

A white light-emitting diode (LED) promoted one pot synthesis of 1,2-dihydropyrimido[1,2-*a*]benzimidazoles in presence of a new spiky magnetic nano catalyst and its anthelmintic studies.

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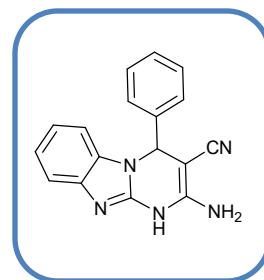
General procedure for the synthesis of 1,2-dihydropyrimido[1,2- *a*]benzimidazoles and its derivatives:

A mixture of aromatic aldehyde (1 mmol), 2-aminobenzimidazole/ 4*H*-1,2,4-triazol-3-amine (1 mmol), and active methylene compounds (malononitrile/ ethylacetoacetate/ methylacetoacetate) (1 mmol) was taken in a round bottom flask (100 mL) containing 25 mL of water and 14 mg of spiky Ni-nanoparticles was added under stirring condition at room temperature (25 °C). The reaction mixture was kept under direct irradiation of white LED light for appropriate time. After completion of the reaction (monitored by TLC), the catalyst was recovered by an external magnet and the products was filtered and recrystallized from ethanol to obtain the pure product.

Analytical data:

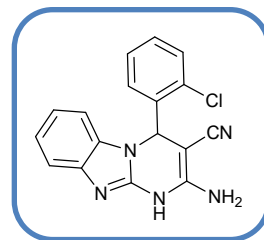
2-amino-4-phenyl-1,4-dihydrobenzo[4,5]imidazo[1,2-*a*]pyrimidine-3-carbonitrile (4a)

White solid, melting point: 234-236 °C [Lit¹. 235-236 °C]; IR (KBr): ν_{\max} 3442, 3320, 3061, 2882, 2190, 1682, 1632, 1602, 1471, 1352, 1248, 1029 cm^{-1} ; ¹H NMR (400 MHz, DMSO-*d*₆): δ 8.60 (s, 1H), 7.63 (d, *J* = 8 Hz, 1H), 7.37-7.33 (m, 3H), 7.29-7.27 (m, 2H), 7.22 (d, *J* = 7.6 Hz, 1H), 7.11 (t, *J* = 7.6 Hz, 1H), 6.99 (t, *J* = 8 Hz, *J* = 7.2 Hz, 1H), 6.84 (s, 2H), 5.21 (s, 1H) ppm. ¹³C NMR (100 MHz, DMSO-*d*₆): δ 151.74, 149.09, 143.55, 142.88, 129.23, 128.66, 127.79, 125.87, 123.28, 119.82, 119.15, 116.01, 112.38, 61.91, 53.17 ppm. Calc. MS (ESI) *m/z*: 287. Found MS (ESI) *m/z*: 287 [M]⁺.



2-amino-4-(2-chlorophenyl)-1,4-dihydrobenzo[4,5]imidazo[1,2-*a*]pyrimidine-3-carbonitrile (4b)

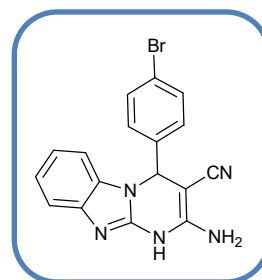
White solid, melting point: 236-238 °C [Lit¹. 235-237 °C]; IR (KBr): ν_{\max} 3420, 3314, 3122, 2180, 1670, 1633, 1601, 1470, 1364, 1250, 1039 cm^{-1} ; ¹H NMR (400 MHz, DMSO-*d*₆): δ 8.52 (s, 1H), 7.66 (d, *J* = 8 Hz, 1H), 7.49-7.43 (m, 1H), 7.36-7.34 (m, 3H), 7.24 (d, *J* = 8 Hz, 1H), 7.13 (t, *J* = 8 Hz, *J* = 7.2 Hz, 1H), 7.02 (t, *J* = 8 Hz, *J* = 7.2 Hz, 1H), 6.90 (s, 2H), 5.64



(s, 1H) ppm. ^{13}C NMR (100 MHz, $\text{DMSO}-d_6$): δ 151.69, 149.49, 143.49, 139.25, 131.34, 129.71, 129.22, 128.38, 127.87, 123.35, 119.93, 118.49, 116.05, 112.43, 60.74, 50.77 ppm. Calc. MS (ESI) m/z : 321. Found MS (ESI) m/z : 322 $[\text{M}+1]^+$.

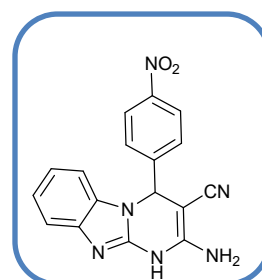
2-amino-4-(4-bromophenyl)-1,4-dihydrobenzo[4,5]imidazo[1,2-*a*]pyrimidine-3-carbonitrile (4c)

White solid, melting point: >310 °C [Lit¹. 318-320 °C]; IR (KBr): ν_{max} 3422, 3326, 3064, 2188, 1675, 1636, 1598, 1467, 1338, 1245, 1072 cm^{-1} ; ^1H NMR (400 MHz, $\text{DMSO}-d_6$): δ 8.62 (s, 1H), 7.62 (d, $J = 7.2$ Hz, 1H), 7.56 (d, $J = 8$ Hz, 2H), 7.24 (d, $J = 7.6$ Hz, 3H), 7.11 (t, $J = 7.6$ Hz, $J = 6.4$ Hz, 1H), 7.00 (t, $J = 7.6$ Hz, $J = 6.4$ Hz, 1H), 6.89 (s, 2H), 5.24 (s, 1H) ppm. ^{13}C NMR (100 MHz, $\text{DMSO}-d_6$): δ 151.55, 149.19, 143.48, 142.16, 131.57, 129.19, 128.22, 123.33, 120.93, 119.89, 119.01, 116.07, 112.43, 61.33, 52.55 ppm. Calc. MS (ESI) m/z : 365. Found MS (ESI) m/z : 366 $[\text{M}+1]^+$, 368 $[\text{M}+2]^+$.



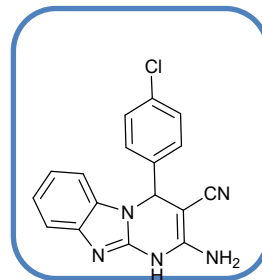
2-amino-4-(4-nitrophenyl)-1,4-dihydrobenzo[4,5]imidazo[1,2-*a*]pyrimidine-3-carbonitrile (4d)

White solid, melting point: 236-238 °C [Lit². 237 °C]; IR (KBr): ν_{max} 3463, 3325, 3227, 3014, 2196, 1686, 1637, 1601, 1516, 1474, 1351, 1256, 1013 cm^{-1} ; ^1H NMR (400 MHz, $\text{DMSO}-d_6$): δ 8.79 (s, 1H), 8.24 (d, $J = 8.4$ Hz, 2H), 7.64 (d, $J = 8$ Hz, 1H), 7.56 (d, $J = 8.4$ Hz, 2H), 7.25 (d, $J = 7.6$ Hz, 1H), 7.13 (t, $J = 7.2$ Hz, $J = 7.6$ Hz, 1H), 7.03-7.01 (m, 1H), 6.98 (s, 2H), 5.45 (s, 1H) ppm. ^{13}C NMR (100 MHz, $\text{DMSO}-d_6$): δ 151.41, 150.10, 149.41, 146.97, 143.45, 129.17, 127.18, 124.04, 123.43, 120.02, 118.92, 116.17, 112.50, 60.55, 52.44 ppm. Calc. MS (ESI) m/z : 332. Found MS (ESI) m/z : 333 $[\text{M}+1]^+$.



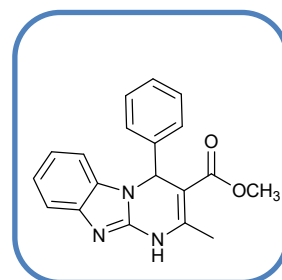
2-amino-4-(4-chlorophenyl)-1,4-dihydrobenzo[4,5]imidazo[1,2-*a*]pyrimidine-3-carbonitrile (4e)

White solid, melting point: 236-238 °C [Lit¹. 235-238 °C]; IR (KBr): ν_{\max} 3421, 3326, 3068, 2186, 1679, 1638, 1585, 1467, 1309, 1246, 1094 cm^{-1} ; ¹H NMR (400 MHz, DMSO-*d*₆): δ 8.54 (s, 1H), 7.61 (d, *J* = 8 Hz, 1H), 7.41 (d, *J* = 8.4 Hz, 2H), 7.29 (d, *J* = 8.8 Hz, 2H), 7.21 (d, *J* = 8 Hz, 1H), 7.09 (t, *J* = 7.6 Hz, *J* = 8 Hz, 1H), 6.98 (t, *J* = 8 Hz, *J* = 7.2 Hz, 1H), 6.88 (s, 2H), 5.24 (s, 1H) ppm. ¹³C NMR (100 MHz, DMSO-*d*₆): δ 151.55, 149.19, 143.49, 141.75, 138.98, 130.01, 129.19, 128.63, 127.87, 123.31, 119.86, 119.01, 116.06, 114.00, 112.40, 61.38, 52.50 ppm. Calc. MS (ESI) *m/z*: 321. Found MS (ESI) *m/z*: 322 [M+1]⁺.



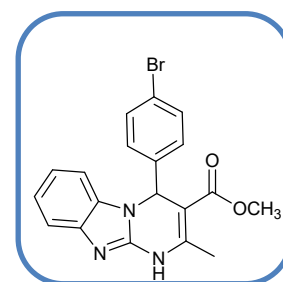
methyl 2-methyl-4-phenyl-1,4-dihydrobenzo[4,5]imidazo[1,2-*a*]pyrimidine-3-carboxylate (6a)

White solid, melting point: 262-264 °C ; IR (KBr): ν_{\max} 3379, 3206, 3064, 2952, 2856, 1633, 1604, 1580, 1459, 1353, 1250, 1097 cm^{-1} ; ¹H NMR (400 MHz, DMSO-*d*₆): δ 10.86 (s, 1H), 7.33 (d, *J* = 8.4 Hz, 3H), 7.24 (t, *J* = 6.8 Hz, *J* = 7.6 Hz, 3H), 7.15 (t, *J* = 7.2 Hz, 1H), 7.02 (t, *J* = 7.6 Hz, 1H), 6.93 (t, *J* = 7.6 Hz, *J* = 7.2 Hz, 1H), 6.42 (s, 1H), 3.55 (s, 3H), 2.44 (s, 3H) ppm. ¹³C NMR (100 MHz, DMSO-*d*₆): δ 165.62, 146.63, 145.58, 142.23, 141.93, 131.43, 128.39, 127.71, 126.85, 121.70, 120.14, 116.73, 109.76, 97.79, 59.29, 55.74, 50.74, 18.62, 13.98 ppm. Calc. MS (ESI) *m/z*: 319. Found MS (ESI) *m/z*: 320 [M+1]⁺.



methyl 4-(4-bromophenyl)-2-methyl-1,4-dihydrobenzo[4,5]imidazo[1,2-*a*]pyrimidine-3-carboxylate (6b)

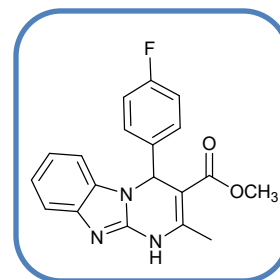
White solid, melting point: 262-264 °C [Lit³. 263-264 °C]; IR (KBr): ν_{\max} 3310, 3228, 3096, 2957, 2842, 1669, 1654, 1619, 1574, 1438, 1339, 1267, 1075 cm^{-1} ; ¹H NMR (400 MHz, DMSO-*d*₆): δ 10.90 (s, 1H), 7.44 (d, *J* = 8 Hz, 2H), 7.34-7.28 (m, 3H), 7.24 (d, *J* = 8 Hz, 1H), 7.03 (t, *J* = 8 Hz, *J* = 7.2 Hz, 1H), 6.94 (t, *J* = 7.2 Hz, *J* = 7.6 Hz, 1H), 6.43 (s, 1H), 3.55 (s,



3H), 2.43 (s, 3H) ppm. ^{13}C NMR (100 MHz, $\text{DMSO-}d_6$): δ 164.88, 146.32, 144.75, 141.57, 140.68, 130.73, 128.51, 121.22, 120.26, 119.65, 116.20, 109.14, 96.66, 54.53, 50.18, 18.06 ppm. Calc. MS (ESI) m/z : 397. Found MS (ESI) m/z : 397 $[\text{M}]^+$, 399 $[\text{M}+2]^+$.

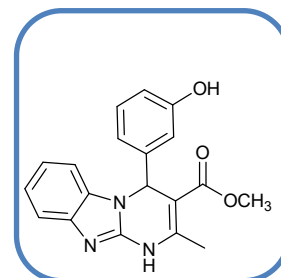
methyl **4-(4-fluorophenyl)-2-methyl-1,4-dihydrobenzo[4,5]imidazo[1,2-*a*]pyrimidine-3-carboxylate (6c)**

White solid, melting point: 172-174 °C ; IR (KBr): ν_{max} 3381, 3234, 3039, 2948, 2863, 1700, 1655, 1617, 1571, 1458, 1384, 1236, 1095 cm^{-1} ; ^1H NMR (400 MHz, $\text{DMSO-}d_6$): δ 10.88 (s, 1H), 7.39-7.36 (m, 2H), 7.33 (d, $J = 7.6$ Hz, 1H), 7.26 (d, $J = 8$ Hz, 1H), 7.09-7.00 (m, 3H), 6.94 (t, $J = 7.6$ Hz, 1H), 6.45 (s, 1H), 3.55 (s, 3H), 2.43 (s, 3H) ppm. ^{13}C NMR (100 MHz, $\text{DMSO-}d_6$): δ 165.58, 162.57, 160.14, 146.75, 145.41, 142.14, 138.23, 131.31, 128.90, 121.82, 120.25, 116.77, 115.09, 109.76, 97.65, 59.35, 54.99, 18.62, 13.97 ppm. Calc. MS (ESI) m/z : 337. Found MS (ESI) m/z : 338 $[\text{M}+1]^+$.



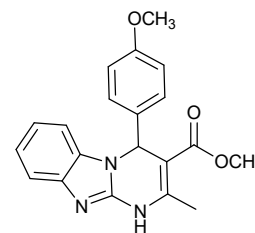
methyl **4-(3-hydroxyphenyl)-2-methyl-1,4-dihydrobenzo[4,5]imidazo[1,2-*a*]pyrimidine-3-carboxylate (6d)**

White solid, melting point: 260-262 °C ; IR (KBr): ν_{max} 3331, 3154, 3039, 2948, 2841, 1666, 1646, 1619, 1571, 1457, 1343, 1263, 1093 cm^{-1} ; ^1H NMR (400 MHz, $\text{DMSO-}d_6$): δ 10.79 (s, 1H), 9.36 (s, 1H), 7.33 (d, $J = 8$ Hz, 1H), 7.22 (d, $J = 8$ Hz, 1H), 7.02 (t, $J = 8$ Hz, $J = 7.6$ Hz, 2H), 6.94 (t, $J = 7.6$ Hz, $J = 7.2$ Hz, 1H), 6.77 (d, $J = 7.6$ Hz, 1H), 6.64 (s, 1H), 6.54 (d, $J = 8$ Hz, 1H), 6.33 (s, 1H), 3.57 (s, 3H), 2.42 (s, 3H) ppm. ^{13}C NMR (100 MHz, $\text{DMSO-}d_6$): δ 166.15, 157.83, 146.87, 146.14, 143.70, 142.71, 131.97, 129.73, 122.18, 120.61, 118.16, 117.19, 115.27, 113.87, 110.28, 98.33, 56.07, 51.25, 19.10 ppm. Calc. MS (ESI) m/z : 335. Found MS (ESI) m/z : 336 $[\text{M}+1]^+$.



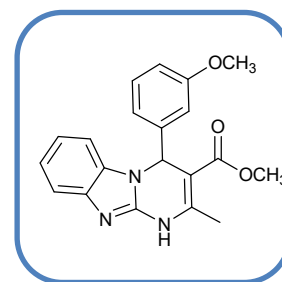
methyl **4-(4-methoxyphenyl)-2-methyl-1,4-dihydrobenzo[4,5]imidazo[1,2-*a*]pyrimidine-3-carboxylate (6e)**

White solid, melting point: 240-242 °C ; IR (KBr): ν_{\max} 3307, 3031, 2951, 2834, 1698, 1654, 1611, 1570, 1456, 1383, 1257, 1089 cm^{-1} ; ^1H NMR (400 MHz, $\text{DMSO-}d_6$): δ 10.79 (s, 1H), 7.32 (d, $J = 7.6$ Hz, 1H), 7.24 (d, $J = 8.8$ Hz, 3H), 7.02 (t, $J = 7.6$ Hz, $J = 8$ Hz, 1H), 6.93 (t, $J = 6.8$ Hz, $J = 7.2$ Hz, 1H), 6.78 (d, $J = 8.8$ Hz, 2H), 6.37 (s, 1H), 3.64 (s, 3H), 3.34 (s, 3H), 2.43 (s, 3H) ppm. ^{13}C NMR (100 MHz, $\text{DMSO-}d_6$): δ 165.67, 158.57, 146.27, 145.59, 142.25, 134.05, 131.44, 128.07, 121.63, 120.06, 116.67, 113.67, 109.82, 98.03, 55.15, 54.88, 50.74, 18.59 ppm. Calc. MS (ESI) m/z : 349. Found MS (ESI) m/z : 350 $[\text{M}+1]^+$.



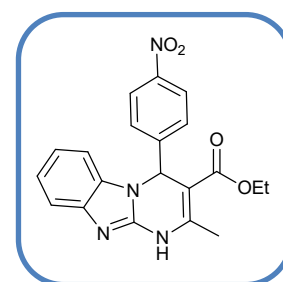
methyl 4-(3-methoxyphenyl)-2-methyl-1,4-dihydrobenzo[4,5]imidazo[1,2-a]pyrimidine-3-carboxylate (6f)

White solid, melting point: 212-214 °C ; IR (KBr): ν_{\max} 3233, 3023, 2924, 2833, 1694, 1657, 1619, 1572, 1488, 1379, 1256, 1086 cm^{-1} ; ^1H NMR (400 MHz, $\text{DMSO-}d_6$): δ 10.82 (s, 1H), 7.34-7.27 (m, 2H), 7.15 (t, $J = 8$ Hz, 1H), 7.03 (t, $J = 8$ Hz, $J = 7.2$ Hz, 1H), 6.94 (t, $J = 8$ Hz, $J = 7.2$ Hz, 1H), 6.89 (s, 1H), 6.83 (d, $J = 8$ Hz, 1H), 6.74 (d, $J = 8$ Hz, 1H), 6.39 (s, 1H), 3.66 (s, 3H), 3.57 (s, 3H), 2.43 (s, 3H) ppm. ^{13}C NMR (100 MHz, $\text{DMSO-}d_6$): δ 166.13, 159.51, 147.18, 146.12, 143.95, 142.72, 131.96, 130.11, 122.24, 120.69, 119.29, 117.24, 113.75, 112.89, 110.37, 98.20, 56.04, 55.41, 51.27, 19.11 ppm. Calc. MS (ESI) m/z : 349. Found MS (ESI) m/z : 350 $[\text{M}+1]^+$.



ethyl 2-methyl-4-(4-nitrophenyl)-1,4-dihydrobenzo[4,5]imidazo[1,2-a]pyrimidine-3-carboxylate (6g)

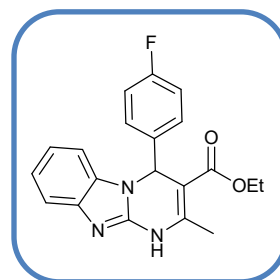
White solid, melting point: 300-302 °C [Lit⁴. 302-303 °C]; IR (KBr): ν_{\max} 3310, 3235, 3039, 2928, 2856, 1697, 1656, 1618, 1571, 1458, 1351, 1254, 1093 cm^{-1} ; ^1H NMR (400 MHz, $\text{DMSO-}d_6$): δ 10.96 (s, 1H), 8.12 (d, $J = 8.8$ Hz, 2H), 7.64 (d, $J = 8.8$ Hz, 2H), 7.35 (d, $J = 8$ Hz, 1H), 7.26 (d, $J = 7.6$ Hz, 1H), 7.04 (t, $J = 8$ Hz, $J = 7.2$ Hz, 1H), 6.94 (t, $J = 6.8$ Hz, $J = 7.6$ Hz, 1H), 6.59 (s, 1H), 4.03-3.97 (m, 2H), 2.46 (s, 3H), 1.14 (t, $J = 6.8$ Hz,



$J = 7.2$ Hz, 3H) ppm. ^{13}C NMR (100 MHz, $\text{DMSO-}d_6$): δ 165.36, 149.46, 147.94, 147.36, 145.68, 142.68, 131.78, 128.97, 124.15, 122.48, 120.88, 117.42, 110.22, 97.23, 59.99, 55.67, 19.20, 14.49 ppm. Calc. MS (ESI) m/z : 378. Found MS (ESI) m/z : 379 $[\text{M}+1]^+$.

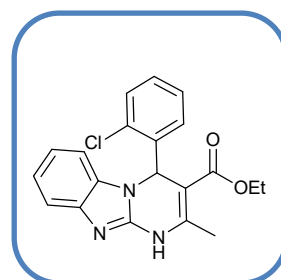
ethyl 4-(4-fluorophenyl)-2-methyl-1,4-dihydrobenzo[4,5]imidazo[1,2-*a*]pyrimidine-3-carboxylate (6h)

White solid, melting point: >310 °C [Lit³. >300 °C]; IR (KBr): ν_{max} 3370, 3236, 3039, 2982, 2868, 1696, 1657, 1615, 1515, 1458, 1329, 1253, 1096 cm^{-1} ; ^1H NMR (400 MHz, $\text{DMSO-}d_6$): δ 10.83 (s, 1H), 7.41-7.37 (m, 2H), 7.33 (d, $J = 8$ Hz, 1H), 7.26 (d, $J = 8$ Hz, 1H), 7.09-7.00 (m, 3H), 6.94 (t, $J = 7.6$ Hz, 1H), 6.44 (s, 1H), 4.02-3.97 (m, 2H), 2.44 (s, 3H), 1.12 (t, $J = 7.2$ Hz, $J = 6.8$ Hz, 3H) ppm. ^{13}C NMR (100 MHz, $\text{DMSO-}d_6$): δ 165.05, 162.56, 160.14, 146.60, 145.38, 142.19, 138.27, 131.37, 129.17, 121.77, 120.17, 116.76, 115.21, 114.99, 109.81, 97.68, 59.33, 55.09, 18.57, 13.99 ppm. Calc. MS (ESI) m/z : 351. Found MS (ESI) m/z : 352 $[\text{M}+1]^+$.



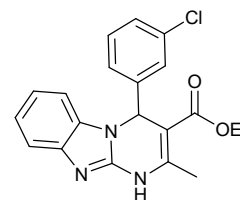
ethyl 4-(2-chlorophenyl)-2-methyl-1,4-dihydrobenzo[4,5]imidazo[1,2-*a*]pyrimidine-3-carboxylate (6i)

White solid, melting point: >310 °C [Lit³. >300 °C]; IR (KBr): ν_{max} 3383, 3241, 3107, 2927, 2851, 1700, 1663, 1619, 1594, 1577, 1459, 1385, 1256, 1086 cm^{-1} ; ^1H NMR (400 MHz, $\text{DMSO-}d_6$): δ 10.93 (s, 1H), 7.43 (d, $J = 7.2$ Hz, 1H), 7.38-7.32 (m, 2H), 7.28-7.16 (m, 3H), 7.03 (t, $J = 7.6$ Hz, 1H), 6.93 (t, $J = 7.6$ Hz, 1H), 6.73 (s, 1H), 3.97 (q, $J = 4$ Hz, 2H), 2.45 (s, 3H), 1.06 (t, $J = 6.8$ Hz, $J = 7.2$ Hz, 3H) ppm. ^{13}C NMR (100 MHz, $\text{DMSO-}d_6$): δ 164.92, 147.25, 145.17, 142.05, 138.75, 131.63, 131.58, 130.41, 129.58, 129.44, 127.34, 121.86, 120.27, 116.86, 109.14, 96.28, 59.22, 53.64, 18.59, 13.97 ppm. Calc. MS (ESI) m/z : 367. Found MS (ESI) m/z : 368 $[\text{M}+1]^+$.



