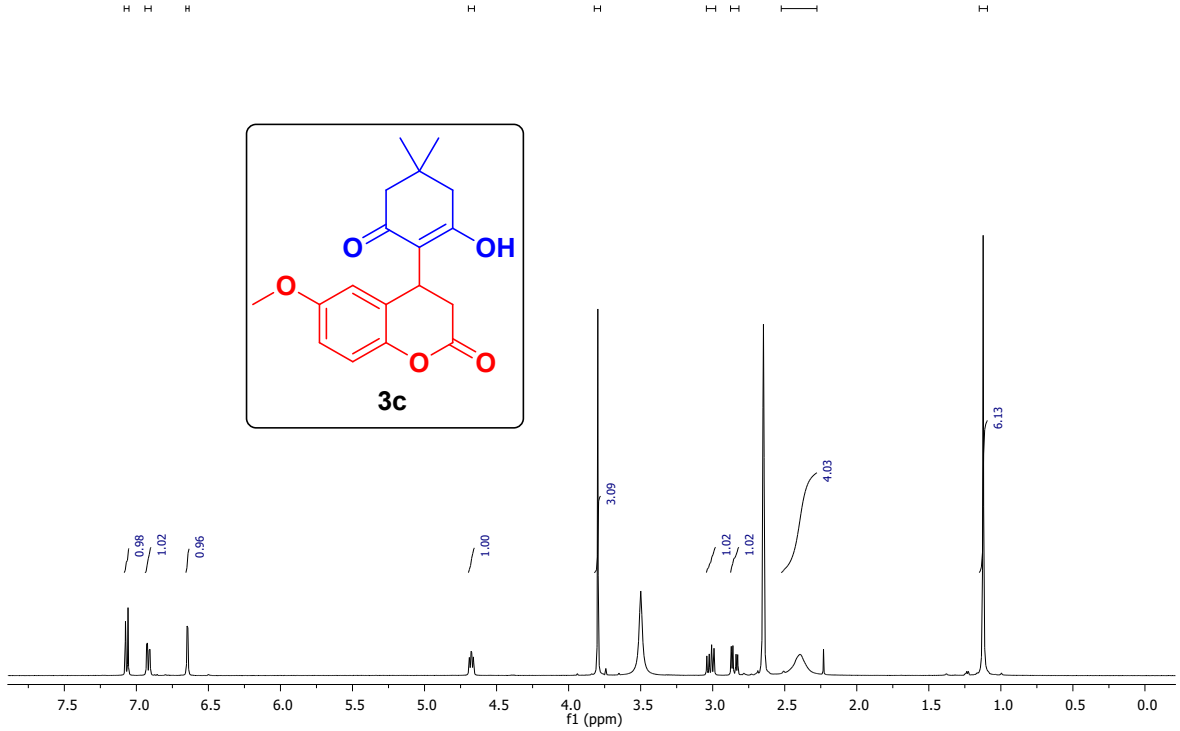


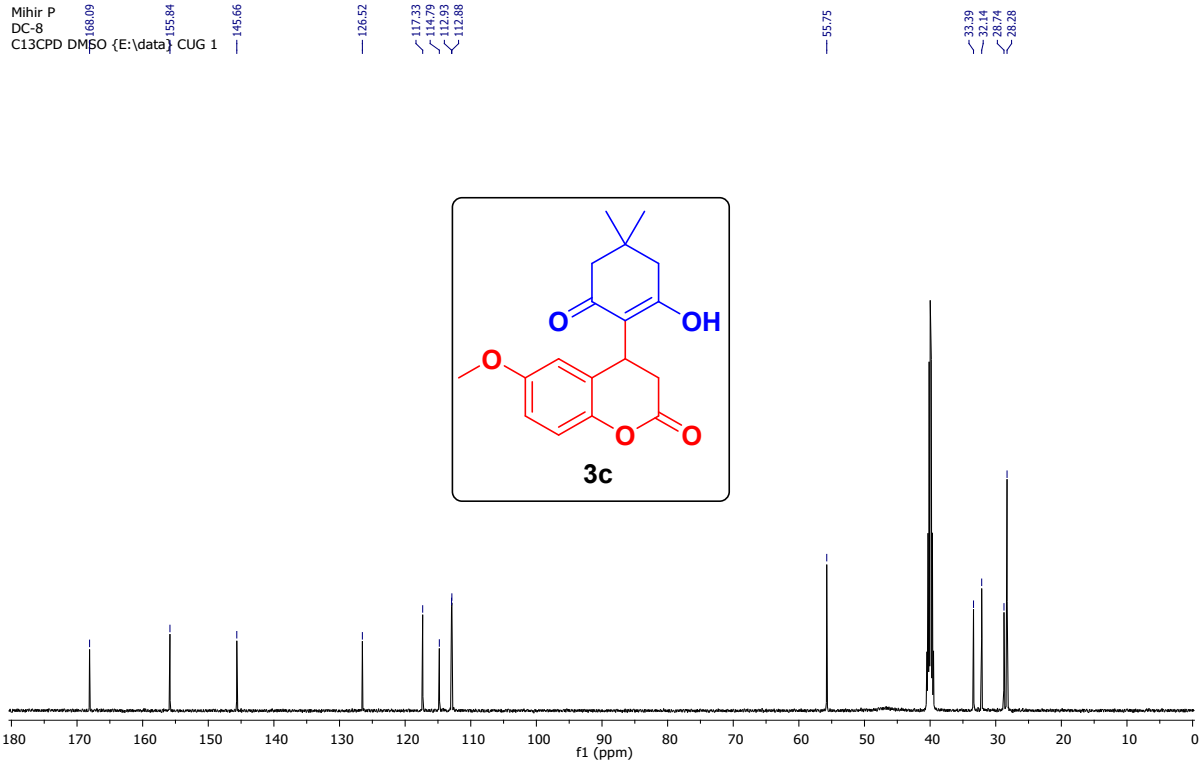
Copies of ^{1}HNMR and ^{13}CNMR spectra of **Compound 3b**



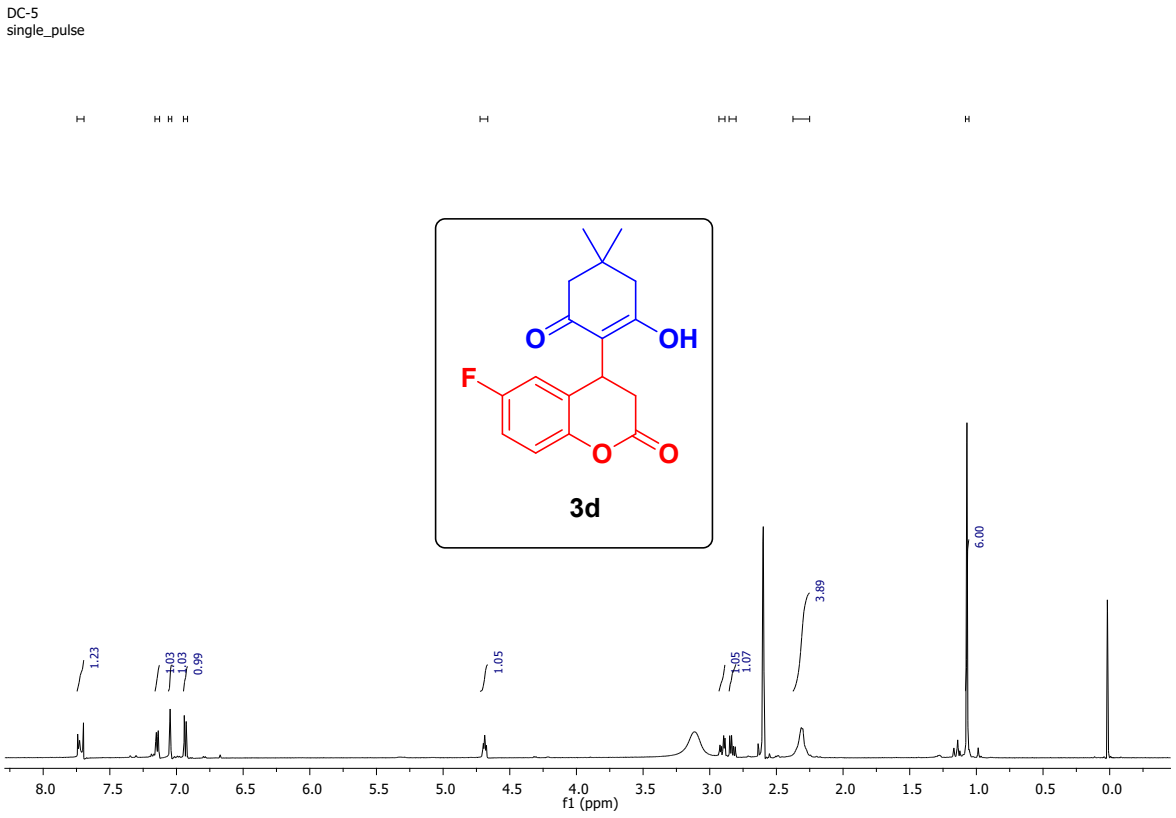


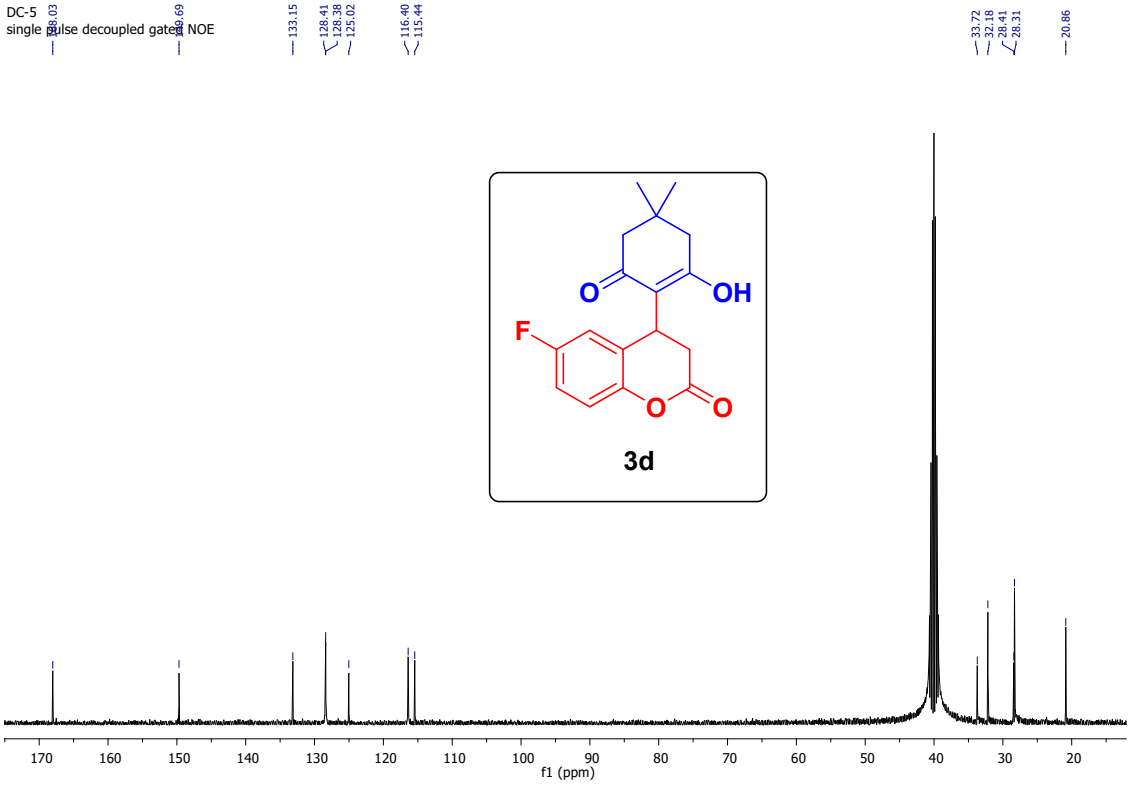
Copies of ^{1}HNMR and ^{13}CNMR spectra of **Compound 3c**



