

**Selective synthesis of tetrahydroimidazo[1,2-*a*]pyridine and pyrrolidine  
derivatives via One-pot two-step reaction**

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**Supporting Information**

|                                                                 |      |
|-----------------------------------------------------------------|------|
| Figures of single crystal structures Fig. s1-Fig. s5            | 2-3  |
| <sup>1</sup> H and <sup>13</sup> C NMR spectra of the compounds | 4-45 |

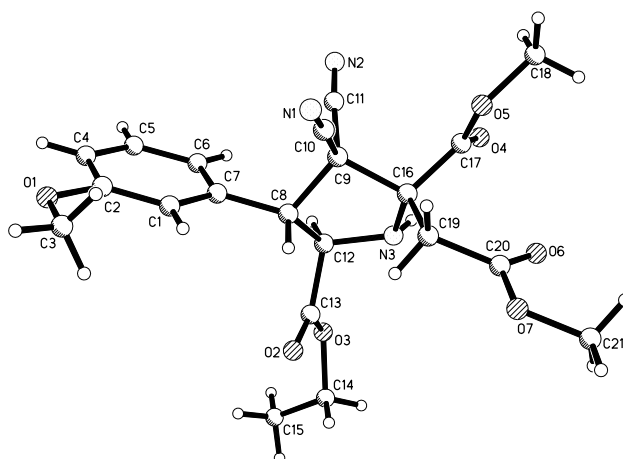


Fig. s1 Single crystal structure of compound **3d**

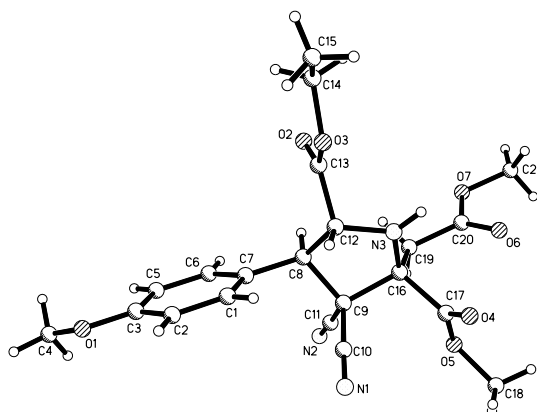


Fig. s2 Single crystal structure of compound **3e**

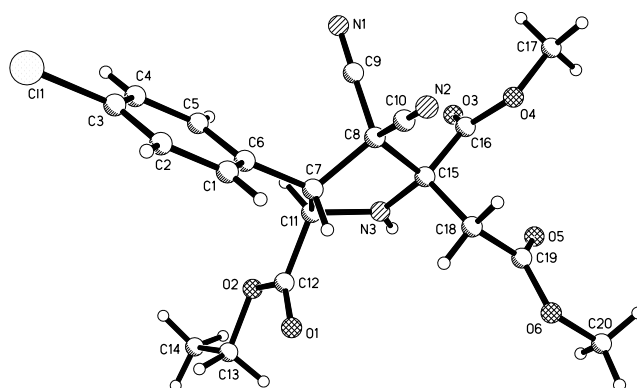


Fig. s3 Single crystal structure of compound **3i**

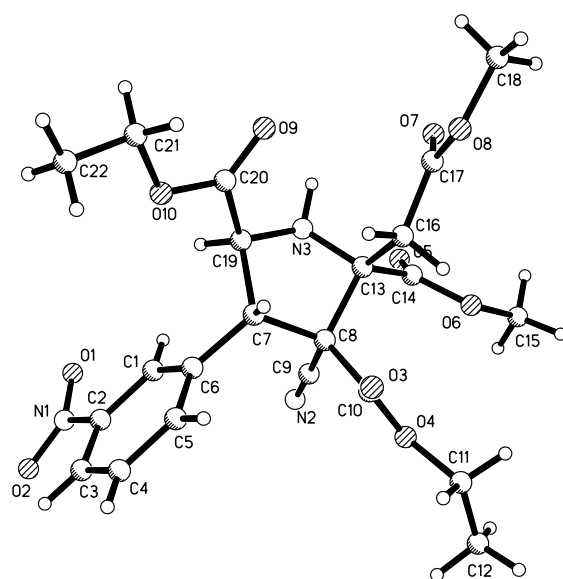


Fig. s4 Single crystal structure of compound **4f**

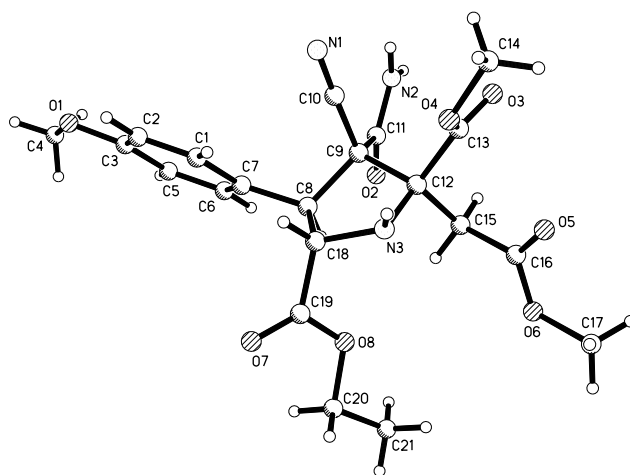
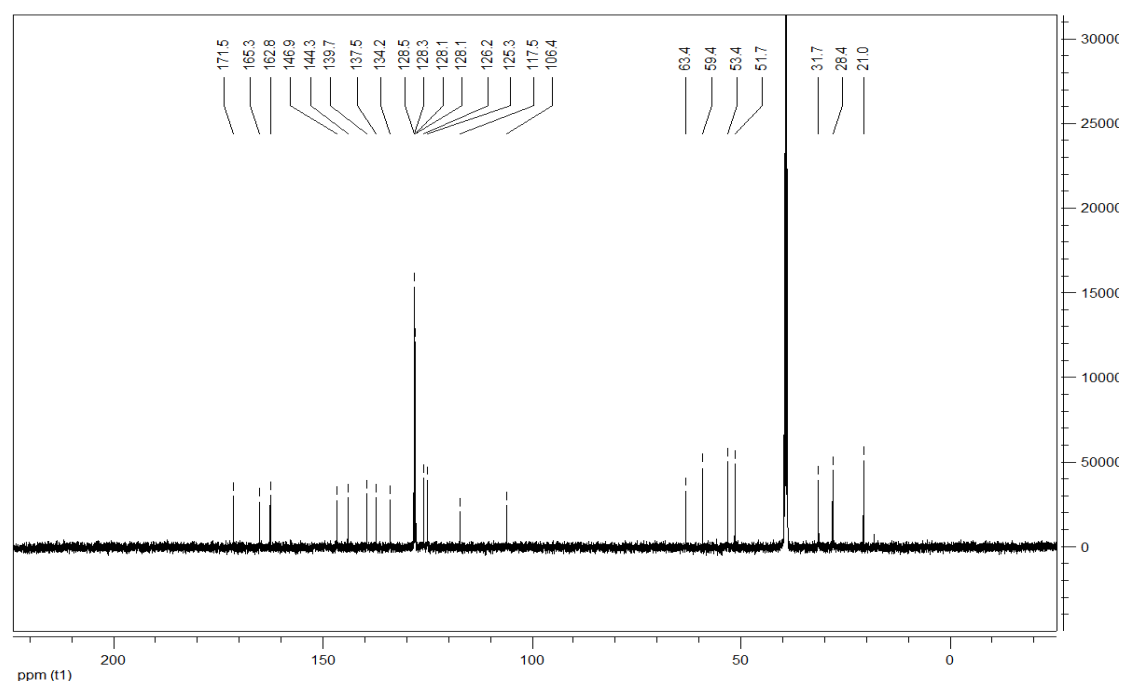
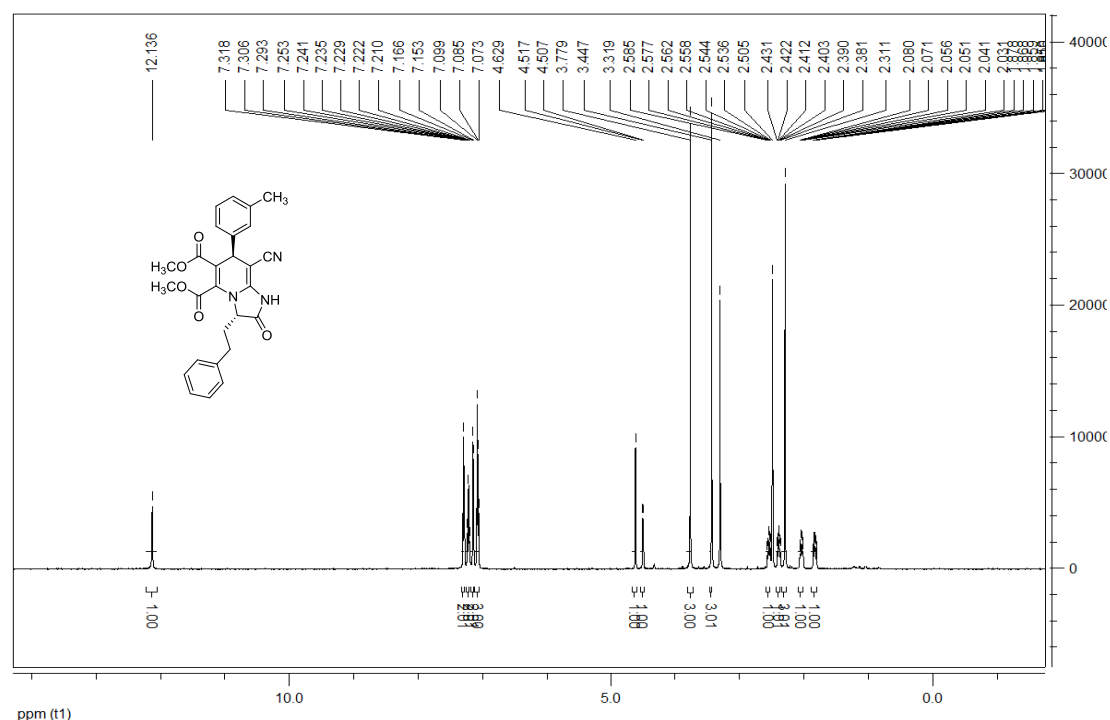


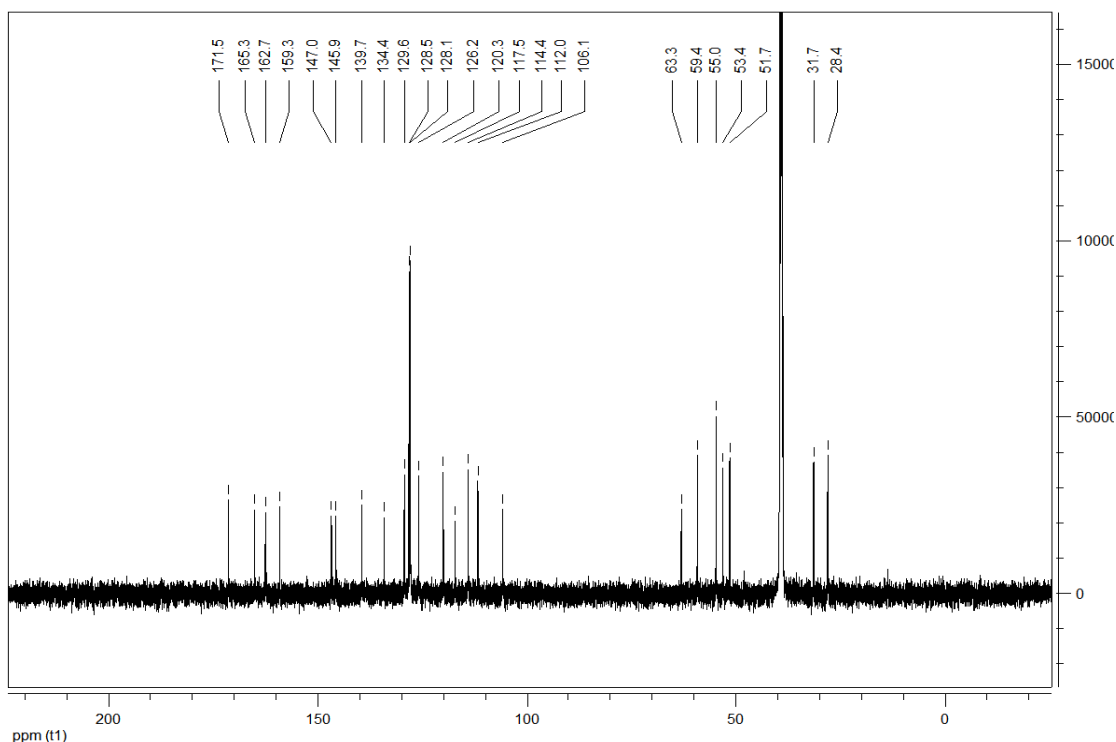
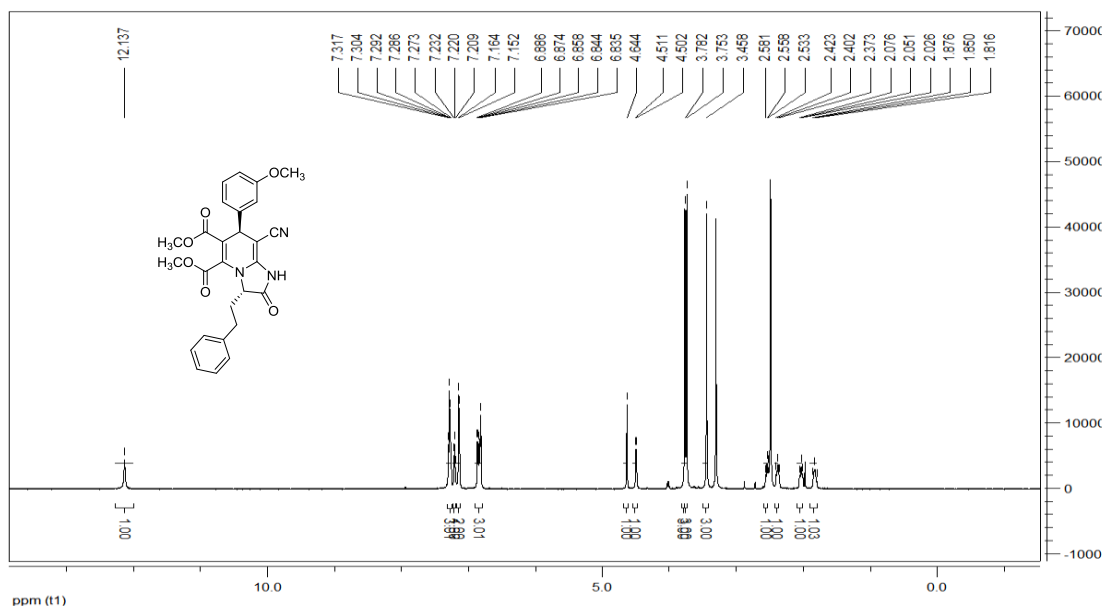
Fig. s5 Single crystal structure of compound **4m**



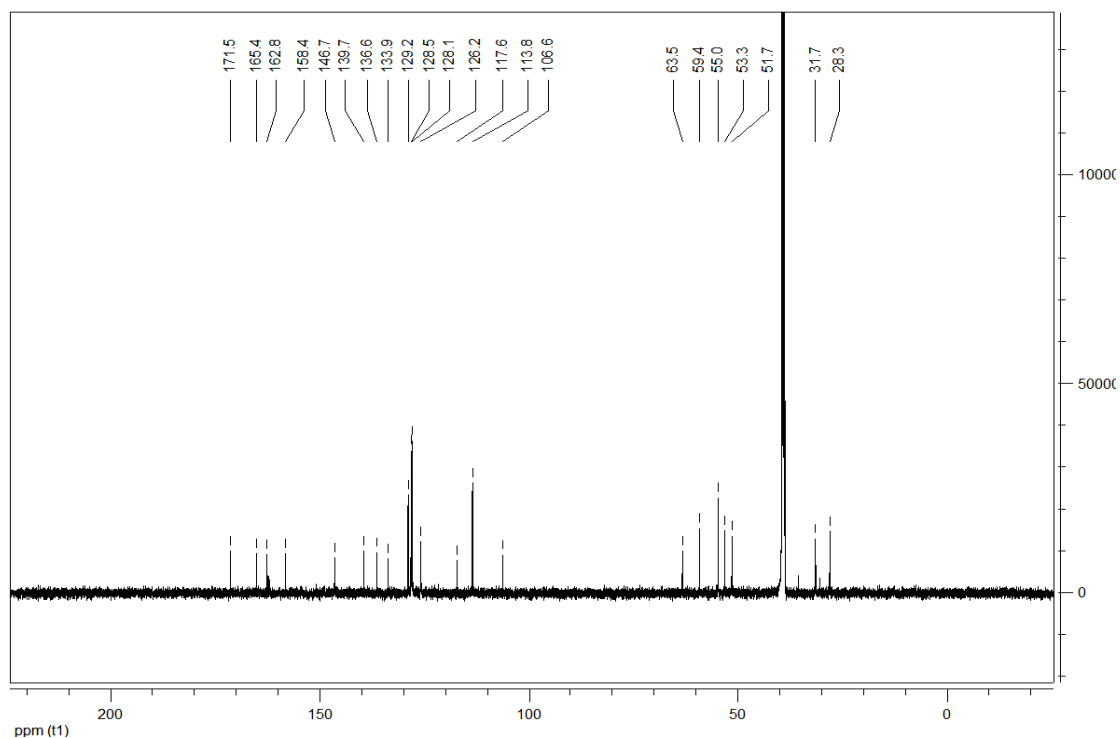
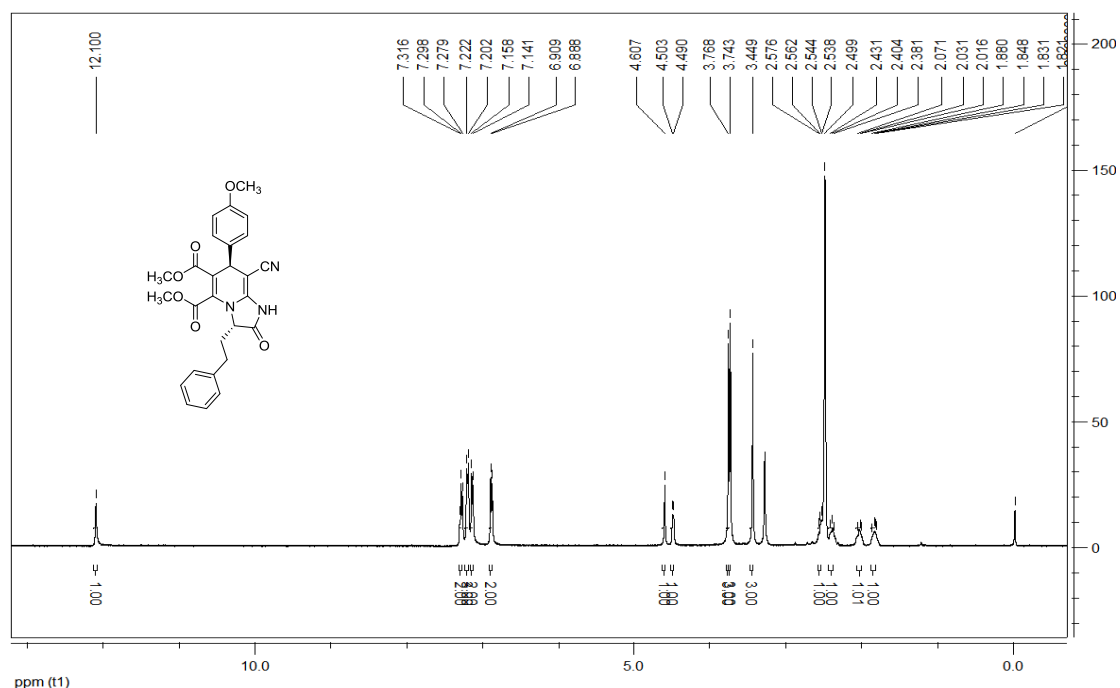
**Dimethyl 8-cyano-2-oxo-3-phenethyl-7-(m-tolyl)-1,2,3,7-tetrahydroimidazo[1,2-a]pyridine-5,6-dicarboxylate (1b):** yellow solid, 69%, m.p. 169~171 °C;  $^1\text{H}$  NMR (600MHz, DMSO- $d_6$ )  $\delta$ : 12.14(s, 1H, NH), 7.31 (t,  $J$  = 7.8 Hz, 2H, ArH), 7.25~7.21 (m, 2H, ArH), 7.16 (d,  $J$  = 7.8 Hz, 2H, ArH), 7.09 (t,  $J$  = 7.2 Hz, 3H, ArH), 4.63 (s, 1H, CH), 4.51 (d,  $J$  = 6.0 Hz, 1H, CH), 3.78 (s, 3H, OCH<sub>3</sub>), 3.45 (s, 3H, OCH<sub>3</sub>), 2.59~2.51 (m, 1H, CH), 2.43~2.38 (m, 1H, CH), 2.31 (s, 3H, CH<sub>3</sub>), 2.08~2.03 (m, 1H, CH), 1.88~1.82 (m, 1H, CH);  $^{13}\text{C}$  NMR (150 MHz, DMSO- $d_6$ )  $\delta$ : 171.4, 165.2, 162.7, 146.9, 144.2, 139.6, 137.5, 134.1, 128.4, 128.3, 128.1, 128.0, 126.1, 125.2, 117.5, 106.3, 63.3, 59.4, 53.3, 51.6, 31.7, 28.3, 21.0; IR (KBr)  $\nu$ : 3634, 3025, 2953, 2203, 1754, 1685, 1606, 1494, 1426, 1382, 1313, 1221, 1105, 972, 778, 705  $\text{cm}^{-1}$ ; MS (m/z): HRMS (ESI) Calcd. for  $\text{C}_{27}\text{H}_{25}\text{NaN}_3\text{O}_5$  ( $[\text{M}+\text{Na}]^+$ ): 494.1686. Found: 494.1691.



