Electronic Supplementary Material (ESI) for RSC Advances.

Supporting Information

Highly Efficient Catalyst-Free Domino Conjugate Addition, Decarboxylation and Esterification/Amidation of Coumarin Carboxylic Acid/Esters with Pyrazolones: Green Chemistry Approach

Shanta Raj Lakshmi,[a] Vipin Singh,[a] L. Raju Chowhan*[a]

[a]Centre for Applied Chemistry, Central University of Gujarat, Sector 30, Gandhinagar, INDIA-382030.

*Corresponding author E-mail: rchowhan@cug.ac.in

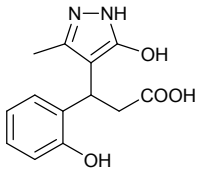
Table of content

General information

All commercially available chemicals were used without further purification. ^{1}H NMR spectra were obtained on Bruker 500 MHz FT-NMR spectrometers. ^{13}C NMR spectra were recorded at 125MHz's Chemical shifts are reported in 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. FT-IR spectrometer (Shimadzu) in the range of 400–4000 cm^{-1}. TOF and quadrupole mass analyzer types are used for the HRMS measurements. Coumarins were synthesised by following the reported literature procedure.[1]

General procedure for the synthesis of pyrazolyl phenyl propionic acid/esters 3a-m

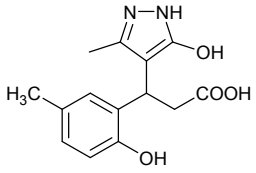
In a 5 mL round bottom flask containing a solution of coumarin 3-carboxylic acid/ester **1** (1 mmol) in 4 mL of solvent (water/MeOH/i-PrOH) was added 5-methyl-2,4-dihydro-3H-pyrazol-3-one **2a** (1 mmol), fixed the reflux condenser and stirred for 18 h maintaining the temperature at 65 ^{o}C. The reaction mixture becomes homogeneous while the reaction is in progress. The progress of reaction was monitored by TLC. After completion of the reaction, the solid product **3** filtered on sintered glass funnel and washed with water (2x10 mL), MeOH (2x10 mL). The solid was collected was then dried in vacuum. The obtained product was pure and does not require any further purification.



3a

3-(2-hydroxyphenyl)-3-(5-methyl-3-oxo-3H-pyrazol-4-yl)propanoic acid (3a)

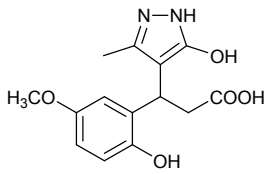
Pale white solid, yield: 87%; TLC (SiO_2): R_f = 0.53 (70% EtOAc/Hexanes); IR (neat): 3358, 3303, 2645, 1751, 1608, 1586, 1520, 1484, 1455, 1345, 1281, 1268, 1151, 1101, 1030, 960, 873, 807, 728, 697, 667 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$) δ 7.26 (d, *J* = 6.1 Hz, 1H), 7.13 – 7.01 (m, 2H), 6.97 (d, *J* = 7.3 Hz, 1H), 4.26 (s, 1H), 3.08 (dd, *J* = 15.7, 10.1 Hz, 1H), 2.89 – 2.78 (m, 1H), 1.95 (s, 3H). ^{13}C NMR (126 MHz, DMSO) δ 168.0, 159.4, 151.3, 137.1, 128.1, 127.6, 126.1, 124.2, 116.3, 99.1, 34.4, 28.9, 9.9.; HRMS (ESI+): *m/z* calculated for $[C_{13}H_{12}N_2O_4 + H]^+$: 263.1031; found: 263.1056.



3b

3-(2-hydroxy-5-methylphenyl)-3-(5-methyl-3-oxo-3H-pyrazol-4-yl)propanoic acid (3b)

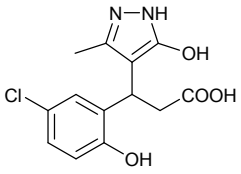
Pale white solid, yield: 85%; TLC (SiO_2): R_f = 0.57 (70% EtOAc/Hexanes); IR (neat): 3461, 3412, 1746, 1708, 1616, 1519, 1490, 1342, 1254, 1168, 1117, 928, 873, 818, 600 cm^{-1}; ^1H NMR (500 MHz, DMSO) δ 7.07 (t, *J* = 14.8 Hz, 1H), 6.97 (d, *J* = 7.8 Hz, 1H), 6.78 (s, 1H), 4.25 (s, 1H), 3.13 – 2.94 (m, 1H), 2.91 – 2.81 (m, 1H), 2.23 (s, 3H), 1.95 (s, 3H).^{13}C NMR (126 MHz, DMSO) δ 168.1, 159.4, 149.3, 137.2, 134, 128.5, 127.8, 125.7, 116, 99.3, 34.5, 28.9, 20.3, 9.9.; HRMS (ESI+): *m/z* calculated for $[C_{14}H_{14}N_2O_4 + H]^+$: 277.1110; found: 277.1215.



3c

3-(2-hydroxy-5-methoxyphenyl)-3-(5-methyl-3-oxo-3H-pyrazol-4-yl)propanoic acid (3c)

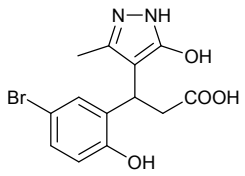
Pale white solid, yield: 86%; TLC (SiO_2): R_f = 0.55 (70% EtOAc/Hexanes); IR (neat): 3479, 2830, 2653, 1759, 1611, 1591, 1533, 1487, 1345, 1267, 1198, 1068, 924, 880, 792, 669, 624 cm^{-1}; ^1H NMR (500 MHz, DMSO) δ 7.03 (d, *J* = 8.8 Hz, 1H), 6.85 (d, *J* = 8.8 Hz, 1H), 6.49 (s, 1H), 4.30 – 4.20 (m, 1H), 3.67 (s, 3H), 3.01 (dd, *J* = 15.9, 9.6 Hz, 1H), 2.82 (dd, *J* = 16.0, 5.5 Hz, 1H), 1.93 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 168.3, 159.5, 155.8, 145.4, 137.3, 127.4, 117.2, 112.9, 112.9, 99.1, 55.5, 34.5, 29.3, 10.0; HRMS (ESI+): *m/z* calculated for $[C_{14}H_{16}N_2O_5 + H]^+$: 293.1137; found: 293.1163.



3d

3-(5-chloro-2-hydroxyphenyl)-3-(5-methyl-3-oxo-3H-pyrazol-4-yl)propanoic acid (3d)

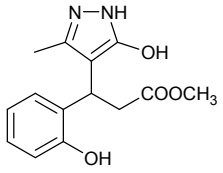
Pale white solid, yield: 80%; TLC (SiO_2): R_f = 0.58 (70% EtOAc/Hexanes); IR (neat): 3305, 2919, 1863, 1708, 1586, 1534, 1496, 1435, 1416, 1308, 1275, 1254, 1243, 1197, 970, 895, 754, 649 cm^{-1}; ^1H NMR (500 MHz, DMSO) δ 7.21 (s, 1H), 6.99 (d, *J* = 8.5 Hz, 1H), 6.75 (d, *J* = 8.5 Hz, 1H), 4.52 – 4.40 (m, 1H), 2.93 (dd, *J* = 15.3, 9.8 Hz, 1H), 2.77 (dd, *J* = 15.6, 5.5 Hz, 1H), 2.06 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 173.8, 160, 153.3, 137.5, 133.2, 128, 127, 122.2, 116.7, 101.8, 38.0, 29.4, 10.2.; HRMS (ESI+): *m/z* calculated for $[C_{13}H_{13}ClN_2O_4 + H]^+$: 297.06421; found: 297.0667.



3e

3-(5-bromo-2-hydroxyphenyl)-3-(5-methyl-3-oxo-3H-pyrazol-4-yl) propanoic acid (3e)

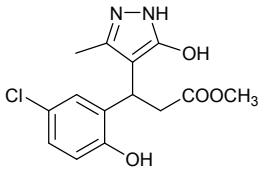
Pale white solid, yield: 92%; TLC (SiO_2): R_f = 0.57 (70% EtOAc/Hexanes); IR (neat): 3522, 3446, 3309, 2932, 2689, 1760, 1646, 1609, 1490, 1417, 1342, 1274, 1153, 1060, 1038, 951, 800, 684, 557 cm^{-1}; ^1H NMR (500 MHz, DMSO) δ 7.89 (s, 2H), 7.37 (d, *J* = 8.4 Hz, 1H), 7.05 (s, 1H), 6.97 (d, *J* = 8.5 Hz, 1H), 4.29 – 4.13 (m, 1H), 3.21 – 3.15 (m, 1H), 2.85 – 2.79 (m, 1H), 2.07 (s, 3H). ^{13}C NMR (126 MHz, DMSO) δ 167.5, 167.3, 159.4, 150.2, 137.5, 131.8, 128.6, 127.1, 118.3, 98.6, 34.0, 28.9, 9.9.; HRMS (ESI+): *m/z* calculated for $[C_{13}H_{11}BrN_2O_4+ H]^+$: 338.9980; found: 338.9980 .



3f

methyl 3-(2-hydroxyphenyl)-3-(5-methyl-3-oxo-3H-pyrazol-4-yl) propanoate (3f)

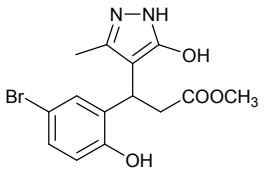
Pale white solid, yield: 92%; TLC (SiO_2): R_f = 0.50 (70% EtOAc/Hexanes); IR (neat): 3137, 3117, 2954, 1917, 1880, 1708, 1618, 1596, 1503, 1475, 1400, 1322, 1281, 1172, 1153, 1103, 1046, 982, 920, 910, 861, 850, 812 cm^{-1}; ^1H NMR (500 MHz, DMSO) δ 7.23 (d, *J* = 7.3 Hz, 1H), 6.98 (t, *J* = 7.2 Hz, 1H), 6.79 (d, *J* = 7.7 Hz, 1H), 6.70 (t, *J* = 7.2 Hz, 1H), 4.55 – 4.44 (m, 1H), 3.56 (s, 3H), 3.28 (dd, *J* = 15.7, 9.9 Hz, 1H), 2.98 (dd, *J* = 15.8, 5.6 Hz, 1H), 2.17 (s, 3H).^{13}C NMR (126 MHz, DMSO) δ 170.6, 166.2, 157.9, 149.7, 135.6, 126.3, 125.9, 124.4, 122.4, 114.5, 97.2, 50.1, 32.8, 27.4, 8.3.; HRMS (ESI+): *m/z* calculated for $[C_{14}H_{16}N_2O_4+ H]^+$: 277.1188; found: 277.1188.



3g

methyl 3-(5-chloro-2-hydroxyphenyl)-3-(5-methyl-3-oxo-3H-pyrazol-4-yl) propanoate (3g)

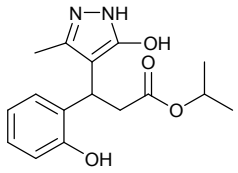
Pale white solid, yield: 90%; TLC (SiO_2): R_f = 0.62 (70% EtOAc/Hexanes); IR (neat): 3137, 3118, 2926, 2854, 1709, 1610, 1589, 1403, 1310, 1277, 1222, 1174, 986, 958, 923, 885, 875, 811, 789, 713 cm^{-1}; ^1H NMR (500 MHz, DMSO) δ 7.23 (s, 1H), 6.91 (d, *J* = 8.4 Hz, 1H), 6.75 (d, *J* = 8.5 Hz, 1H), 4.51 (dd, *J* = 9.4, 5.6 Hz, 1H), 3.55 (s, 3H), 3.28 – 3.12 (m, 1H), 2.93 (d, *J* = 14.6 Hz, 1H), 2.17 (s, 3H). ^{13}C NMR (126 MHz, DMSO) δ 172.4, 160.7, 152.7, 137.7, 131.9, 127.5, 126.2, 123.1, 115.5, 101.6, 51.2, 36.9, 28.9, 9.9.; HRMS (ESI+): *m/z* calculated for $[C_{14}H_{15}ClN_2O_4 + H]^+$: 311.0798; found: 311.0806.



3h

methyl 3-(5-bromo-2-hydroxyphenyl)-3-(5-methyl-3-oxo-3H-pyrazol-4-yl) propanoate (3h)

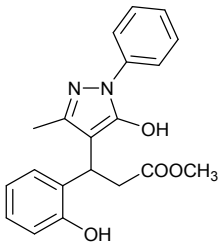
Pale white solid, yield: 93%; TLC (SiO_2): R_f = 0.63 (70% EtOAc/Hexanes); IR (neat): 3137, 3032, 2954, 1847, 1712, 1607, 1522, 1422, 1308, 1277, 1202, 1175, 1081, 1045, 985, 956, 919, 881, 810, 788, 712 cm^{-1}; ^1H NMR (500 MHz, DMSO) δ 7.36 (s, 1H), 7.05 (d, *J* = 8.4 Hz, 1H), 6.71 (d, *J* = 8.5 Hz, 1H), 4.51 (dd, *J* = 9.5, 5.8 Hz, 1H), 3.55 (s, 3H), 3.17 (dd, *J* = 15.8, 10.0 Hz, 1H), 2.92 (dd, *J* = 15.7, 5.4 Hz, 1H), 2.16 (s, 3H). ^{13}C NMR (126 MHz, DMSO) δ 170.7, 159.0, 152.2, 136.6, 131.4, 129.4, 127.8, 115.7, 108.8, 100, 49.7, 35.5, 28.1, 8.7.; HRMS (ESI+): *m/z* calculated for $[C_{14}H_{15}BrN_2O_4 + H]^+$: 355.0293; found: 355.0316.



3i

isopropyl 3-(2-hydroxyphenyl)-3-(5-methyl-3-oxo-3H-pyrazol-4-yl) propanoate (3i)

Pale white solid, yield: 96%; TLC (SiO_2): R_f = 0.56 (70% EtOAc/Hexanes); IR (neat): 3412, 3055, 2862, 2644, 1753, 1696, 1607, 1565, 1521, 1485, 1456, 1370, 1238, 1184, 1151, 1030, 817, 782, 754 cm^{-1}; ^1H NMR (500 MHz, DMSO) δ 7.72 (s, 1H), 7.23 (d, *J* = 7.4 Hz, 1H), 6.97 (t, *J* = 7.3 Hz, 1H), 6.77 (d, *J* = 7.9 Hz, 1H), 6.70 (t, *J* = 7.2 Hz, 1H), 4.76 (d, *J* = 11.7, 5.7 Hz, 1H), 4.36 (dd, *J* = 9.0, 6.3 Hz, 1H), 3.19 (dd, *J* = 15.4, 9.6 Hz, 1H), 2.97 (dd, *J* = 15.1, 6.1 Hz, 1H), 2.19 (s, 3H), 1.09 (d, *J* = 6.2 Hz, 6H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 171.4, 160.9, 154.2, 138.2, 130, 128.2, 126.6, 118.6, 115.3, 102.3, 66.5, 37.4, 30.0, 25.1, 21.3, 10.2.; HRMS (ESI+): *m/z* calculated for $[C_{16}H_{18}N_2O_4 + H]^+$: 305.1501; found: 305.1518.

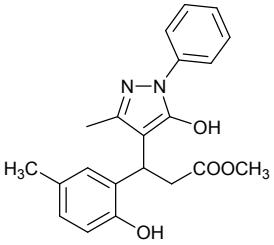


3j

Methyl 3-(2-hydroxyphenyl)-3-(5-methyl-3-oxo-2-phenyl-2,3-dihydro-1H-pyrazol-4-yl) propanoate (3j)

Pale white solid, yield: 88%; TLC (SiO_2): R_f = 0.58 (80% EtOAc/Hexanes); IR (neat): 3137, 1765, 1619, 1497, 1455, 1402, 1314, 1279, 1215, 919, 832, 754 cm^{-1}; 1H NMR (500 MHz, $CDCl_3$) δ 7.45 (d, *J* = 8.0 Hz, 2H), 7.30 – 7.19 (m, 2H), 7.12 – 7.08 (m, 3H), 6.93 (d, *J* = 7.9 Hz, 1H), 6.81 (t, *J* = 7.3 Hz, 1H), 4.30 (dd, *J* = 9.5, 5.0 Hz, 1H), 3.66-3.56 (m, 4H), 3.03 (dd, *J* = 17.0, 5.1 Hz, 1H), 2.32 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 173.4, 171.5, 168.6, 153.2,

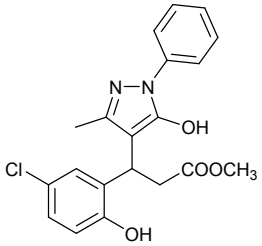
151.5, 146.2, 135.7, 129.1, 129, 127.4, 126.2, 124.6, 120.5, 117.1, 60.5, 29.9, 21.2 14.2.; HRMS (ESI+): *m/z* calculated for $[C_{20}H_{20}N_2O_4+ H]^+$: 353.1501; found: 353.1533.



3k

methyl 3-(2-hydroxy-5-methylphenyl)-3-(5-methyl-3-oxo-2-phenyl-2,3-dihydro-1H-pyrazol-4-yl) propanoate (3k)

Pale white solid, yield: 85%; TLC (SiO_2): R_f = 0.6 (70% EtOAc/Hexanes); IR (neat): 3137, 1736, 1710, 1609, 1403, 1163, 1113, 988, 874, 813, 755, 690, 617 cm^{-1}; 1H NMR (500 MHz, $CDCl_3$) δ 7.18 (d, *J* = 8.9 Hz, 2H), 7.04 – 6.95 (m, 2H), 6.88 (d, *J* = 6.5 Hz, 1H), 6.82 (d, *J* = 7.6 Hz, 2H), 6.68 (d, *J* = 7.6 Hz, 1H), 4.12 (dd, J = 8.8, 5.4 Hz, 1H), 3.50 (s, 3H), 3.41 (dd, *J* = 16.5, 9.2 Hz, 1H), 2.90 (dd, *J* = 16.8, 5.0 Hz, 1H), 2.16 (s, 6H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 173.7, 152.9, 146.2, 135.1, 130.7, 129.5, 129.0, 128.9, 126.4, 120.7, 119.6, 107.8, 60.7, 51.6, 35.0, 25.7, 20.6, 11.0.; HRMS (ESI+): *m/z* calculated for $[C_{21}H_{22}N_2O_4+ H]^+$: 367.1657; found: 367.1687.

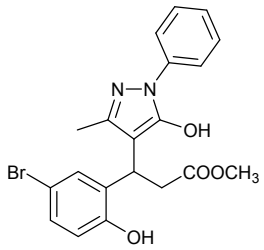


3l

methyl 3-(5-chloro-2-hydroxyphenyl)-3-(5-methyl-3-oxo-2-phenyl-2,3-dihydro-1H-pyrazol-4-yl) propanoate (3l)

Pale white solid, yield: 83%; TLC (SiO_2): R_f = 0.55 (80% EtOAc/Hexanes); IR (neat): 3137, 1959, 1864, 1736, 1603, 1594, 1558, 1498, 1458, 1308, 1250, 1026, 989, 904, 847, 826, 811, 785, 761, 744, 687, 667 cm^{-1}; 1H NMR (500 MHz, $CDCl_3$) δ 7.27 (d, *J* = 6.5 Hz, 2H), 7.11 (*t*, J = 7.2 Hz, 2H), 7.05 (d, *J* = 5.4 Hz, 2H), 6.99 (t, *J* = 7.1 Hz, 1H), 6.80 (d, *J* = 9.1 Hz, 1H),

4.17 (dd, J = 8.9, 5.5 Hz, 1H), 3.59 (s, 3H), 3.45 (dd, J = 16.8, 9.4 Hz, 1H), 2.98 (dd, J = 16.9, 5.2 Hz, 1H), 2.22 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 173.1, 154.2, 146.5, 135.1, 134.9, 131.1, 129.6, 129.0, 128.3, 126.7, 124.4, 121.1, 120.7, 51.9, 34.8, 22.6, 11.1.; HRMS (ESI+): *m/z* calculated for $[C_{20}H_{19}ClN_2O_4 + H]^+$: 387.1111; found: 387.1144.



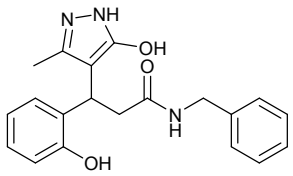
3m

Methyl3-(5-bromo-2-fhydroxyphenyl)-3-(5-methyl-3-oxo-2-phenyl-2,3-dihydro-1H-pyrazol-4-yl) propanoate (3m)

Pale white solid, yield: 82%; TLC (SiO_2): R_f = 0.54 (70% EtOAc/Hexanes); IR (neat): 3136, 1735, 1605, 1572, 1497, 1403, 1304, 1272, 1247, 1165, 1109, 989, 862, 814, 753, 690 cm^{-1}; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.45 (d, J = 8.1 Hz, 2H), 7.31 – 7.25 (m, 2H), 7.21 (d, J = 6.7 Hz, 2H), 7.13 (t, J = 7.3 Hz, 1H), 6.82 (d, J = 9.1 Hz, 1H), 4.21 (dd, J = 9.6, 4.8 Hz, 1H), 3.62 (s, 3H), 3.59 (d, J = 9.7 Hz, 1H), 2.99 (dd, J = 17.2, 4.7 Hz, 1H), 2.34 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 173.2, 162.5, 155, 146.5, 135.0, 132.6, 131.7, 131.4, 129.1, 129.1, 126.8, 121.7, 120.8, 15.0, 111.7, 107.9, 52.2, 35.3, 11.2.; HRMS (ESI+): *m/z* calculated for $[C_{20}H_{19}BrN_2O_4 + H]^+$: 431.0606 ; found: 431.0642.

General procedure for the synthesis of amides 5a-t

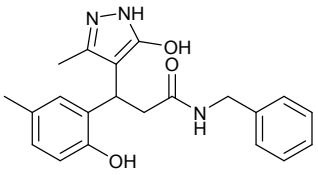
In a 5 mL round bottom flask containing a solution of coumarin 3-carboxylic acid **1** (1 mmol) in methyl-THF (4 mL) was added 5-methyl-2,4-dihydro-3H-pyrazol-3-one **2a** (1 mmol) and benzylamine (1 mmol), fixed the reflux condenser and stirred for 18 h maintaining at 65 ^{o}C temperature. The reaction mixture becomes homogeneous while the reaction is in progress. The progress of reaction was monitored by TLC. After completion of the reaction, the solid product **5a** filtered on sintered glass funnel and washed with water (2x10 mL), methanol (2x10 mL). The solid was collected was then dried in vacuum. The obtained product was pure and does not require any further purification.



5a

N-benzyl-3-(2-hydroxyphenyl)-3-(5-methyl-3-oxo-3H-pyrazol-4-yl) propenamide (5a)

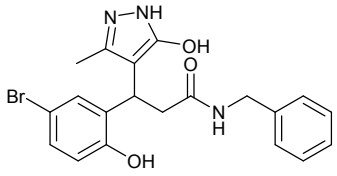
Pale white solid, yield: 92%; TLC (SiO_2): R_f = 0.12 (EtOAc); M.P.115-119° C; IR (neat): 3394, 3032, 2923, 1703, 1606, 1547, 1455, 1351, 1268, 1206, 1146, 1104, 1067, 1029, 931, 858, 751, 699 cm^{-1}; 1H NMR (500 MHz, DMSO) δ 8.24 (s, 1H), 7.33 (d, *J* = 7.2 Hz, 1H), 7.18 (dd, *J* = 17.3, 6.7 Hz, 4H), 6.95 (t, *J* = 10.5 Hz, 3H), 6.76 – 6.63 (m, 2H), 5.65 (s, 1H), 4.57 (d, *J* = 7.3 Hz, 1H), 4.18 (dd, *J* = 14.4, 4.9 Hz, 2H), 2.98 – 2.87 (m, 1H), 2.80 (dd, *J* = 14.0, 6.3 Hz, 1H), 2.05 (s, 3H). 13C NMR (126 MHz, DMSO) δ 171, 161.2, 159.0, 154.3, 152.6, 139.4, 136.9, 130.9, 128, 126.7, 118.6, 115.1, 114.3, 106.8, 102.9, 100.5, 41.7, 29.4, 18.7, 10.2.; HRMS (ESI+): *m/z* calculated for $[C_{20}H_{21}N_3O_3+ H]^+$: 352.1661; found: 352.1692 .



5b

N-benzyl-3-(2-hydroxy-5-methylphenyl)-3-(5-methyl-3-oxo-3H-pyrazol-4-yl) propenamide (5b)

Pale white solid, yield: 91%; TLC (SiO_2): R_f = 0.12 (EtOAc); IR (neat): 3393, 3289, 3031, 2731, 1703, 1606, 1548, 1456, 1352, 1269, 1251, 1105, 1030, 930, 870, 795, 699, 685 cm^{-1}; ^1H NMR (500 MHz, DMSO) δ 8.25 (s, 1H), 7.23 – 7.11 (m, 5H), 6.94 (d, *J* = 7.2 Hz, 2H), 6.76 (d, *J* = 7.8 Hz, 1H), 6.61 (d, *J* = 7.9 Hz, 1H), 5.83 (s, 1H), 4.53 (t, *J* = 7.4 Hz, 1H), 4.18 (d, *J* = 5.3 Hz, 2H), 2.87 (d, *J* = 8.9 Hz, 1H), 2.83 – 2.77 (m, 1H), 2.36 (s, 1H), 2.14 (s, 3H).; ^{13}C NMR (126 MHz, DMSO) δ 171.4, 161.36, 152.7, 139.6, 137, 130.8, 129.1, 128.1, 126.6, 115.2, 106.9, 103.1, 100.6, 41.8, 29.7, 20.6, 18.8, 11.4, 10.4.; HRMS (ESI+): *m/z* calculated for $[C_{21}H_{23}N_3O_3+ H]^+$: 366.1817; found: 366.1850 .

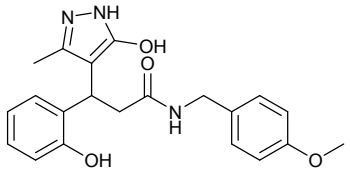


5c

N-benzyl-3-(5-bromo-2-hydroxyphenyl)-3-(5-methyl-3-oxo-3H-pyrazol-4-yl)propenamide (5c)

Pale white solid, yield: 95%; TLC (SiO_2): R_f = 0.12 (EtOAc); IR (neat): 3402, 3070, 3030, 2951, 3225, 1702, 1647, 1606, 1551, 1433, 1454, 1301, 1080, 951, 871, 850, 752, 588 cm^{-1}; ^1H NMR (500 MHz, DMSO) δ 8.26 (s, 1H), 7.49 (s, 1H), 7.22 (t, *J* = 7.4 Hz, 2H), 7.19 – 7.14 (m, 2H), 7.12 (d, *J* = 8.5 Hz, 1H), 6.95 (d, *J* = 7.2 Hz, 2H), 6.69 (d, *J* = 8.5 Hz, 1H), 5.83 (s, 1H), 4.56 (t, *J* = 7.6 Hz, 1H), 4.26 – 4.11 (m, 2H), 2.84 (d, *J* = 7.4 Hz, 2H), 2.06 (s, 3H). ^{13}C NMR (126 MHz, DMSO) δ 171, 161.4, 159, 152.7, 143.2, 139.6, 137, 133, 131.6, 128.8, 128.2,

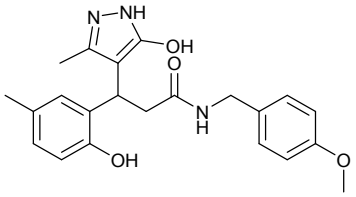
126.6, 106.8, 100.6, 41.8, 29.4, 18.8, 11.4.; HRMS (ESI+): *m/z* calculated for $[C_{20}H_{20}BrN_3O_3+H]^+$: 430.0766; found: 430.0800.