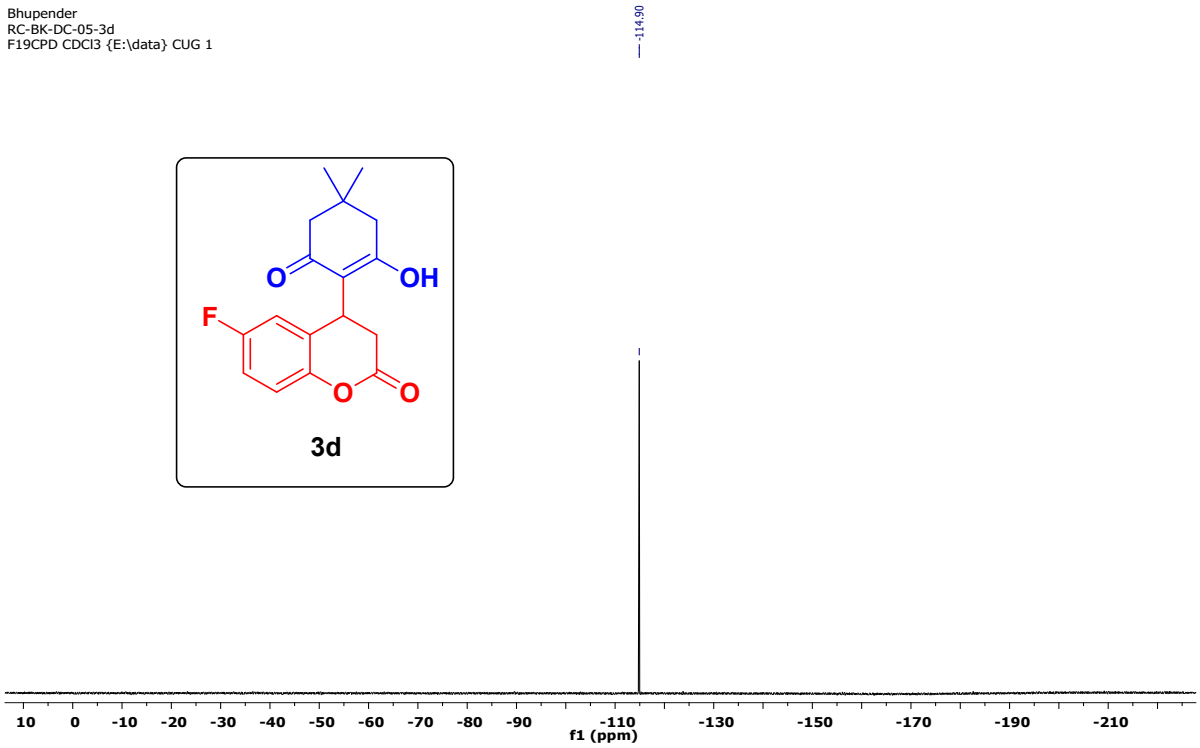


Copies of ^{1}HNMR and ^{13}CNMR spectra of **Compound 3d**

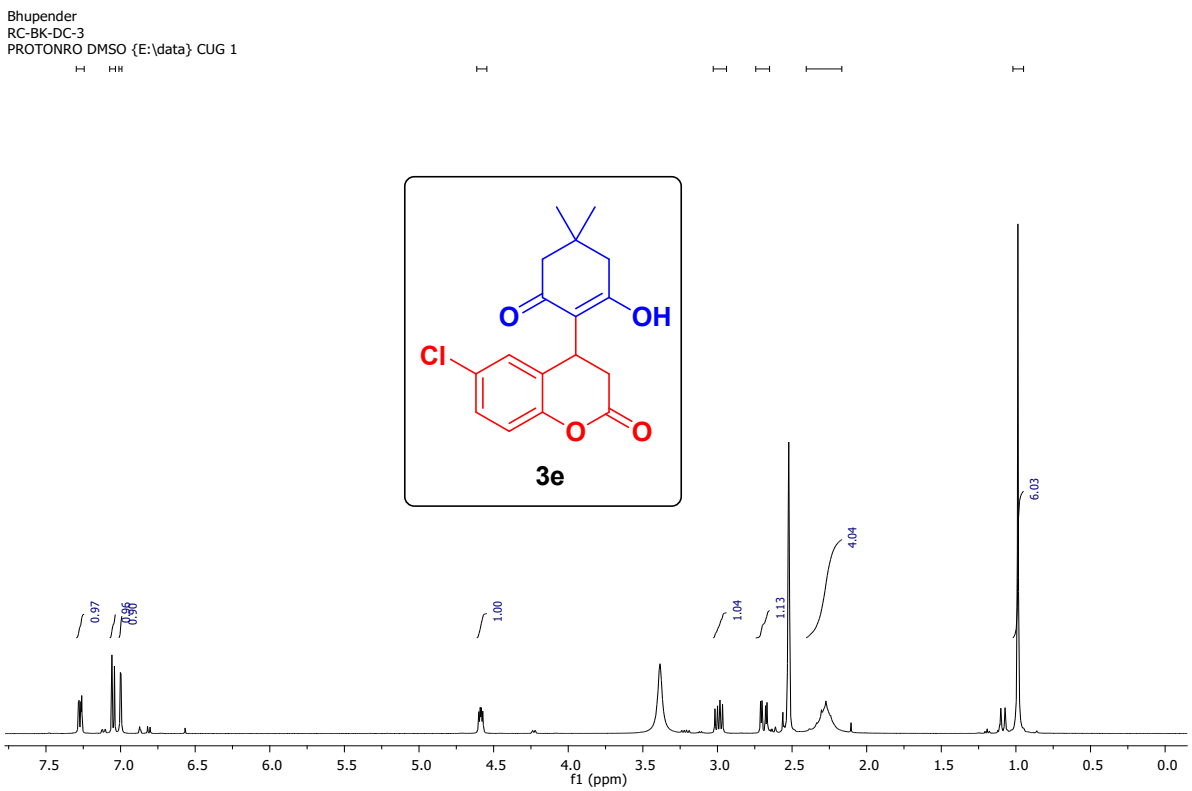


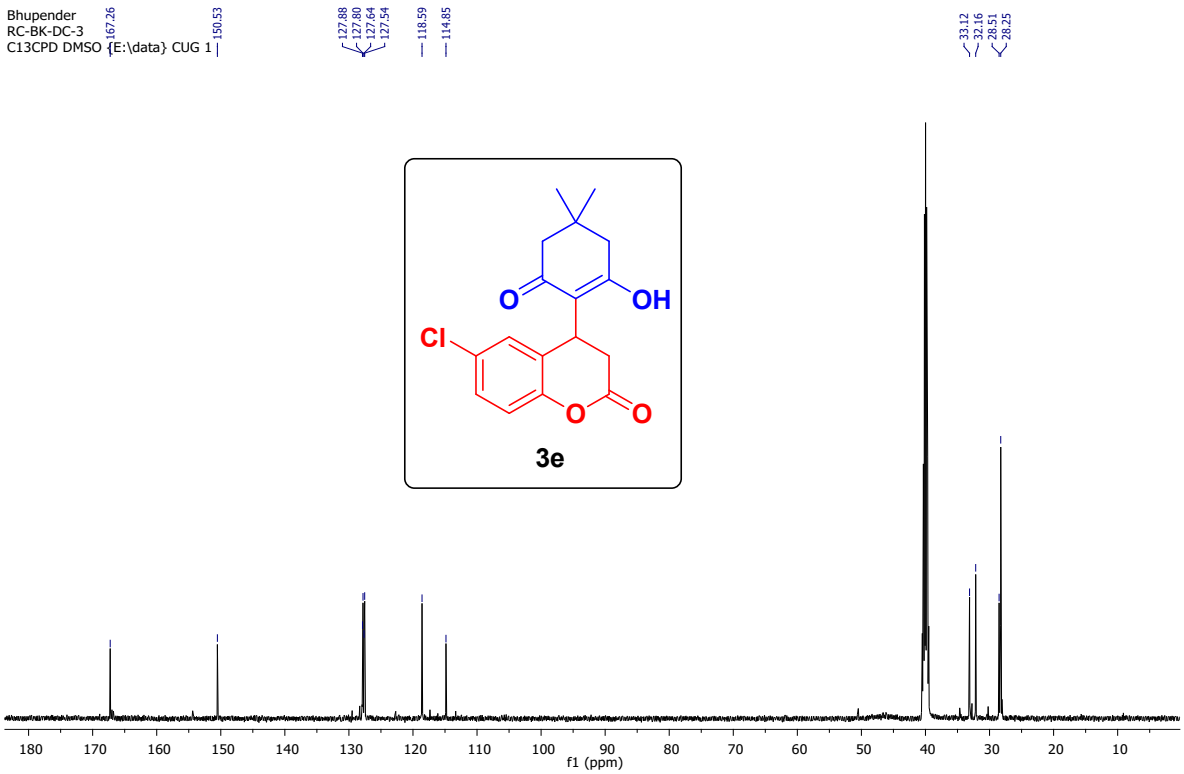


Copy of ^{19}FNMR spectra of **Compound 3d**

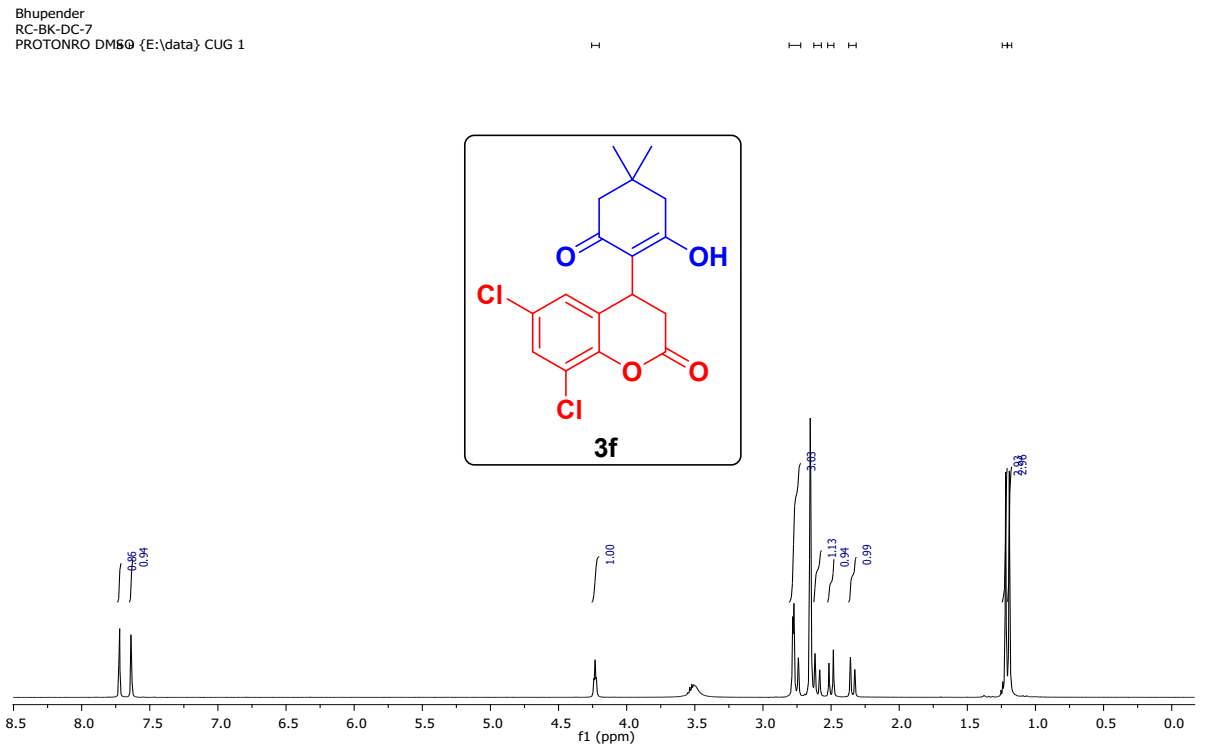


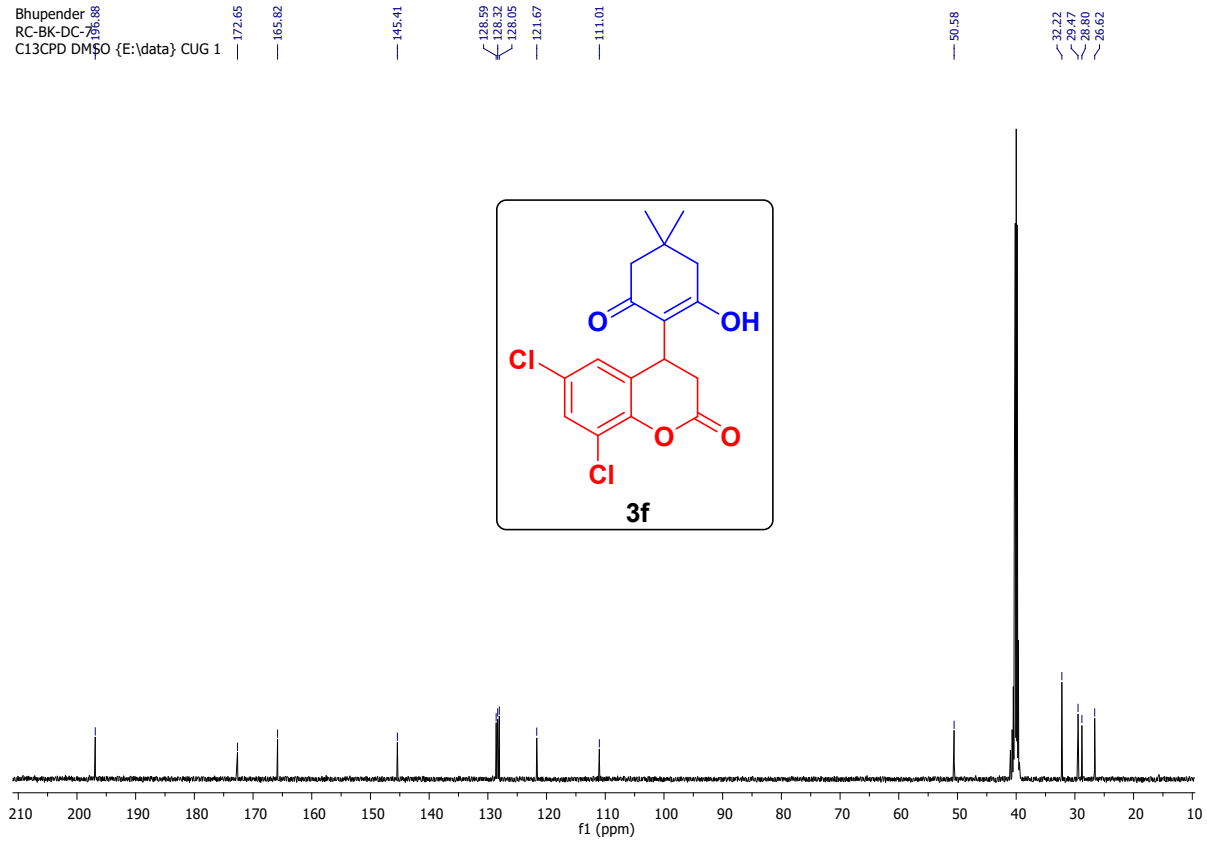
Copies of ^{1}HNMR and ^{13}CNMR spectra of **Compound 3e**