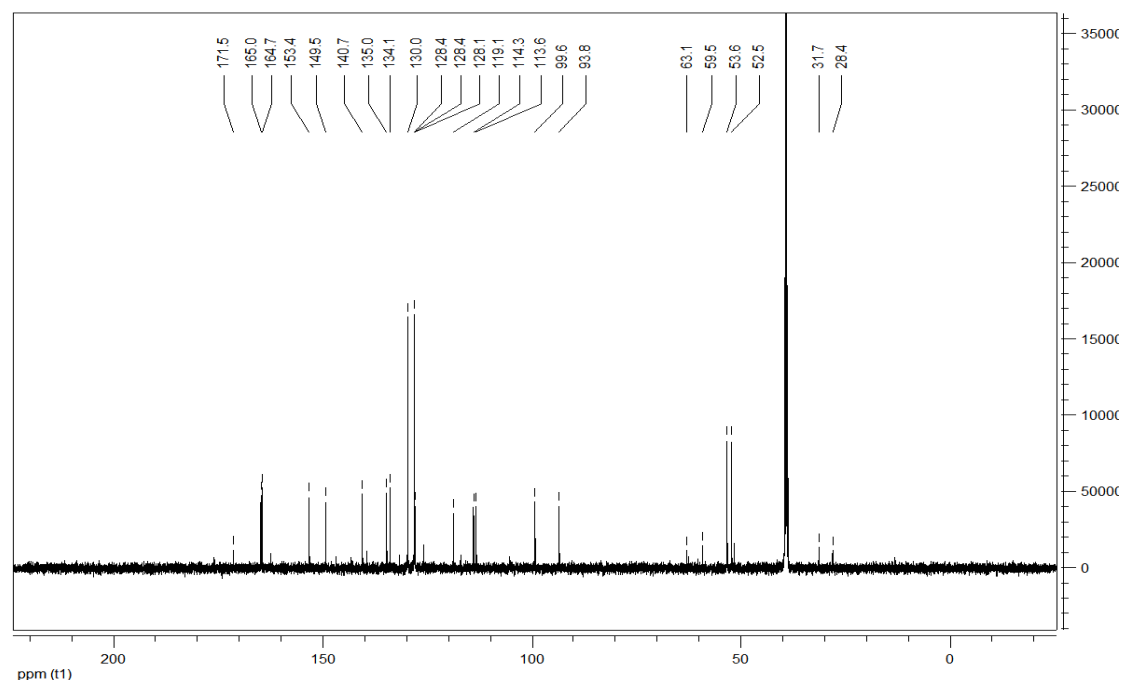
**Dimethyl 8-cyano-7-(3-methoxyphenyl)-2-oxo-3-phenethyl-1,2,3,7-tetrahydroimidazo[1,2-a]pyridine-5,6-dicarboxylate (1c):** yellow solid, 66%, m.p. 173~175°C;  $^1\text{H}$  NMR (600MHz, DMSO- $d_6$ )  $\delta$ : 12.14(s, 1H, NH), 7.32~7.27 (m, 3H, ArH), 7.22 (t,  $J$  = 6.6 Hz, 1H, ArH), 7.16 (d,  $J$  = 7.2 Hz, 2H, ArH), 6.89~6.84 (m, 3H, ArH), 4.64 (s, 1H, CH), 4.51 (d,  $J$  = 5.4 Hz, 1H, CH), 3.78 (s, 3H, OCH<sub>3</sub>), 3.75 (s, 3H, OCH<sub>3</sub>), 3.46 (s, 3H, OCH<sub>3</sub>), 2.58~2.53 (m, 1H, CH), 2.42~2.37 (m, 1H, CH), 2.08~2.03 (m, 1H, CH), 1.88~1.82 (m, 1H, CH);  $^{13}\text{C}$  NMR (150 MHz, DMSO- $d_6$ )  $\delta$ : 171.5, 165.2, 162.7, 159.2, 146.9, 145.8, 139.6, 134.3, 129.5, 128.4, 128.1, 126.1, 120.2, 117.4, 114.3, 112.0, 106.0, 63.2, 59.4, 54.9, 53.3, 51.7, 31.7, 28.3; IR (KBr)  $\nu$ : 3137 3062, 2954, 2785, 2207, 1759, 1717, 1686, 1606, 1491, 1426, 1378, 1317, 1222, 1162, 1112, 1039, 977, 866, 749, 704  $\text{cm}^{-1}$ ; MS ( $m/z$ ): HRMS (ESI) Calcd. for  $\text{C}_{27}\text{H}_{25}\text{NaN}_3\text{O}_6$  ( $[\text{M}+\text{Na}]^+$ ): 510.1636. Found: 510.1639.



**Dimethyl 8-cyano-7-(4-methoxyphenyl)-2-oxo-3-phenethyl-1,2,3,7-tetrahydroimidazo[1,2-a]pyridine-5,6-Dicarboxylate (1d):** yellow solid, 59%, m.p. 265~267°C;  $^1\text{H}$  NMR (400 MHz, DMSO- $d_6$ )  $\delta$ : 12.07 (s, 1H, NH), 7.26 (t,  $J$  = 7.6 Hz, 2H, ArH), 7.18 (d,  $J$  = 8.0 Hz, 3H, ArH), 7.12 (d,  $J$  = 6.8 Hz, 2H, ArH), 6.87 (d,  $J$  = 8.4 Hz, 2H, ArH), 4.58 (s, 1H, CH), 4.46 (d,  $J$  = 5.2 Hz, 1H, CH), 3.74 (s, 3H, OCH<sub>3</sub>), 3.71 (s, 3H, OCH<sub>3</sub>), 3.42 (s, 3H, OCH<sub>3</sub>), 2.55~2.51 (m, 1H, CH), 2.40~2.35 (m, 1H, CH), 2.04~1.99 (m, 1H, CH), 1.85~1.79 (m, 1H, CH);  $^{13}\text{C}$  NMR (150 MHz, DMSO- $d_6$ )  $\delta$ : 171.4, 165.3, 162.7, 158.4, 146.7, 139.6, 136.6, 133.8, 129.1, 128.4, 128.1, 126.1, 117.5, 113.7, 106.6, 63.5, 59.4, 54.9, 53.3, 51.7, 31.7, 28.3; IR (KBr)  $\nu$ : 3341, 3211, 3023, 2952, 2203, 1754, 1691, 1610, 1509, 1427, 1382, 1313, 1233, 1163, 1106, 1033, 927, 841, 789  $\text{cm}^{-1}$ ; MS ( $m/z$ ): HRMS (ESI) Calcd. for C<sub>27</sub>H<sub>26</sub>N<sub>3</sub>O<sub>6</sub> ([M+H]<sup>+</sup>): 488.1822. Found: 488.1823.

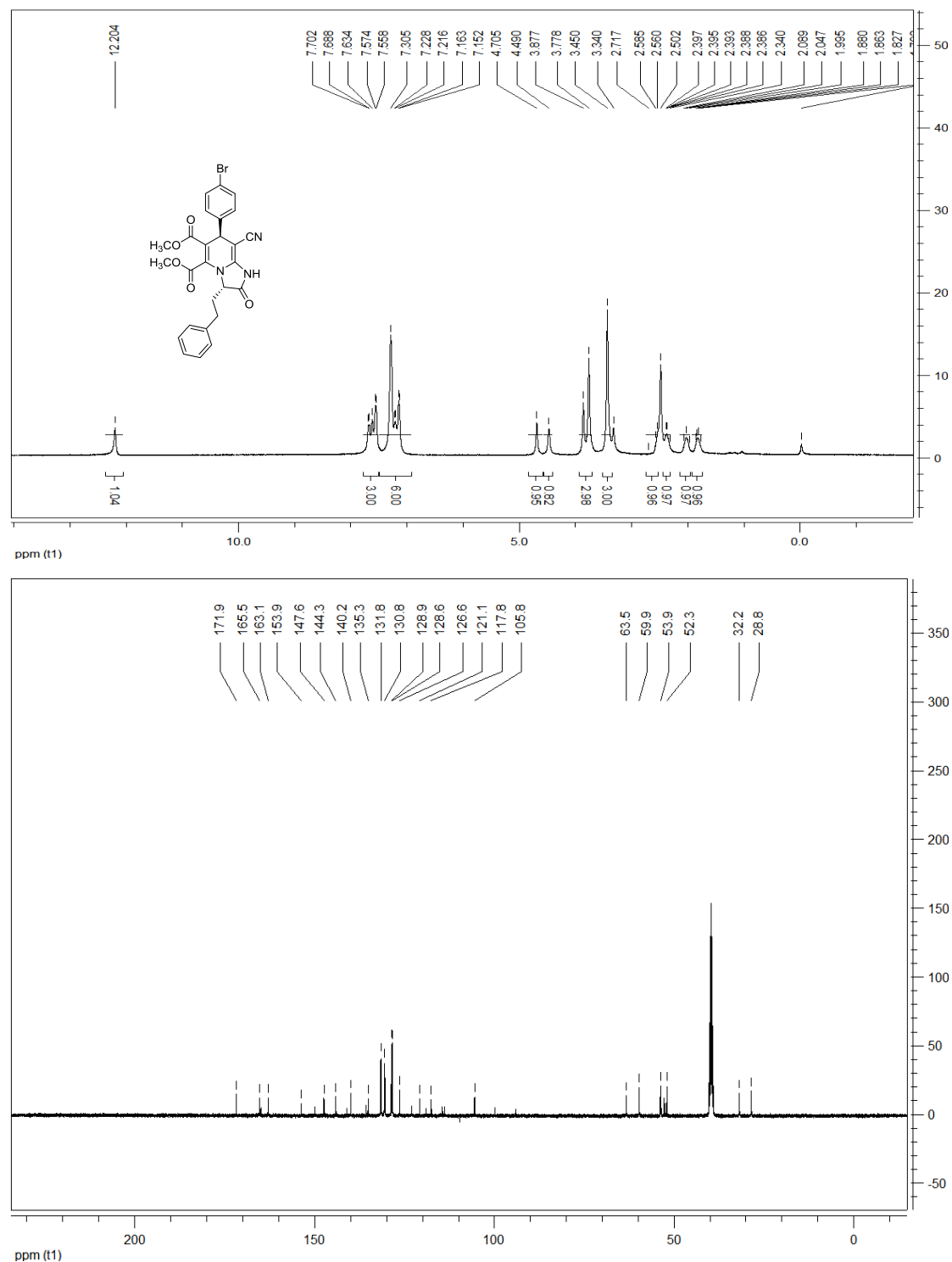


**7-(4-chlorophenyl)-8-cyano-2-oxo-3-phenethyl-1,2,3,7-tetrahydroimidazo[1,2-a]pyridine-5,6-dicarboxylate (1e):** yellow solid, 58%, m.p. 239~241 °C; <sup>1</sup>H NMR (600MHz, DMSO-d<sub>6</sub>) δ: 12.17 (s, 1H, NH), 7.42 (d, *J* = 7.8 Hz, 2H, ArH), 7.35 (d, *J* = 7.8 Hz, 2H, ArH), 7.30 (t, *J* = 7.2 Hz, 2H, ArH), 7.22 (t, *J* = 6.6 Hz, 1H, ArH), 7.16 (d, *J* = 7.2 Hz, 2H, ArH), 4.71 (s, 1H, CH), 4.49 (brs, 1H, CH), 3.78 (s, 3H, OCH<sub>3</sub>), 3.45 (s, 3H, OCH<sub>3</sub>), 2.58~2.55 (m, 1H, CH), 2.42~2.38 (m, 1H, CH), 2.08~2.04 (m, 1H, CH), 1.87~1.83 (m, 1H, CH); <sup>13</sup>C NMR (150 MHz, DMSO-d<sub>6</sub>) δ: 171.4, 164.9, 164.7, 153.4, 149.5, 140.7, 134.9, 134.1, 129.9, 128.4, 128.3, 128.1, 119.0, 114.2, 113.6, 99.5, 93.7, 63.0, 59.4, 53.5, 52.4, 31.6, 28.3; IR (KBr) ν: 3438, 3348, 3252, 2954, 2223, 1736, 1646, 1567, 1494, 1436, 1361, 1295, 1243, 1159, 1094, 1028, 985, 932, 838, 796, 744 cm<sup>-1</sup>; MS (m/z): HRMS (ESI) Calcd. for C<sub>26</sub>H<sub>22</sub>ClN<sub>3</sub>NaO<sub>5</sub> ([M+Na]<sup>+</sup>): 518.1595. Found: 510.1654.

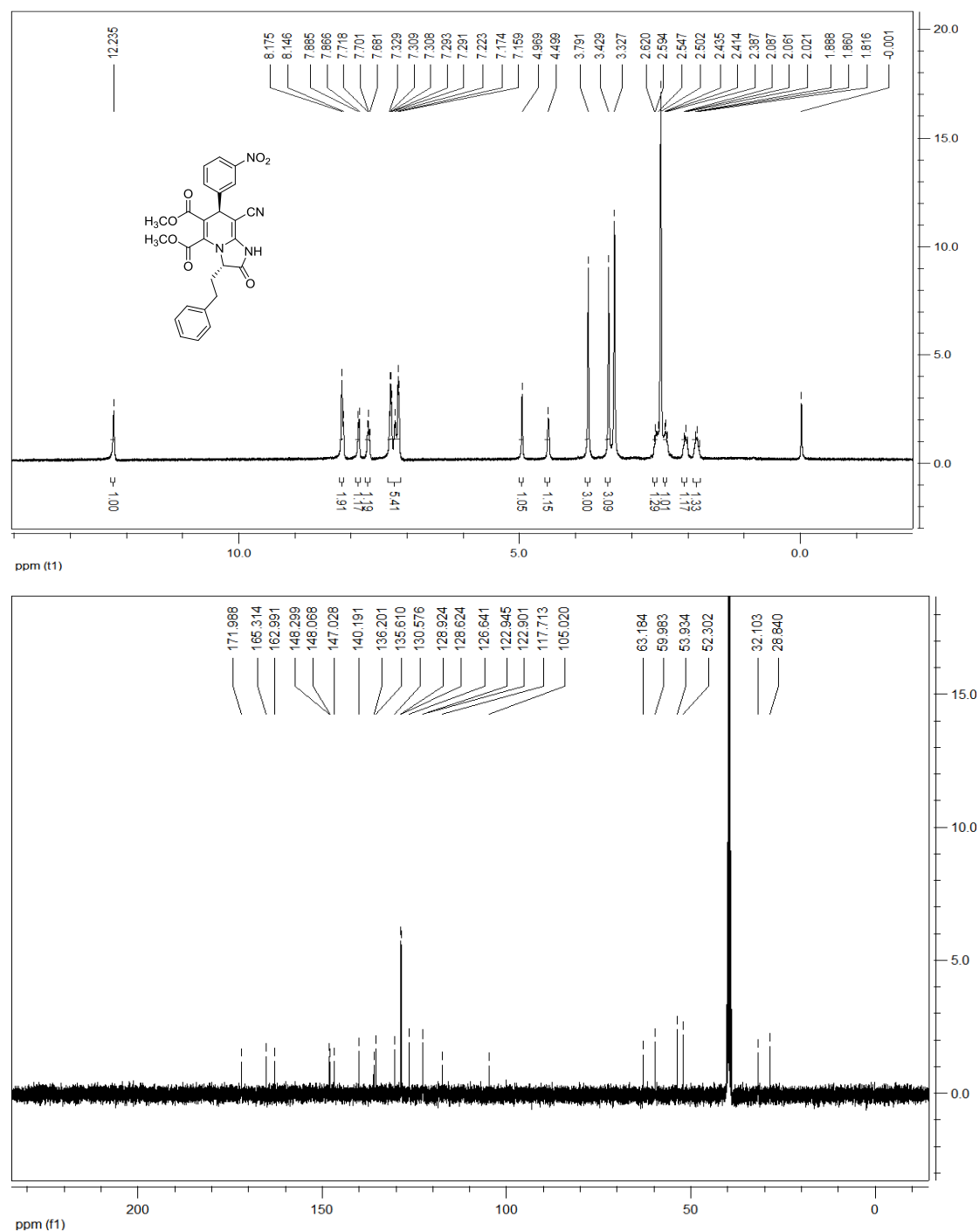




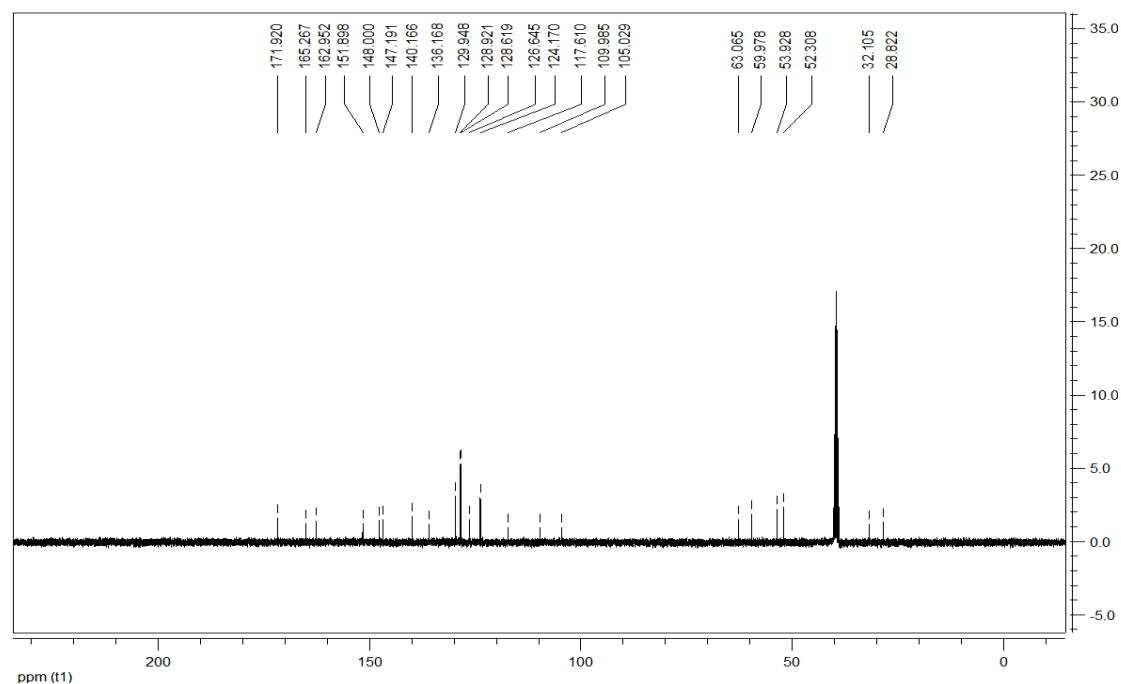
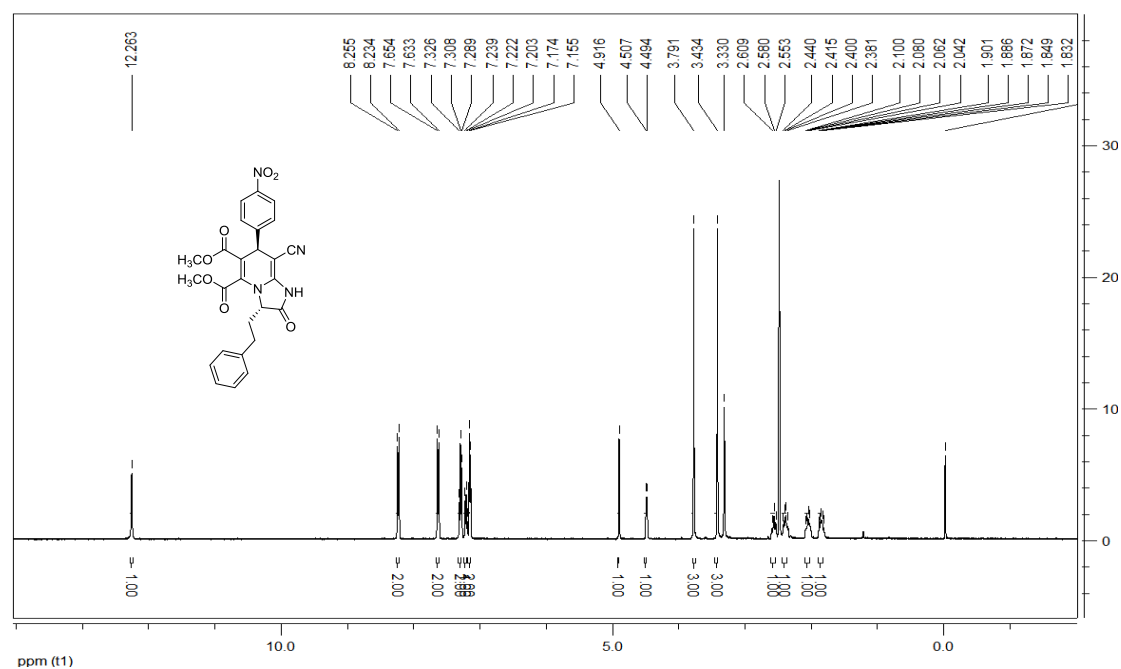
**dimethyl 7-(4-bromophenyl)-8-cyano-2-oxo-3-phenethyl-1,2,3,7-tetrahydroimidazo[1,2-a]-pyridine-5,6-dicarboxylate (1f):** yellow solid, 73%, m.p. 240~242°C;  $^1\text{H}$  NMR (400 MHz, DMSO- $d_6$ )  $\delta$ : 12.20 (s, 1H, NH), 7.70~7.56 (m, 3H, ArH), 7.31~7.15 (m, 6H, ArH), 4.71 (s, 1H, CH), 4.49 (s, 1H, CH), 3.82 (s, 3H, OCH<sub>3</sub>), 3.45 (s, 3H, OCH<sub>3</sub>), 2.72~2.56 (m, 1H, CH), 2.40~2.34 (m, 1H, CH), 2.09~2.00 (m, 1H, CH), 1.88~1.79 (m, 1H, CH);  $^{13}\text{C}$  NMR (100 MHz, DMSO- $d_6$ )  $\delta$ : 171.9, 165.5, 163.0, 153.9, 147.6, 144.2, 140.1, 135.3, 131.8, 130.7, 128.9, 128.6, 126.6, 121.0, 117.8, 105.8, 63.4, 59.9, 53.8, 52.2, 32.1; IR (KBr)  $\nu$ : 2928, 2843, 1706, 1598, 1496, 1366, 1319, 1245, 1179, 1096, 1017, 847, 782, 708  $\text{cm}^{-1}$ ; MS (m/z): HRMS (ESI) Calcd. for  $\text{C}_{26}\text{H}_{23}\text{BrN}_3\text{O}_5$  ( $[\text{M}+\text{H}]^+$ ): 536.0816. Found: 536.0805.