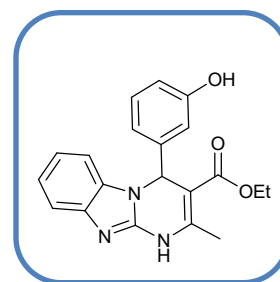
ethyl 4-(3-chlorophenyl)-2-methyl-1,4-dihydrobenzo[4,5]imidazo[1,2-*a*]pyrimidine-3-carboxylate (6j)

White solid, melting point: 268-270 °C [Lit⁴. 269.6-269.8 °C]; IR (KBr): ν_{\max} 3310, 3236, 3048, 2928, 2865, 1698, 1657, 1615, 1571, 1457, 1365, 1258, 1088 cm^{-1} ; ¹H NMR (400 MHz, DMSO-*d*₆): δ 10.87 (s, 1H), 7.45 (s, 1H), 7.34 (d, *J* = 8 Hz, 1H), 7.29-7.23 (m, 4H), 7.04 (t, *J* = 7.6 Hz, 1H), 6.96 (t, *J* = 7.6 Hz, *J* = 7.2 Hz, 1H), 6.45 (s, 1H), 4.01 (q, *J* = 8.8 Hz, *J* = 7.2 Hz, 2H), 2.44 (s, 3H), 1.14 (t, *J* = 7.2 Hz, 3H) ppm. ¹³C NMR (100 MHz, DMSO-*d*₆): δ 164.95, 146.99, 145.34, 144.35, 142.18, 132.79, 131.36, 130.36, 127.71, 127.07, 125.61, 121.88, 120.29, 116.83, 109.81, 97.25, 59.38, 55.28, 18.64, 13.94 ppm. Calc. MS (ESI) *m/z*: 367. Found MS (ESI) *m/z*: 368 [M+1]⁺.



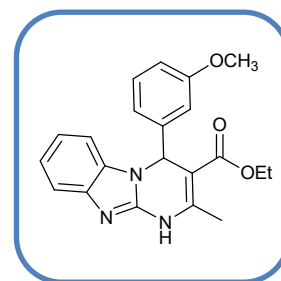
ethyl 4-(3-hydroxyphenyl)-2-methyl-1,4-dihydrobenzo[4,5]imidazo[1,2-a]pyrimidine-3-carboxylate (6k)

White solid, melting point: 242-244 °C ; IR (KBr): ν_{\max} 3351, 3241, 3031, 2909, 2842, 1678, 1615, 1591, 1571, 1455, 1369, 1257, 1091 cm^{-1} ; ¹H NMR (400 MHz, DMSO-*d*₆): δ 10.80 (s, 1H), 9.38 (s, 1H), 7.33 (d, *J* = 8 Hz, 1H), 7.22-7.20 (m, 1H), 7.03 (t, *J* = 8 Hz, 2H), 6.94 (t, *J* = 8 Hz, *J* = 7.2 Hz, 1H), 6.78 (t, *J* = 6.8 Hz, *J* = 6 Hz, 1H), 6.65 (d, *J* = 5.6 Hz, 1H), 6.55 (d, *J* = 8 Hz, 1H), 6.32 (s, 1H), 4.04-3.98 (m, 2H), 2.42 (s, 3H), 1.14 (t, *J* = 7.2 Hz, *J* = 6.8 Hz, 3H) ppm. ¹³C NMR (100 MHz, DMSO-*d*₆): δ 165.67, 165.18, 157.28, 145.60, 143.25, 142.22, 131.51, 129.14, 121.68, 120.08, 117.88, 166.68, 114.74, 113.58, 109.79, 97.92, 59.32, 55.72, 18.56, 14.01 ppm. Calc. MS (ESI) *m/z*: 349. Found MS (ESI) *m/z*: 350 [M+1]⁺.



ethyl 4-(3-methoxyphenyl)-2-methyl-1,4-dihydrobenzo[4,5]imidazo[1,2-a]pyrimidine-3-carboxylate (6l)

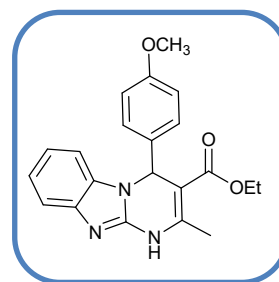
White solid, melting point: 210-212 °C [Lit⁴. 211-214 °C]; IR (KBr): ν_{\max} 3389, 3232, 3100, 3021, 2924, 2839, 1702, 1657, 1618, 1575, 1457, 1365, 1249, 1086, 1048 cm^{-1} ; ¹H NMR (400 MHz, DMSO-*d*₆): δ 10.81 (s, 1H),



7.34-7.27 (m, 2H), 7.15 (t, $J = 8$ Hz, 1H), 7.02 (t, $J = 8$ Hz, $J = 7.2$ Hz, 1H), 6.96-6.92 (m, 2H), 6.85-6.82 (m, 1H), 6.74 (dd, $J = 8$ Hz, $J = 2.8$ Hz, 1H), 6.38 (s, 1H), 4.05-3.96 (m, 2H), 3.67 (s, 3H), 2.43 (s, 3H), 1.14 (t, $J = 7.2$ Hz, $J = 6.8$ Hz, 3H) ppm. ^{13}C NMR (100 MHz, $\text{DMSO-}d_6$): δ 165.62, 159.44, 146.98, 146.06, 144.00, 143.94, 142.73, 131.99, 130.01, 122.20, 120.62, 119.46, 117.19, 113.95, 112.87, 110.37, 98.25, 59.82, 56.16, 55.40, 19.05, 14.52 ppm. Calc. MS (ESI) m/z : 363. Found MS (ESI) m/z : 364 $[\text{M}+1]^+$.

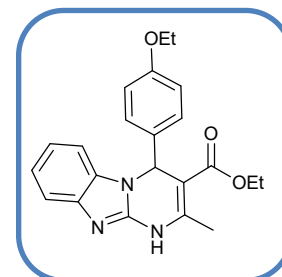
ethyl 4-(4-methoxyphenyl)-2-methyl-1,4-dihydrobenzo[4,5]imidazo[1,2-*a*]pyrimidine-3-carboxylate (6m)

White solid, melting point: 250-252 °C [Lit⁴. 250-252 °C]; IR (KBr): ν_{max} 3394, 3231, 3017, 2907, 2838, 1705, 1656, 1617, 1574, 1457, 1365, 1247, 1080 cm^{-1} ; ^1H NMR (400 MHz, $\text{DMSO-}d_6$): δ 10.76 (s, 1H), 7.32 (d, $J = 8$ Hz, 2H), 7.26-7.23 (m, 2H), 7.02 (t, $J = 7.2$ Hz, $J = 7.6$ Hz, 1H), 6.93 (t, $J = 7.6$ Hz, $J = 8$ Hz, 1H), 6.74 (d, $J = 8.4$ Hz, 2H), 6.36 (s, 1H), 4.03-3.90 (m, 2H), 3.64 (s, 3H), 2.43 (s, 3H), 1.13 (t, $J = 7.2$ Hz, $J = 6.8$ Hz, 3H) ppm. ^{13}C NMR (100 MHz, $\text{DMSO-}d_6$): δ 165.66, 165.17, 158.57, 146.26, 146.07, 145.58, 142.25, 134.10, 131.44, 128.23, 121.62, 120.01, 116.66, 113.66, 109.82, 98.10, 59.25, 54.88, 50.73, 18.59, 14.03 ppm. Calc. MS (ESI) m/z : 363. Found MS (ESI) m/z : 364 $[\text{M}+1]^+$.



ethyl 4-(4-ethoxyphenyl)-2-methyl-1,4-dihydrobenzo[4,5]imidazo[1,2-*a*]pyrimidine-3-carboxylate (6n)

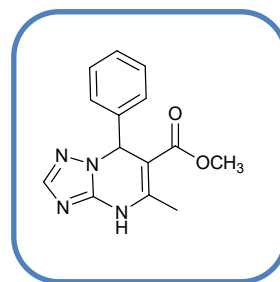
White solid, melting point: 252-254 °C [Lit⁵. 253-255 °C]; IR (KBr): ν_{max} 3303, 3192, 2975, 2888, 1650, 1614, 1558, 1474, 1391, 1248, 1051 cm^{-1} ; ^1H NMR (400 MHz, $\text{DMSO-}d_6$): δ 10.77 (s, 1H), 7.33 (d, $J = 8$ Hz, 1H), 7.25 (d, $J = 8$ Hz, 1H), 7.25 (d, $J = 8.4$ Hz, 3H), 7.03 (t, $J = 7.6$ Hz, 1H),



6.94 (t, $J = 7.2$ Hz, 1H), 6.78 (d, $J = 8.4$ Hz, 2H), 6.37 (s, 1H), 4.04-3.96 (m, 2H), 3.91 (q, $J = 7.2$ Hz, $J = 7.6$ Hz, 2H), 2.44 (s, 3H), 1.24 (t, $J = 7.2$ Hz, $J = 6.8$ Hz, 3H), 1.14 (t, $J = 6.8$ Hz, $J = 7.2$ Hz, 3H) ppm. ^{13}C NMR (100 MHz, DMSO- d_6): δ 165.18, 157.87, 146.06, 145.53, 142.19, 133.93, 131.44, 128.24, 121.64, 120.03, 116.65, 113.95, 109.83, 98.10, 62.81, 59.28, 55.26, 18.52, 14.51, 14.00 ppm. Calc. MS (ESI) m/z : 377. Found MS (ESI) m/z : 378 $[\text{M}+1]^+$.

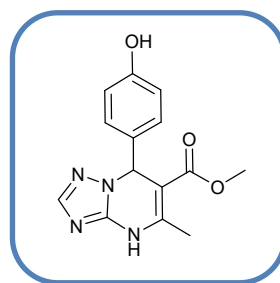
methyl 5-methyl-7-phenyl-4,7-dihydro-[1,2,4]triazolo[1,5-*a*]pyrimidine-6-carboxylate (8a)

White solid, melting point: 220-222 °C ; IR (KBr): ν_{max} 3244, 3137, 3063, 1734, 1699, 1594, 1484, 1339, 1180, 1076 cm^{-1} ; ^1H NMR (400 MHz, DMSO- d_6): δ 10.85 (s, 1H), 7.65 (s, 1H), 7.45-7.41 (m, 2H), 7.29 (d, $J = 7.2$ Hz, 2H), 7.20 (d, $J = 7.6$ Hz, 2H), 6.26 (s, 1H), 3.50 (s, 3H), 2.41 (s, 3H) ppm. ^{13}C NMR (100 MHz, DMSO- d_6): δ 165.58, 150.09, 146.86, 141.90, 128.39, 127.88, 126.78, 97.01, 81.17, 59.28, 50.85, 18.47 ppm. Calc. MS (ESI) m/z : 270. Found MS (ESI) m/z : 271 $[\text{M}+1]^+$.



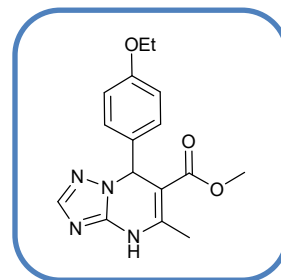
methyl 7-(4-hydroxyphenyl)-5-methyl-4,7-dihydro-[1,2,4]triazolo[1,5-*a*]pyrimidine-6-carboxylate (8b)

White solid, melting point: 282-284 °C ; IR (KBr): ν_{max} 3232, 3099, 3023, 1697, 1674, 1617, 1578, 1456, 1328, 1247, 1092 cm^{-1} ; ^1H NMR (400 MHz, DMSO- d_6): δ 10.74 (s, 1H), 9.47 (s, 1H), 7.64 (s, 1H), 7.01 (d, $J = 8.4$ Hz, 2H), 6.67 (d, $J = 8.4$ Hz, 2H), 6.17 (s, 1H), 3.52 (s, 3H), 2.40 (s, 3H) ppm. ^{13}C NMR (100 MHz, DMSO- d_6): δ 165.69, 156.98, 149.89, 146.80, 146.35, 132.48, 127.99, 114.99, 97.35, 58.75, 50.82, 18.41 ppm. Calc. MS (ESI) m/z : 286. Found MS (ESI) m/z : 287 $[\text{M}+1]^+$.



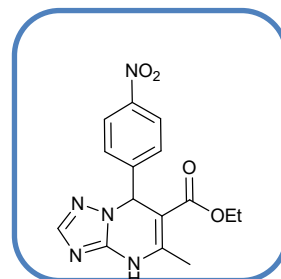
methyl 7-(4-ethoxyphenyl)-5-methyl-4,7-dihydro-[1,2,4]triazolo[1,5-*a*]pyrimidine-6-carboxylate (8c)

White solid, melting point: 210-212 °C ; IR (KBr): ν_{\max} 3313, 3133, 3063, 1671, 1658, 1611, 1510, 1486, 1385, 1297, 1151, 1035 cm^{-1} ; ^1H NMR (400 MHz, $\text{DMSO-}d_6$): δ 10.77 (s,1H), 7.63 (s, 1H), 7.1 (d, $J = 8$ Hz, 2H), 6.8 (d, $J = 8.4$ Hz, 2H), 6.20 (s, 1H), 3.96 (q, $J = 7.2$ Hz, $J = 6.8$ Hz, 2H), 3.50 (s, 3H), 2.39 (s,3H), 1.28 (t, $J = 7.2$ Hz, 3H) ppm. ^{13}C NMR (100 MHz, $\text{DMSO-}d_6$): δ 165.64, 158.06, 149.95, 146.82, 146.54, 133.93, 127.99, 114.07, 97.21, 62.89, 58.69, 50.82, 18.42, 14.54 ppm. Calc. MS (ESI) m/z : 314. Found MS (ESI) m/z : 315 $[\text{M}+1]^+$.



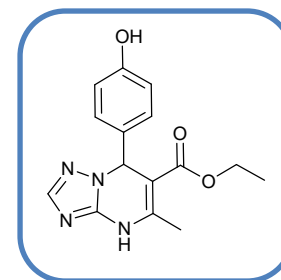
ethyl 5-methyl-7-(4-nitrophenyl)-4,7-dihydro-[1,2,4]triazolo[1,5-a]pyrimidine-6-carboxylate (8d)

White solid, melting point: 234-236 °C ; IR (KBr): ν_{\max} 3235, 3148, 3070, 1709, 1624, 1600, 1541, 1495, 1383, 1231, 1151, 1093 cm^{-1} ; ^1H NMR (400 MHz, $\text{DMSO-}d_6$): δ 10.98 (s,1H), 8.17 (d, $J = 8$ Hz, 2H), 7.67 (s, 1H), 7.51 (d, $J = 8$ Hz, 2H), 6.41 (s, 1H), 3.93 (q, $J = 2.8$ Hz, 2H), 2.42 (s, 3H), 1.02 (t, $J = 6.8$ Hz, $J = 7.2$ Hz, 3H) ppm. ^{13}C NMR (100 MHz, $\text{DMSO-}d_6$): δ 164.76, 150.43, 148.94, 147.64, 146.79, 128.48, 123.64, 96.07, 81.37, 59.50, 58.82, 18.52, 13.79 ppm. Calc. MS (ESI) m/z : 329. Found MS (ESI) m/z : 330 $[\text{M}+1]^+$.



ethyl 7-(4-hydroxyphenyl)-5-methyl-4,7-dihydro-[1,2,4]triazolo[1,5-a]pyrimidine-6-carboxylate (8e)

White solid, melting point: 292-294 °C ; IR (KBr): ν_{\max} 3249, 3155, 3078, 1698, 1635, 1542, 1456, 1383, 1262, 1154, 1079 cm^{-1} ; ^1H NMR (400 MHz, $\text{DMSO-}d_6$): δ 10.71 (s,1H), 9.46 (s,1H), 7.64 (s,1H), 7.02 (d, $J = 8$ Hz, 2H), 6.67 (d, $J = 8$ Hz, 2H), 6.17 (s, 1H), 4.01-3.92 (m, 2H), 2.40 (s, 3H), 1.06 (t, $J = 6.8$ Hz, 3H,) ppm. ^{13}C NMR (100 MHz, $\text{DMSO-}d_6$): δ 165.16, 156.94, 149.87, 146.77, 146.13, 132.64, 128.12, 114.90, 97.53, 59.25, 58.87, 18.31, 13.87 ppm. Calc. MS (ESI) m/z : 300. Found MS (ESI) m/z : 301 $[\text{M}+1]^+$.

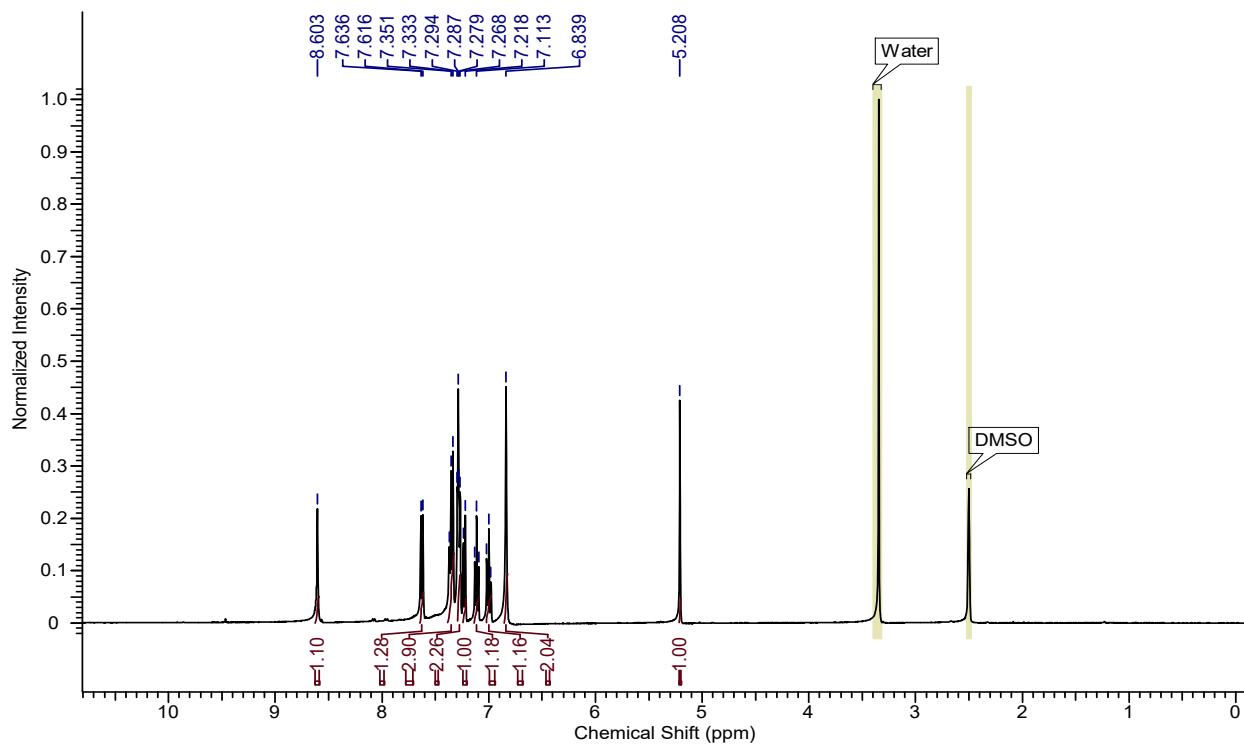


References

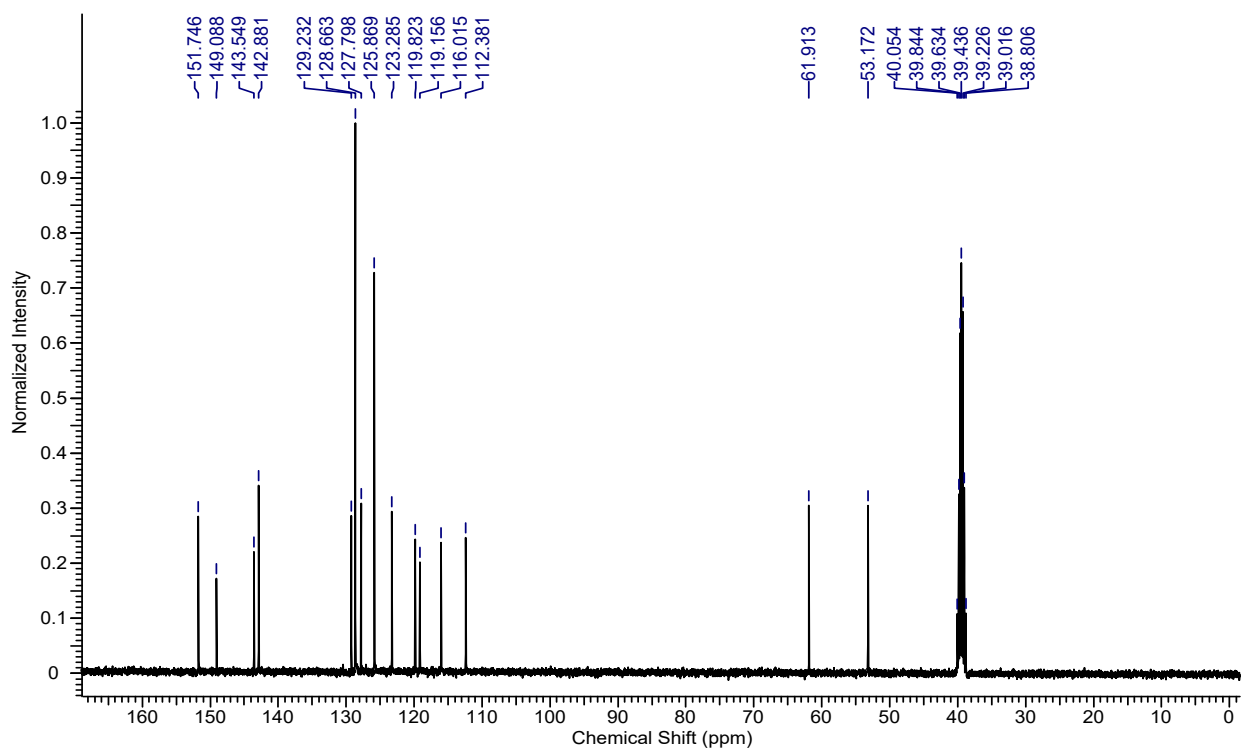
- (1) Hemmati, B.; Javanshir, S.; Dolatkhah, Z. *RSC Adv.* **2016**, *6* (56), 50431–50436.
- (2) Hamidinasab, M.; Mobinikhaledi, A. *ChemistrySelect* **2019**, *4* (1), 17–23.
- (3) Shaterian, H. R.; Fahimi, N.; Azizi, K. *Res. Chem. Intermed.* **2014**, *40* (5), 1879–1898.
- (4) Abedini, M.; Shirini, F.; Mousapour, M.; Goli Jolodar, O. *Res. Chem. Intermed.* **2016**, *42* (7), 6221–6229.
- (5) Reddy, M. V.; Reddy, A. V. S.; Jeong, Y. T. *Res. Chem. Intermed.* **2016**, *42* (5), 4893–4906.