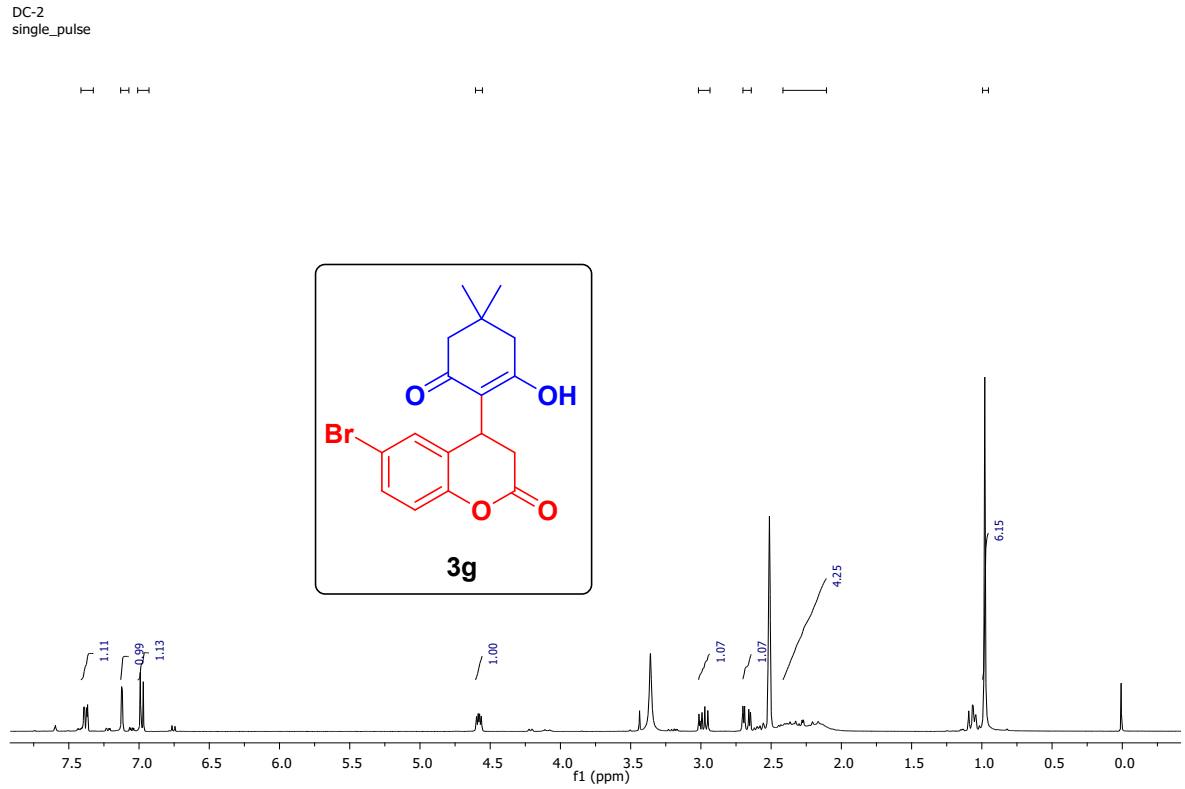

Bhupender
RC-BK-DC-3
C13CPD DMSO {E:\data} CUG 1
167.26
150.53
127.88
127.80
127.64
127.54
118.59
114.85
33.12
32.16
28.51
28.25
O
OH
Cl
O
O
3e
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

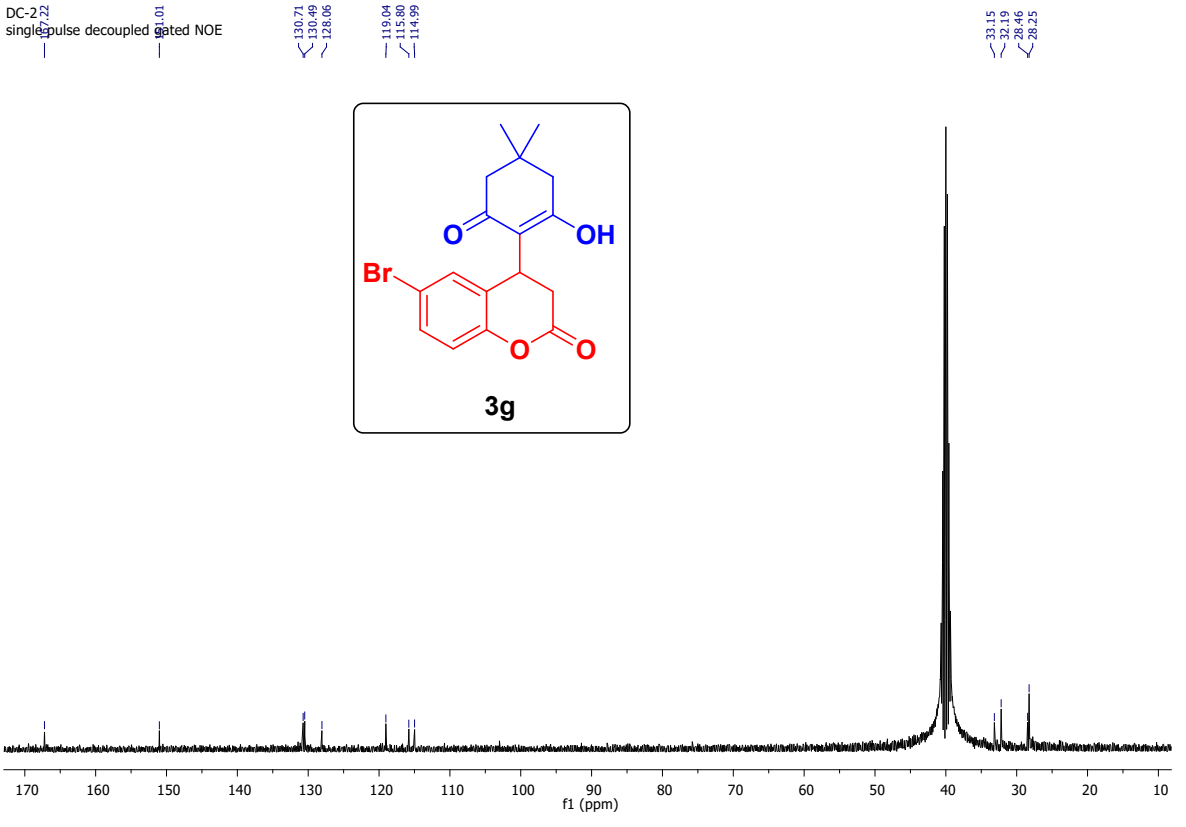
Copies of ^{1}HNMR and ^{13}CNMR spectra of **Compound 3f**