5d

3-(2-hydroxyphenyl)-N-(4-methoxybenzyl)-3-(5-methyl-3-oxo-3H-pyrazol-4yl)propenamide (5d)

Pale white solid, yield: 91%; TLC (SiO_2): R_f = 0.12 (EtOAc); IR (neat): 3521, 3628, 3413, 3351, 3307, 2938, 2833, 2727, 1602, 1556, 1519, 1453, 1320, 1286, 1145, 1032, 947, 864, 799, 659 cm^{-1}; ^1H NMR (500 MHz, DMSO) δ 8.09 (s, 1H), 7.30 (d, *J* = 7.4 Hz, 1H), 6.95 (t, *J* = 7.5 Hz, 1H), 6.85 (d, *J* = 7.9 Hz, 2H), 6.78 – 6.72 (m, 3H), 6.68 (t, *J* = 7.3 Hz, 1H), 4.56 (t, *J* = 7.4 Hz, 1H), 4.19 (dd, *J* = 15.1, 5.7 Hz, 1H), 4.08 (dd, *J* = 15.1, 5.4 Hz, 1H), 3.72 (s, 3H), 2.97 (dd, *J* = 13.5, 9.6 Hz, 1H), 2.80 (dd, *J* = 14.1, 6.1 Hz, 1H), 2.08 (s, 3H). ^{13}C NMR (126 MHz, DMSO) δ 171.6, 160.7, 158, 154.5, 131.3, 130.9, 127.9, 118.7, 115.4, 113.5, 103, 55.0, 41.5, 29.9, 10.3.; HRMS (ESI+): *m/z* calculated for $[C_{21}H_{23}N_3O_4+H]^+$: 382.1766; found: 382.1799.

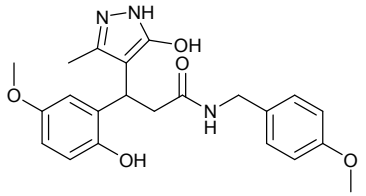


5e

3-(2-hydroxy-5-methylphenyl)-N-(4-methoxybenzyl)-3-(5-methyl-3-oxo-3H-pyrazol-4-yl)propenamide (5e)

Pale white solid, yield: 89%; TLC (SiO_2): R_f = 0.12 (EtOAc); IR (neat): 3475, 3555, 2921, 2580, 1596, 1515, 1438, 1370, 1177, 11123, 995, 846, 878, 814, 747 cm^{-1}; ^1H NMR (500 MHz, DMSO) δ 8.16 (s, 1H), 7.11 (s, 1H), 6.87 (d, *J* = 7.7 Hz, 2H), 6.81 – 6.73 (m, 3H), 6.61 (d, *J* = 7.9 Hz, 1H), 4.53 (t, *J* = 7.3 Hz, 1H), 4.19 – 4.03 (m, 2H), 3.70 (s, 3H), 2.88 (dd, *J* = 13.9, 9.1

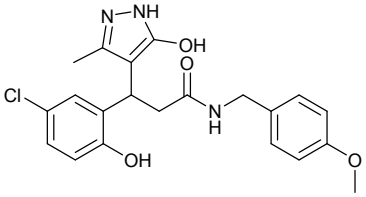
Hz, 1H), 2.77 (dd, *J* = 14.1, 6.4 Hz, 1H), 2.13 (s, 3H), 2.04 (s, 3H).; ^{13}C NMR (126 MHz, DMSO) δ 171.3, 160.3, 157.9, 152.1, 131.5, 130.8, 129.1, 127.9, 126.8, 126.8, 126.2, 115.2, 113.5, 103.0, 55.1, 41.3, 29.7, 20.6, 10.4.; HRMS (ESI+): *m/z* calculated for $[C_{22}H_{25}N_3O_4+ H]^+$: 396.1923; found: 396.1959.



5f

3-(2-hydroxy-5-methoxyphenyl)-N-(4-methoxybenzyl)-3-(5-methyl-3-oxo-3H-pyrazol-4-yl)propenamide (3f)

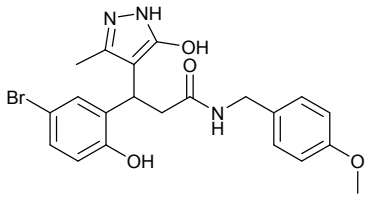
Pale white solid, yield: 85%; TLC (SiO_2): R_f = 0.12 (EtOAc); IR (neat): 3535, 3445, 3270, 3074, 2928, 2834, 1607, 1559, 1537, 1513, 1502, 1463, 1451, 1366, 1342, 1244, 1147, 1112, 1014, 827, 812, 745, 686, 614 cm^{-1}; 1H NMR (500 MHz, DMSO) δ 8.20 (s, 1H), 6.95 (s, 1H), 6.87 (d, *J* = 8.0 Hz, 2H), 6.76 (d, *J* = 7.9 Hz, 2H), 6.64 (d, *J* = 8.6 Hz, 1H), 6.55 (d, *J* = 7.5 Hz, 1H), 4.54 (t, *J* = 7.7 Hz, 1H), 4.18 – 4.03 (m, 2H), 3.70 (s, 3H), 3.61 (s, 3H), 2.85 (dd, *J* = 13.8, 9.2 Hz, 1H), 2.78 (dd, *J* = 14.2, 6.9 Hz, 1H), 2.05 (s, 3H).; ^{13}C NMR (126 MHz, DMSO) δ 171.3, 160.3, 158.0, 152.1, 148.2, 137.5, 132.1, 131.5, 128.0, 115.5, 114.9, 113.6, 110.9, 102.9, 55.2, 55.1, 41.6, 29.7, 14.02, 10.8.; HRMS (ESI+): *m/z* calculated for $[C_{22}H_{25}N_3O_5+ H]^+$: 412.1872; found: 412.1920 .



5g

3-(5-chloro-2-hydroxyphenyl)-N-(4-methoxybenzyl)-3-(5-methyl-3-oxo-3H-pyrazol-4-yl)propenamide (5g)

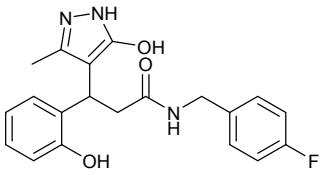
Pale white solid, yield: 86%; TLC (SiO_2): R_f = 0.12 (EtOAc); IR (neat): 3519, 3422, 3331, 2835, 2924, 1734, 1610, 1563, 1513, 1422, 1354, 1304, 1274, 1254, 1114, 948, 816 cm^{-1}; ^1H NMR (500 MHz, DMSO) δ 8.22 (s, 1H), 7.33 (s, 1H), 7.00 (d, *J* = 8.5 Hz, 1H), 6.88 (d, *J* = 7.9 Hz, 1H), 6.78 (d, *J* = 7.5 Hz, 2H), 6.73 (d, *J* = 78.4Hz, 1H), 4.54 (t, *J* = 7.5 Hz, 1H), 4.11 (d, *J* = 5.3 Hz, 2H), 3.71 (s, 3H), 2.81 (d, *J* = 7.6 Hz, 2H), 2.06 (s, 3H). ^{13}C NMR (126 MHz, DMSO) δ 171, 160.2, 158.0, 153.5, 137.5, 133.2, 131.5, 128.2, 127.9, 126.2, 122.2, 116.7, 113.6, 102.2, 55.1, 41.3, 38.9, 29.5, 10.3.; HRMS (ESI+): *m/z* calculated for $[C_{21}H_{22}ClN_3O_4 + H]^+$: 416.137709; found: 416.1411.



5h

3-(5-bromo-2-hydroxyphenyl)-N-(4-methoxybenzyl)-3-(5-methyl-3-oxo-3H-pyrazol-4-yl)propenamide (5h)

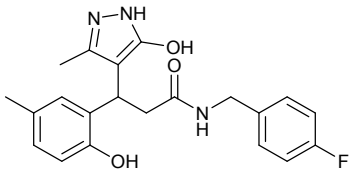
Pale white solid, yield: 88%; TLC (SiO_2): R_f = 0.12 (EtOAc); IR (neat): 3607, 3520, 3443, 3319, 2572, 1648, 1628, 1595, 1514, 1459, 1274, 1174, 950, 819 cm^{-1}; ^1H NMR (500 MHz, DMSO) δ 8.23 (s, 1H), 7.46 (s, 1H), 7.12 (d, *J* = 7.6 Hz, 1H), 6.88 (d, *J* = 7.8 Hz, 2H), 6.78 (d, *J* = 8.0 Hz, 2H), 6.69 (d, *J* = 8.3 Hz, 1H), 4.54 (t, *J* = 7 Hz 1H), 4.11 (d, *J* = 4.8 Hz, 2H), 3.71 (s, 3H), 2.81 (d, *J* = 7.1 Hz, 2H), 2.06 (s, 3H). ^{13}C NMR (126 MHz, DMSO) δ 171.0, 160.3, 158.0, 153.9, 153.4, 137.6, 133.8, 131.5, 131.0, 129.2, 128, 117.3, 113.7, 110.1, 102.3, 55.1, 41.4, 38.9, 29.5, 10.3.; HRMS (ESI+): *m/z* calculated for $[C_{21}H_{22}BrN_3O_4 + H]^+$: 460.0871; found: 460.0903.



5i

N-(4-fluorobenzyl)-3-(2-hydroxyphenyl)-3-(5-methyl-3-oxo-3H-pyrazol-4-yl)propenamide (5i)

Pale white solid, yield: 85%; TLC (SiO_2): R_f = 0.12 (EtOAc); IR (neat): 3388, 3334, 3075, 2976, 2894, 2753, 1640, 1597, 1542, 1510, 1405, 1361, 1339, 1252, 1157, 1045, 942, 849, 831, 806, 712, 648 cm^{-1}; ^1H NMR (500 MHz, DMSO) δ 8.25 (s, 1H), 7.33 (d, *J* = 7.4 Hz, 1H), 7.04 – 6.89 (m, 6H), 6.75 – 6.66 (m, 2H), 4.57 (t, *J* = 7.5 Hz, 1H), 4.21 (dd, *J* = 15.2, 5.7 Hz, 1H), 4.10 (dd, *J* = 15.3, 5.3 Hz, 1H), 2.90 (dd, *J* = 13.4, 9.5 Hz, 1H), 2.77 (dd, *J* = 13.8, 6.2 Hz, 1H), 2.05 (s, 3H).; 13C NMR (126 MHz, DMSO) δ 171.28, 161.79, 160.24, 159.87, 154.28, 135.68, 135.66, 130.79, 128.48, 128.39, 128.32, 126.42, 118.54, 115.04, 114.74, 114.57, 102.66, 40.96, 29.45, 10.18..; HRMS (ESI+): *m/z* calculated for $[C_{20}H_{20}FN_3O_3+ H]^+$: 370.1566; found: 370.1591.

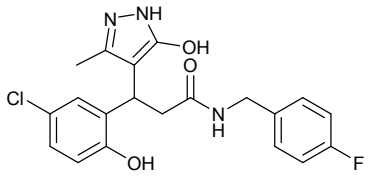


5j

N-(4-fluorobenzyl)-3-(2-hydroxy-5-methylphenyl)-3-(5-methyl-3-oxo-3H-pyrazol-4-yl)propenamide (5j)

Pale white solid, yield: 89%; TLC (SiO_2): R_f = 0.12 (EtOAc); IR (neat): 3301, 2924, 1607, 1537, 1514, 1443,1342, 1252, 1216, 1158, 1105, 1027, 822, 698 cm^{-1}; ^1H NMR (500 MHz, DMSO) δ 8.23 (s, 1H), 7.12 (s, 1H), 7.01 (t, *J* = 8.7 Hz, 2H), 6.94 – 6.90 (m, 2H), 6.76 (d, *J* = 7.6 Hz, 1H), 6.61 (d, *J* = 8.0 Hz, 1H), 4.52 (t, *J* = 7.5 Hz, 1H), 4.19 (dd, *J* = 15.5, 5.6 Hz, 1H), 4.12 (dd, *J* = 15.5, 5.6 Hz, 1H), 2.89 (dd, *J* = 13.6, 9.5 Hz, 1H), 2.77 (dd, *J* = 14.0, 6.6 Hz, 1H),

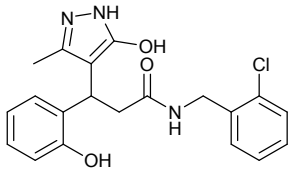
2.13 (s, 3H). ^{13}C NMR (126 MHz, DMSO) δ 171.5, 161.9, 160.4, 160.0, 152.1, 135.8, 135.8, 130.7, 129.0, 128.3, 126.9, 125.4, 114.8, 114.7, 103.0, 41.1, 29.8, 21.1, 20.6, 10.3. HRMS (ESI+): *m/z* calculated for $[C_{21}H_{22}FN_3O_3+ H]^+$: 384.1723; found: 384.1757.



5k

3-(5-chloro-2-hydroxyphenyl)-N-(4-fluorobenzyl)-3-(5-methyl-3-oxo-3H-pyrazol-4-yl)propenamide (5k)

Pale white solid, yield: 84%; TLC (SiO_2): R_f = 0.12 (EtOAc); IR (neat): 3776, 3530, 3448, 3301, 1756, 1628, 1596, 1513, 1341, 1235, 1113, 953, 852, 822, 650 cm^{-1}; ^{1}H NMR (500 MHz, DMSO) δ 8.34 (d, *J* = 5.2 Hz, 1H), 7.40 – 7.31 (m, 1H), 7.07 – 6.91 (m, 5H), 6.76 (d, J = 8.4 Hz, 1H), 4.58 (t, *J* = 7.7 Hz, 1H), 4.24-4.10 (m, 1H), 2.87 (dd, *J* = 20.7, 6.3 Hz, 2H), 2.08 (s, 3H). ^{13}C NMR (126 MHz, DMSO) δ 171.0, 167.5, 161.8, 160.2, 153.4, 150.2, 137.5, 135.6, 132.9, 128.3, 126.1, 122.1, 118.2, 116.5, 114.8, 101.9, 98.6, 41.0, 34.0, 29.4, 10.1. HRMS (ESI+): *m/z* calculated for $[C_{20}H_{19}ClFN_3O_3+ H]^+$: 404.1177; found: 404.1205 .

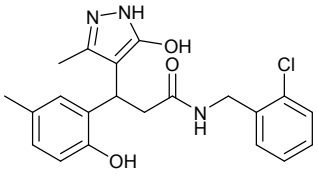


5l

N-(4-chlorobenzyl)-3-(2-hydroxyphenyl)-3-(5-methyl-3-oxo-3H-pyrazol-4- yl) propenamide (5l)

Pale white solid, yield: 85%; TLC (SiO_2): R_f = 0.12 (EtOAc); IR (neat): 3519, 3330, 3064, 2951, 2887, 2843, 1642, 1595, 1514, 1412, 1390, 1254, 1219, 1102, 999, 910, 875, 822, 806, 752, 668 cm^{-1}; ^{1}H NMR (500 MHz, DMSO) δ 7.79 (s, 1H), 7.71 (s, 1H), 7.27 (d, *J* = 5.9 Hz, 2H), 7.14 – 7.06 (m, 2H), 7.02 (t, *J* = 7.0 Hz, 1H), 6.80 (d, *J* = 7.8 Hz, 1H), 6.77 – 6.65 (m,

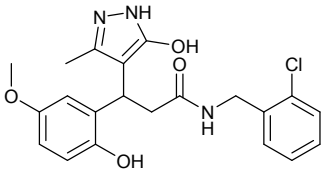
2H), 4.52 (dd, *J* = 10.9, 4.2 Hz, 1H), 4.38 (dd, *J* = 16.2, 5.8 Hz, 1H), 4.28 (dd, *J* = 16.0, 5.2 Hz, 1H), 3.23 (dd, *J* = 13.5, 9.0 Hz, 1H), 3.02 (dd, *J* = 13.8, 6.7 Hz, 1H), 2.12 (s, 3H).; ^{13}C NMR (126 MHz, DMSO) δ 171.77, 160.60, 154.32, 138.00, 136.12, 131.55, 130.69, 128.49, 127.67, 127.59, 126.79, 126.41, 119.13, 118.57, 115.34, 102.80, 29.99, 10.13.; HRMS (ESI+): *m/z* calculated for $[C_{20}H_{20}ClN_3O_3+ H]^+$: 386.1271; found: 386.1302.



5m, 89%

N-(4-chlorobenzyl)-3-(2-hydroxy-5-methylphenyl)-3-(5-methyl-3-oxo-3H-pyrazol-4-yl)propenamide (5m)

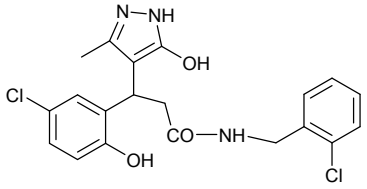
Pale white solid, yield: 89%; TLC (SiO_2): R_f = 0.12 (EtOAc); IR (neat): 3625, 3521, 3315, 2580, 1652, 1627, 1598, 1342, 1256, 1106, 1054, 756 cm^{-1}; 1H NMR (500 MHz, DMSO) δ 8.28 (s, 1H), 7.36 (d, *J* = 7.8 Hz, 1H), 7.21 (t, *J* = 7.0 Hz, 1H), 7.20 – 7.08 (m, 2H), 6.77 (d, *J* = 7.8 Hz, 1H), 6.66 (d, *J* = 7.5 Hz, 1H), 6.62 (d, *J* = 7.9 Hz, 1H), 4.53 (t, *J* = 7.5 Hz, 1H), 4.27 – 4.13 (m, 2H), 2.91 (dd, *J* = 14.1, 9.1 Hz, 1H), 2.84 (dd, *J* = 13.8, 6.7 Hz, 1H), 2.15 (s, 3H), 2.04 (s, 3H).; ^{13}C NMR (126 MHz, DMSO) δ 171.7, 160.4, 152.1, 137.6, 136.4, 131.6, 130.7, 129.1, 128.8, 128.2, 127.8, 127.1, 126.9, 115.2, 103.0, 40.0, 39.0, 29.7, 20.7, 10.9.; HRMS (ESI+): *m/z* calculated for $[C_{21}H_{22}ClN_3O_3+ H]^+$: 400.1427; found: 400.1453 .



5n

N-(4-chlorobenzyl)-3-(2-hydroxy-5-methoxyphenyl)-3-(5-methyl-3-oxo-3H-pyrazol-4-yl)propenamide (5n)

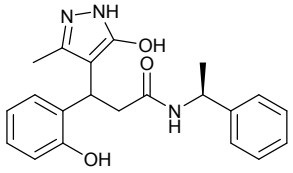
Pale white solid, yield: 88%; TLC (SiO_2): R_f = 0.12 (EtOAc); IR (neat): 2932, 2836, 1760, 1646, 1604, 1539, 1506, 1342, 1270, 947, 875, 792, 756, 700, 565 cm^{-1}.; ^1H NMR (500 MHz, DMSO) δ 8.31 (s, 1H), 7.37 (d, *J* = 7.3 Hz, 1H), 7.22 (d, *J* = 7.0 Hz, 1H), 7.15 (d, *J* = 6.9 Hz, 1H), 7.03 (s, 1H), 6.77 – 6.51 (m, 3H), 4.58 (s, 1H), 4.30-4.15 (m, 2H), 3.64 (s, 3H), 2.94 (d, *J* = 13.6, 8.8 Hz, 1H), 2.87 (dd, *J* = 13.6, 6.0 Hz, 1H), 2.07 (s, 3H).; ^{13}C NMR (126 MHz, DMSO) δ 171.4, 160.2, 155.7, 151.9, 147.9, 136.6, 131.9, 131.5, 129.0, 128.3, 127.9, 127.0, 115.7, 114.9, 111.0, 102.9, 56.0, 34.6, 29.7, 29.2, 10.4.; HRMS (ESI+): *m/z* calculated for $[C_{21}H_{22}ClN_3O_4 + H]^+$: 416.1377; found: 416.1408 .



5o

3-(5-chloro-2-hydroxyphenyl)-N-(4-chlorobenzyl)-3-(5-methyl-3-oxo-3H-pyrazol-4-yl)propenamide (5o)

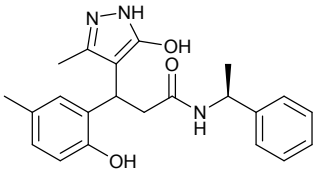
Pale white solid, yield: 89%; TLC (SiO_2): R_f = 0.12 (EtOAc); IR (neat): 3606, 3521, 2928, 2572, 1734, 1608, 1539, 1519, 1492, 1460, 1446, 1274, 1113, 1038, 950, 801, 751, 649 cm^{-1}; ^1H NMR (500 MHz, DMSO) δ 8.37 (s, 1H), 7.40 (s, 1H), 7.37 (d, *J* = 7.7 Hz, 1H), 7.22 (t, *J* = 7.3 Hz, 1H), 7.15 (t, *J* = 7.2 Hz, 1H), 7.01 (d, *J* = 8.3 Hz, 1H), 6.73 (dd, *J* = 15.2, 8.0 Hz, 2H), 4.56 (t, *J* = 7.5 Hz, 1H), 4.21 (d, *J* = 4.7 Hz, 2H), 2.89 (d, *J* = 7.4 Hz, 2H), 2.06 (s, 3H).; ^{13}C NMR (126 MHz, DMSO) δ 171.3, 160.2, 153.4, 137.3, 137.0, 136.3, 133.1, 131.6, 128.8, 128.2, 127.7, 127.1, 126.2, 122.1, 116.6, 102.0, 29.4, 10.2. HRMS (ESI+): *m/z* calculated for $[C_{20}H_{19}C_{l2}N_3O_3 + H]^+$: 420.0881; found: 420.0910.



5p

3-(2-hydroxyphenyl)-3-(5-methyl-3-oxo-3H-pyrazol-4-yl)-N-((R)-1-phenylethyl) propenamide (5p)

Pale white solid, yield: 87%; TLC (SiO_2): R_f = 0.12 (EtOAc); IR (neat): 3388, 3350, 3071, 3026, 2735, 1733, 1639, 1598, 1520, 1455, 1401, 1362, 1343, 1311, 1281, 1218, 1182, 1022, 910, 833, 698 cm^{-1}; ^1H NMR (500 MHz, DMSO) δ 7.75 (s, 1H), 7.28 (t, *J* = 8.1 Hz, 1H), 7.24 – 7.16 (m, 2H), 7.13 (dd, *J* = 11.8, 6.5 Hz, 1H), 7.09 (d, *J* = 7.4 Hz, 1H), 7.01 (d, *J* = 7.5 Hz, 1H), 6.97 (t, *J* = 7.5 Hz, 1H), 6.77 (t, *J* = 8.2 Hz, 1H), 6.69 (t, *J* = 7.3 Hz, 1H), 4.88 (dd, *J* = 13.9, 6.9 Hz, 1H), 4.51 (dd, *J* = 15.5, 7.2 Hz, 1H), 3.16 (dd, *J* = 13.7, 9.5 Hz, 0.5H), 3.05 (dd, *J* = 13.7, 8.8 Hz, 0.5H), 2.94 (dd, *J* = 14.0, 7.0 Hz, 0.5H), 2.84 (dd, *J* = 13.9, 5.9 Hz, 0.5H), 2.11 (s, 1.3H), 2.05 (s, 1.3H), 1.30 (d, *J* = 6.8 Hz, 1.37H), 1.24 (d, *J* = 6.8 Hz, 1.37H).; ^{13}C NMR (126 MHz, DMSO) δ 171.2, 161.2, 154.3, 143.9, 139.1, 130.8, 128.7, 127.9, 126.6, 126.2, 125.6, 125.4, 118.9, 116.0, 103.3, 47.8, 31.0, 21.8, 10.1.; HRMS (ESI+): *m/z* calculated for $[C_{21}H_{23}N_3O_3+ H]^+$: 366.1817; found: 366.1850.

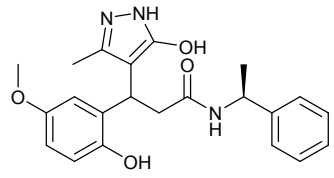


5q

3-(2-hydroxy-5-methylphenyl)-3-(5-methyl-3-oxo-3H-pyrazol-4-yl)-N-((R)-1-phenylethyl) propanamide (5q)

Pale white solid, yield: 89%; TLC (SiO_2): R_f = 0.12 (EtOAc); IR (neat): 3394, 3279, 2927, 2578, 1607, 1533, 1519, 1450, 1277, 1154, 1064, 951, 897, 822, 699, 623 cm^{-1} ; ^1H NMR (500 MHz, DMSO) δ 8.16 (d, *J* = 7.7 Hz, 0.42H), 8.09 (d, *J* = 7.4 Hz, 0.39H), 7.26 – 6.99 (m, 7H), 6.74 (d, *J* = 7.2 Hz, 1H), 6.60 (dd, *J* = 17.6, 7.8 Hz, 1H), 4.87 – 4.70 (m, 1H), 4.48 (d, *J* = 6.9

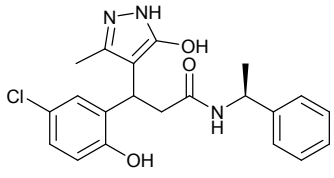
Hz, 1H), 2.99 – 2.85 (m, 1H), 2.79 (DD, *J* = 13.9, 8.0 Hz, 0.5H), 2.72 (dd, *J* = 13.9, 6.1 Hz, 0.5H), 2.15 (s, 3H), 2.01 (d, *J* = 25 Hz, 1H), 1.24 (d, J = 7Hz 3H). ^{13}C NMR (126 MHz, DMSO) δ 170.5, 160.3, 152.0, 144.8, 144.5, 137.6, 130.8, 129.0, 128.0, 126.7, 126.2, 125.7, 125.6, 115.1, 103.3, 103.0, 47.5, 29.7, 22.0, 20.5, 10.3.; HRMS (ESI+): *m/z* calculated for $[C_{22}H_{25}N_3O_3+ H]^+$: 380.1974; found: 380.2012 .



5r

3-(2-hydroxy-5-methoxyphenyl)-3-(5-methyl-3-oxo-3H-pyrazol-4-yl)-N-((R)-1-phenylethyl) propenamide (5r)

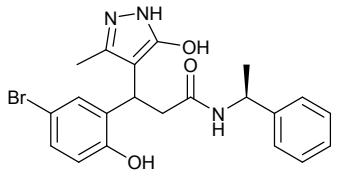
Pale white solid, yield: 85%; TLC (SiO_2): R_f = 0.12 (EtOAc); IR (neat): 3607, 3522, 3300, 2930, 2830, 1646, 1625, 1533, 1514, 1451, 1430, 1366, 1299, 1165, 1058, 1036, 951, 911, 862, 759, 700 cm^{-1} ; ^{1}H NMR (500 MHz, DMSO) δ 8.15 (d, *J* = 7.9 Hz, 0.42H), 8.09 (d, *J* = 7.1 Hz, 0.5H) 7.26 – 7.13 (m, 3H), 7.10 (d, *J* = 6.8 Hz, 1H), 7.05 (d, *J* = 6.9 Hz, 1H), 6.99 (s, 1H), 6.95 (s, 1H), 6.62 (dd, *J* = 17.3, 8.3 Hz, 1H), 6.53 (d, *J* = 8.1 Hz, 1H), 4.79 (s, 1H), 4.49 (d, *J* = 6.0 Hz, 1H), 3.62 (s, 3H), 2.95 – 2.84 (m, 1H), 2.82 – 2.69 (m, 1H), 2.04 (s, 1.27H), 1.99 (s, 1.21H), 1.24 (s, 3H). ^{13}C NMR (126 MHz, DMSO) δ 170.4, 160.2, 151.9, 148.0, 144.7, 144.6, 137.3, 132.1, 128.0, 126.2, 125.7, 115.4, 114.7, 110.9, 103.1, 55.1, 47.5, 29.6, 22.3, 10.2.; HRMS (ESI+): *m/z* calculated for $[C_{22}H_{25}N_3O_4+ H]^+$: 396.1923; found: 396.1956.