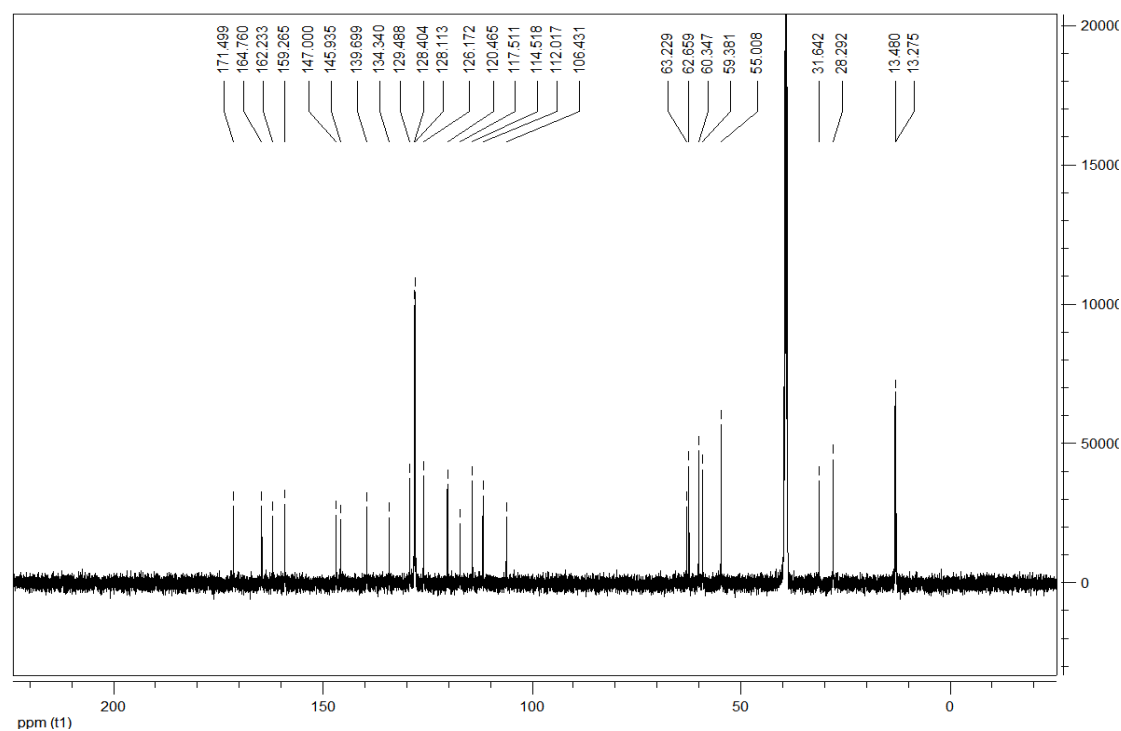
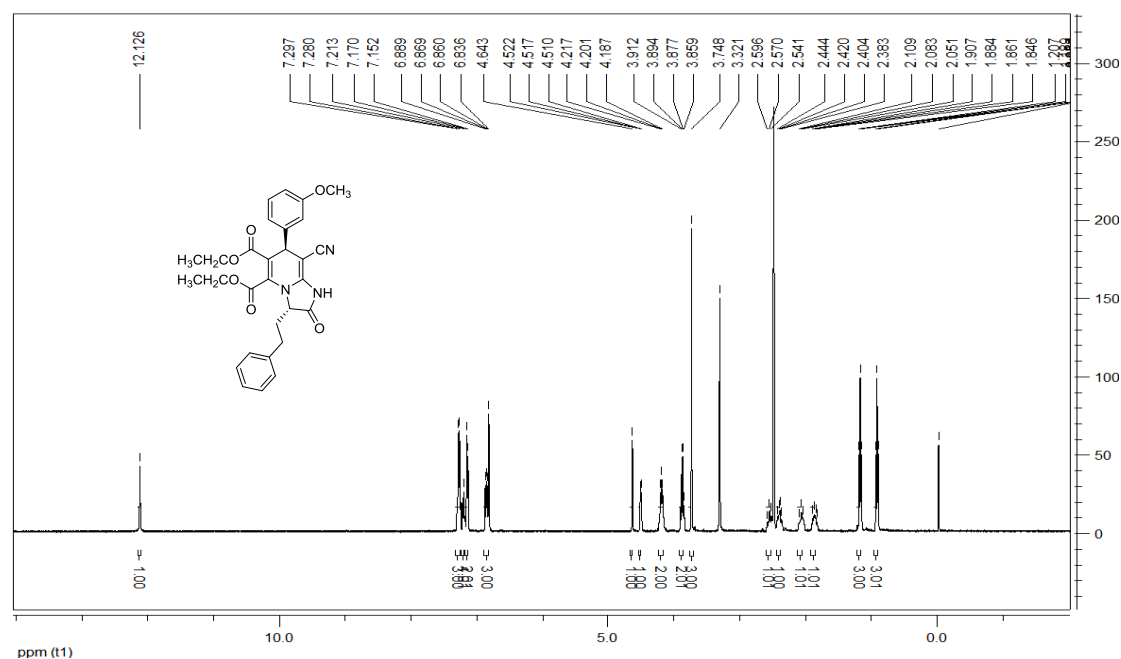
**Dimethyl 8-cyano-7-(3-nitrophenyl)-2-oxo-3-phenethyl-1,2,3,7-tetrahydroimidazo[1,2-a]-pyridine-5,6-dicarboxylate (1g):** yellow solid, 61%, m.p. 199~201°C;  $^1\text{H}$  NMR (400 MHz, DMSO- $d_6$ )  $\delta$ : 12.24 (s, 1H, NH), 8.16 (d,  $J$  = 11.6 Hz, 2H, ArH), 7.88 (d,  $J$  = 7.6 Hz, 1H, ArH), 7.70 (t,  $J$  = 8.0 Hz, 1H, ArH), 7.33~7.16 (m, 5H, ArH), 4.97 (s, 1H, CH), 4.50 (s, 1H, CH), 3.79 (s, 3H, OCH<sub>3</sub>), 3.43 (s, 3H, OCH<sub>3</sub>), 2.62~2.55 (m, 1H, CH), 2.44~2.39 (m, 1H, CH), 2.09~2.02 (m, 1H, CH), 1.89~1.82 (m, 1H, CH);  $^{13}\text{C}$  NMR (100 MHz, DMSO- $d_6$ )  $\delta$ : 171.9, 165.3, 162.9, 148.3, 148.0, 147.0, 140.1, 136.1, 135.6, 130.5, 128.9, 128.6, 126.6, 122.9, 122.8, 105.0, 63.1, 59.9, 53.9, 52.2, 49.0, 32.1, 28.8; IR (KBr)  $\nu$ : 3675, 3439, 3347, 3251, 3137, 3060, 2952, 2208, 1773, 1741, 1707, 1679, 1606, 1489, 1428, 1371, 1297, 1244, 1204, 1106, 1003, 840, 752, 707  $\text{cm}^{-1}$ ; MS ( $m/z$ ): HRMS (ESI) Calcd. for  $\text{C}_{26}\text{H}_{22}\text{N}_4\text{NaO}_7$  ( $[\text{M}+\text{Na}]^+$ ): 525.1381. Found: 525.1381.



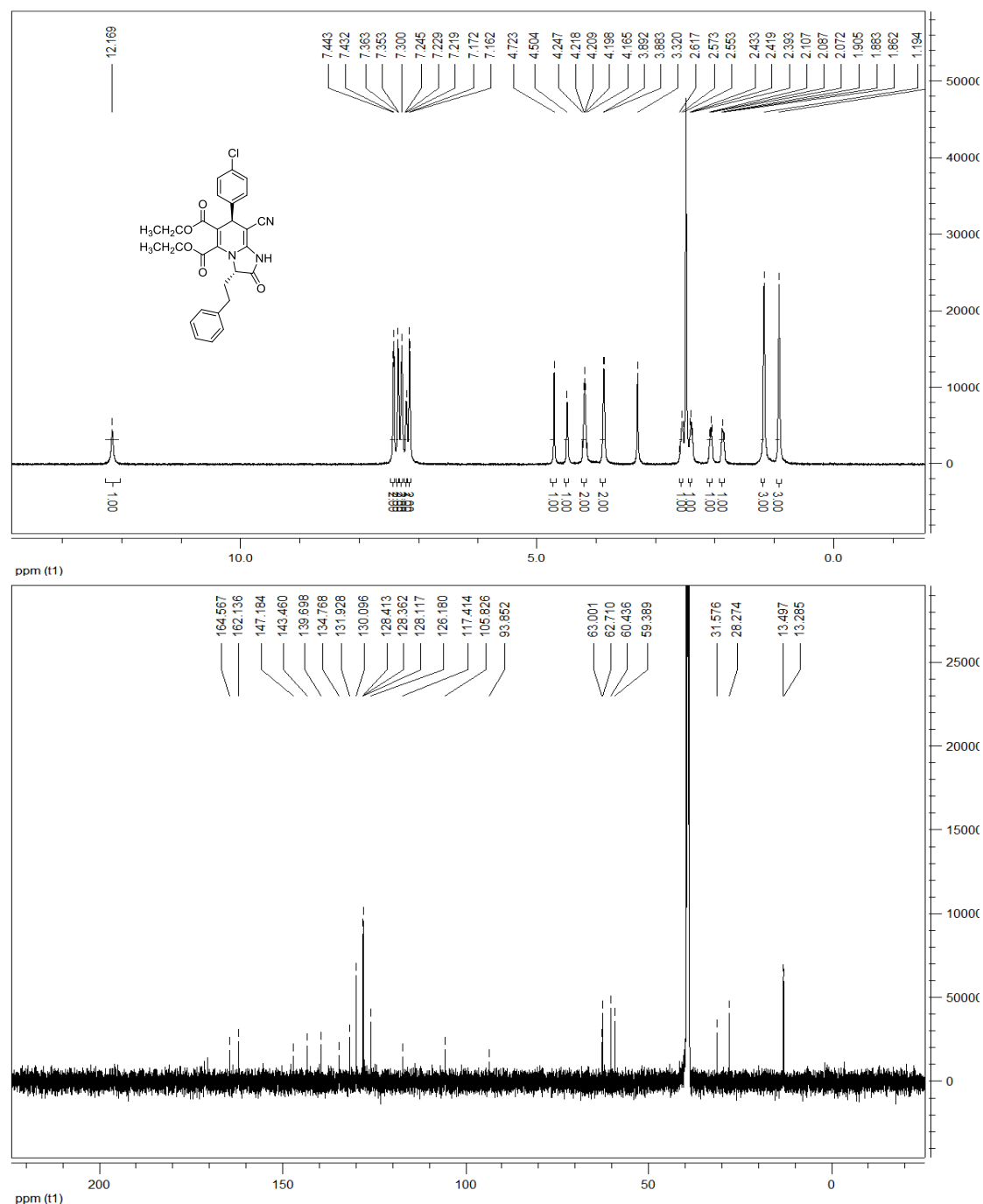
**Dimethyl 8-cyano-7-(4-nitrophenyl)-2-oxo-3-phenethyl-1,2,3,7-tetrahydroimidazo[1,2-a]pyridine-5,6-dicarboxylate (1h):** yellow solid, 59%, m.p. 253~255°C;  $^1\text{H}$  NMR (400 MHz, DMSO- $d_6$ )  $\delta$ : 12.26 (s, 1H, NH), 8.24 (d,  $J = 7.6$  Hz, 2H, ArH), 7.64 (d,  $J = 7.6$  Hz, 2H, ArH), 7.31 (t,  $J = 7.6$  Hz, 2H, ArH), 7.22 (t,  $J = 7.6$  Hz, 1H, ArH), 7.16 (t,  $J = 7.2$  Hz, 2H, ArH), 4.92 (s, 1H, CH), 4.50 (d,  $J = 5.2$  Hz, 1H, CH), 3.79 (s, 3H, OCH<sub>3</sub>), 3.44 (s, 3H, OCH<sub>3</sub>), 2.61~2.55 (m, 1H, CH), 2.44~2.38 (m, 1H, CH), 2.10~2.03 (m, 1H, CH), 1.91~1.85 (m, 1H, CH);  $^{13}\text{C}$  NMR (100 MHz, DMSO- $d_6$ )  $\delta$ : 171.9, 165.2, 162.9, 151.8, 147.9, 147.1, 140.1, 136.1, 129.9, 128.9, 128.6, 126.6, 124.1, 117.6, 109.9, 105.0, 63.0, 59.9, 53.9, 52.3, 32.1, 28.8; IR (KBr)  $\nu$ : 3139, 3064, 2955, 2203, 1772, 1743, 1703, 1678, 1607, 1521, 1426, 1384, 1349, 1314, 1237, 1211, 1156, 1106, 1012, 971, 929, 862, 822, 750, 702  $\text{cm}^{-1}$ ; MS (m/z): HRMS (ESI) Calcd. for C<sub>26</sub>H<sub>22</sub>N<sub>4</sub>NaO<sub>7</sub> ([M+Na]<sup>+</sup>): 525.1381. Found: 525.1374.



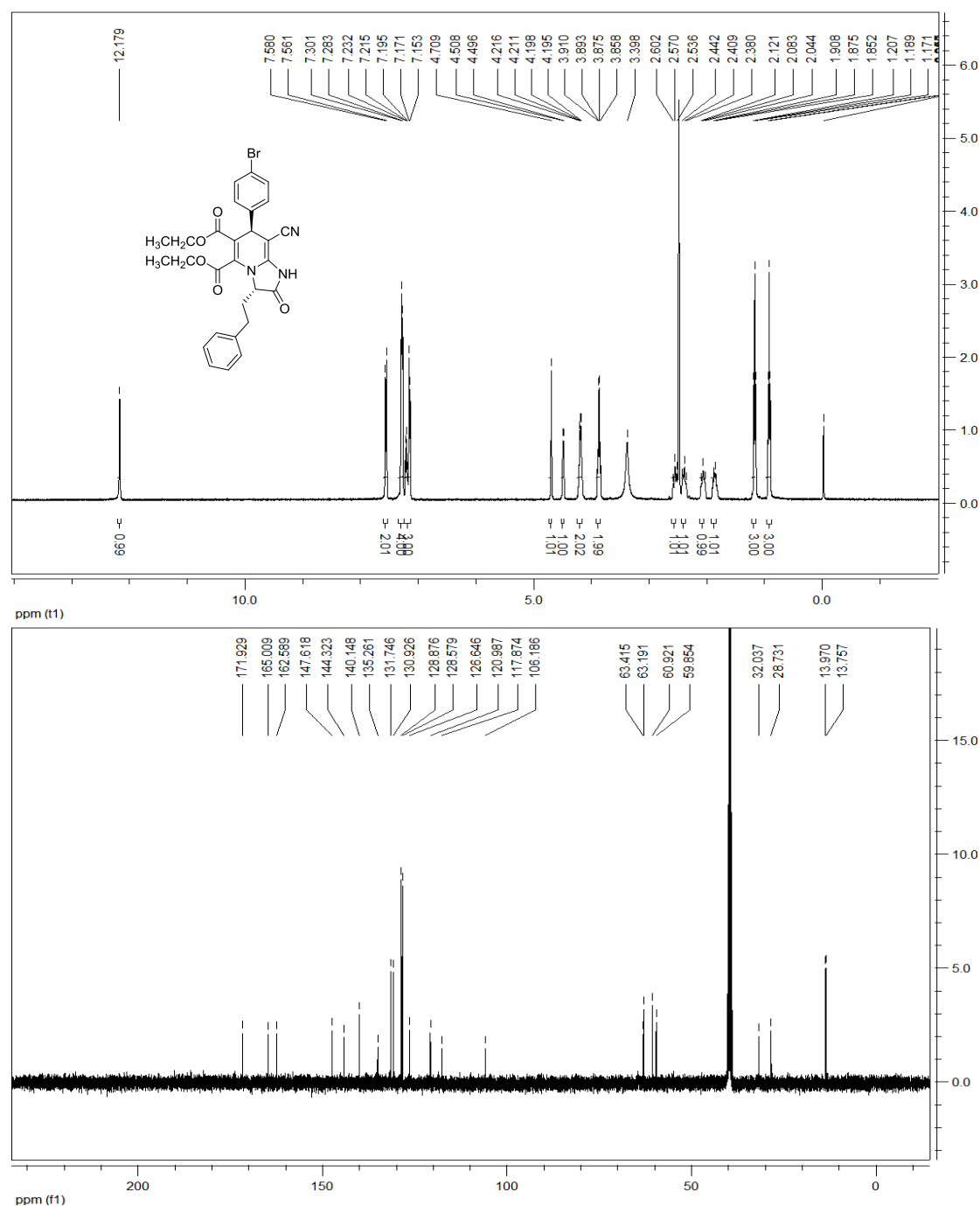
**Diethyl 8-cyano-7-(3-methoxyphenyl)-2-oxo-3-phenethyl-1,2,3,7-tetrahydroimidazo[1,2-a]-pyridine-5,6-dicarboxylate(1i):** yellow solid, 53%, m.p. 162~165°C;  $^1\text{H}$  NMR (600 MHz, DMSO- $d_6$ )  $\delta$ : 12.11 (s, 1H, NH), 7.31~7.27 (m, 3H, ArH), 7.21 (t,  $J$  = 7.2 Hz, 1H, ArH), 7.16 (d,  $J$  = 7.2 Hz, 2H, ArH), 6.89~6.84 (m, 3H, ArH), 4.65 (s, 1H, CH), 4.52 (d,  $J$  = 5.4 Hz, 1H, CH), 4.24~4.17 (m, 2H, CH), 3.90~3.87 (m, 2H, CH), 3.75 (s, 3H, OCH<sub>3</sub>), 2.59~2.55 (m, 1H, CH), 2.44~2.39 (m, 1H, CH), 2.11~2.06 (m, 1H, CH), 1.92~1.86 (m, 1H, CH), 1.19 (t,  $J$  = 7.2 Hz, 3H, CH<sub>3</sub>), 0.93 (t,  $J$  = 7.2 Hz, 3H, CH<sub>3</sub>);  $^{13}\text{C}$  NMR (150 MHz, DMSO- $d_6$ )  $\delta$ : 171.4, 164.7, 162.2, 159.2, 146.9, 145.9, 139.6, 134.3, 129.4, 128.4, 128.1, 126.1, 120.4, 117.5, 114.5, 112.0, 106.4, 63.2, 62.6, 60.3, 59.3, 55.0, 31.6, 28.2, 13.4, 13.2; IR (KBr)  $\nu$ : 3188, 3067, 2986, 2205, 1758, 1693, 1603, 1489, 1427, 1381, 1310, 1214, 1159, 1107, 1032, 862, 754, 701  $\text{cm}^{-1}$ ; MS ( $m/z$ ): HRMS (ESI) Calcd. for C<sub>29</sub>H<sub>29</sub>N<sub>3</sub>NaO<sub>6</sub> ([M+Na]<sup>+</sup>): 538.1949. Found: 538.1955.



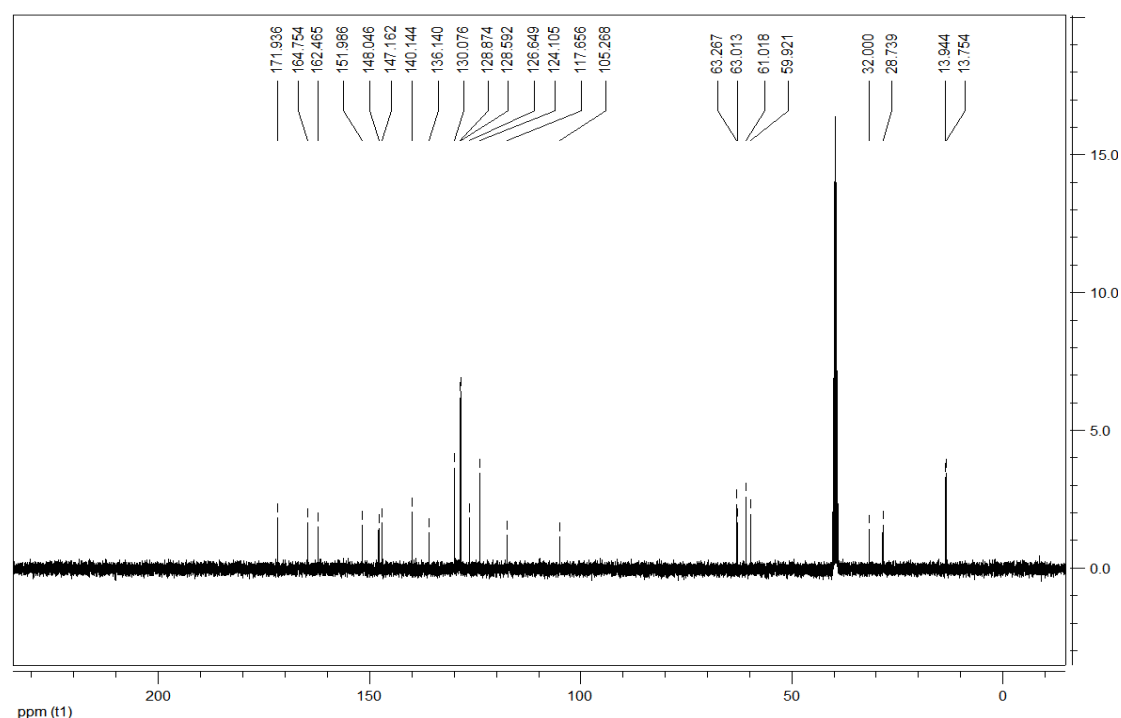
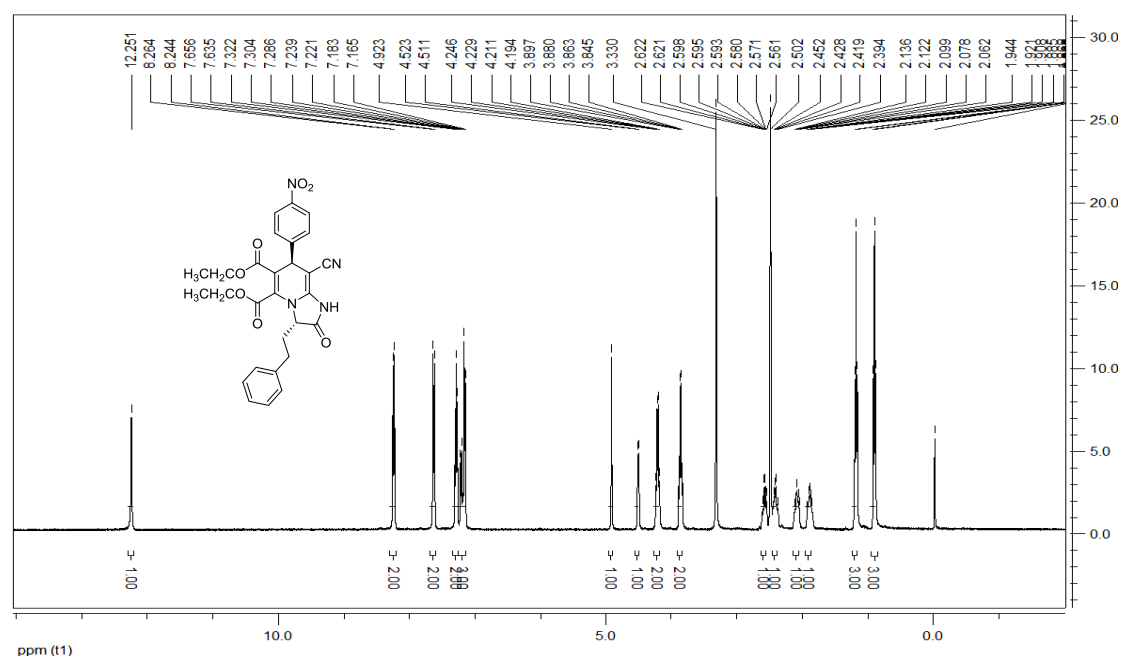
**diethyl 7-(4-chlorophenyl)-8-cyano-2-oxo-3-phenethyl-1,2,3,7-tetrahydroimidazo[1,2-a]-pyridine-5,6-dicarboxylate (1j):** yellow solid, 57%, m.p. 199~201°C;  $^1\text{H}$  NMR (600 MHz, DMSO- $d_6$ )  $\delta$ : 12.17 (s, 1H, NH), 7.44 (d,  $J$  = 6.6 Hz, 2H, ArH), 7.36 (d,  $J$  = 6.0 Hz, 2H, ArH), 7.30 (t,  $J$  = 6.0 Hz, 2H, ArH), 7.25~7.22 (m, 1H, ArH), 7.17 (d,  $J$  = 6.0 Hz, 2H, ArH), 4.72 (s, 1H, CH), 4.50 (s, 1H, CH), 4.20 (t,  $J$  = 6.6 Hz, 2H, CH), 3.88 (d,  $J$  = 5.4 Hz, 2H, CH), 2.62~2.55 (m, 1H, CH), 2.43~2.39 (m, 1H, CH), 2.11~2.07 (m, 1H, CH), 1.91~1.86 (m, 1H, CH), 1.19 (s, 3H, CH<sub>3</sub>), 0.94 (s, 3H, CH<sub>3</sub>);  $^{13}\text{C}$  NMR (150 MHz, DMSO- $d_6$ )  $\delta$ : 164.5, 162.1, 147.1, 143.4, 139.6, 134.7, 131.9, 130.0, 128.4, 128.3, 128.1, 126.1, 117.4, 105.8, 93.8, 63.0, 62.7, 60.4, 59.3, 31.5, 28.2, 13.4, 13.2; IR (KBr)  $\nu$ : 3735, 3136, 3061, 2986, 2205, 1771, 1740, 1678, 1607, 1488, 1427, 1375, 1310, 1235, 1202, 1096, 1014, 853, 753, 708  $\text{cm}^{-1}$ ; MS (m/z): HRMS (ESI) Calcd. for  $\text{C}_{28}\text{H}_{26}\text{N}_3\text{ClNaO}_5$  ( $[\text{M}+\text{Na}]^+$ ): 542.1459. Found: 542.1459.