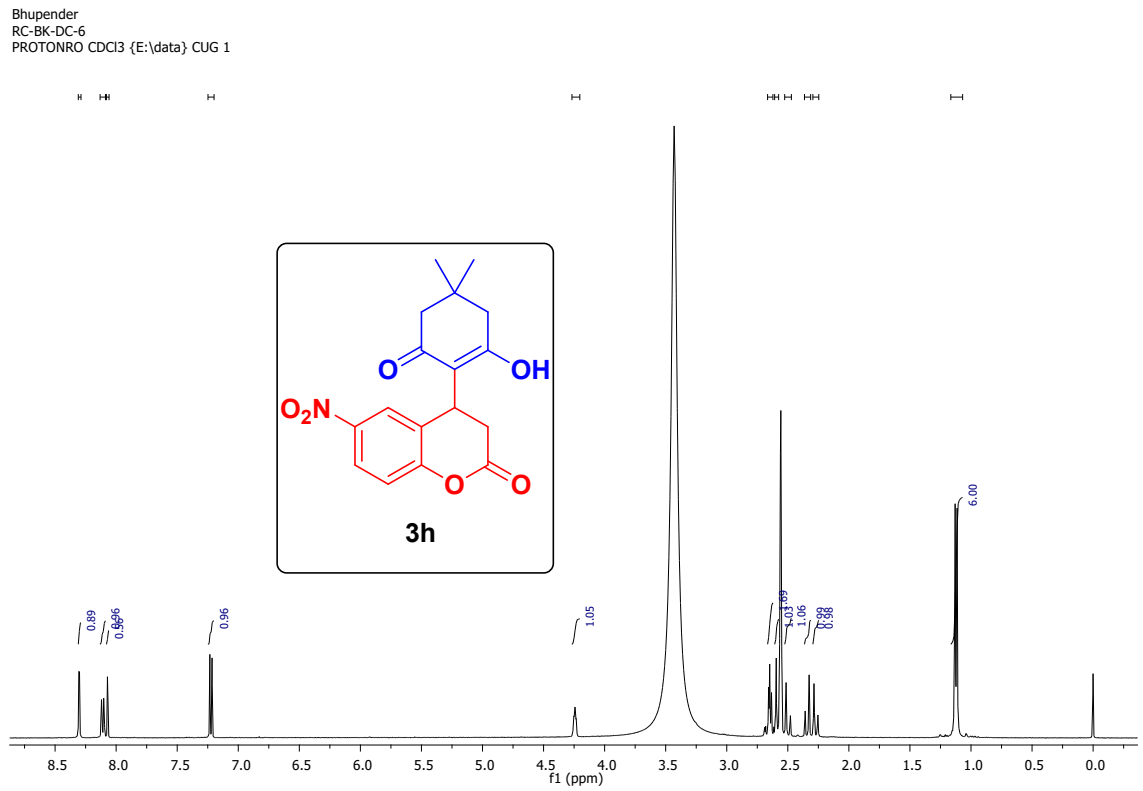


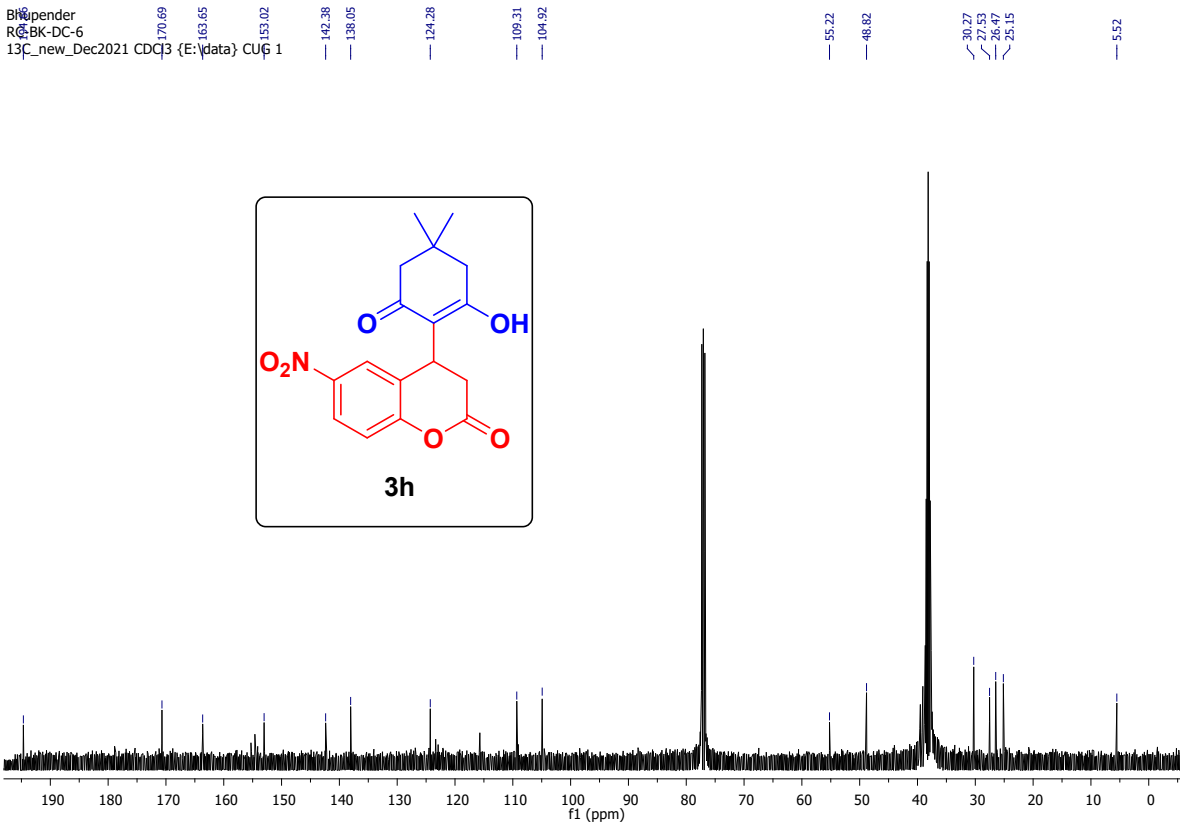
Copies of ^{1}HNMR and ^{13}CNMR spectra of **Compound 3g**