5s

3-(5-chloro-2-hydroxyphenyl)-3-(5-methyl-3-oxo-3H-pyrazol-4-yl)-N-((R)-1-phenylethyl) propenamide (5s)

Pale white solid, yield: 83%; TLC (SiO_2): R_f = 0.12 (EtOAc); IR (neat): 3222, 2931, 2575, 1735, 1608, 1595, 1518, 1494, 1419, 1353, 1272, 1114, 978, 951, 920, 823, 754, 697, 605 cm^{-1} ; ^1H NMR (500 MHz, DMSO) δ 8.26 (d, *J* = 7.7 Hz, 0.4H), 8.16 (d, *J* = 7.5 Hz, 0.38H), 7.41 (s, 0.55H), 7.35 (s, 0.45H), 7.26-7.17 (m, 2H), 7.16 – 7.13 (m, 1H), 7.11 (d, *J* = 7.3 Hz, 1H), 7.06 (d, *J* = 7.1 Hz, 1H), 6.98 (d, *J* = 8.1 Hz, 1H), 6.73 (d, *J* = 8.4 Hz, 0.5H), 6.68 (d, *J* = 8.4 Hz, 0.5H), 4.79 (s, 1H), 4.50 (s, 1H), 2.97 (dd, *J* = 14.2, 8.5 Hz, 0.5 H), 2.85 (dd, *J* = 13.9, 8.6 Hz, 0.5H), 2.77 (dd, *J* = 14.1, 7.0 Hz, 0.5H), 2.71 (dd, *J* = 14.3, 7.5 Hz, 0.5H), 2.06 (s, 1.21H), 2.00 (s, 1.26H), 1.24 (s, 3H).; ^{13}C NMR (126 MHz, DMSO) δ 170.1, 160.1, 153.3, 144.8, 144.5, 137.3, 133.1, 128.0, 126.2, 125.6, 122.0, 116.5, 116.4, 102.5, 47.5, 29.4, 29.0, 22.6, 22.5, 10.1.; HRMS (ESI+): *m/z* calculated for $[C_{21}H_{22}ClN_3O_3 + H]^+$: 400.1427; found: 400.1465.

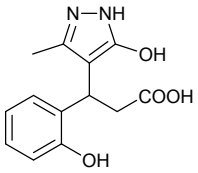


5t

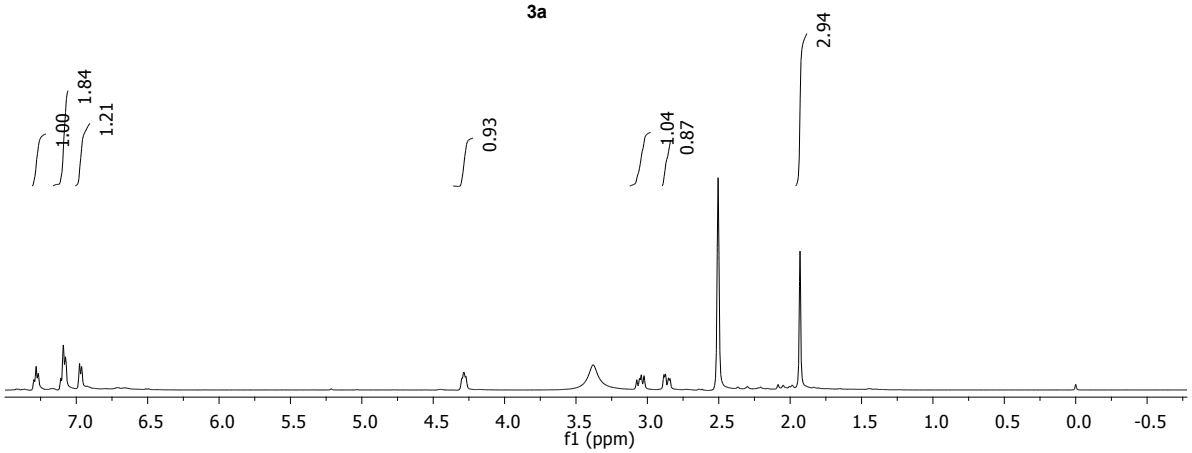
3-(5-bromo-2-hydroxyphenyl)-3-(5-methyl-3-oxo-3H-pyrazol-4-yl)-N-((R)-1-phenylethyl)propenamide (5t)

Pale white solid, yield: 88%; TLC (SiO_2): R_f = 0.12 (EtOAc); IR (neat): 3936, 3501, 3436, 3401, 2634, 2573, 1950, 1880, 1806, 1607, 1594, 1537, 1373, 1300, 1239, 1167, 1078, 1024, 1013, 909, 801, 763, 720, 697 cm^{-1} ; ^1H NMR (500 MHz, DMSO) δ 8.26 (d, *J* = 7.5 Hz, 0.38H), 8.17 (d, *J* = 7.4 Hz, 0.34H), 7.53 (s, 0.43H), 7.47 (s, 0.41H), 7.30-7.02 (m, 7H), 6.69 (d, *J* = 8.4 Hz, 0.5H), 6.64 (d, *J* = 8.3 Hz, 0.35H), 4.79 (s, 0.5H), 4.50 (s, 0.5H), 2.96 (dd, *J* = 13.7, 8.5 Hz, 0.5H), 2.84 (dd, *J* = 11.7, 7.8 Hz, 0.5H), 2.80– 2.67 (m, 1H), 2.06 (s, 1.5H), 2.00 (s, 1.5H), 1.25 (s, 3H).; ^{13}C NMR (126 MHz, DMSO) δ 170.1, 160.1, 144.8, 144.5, 137.4, 137.2, 133.7, 130.9, 129.9, 129.0, 128.0, 126.2, 125.6, 110.0, 102.5, 47.6, 29.4, 22.6, 10.1.; HRMS (ESI+): *m/z* calculated for $[C_{21}H_{22}BrN_3O_3 + H]^+$: 444.092277; found: 444.0954.

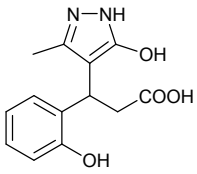
1. Goutam Brahmachari, *ACS Sustainable Chem. Eng.* 2015, **3**, 9, 2350.


N—NH
OH
COOH
OH

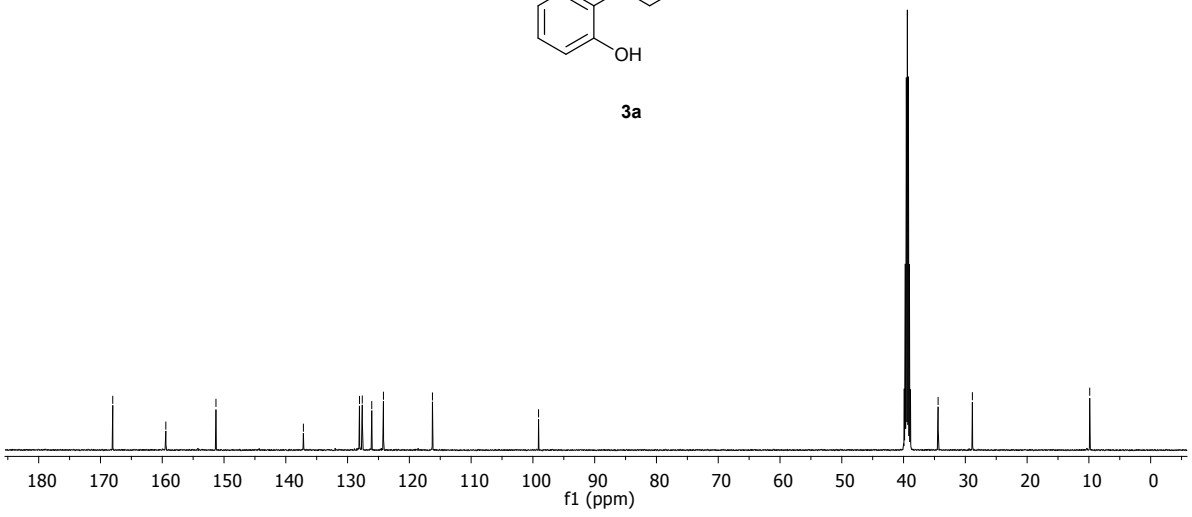
3a

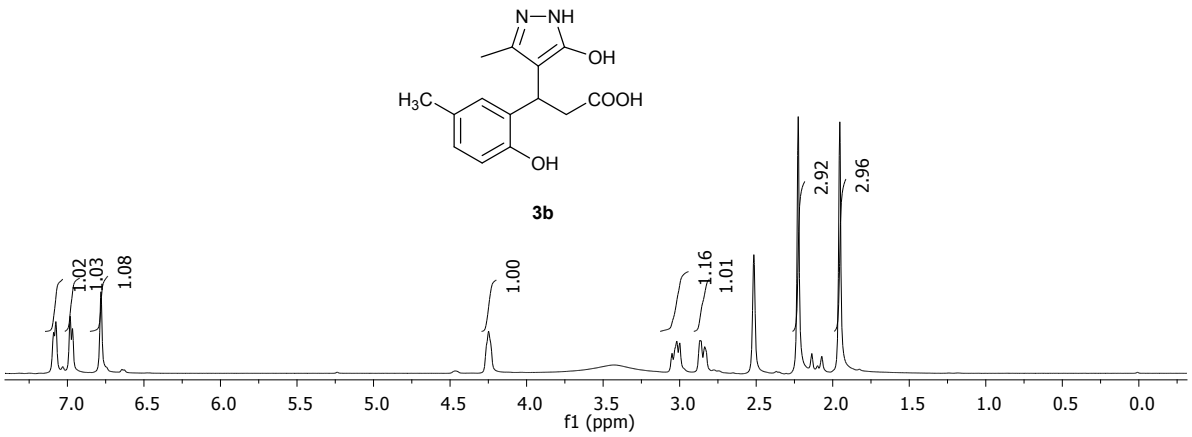

1.00
1.84
1.21
0.93
1.04
0.87
2.94
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

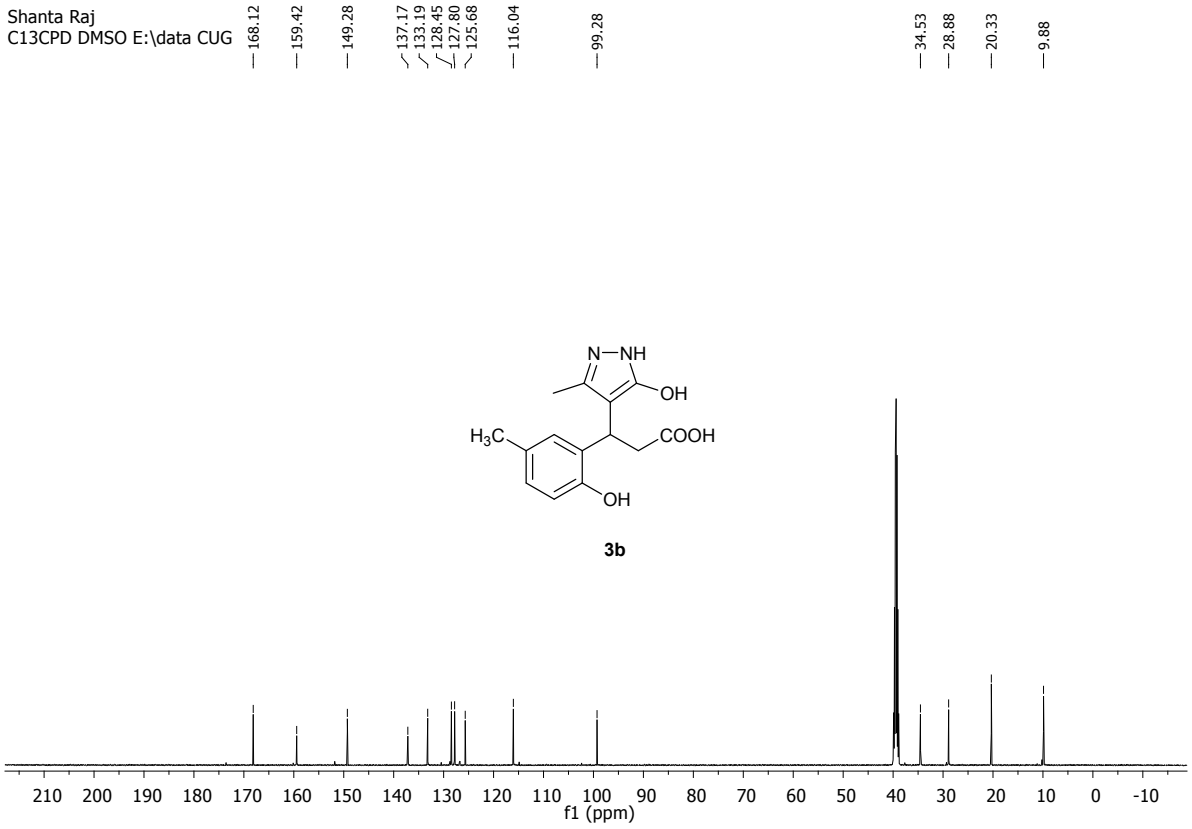

Shanta Raj
RC-SRL-CH3-Est-py
C13CPD DMSO E:\data CUG
168.01
159.42
151.31
137.15
128.07
127.62
126.09
124.19
116.26
99.09
34.41
28.86
9.87

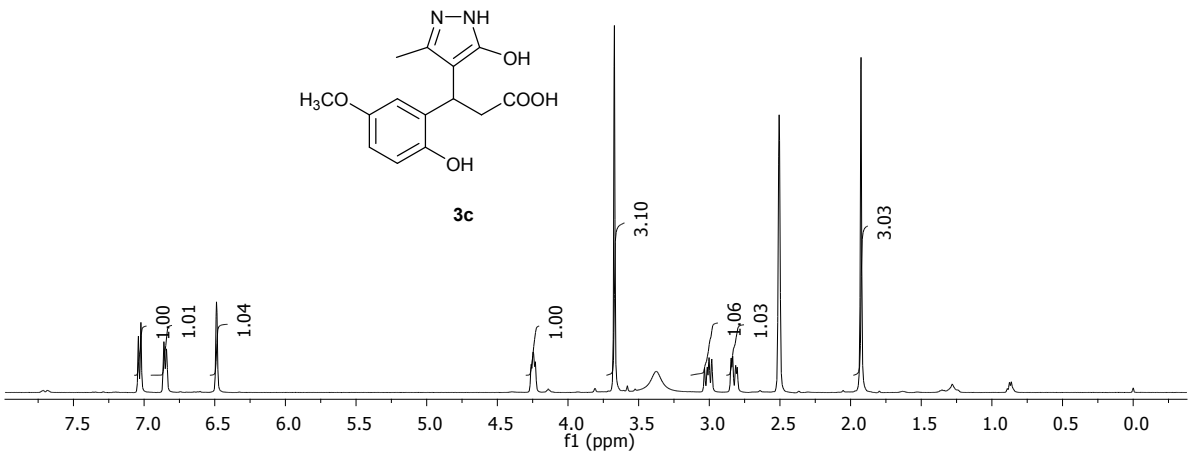

N—NH
OH
COOH
OH

3a


180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

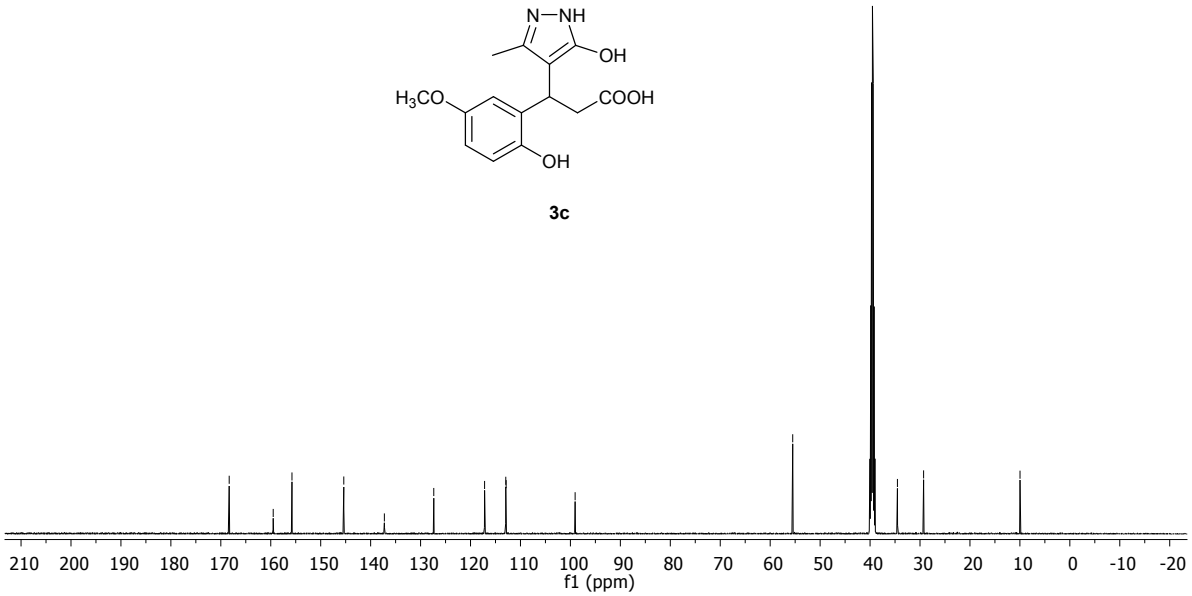

N—NH
OH
H3C
COOH
OH
3b
1.02
1.03
1.08
1.00
1.16
1.01
2.92
2.96
7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

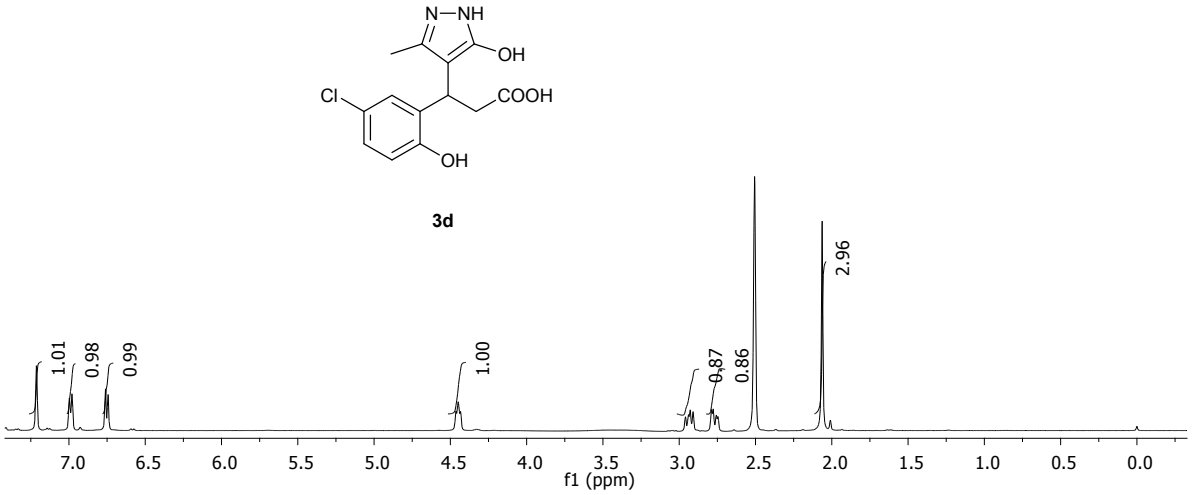

Shanta Raj
C13CPD DMSO E:\data CUG
168.12
159.42
149.28
137.17
133.19
128.45
127.80
125.68
116.04
99.28
34.53
28.88
20.33
9.88
N—NH
OH
H3C
COOH
OH
3b
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)



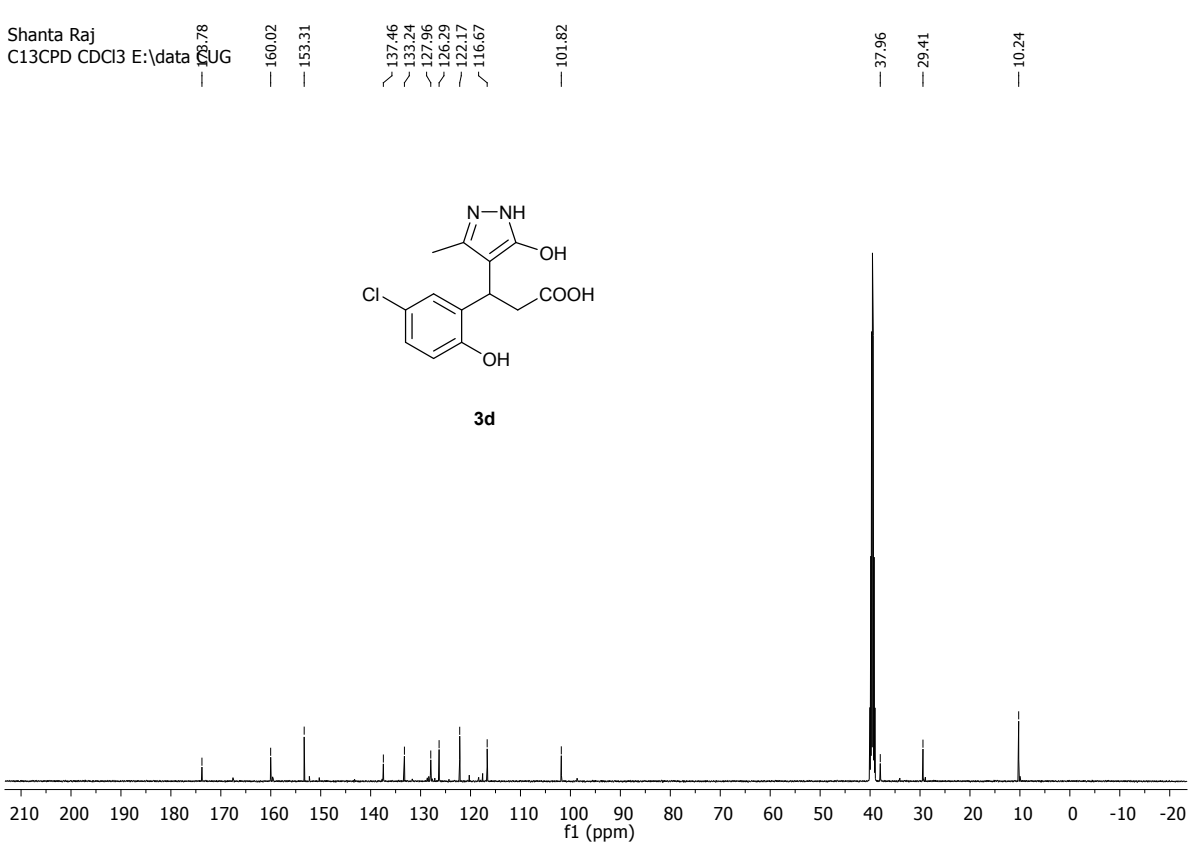
Shanta Raj
RC-SRL-188
C13CPD CDCl3 E:\data CUG

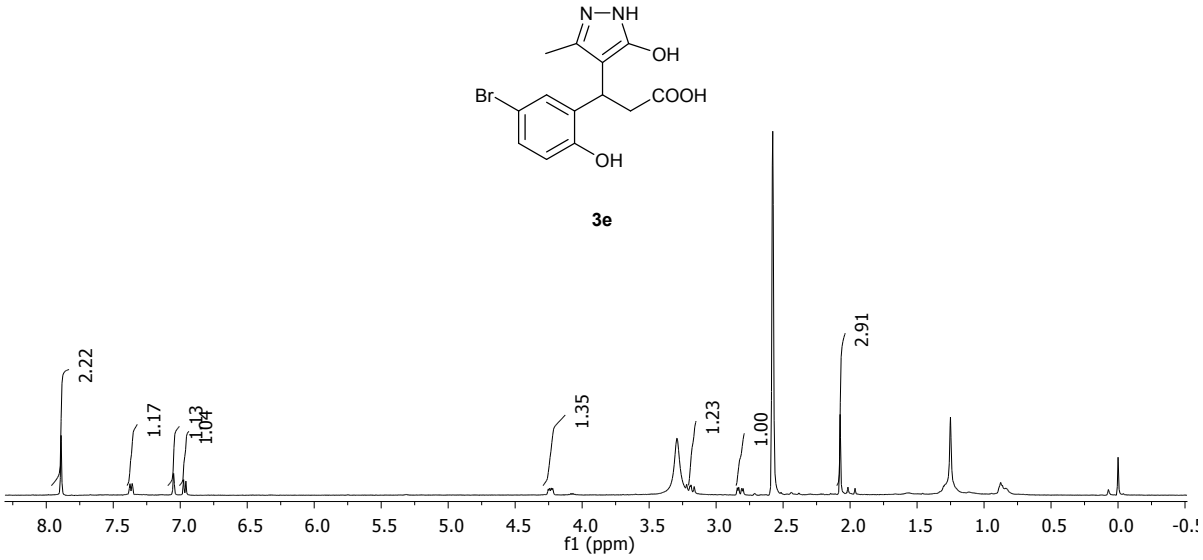
168.32 159.51 155.75 145.38 137.25 127.36 117.18 112.94 112.87 99.06 55.49 34.52 29.28 9.97



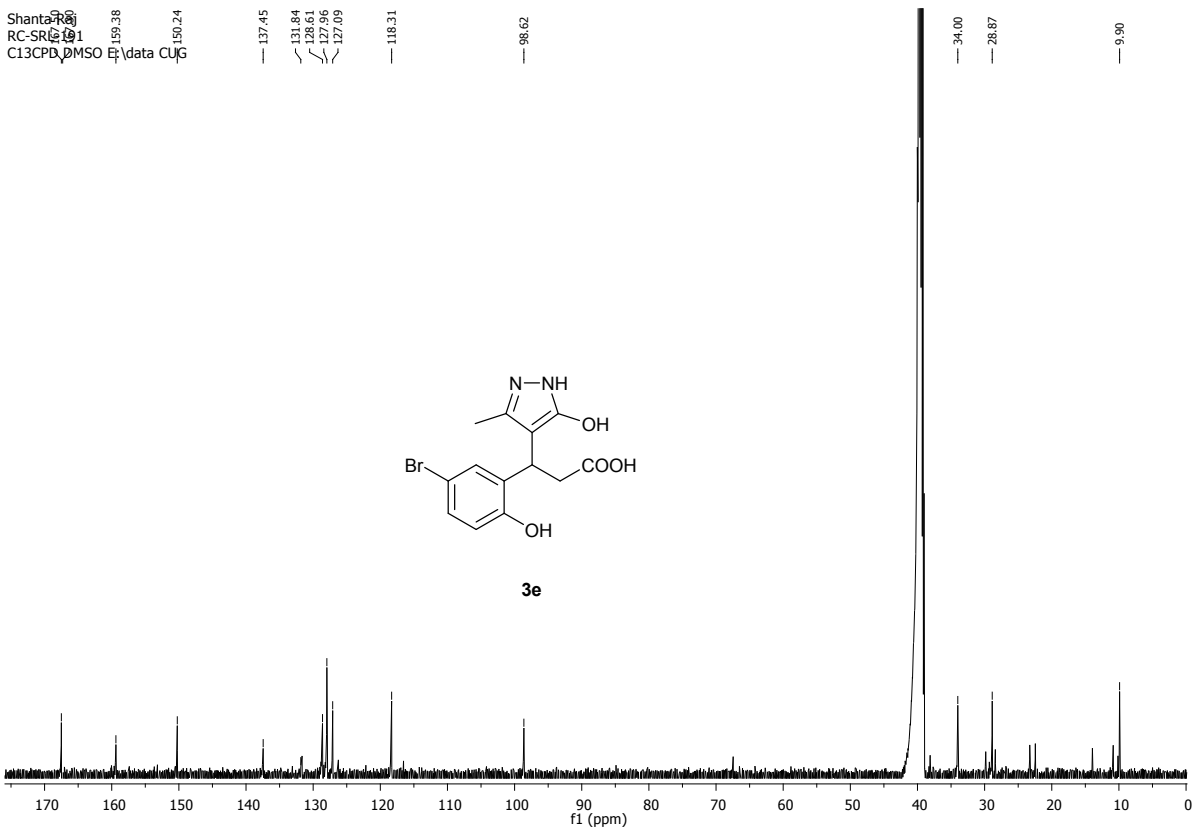


Shanta Raj
C13CPD CDCl3 E:\data CUG

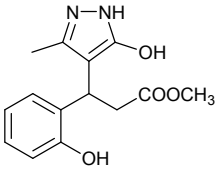



N—NH
OH
Br
COOH
OH
2.22
1.17
1.13
1.04
1.35
1.23
1.00
2.91
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