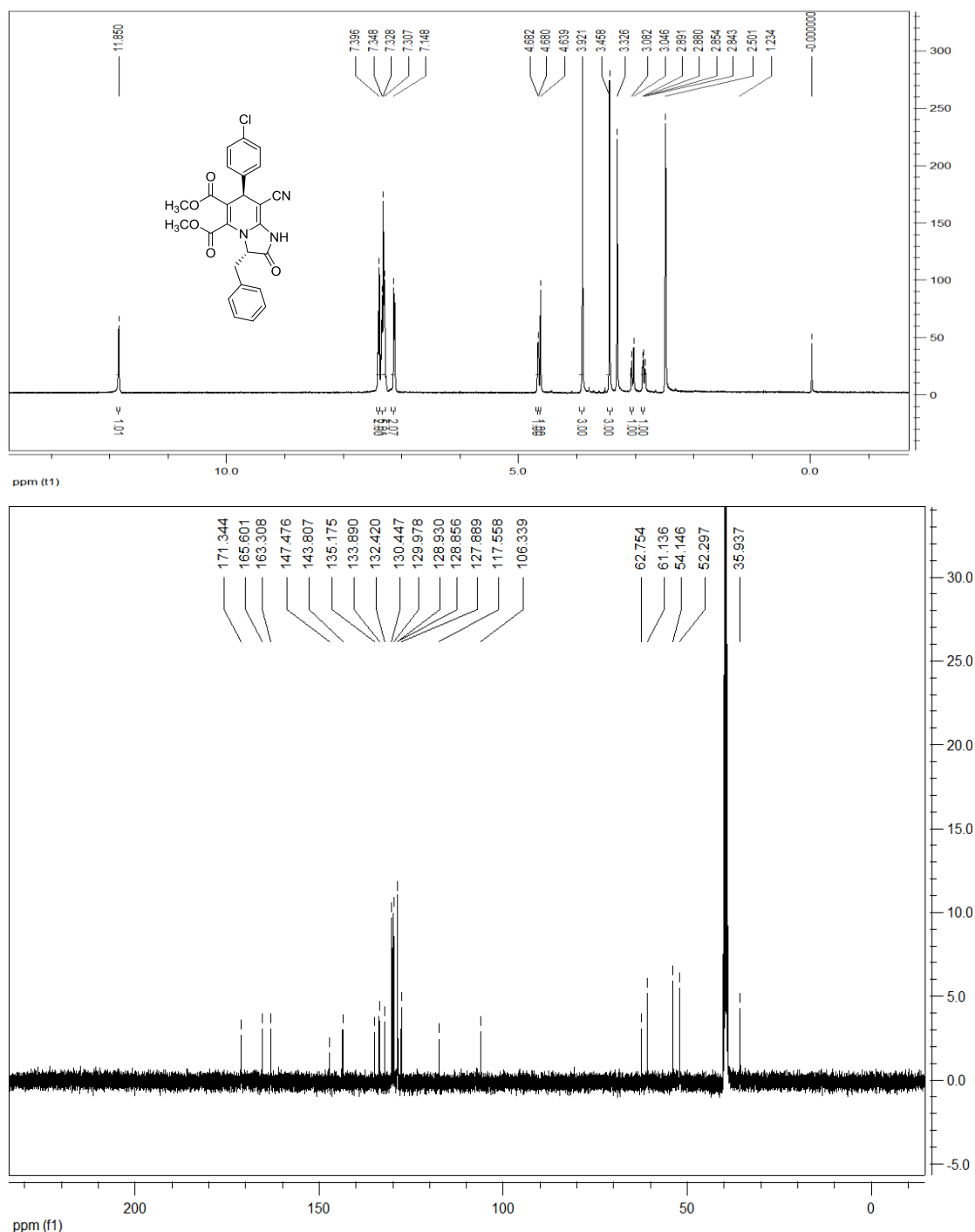
**diethyl 7-(4-bromophenyl)-8-cyano-2-oxo-3-phenethyl-1,2,3,7-tetrahydroimidazo[1,2-a]-pyridine-5,6-dicarboxylate (1k):** yellow solid, 60%, m.p. 199~201°C;  $^1\text{H}$  NMR (400 MHz, DMSO- $d_6$ )  $\delta$ : 12.18 (s, 1H, NH), 7.57 (d,  $J$  = 7.6 Hz, 2H, ArH), 7.29 (d,  $J$  = 7.2 Hz, 4H, ArH), 7.23~7.15 (m, 3H, ArH), 4.71 (s, 1H, CH), 4.50 (d,  $J$  = 4.8 Hz, 1H, CH), 4.22~4.20 (m, 2H, CH), 3.91~3.86 (m, 2H, CH), 2.60~2.54 (m, 1H, CH), 2.44~2.38 (m, 1H, CH), 2.12~2.04 (m, 1H, CH), 1.91~1.85 (m, 1H, CH), 1.18 (t,  $J$  = 7.2 Hz, 3H, CH<sub>3</sub>), 0.93 (t,  $J$  = 7.2 Hz, 3H, CH<sub>3</sub>);  $^{13}\text{C}$  NMR (100 MHz, DMSO- $d_6$ )  $\delta$ : 171.9, 165.0, 162.5, 147.6, 144.3, 140.1, 135.2, 131.7, 130.9, 128.8, 128.5, 126.6, 120.9, 117.8, 106.1, 63.4, 63.1, 60.9, 59.8, 32.0, 28.7, 13.9; IR (KBr)  $\nu$ : 33144, 3061, 2989, 2777, 2203, 1775, 1740, 1688, 1607, 1485, 1424, 1371, 1318, 1240, 1195, 1098, 1011, 849, 789, 748, 703  $\text{cm}^{-1}$ ; MS (m/z): HRMS (ESI) Calcd. for C<sub>28</sub>H<sub>27</sub>BrN<sub>3</sub>O<sub>5</sub> ([M+H]<sup>+</sup>): 564.1129. Found: 564.1119.



**diethyl 8-cyano-7-(4-nitrophenyl)-2-oxo-3-phenethyl-1,2,3,7-tetrahydroimidazo[1,2-a]-pyridine-5,6- dicarboxylate (11):** yellow solid, 51%, m.p. 243~245°C;  $^1\text{H}$  NMR (400 MHz, DMSO- $d_6$ )  $\delta$ : 12.25 (s, 1H, NH), 8.25 (d,  $J$  = 8.0 Hz, 2H, ArH), 7.65 (d,  $J$  = 8.0 Hz, 2H, ArH), 7.30 (t,  $J$  = 7.2 Hz, 2H, ArH), 7.24~7.17 (m, 3H, ArH), 4.92 (s, 1H, CH), 4.52 (d,  $J$  = 4.8 Hz, 1H, CH), 4.25~4.19 (m, 2H, CH), 3.90~3.85 (m, 2H, CH), 2.62~2.56 (m, 1H, CH), 2.45~2.39 (m, 1H, CH), 2.14~2.06 (m, 1H, CH), 1.94~1.87 (m, 1H, CH), 1.19 (t,  $J$  = 6.8 Hz, 3H, CH<sub>3</sub>), 0.91 (t,  $J$  = 6.8 Hz, 3H, CH<sub>3</sub>);  $^{13}\text{C}$  NMR (100 MHz, DMSO- $d_6$ )  $\delta$ : 171.9, 164.7, 162.4, 151.9, 148.0, 147.1, 140.1, 136.1, 130.0, 128.8, 128.5, 126.6, 124.1, 117.6, 105.2, 63.2, 63.0, 61.0, 59.9, 31.9, 28.7, 13.9, 13.7; IR (KBr)  $\nu$ : 3140, 2777, 2202, 1771, 1741, 1699, 1676, 1612, 1519, 1429, 1389, 1347, 1309, 1233, 1205, 1154, 1100, 1039, 1009, 912, 859, 821, 749, 702  $\text{cm}^{-1}$ ; MS ( $m/z$ ): HRMS (ESI) Calcd. for  $\text{C}_{28}\text{H}_{26}\text{N}_4\text{NaO}_7$  ( $[\text{M}+\text{Na}]^+$ ): 553.1694. Found: 553.1685.

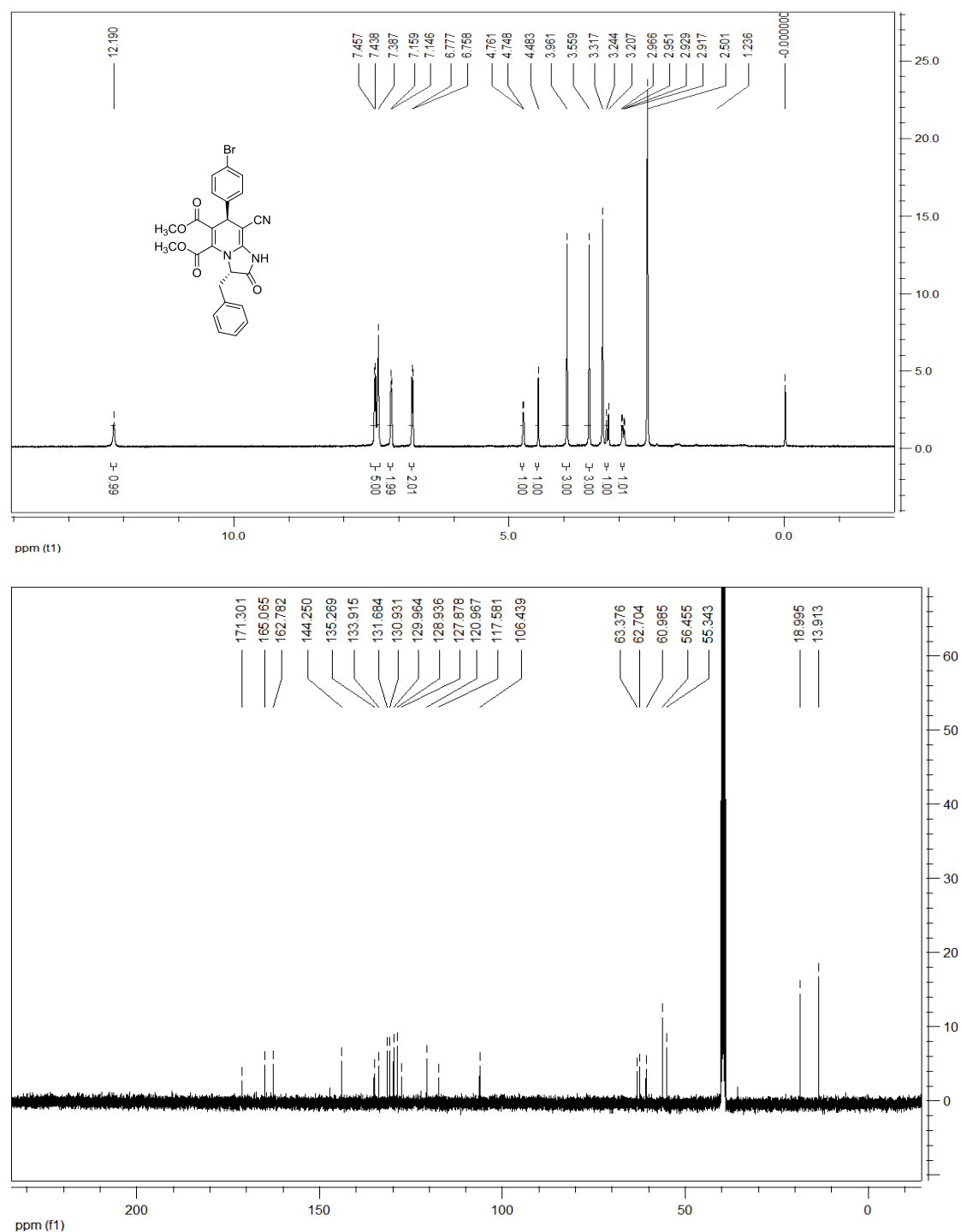


**dimethyl 3-benzyl-7-(4-chlorophenyl)-8-cyano-2-oxo-1,2,3,7-tetrahydroimidazo[1,2-a]-pyridine-5,6- dicarboxylate (2a):** yellow solid, 60%, m.p. 233~235°C;  $^1\text{H}$  NMR (400 MHz, DMSO- $d_6$ )  $\delta$ : 11.85 (s, 1H, NH), 7.41 (d,  $J$  = 8.0 Hz, 2H, ArH), 7.37~7.31 (m, 5H, ArH), 7.14 (d,  $J$  = 7.2 Hz, 2H, ArH), 4.68 (s, 1H, CH), 4.64 (s, 1H, CH), 3.92 (s, 3H, OCH<sub>3</sub>), 3.46 (s, 3H, OCH<sub>3</sub>), 3.08~3.05 (m, 1H, CH), 2.89~2.84 (m, 1H, CH);  $^{13}\text{C}$  NMR (100 MHz, DMSO- $d_6$ )  $\delta$ : 171.3, 165.6, 163.3, 147.4, 143.8, 135.1, 133.8, 132.4, 130.4, 129.9, 128.9, 128.8, 127.8, 117.5, 106.3, 62.7, 61.1, 54.1, 52.2, 35.9; IR (KBr)  $\nu$ : 3163, 3064, 2955, 2918, 2849, 2201, 1752, 1720, 1695, 1609, 1492, 1423, 1385, 1313, 1268, 1239, 1192, 1156, 1107, 1035, 1015, 986, 963, 928, 881, 828, 789, 739  $\text{cm}^{-1}$ ; MS ( $m/z$ ): HRMS (ESI) Calcd. for  $\text{C}_{25}\text{H}_{20}\text{ClN}_3\text{NaO}_5$  ( $[\text{M}+\text{Na}]^+$ ): 500.0989 Found: 500.0992.

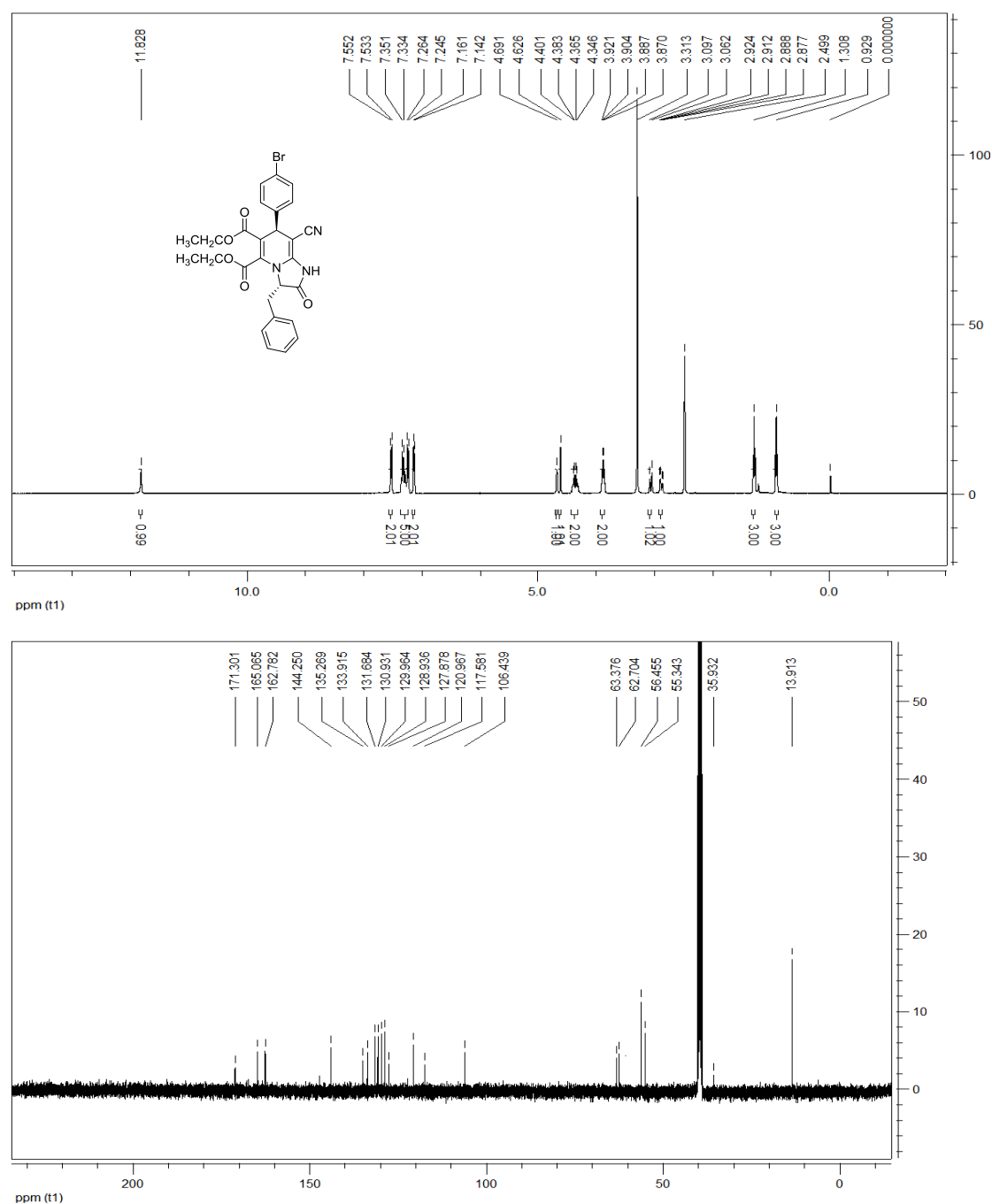




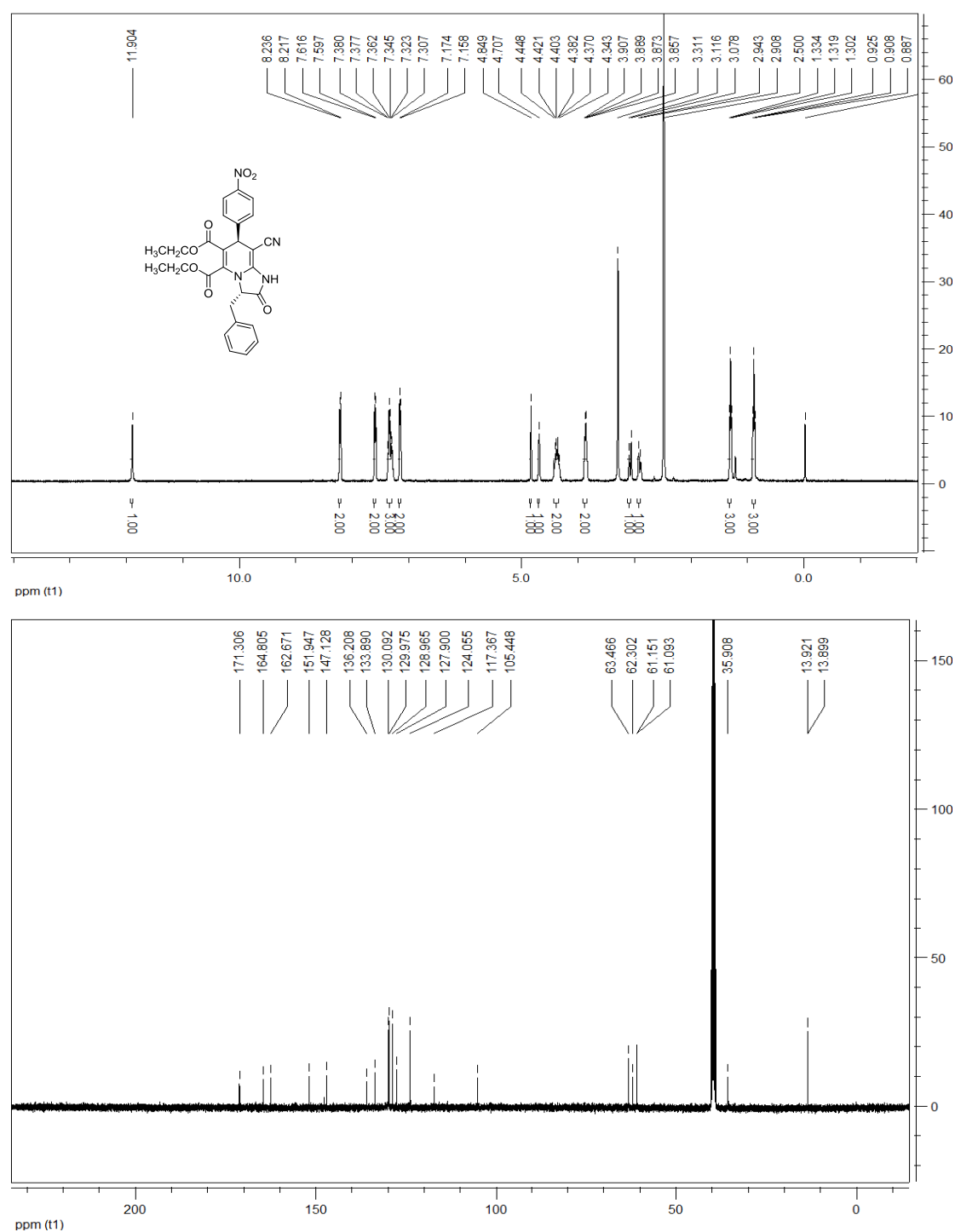
**dimethyl 3-benzyl-7-(4-bromophenyl)-8-cyano-2-oxo-1,2,3,7-tetrahydroimidazo[1,2-a]-pyridine-5,6-dicarboxylate (2b):** yellow solid, 63%, m.p. 201~203°C;  $^1\text{H}$  NMR (400 MHz, DMSO- $d_6$ )  $\delta$ : 12.19 (s, 1H, NH), 7.46~7.39 (m, 5H, ArH), 7.15 (d,  $J$  = 5.2 Hz, 2H, ArH), 6.77 (d,  $J$  = 7.6 Hz, 2H, ArH), 4.75 (d,  $J$  = 5.2 Hz, 1H, CH), 4.48 (s, 1H, CH), 3.96 (s, 3H, OCH<sub>3</sub>), 3.56 (s, 3H, OCH<sub>3</sub>), 3.24~3.21 (m, 1H, CH), 2.97~2.92 (m, 1H, CH);  $^{13}\text{C}$  NMR (100 MHz, DMSO- $d_6$ )  $\delta$ : 171.3, 165.0, 162.7, 144.2, 135.2, 133.9, 131.6, 130.9, 129.9, 128.9, 127.8, 120.9, 117.5, 106.4, 63.3, 62.7, 60.9, 55.3, 13.9; IR (KBr)  $\nu$ : 3062, 2955, 2920, 2851, 2201, 1746, 1707, 1680, 1602, 1487, 1456, 1417, 1382, 1316, 1284, 1231, 1156, 1113, 1073, 1036, 1008, 925, 876, 834, 791, 759, 723, 703  $\text{cm}^{-1}$ ; MS ( $m/z$ ): HRMS (ESI) Calcd. for  $\text{C}_{25}\text{H}_{20}\text{BrNaN}_3\text{O}_5$  ( $[\text{M}+\text{Na}]^+$ ): 544.0479. Found: 544.0479.