Spectral Data

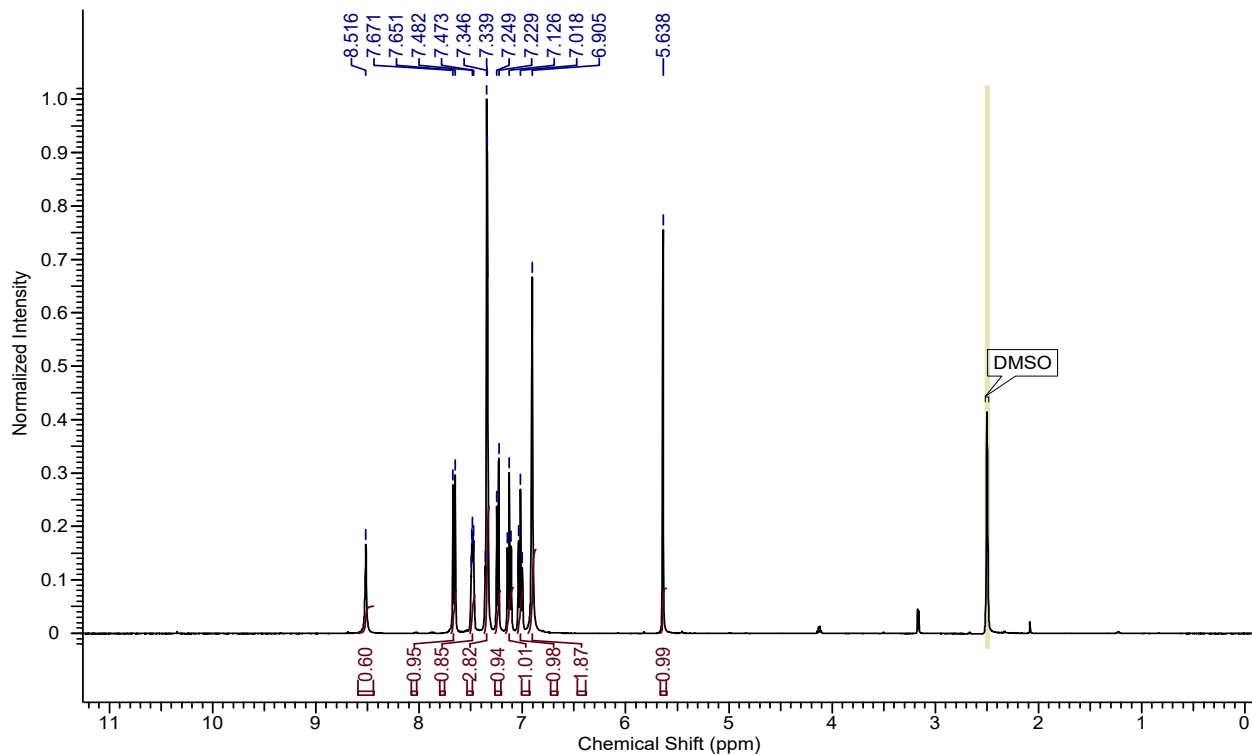
¹H NMR of (4a)