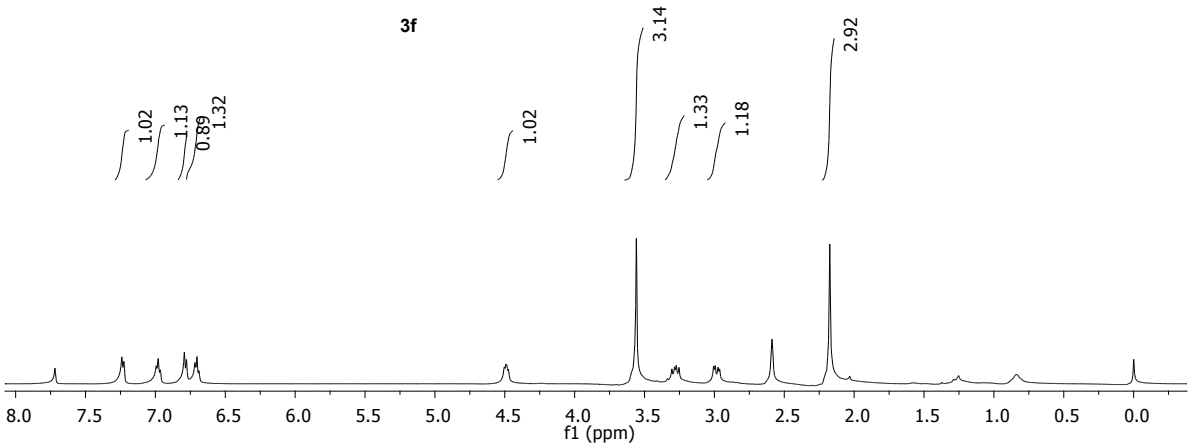
3e


Shanta Raj
RC-SR-Ex-191
C13CPD_DMSO E:\data CUG
159.38
150.24
137.45
131.84
128.61
127.96
127.09
118.31
98.62
34.00
28.87
9.90
N—NH
OH
Br
COOH
OH
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

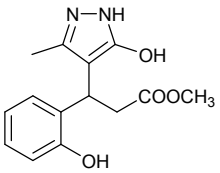
3e


N—NH
OH
COOCH3
OH

3f

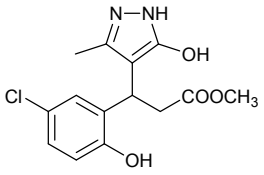

1.02
1.13
0.89
1.32
1.02
3.14
1.33
1.18
2.92
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


Shanta Raj
RG-SRL-158
C13CPD DMSO E:\data CUG
166.71
157.62
149.70
135.59
126.31
125.88
124.37
122.42
114.54
97.19
49.30
32.79
27.39
8.28

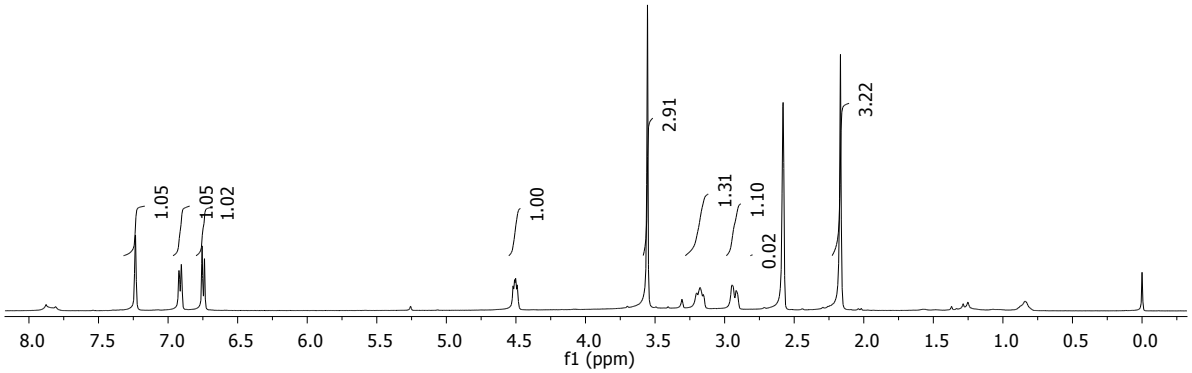

N—NH
OH
COOCH3
OH

3f

160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

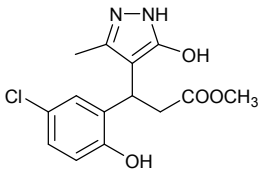


3g

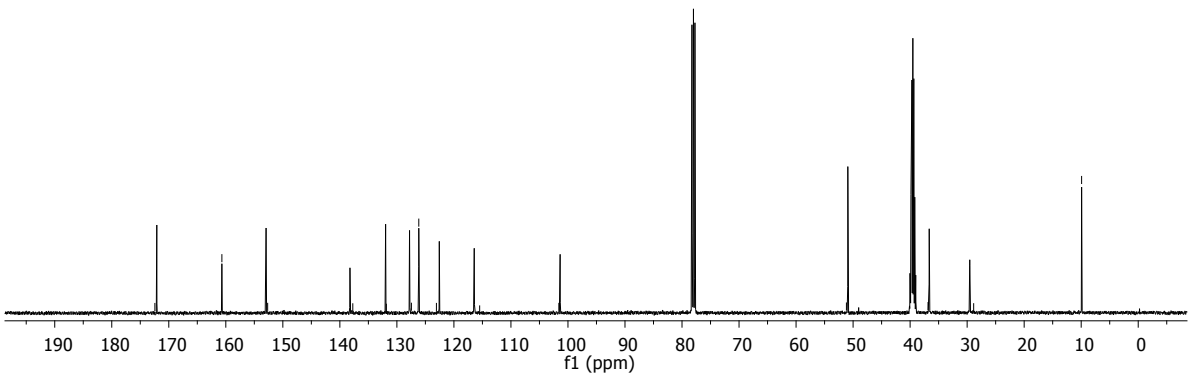


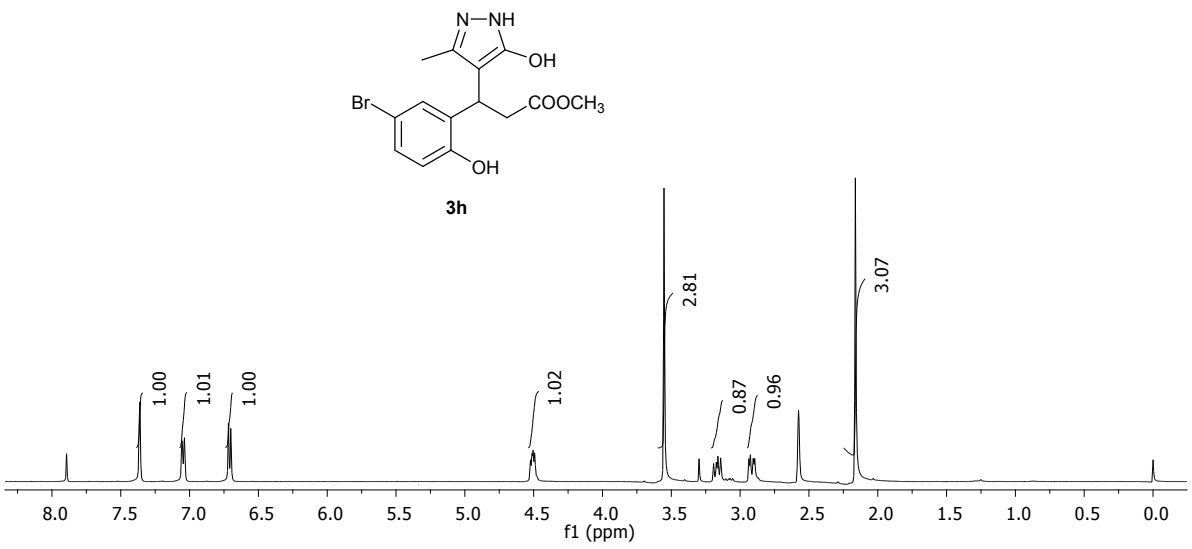
Shanta Raj
RC-SRL-161
C13CPD DMSO E:\data CUG

172.44 160.69 152.66 137.73 131.85 127.45 126.16 123.07 115.48 101.60 51.17 36.86 28.86 9.93



3g

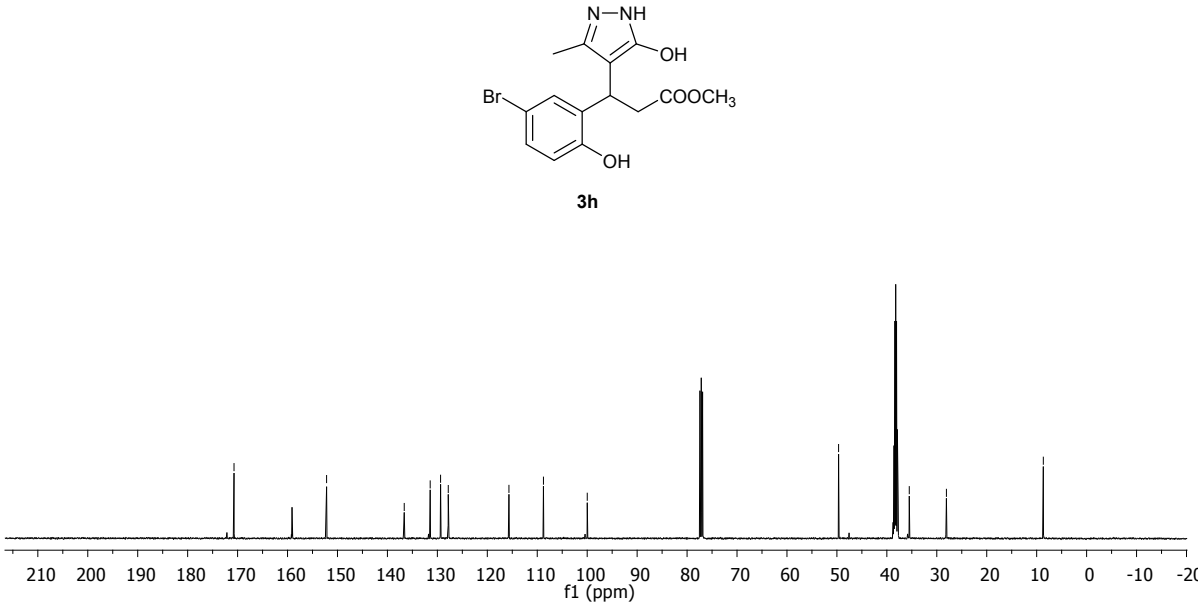




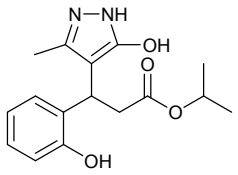
3h

Shanta Raj
C13CPD DMSO E:\data CUG

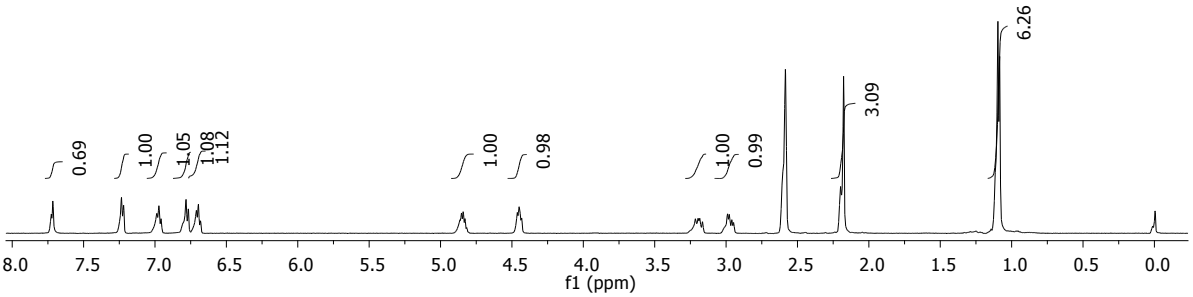
170.72
159.02
152.18
136.63
131.44
129.36
127.82
115.67
108.76
99.99
49.66
35.51
28.07
8.67



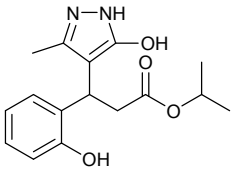
3h



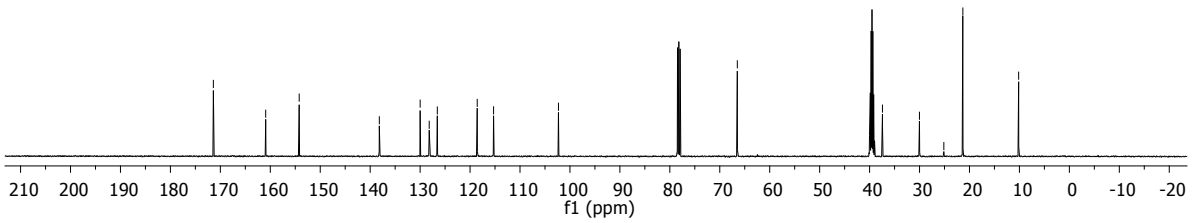
3i

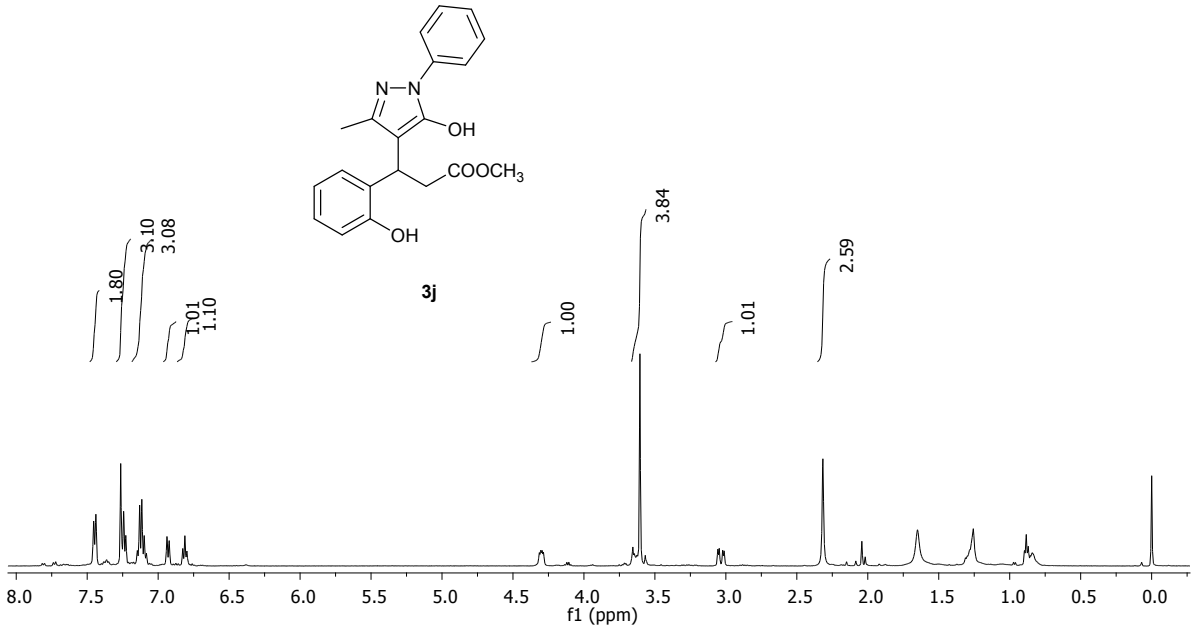


Shanta Raj
C13CPD CDCl3 E:\data CDG

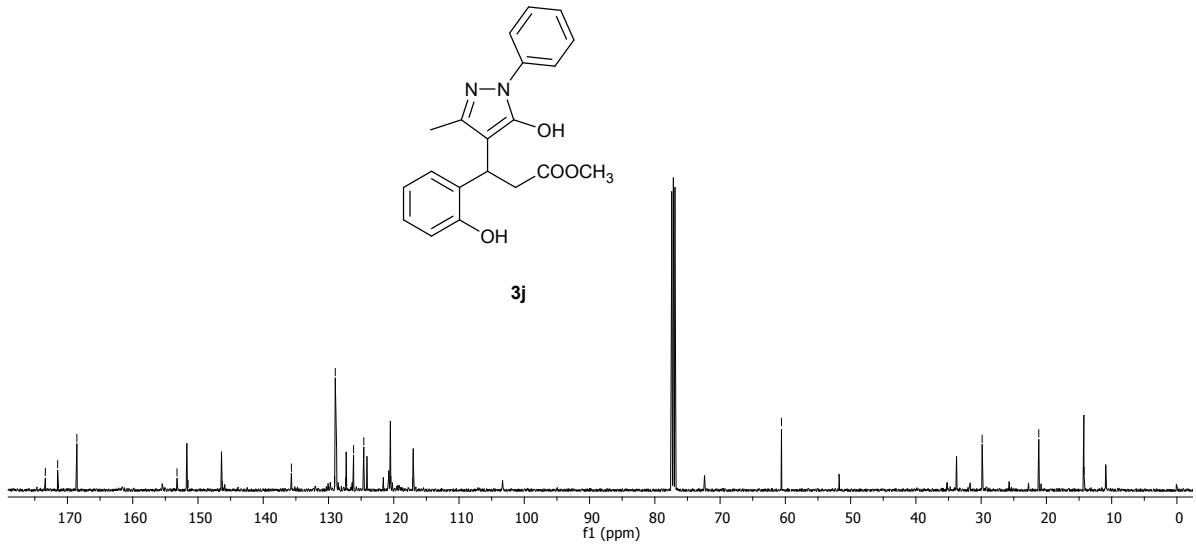


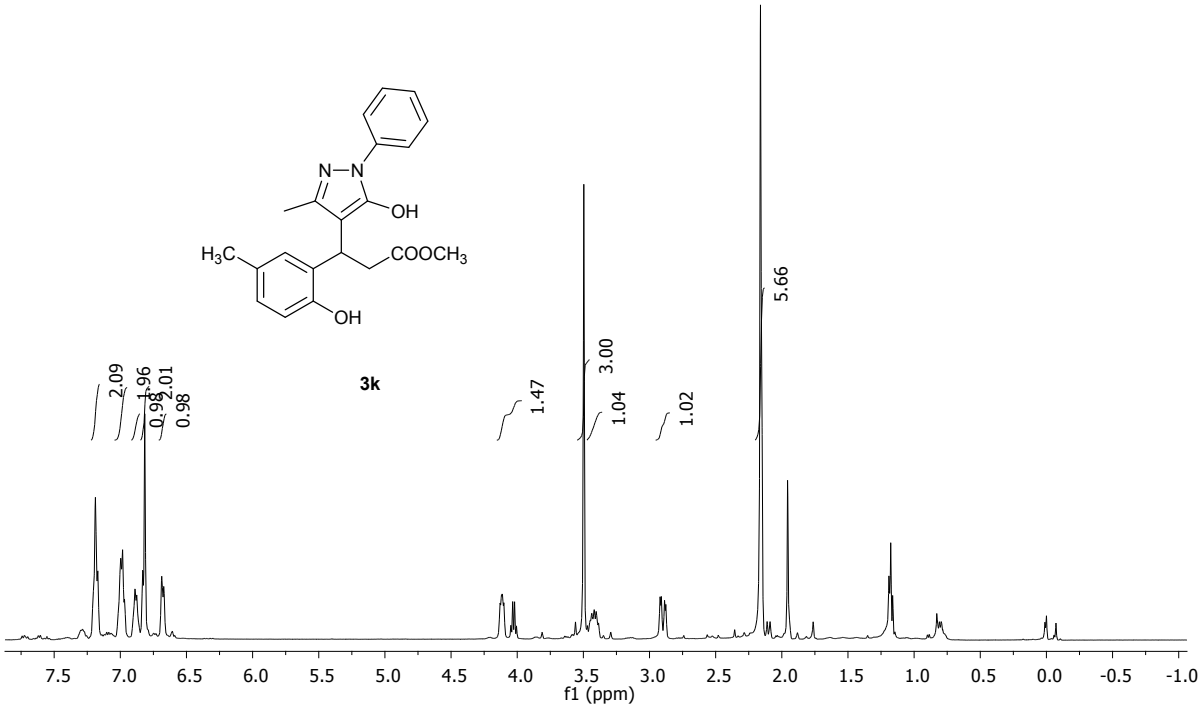
3i

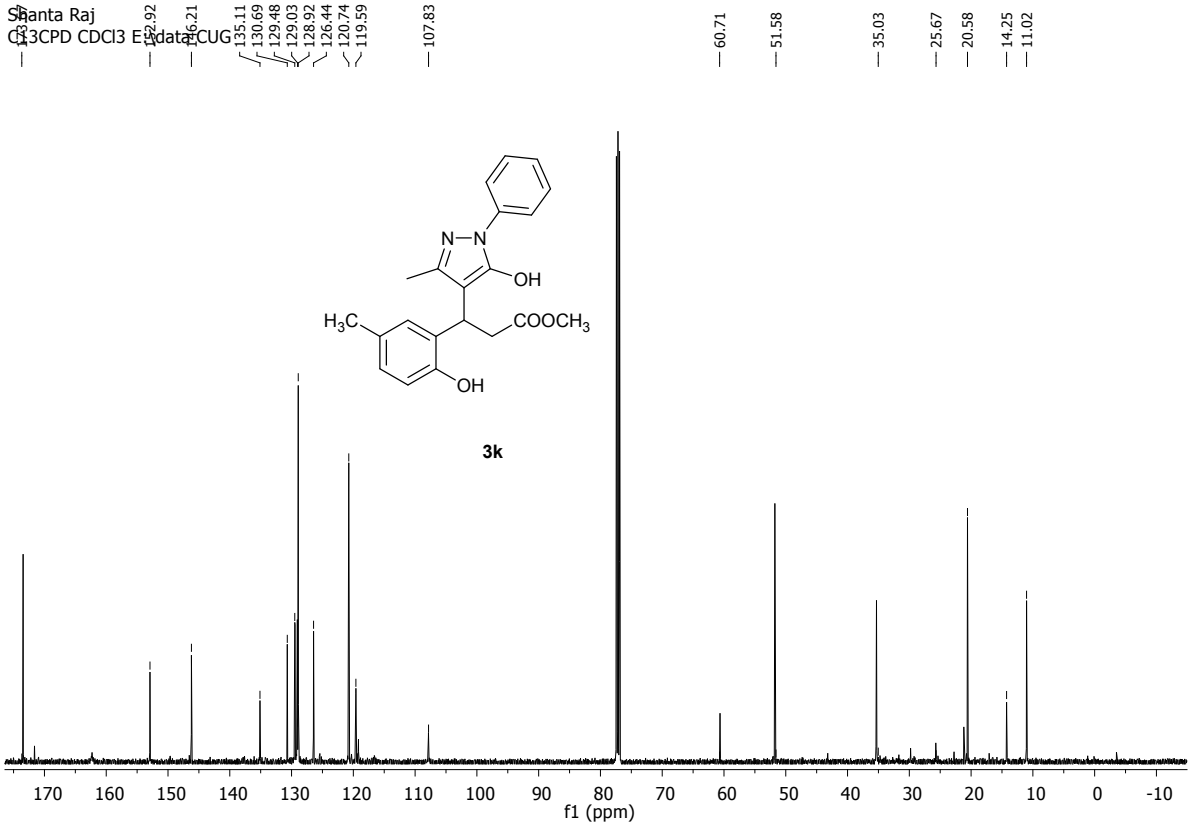


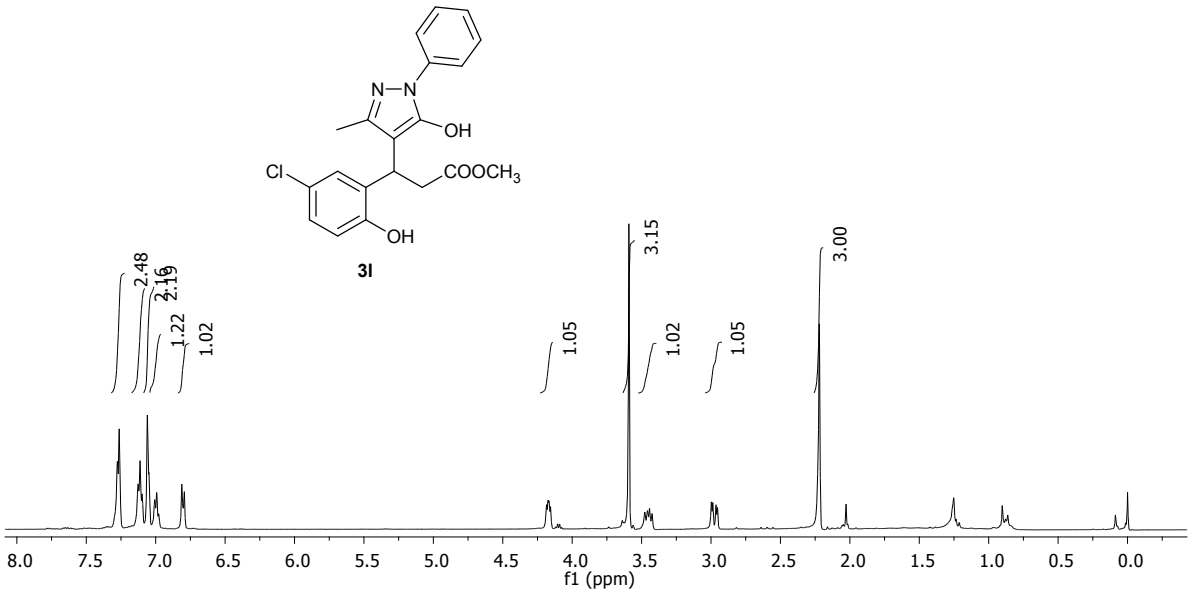

N—N
OH
COOCH3
OH
3j
1.80
3.10
3.08
1.01
1.10
1.00
3.84
1.01
2.59
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