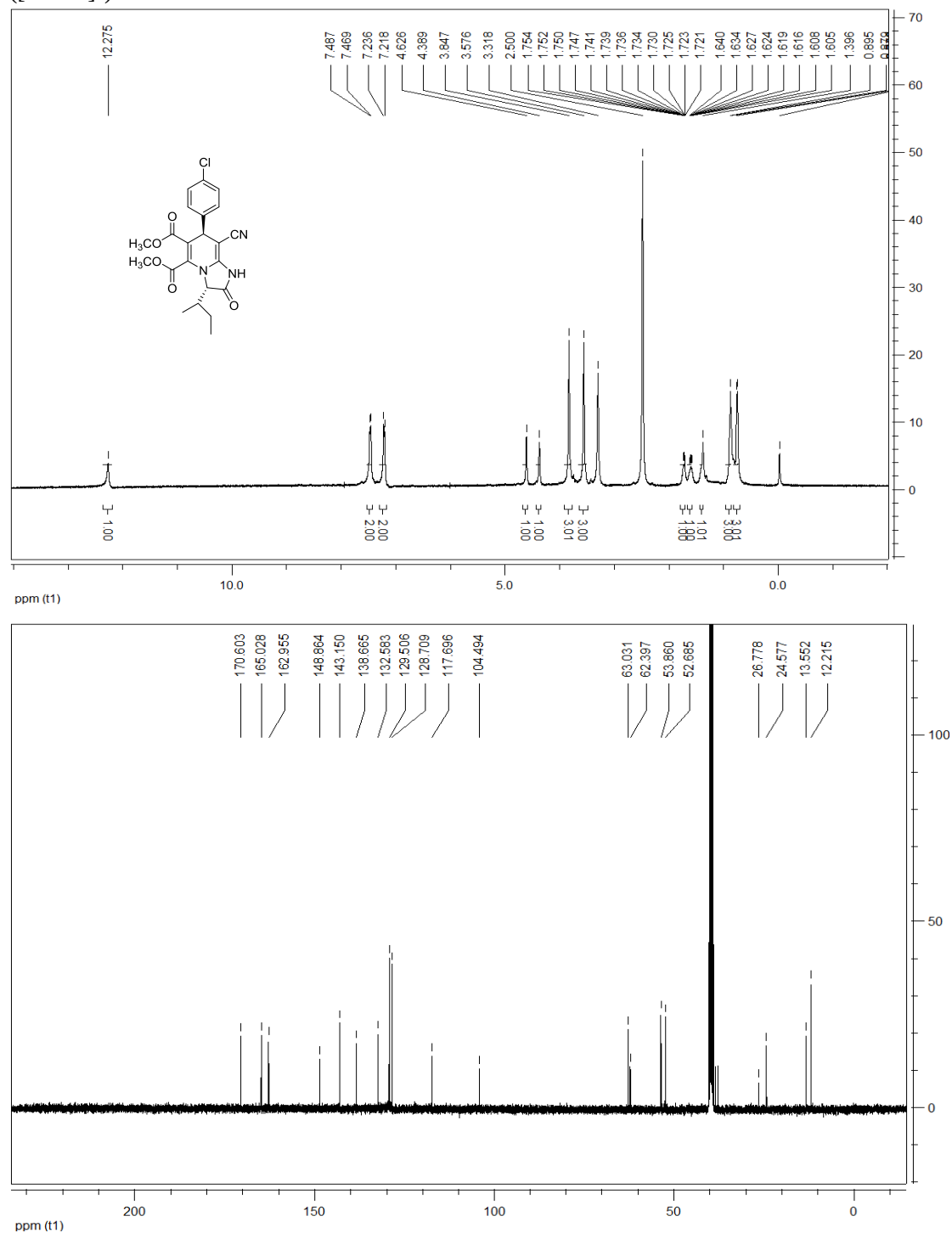
**diethyl 3-benzyl-7-(4-bromophenyl)-8-cyano-2-oxo-1,2,3,7-tetrahydroimidazo[1,2-a]-pyridine-5,6- dicarboxylate (2c):** yellow solid, 61%, m.p. 223~225°C;  $^1\text{H}$  NMR (400 MHz, DMSO- $d_6$ )  $\delta$ : 11.83 (s, 1H, NH), 7.54 (d,  $J$  = 7.6 Hz, 2H, ArH), 7.37~7.30 (m, 3H, ArH), 7.25 (d,  $J$  = 7.6 Hz, 2H, ArH), 7.15 (d,  $J$  = 7.6 Hz, 2H, ArH), 4.69 (s, 1H, CH), 4.63 (s, 1H, CH), 4.40~4.35 (m, 2H, CH), 3.92~3.87 (m, 2H, CH), 3.08 (d,  $J$  = 14.0 Hz, 1H, CH), 2.90 (dd,  $J_1$  = 14.0 Hz,  $J_2$  = 4.8 Hz, 1H, CH), 1.31 (t,  $J$  = 7.2 Hz, 3H, CH<sub>3</sub>), 0.93 (t,  $J$  = 6.8 Hz, 3H, CH<sub>3</sub>),  $^{13}\text{C}$  NMR (100 MHz, DMSO- $d_6$ )  $\delta$ : 234.3, 171.3, 165.0, 162.7, 144.2, 135.2, 133.9, 131.6, 130.9, 129.9, 128.9, 127.8, 120.9, 117.5, 106.4, 63.3, 62.7, 56.4, 55.3, 35.9, 13.9; IR (KBr)  $\nu$ : 3163, 3064, 2955, 2918, 2849, 2201, 1752, 1720, 1695, 1609, 1492, 1423, 1313, 1268, 1239, 1192, 1156, 1107, 1035, 1015, 986, 963, 928, 881, 828, 789, 739  $\text{cm}^{-1}$ ; MS ( $m/z$ ): HRMS (ESI) Calcd. for  $\text{C}_{27}\text{H}_{25}\text{BrN}_3\text{O}_5$  ( $[\text{M}+\text{Na}]^+$ ): 550.0978. Found: 550.0816.



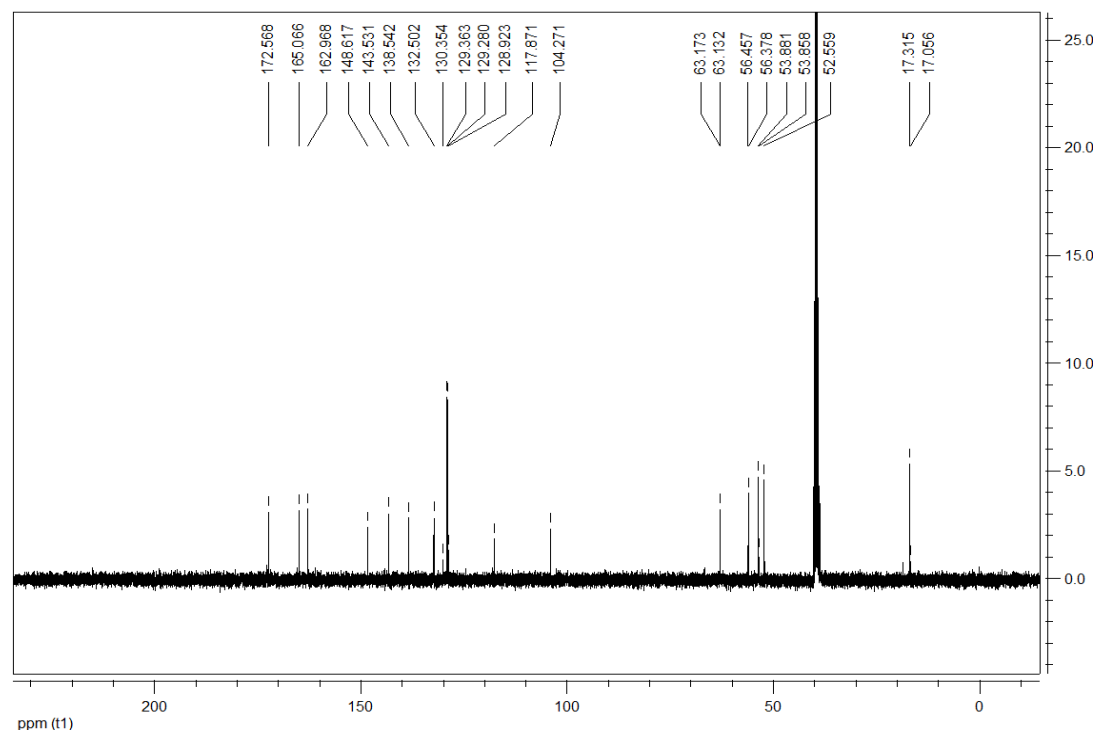
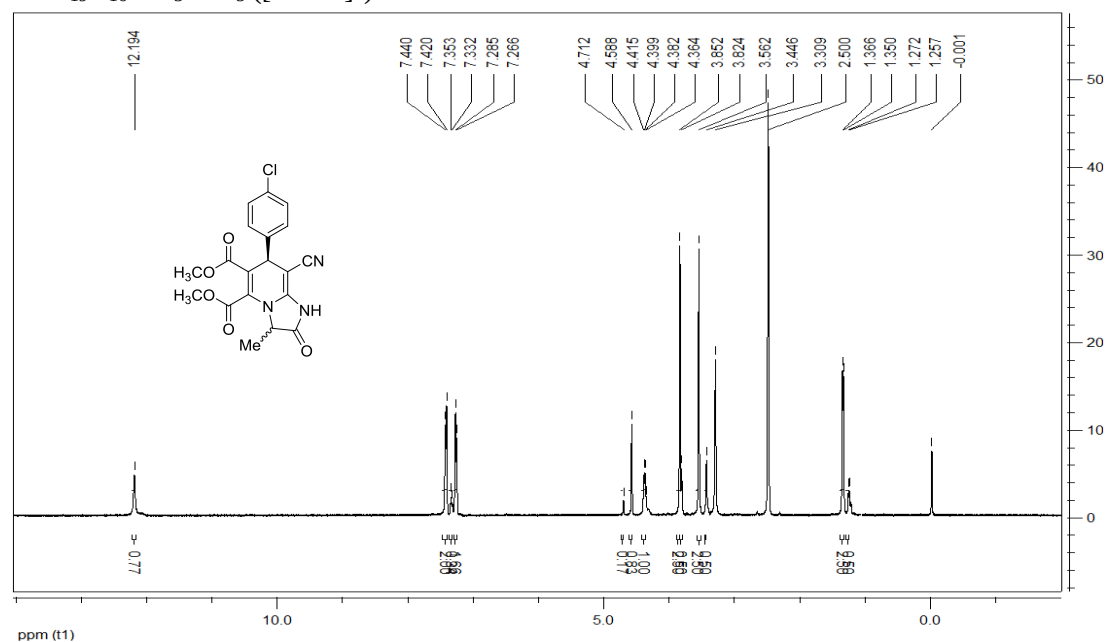
**diethyl 3-benzyl-8-cyano-7-(4-nitrophenyl)-2-oxo-1,2,3,7-tetrahydroimidazo[1,2-a]-pyridine-5,6-dicarboxylate (2d):** yellow solid, 55%, m.p. 215~217°C;  $^1\text{H}$  NMR (400 MHz, DMSO- $d_6$ )  $\delta$ : 11.90 (s, 1H, NH), 8.22 (d,  $J$  = 7.6 Hz, 2H, ArH), 7.60 (d,  $J$  = 7.6 Hz, 2H, ArH), 7.38~7.31 (m, 3H, ArH), 7.17 (d,  $J$  = 6.4 Hz, 2H, ArH), 4.85 (s, 1H, CH), 4.71 (s, 1H, CH), 4.42~4.34 (m, 2H, CH), 3.91~3.86 (m, 2H, CH), 3.09 (d,  $J$  = 15.2 Hz, 1H, CH), 2.92 (d,  $J$  = 14.0 Hz, 1H, CH), 1.32 (t,  $J$  = 6.8 Hz, 3H, CH<sub>3</sub>), 0.91 (t,  $J$  = 6.8 Hz, 3H, CH<sub>3</sub>),  $^{13}\text{C}$  NMR (100 MHz, DMSO- $d_6$ )  $\delta$ : 171.3, 164.8, 162.6, 151.9, 147.1, 136.2, 133.8, 130.0, 129.9, 128.9, 127.8, 124.0, 117.3, 105.4, 63.4, 62.3, 61.1, 61.0, 35.9, 13.9, 13.8; IR (KBr)  $\nu$ : 3067, 2921, 2851, 2201, 1752, 1714, 1687, 1604, 1524, 1430, 1348, 1309, 1277, 1241, 1210, 1155, 1090, 1014, 909, 861, 817, 737  $\text{cm}^{-1}$ ; MS (m/z): HRMS (ESI) Calcd. for C<sub>27</sub>H<sub>25</sub>N<sub>4</sub>O<sub>7</sub> ([M+H]<sup>+</sup>): 517.1723. Found: 517.1721.



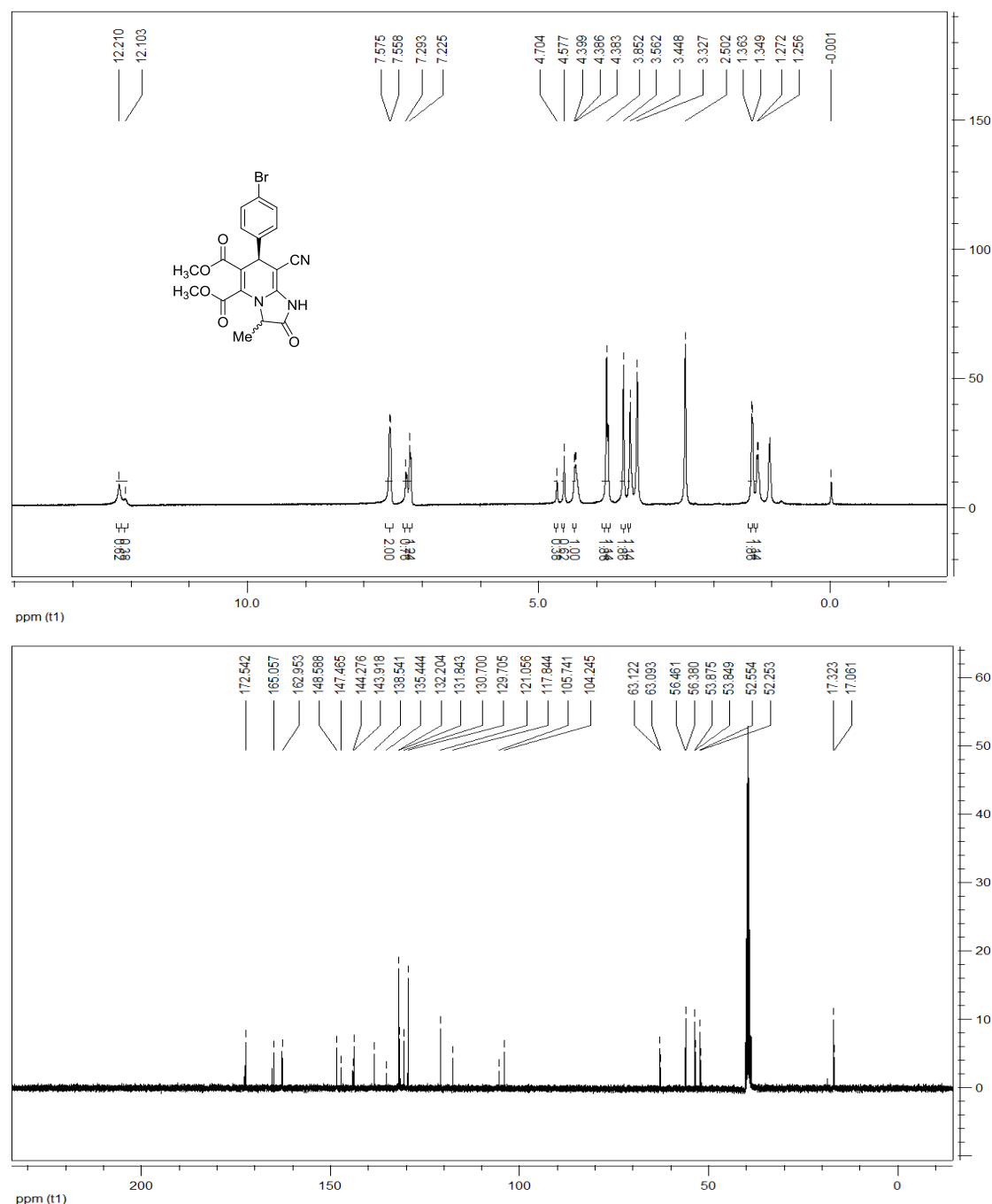
**dimethyl 3-(sec-butyl)-7-(4-chlorophenyl)-8-cyano-2-oxo-1,2,3,7-tetrahydroimidazo[1,2-a]-pyridine-5,6-dicarboxylate (2e):** yellow solid, 63%, m.p. 161~163°C;  $^1\text{H}$  NMR (400 MHz, DMSO- $d_6$ )  $\delta$ : 12.28 (s, 1H, NH), 7.47 (d,  $J$  = 6.8 Hz, 2H, ArH), 7.22 (d,  $J$  = 7.2 Hz, 2H, ArH), 4.63 (s, 1H, CH), 4.39 (s, 1H, CH), 3.85 (s, 3H, OCH<sub>3</sub>), 3.58 (s, 3H, OCH<sub>3</sub>), 1.76~1.72 (m, 1H, CH), 1.64~1.59 (m, 1H, CH), 1.42~1.38 (m, 1H, CH), 0.89 (t,  $J$  = 6.4 Hz, 3H, CH<sub>3</sub>), 0.77 (t,  $J$  = 5.2 Hz, 3H, CH<sub>3</sub>),  $^{13}\text{C}$  NMR (100 MHz, DMSO- $d_6$ )  $\delta$ : 170.6, 165.0, 162.9, 148.8, 143.1, 138.6, 132.5, 129.5, 128.7, 117.6, 104.4, 63.0, 62.3, 53.8, 52.6, 26.7, 24.5, 13.5, 12.2; IR (KBr)  $\nu$ : 3137, 3063, 2961, 2876, 2205, 1746, 1712, 1681, 1602, 1491, 1423, 1379, 1340, 1227, 1153, 1112, 1090, 1042, 1014, 974, 934, 866, 834, 784, 709  $\text{cm}^{-1}$ ; MS ( $m/z$ ): HRMS (ESI) Calcd. for  $\text{C}_{22}\text{H}_{23}\text{ClN}_3\text{O}_5$  ( $[\text{M}+\text{Na}]^+$ ): 444.1326. Found: 444.1293.