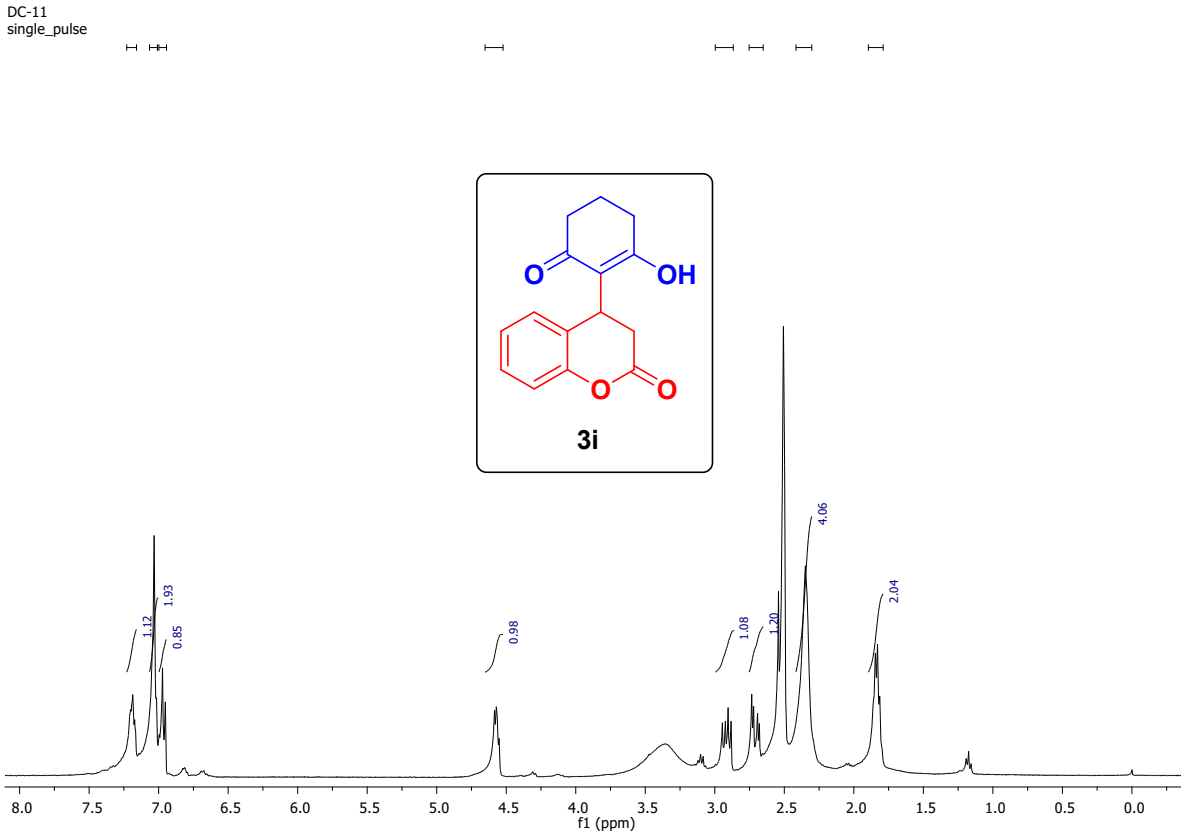


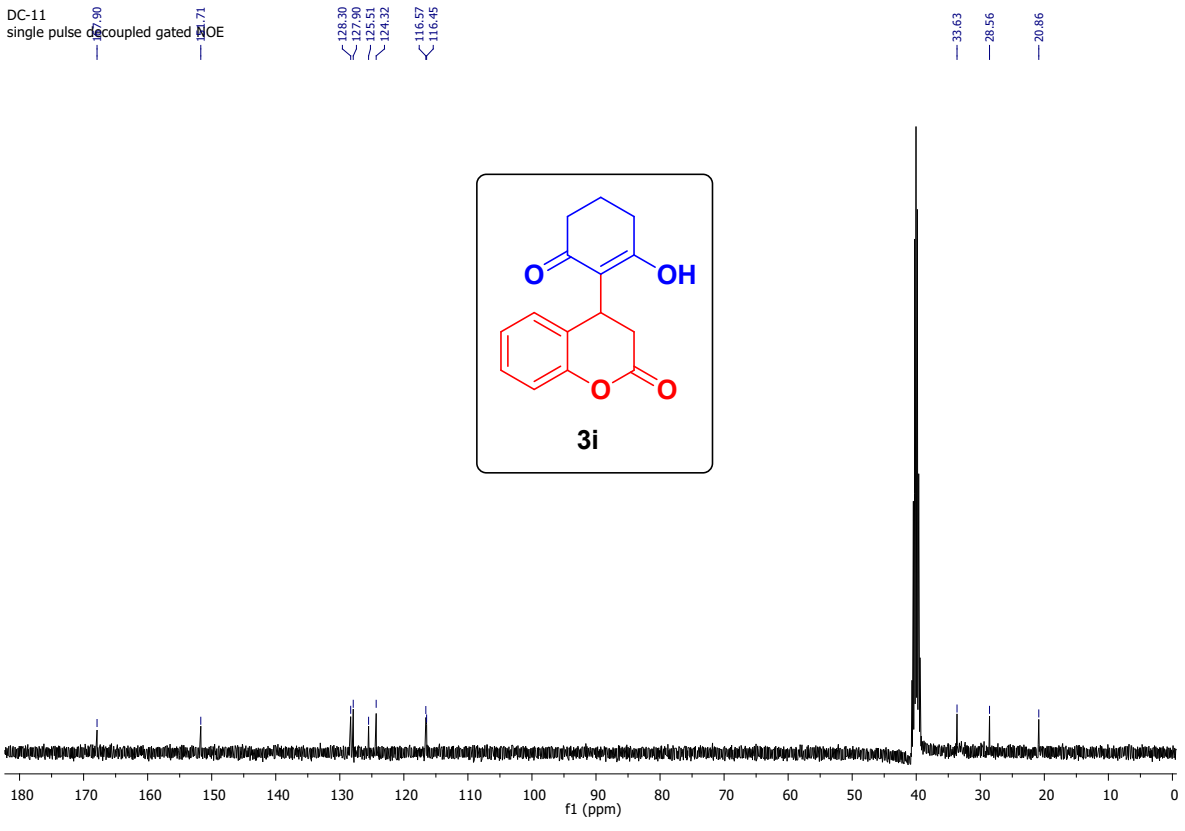
Copies of ^{1}HNMR and ^{13}CNMR spectra of **Compound 3h**



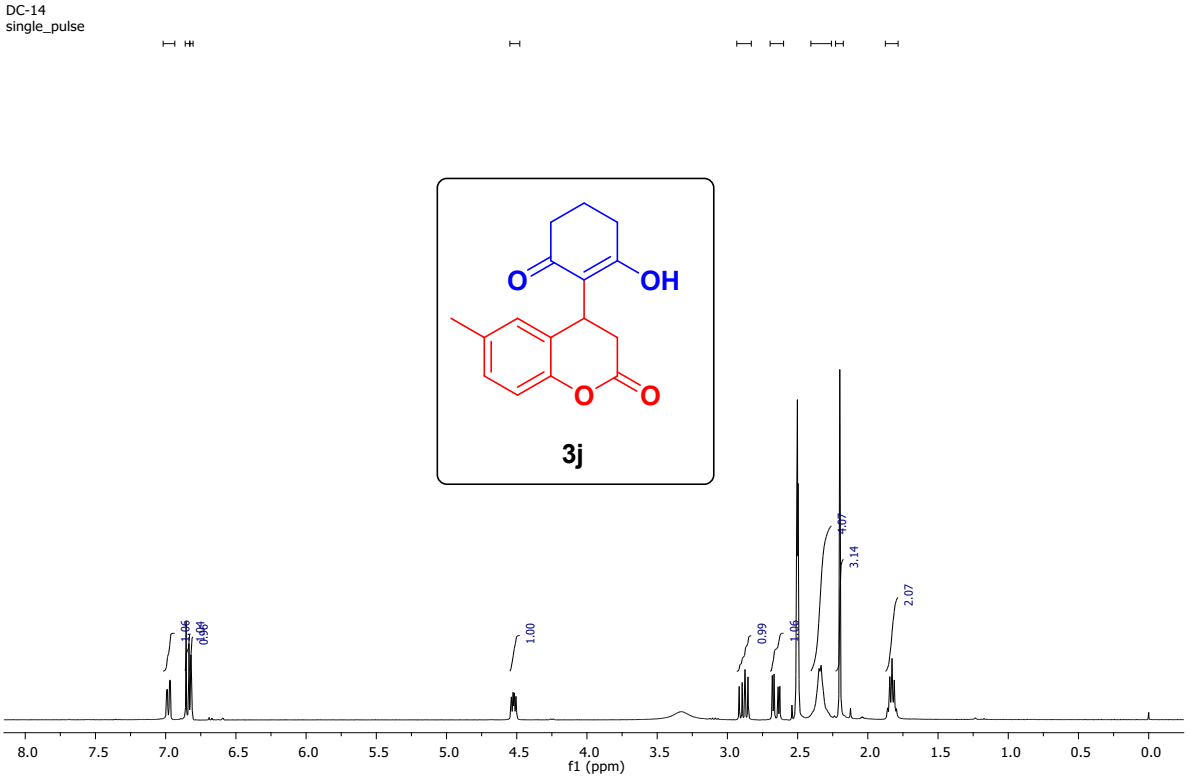


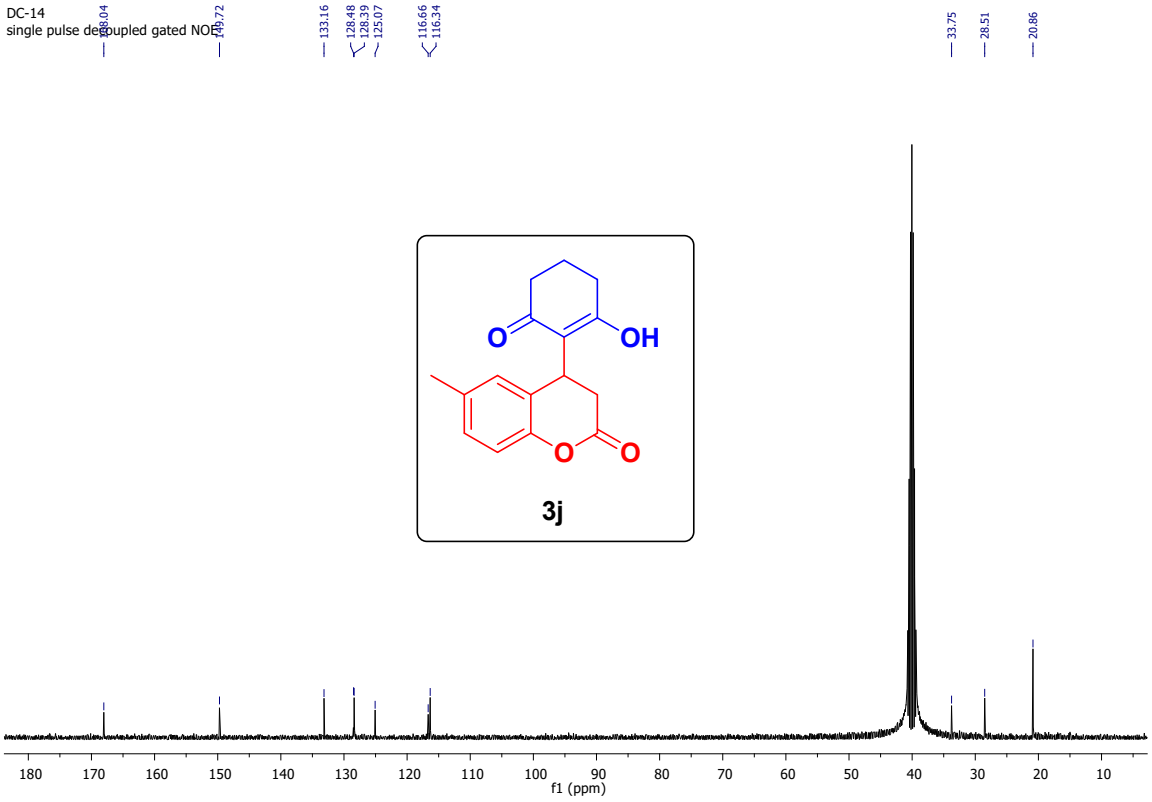
Copies of ^{1}HNMR and ^{13}CNMR spectra of **Compound 3i**