Shanta Raj
C13CDCl3 E:\data CDCl3
146.28
135.68
129.06
128.97
127.36
126.16
124.59
120.45
117.09
60.59
29.85
21.17
14.23

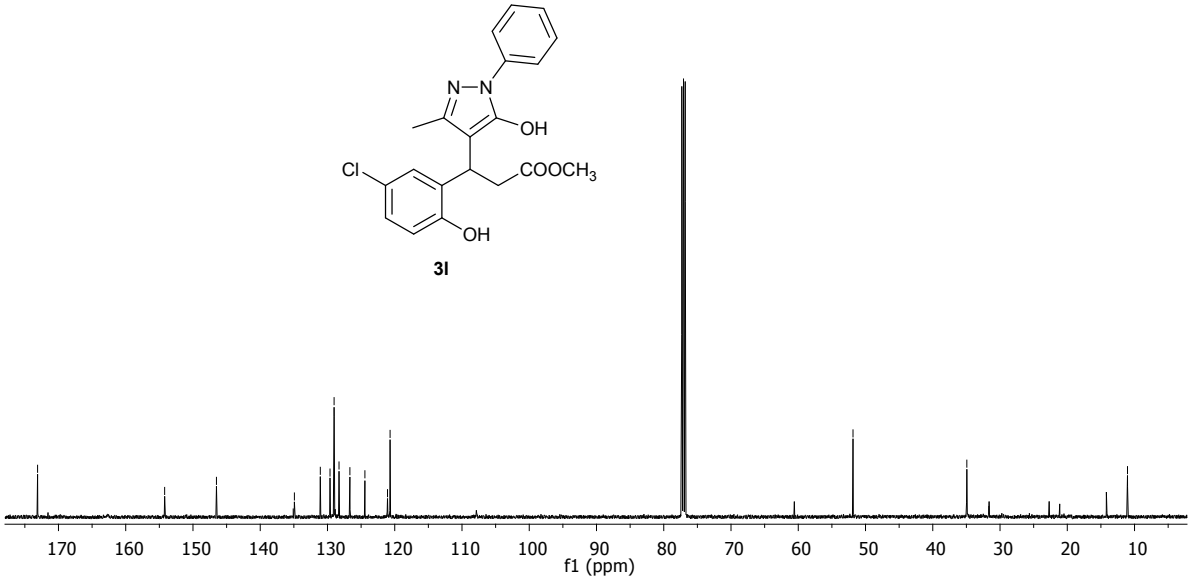

N—N
OH
COOCH3
OH
3j
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

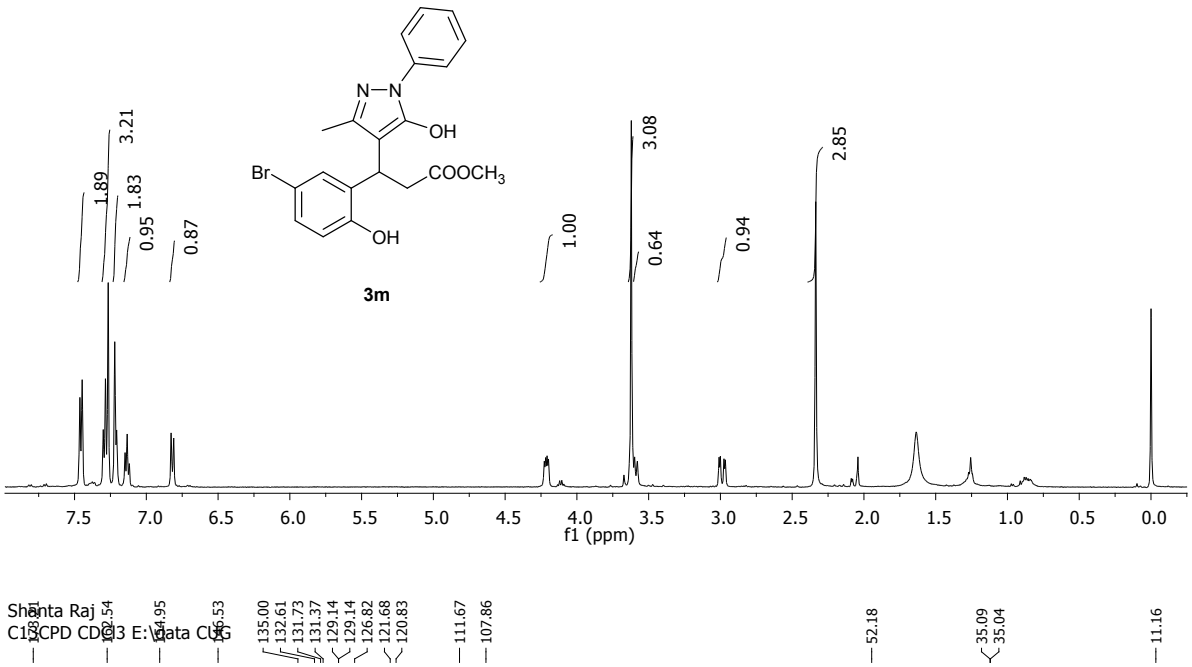

N–N
OH
H3C
COOCH3
OH
3k
2.09
1.96
0.98
2.01
0.98
1.47
3.00
1.04
1.02
5.66
7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

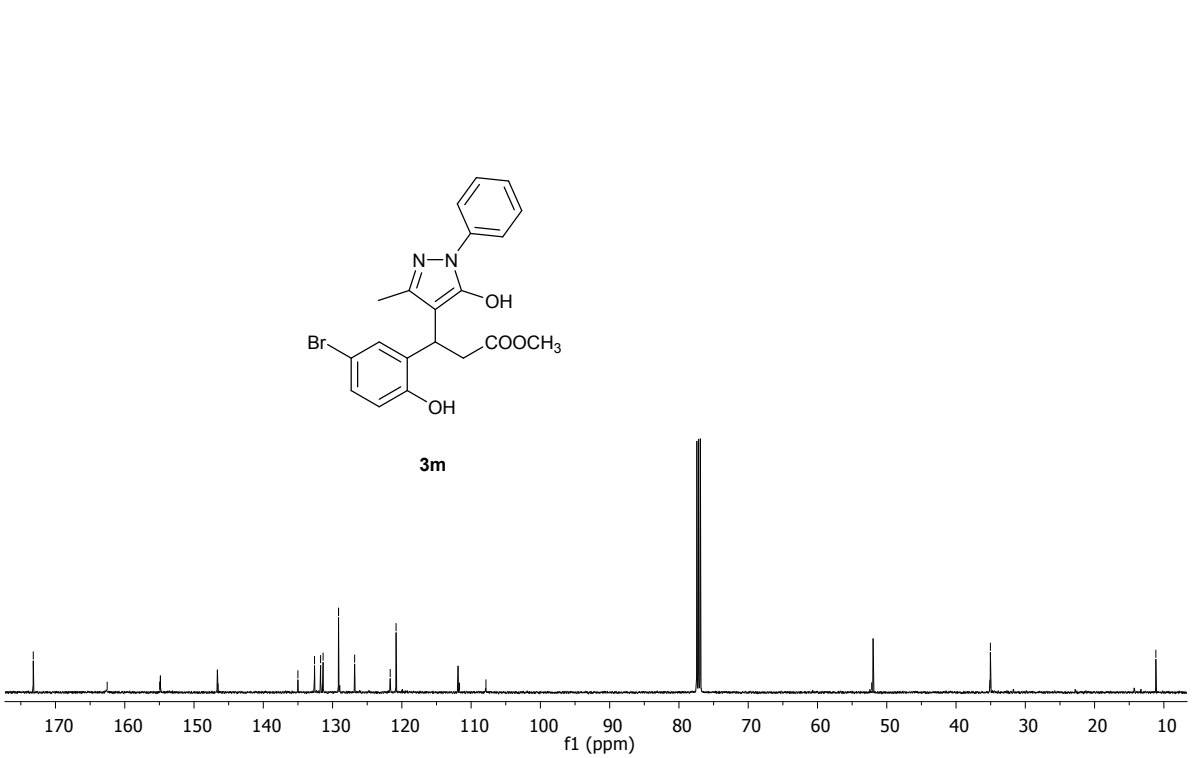

Shanta Raj
C13CPD CDCl3 Exdata.ECUG
142.92
136.21
135.11
130.69
129.48
129.03
128.92
126.44
120.74
119.59
107.83
60.71
51.58
35.03
25.67
20.58
14.25
11.02
N–N
OH
H3C
COOCH3
OH
3k
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


N–N
OH
Cl
COOCH3
OH
3l
2.48
2.16
2.15
1.22
1.02
1.05
3.15
1.02
1.05
3.00
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

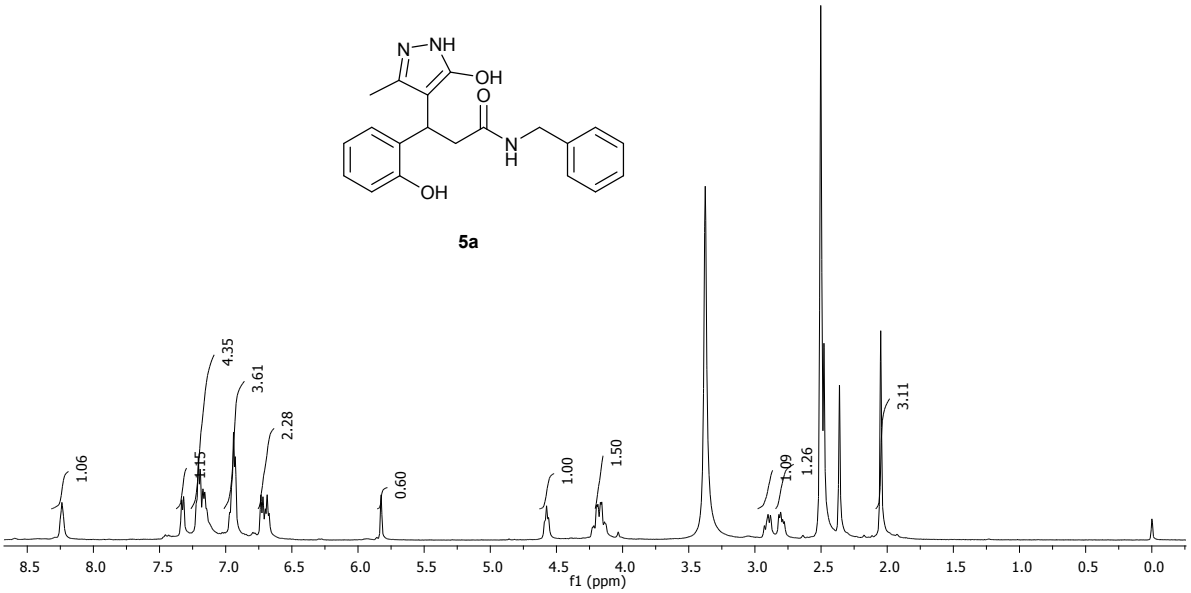

Shanta Raj
RC-SRL-161+PH
C13CPD CDCl3 E:\data CU\G
154.21
146.51
135.10
134.92
131.07
129.62
129.02
128.28
126.67
124.44
121.08
120.69
51.86
34.94
31.66
11.05


N–N
OH
Cl
COOCH3
OH
3l
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)


3.21
1.89
1.83
0.95
0.87
1.00
3.08
0.64
0.94
2.85
Br
OH
COOCH3
OH
3m
f1 (ppm)


Shanta Raj
C13CPD CDCl3 E:\Data CDCl3
135.00
132.61
131.73
131.37
129.14
129.14
126.82
121.68
120.83
111.67
107.86
52.18
35.09
35.04
11.16
Br
OH
COOCH3
OH
3m
f1 (ppm)

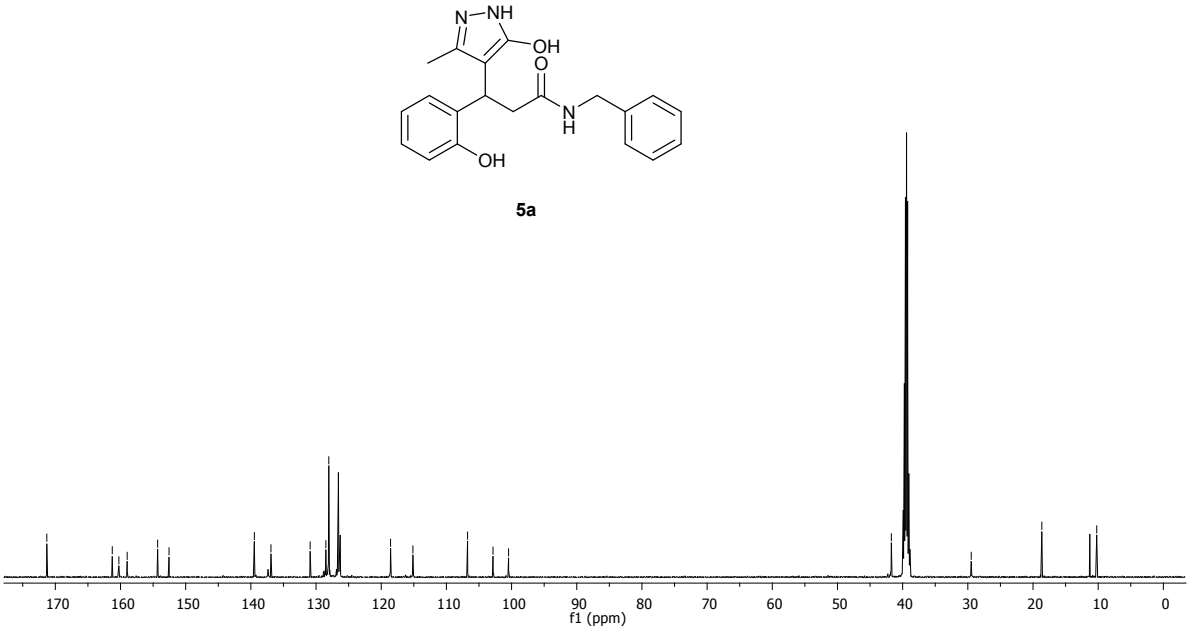
Shanta Raj
PROTON DMSO E:\data CUG



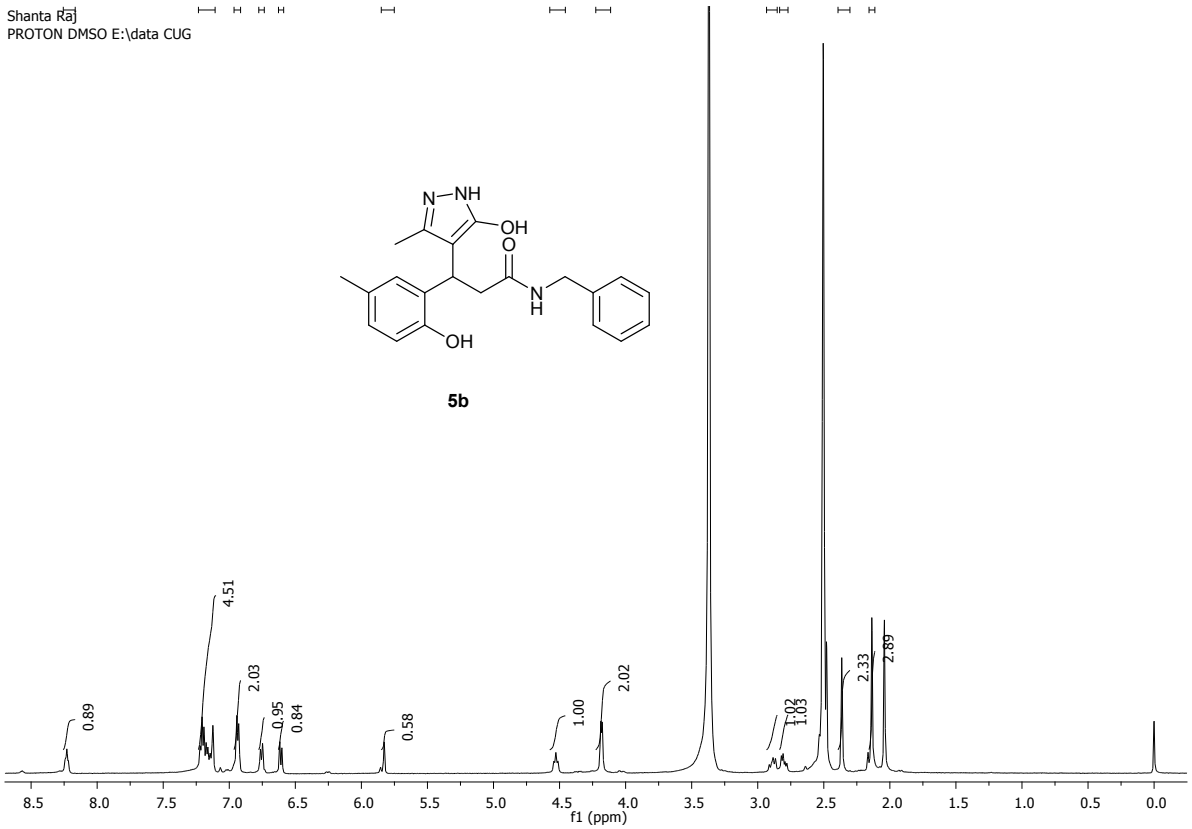
5a

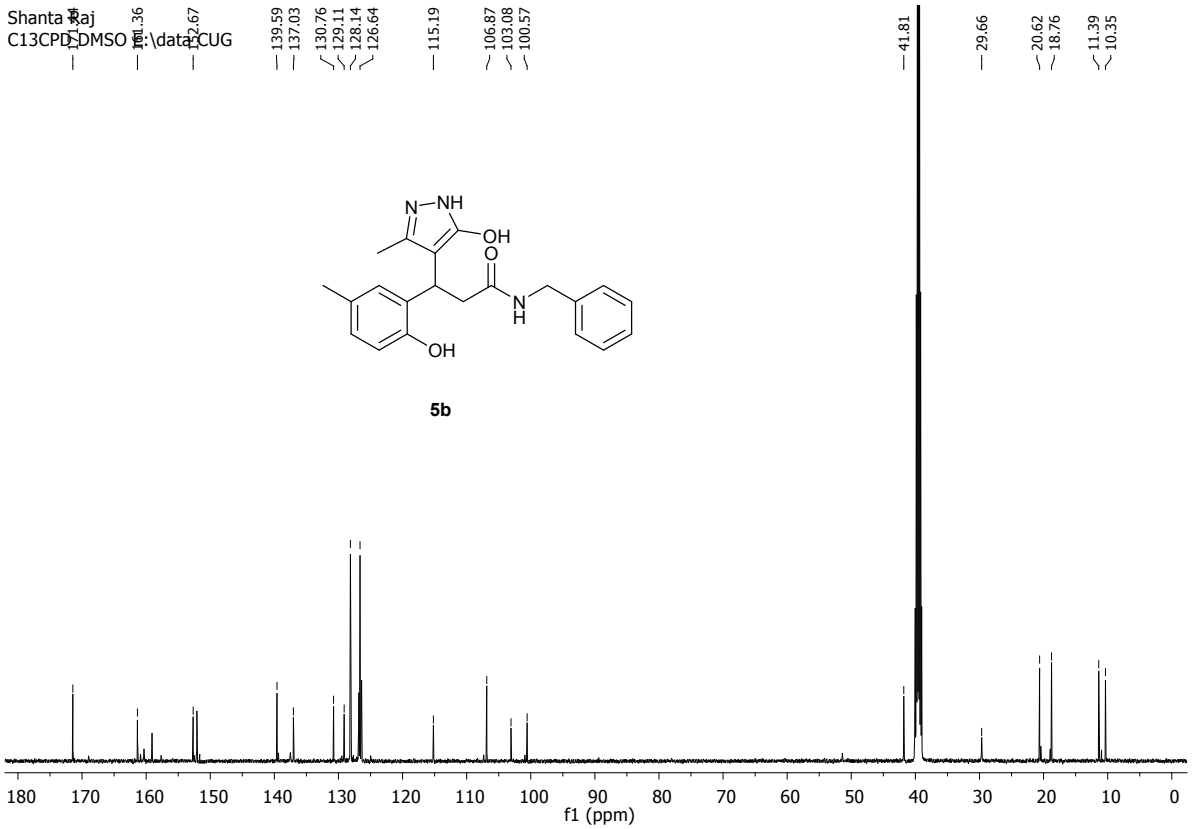
Shanta Raj
RC-SRL-227
C13CPD DMSO E:\data\CUG

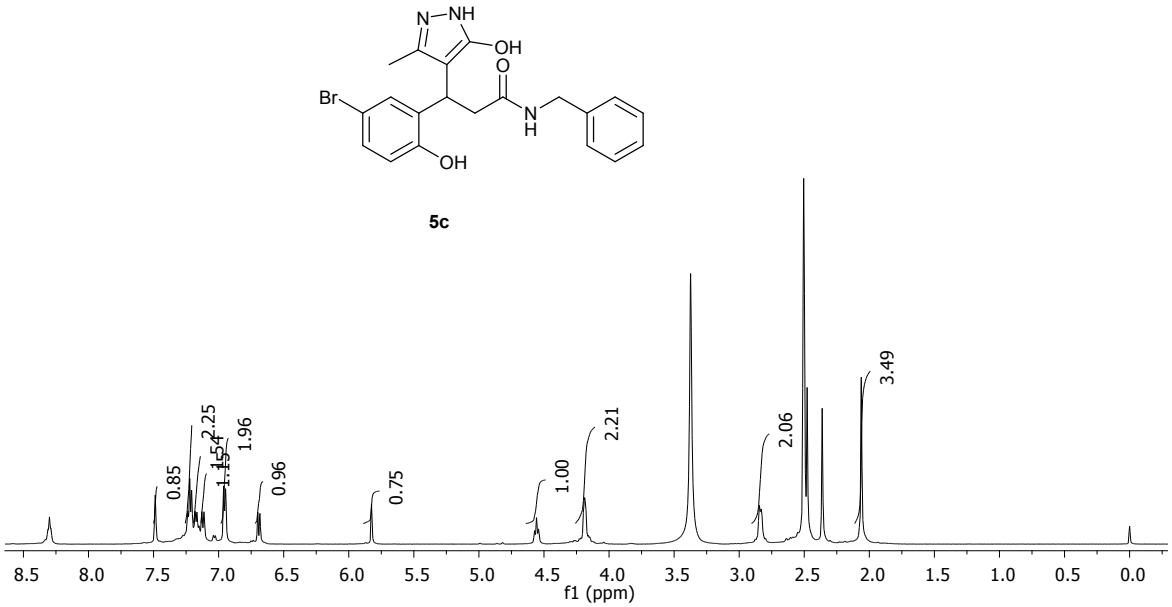
161.26
160.25
158.98
154.30
152.56
139.47
136.92
130.90
128.50
128.04
126.67
118.57
115.14
114.25
106.76
102.85
100.46
41.73
29.48
18.65
10.22



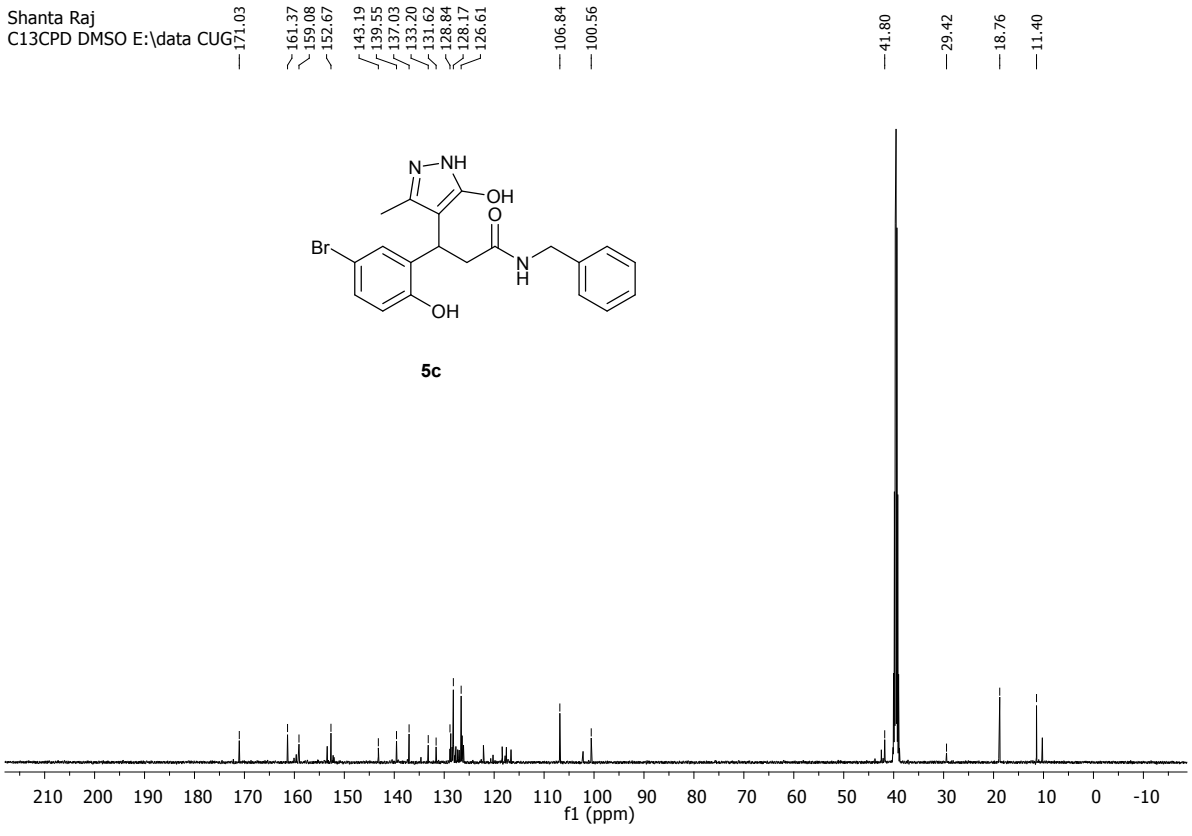
5a


Shanta Raj
PROTON DMSO E:\data CUG
N
NH
OH
O
N
H
OH
5b
4.51
2.03
0.95
0.84
0.89
0.58
1.00
2.02
1.02
1.03
2.33
2.89
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