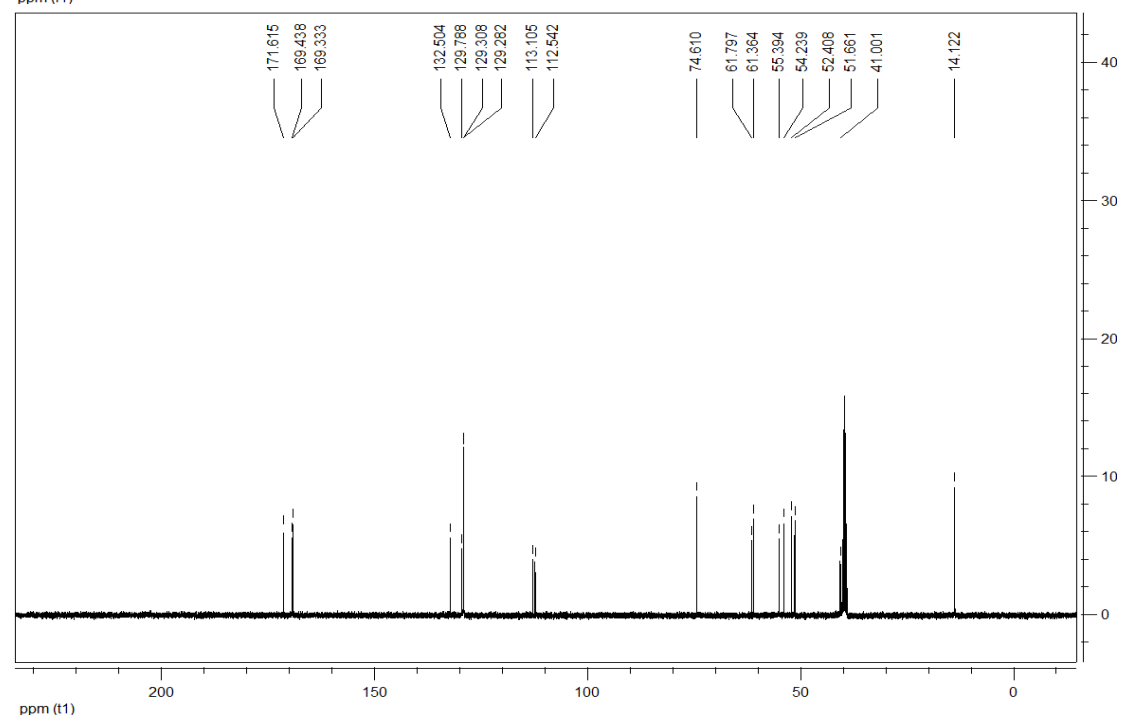
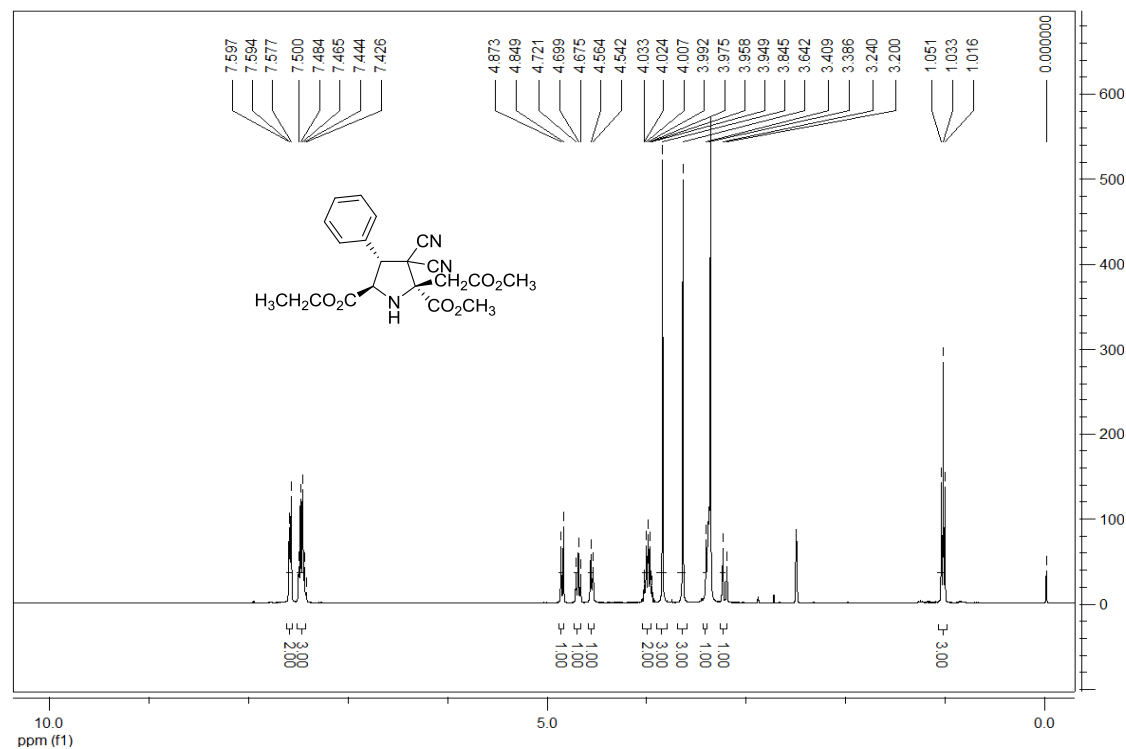
**Dimethyl 7-(4-chlorophenyl)-8-cyano-3-methyl-2-oxo-1,2,3,7-tetrahydroimidazo[1,2-a]pyridine-5,6-dicarboxylate (2f):** yellow solid, 62%, m.p. 205~207°C;  $^1\text{H}$  NMR (400 MHz, DMSO- $d_6$ )  $\delta$ : major isomer: 12.19 (s, 1H, NH), 7.43 (d,  $J$  = 8.0 Hz, 2H, ArH), 7.27 (d,  $J$  = 7.6 Hz, 2H, ArH), 4.59 (s, 1H, CH), 4.42~3.36 (m, 1H, CH), 3.85 (s, 3H, OCH<sub>3</sub>), 3.56 (s, 3H, OCH<sub>3</sub>), 1.36 (d,  $J$  = 6.4 Hz, 3H, CH<sub>3</sub>); minor isomer: 7.34 (d,  $J$  = 8.4 Hz, 2H, ArH), 4.71 (s, 1H, CH), 3.82 (s, 3H, OCH<sub>3</sub>), 3.45 (s, 3H, OCH<sub>3</sub>), 1.26 (d,  $J$  = 6.0 Hz, 3H, CH<sub>3</sub>). Ratio of major/minor = 5:1.  $^{13}\text{C}$  NMR (100 MHz, DMSO- $d_6$ )  $\delta$ : 172.5, 165.0, 162.9, 148.6, 143.5, 138.5, 132.5, 130.3, 129.3, 129.2, 128.9, 117.8, 104.2, 63.1, 63.1, 56.4, 56.3, 53.8, 53.8, 52.5, 17.3, 17.0; IR (KBr)  $\nu$ : 3155, 3066, 2955, 2920, 2850, 2203, 1772, 1745, 1712, 1683, 1606, 1489, 1421, 1383, 1337, 1304, 1216, 1155, 1111, 1041, 1013, 974, 936, 903, 879, 840, 786, 726  $\text{cm}^{-1}$ ; MS (m/z): HRMS (ESI) Calcd. for C<sub>19</sub>H<sub>16</sub>ClN<sub>3</sub>NaO<sub>5</sub> ([M+Na]<sup>+</sup>): 424.0676. Found: 424.0673.



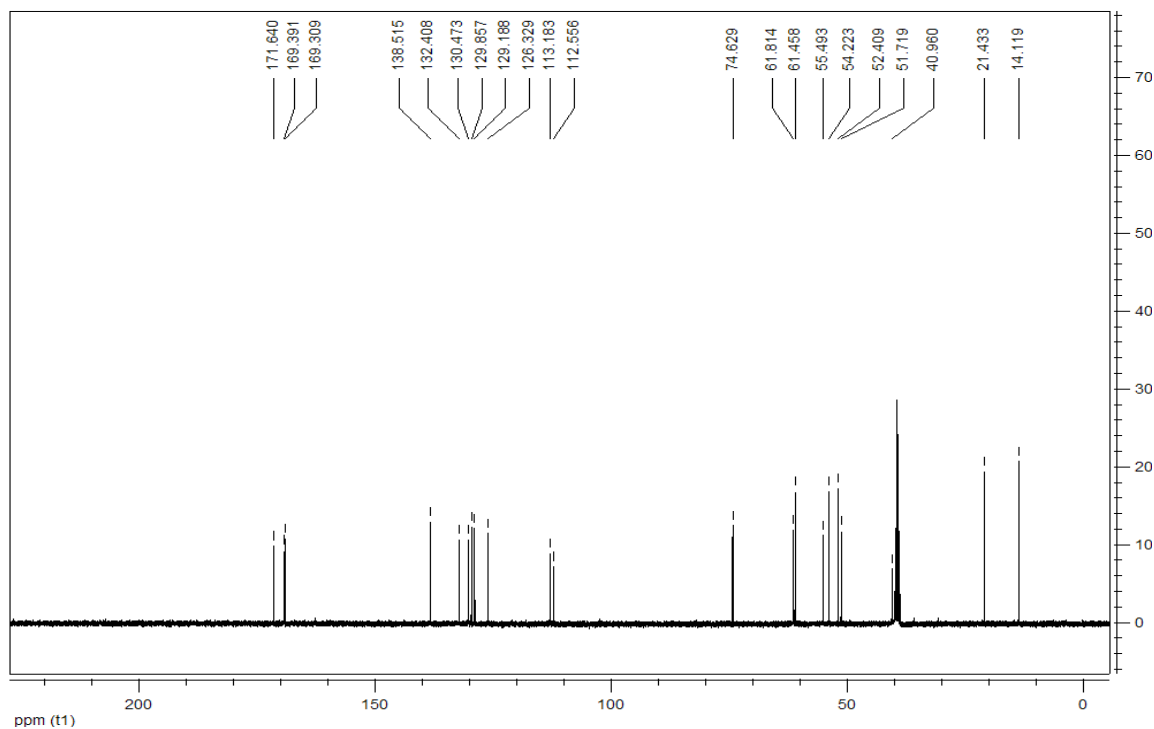
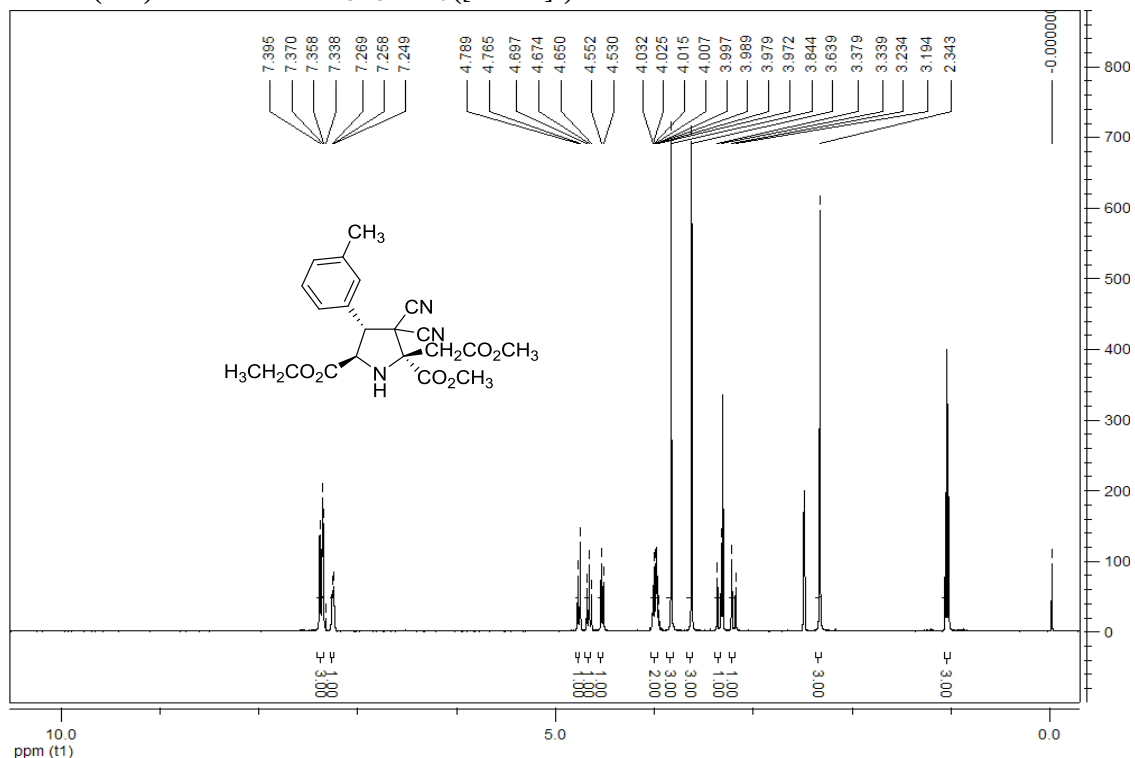
**Dimethyl 7-(4-bromophenyl)-8-cyano-3-methyl-2-oxo-1,2,3,7-tetrahydroimidazo[1,2-a]-pyridine-5,6-dicarboxylate (2g):** yellow solid, 66%, m.p. 195~197°C;  $^1\text{H}$  NMR (400 MHz, DMSO- $d_6$ )  $\delta$ : major isomer: 12.21 (s, 1H, NH), 7.56 (d,  $J$  = 6.8 Hz, 2H, ArH), 7.21 (d,  $J$  = 6.8 Hz, 2H, ArH), 4.58 (s, 1H, CH), 4.40~3.38 (m, 1H, CH), 3.85 (s, 3H, OCH<sub>3</sub>), 3.56 (s, 3H, OCH<sub>3</sub>), 1.35 (d,  $J$  = 5.6 Hz, 3H, CH<sub>3</sub>); minor isomer: 12.10 (s, 1H, NH), 7.28 (d,  $J$  = 7.6 Hz, 2H, ArH), 4.70 (s, 1H, CH), 3.83 (s, 3H, OCH<sub>3</sub>), 3.45 (s, 3H, OCH<sub>3</sub>), 1.26 (d,  $J$  = 5.6 Hz, 3H, CH<sub>3</sub>). Ratio of major/minor = 0.62:0.38.  $^{13}\text{C}$  NMR (100 MHz, DMSO- $d_6$ )  $\delta$ : 172.5, 165.0, 162.9, 148.5, 147.4, 144.2, 143.9, 138.5, 135.4, 132.2, 131.8, 130.7, 129.7, 121.0, 117.8, 105.7, 104.2, 63.1, 63.0, 56.4, 56.3, 53.8, 53.8, 52.5, 52.2, 17.3, 17.0; IR (KBr)  $\nu$ : 3200, 3064, 2952, 2849, 2789, 2202, 1744, 1713, 1683, 1607, 1486, 1422, 1383, 1334, 1305, 1272, 1215, 1154, 1104, 1072, 1042, 1010, 975, 936, 902, 879, 841, 828, 812, 783, 768, 724  $\text{cm}^{-1}$ ; MS (m/z): HRMS (ESI) Calcd. for C<sub>19</sub>H<sub>16</sub>BrN<sub>3</sub>NaO<sub>5</sub> ([M+Na]<sup>+</sup>): 468.0171. Found: 468.0166.



**5-Ethyl 2-methyl 3,3-dicyano-2-(2-methoxy-2-oxoethyl)-4-phenylpyrrolidine-2,5-dicarboxylate (3a):** White solid, 44%, m.p. 124-126°C;  $^1\text{H}$  NMR (400 MHz,  $\text{DMSO-}d_6$ )  $\delta$ : 7.60-7.58 (m, 2H, ArH), 7.50-7.43 (m, 3H, ArH), 4.86 (d,  $J = 9.6$  Hz, 1H, CH), 4.72-4.68 (m, 1H, CH), 4.55 (d,  $J = 8.8$  Hz, 1H, NH), 4.03-3.95 (m, 2H, CH), 3.84 (s, 3H,  $\text{OCH}_3$ ), 3.64 (s, 3H,  $\text{OCH}_3$ ), 3.40 (d,  $J = 16.0$  Hz, 1H, CH), 3.22 (d,  $J = 16.0$  Hz, 1H, CH), 1.03 (t,  $J = 7.1$  Hz, 3H,  $\text{CH}_3$ );  $^{13}\text{C}$  NMR (100 MHz,  $\text{DMSO-}d_6$ )  $\delta$ : 171.6, 169.4, 169.3, 132.5, 129.8, 129.3, 129.2, 113.1, 112.5, 74.6, 61.8, 61.4, 55.4, 54.2, 52.4, 51.7, 41.0, 14.1; IR (KBr)  $\nu$ : 3352, 2957, 1743, 1500, 1444, 1366, 1278, 1202, 1102, 1002, 855, 746, 703  $\text{cm}^{-1}$ ; MS ( $m/z$ ): HRMS (ESI) Calcd. for  $\text{C}_{20}\text{H}_{21}\text{N}_3\text{NaO}_6$  ( $[\text{M}+\text{Na}]^+$ ): 422.1323. Found: 422.1336.

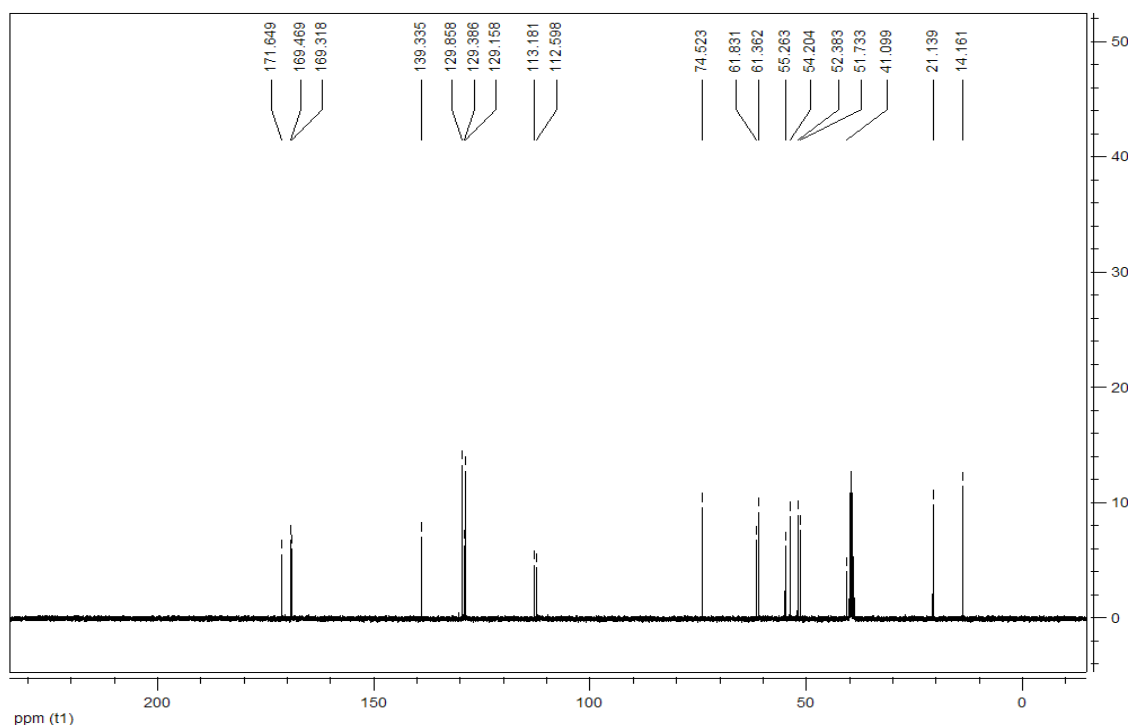
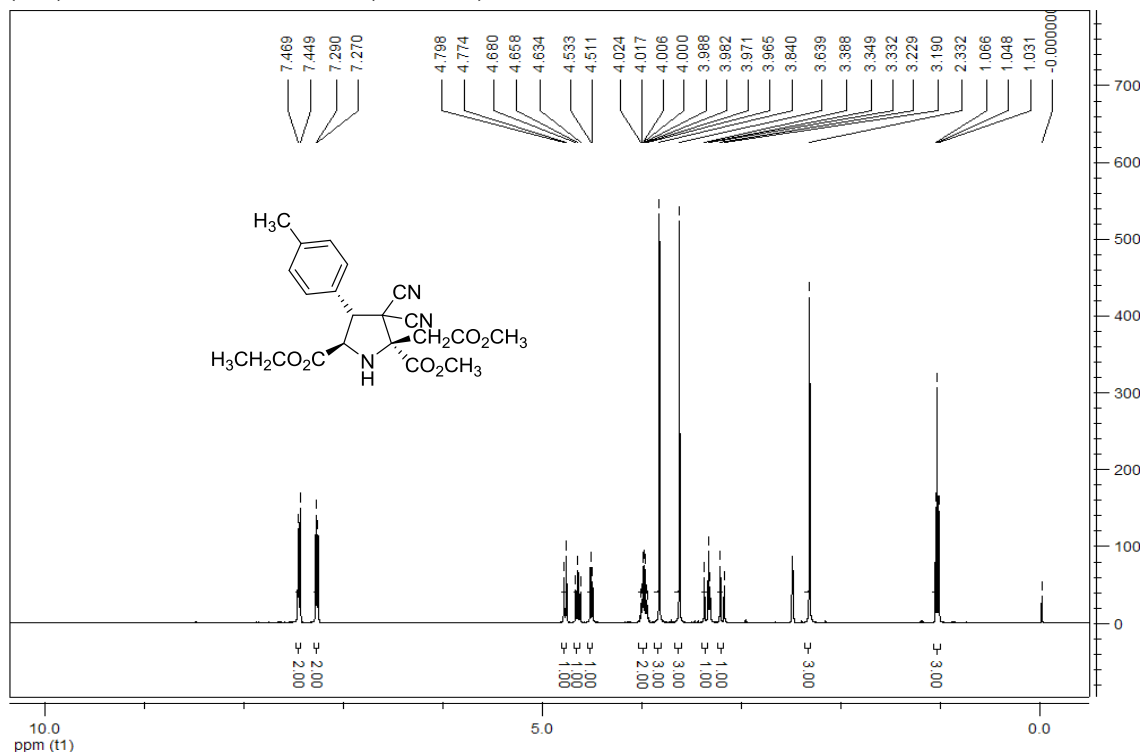


**5-Ethyl 2-methyl 3,3-dicyano-2-(2-methoxy-2-oxoethyl)-4-(m-tolyl)pyrrolidine-2,5-dicarboxylate (3b):** White solid, 53%, m.p. 110-112 °C; <sup>1</sup>H NMR (400 MHz, DMSO-*d*<sub>6</sub>) δ: 7.40-7.34 (m, 3H, ArH), 7.27-7.25 (m, 1H, ArH), 4.78 (d, *J* = 8.4 Hz, 1H, CH), 4.70-4.65 (m, 1H, CH), 4.54 (d, *J* = 8.8 Hz, 1H, NH), 4.03-3.97 (m, 2H, CH), 3.84 (s, 3H, OCH<sub>3</sub>), 3.64 (s, 3H, OCH<sub>3</sub>), 3.36 (d, *J* = 16.0 Hz, 1H, CH), 3.21 (d, *J* = 16.0 Hz, 1H, CH), 2.34 (s, 3H, CH<sub>3</sub>), 1.06 (t, *J* = 7.2 Hz, 3H, CH<sub>3</sub>); <sup>13</sup>C NMR (100 MHz, DMSO-*d*<sub>6</sub>) δ: 171.6, 169.4, 169.3, 138.5, 132.4, 130.5, 129.9, 129.2, 126.3, 113.2, 112.6, 74.6, 61.8, 61.5, 55.5, 54.2, 52.4, 51.7, 41.0, 21.4, 14.1; IR (KBr) ν: 3347, 2955, 1745, 1444, 1367, 1283, 1241, 1199, 1102, 1014, 867, 702 cm<sup>-1</sup>; MS (*m/z*): HRMS (ESI) Calcd. for C<sub>21</sub>H<sub>23</sub>N<sub>3</sub>NaO<sub>6</sub> ([M+Na]<sup>+</sup>): 436.1479. Found: 436.1498.