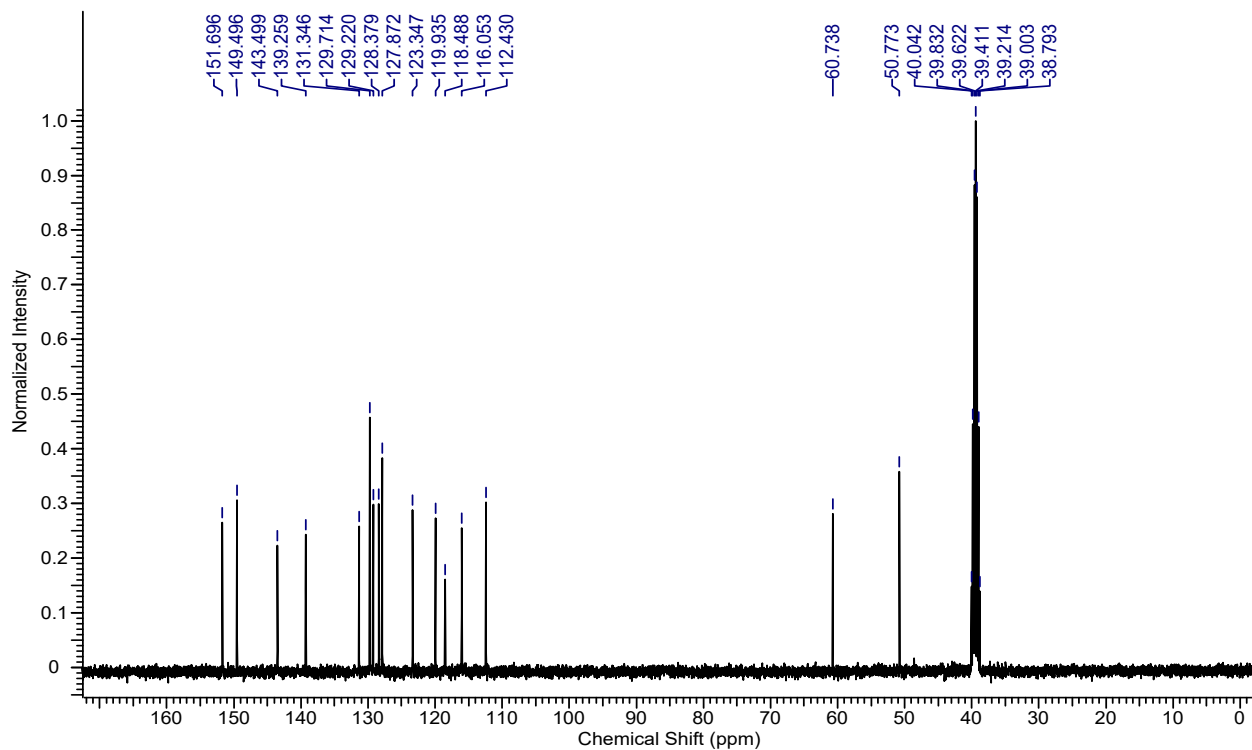
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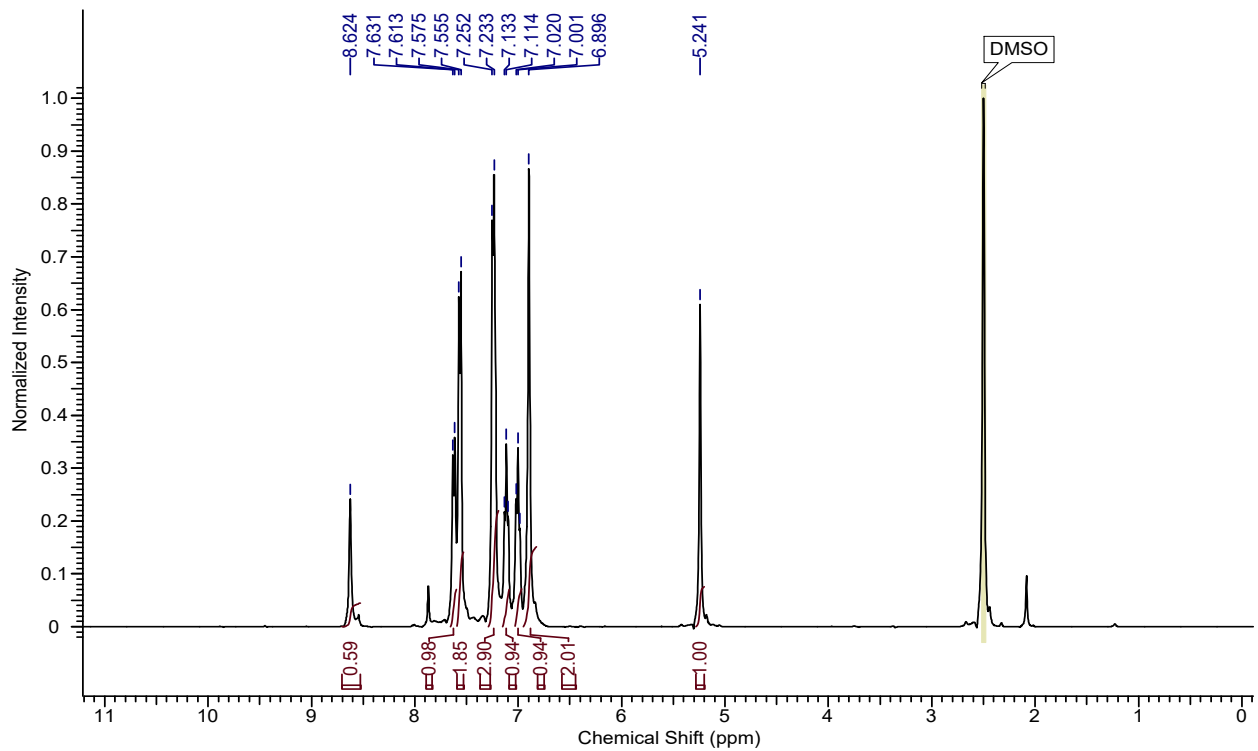
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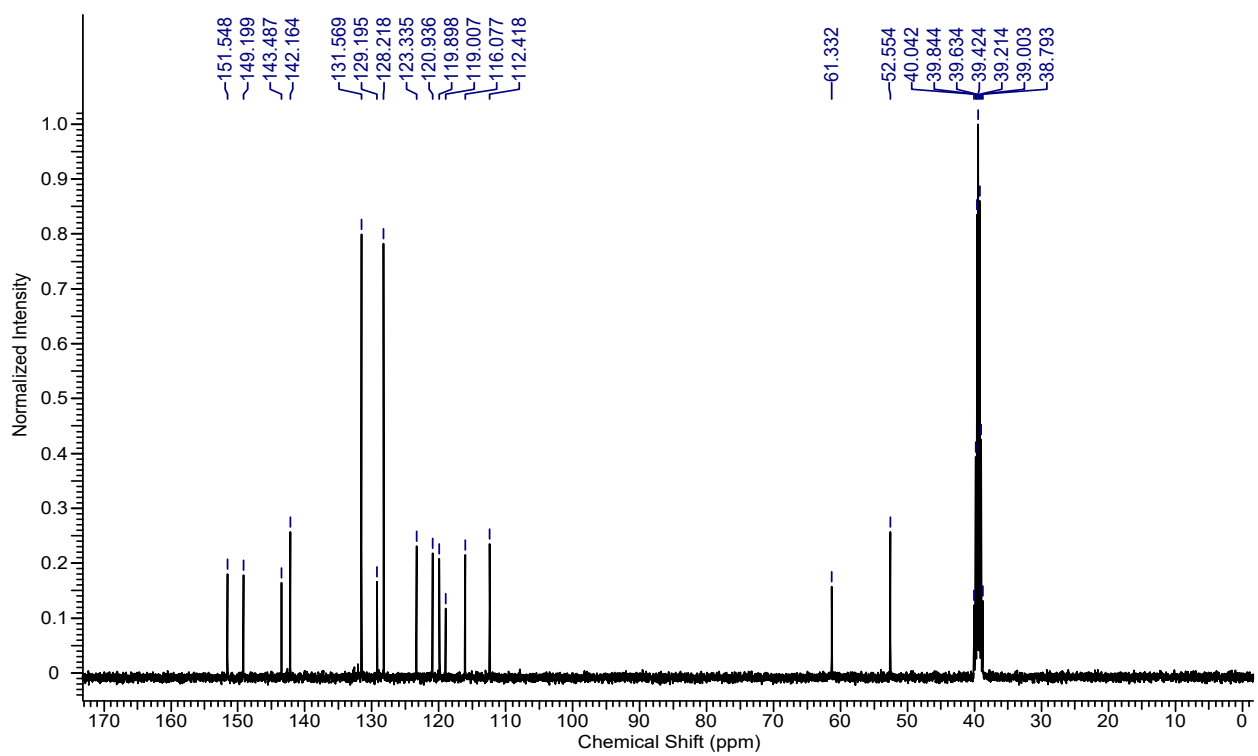
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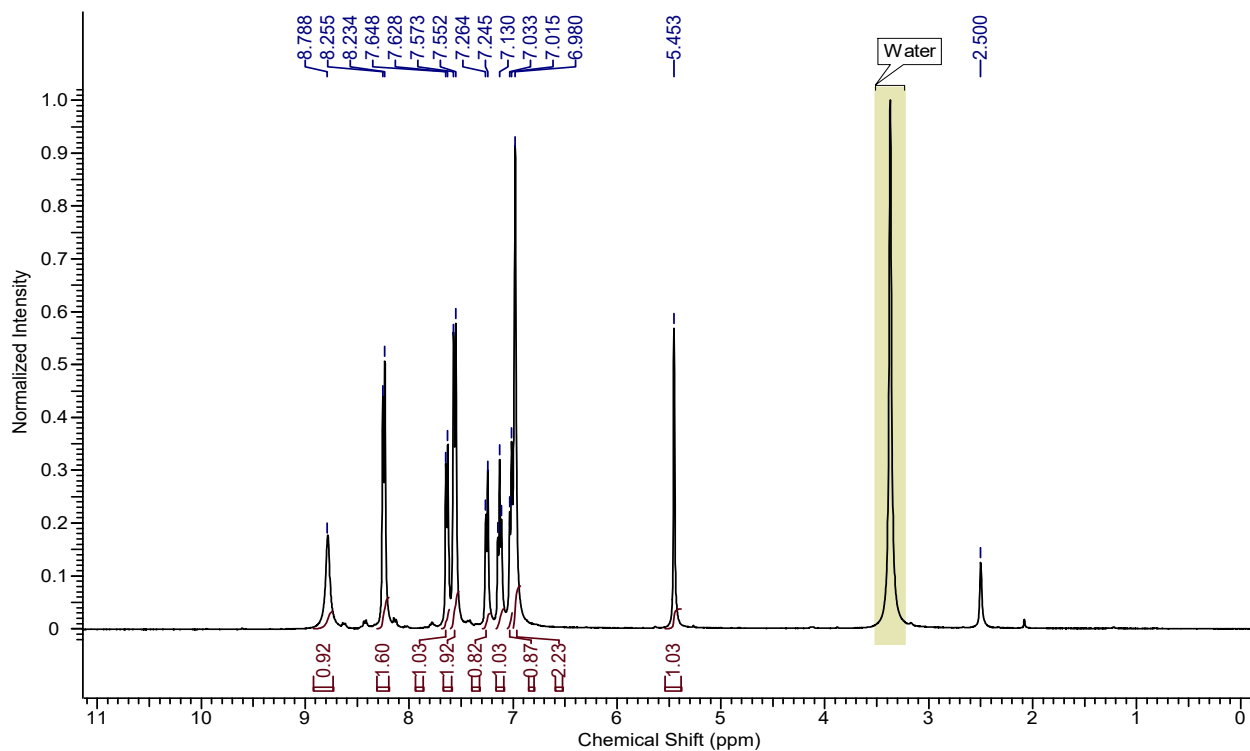
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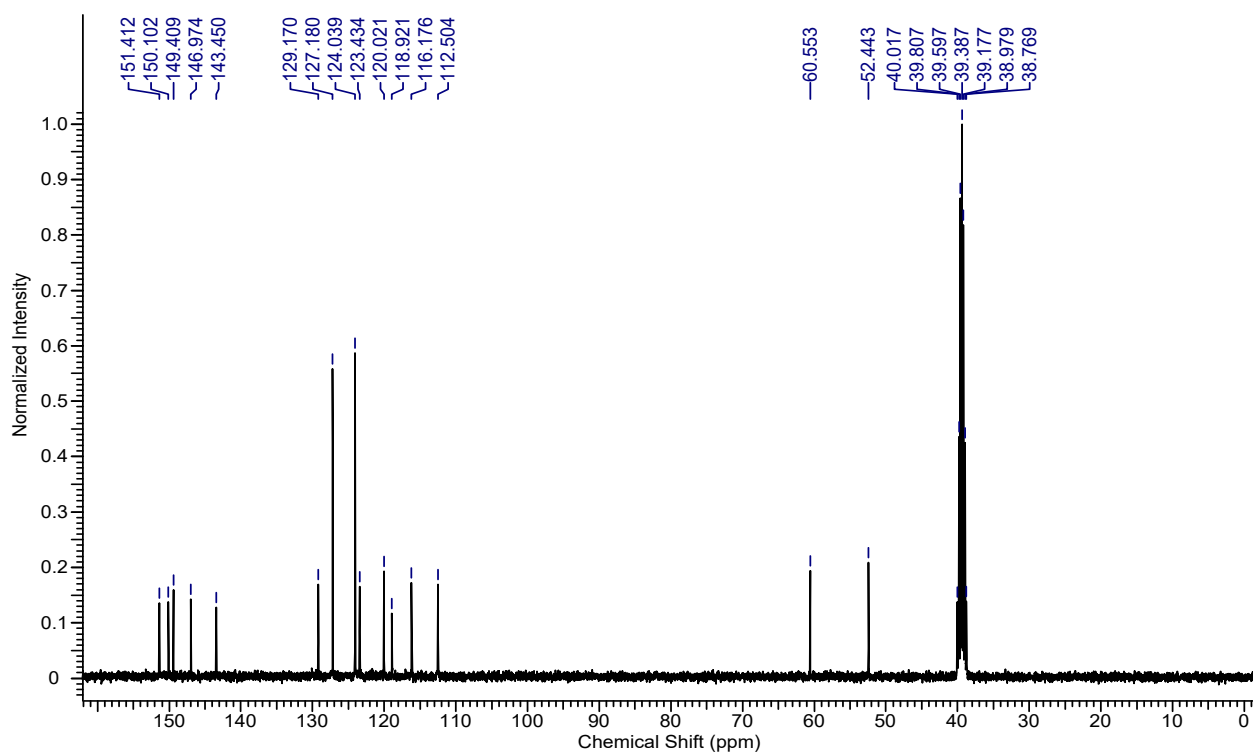
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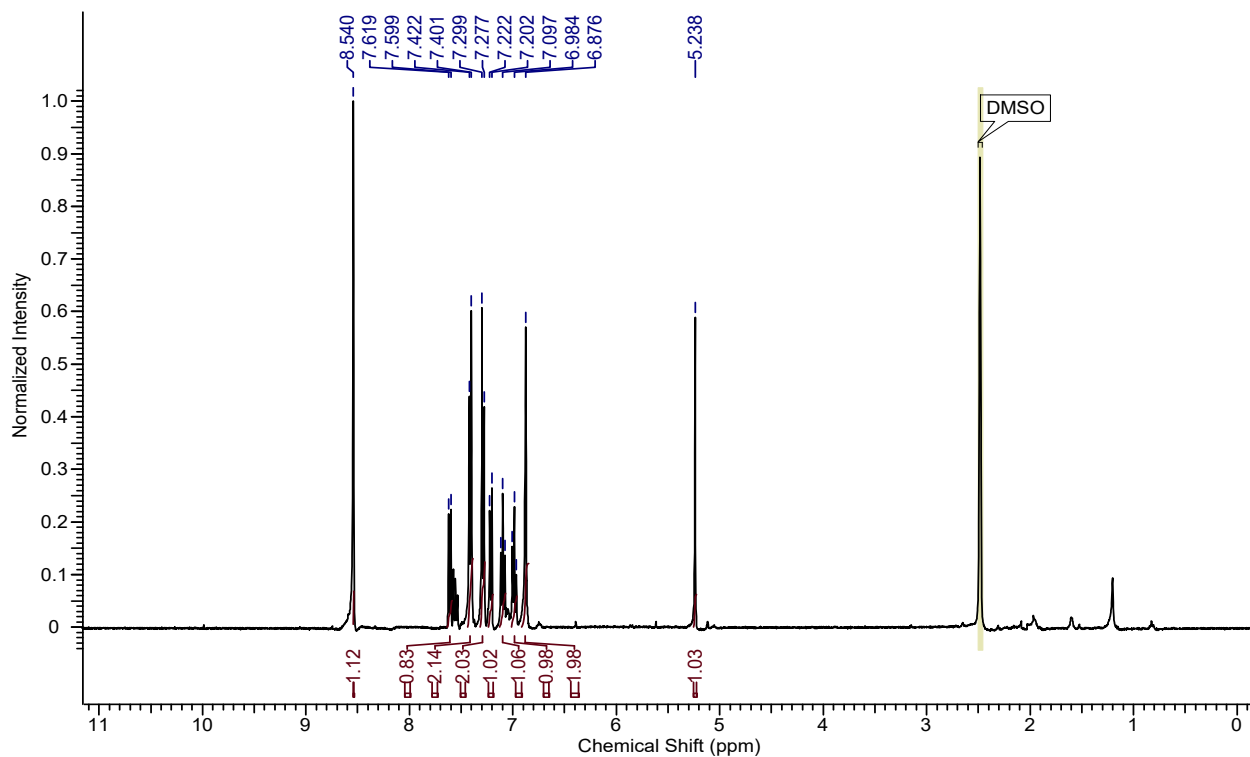
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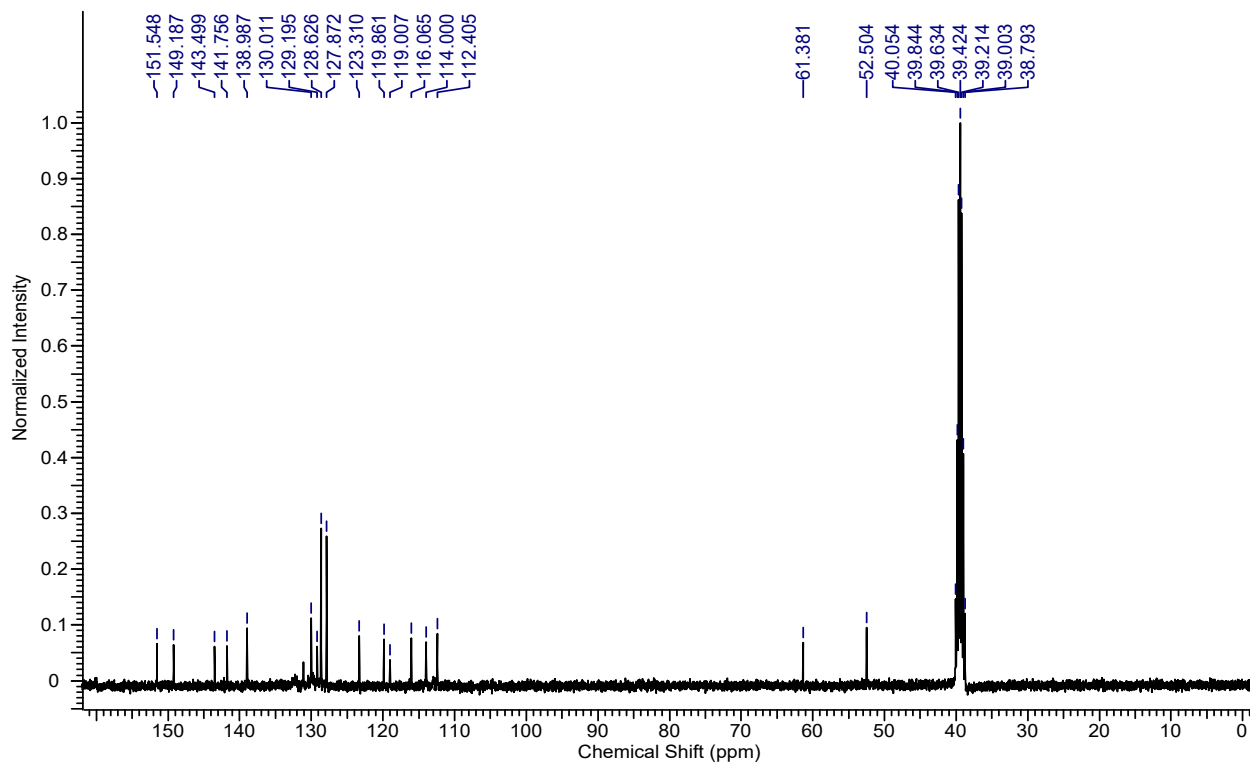
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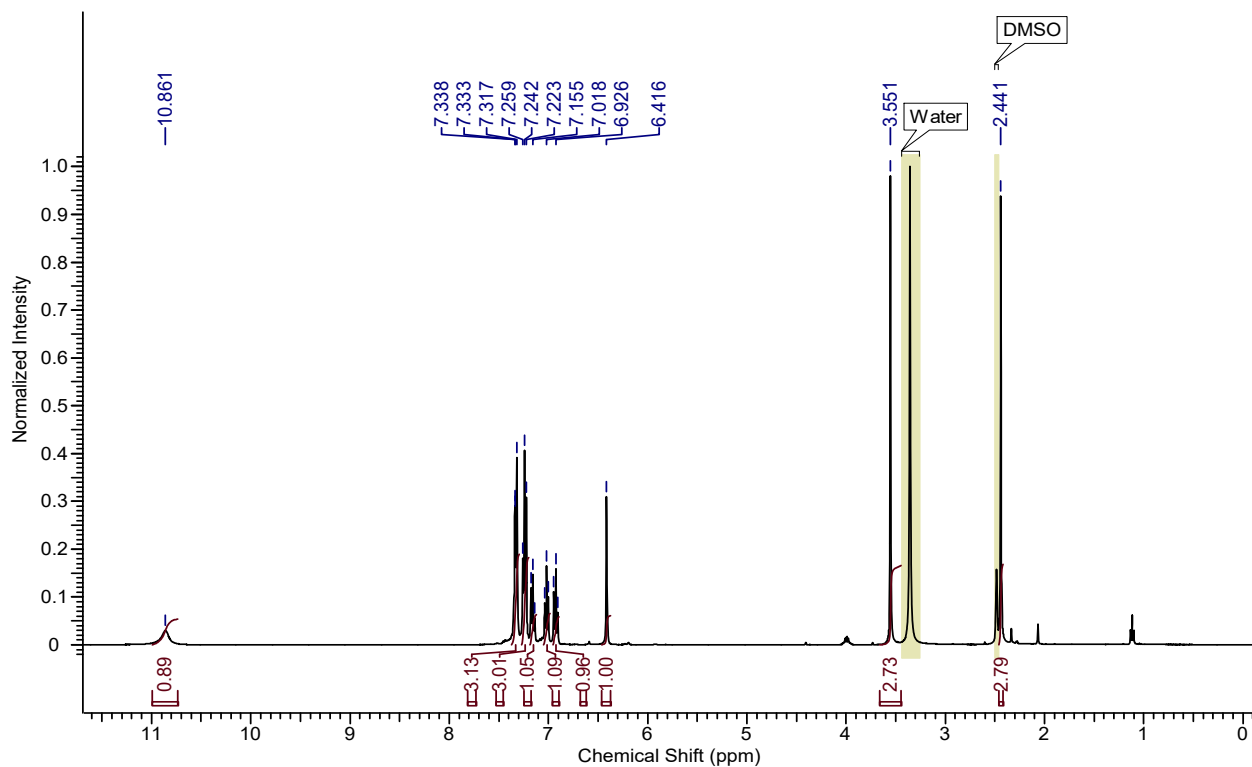
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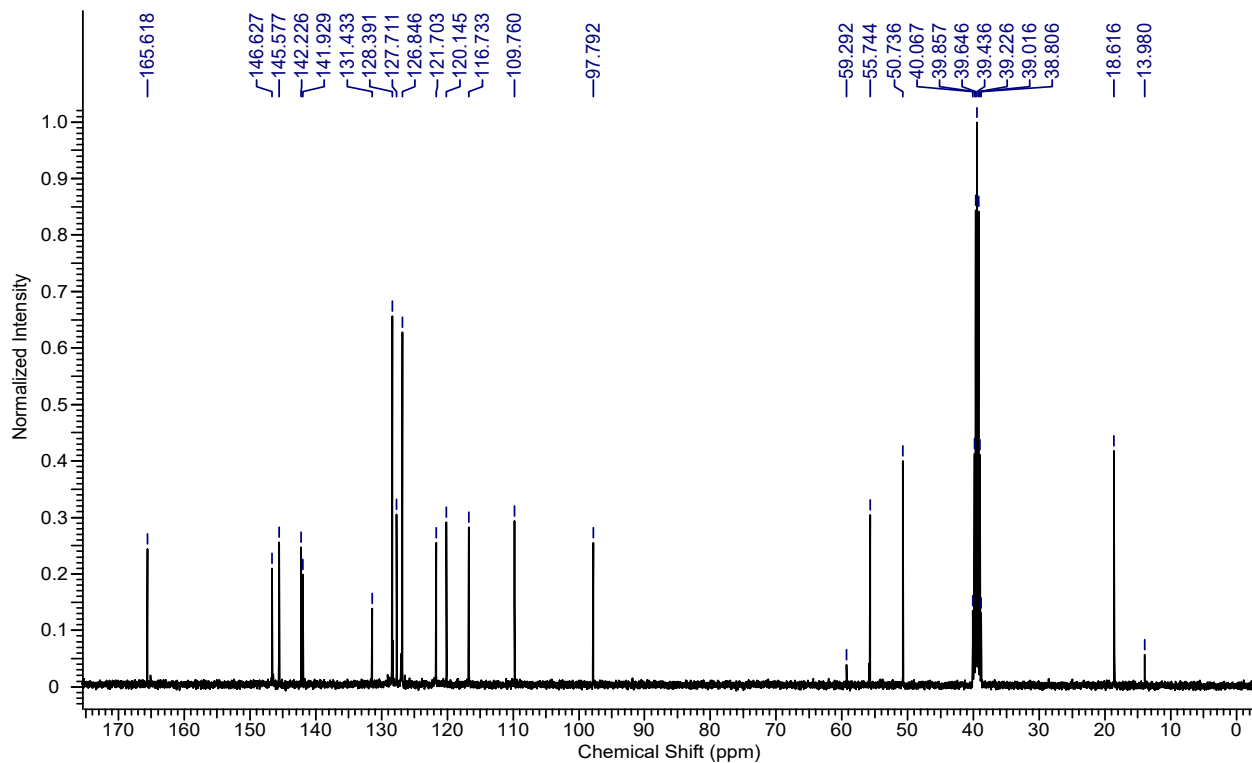
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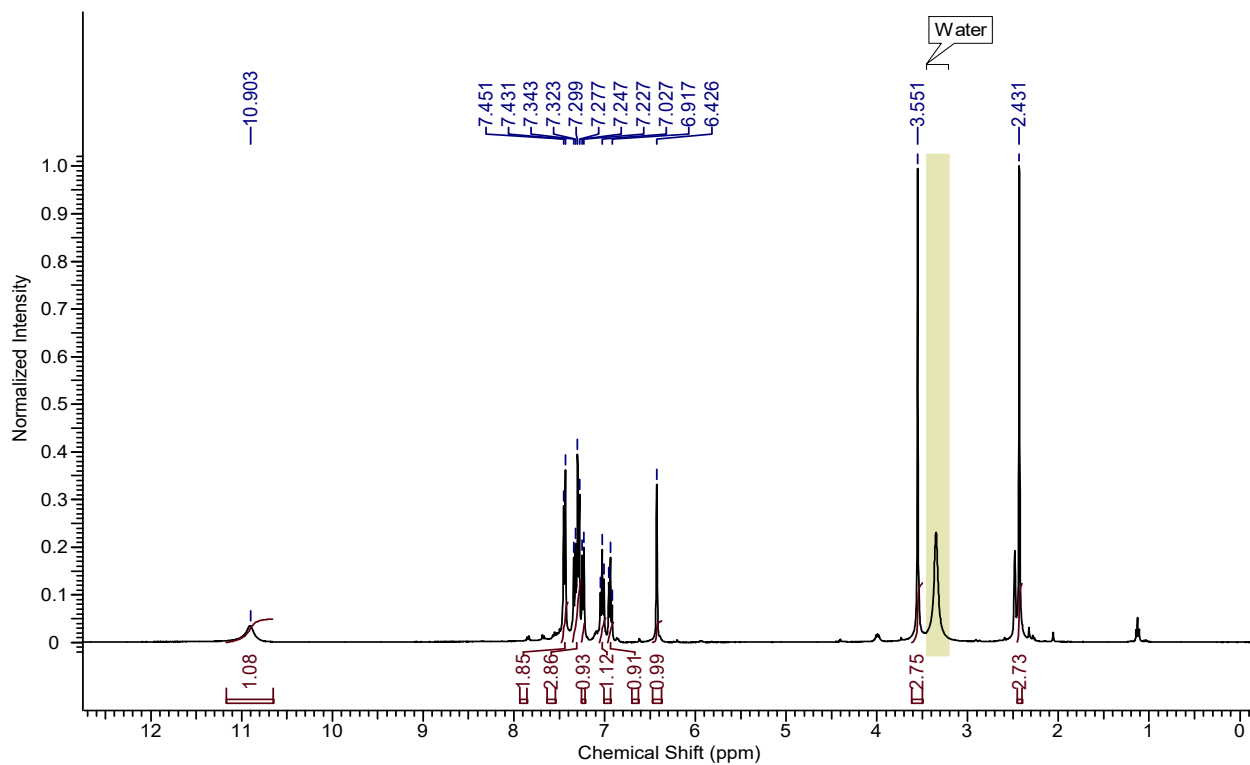
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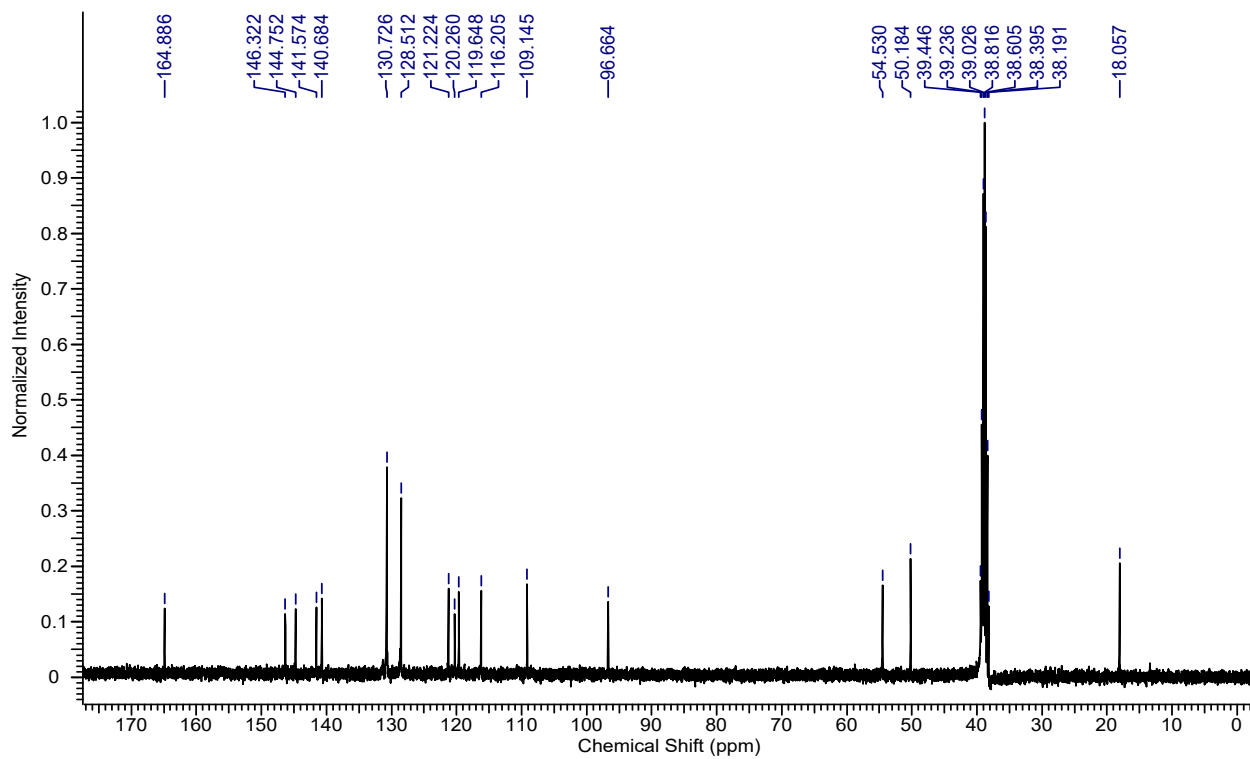
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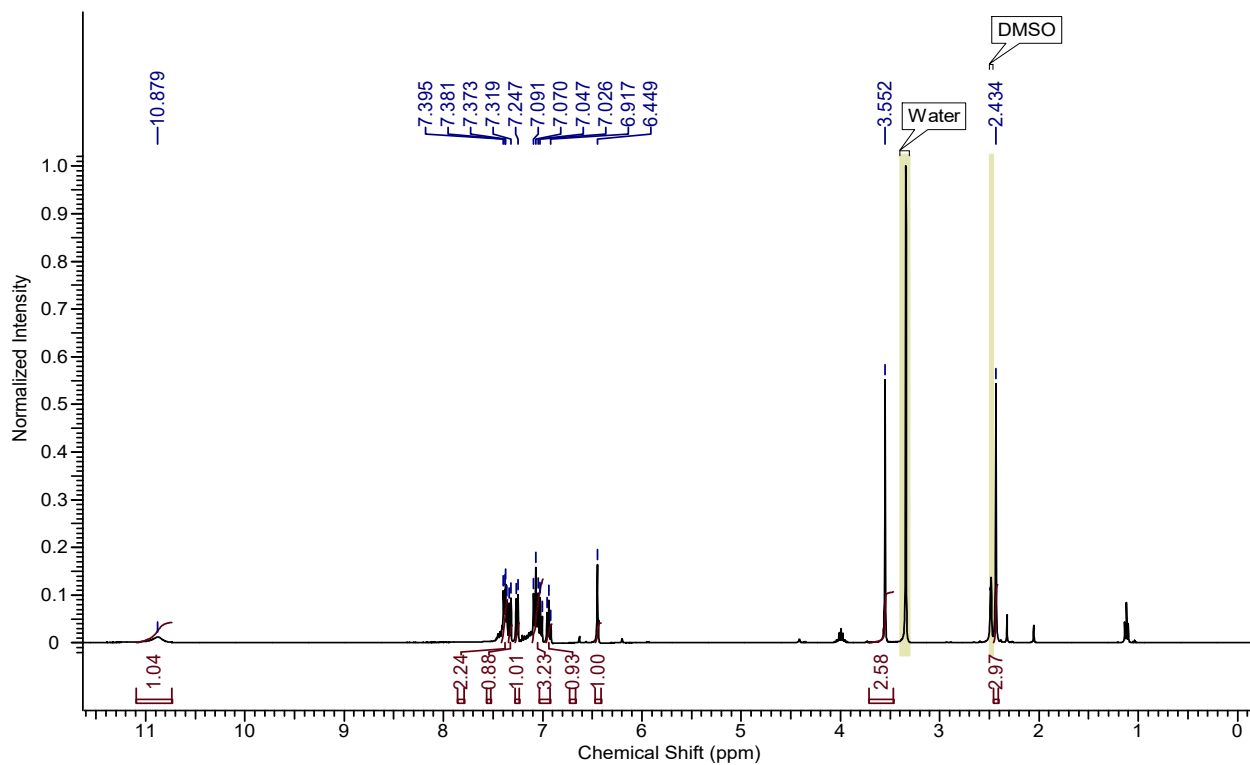
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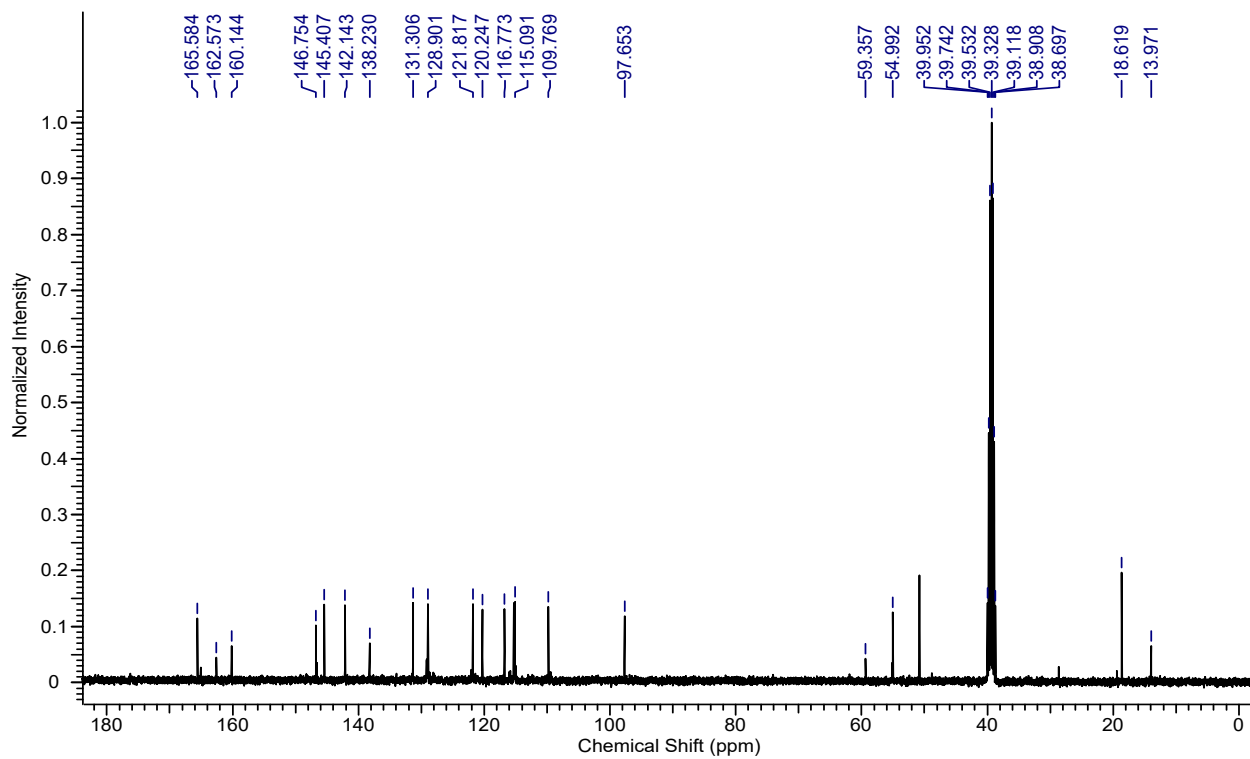
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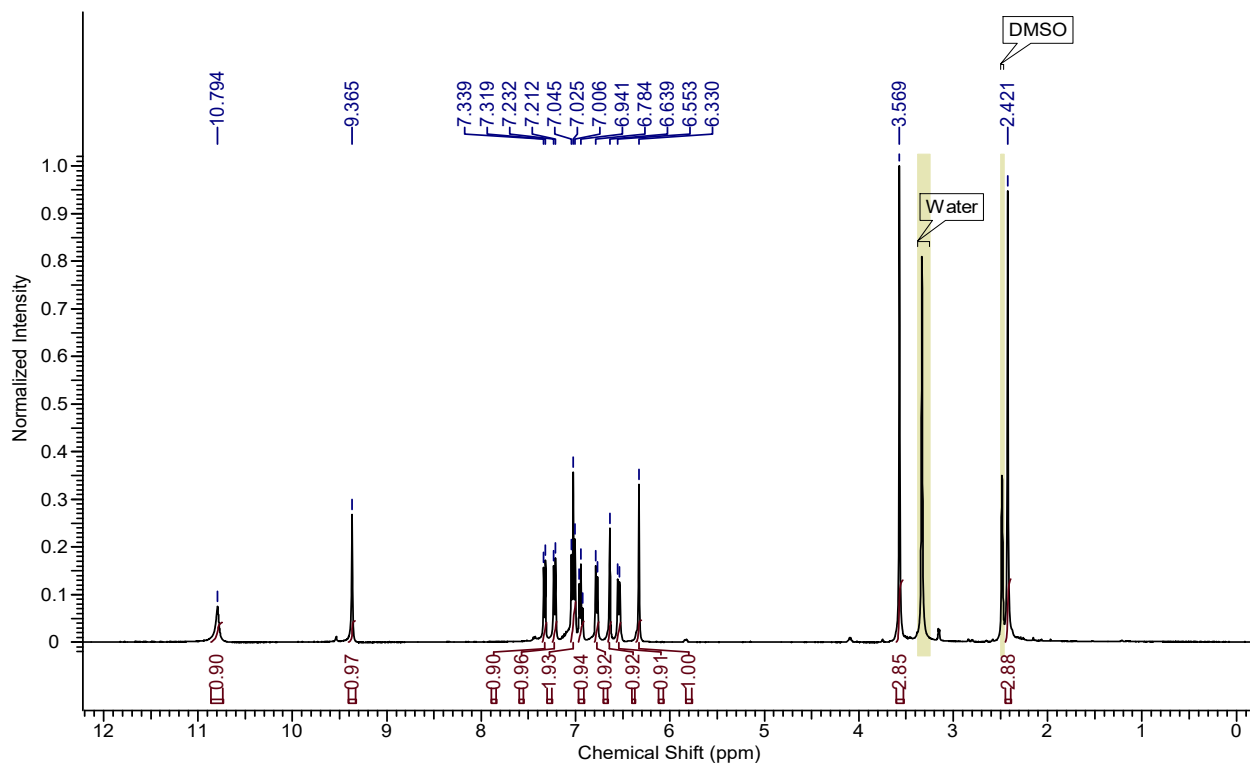
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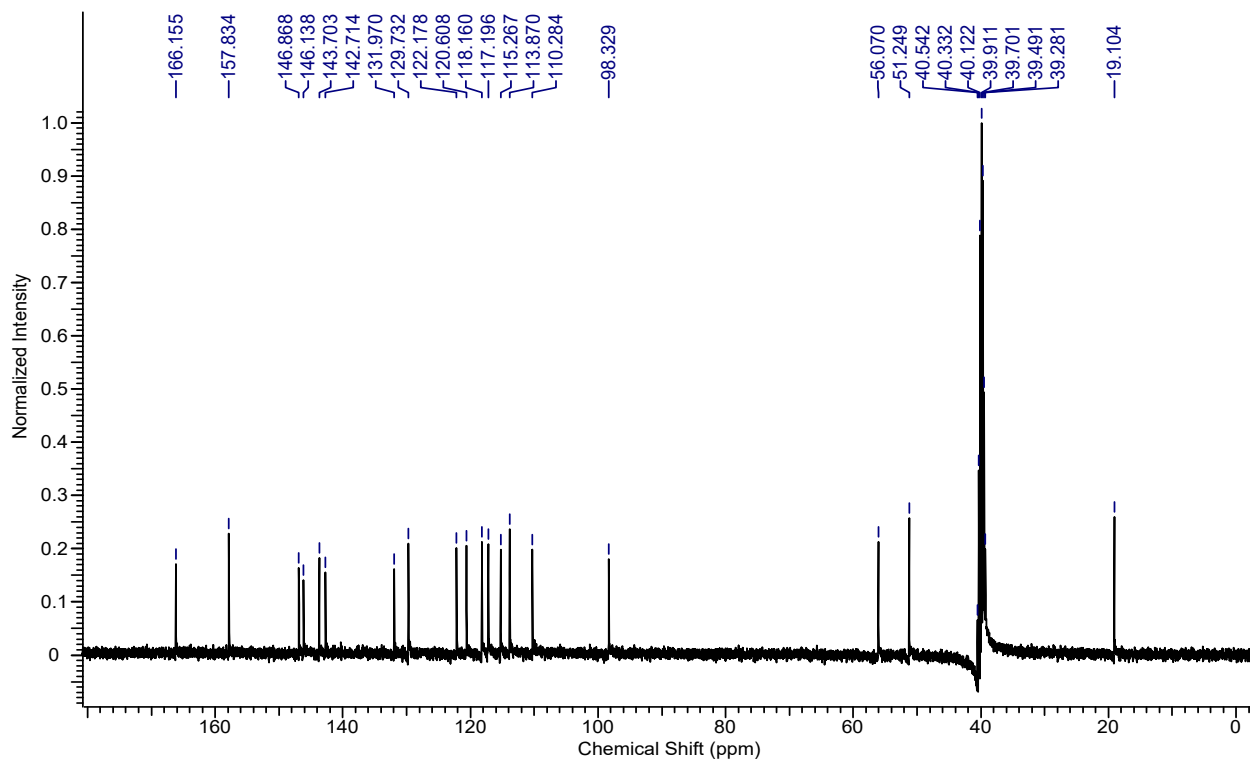
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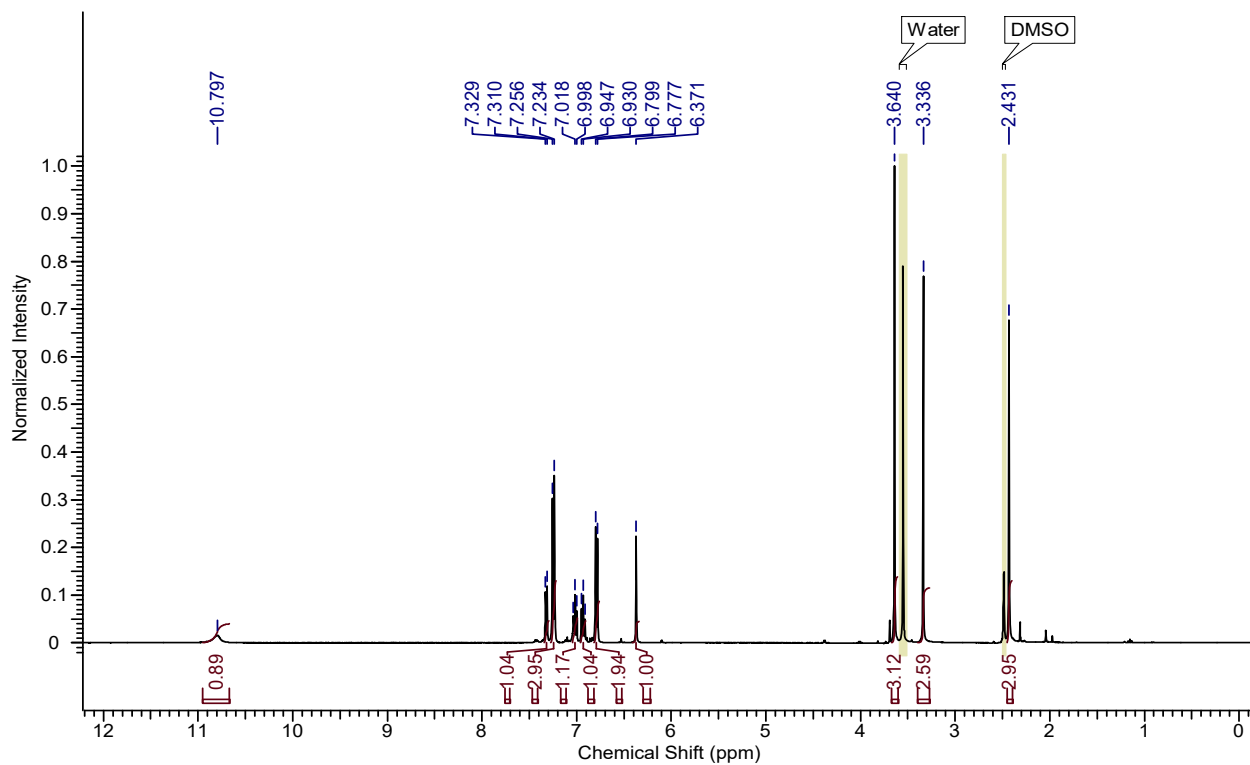
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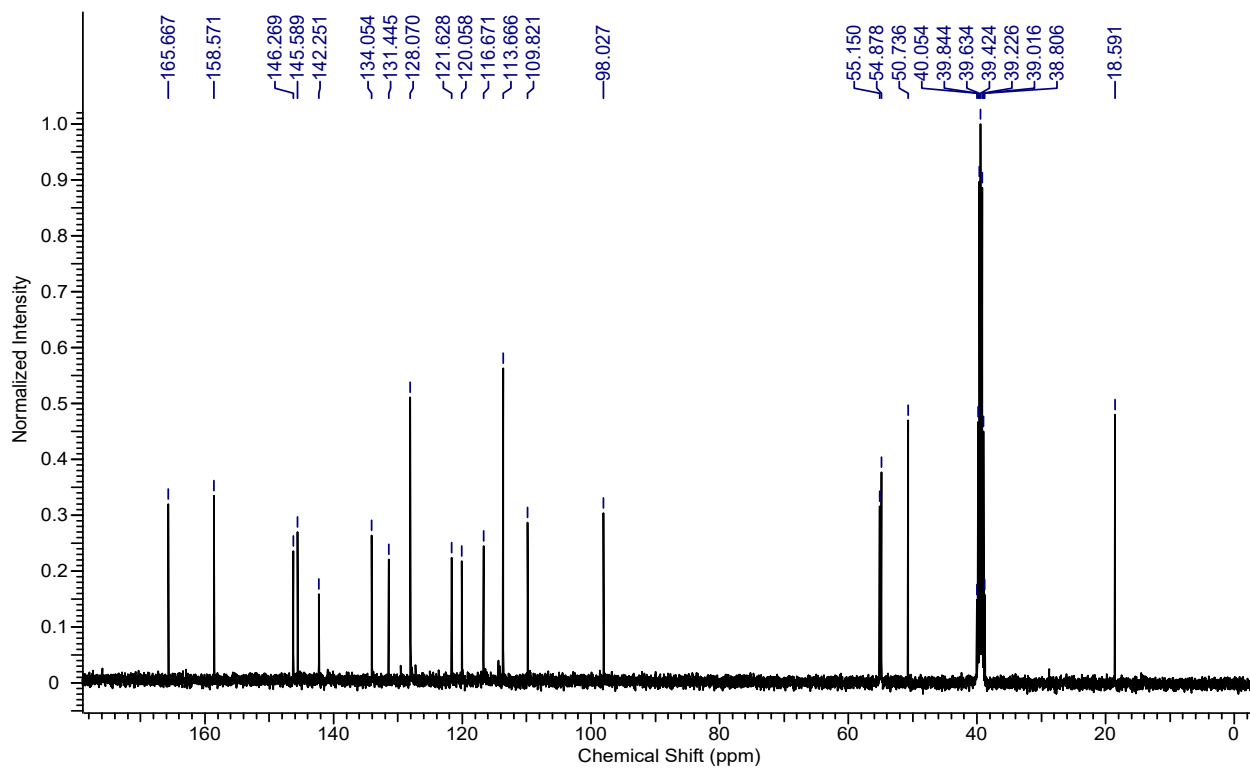
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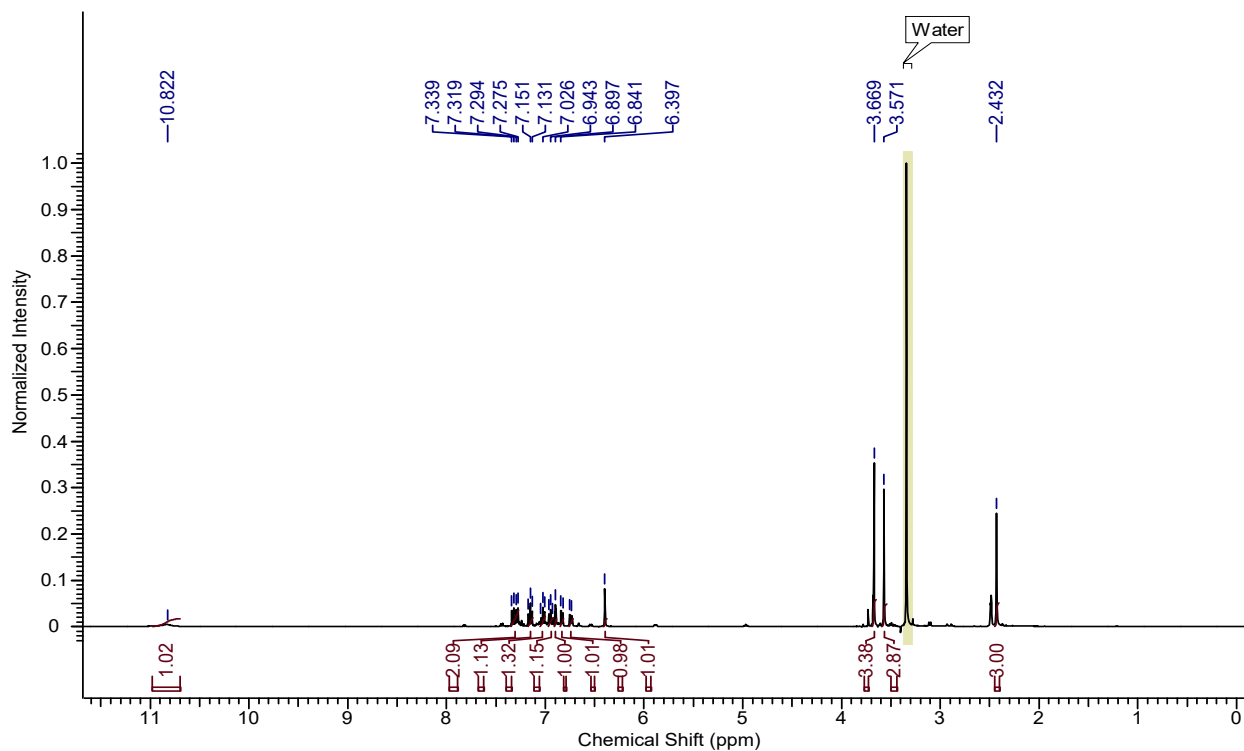
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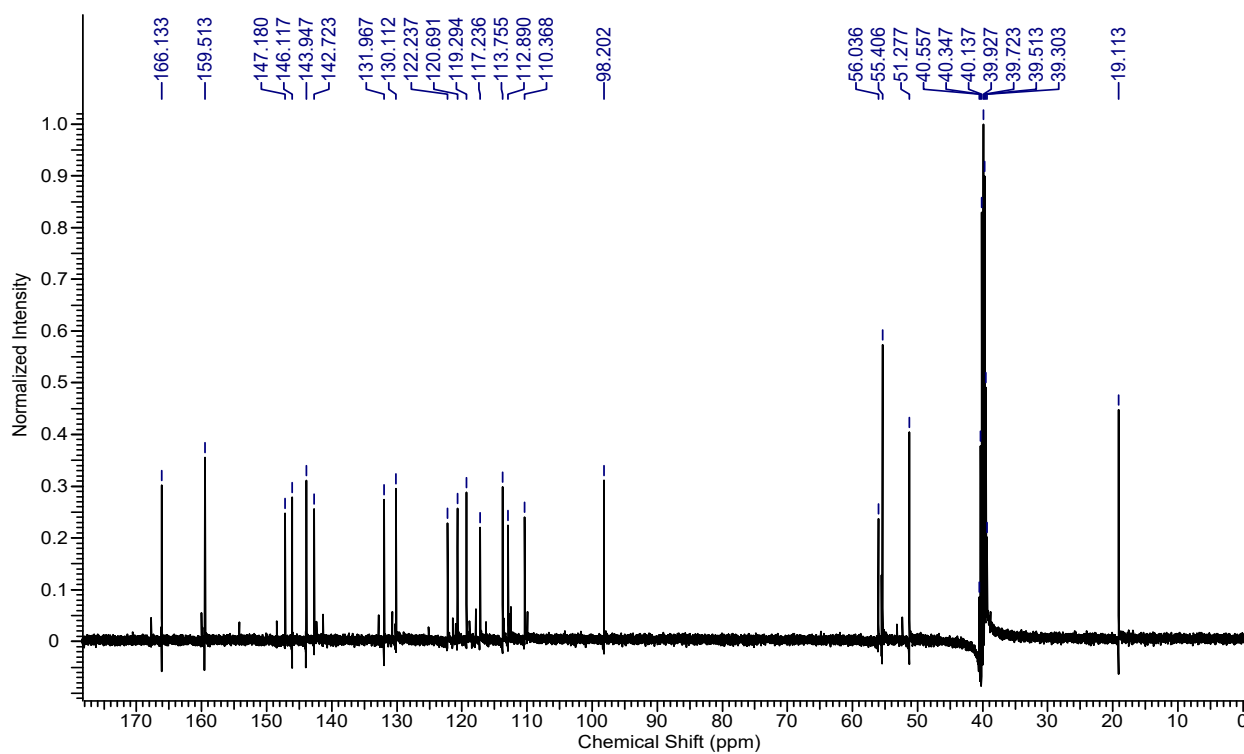
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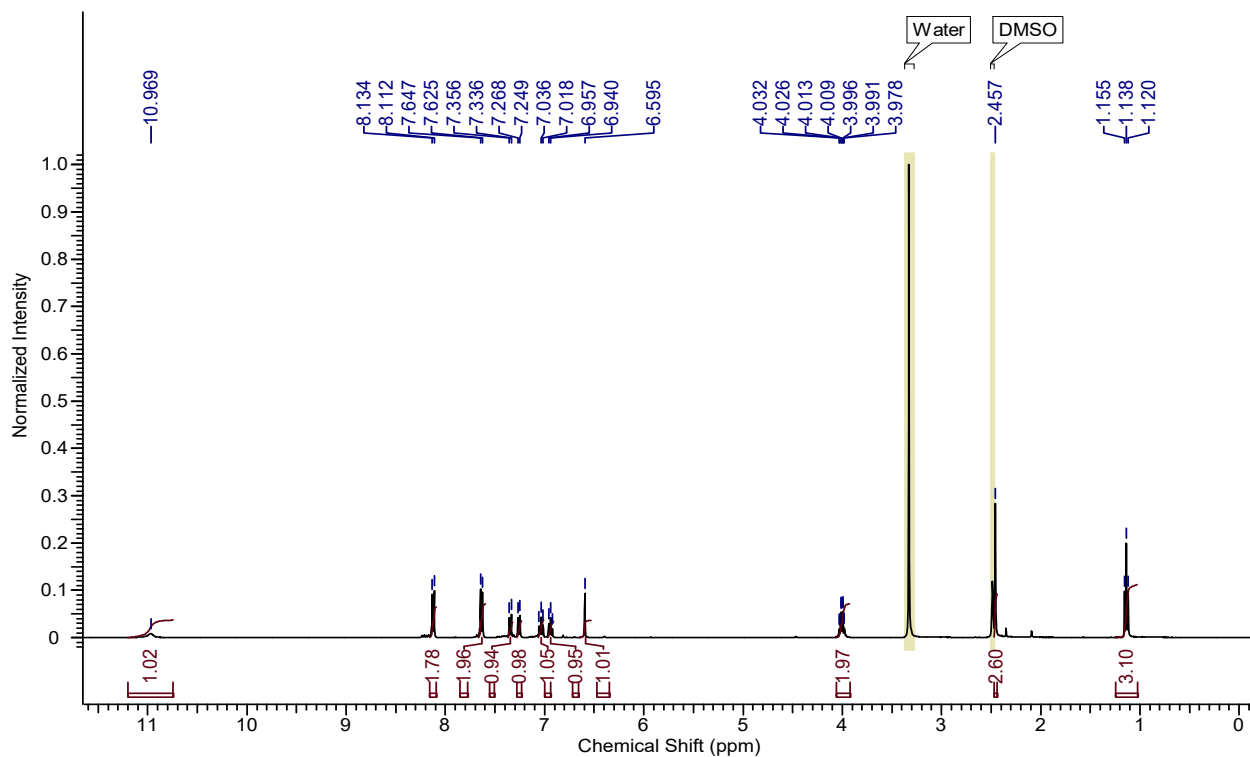
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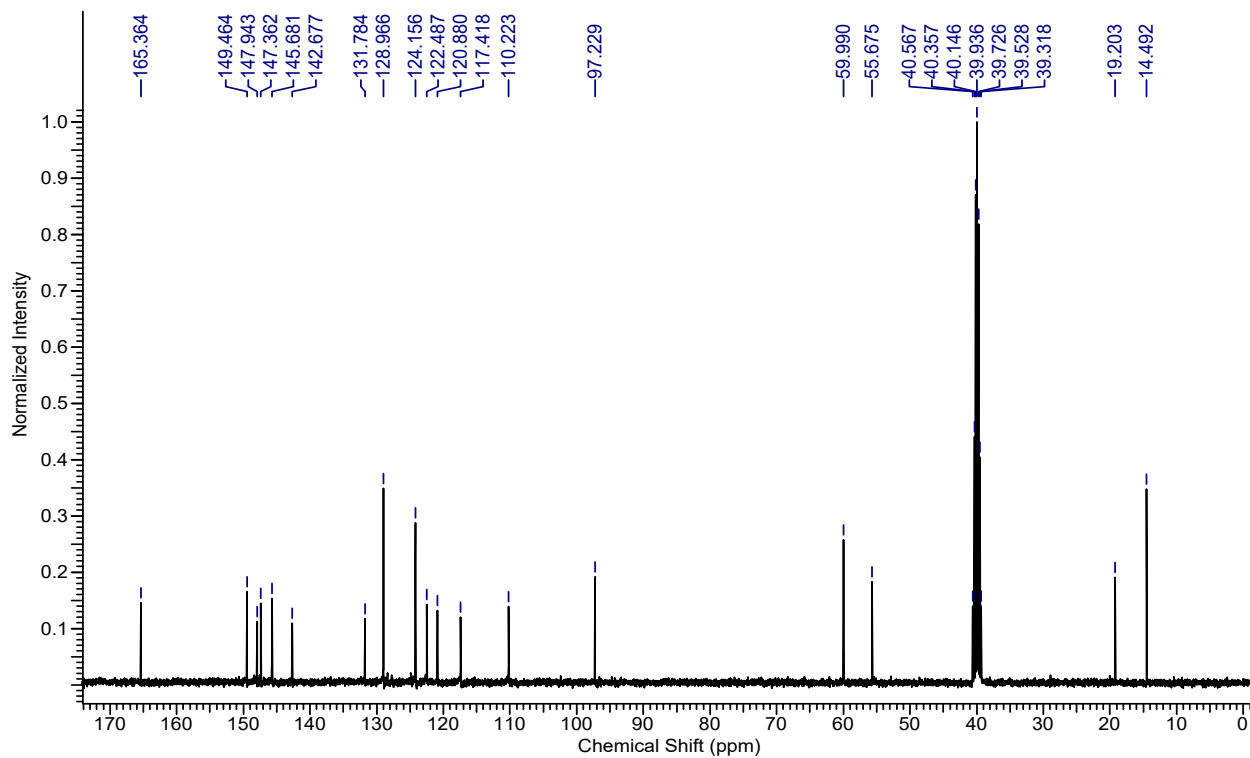
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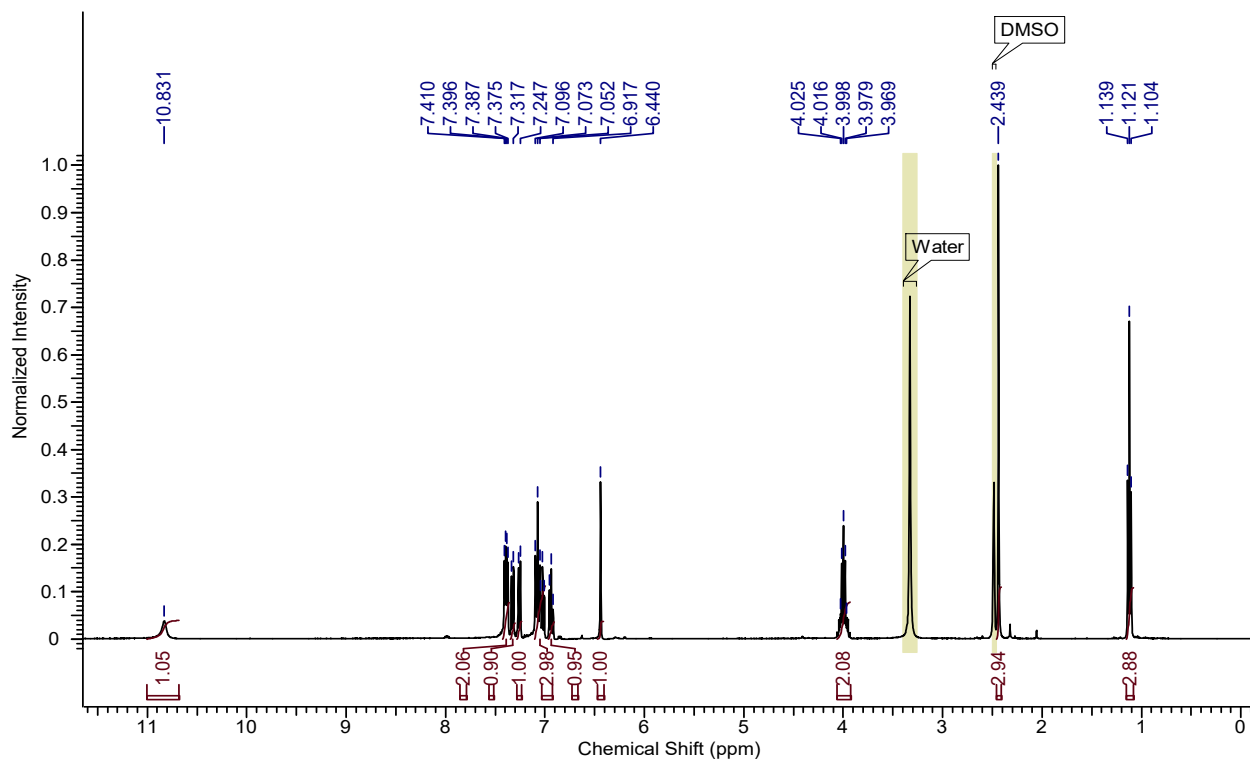
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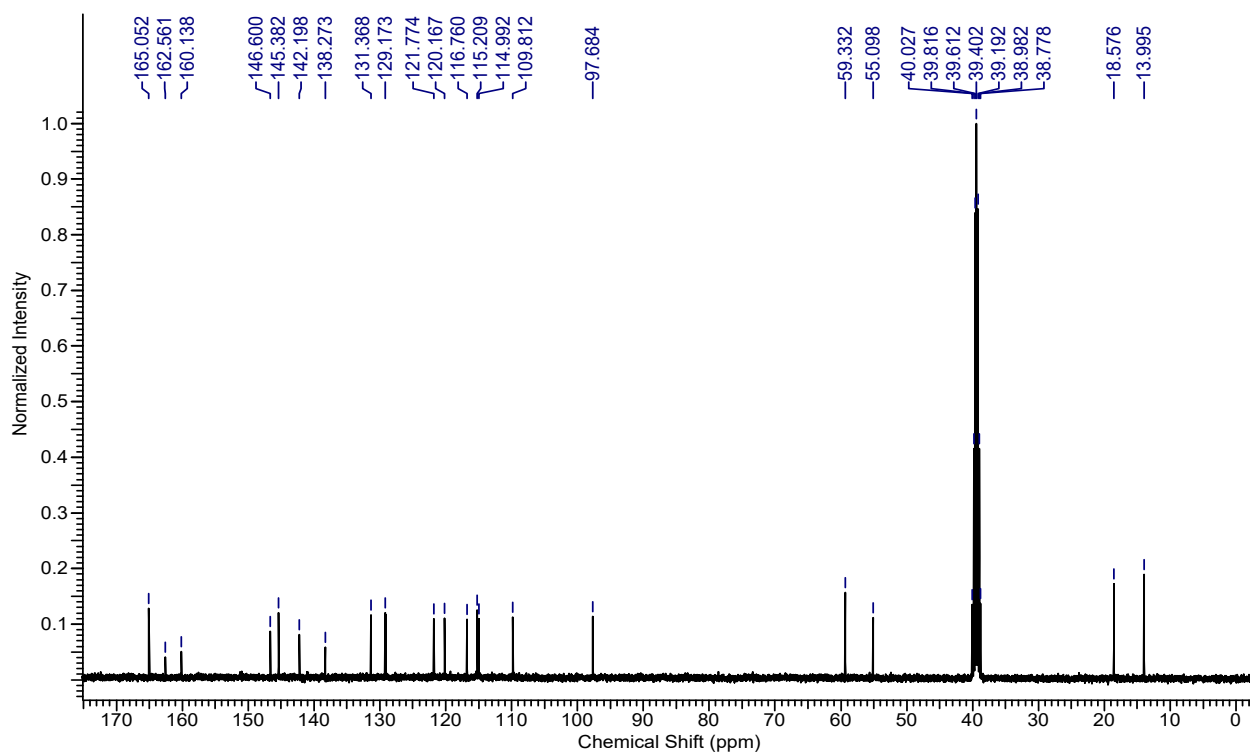
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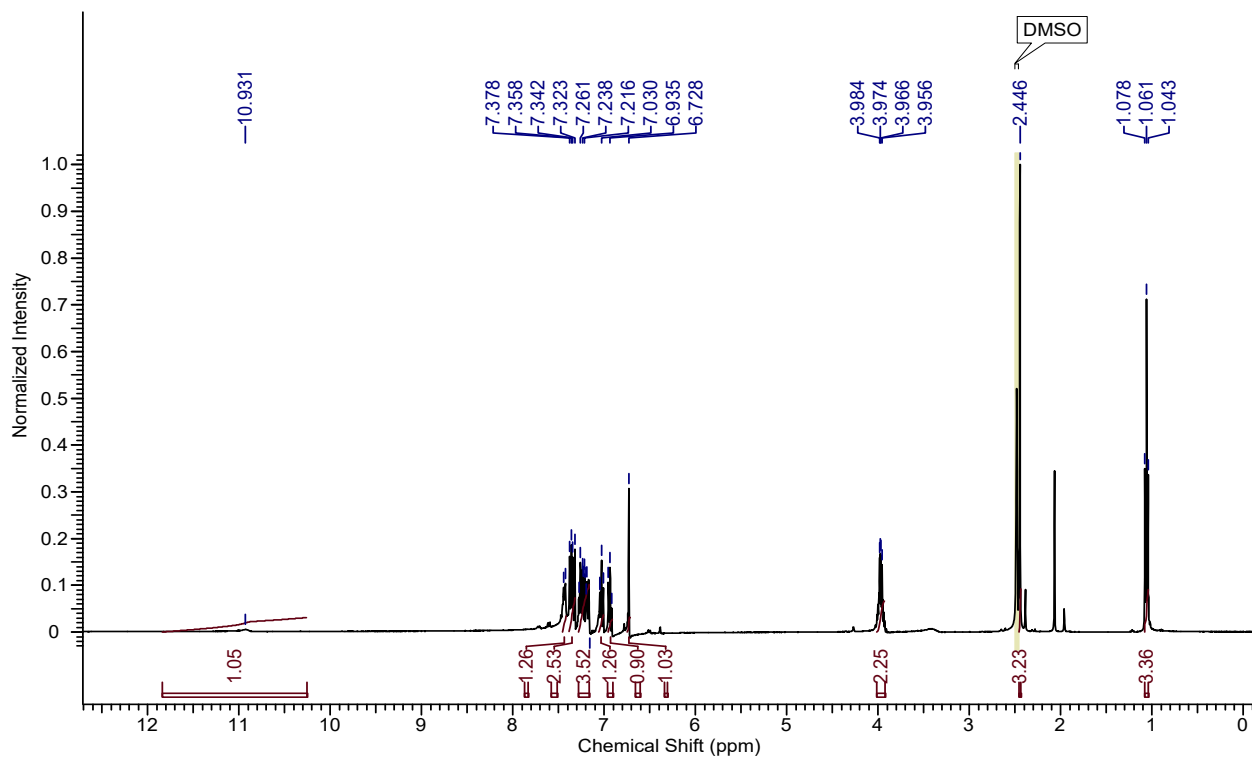
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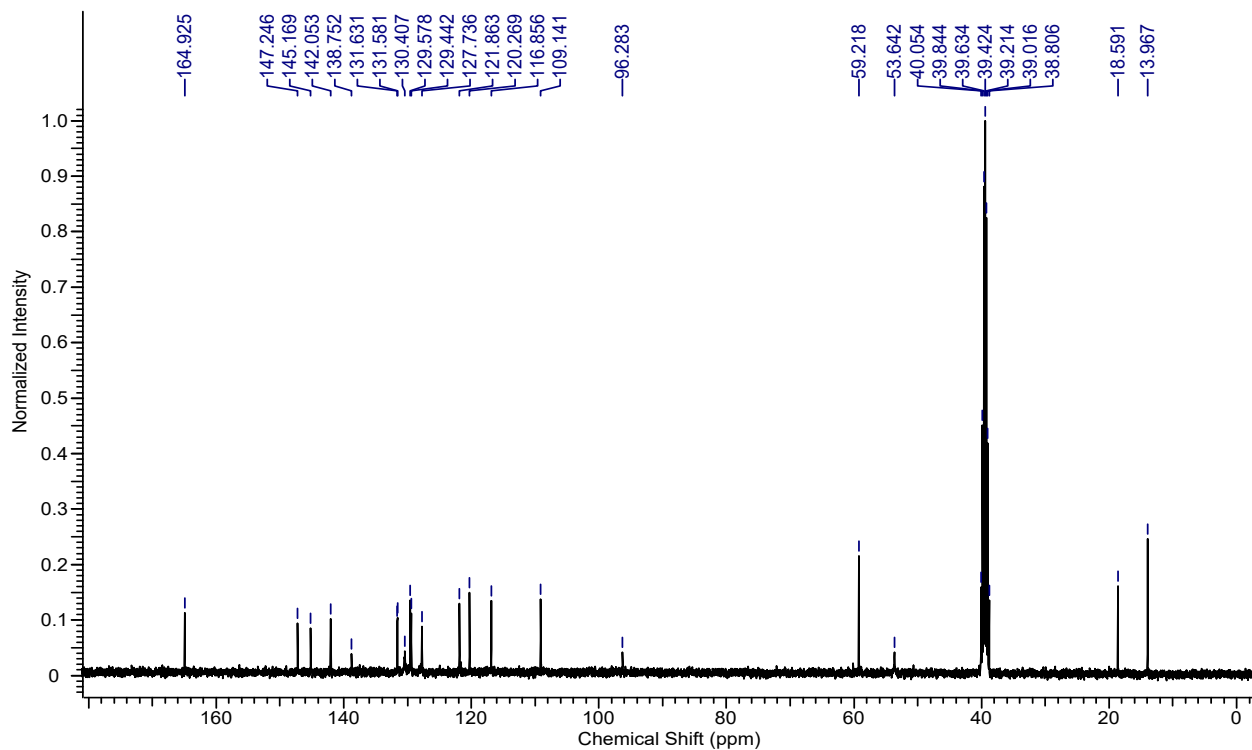
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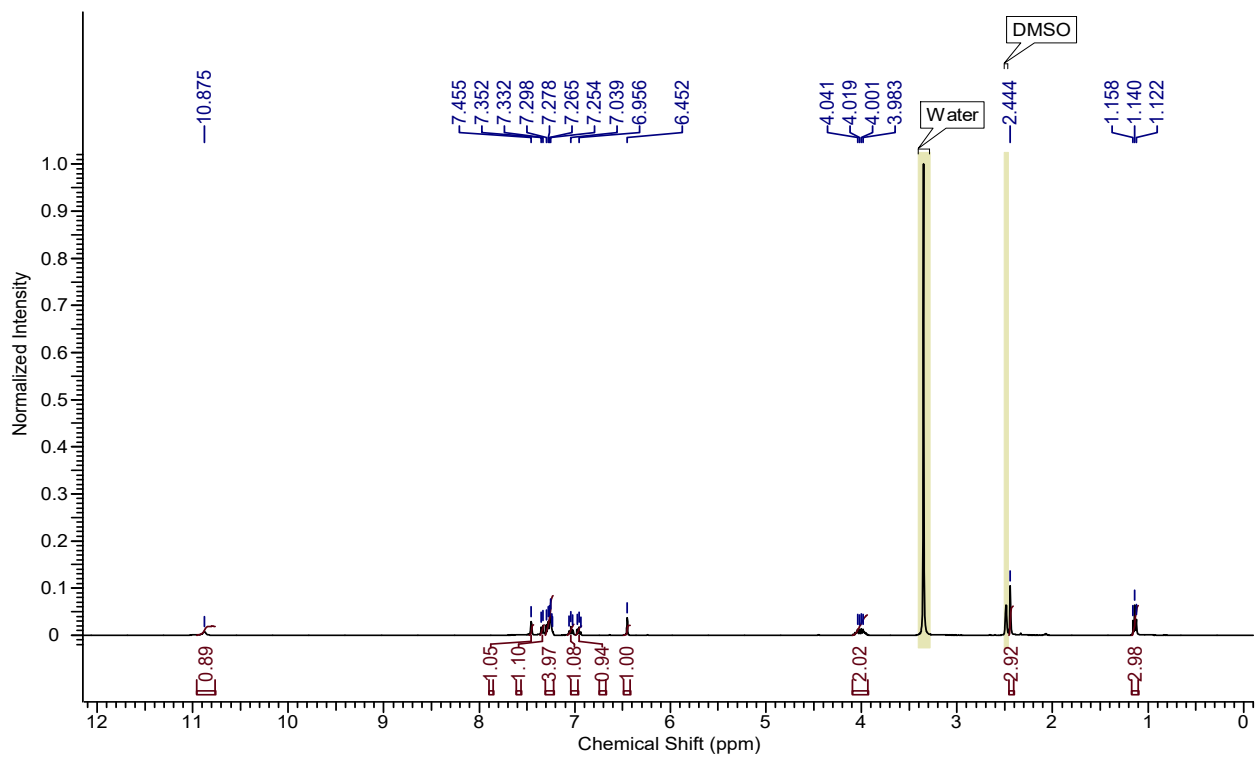
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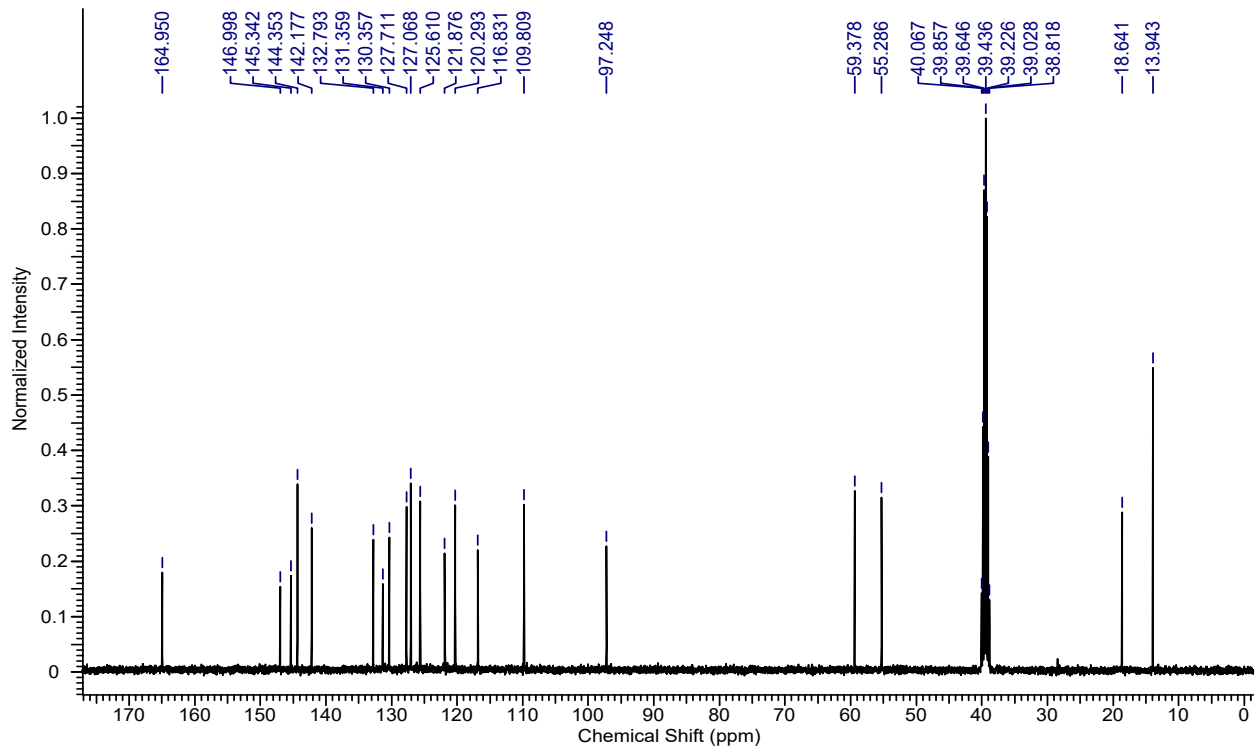
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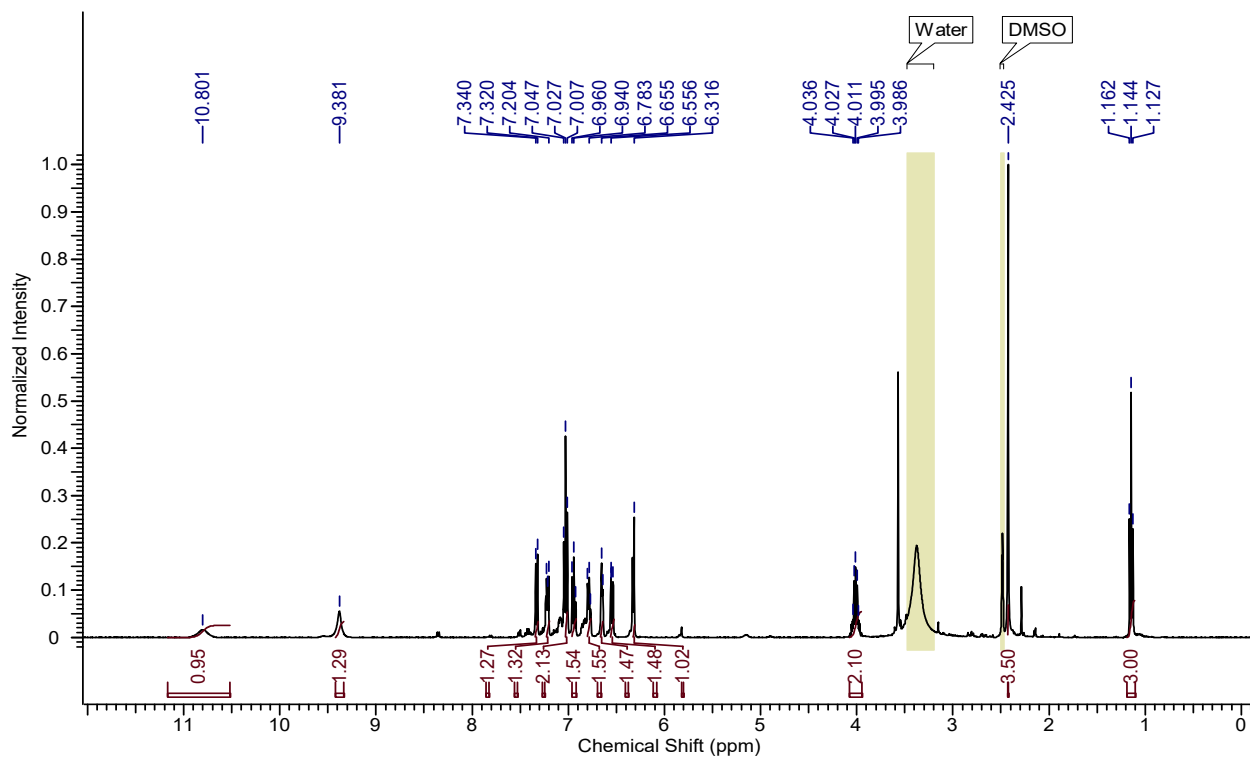
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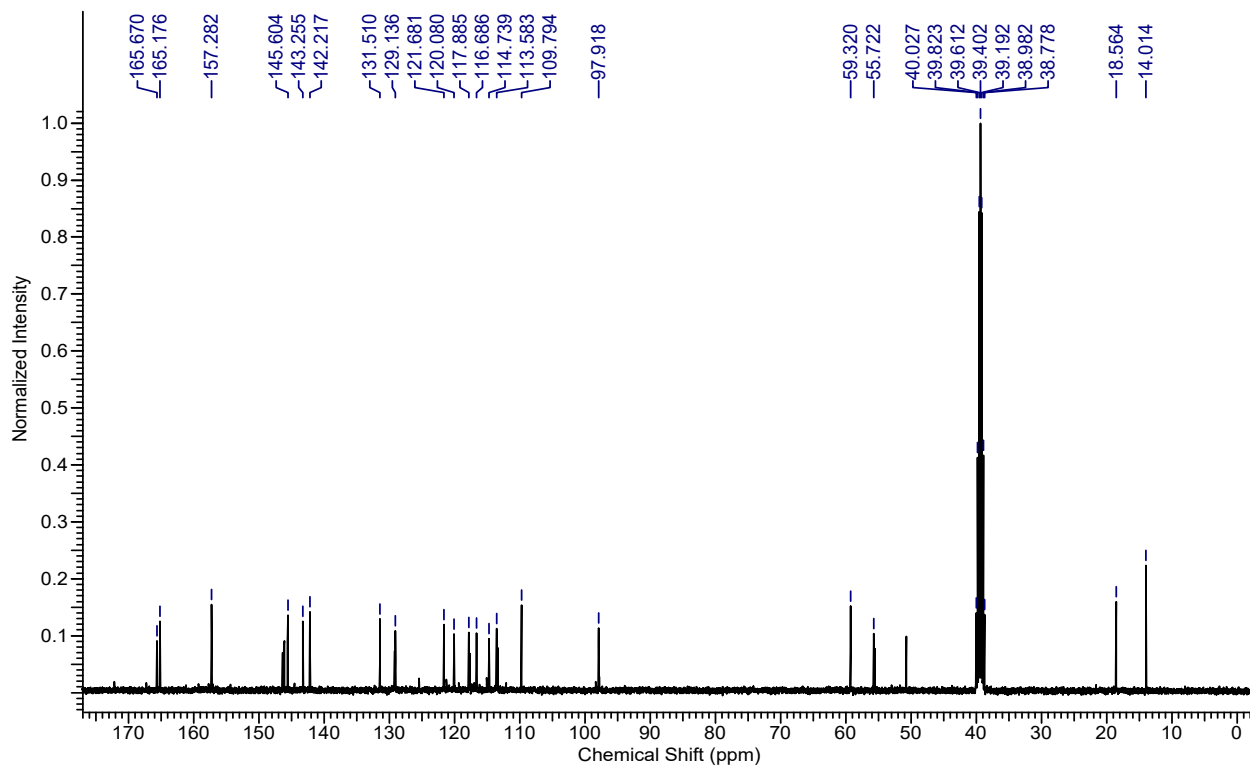
¹³C NMR of (6j)