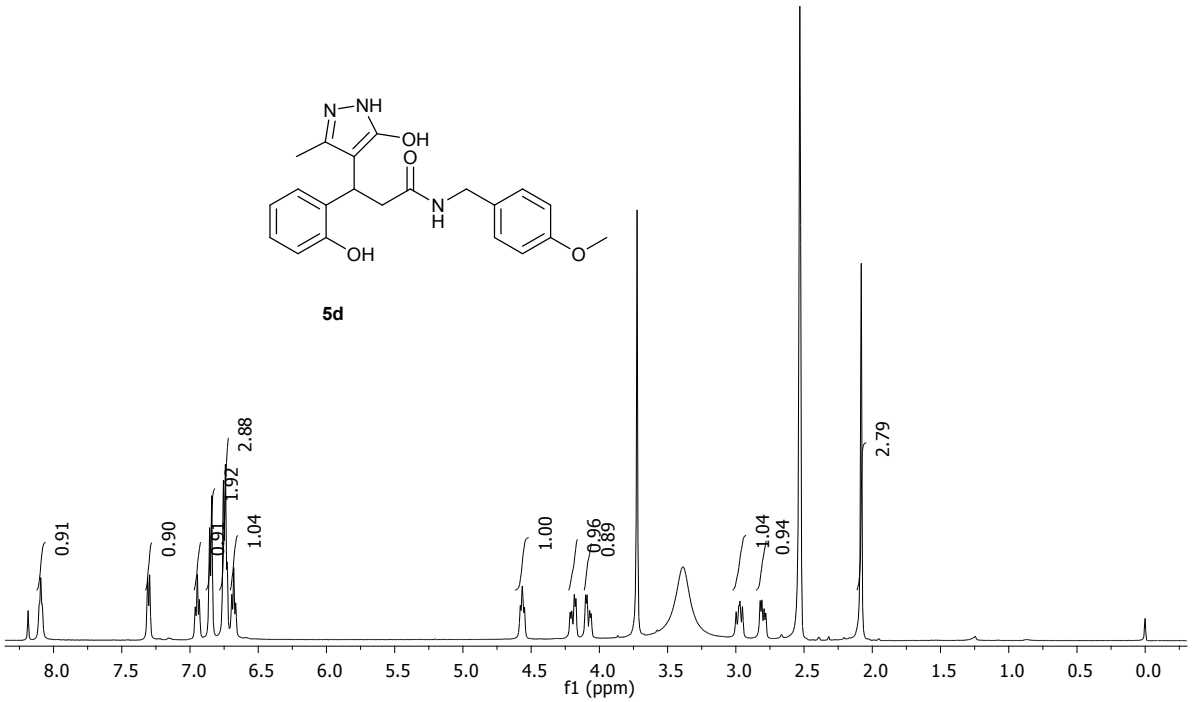

Shanta Raj
C13CPD DMSO E:\data CUG
171.84
161.36
152.67
139.59
137.03
130.76
129.11
128.14
126.64
115.19
106.87
103.08
100.57
41.81
29.66
20.62
18.76
11.39
10.35
N
NH
OH
O
N
H
OH
5b
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


N
NH
OH
O
Br
N
H
OH
0.85
2.25
1.54
1.19
1.96
0.96
0.75
1.00
2.21
2.06
3.49
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

5c


Shanta Raj
C13CPD DMSO E:\data CUG
171.03
161.37
159.08
152.67
143.19
139.55
137.03
133.20
131.62
128.84
128.17
126.61
106.84
100.56
41.80
29.42
18.76
11.40
N
NH
OH
O
Br
N
H
OH
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

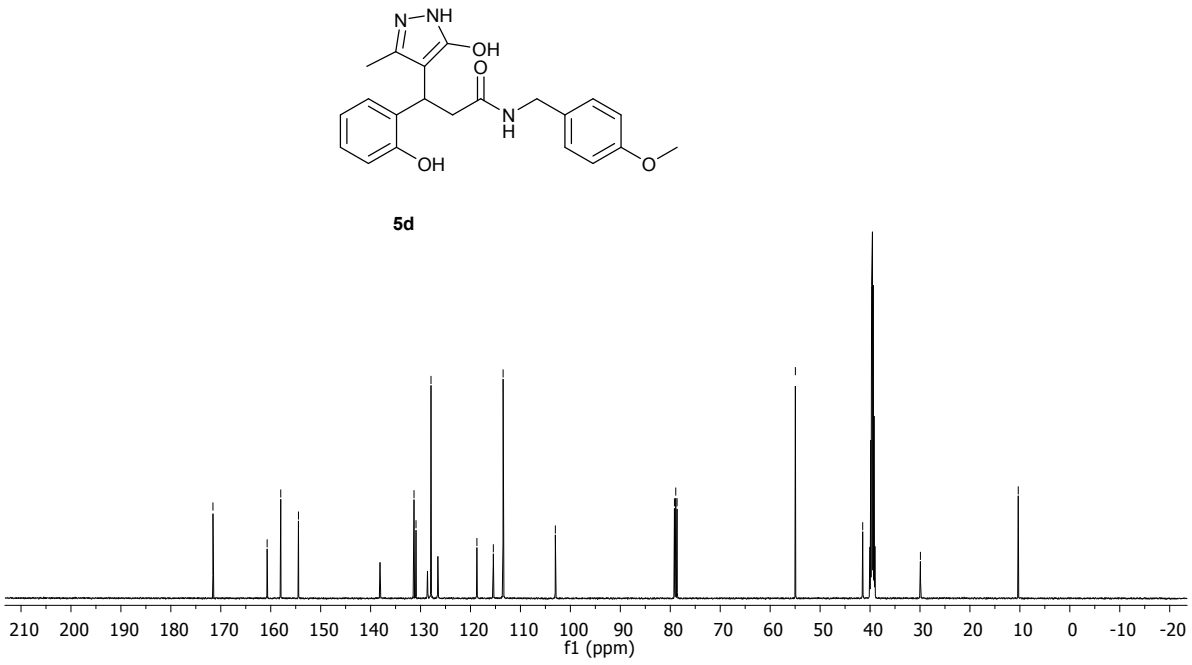
5c



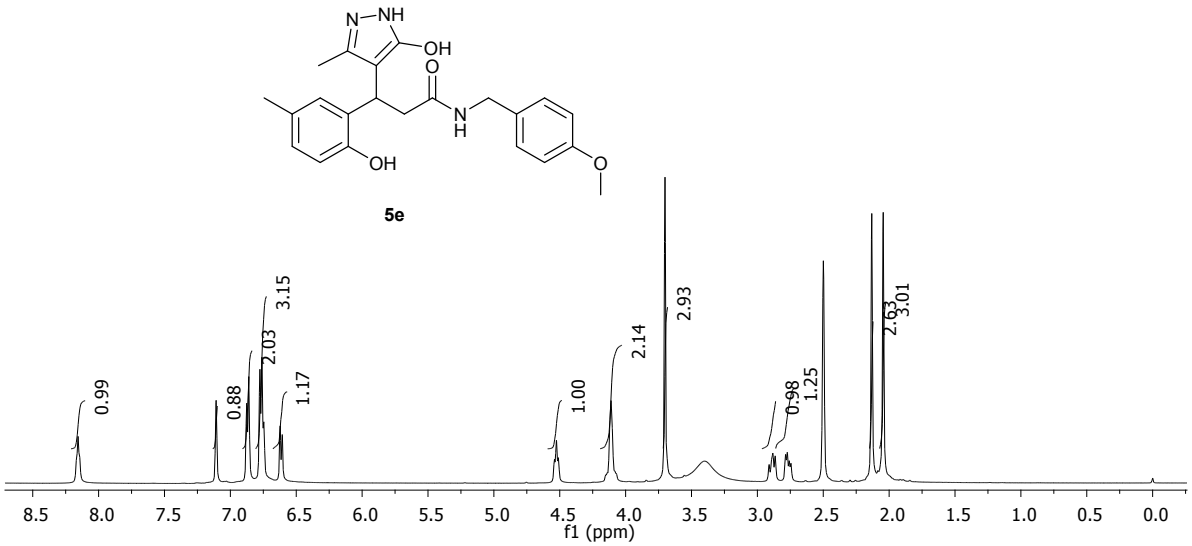
5d

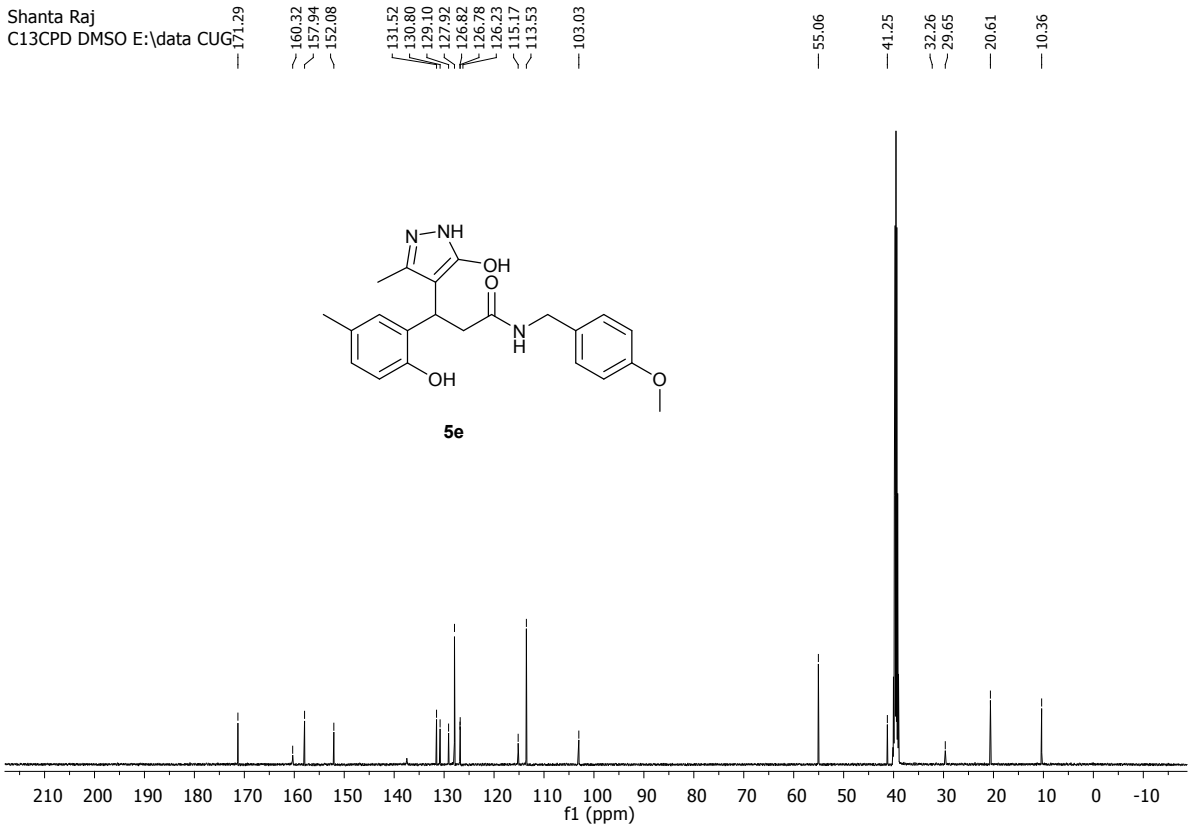
Shanta Raj
RC-SRL-158-HH-Benz
C13CPD CDCl3 E:\data CU\G

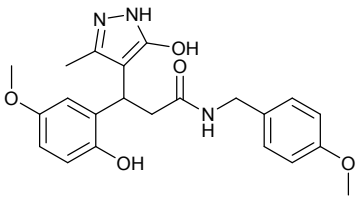
171.57
160.72
157.99
154.45
131.31
130.91
127.91
118.72
115.43
113.47
103.01
79.16
78.90
78.64
54.95
41.47
30.63
29.91
10.33



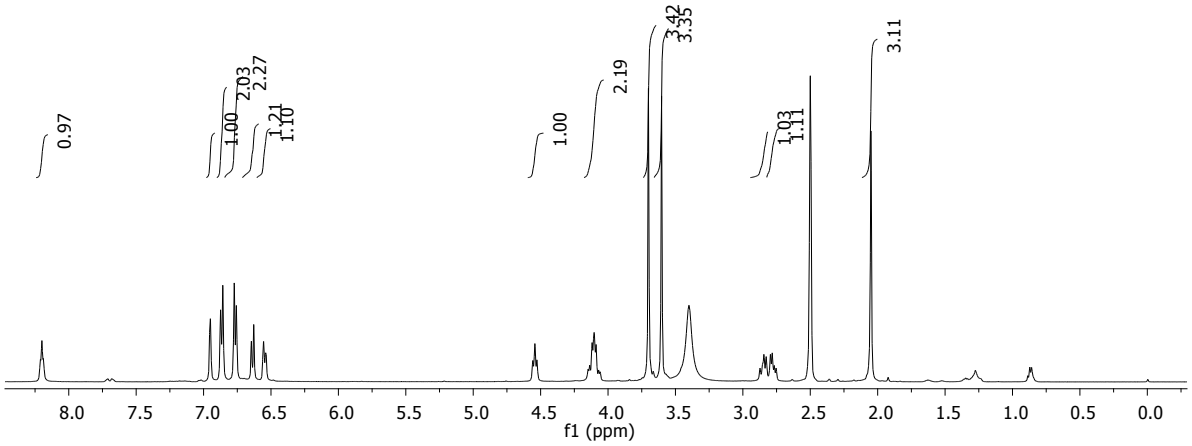
5d


N
NH
OH
O
N
H
OH
O
5e
0.99
0.88
2.03
3.15
1.17
1.00
2.14
2.93
0.98
1.25
2.63
3.01
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

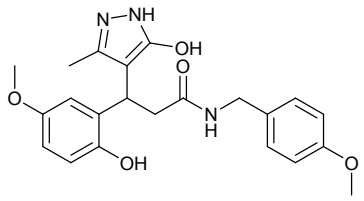

Shanta Raj
C13CPD DMSO E:\data CUG
171.29
160.32
157.94
152.08
131.52
130.80
129.10
127.92
126.82
126.78
126.23
115.17
113.53
103.03
55.06
41.25
32.26
29.65
20.61
10.36
N
NH
OH
O
N
H
OH
O
5e
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


N
NH
OH
O
O
N
H
OH
O

5f


0.97
1.00
2.03
2.27
1.21
1.10
1.00
2.19
3.42
3.35
1.03
1.11
3.11
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

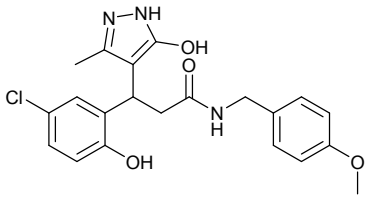

Shanta Raj
C13CPD DMSO-d6 data 2UC 1
170.31
159.01
152.05
148.19
137.49
132.14
131.52
128.00
115.54
114.94
113.59
110.94
102.93
55.23
55.10
41.33
29.71
10.76


N
NH
OH
O
O
N
H
OH
O

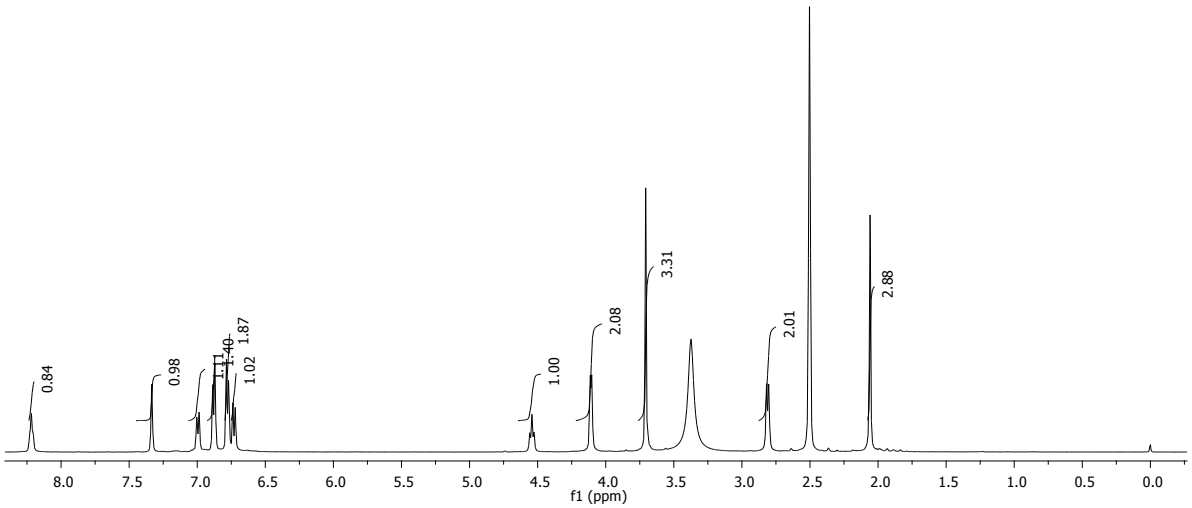
5f

170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

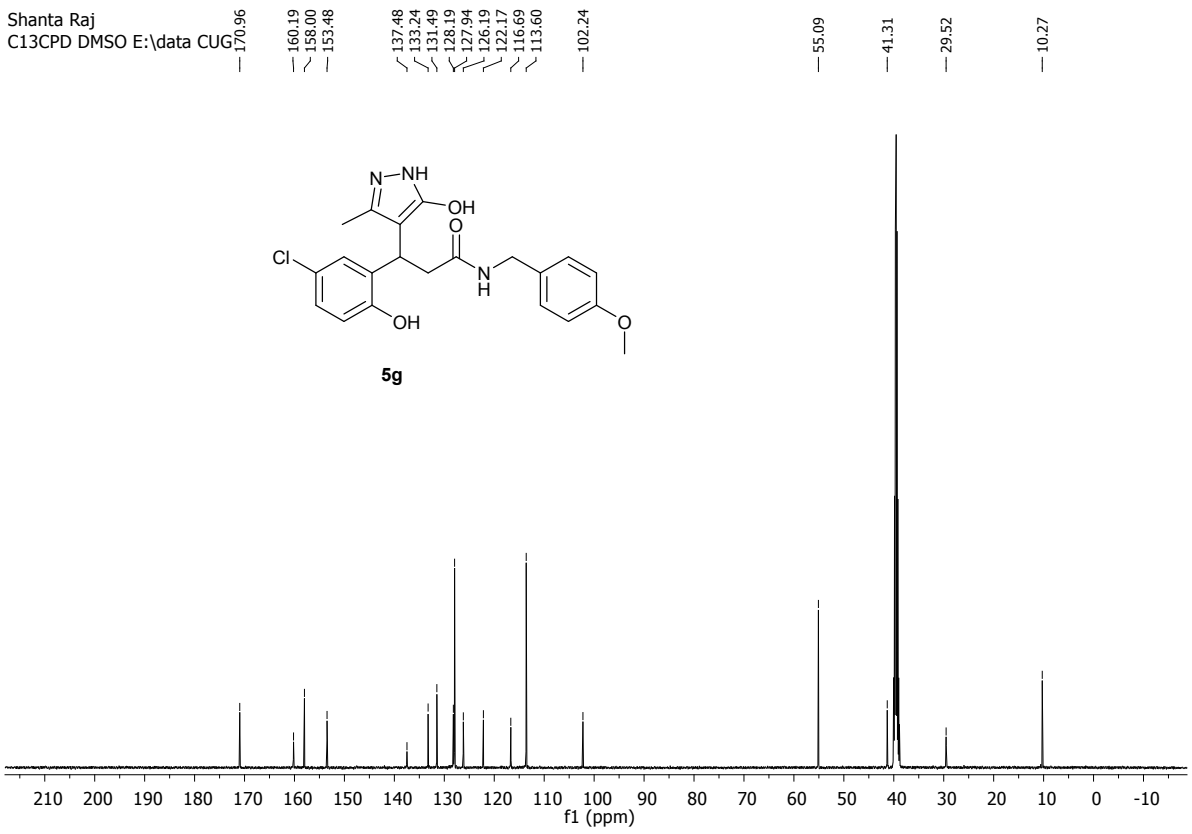
Shanta Raj
PROTON DMSO E:\data CUG



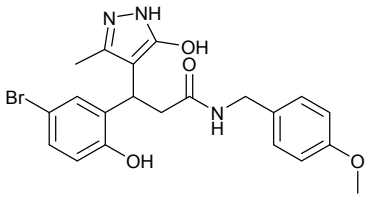
5g



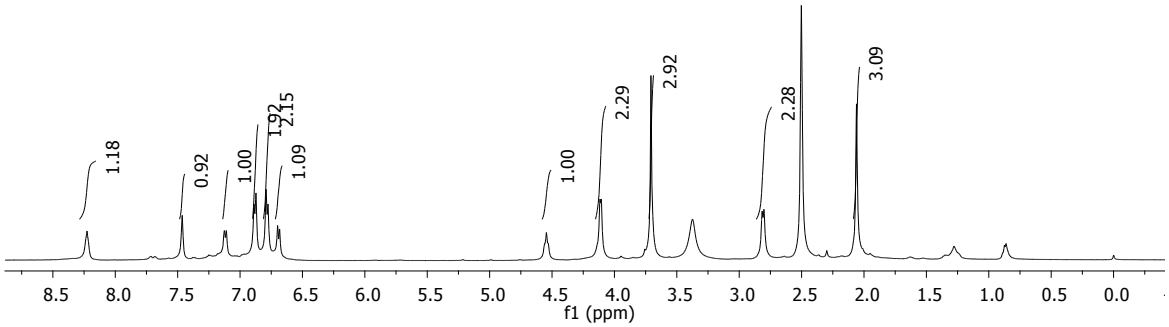
Shanta Raj
C13CPD DMSO E:\data CUG

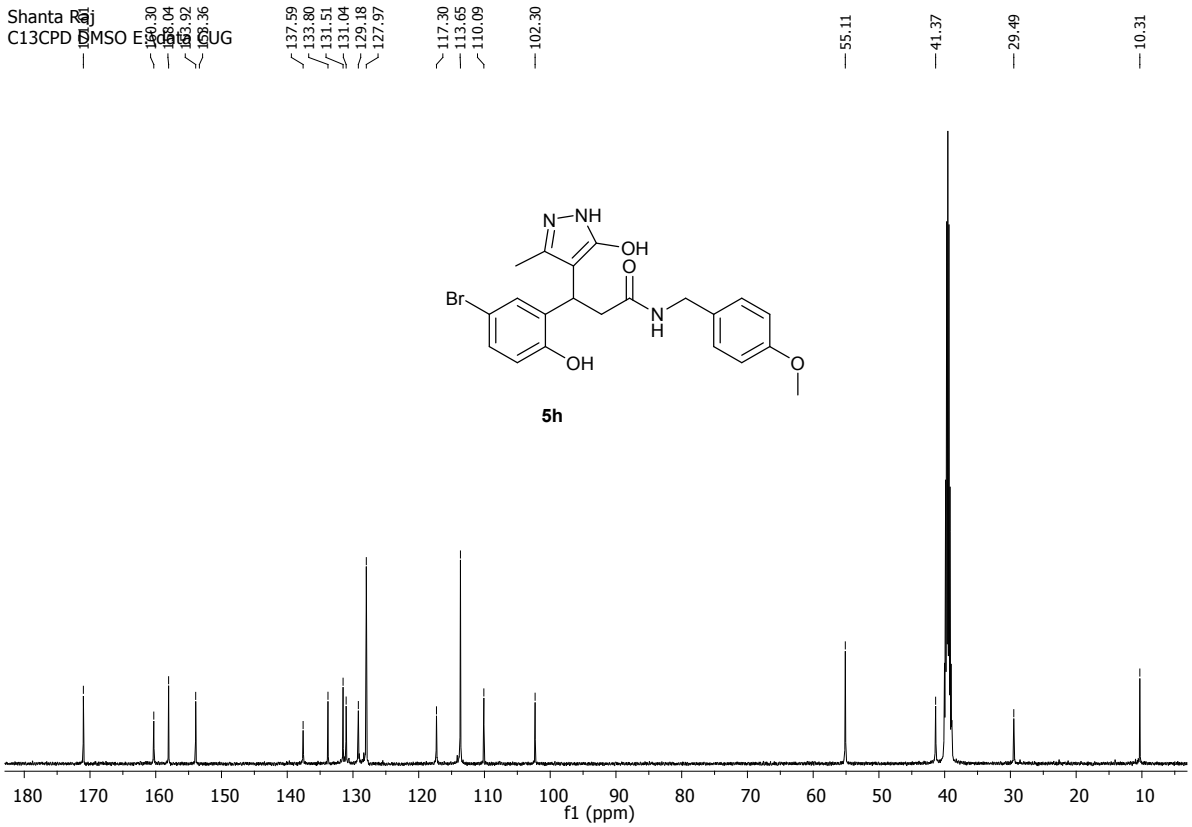


5g


N
NH
OH
O
Br
N
H
OH
O

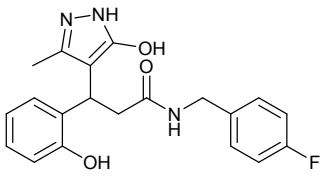
5h


1.18
0.92
1.00
1.92
2.15
1.09
1.00
2.29
2.92
2.28
3.09
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

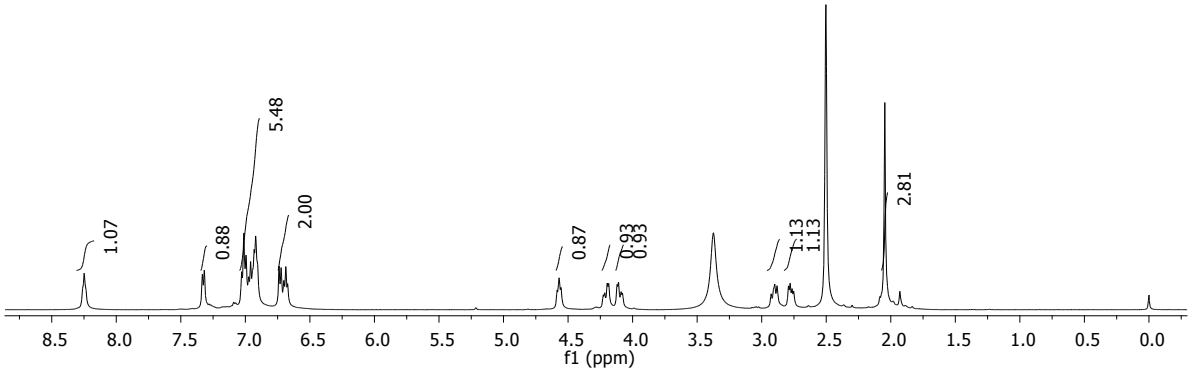

Shanta Raj
C13CPD DMSO Eqdata CUG
137.59
133.80
131.51
131.04
129.18
127.97
117.30
113.65
110.09
102.30
55.11
41.37
29.49
10.31
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

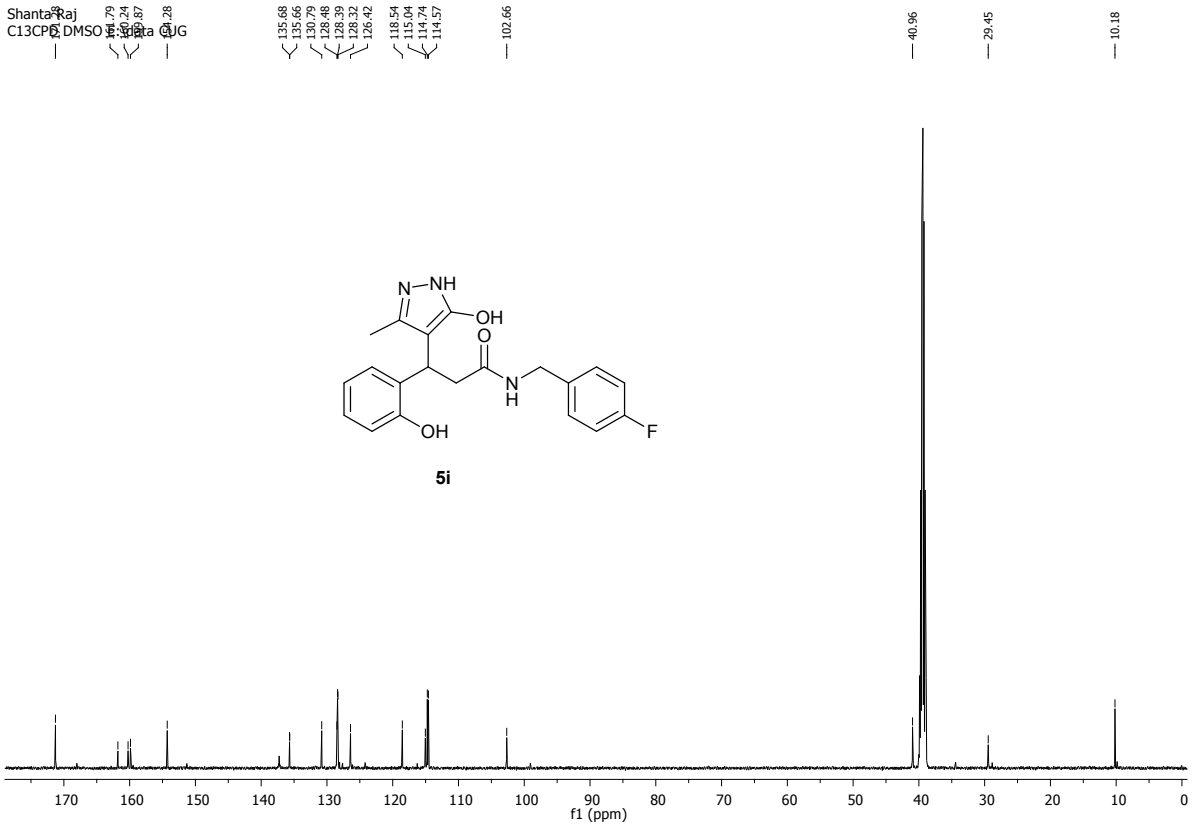
N
NH
OH
O
Br
N
H
OH
O

5h


N
NH
OH
O
N
H
OH
F

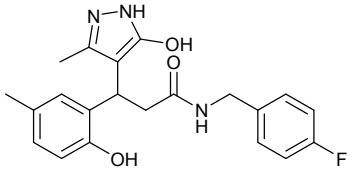
5i


1.07
0.88
5.48
2.00
0.87
0.93
0.93
1.13
1.13
2.81
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