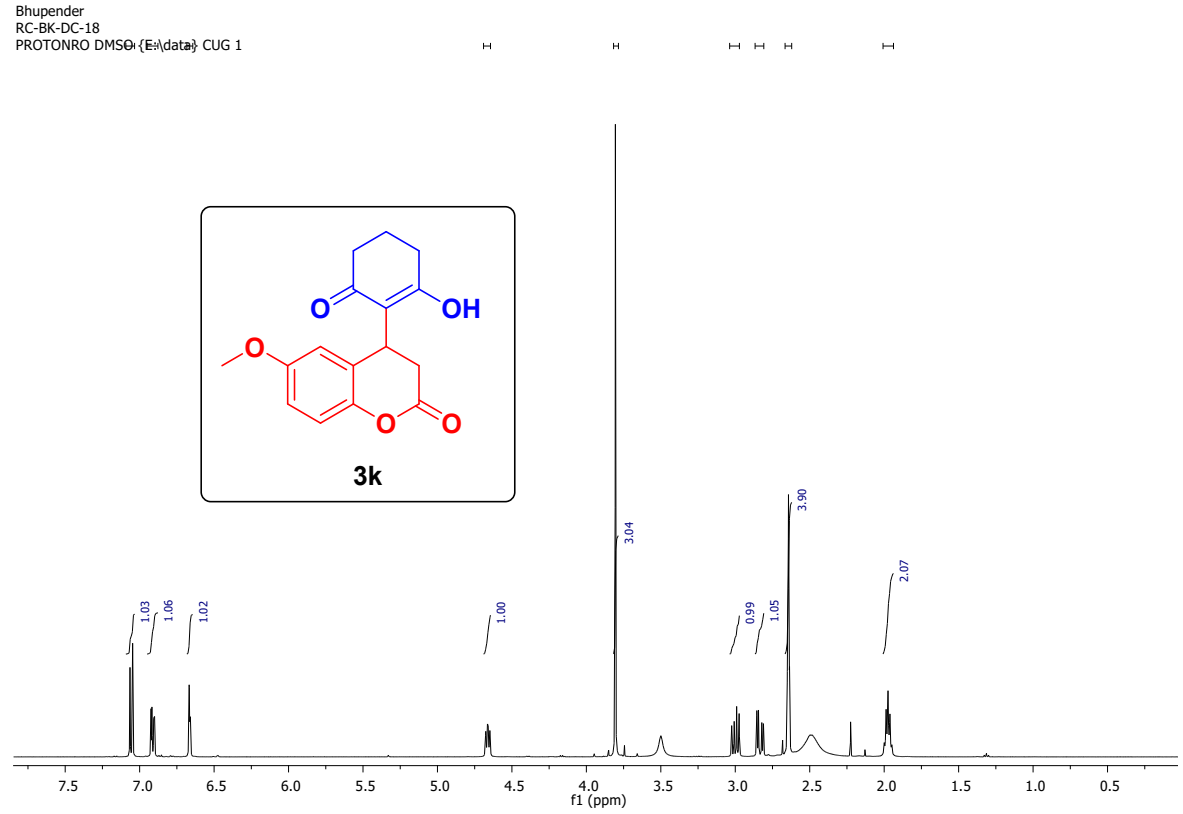


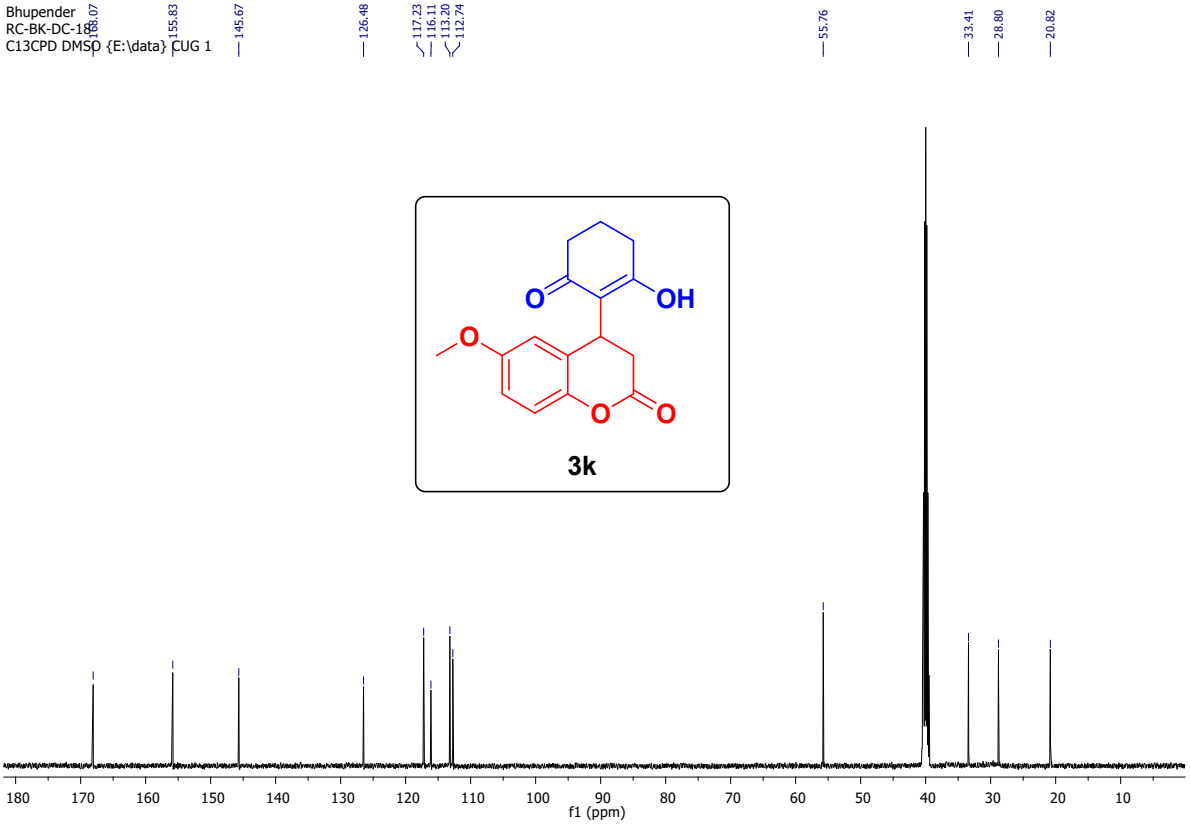
Copies of ^{1}HNMR and ^{13}CNMR spectra of **Compound 3j**



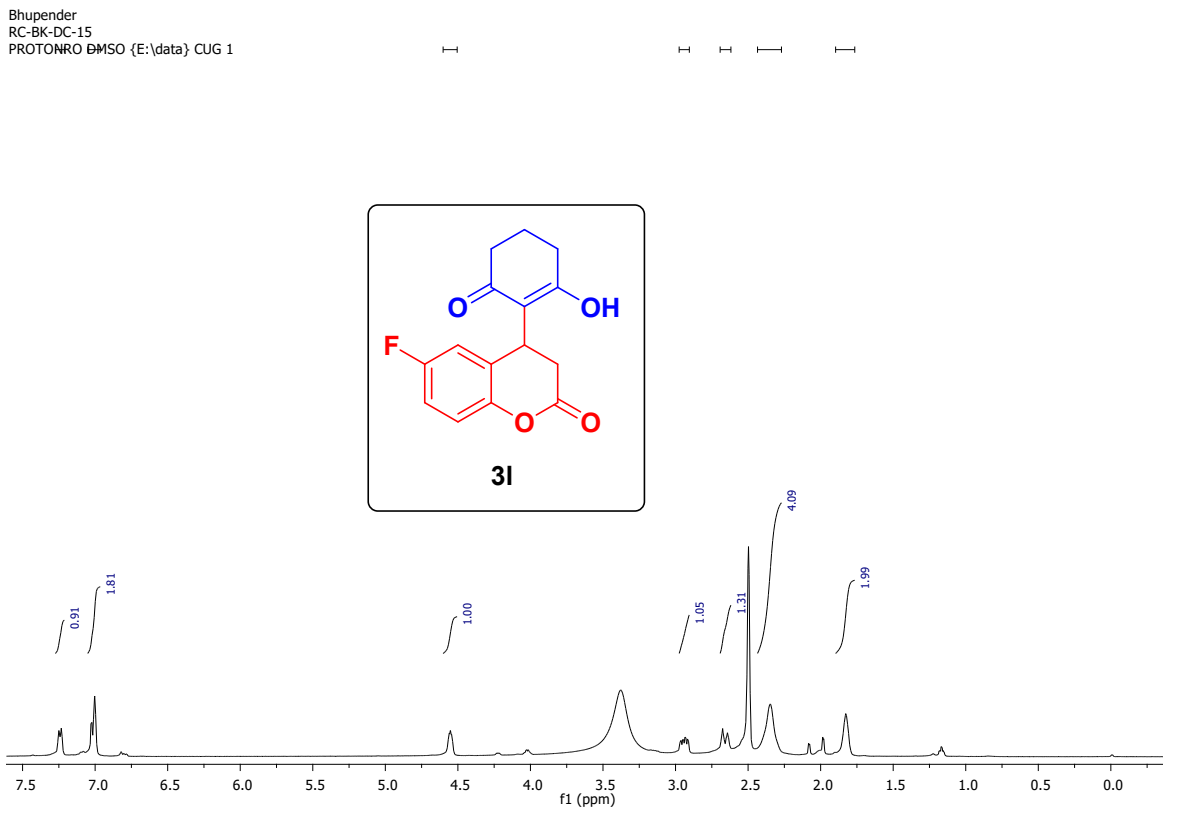


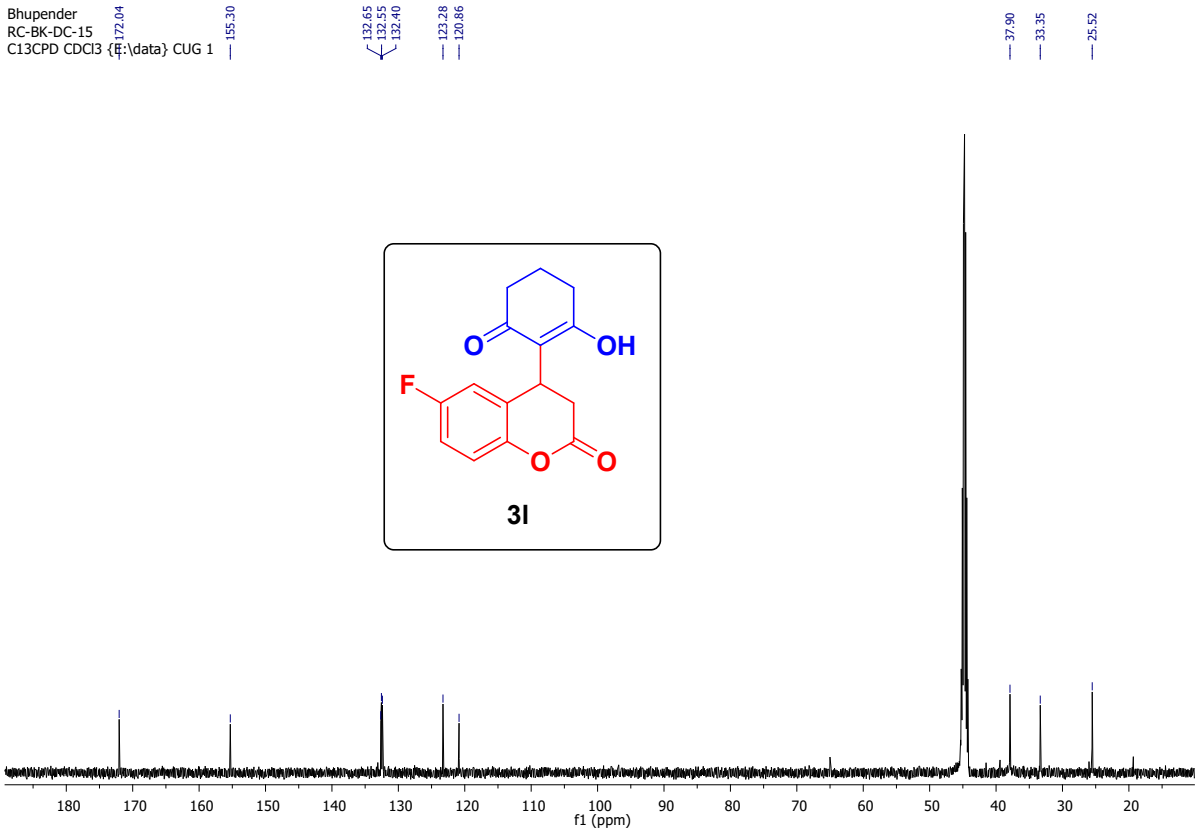
Copies of ^{1}HNMR and ^{13}CNMR spectra of **Compound 3k**