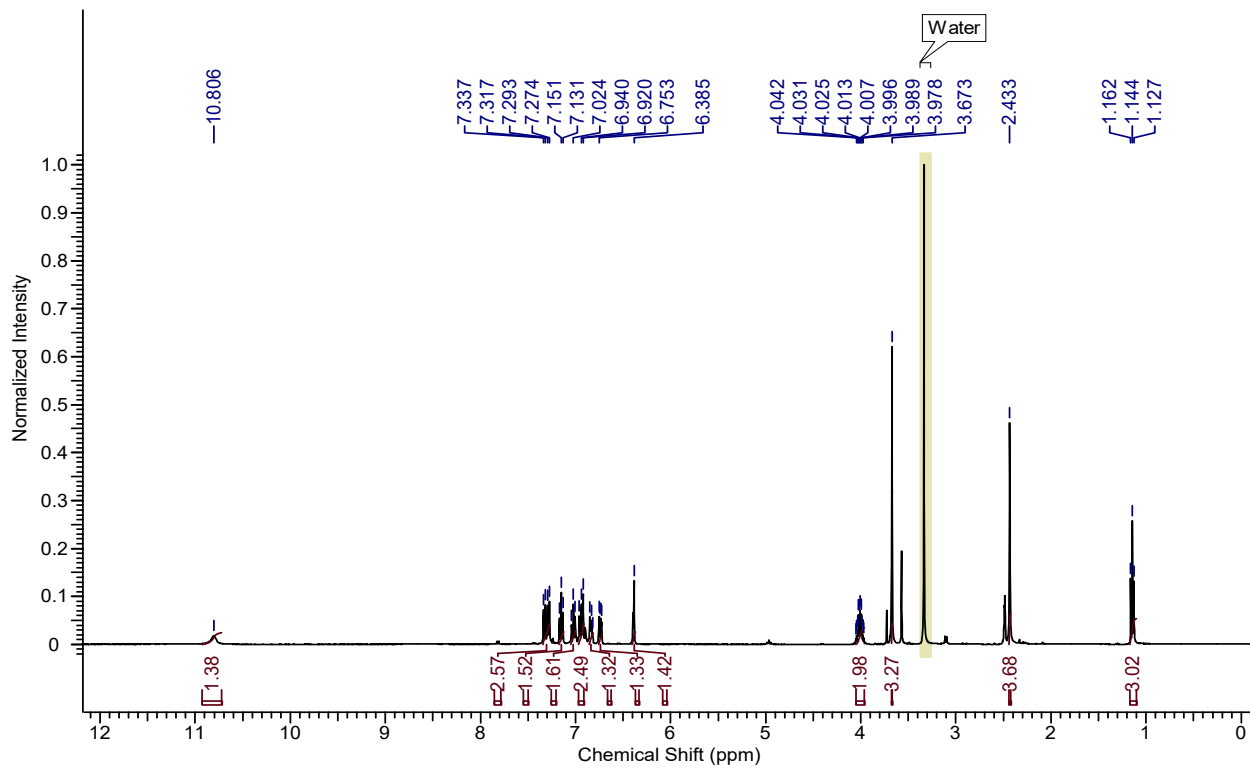
¹H NMR of (6k)