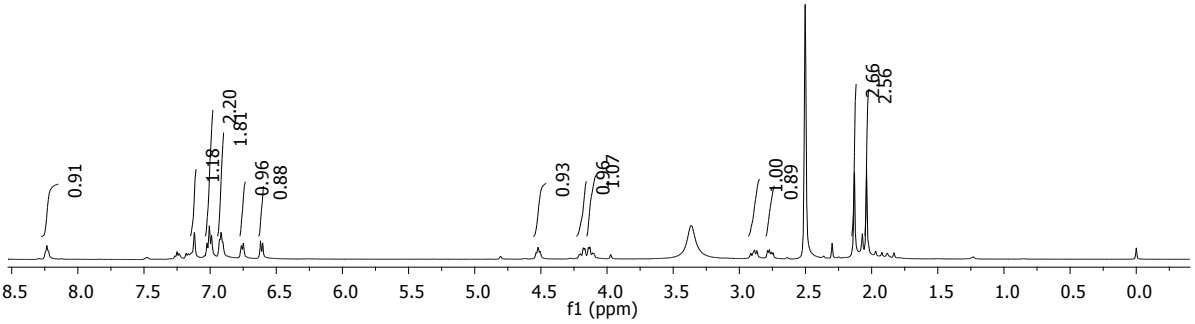

Shanta Raj
C13CPD, DMSO, Shanta CUG
135.68
135.66
130.79
128.48
128.39
128.32
126.42
118.54
115.04
114.74
114.57
102.66
40.96
29.45
10.18
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

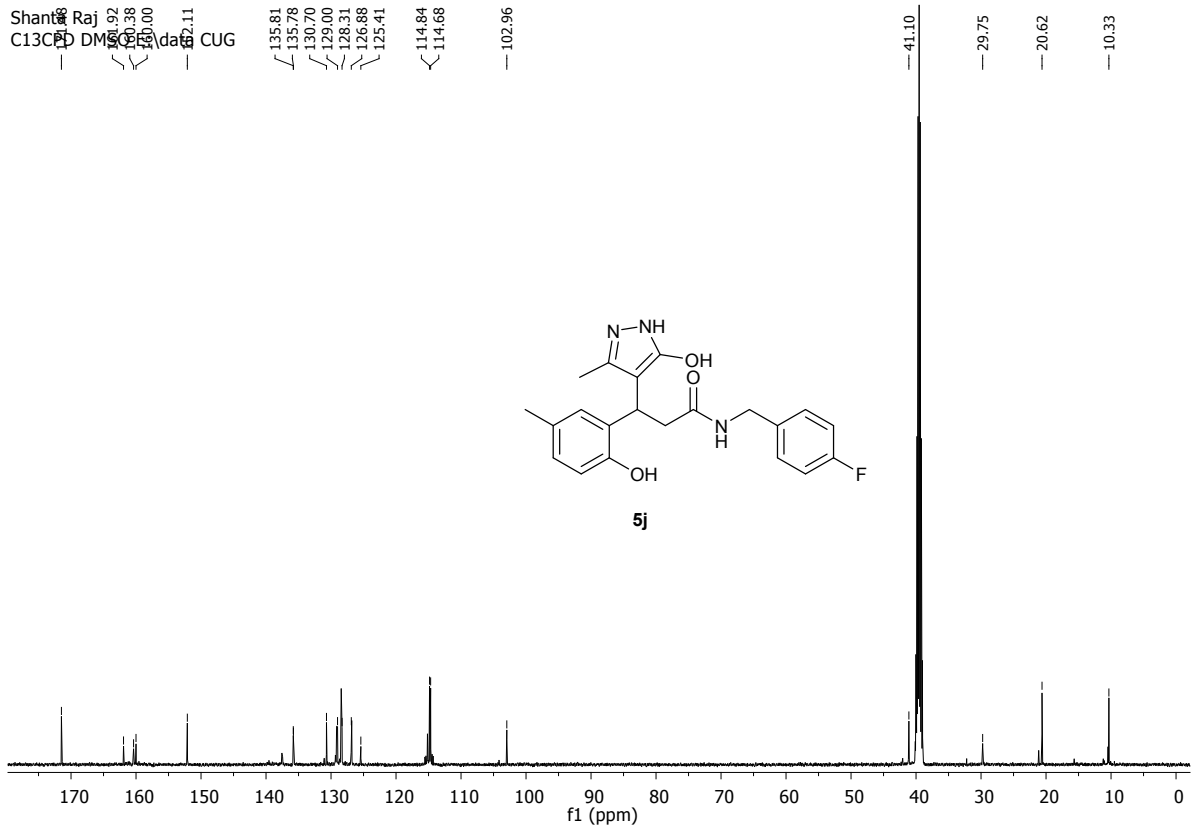
N
NH
OH
O
N
H
OH
F

5i


N
NH
OH
O
N
H
OH
F

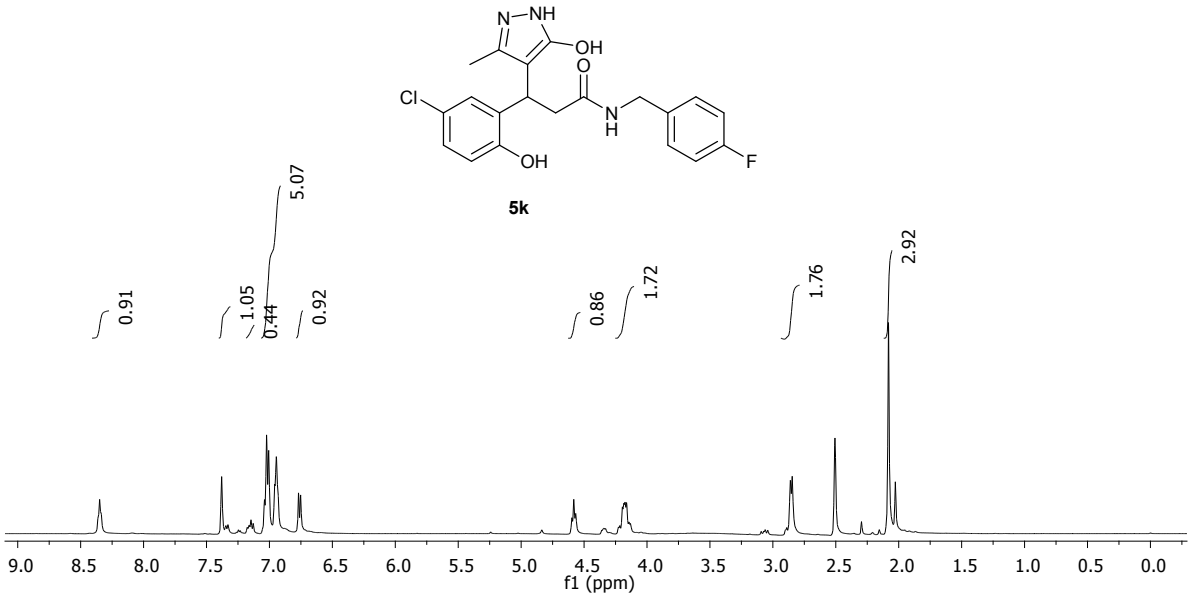
5j


0.91
1.18
2.20
1.81
0.96
0.88
0.93
0.96
1.07
1.00
0.89
2.66
2.56
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


Shanta Raj
C13CPD DMSO-D6 29\data CUG
135.81
135.78
130.70
129.00
128.31
126.88
125.41
114.84
114.68
102.96
41.10
29.75
20.62
10.33
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

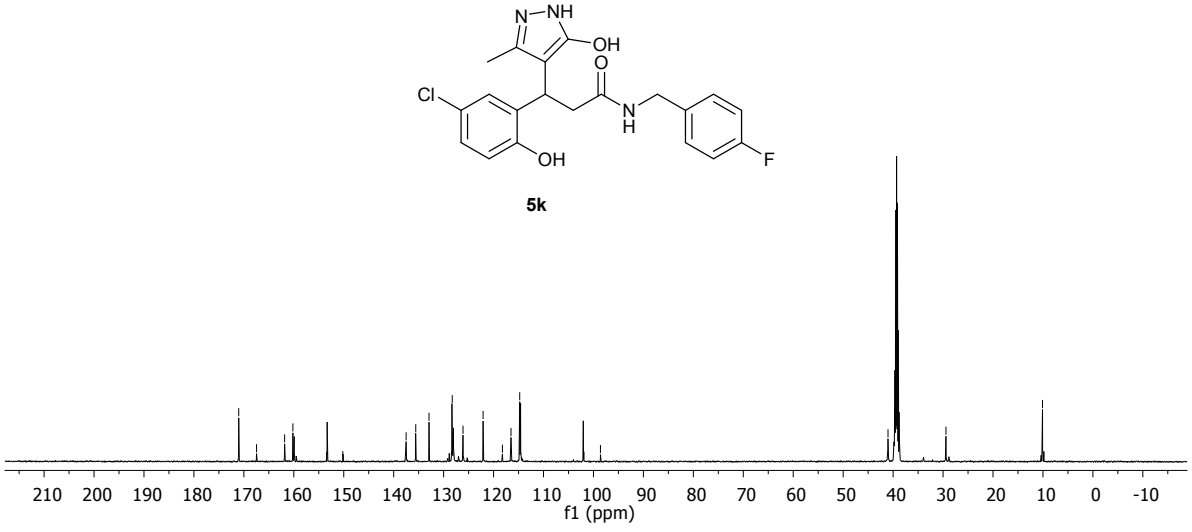
N
NH
OH
O
N
H
OH
F

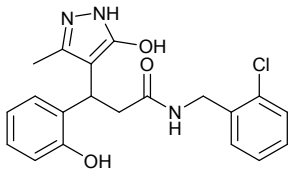
5j



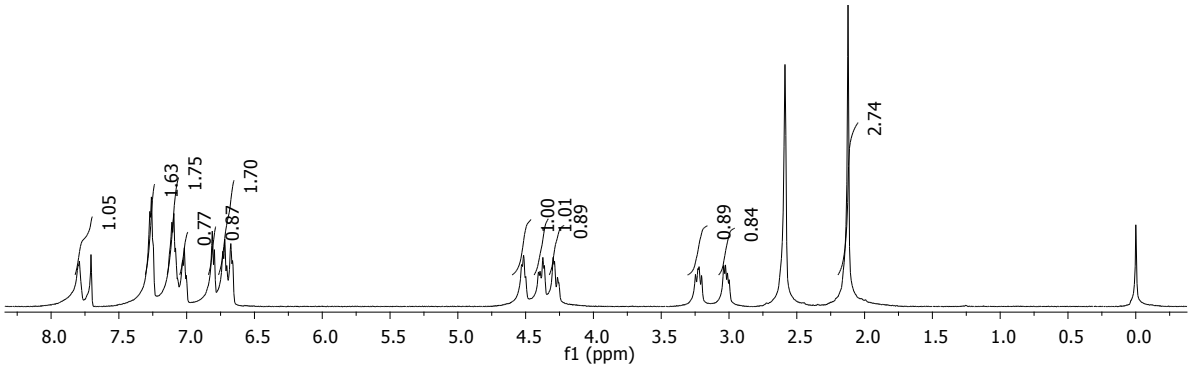
Shanta Raj
RC-SRL-208
C13CPD DMSO E:\data CUG

171.03
167.46
161.84
160.18
153.43
150.19
137.51
135.58
132.93
128.28
126.12
122.10
118.23
116.51
114.76
101.90
98.60
41.02
29.42
10.09



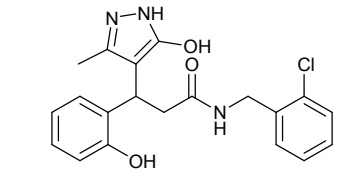


5l

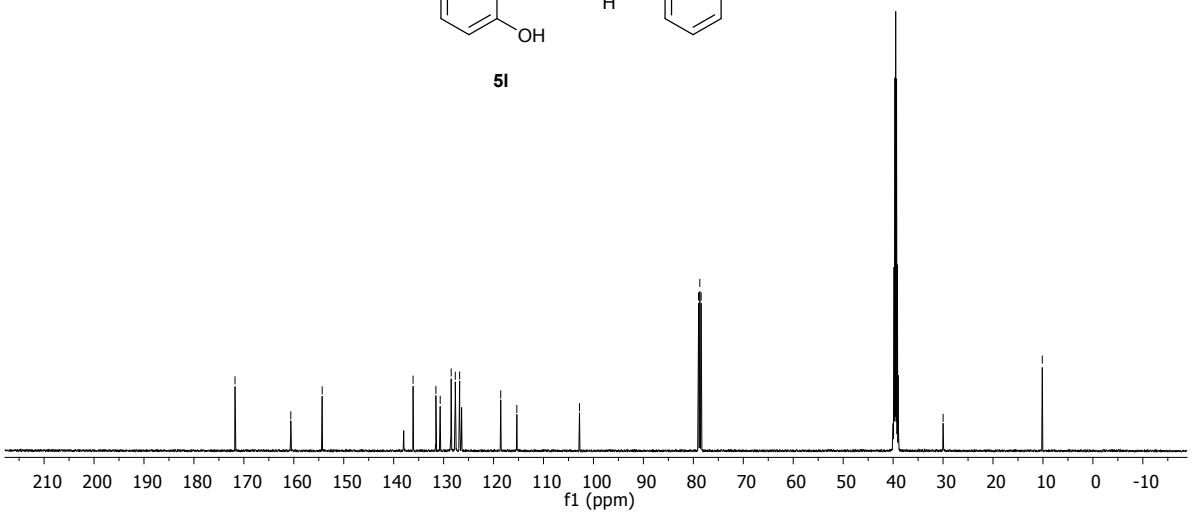


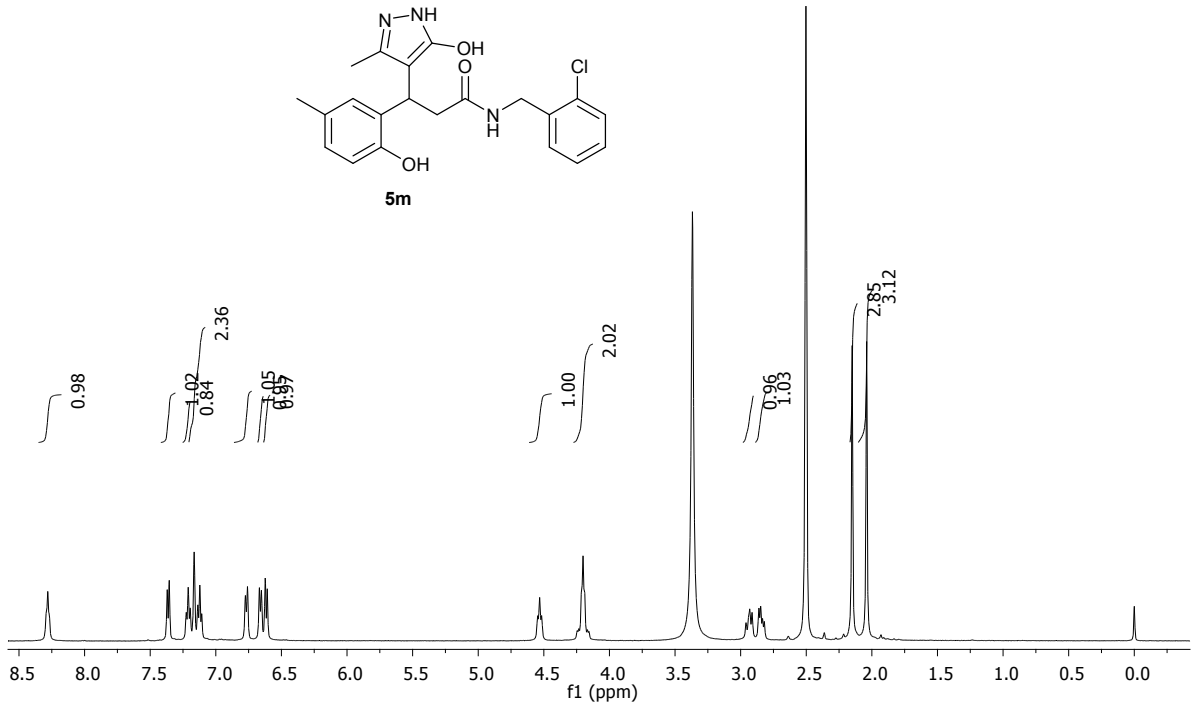
Shanta Raj
RC-SRL-181
C13CPD DMSO E:\data CUG

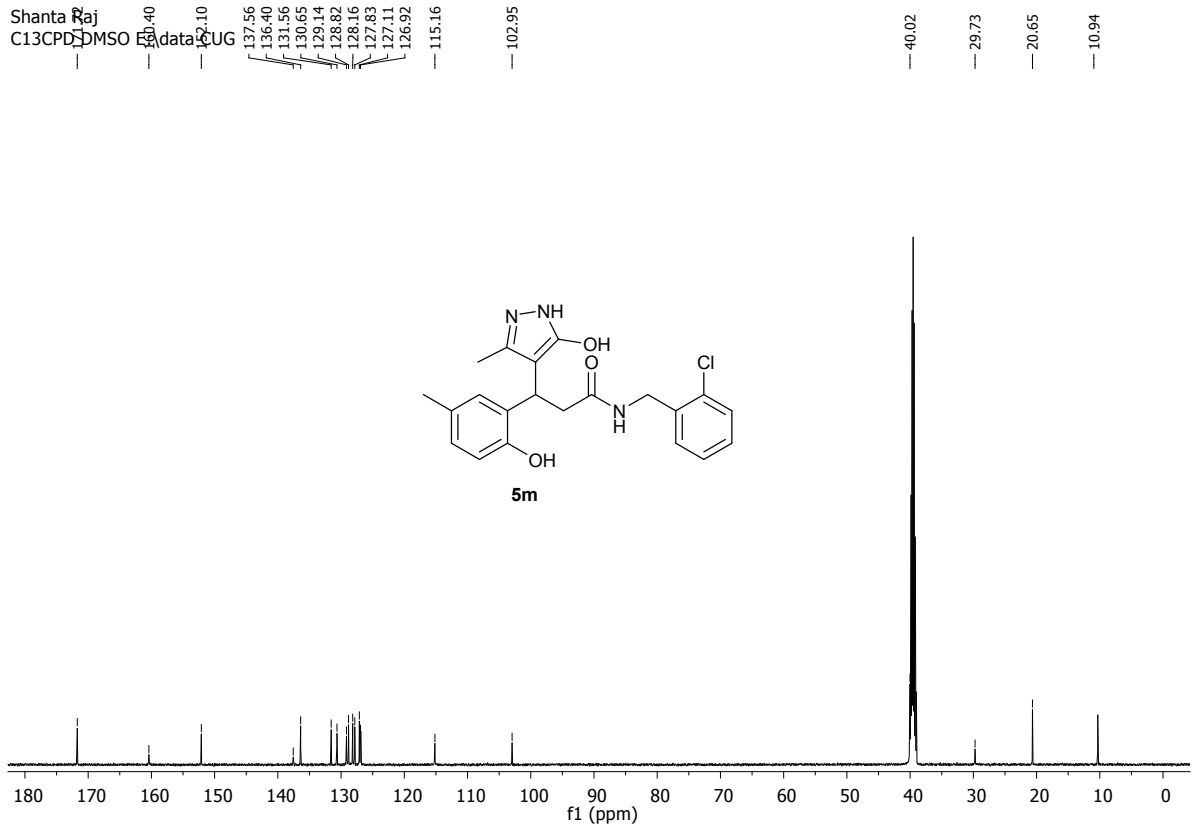
171.77
160.60
154.32
136.12
131.55
130.69
128.49
127.67
126.79
119.13
118.57
115.34
102.80
78.96
78.70
78.44
29.99
10.13

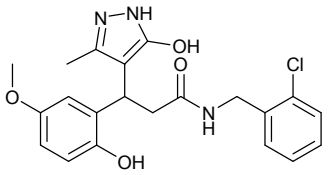


5l

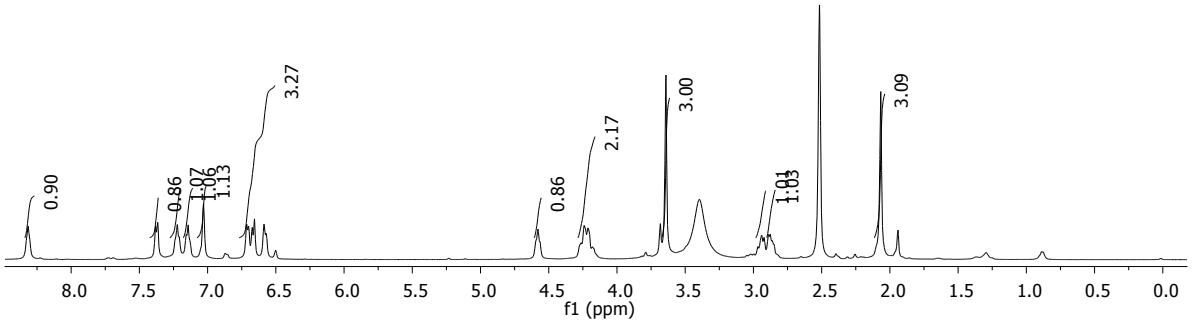


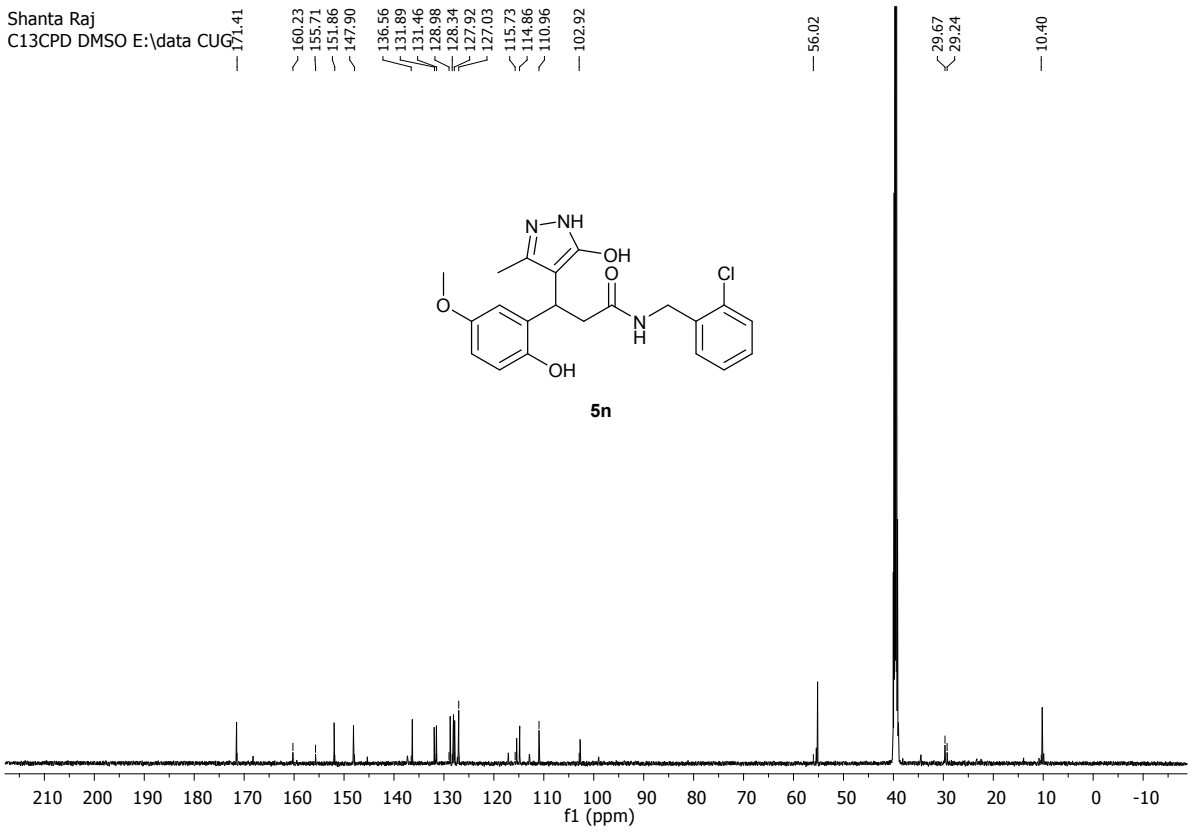

N
NH
OH
O
Cl
N
H
OH
5m
0.98
1.02
0.84
2.36
1.05
0.97
1.00
2.02
0.96
1.03
2.85
3.12
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


Shanta Raj
C13CPD_DMSO E:\data\SUG
171.72
160.40
152.10
137.56
136.40
131.56
130.65
129.14
128.82
128.16
127.83
127.11
126.92
115.16
102.95
40.02
29.73
20.65
10.94
N
NH
OH
O
Cl
N
H
OH
5m
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


N
NH
OH
O
Cl
O
N
H
OH

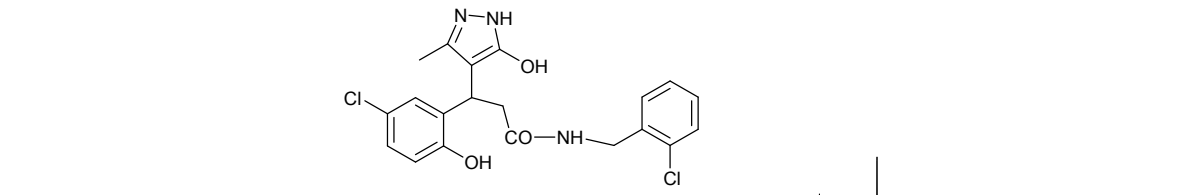
5n


0.90
0.86
1.07
1.06
1.13
3.27
0.86
2.17
3.00
1.01
1.03
3.09
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