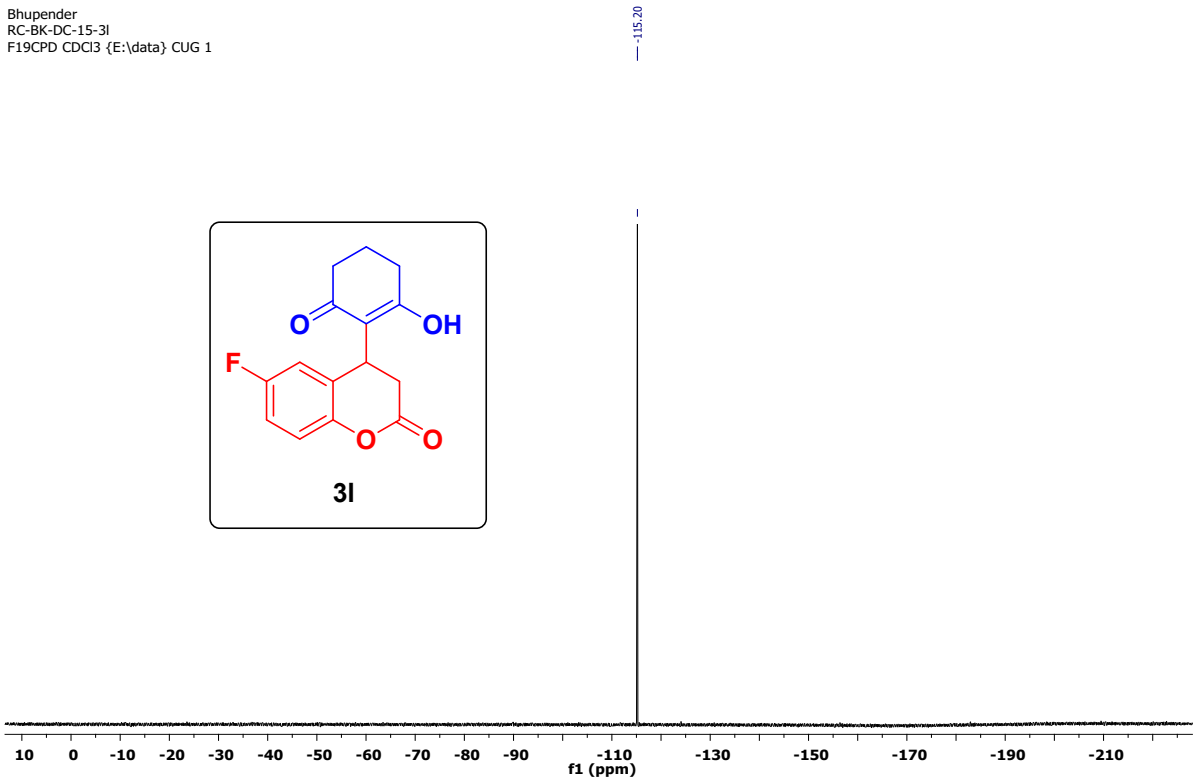


Copies of ^{1}HNMR and ^{13}CNMR spectra of **Compound 3l**

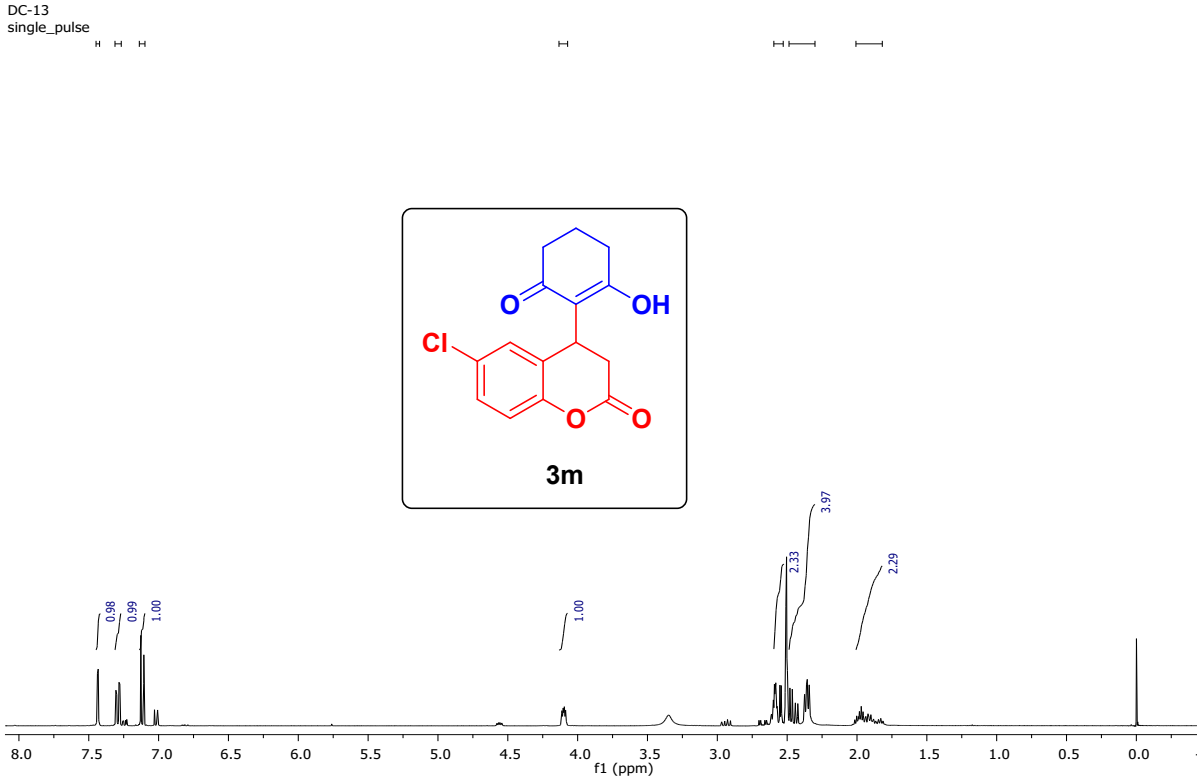


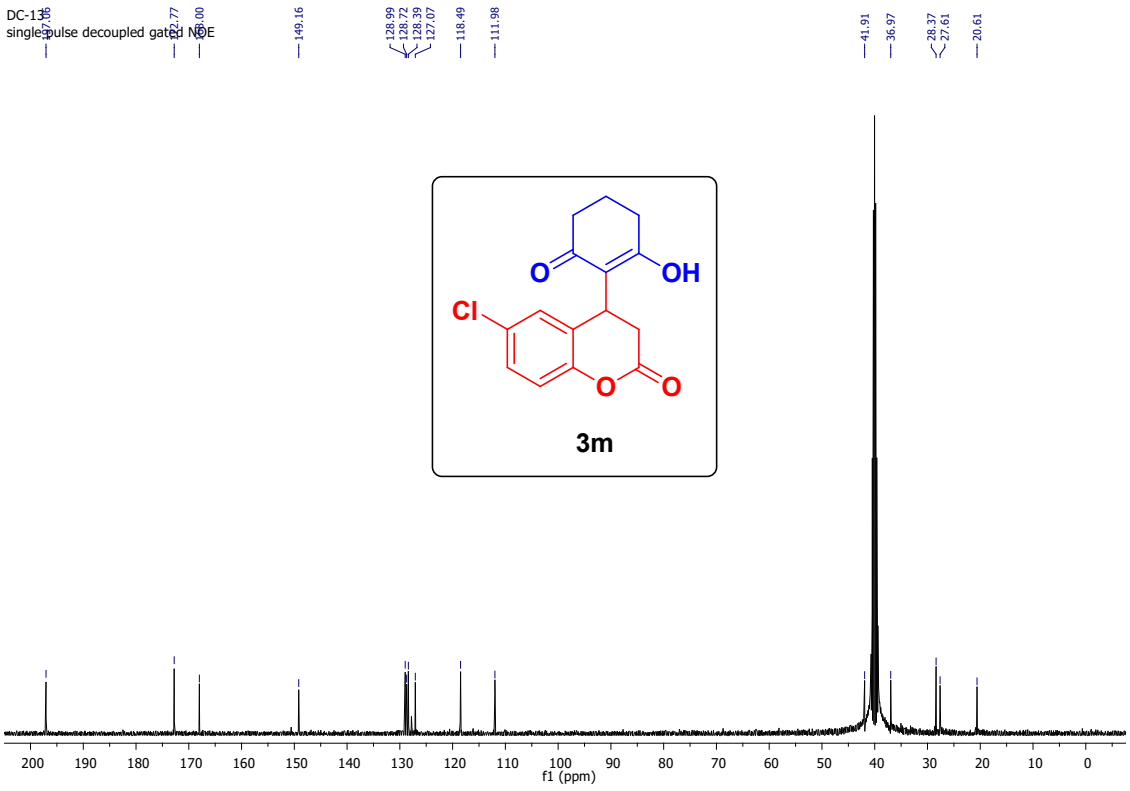


Copy of ^{19}FNMR spectra of **Compound 3l**

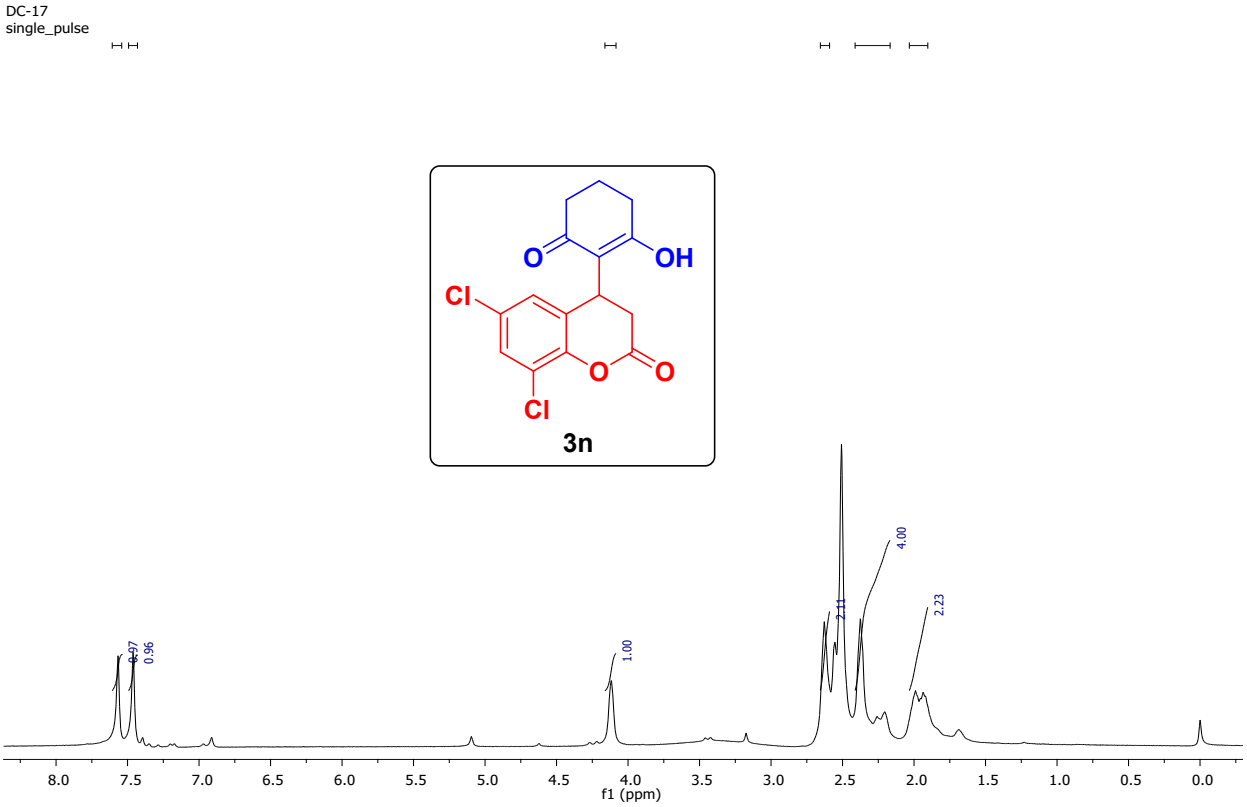


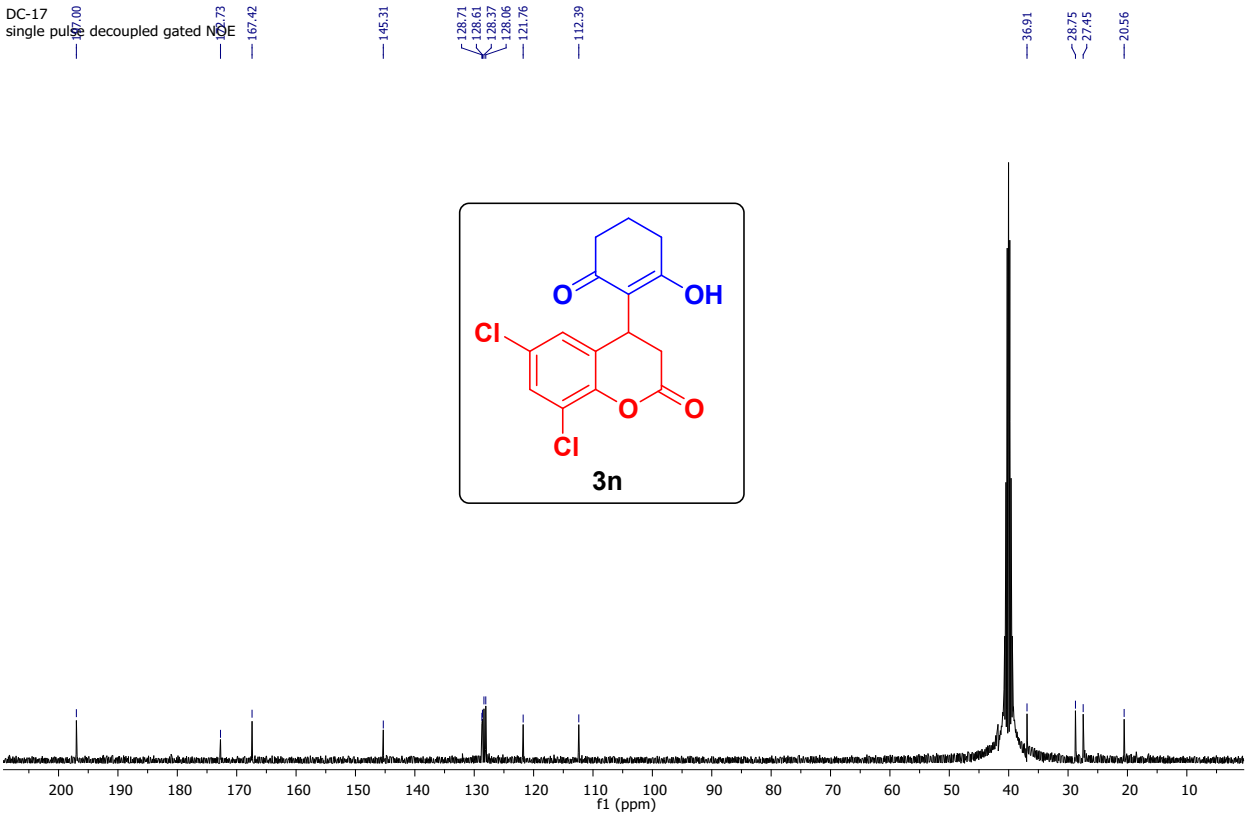
Copies of ^{1}HNMR and ^{13}CNMR spectra of **Compound 3m**




DC-13
single pulse decoupled gated NOE
167.08
162.77
157.00
149.16
128.99
128.72
128.38
127.07
118.49
111.98
41.91
36.97
28.37
27.61
20.61