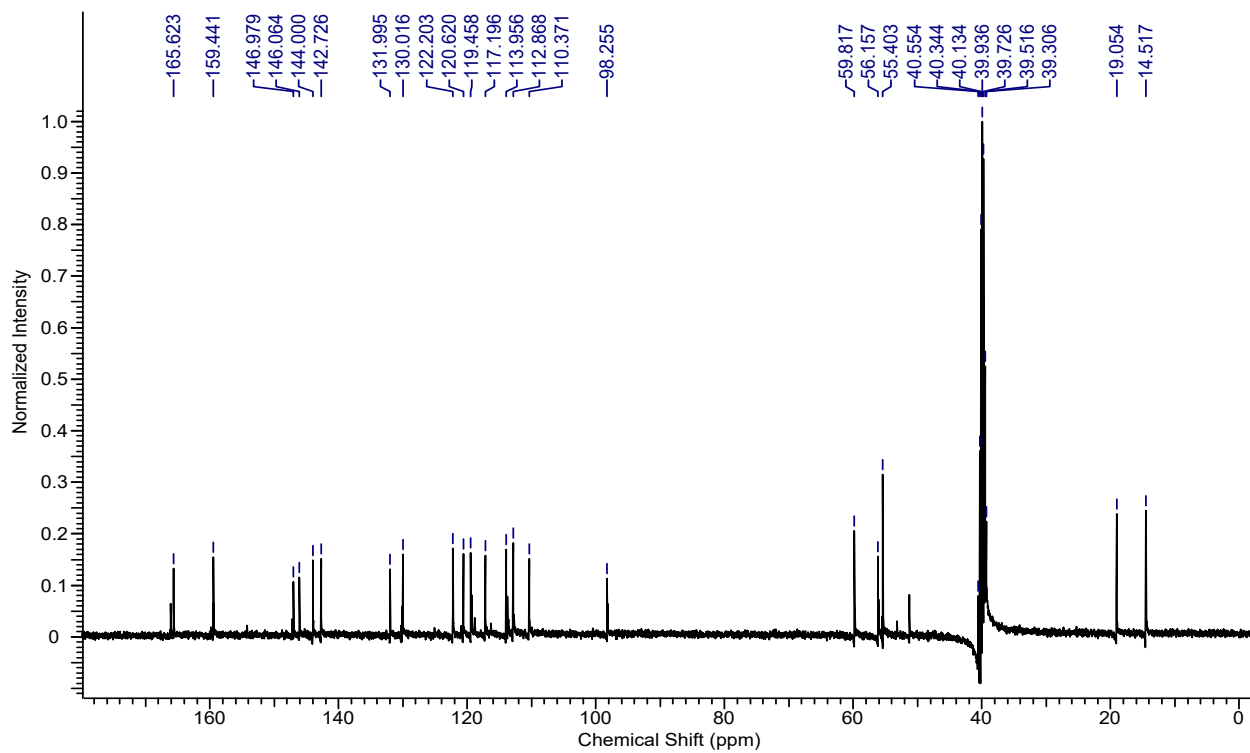
¹³C NMR of (6k)



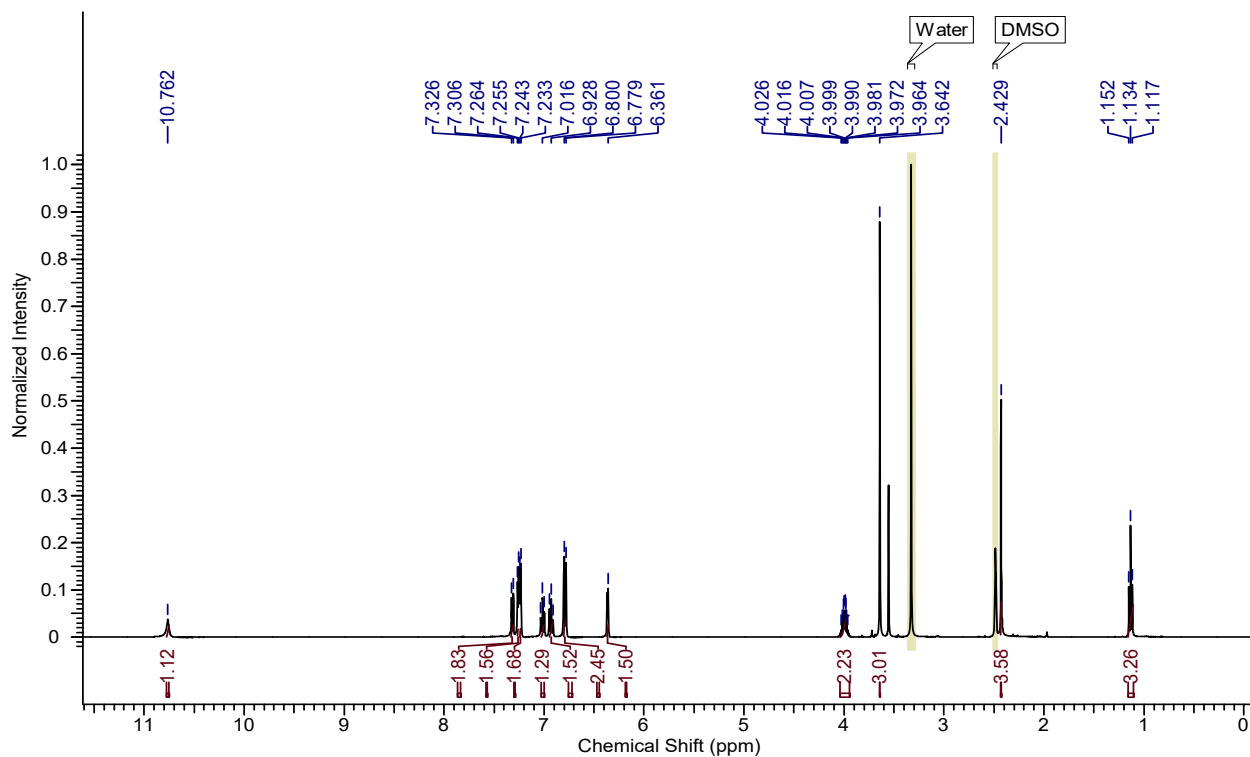
¹H NMR of (6l)