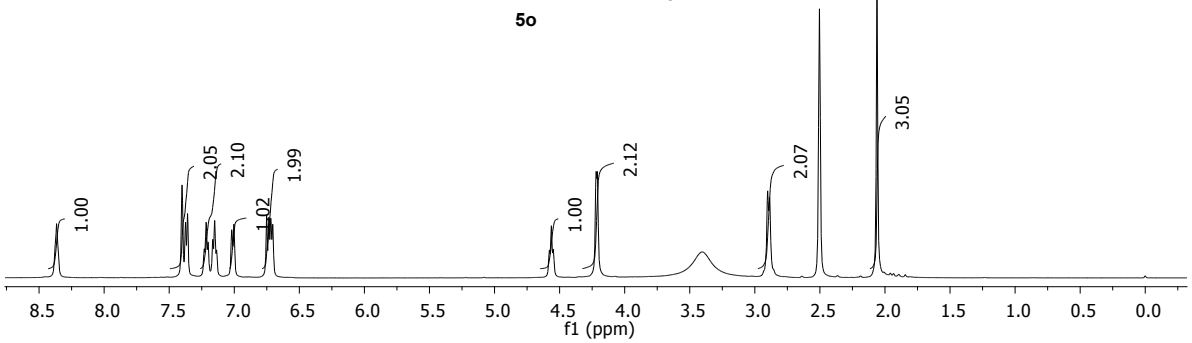

Shanta Raj
C13CPD DMSO E:\data CUG
171.41
160.23
155.71
151.86
147.90
136.56
131.89
131.46
128.98
128.34
127.92
127.03
115.73
114.86
110.96
102.92
56.02
29.67
29.24
10.40
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

N
NH
OH
O
Cl
O
N
H
OH

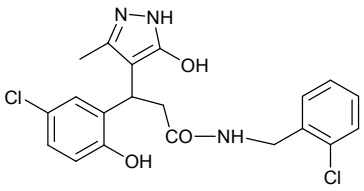
5n


N—NH
OH
Cl
CO—NH
OH
Cl

5o

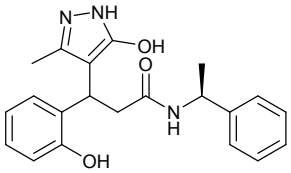

1.00
2.05
2.10
1.02
1.99
1.00
2.12
2.07
3.05
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


Shanta Raj
RC-SRL-193
C13CPD DMSO E:\data CUG
160.15
153.44
137.31
136.98
136.34
133.10
131.55
128.83
128.16
127.74
127.09
126.18
122.11
116.61
102.04
29.48
10.18

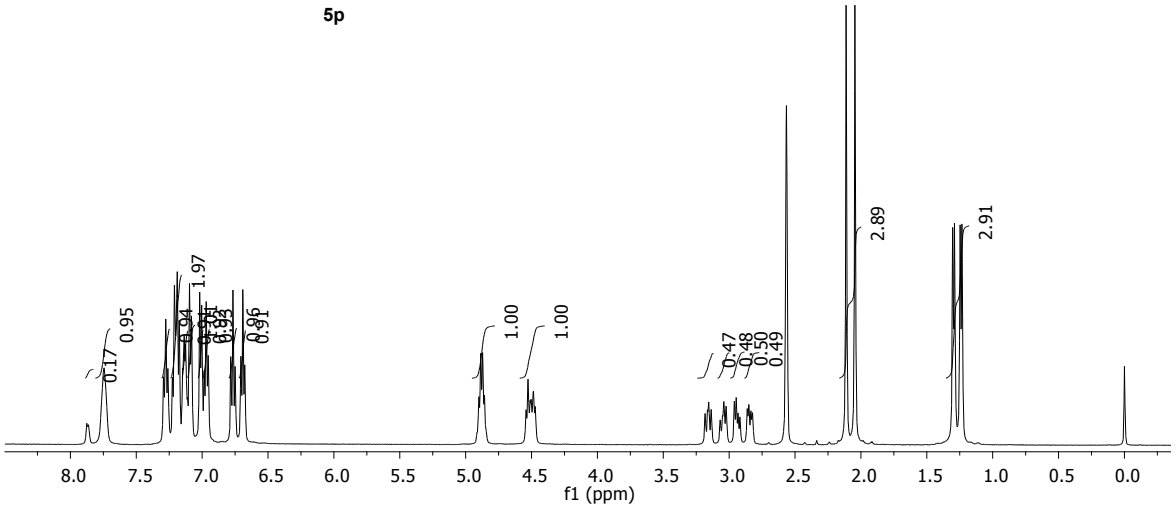

N—NH
OH
Cl
CO—NH
OH
Cl

5o

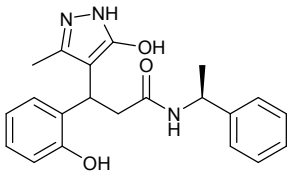
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)



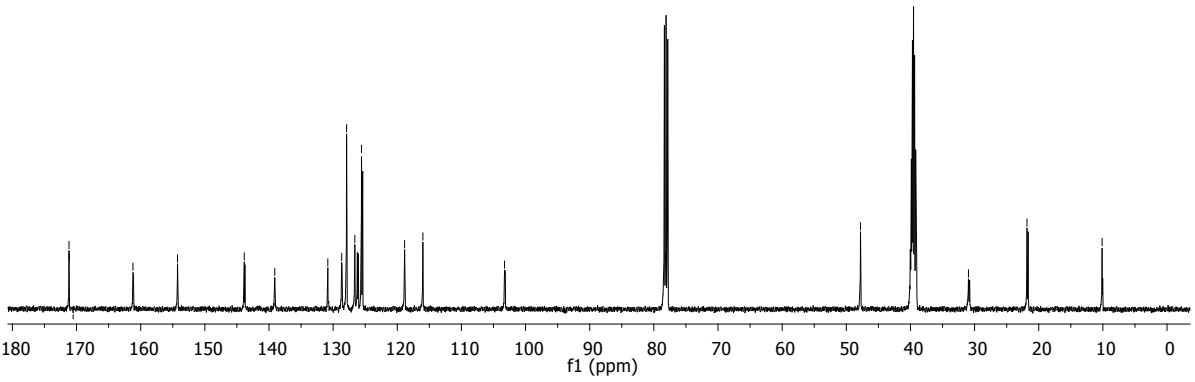
5p

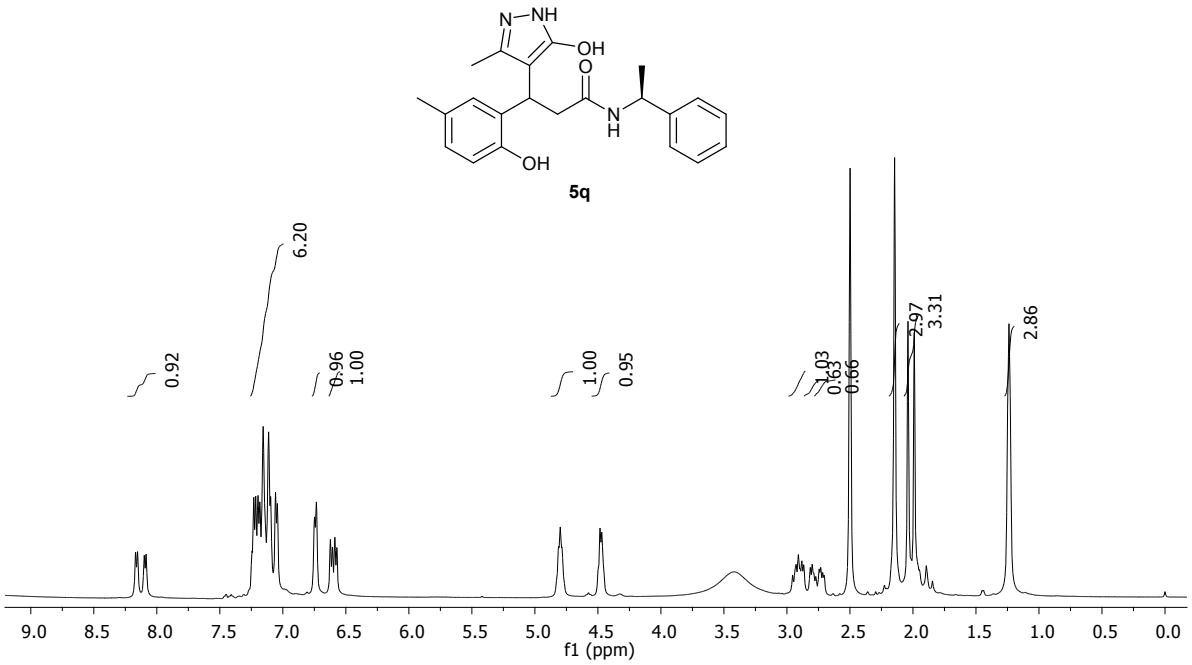

0.17
0.95
1.97
0.94
0.91
0.96
1.00
1.00
0.47
0.48
0.50
0.49
2.89
2.91
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

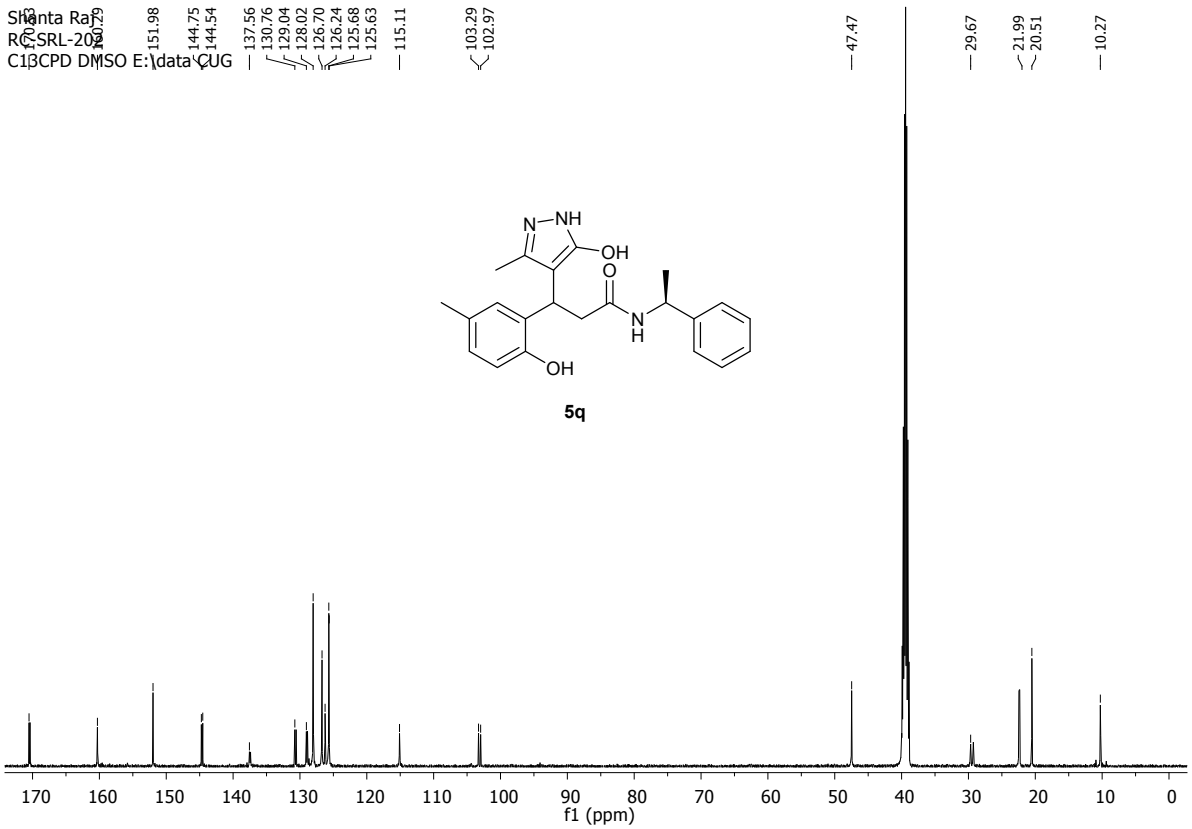

Shanta Raj
RC-SRL-1279
C13CPD DMSO E:\data CUG
161.21
154.26
143.85
139.10
130.83
128.67
127.90
126.62
125.58
118.85
116.01
103.28
47.79
30.96
21.83
10.12

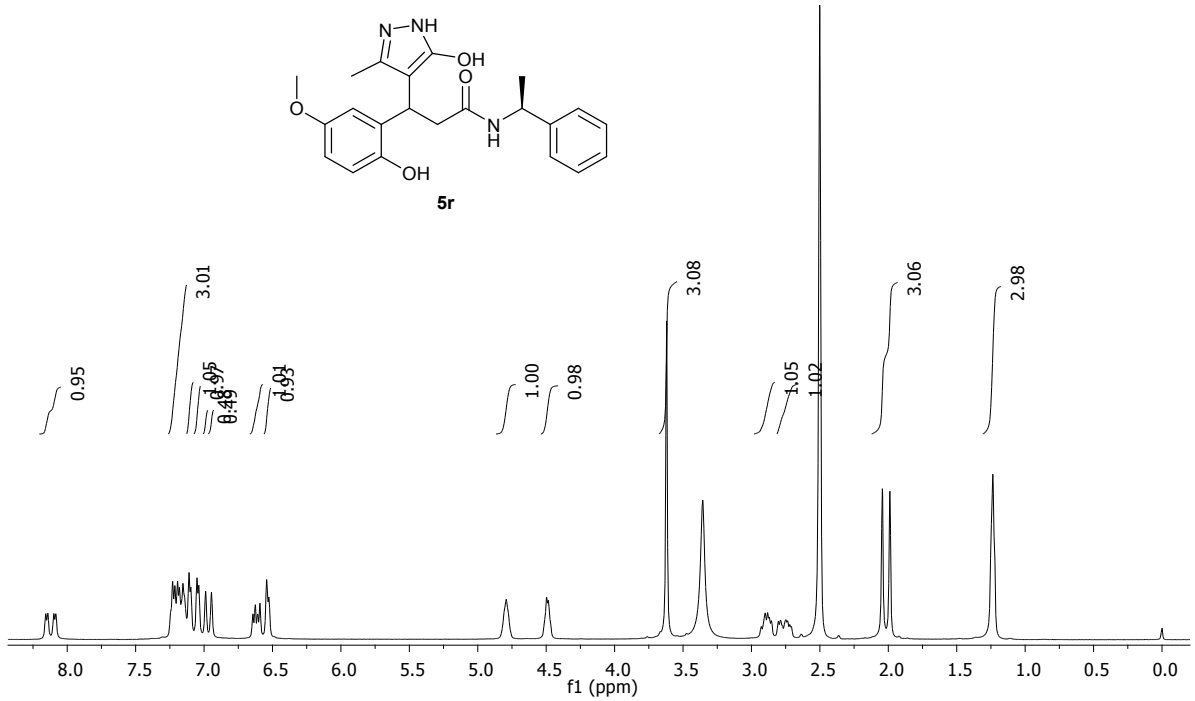


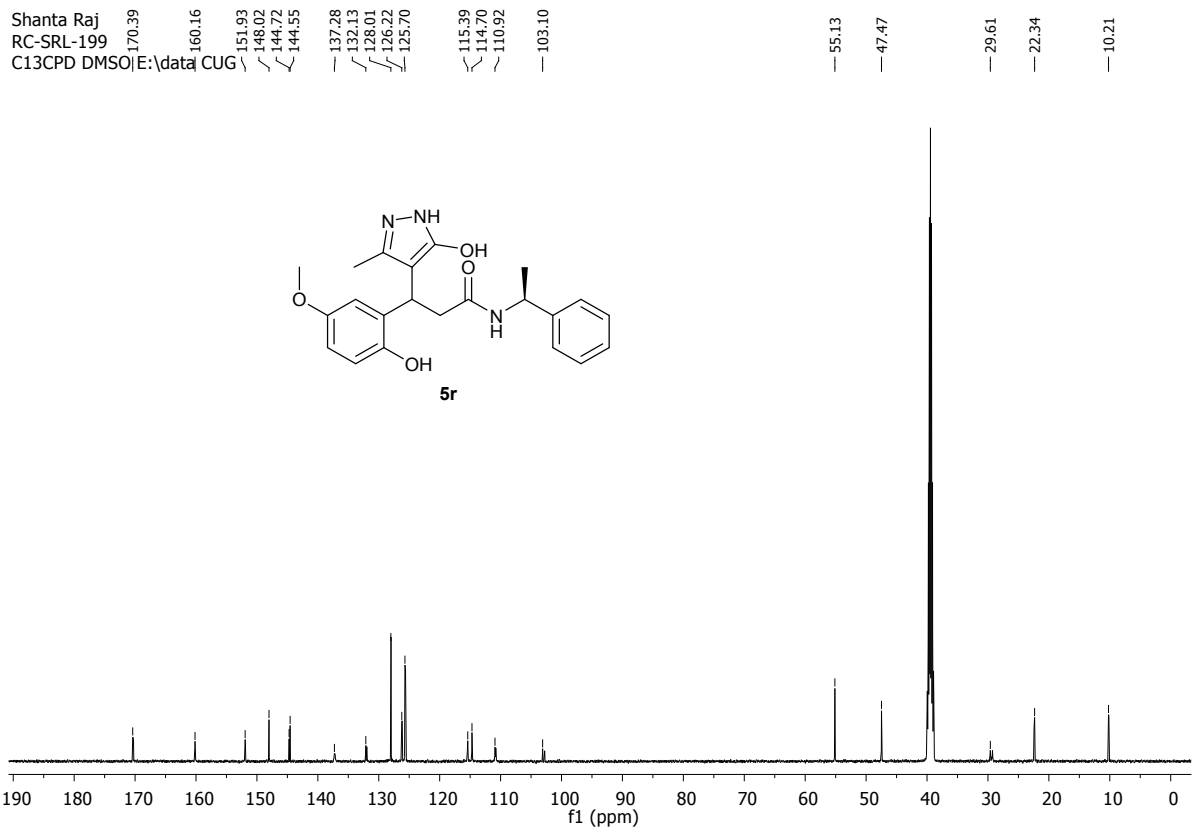
5p

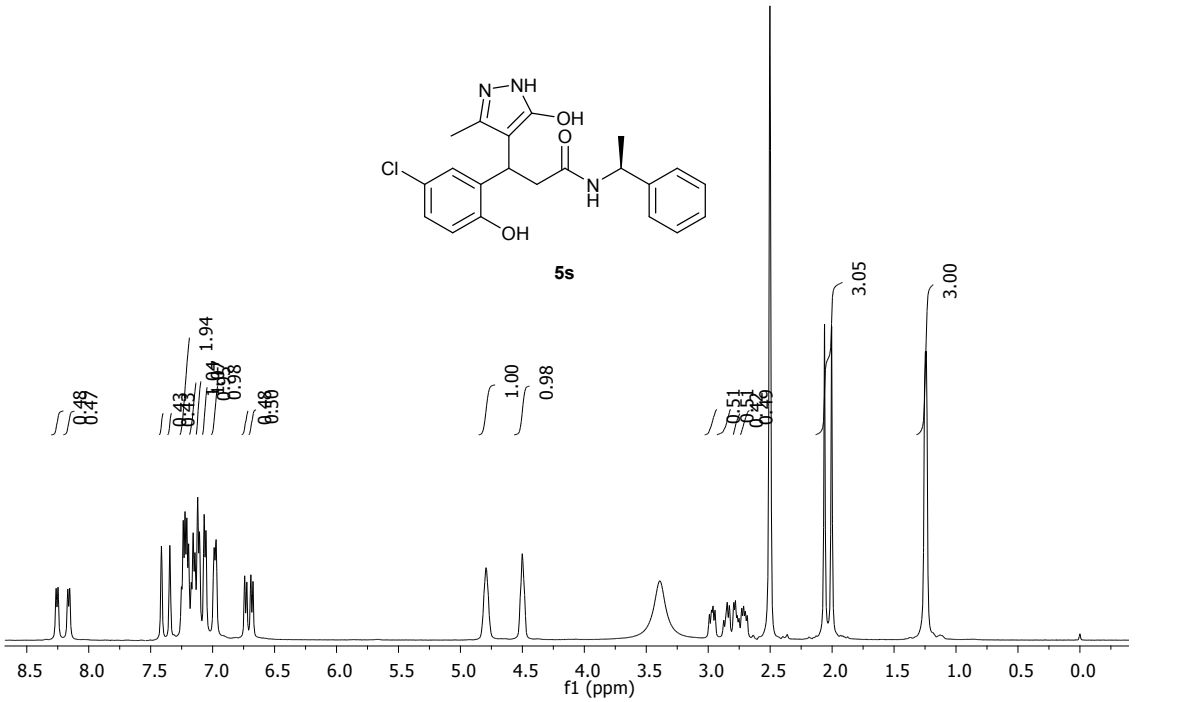

180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

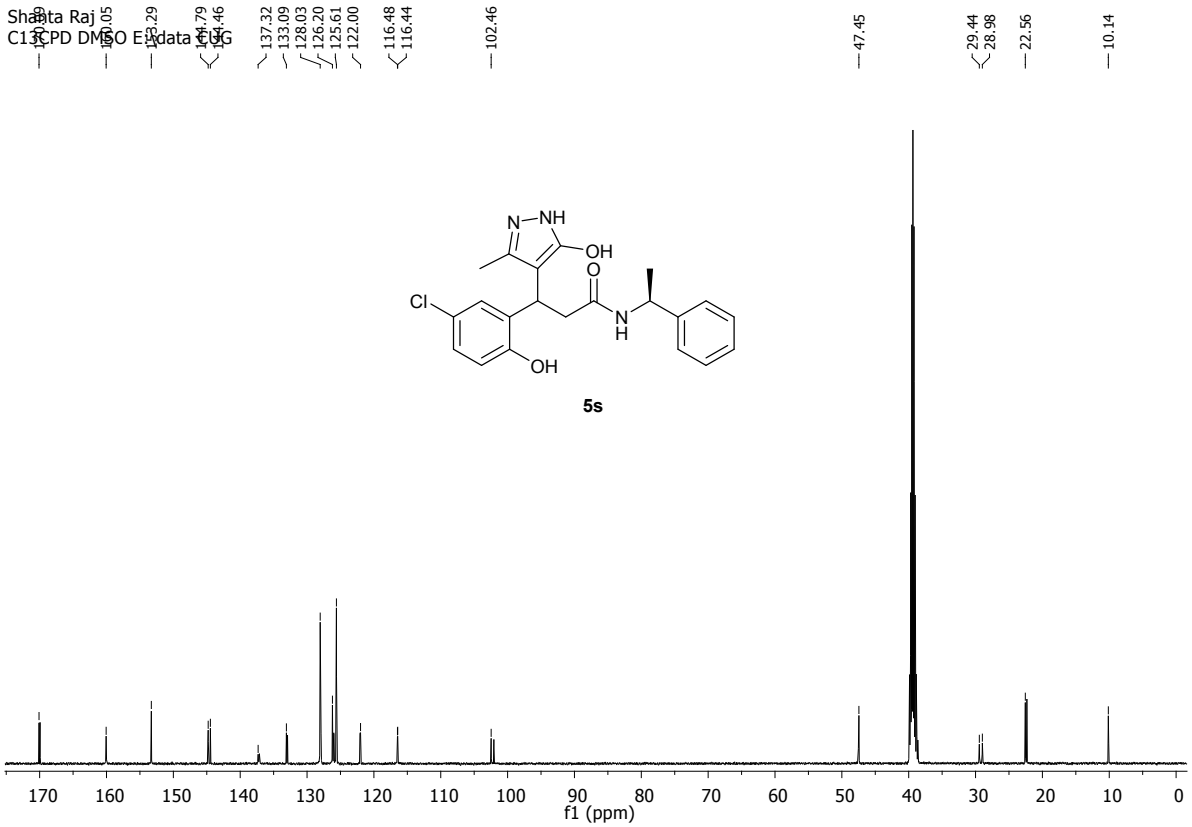

N
NH
OH
O
N
H
OH
5q
6.20
0.92
0.96
1.00
1.00
0.95
1.03
0.63
0.66
2.97
3.31
2.86
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

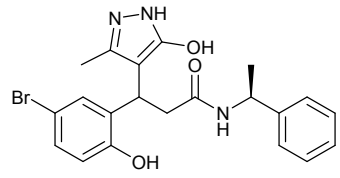

Shanta Raj
RC-SRL-203
C1βCPD DMSO E:\data\CUG
151.98
144.75
144.54
137.56
130.76
129.04
128.02
126.70
126.24
125.68
125.63
115.11
103.29
102.97
47.47
29.67
21.99
20.51
10.27
N
NH
OH
O
N
H
OH
5q
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


N
NH
OH
O
O
N
H
OH
5r
0.95
3.01
1.00
0.98
3.08
1.05
1.02
3.06
2.98
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

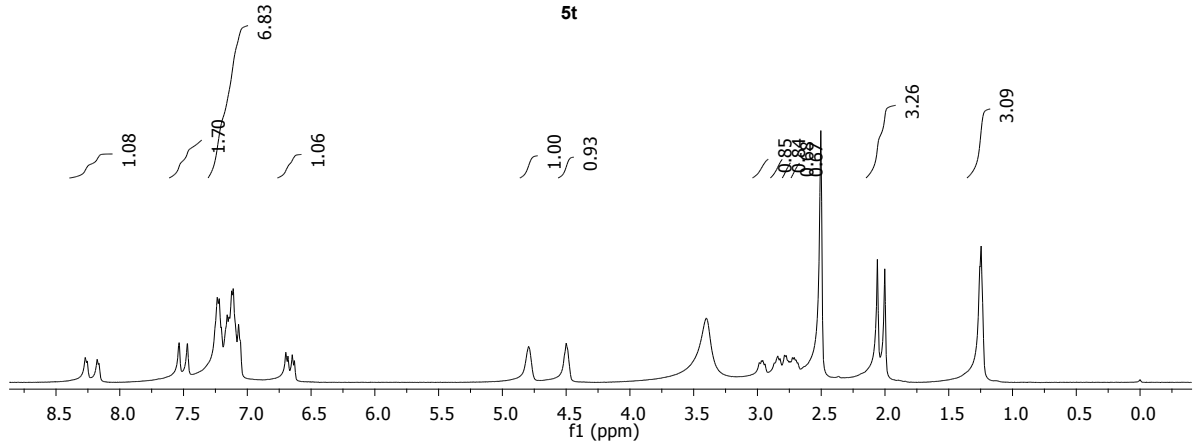

Shanta Raj
RC-SRL-199
C13CPD DMSO E:\data CUG
170.39
160.16
151.93
148.02
144.72
144.55
137.28
132.13
128.01
126.22
125.70
115.39
114.70
110.92
103.10
55.13
47.47
29.61
22.34
10.21
N
NH
OH
O
O
N
H
OH
5r
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


N
NH
OH
O
Cl
N
H
OH
5s
1.94
1.00
0.98
3.05
3.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

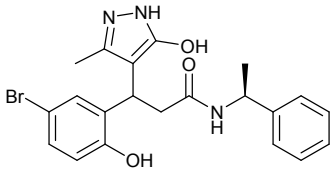

Shaata Raj
C13CPD DMSO E.data 1G
170.89
160.05
152.29
144.79
137.32
133.09
128.03
126.20
125.61
122.00
116.48
116.44
102.46
47.45
29.44
28.98
22.56
10.14
N
NH
OH
O
Cl
N
H
OH
5s
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


N
NH
OH
O
Br
N
H
OH

5t


6.83
1.08
1.70
1.06
1.00
0.93
3.26
3.09
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


Shanta Raj
C13CPD DMSO E:\data C13
40.09
144.77
140.45
137.41
137.22
133.65
130.91
129.87
128.96
128.04
126.22
125.62
109.95
102.50
47.56
29.43
22.56
10.14


N
NH
OH
O
Br
N
H
OH

5t

170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)