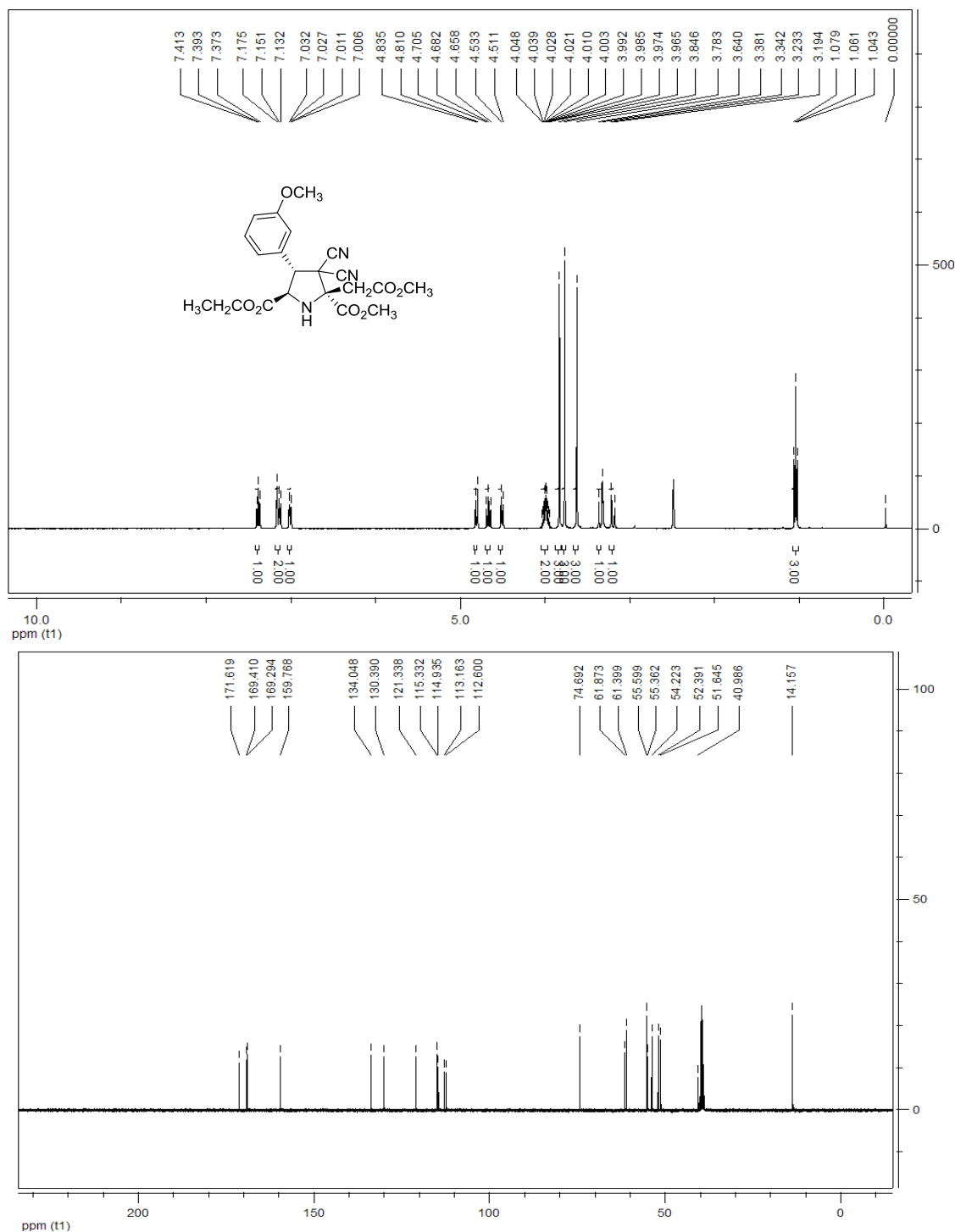




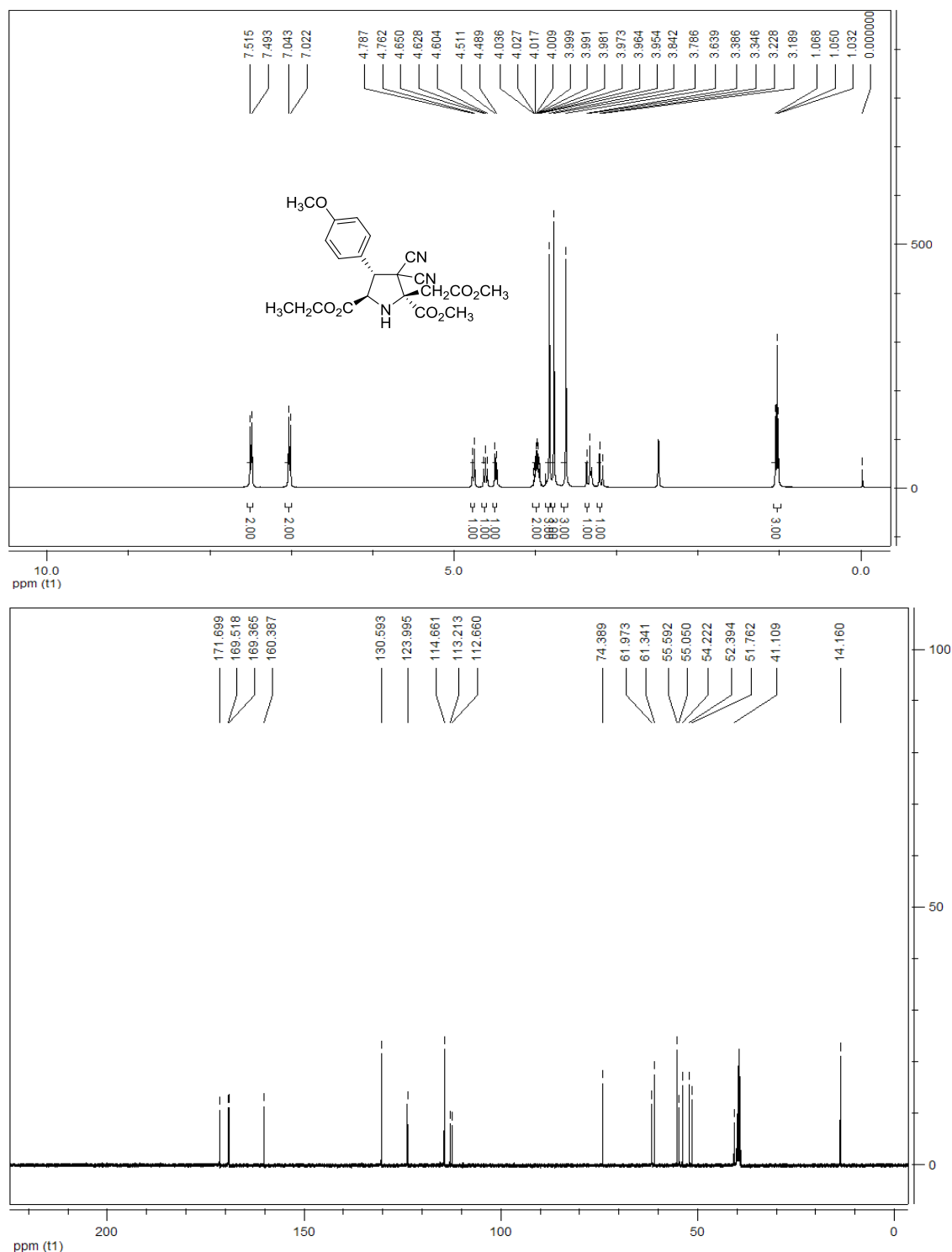
**5-Ethyl 2-methyl 3,3-dicyano-2-(2-methoxy-2-oxoethyl)-4-(p-tolyl)pyrrolidine-2,5-dicarboxylate (3c):** White solid, 48%, m.p. 126-128°C;  $^1\text{H}$  NMR (400 MHz,  $\text{DMSO}-d_6$ )  $\delta$ : 7.46 (d,  $J = 8.0$  Hz, 2H, ArH), 7.28 (d,  $J = 8.0$  Hz, 2H, ArH), 4.79 (d,  $J = 9.6$  Hz, 1H, CH), 4.68-4.63 (m, 1H, CH), 4.52 (d,  $J = 8.8$  Hz, 1H, NH), 4.02-3.96 (m, 2H, CH), 3.84 (s, 3H,  $\text{OCH}_3$ ), 3.64 (s, 3H,  $\text{OCH}_3$ ), 3.37 (d,  $J = 15.6$  Hz, 1H, CH), 3.21 (d,  $J = 15.6$  Hz, 1H, CH), 2.33 (s, 3H,  $\text{CH}_3$ ), 1.06 (t,  $J = 7.2$  Hz, 3H,  $\text{CH}_3$ );  $^{13}\text{C}$  NMR (100 MHz,  $\text{DMSO}-d_6$ )  $\delta$ : 171.6, 169.5, 169.3, 139.3, 129.9, 129.4, 129.2, 113.2, 112.6, 74.5, 61.8, 61.4, 55.3, 54.2, 52.4, 51.7, 41.1, 21.1, 14.2; IR (KBr)  $\nu$ : 3348, 2957, 1749, 1606, 1521, 1443, 1367, 1286, 1204, 1105, 1004, 877, 830  $\text{cm}^{-1}$ ; MS ( $m/z$ ): HRMS (ESI) Calcd. for  $\text{C}_{21}\text{H}_{23}\text{N}_3\text{NaO}_6$  ( $[\text{M}+\text{Na}]^+$ ): 436.1479. Found: 436.1493.



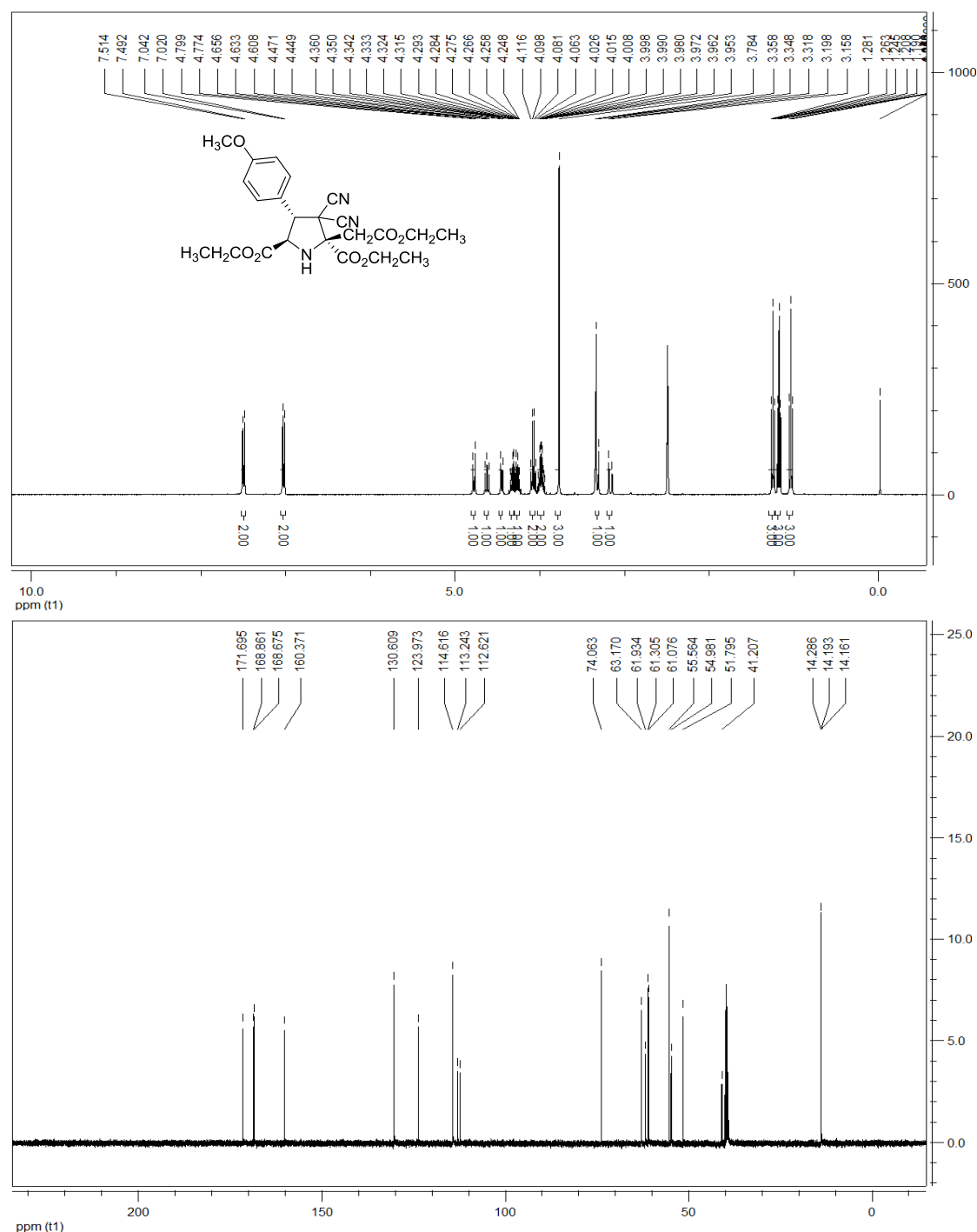
**5-Ethyl 2-methyl 3,3-dicyano-2-(2-methoxy-2-oxoethyl)-4-(3-methoxyphenyl)pyrrolidine-2,5-dicarboxylate (3d):** White solid, 56%, m.p. 134-136°C;  $^1\text{H}$  NMR (400 MHz,  $\text{DMSO}-d_6$ )  $\delta$ : 7.39 (t,  $J = 8.0\text{ Hz}$ , 1H, ArH), 7.18-7.13 (m, 2H, ArH), 7.03-7.01 (m, 1H, ArH), 4.82 (d,  $J = 10.0\text{ Hz}$ , 1H, CH), 4.70-4.66 (m, 1H, CH), 4.52 (d,  $J = 8.8\text{ Hz}$ , 1H, NH), 4.05-3.96 (m, 2H, CH), 3.85 (s, 3H,  $\text{OCH}_3$ ), 3.78 (s, 3H,  $\text{OCH}_3$ ), 3.64 (s, 3H,  $\text{OCH}_3$ ), 3.36 (d,  $J = 15.6\text{ Hz}$ , 1H, CH), 3.21 (d,  $J = 15.6\text{ Hz}$ , 1H, CH), 1.06 (t,  $J = 7.2\text{ Hz}$ , 3H,  $\text{CH}_3$ );  $^{13}\text{C}$  NMR (100 MHz,  $\text{DMSO}-d_6$ )  $\delta$ : 171.6, 169.4, 169.3, 159.8, 134.0, 130.4, 121.3, 115.3, 114.9, 113.2, 112.6, 74.7, 61.9, 61.4, 55.6, 55.4, 54.2, 52.4, 51.6, 41.0, 14.2; IR (KBr)  $\nu$ : 3326, 2971, 1756, 1729, 1601, 1443, 1367, 1289, 1199, 1099, 1006, 947, 858, 766, 709  $\text{cm}^{-1}$ ; MS ( $m/z$ ): HRMS (ESI) Calcd. for  $\text{C}_{21}\text{H}_{23}\text{N}_3\text{NaO}_7$  ( $[\text{M}+\text{Na}]^+$ ): 452.1428. Found: 452.1435.



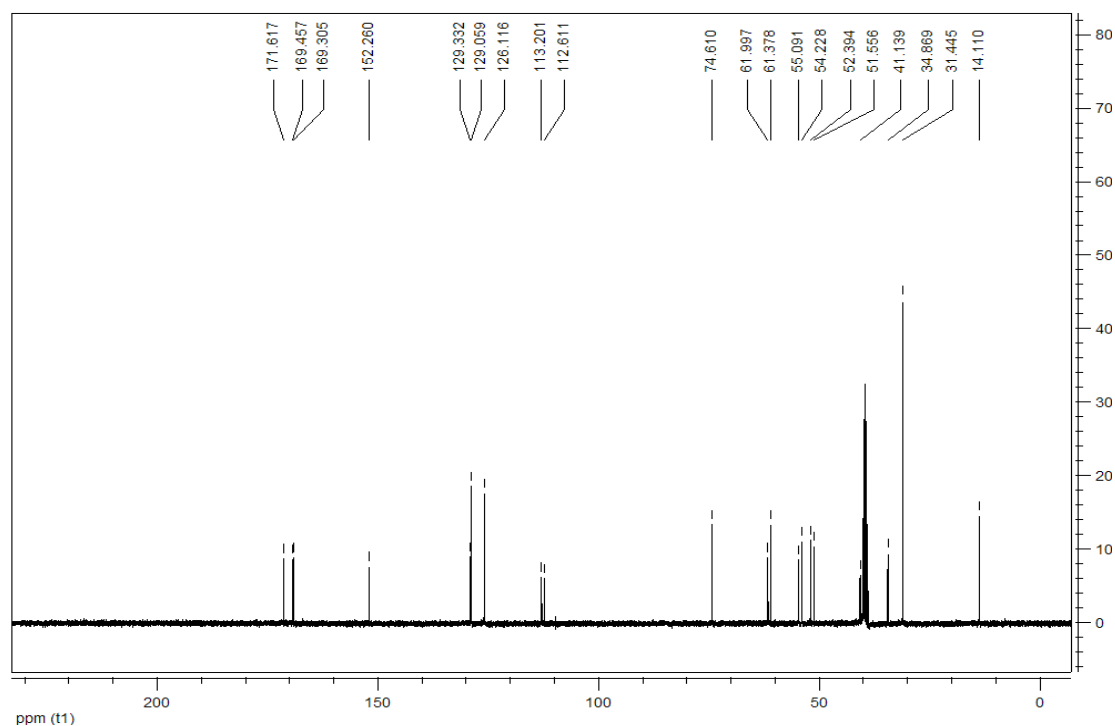
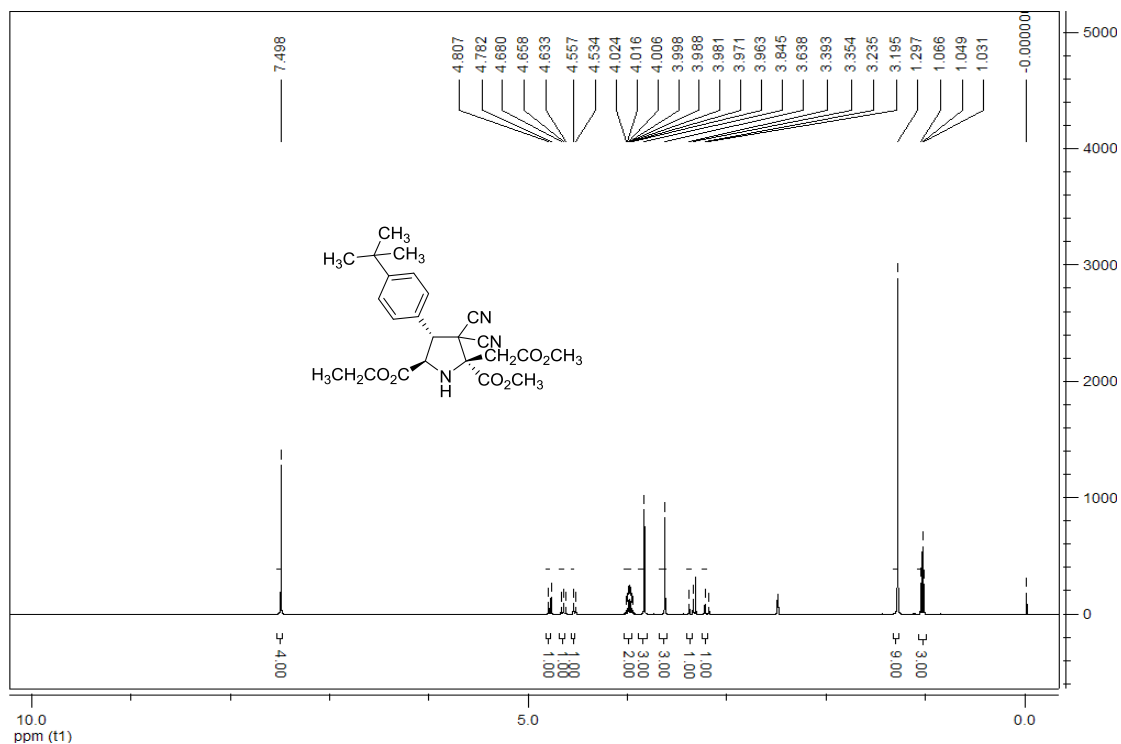
**5-Ethyl 2-methyl 3,3-dicyano-2-(2-methoxy-2-oxoethyl)-4-(4-methoxyphenyl)pyrrolidine-2,5-dicarboxylate (3e):** White solid, 51%, m.p. 126-128°C;  $^1\text{H}$  NMR (400 MHz,  $\text{DMSO-}d_6$ )  $\delta$ : 7.50 (d,  $J = 8.8\text{ Hz}$ , 2H, ArH), 7.03 (d,  $J = 8.4\text{ Hz}$ , 2H, ArH), 4.77 (d,  $J = 10.0\text{ Hz}$ , 1H, CH), 4.65-4.60 (m, 1H, CH), 4.50 (d,  $J = 8.8\text{ Hz}$ , 1H, NH), 4.04-3.95 (m, 2H, CH), 3.84 (s, 3H,  $\text{OCH}_3$ ), 3.79 (s, 3H,  $\text{OCH}_3$ ), 3.64 (s, 3H,  $\text{OCH}_3$ ), 3.37 (d,  $J = 16.0\text{ Hz}$ , 1H, CH), 3.21 (d,  $J = 16.0\text{ Hz}$ , 1H, CH), 1.05 (t,  $J = 7.2\text{ Hz}$ , 3H,  $\text{CH}_3$ );  $^{13}\text{C}$  NMR (100 MHz,  $\text{DMSO-}d_6$ )  $\delta$ : 171.7, 169.5, 169.4, 160.4, 130.6, 124.0, 114.7, 113.2, 112.7, 74.4, 62.0, 61.3, 55.6, 55.0, 54.2, 52.4, 51.8, 41.1, 14.2; IR (KBr)  $\nu$ : 3344, 2962, 1743, 1613, 1519, 1447, 1371, 1290, 1201, 1104, 1027, 847, 806  $\text{cm}^{-1}$ ; MS ( $m/z$ ): HRMS (ESI) Calcd. for  $\text{C}_{21}\text{H}_{23}\text{N}_3\text{NaO}_7$  ( $[\text{M}+\text{Na}]^+$ ): 452.1428. Found: 452.1438.