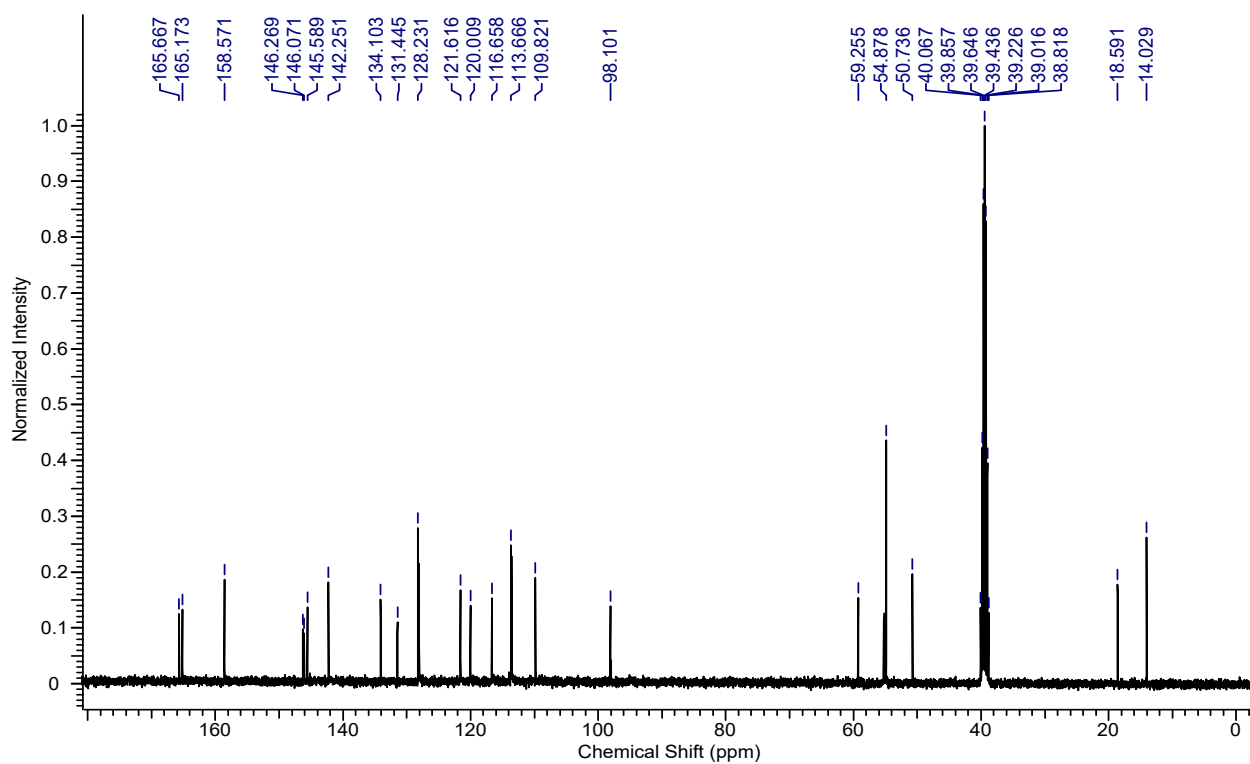
¹³C NMR of (6l)



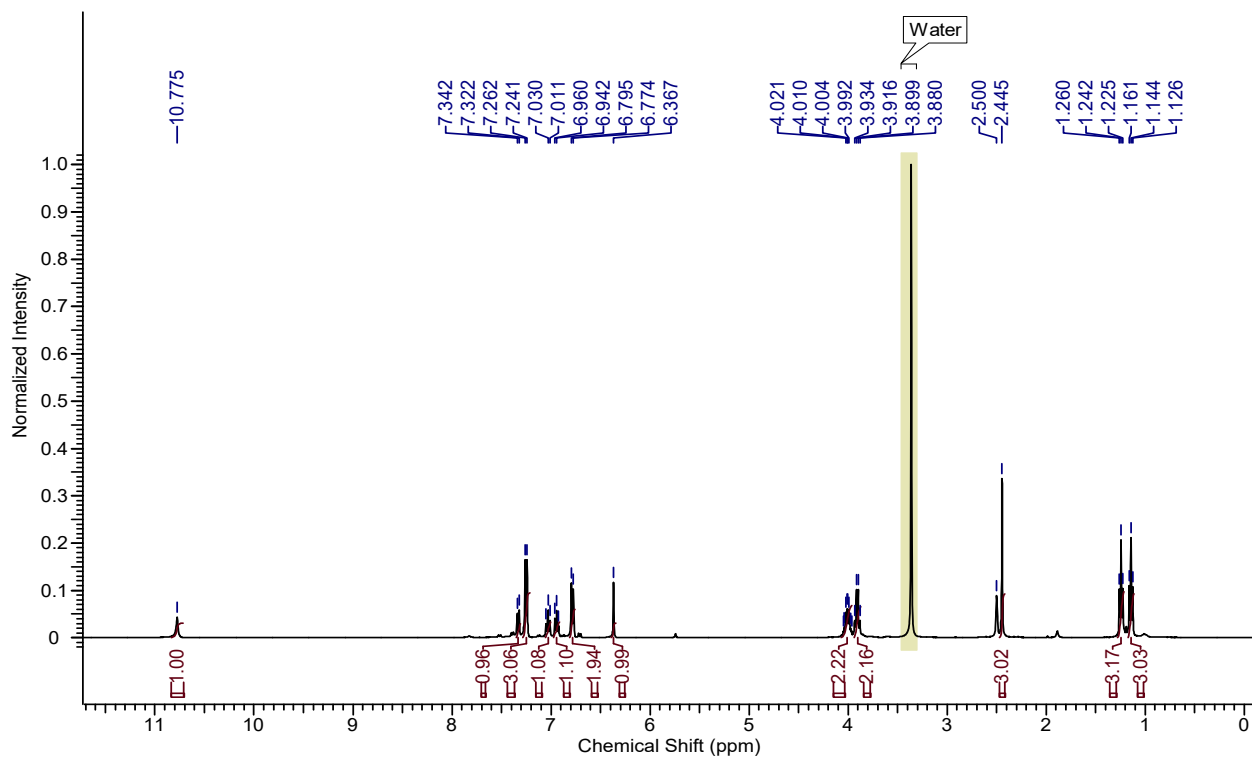
¹H NMR of (6m)



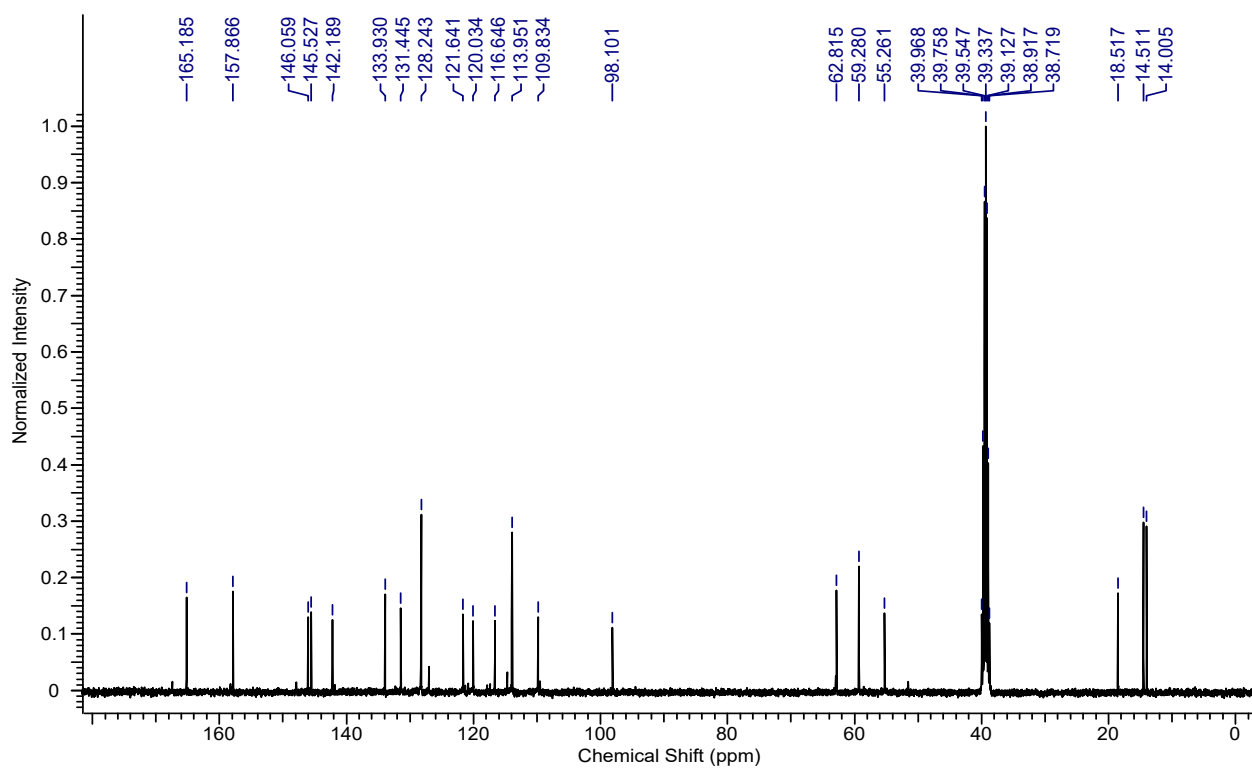
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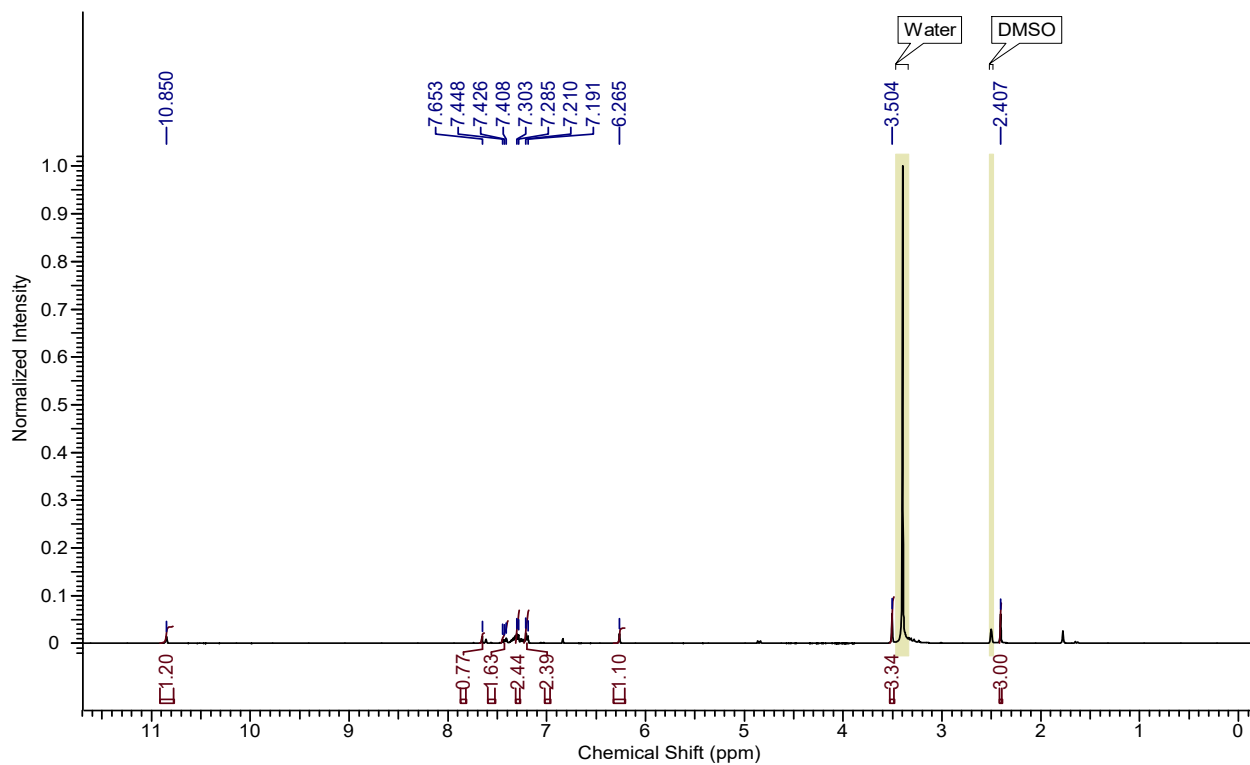
¹H NMR of (6n)



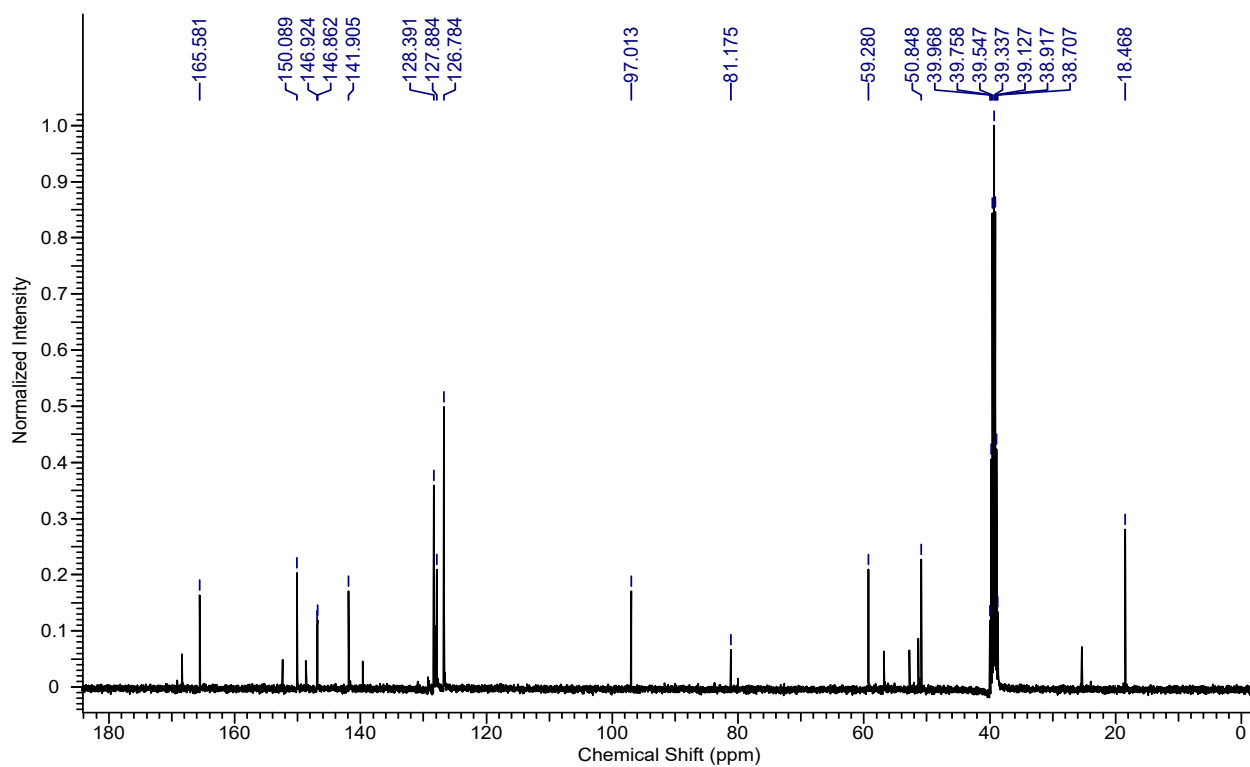
¹³C NMR of (6n)



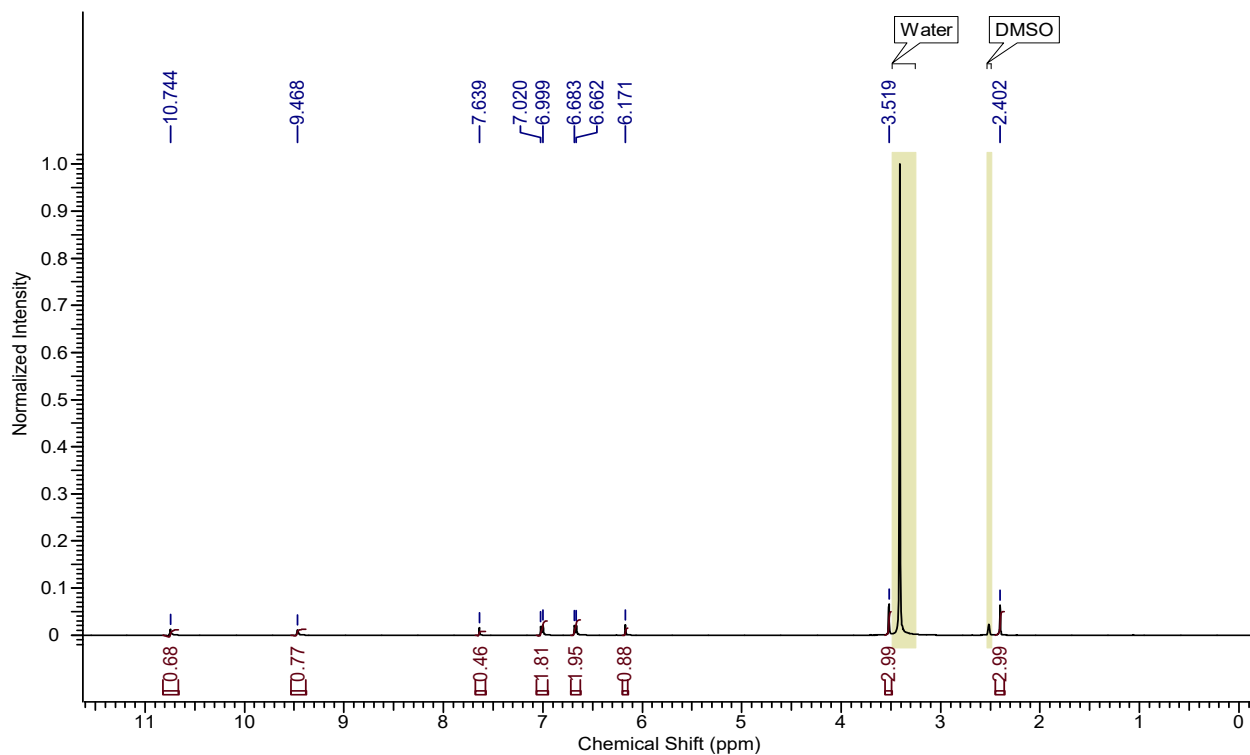
¹H NMR of (8a)



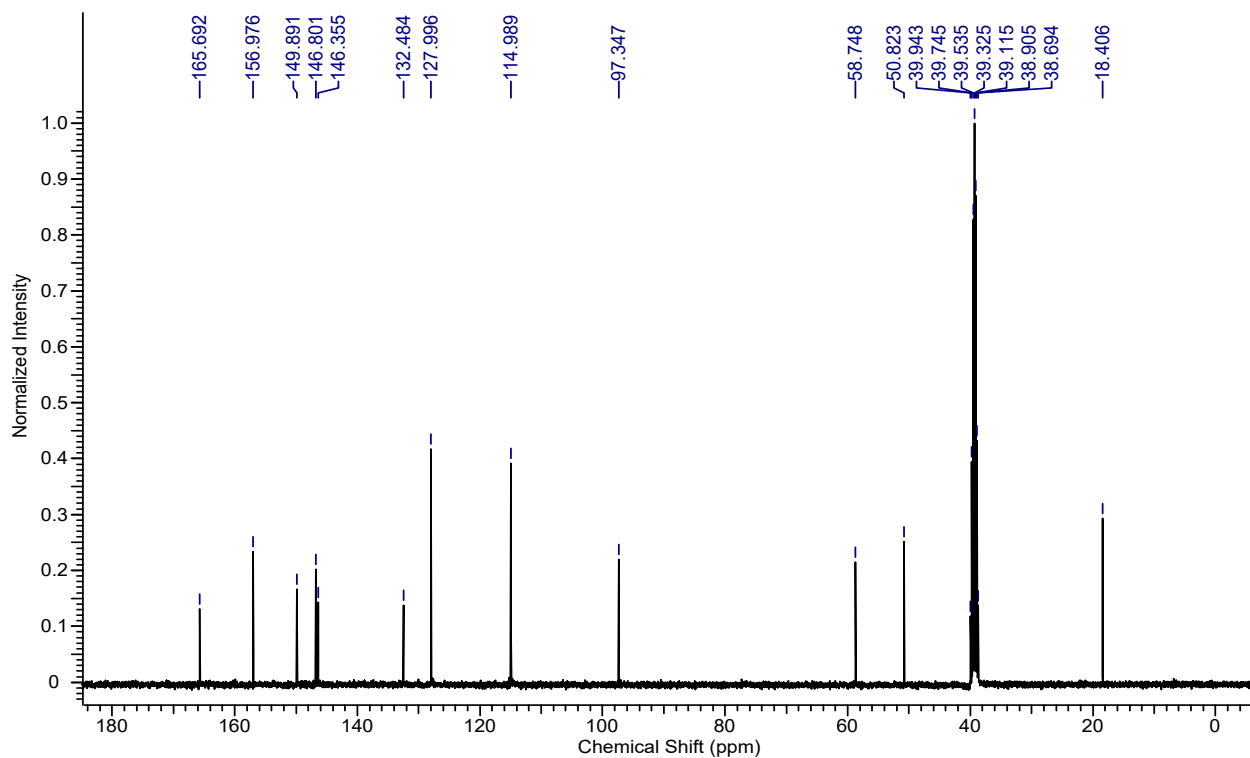
¹³C NMR of (8a)



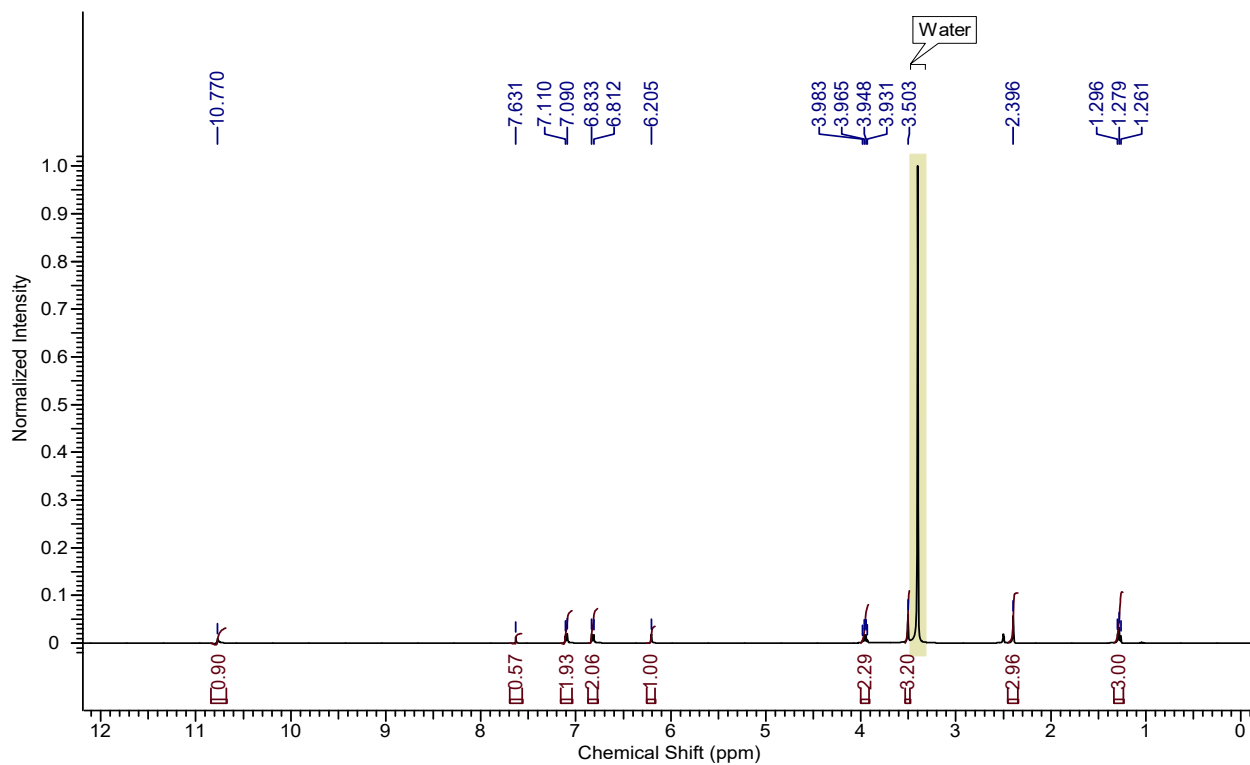
¹H NMR of (8b)