O
OH
Cl
O
O
3m
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

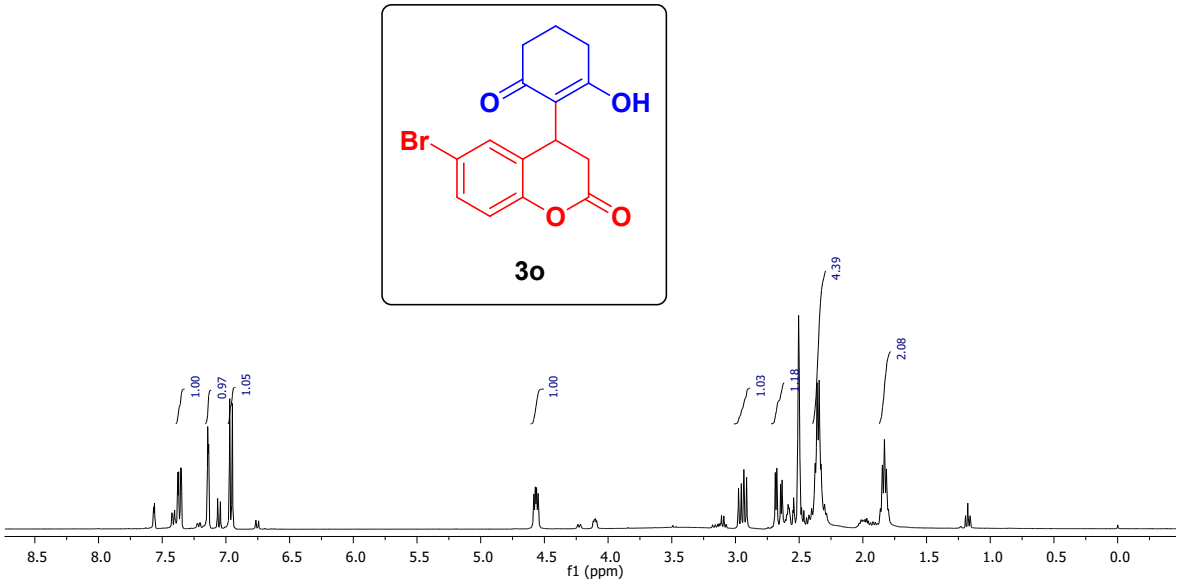
Copies of ^{1}HNMR and ^{13}CNMR spectra of **Compound 3n**





Copies of ^{1}HNMR and ^{13}CNMR spectra of **Compound 3o**

DC-12
single_pulse



DC-12
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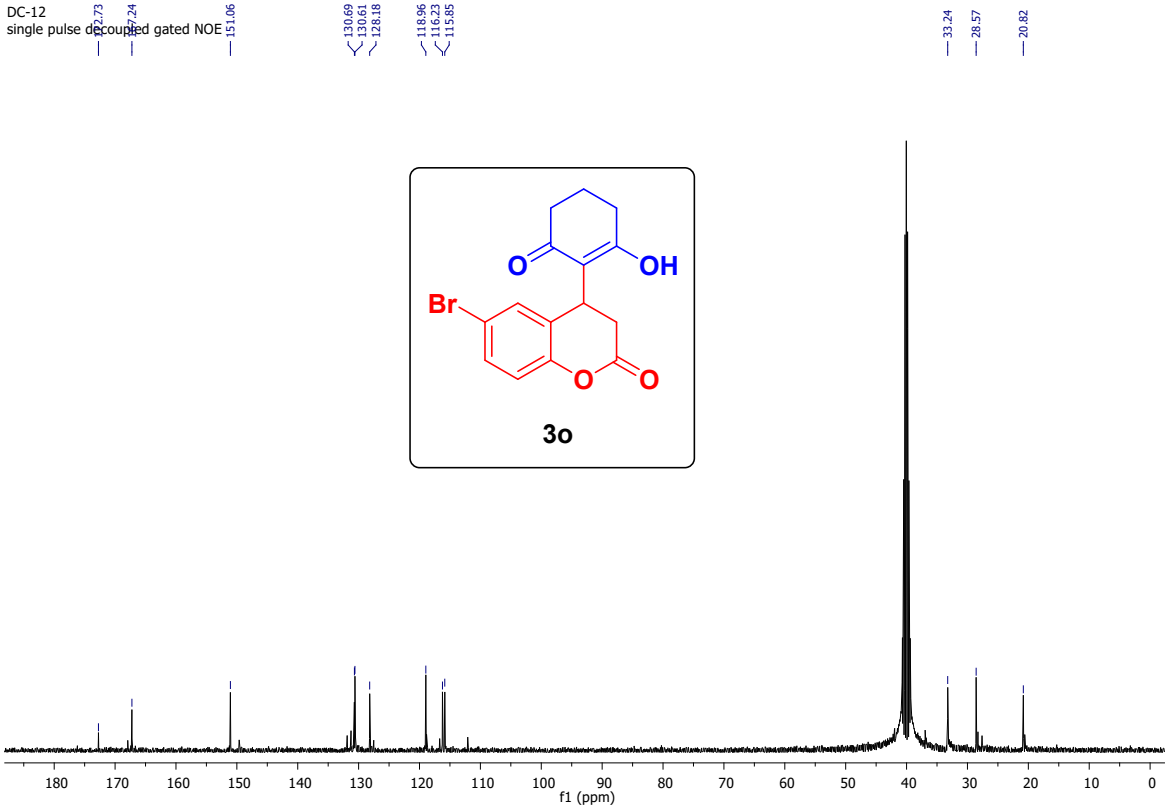
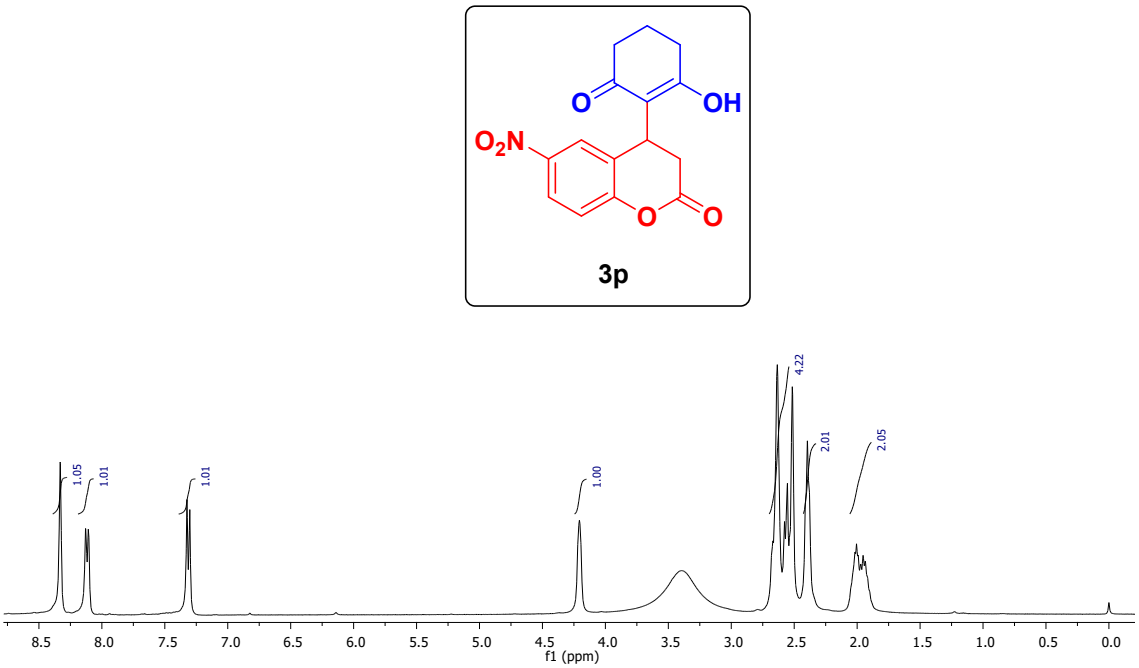


Copies of ^{1}HNMR and ^{13}CNMR spectra of **Compound 3p**

DC-16
single_pulse



DC-16
single pulse decoupled gated NOE