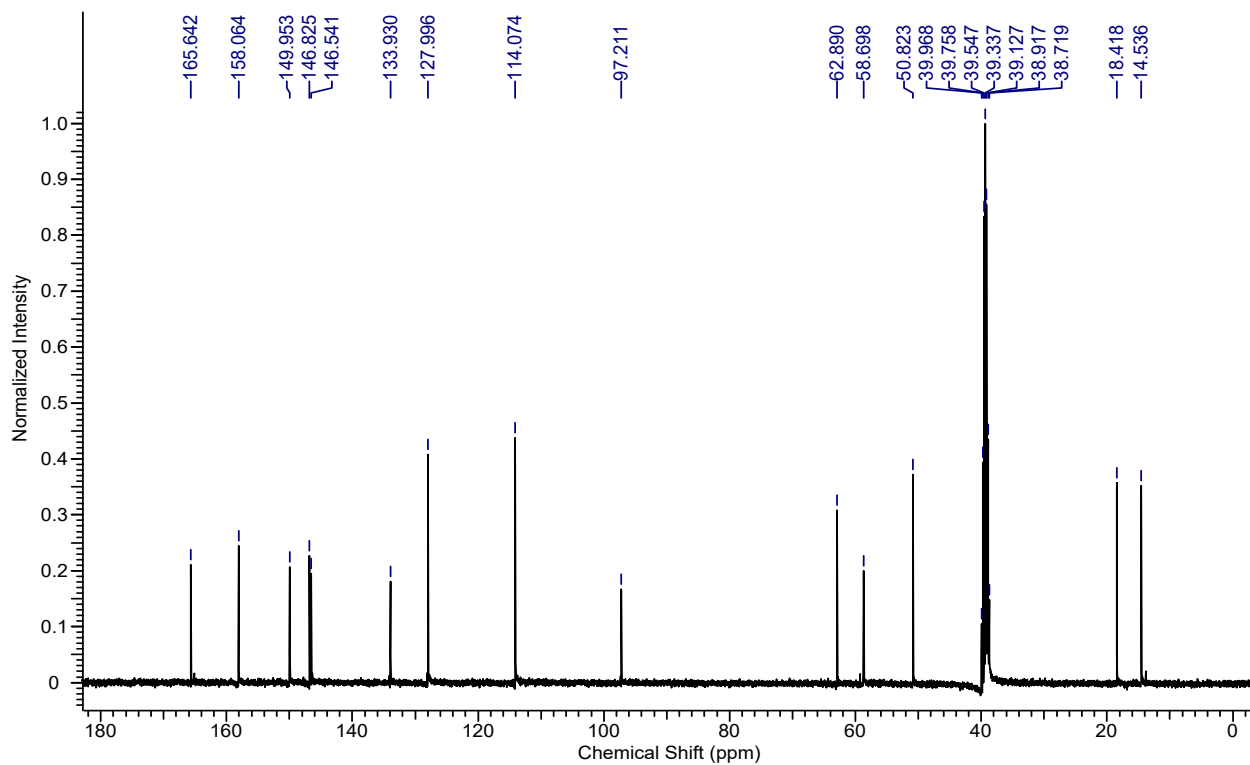
¹³C NMR of (8b)



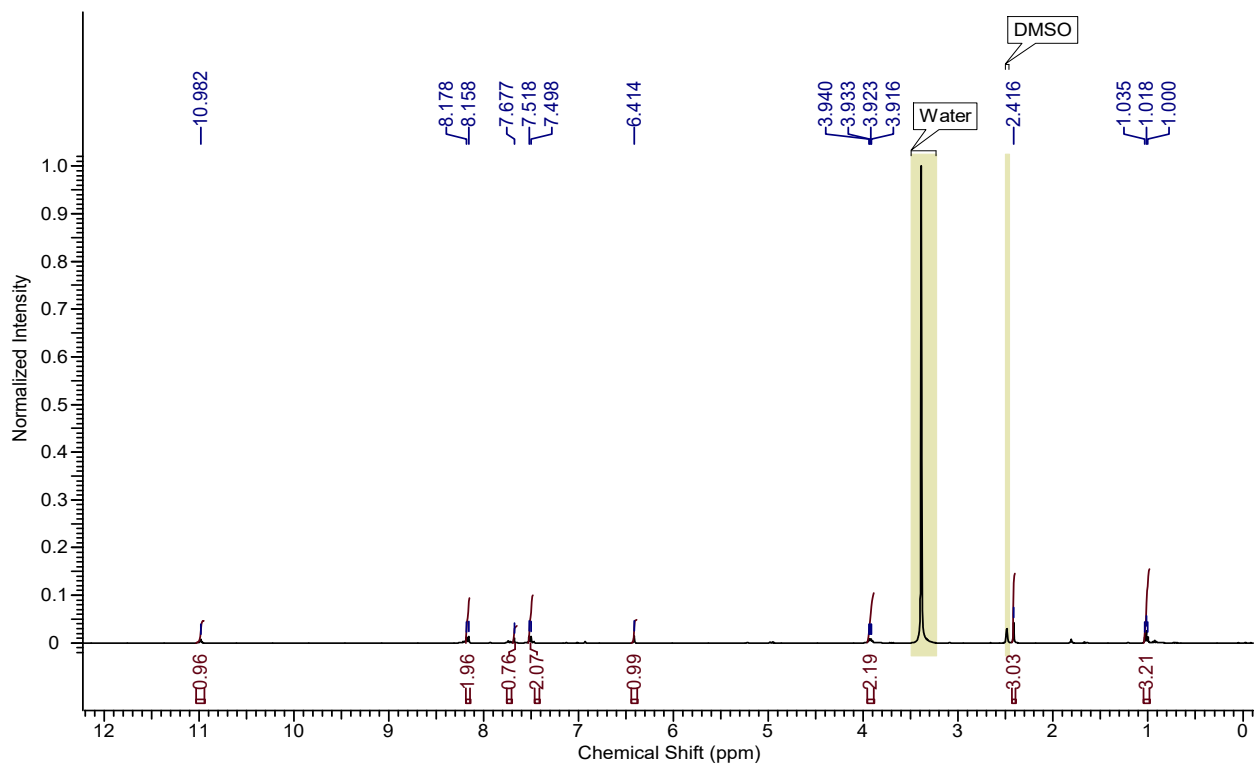
¹H NMR of (8c)



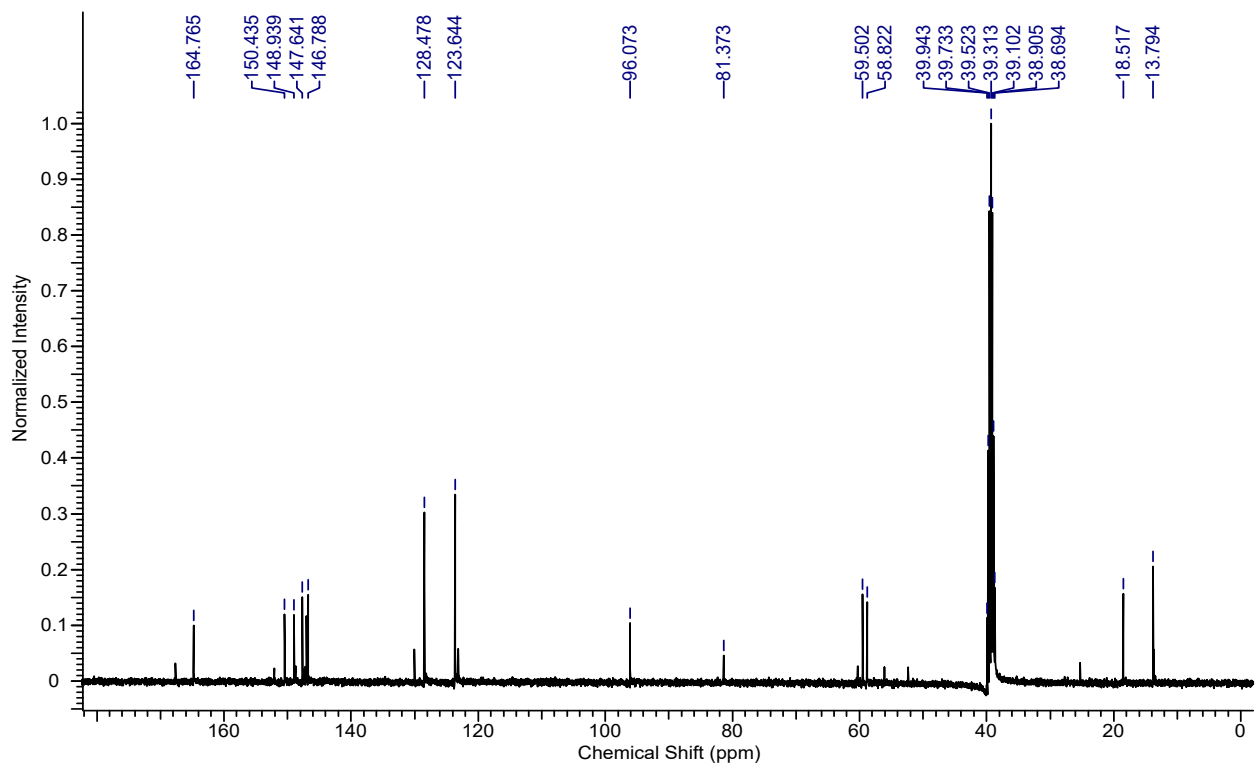
¹³C NMR of (8c)



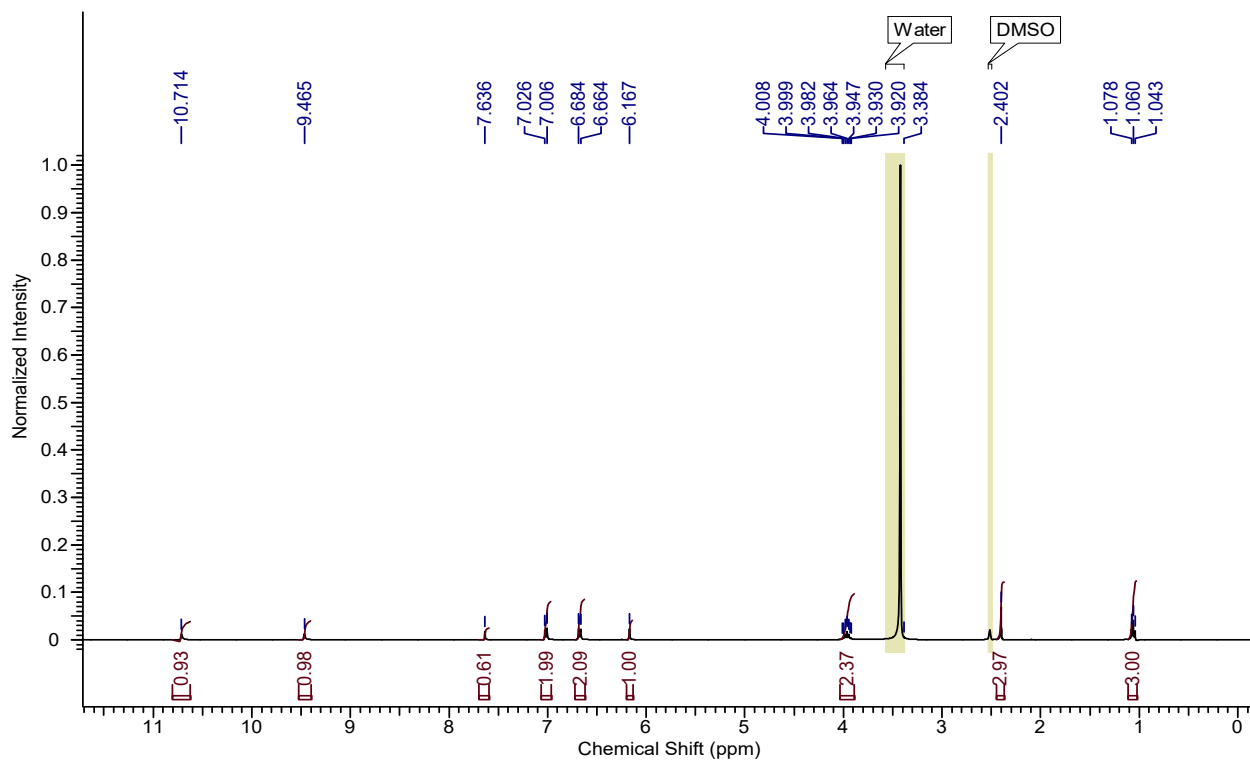
¹H NMR of (8d)



¹³C NMR of (8d)



¹H NMR of (8e)



¹³C NMR of (8e)

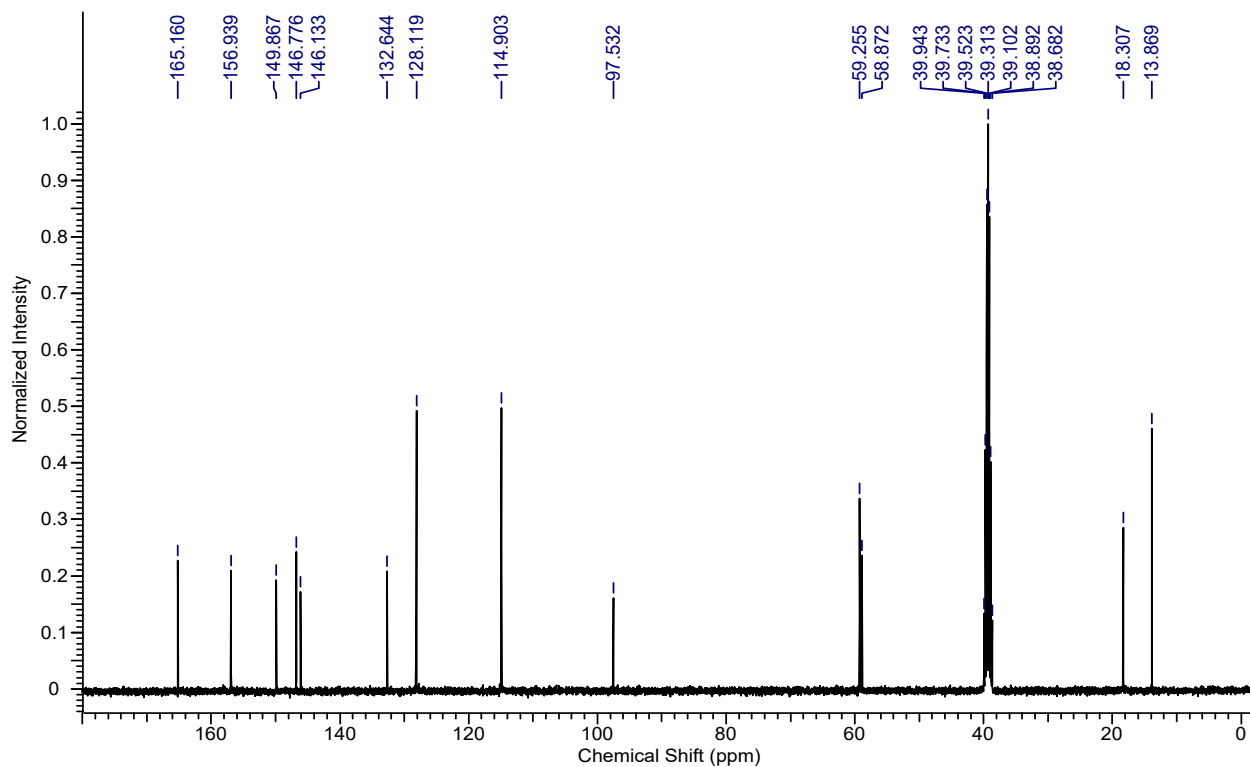


Table-1: In-vitro anthelmintic activity of benzimidazole derivatives against *S. obvelata*. All data are expressed as mean \pm SEM. All data are statistically significant at $p \leq 0.005$ followed by Tukey's test

Benzimidazole derivatives	R	R1	<i>S.obvelata</i> Paralysis Time at 200	<i>S.obvelata</i> MortalityTime at 200 μ g/ml	<i>S.obvelata</i> Paralysis Time at 800	<i>S.obvelata</i> MortalityTime at 800 μ g/ml
6b	OCH ₃	4-Br-C ₆ H ₄	9.83 \pm .21	12.25 \pm .32	10.08 \pm .13	10.41 \pm .54
6c	OCH ₃	4-F-C ₆ H ₄	13.50 \pm .71	16.5 \pm .17	10.91 \pm .48	12.41 \pm .48
6d	OCH ₃	3-OH-C ₆ H ₄	7.41 \pm .47	9.66 \pm .15	6.83 \pm .26	8.50 \pm .24
6e	OCH ₃	4-OCH ₃ -C ₆ H ₄	15.08 \pm .33	18.58 \pm .57	12.75 \pm .12	16.16 \pm .16
6f	OCH ₃	3-OCH ₃ -C ₆ H ₄	16.66 \pm .74	20.08 \pm .22	12.33 \pm .79	14.83 \pm .44
6h	OCH ₂ CH ₃	4-F-C ₆ H ₄	10.58 \pm .23	13.25 \pm .33	10.16 \pm .33	11.83 \pm .25
6i	OCH ₂ CH ₃	2-Cl-C ₆ H ₄	13.33 \pm .66	15.75 \pm .27	12.75 \pm .54	14.16 \pm .16
6j	OCH ₂ CH ₃	3-Cl-C ₆ H ₄	12.41 \pm .27	14.83 \pm .52	10.08 \pm .19	11.66 \pm .23
6k	OCH ₂ CH ₃	3-OH-C ₆ H ₄	8.91 \pm .35	10.91 \pm .11	7.41 \pm .37	8.33 \pm .07
6l	OCH ₂ CH ₃	3-OCH ₃ -C ₆ H ₄	17.21 \pm 1.05	19.58 \pm .84	12.66 \pm .82	14.83 \pm .62
6m	OCH ₂ CH ₃	4-OCH ₃ -C ₆ H ₄	16.16 \pm .62	18.75 \pm .79	13.5 \pm .82	15.25 \pm .43
6n	OCH ₂ CH ₃	4-OEt- C ₆ H ₄	15.83 \pm .54	19.41 \pm .61	14.91 \pm .60	18.08 \pm .76
8a	OCH ₃	C ₆ H ₄	18.08 \pm .25	20.83 \pm .83	13.41 \pm .12	14.83 \pm .44
8b	OCH ₃	4-OH ₂ -C ₆ H ₄	13.91 \pm .66	17.33 \pm .58	11.16 \pm .54	12.58 \pm .46
8c	OCH ₃	4-OEt-C ₆ H ₄	18.50 \pm .70	21.5 \pm .30	14.83 \pm .78	17.7 \pm .34
8d	OCH ₂ CH ₃	4-NO ₂ -C ₆ H ₄	12.58 \pm .18	15.33 \pm .39	10.25 \pm .62	11.33 \pm .31
8e	OCH ₂ CH ₃	4-OH ₂ -C ₆ H ₄	13.83 \pm .11	16.83 \pm .33	10.25 \pm .23	11.23 \pm .14
ALZ			13.75 \pm .85	16.08 \pm .56	6.56 \pm .18	8.33 \pm .27
Control			36.41 \pm .121		43.75 \pm 1.55	

Table 2: *In vivo* anthelmintic effects of benzimidazole derivatives on *S. obvelata* in infected laboratory mice (n=5). Data are expressed as mean \pm SEM. All data are statistically significant at $p \leq 0.005$ followed by Tukey's test

Groups	Benzimidazole Derivatives	Worm Count at Necropsy		Percentage reduction in worm count (%)
		Min-Max	Mean \pm SEM	
I	Control	298-620	452 \pm 67.14	0
II	6k (-OH)			
	20 mg/kg	104-187	145.2 \pm 33.92	67.87
	80 mg/kg	38-92	71.6 \pm 20.62	84.15
III	6b (-Br)			
	20 mg/kg	87-232	160.2 \pm 53.65	64.55
	80 mg/kg	57-116	90.2 \pm 22.96	80.04
IV	8d (NO₂)			
	20 mg/kg	54-147	103.8 \pm 33.64	77.03
	80 mg/kg	17-64	39.8 \pm 17.65	91.19
V	Albendazole	23-57	39.4 \pm 13.27	91.28
	50 mg/kg			

Table 3: Repeated 28 days oral administration with benzimidazole derivatives at 80 mg/kg;ALZ at 50 mg/kg . Body weight and relative organ weight (ROW) of mice. Data are expressed as mean \pm SEM. All data are statistically significant at $p \leq 0.005$ followed by Tukey's test

Sl. No.	Compounds	BodyWeight (gm) (Week 0)	Body Weight (gm) (Week 4)	Liver gm)	Right Kidney (gm)	Left Kidney (gm)	Spleen (gm)
1.	6k(-OH)	24.7 \pm 0.10	22.8 \pm 0.18	1.42 \pm 0.22	0.20 \pm 0.16	0.22 \pm 0.27	0.08 \pm 0.02
2.	6b(-Br)	27.8 \pm 0.73	26.40 \pm 0.42	1.45 \pm 0.35	0.18 \pm 0.41	0.21 \pm 0.13	0.07 \pm 0.02
3.	8d (-NO₂)	27.11 \pm 0.23	24.6 \pm 0.63	1.32 \pm 0.18	0.14 \pm 0.17	0.16 \pm 0.20	0.10 \pm 0.01
4.	Control	26.25 \pm 0.31	28.26 \pm 0.52	1.85 \pm 0.12	0.21 \pm 0.21	0.23 \pm 0.41	0.07 \pm 0.03
5.	ALZ	25.41	24.04 \pm 0.33	1.62 \pm 0.11	0.17 \pm 0.70	0.17 \pm 0.15	0.06 \pm 0.01

Table 4: *In silico* Toxicity Prediction of Benzimidazole Derivatives using online tool Protox II

Compounds	Predicted LD ₅₀ mg/kg	Hepatotoxicity	Cytotoxicity	Mutagenicity	Carcinogenicity	Immunotoxicity	Toxicity Class
6b	2430	inactive	inactive	inactive	inactive	inactive	V
6c	2430	inactive	inactive	inactive	inactive	inactive	V
6d	2430	inactive	inactive	inactive	inactive	inactive	V
6e	2100	inactive	inactive	inactive	inactive	inactive	V
6f	2100	inactive	inactive	inactive	inactive	inactive	V
6h	2430	inactive	inactive	inactive	inactive	inactive	V
6i	1770	inactive	inactive	inactive	inactive	<u>active</u>	IV
6j	630	inactive	inactive	inactive	inactive	inactive	IV
6k	2430	inactive	inactive	inactive	inactive	inactive	V
6l	800	inactive	inactive	inactive	inactive	inactive	IV
6m	2100	inactive	inactive	inactive	inactive	inactive	V
6n	2100	inactive	inactive	inactive	inactive	inactive	V
8a	2100	inactive	inactive	inactive	inactive	inactive	V
8b	2100	<u>active</u>	inactive	<u>active</u>	<u>active</u>	inactive	V
8c	2100	inactive	inactive	<u>active</u>	inactive	inactive	V
8d	2025	inactive	inactive	<u>active</u>	<u>active</u>	inactive	V
8e	2025	inactive	inactive	inactive	inactive	inactive	V