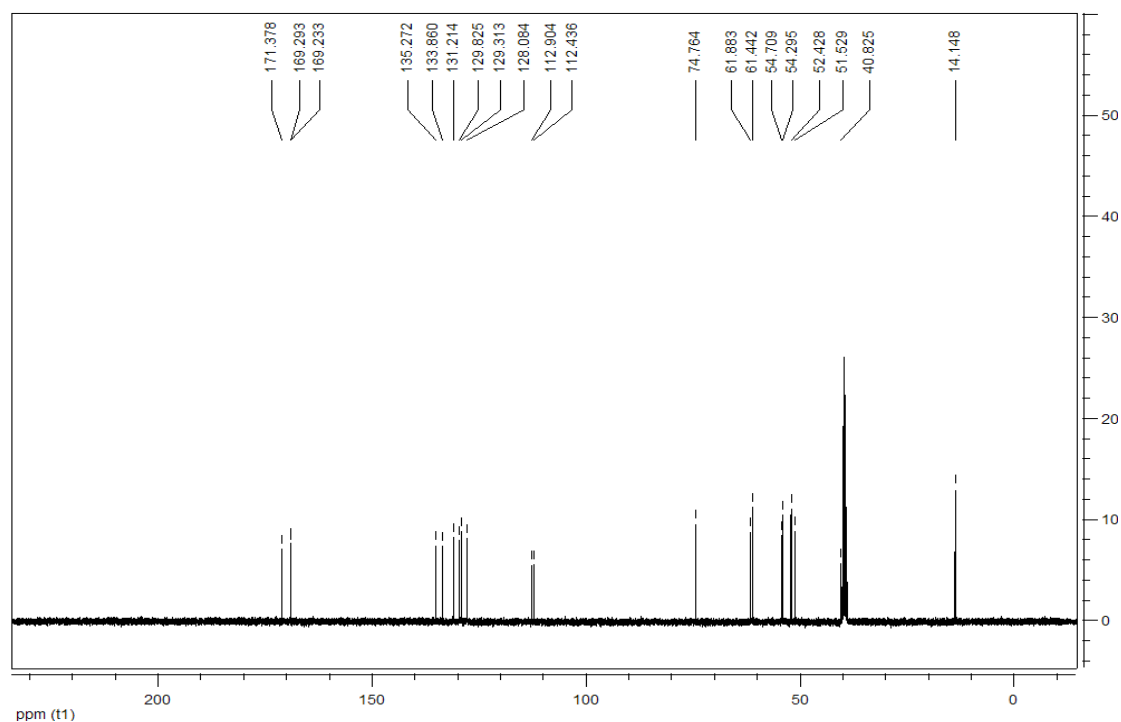
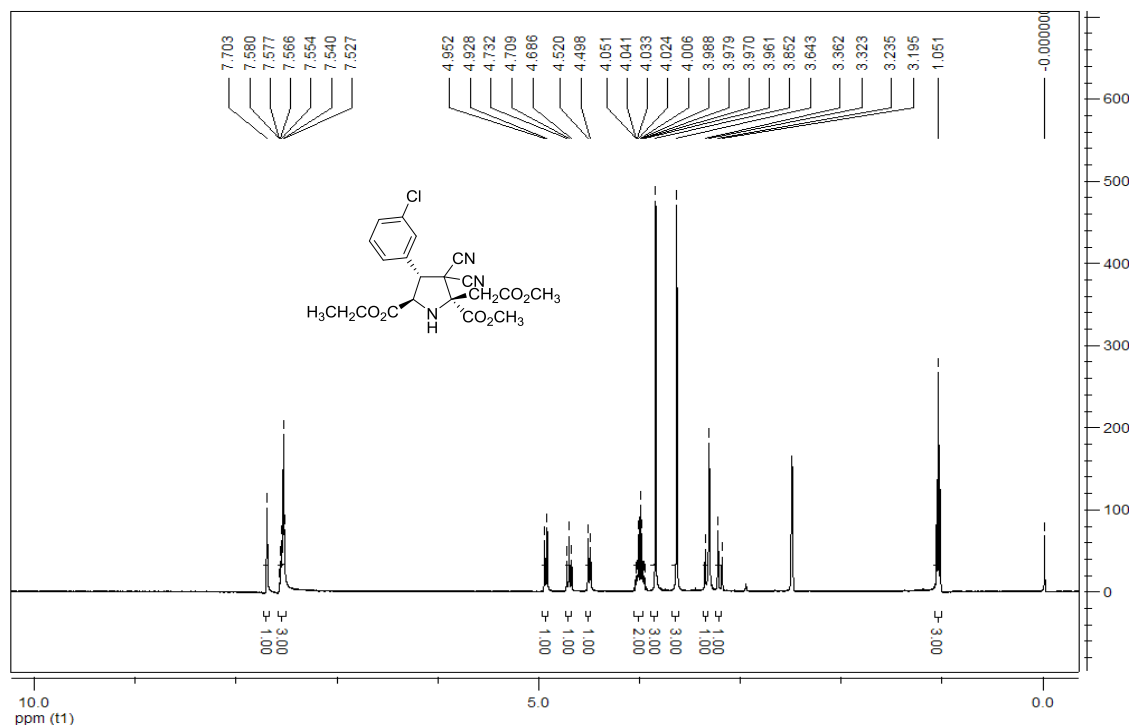
**Diethyl 3,3-dicyano-2-(2-ethoxy-2-oxoethyl)-4-(4-methoxyphenyl)pyrrolidine-2,5-dicarboxylate (3f):** White solid, 46%, m.p. 106-108°C;  $^1\text{H}$  NMR (400 MHz,  $\text{DMSO-}d_6$ )  $\delta$ : 7.51-7.49 (m, 2H, ArH), 7.04-7.02 (m, 2H, ArH), 4.79 (d,  $J = 10.0\text{ Hz}$ , 1H, CH), 4.66-4.61 (m, 1H, CH), 4.46 (d,  $J = 8.8\text{ Hz}$ , 1H, NH), 4.36-4.32 (m, 1H, CH), 4.29-4.25 (m, 1H, CH), 4.09 (q,  $J = 7.2\text{ Hz}$ , 2H, CH), 4.03-3.95 (m, 2H, CH), 3.78 (s, 3H,  $\text{OCH}_3$ ), 3.34 (d,  $J = 16.0\text{ Hz}$ , 1H, CH), 3.18 (d,  $J = 16.0\text{ Hz}$ , 1H, CH), 1.26 (t,  $J = 7.2\text{ Hz}$ , 3H,  $\text{CH}_3$ ), 1.19 (t,  $J = 7.2\text{ Hz}$ , 3H,  $\text{CH}_3$ ), 1.05 (t,  $J = 7.2\text{ Hz}$ , 3H,  $\text{CH}_3$ );  $^{13}\text{C}$  NMR (100 MHz,  $\text{DMSO-}d_6$ )  $\delta$ : 171.7, 168.9, 168.7, 160.4, 130.6, 124.0, 114.6, 113.2, 112.6, 74.6, 63.2, 61.9, 61.3, 61.1, 55.6, 55.0, 51.8, 41.2, 14.3, 14.2, 14.1; IR (KBr)  $\nu$ : 3353, 2985, 1755, 1738, 1611, 1516, 1467, 1379, 1291, 1269, 1242, 1210, 1113, 1029, 948, 722  $\text{cm}^{-1}$ ; MS ( $m/z$ ): HRMS (ESI) Calcd. for  $\text{C}_{23}\text{H}_{27}\text{N}_3\text{NaO}_7$  ( $[\text{M}+\text{Na}]^+$ ): 480.1741. Found: 480.1752.



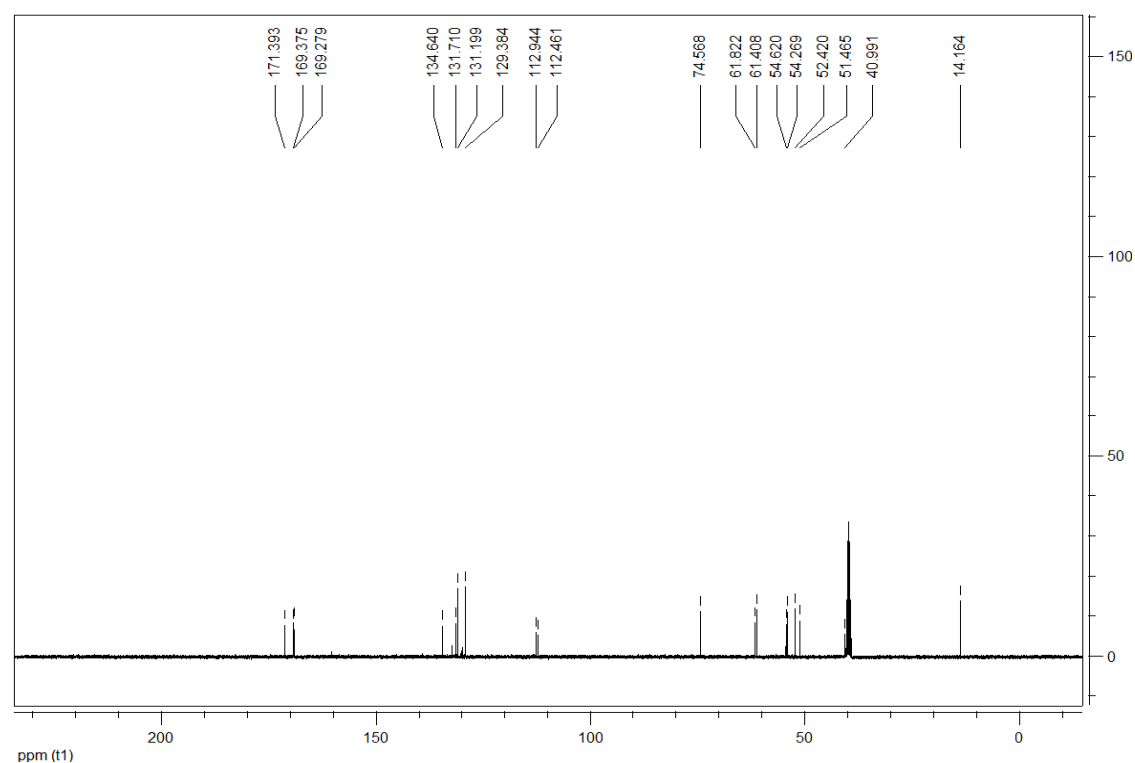
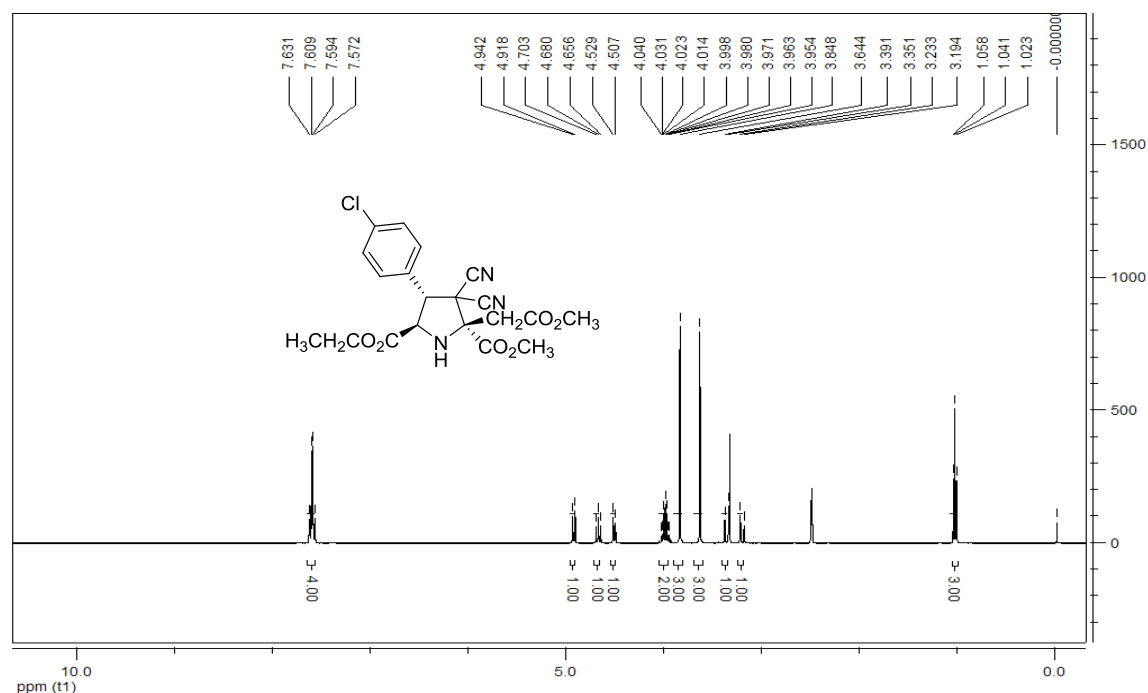
**5-Ethyl 2-methyl 4-(4-(tert-butyl)phenyl)-3,3-dicyano-2-(2-methoxy-2-oxoethyl)pyrrolidine-2,5-dicarboxylate (3g):** White solid, 57%, m.p. 150-152 °C;  $^1\text{H}$  NMR (400 MHz,  $\text{DMSO}-d_6$ )  $\delta$ : 7.50 (s, 4H, ArH), 4.79 (d,  $J = 10.0\text{ Hz}$ , 1H, CH), 4.68-4.63 (m, 1H, CH), 4.50 (d,  $J = 9.2\text{ Hz}$ , 1H, NH), 4.02-3.96 (m, 2H, CH), 3.84 (s, 3H,  $\text{OCH}_3$ ), 3.64 (s, 3H,  $\text{OCH}_3$ ), 3.37 (d,  $J = 15.6\text{ Hz}$ , 1H, CH), 3.22 (d,  $J = 16.0\text{ Hz}$ , 1H, CH), 1.30 (s, 9H,  $\text{CH}_3$ ), 1.05 (t,  $J = 7.1\text{ Hz}$ , 3H,  $\text{CH}_3$ );  $^{13}\text{C}$  NMR (100 MHz,  $\text{DMSO}-d_6$ )  $\delta$ : 171.6, 169.5, 169.3, 152.3, 129.3, 129.1, 126.1, 113.2, 112.6, 74.6, 62.0, 61.4, 55.1, 54.2, 52.4, 51.6, 41.1, 34.9, 31.4, 14.1; IR (KBr)  $\nu$ : 3360, 2966, 1735, 1441, 1359, 1299, 1216, 1105, 988, 866, 787, 714  $\text{cm}^{-1}$ ; MS ( $m/z$ ): HRMS (ESI) Calcd. for  $\text{C}_{24}\text{H}_{29}\text{N}_3\text{NaO}_6$  ( $[\text{M}+\text{Na}]^+$ ): 478.1949. Found: 478.1957.



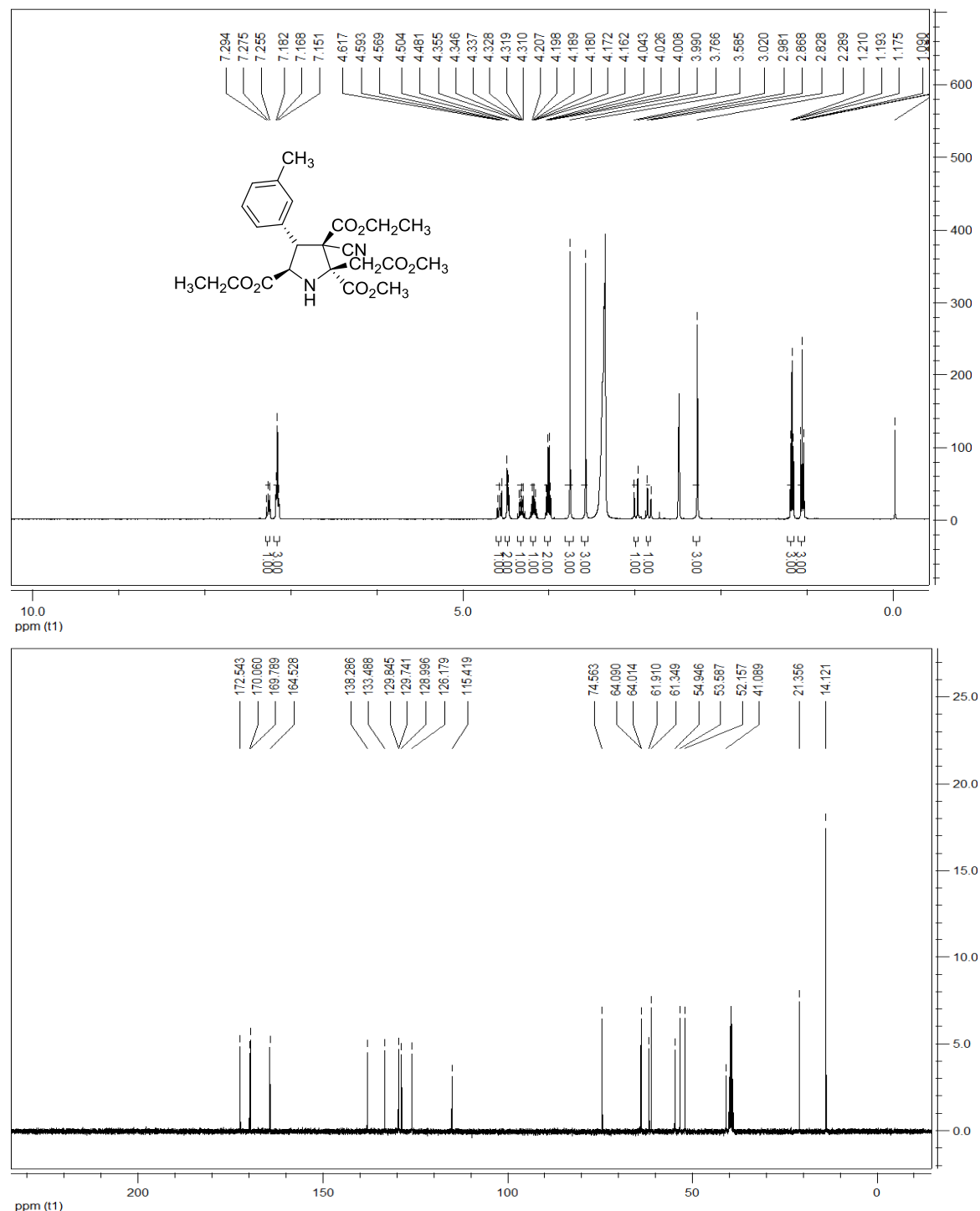
**5-Ethyl 2-methyl 4-(3-chlorophenyl)-3,3-dicyano-2-(2-methoxy-2-oxoethyl)pyrrolidine-2,5-dicarboxylate (3h):** White solid, 51%, m.p. 154-156°C;  $^1\text{H}$  NMR (400 MHz,  $\text{DMSO-}d_6$ )  $\delta$ : 7.70 (brs, 1H, ArH), 7.58-7.53 (m, 3H, ArH), 4.94 (d,  $J = 9.6$  Hz, 1H, CH), 4.73-4.69 (m, 1H, CH), 4.51 (d,  $J = 8.8$  Hz, 1H, NH), 4.05-3.96 (m, 2H, CH), 3.85 (s, 3H,  $\text{OCH}_3$ ), 3.64 (s, 3H,  $\text{OCH}_3$ ), 3.34 (d,  $J = 15.6$  Hz, 1H, CH), 3.22 (d,  $J = 16.0$  Hz, 1H, CH), 1.05 (t,  $J = 7.8$  Hz, 3H,  $\text{CH}_3$ );  $^{13}\text{C}$  NMR (100 MHz,  $\text{DMSO-}d_6$ )  $\delta$ : 171.4, 169.3, 169.2, 135.3, 133.9, 131.2, 129.8, 129.3, 128.1, 112.9, 112.4, 74.8, 61.9, 61.4, 54.7, 54.3, 52.4, 51.5, 40.8, 14.1; IR (KBr)  $\nu$ : 3346, 2955, 1743, 1587, 1443, 1364, 1278, 1206, 1101, 1011, 928  $\text{cm}^{-1}$ ; MS ( $m/z$ ): HRMS (ESI) Calcd. for  $\text{C}_{20}\text{H}_{20}\text{ClN}_3\text{NaO}_6$  ( $[\text{M}+\text{Na}]^+$ ): 456.0933. Found: 456.0947.



**5-Ethyl 2-methyl 4-(4-chlorophenyl)-3,3-dicyano-2-(2-methoxy-2-oxoethyl)pyrrolidine-2,5-dicarboxylate (3i):** White solid, 51%, m.p. 156-158°C;  $^1\text{H}$  NMR (400 MHz,  $\text{DMSO-}d_6$ )  $\delta$ : 7.63-7.57 (m, 4H, ArH), 4.93 (d,  $J = 9.6$  Hz, 1H, CH), 4.70-4.66 (m, 1H, CH), 4.52 (d,  $J = 8.8$  Hz, 1H, NH), 4.04-3.95 (m, 2H, CH), 3.85 (s, 3H,  $\text{OCH}_3$ ), 3.64 (s, 3H,  $\text{OCH}_3$ ), 3.37 (d,  $J = 16.0$  Hz, 1H, CH), 3.21 (d,  $J = 15.6$  Hz, 1H, CH), 1.04 (t,  $J = 7.2$  Hz, 3H,  $\text{CH}_3$ );  $^{13}\text{C}$  NMR (100 MHz,  $\text{DMSO-}d_6$ )  $\delta$ : 171.4, 169.4, 169.3, 134.6, 131.7, 131.2, 129.4, 112.9, 112.5, 74.6, 61.8, 61.4, 54.6, 54.3, 52.4, 51.5, 41.0, 14.2; IR (KBr)  $\nu$ : 3339, 2988, 1754, 1729, 1498, 1442, 1370, 1286, 1215, 1100, 1007, 955, 881, 837, 771, 717  $\text{cm}^{-1}$ ; MS ( $m/z$ ): HRMS (ESI) Calcd. for  $\text{C}_{20}\text{H}_{20}\text{ClN}_3\text{NaO}_6$  ( $[\text{M}+\text{Na}]^+$ ): 456.0933. Found: 456.0942.

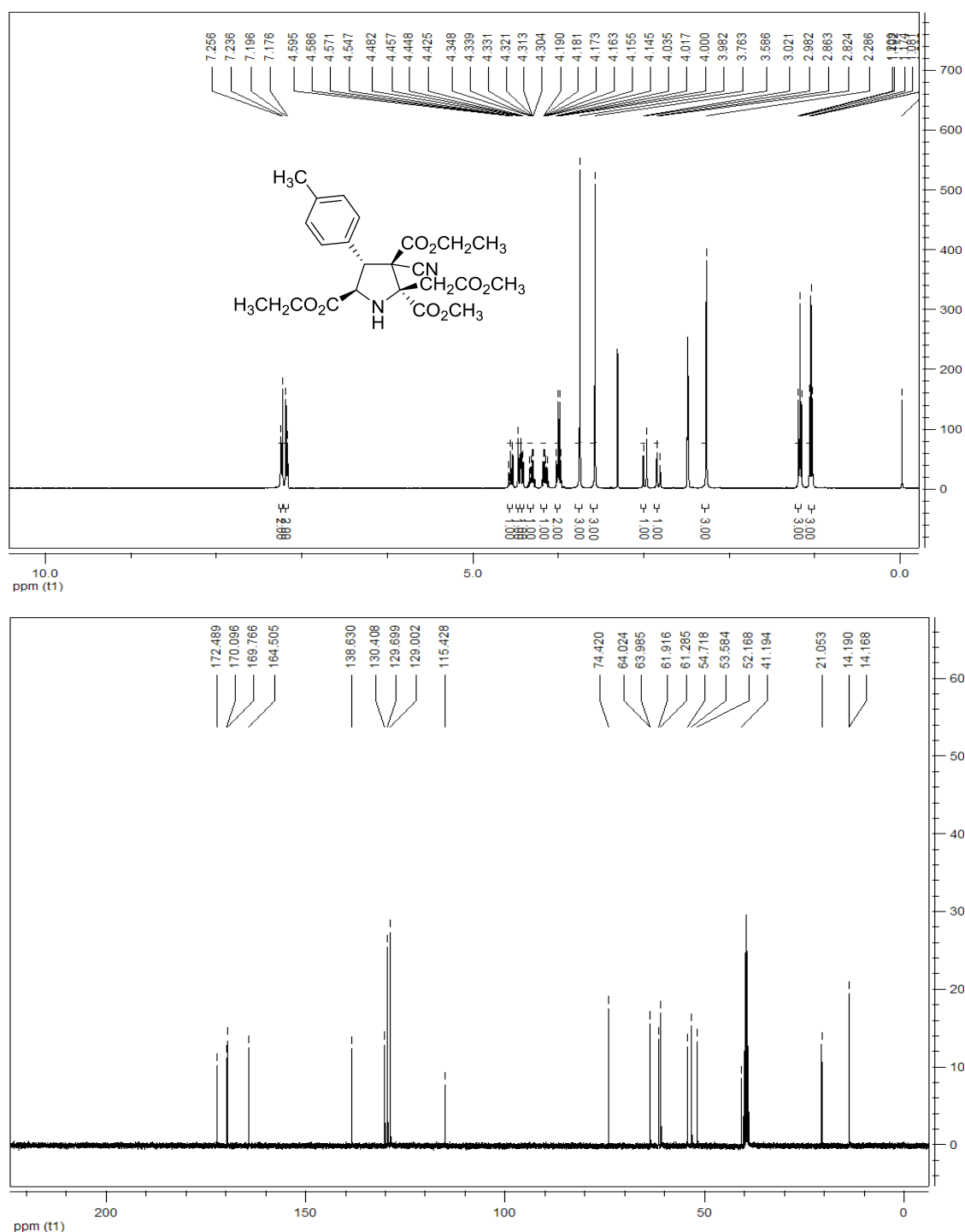


**3,5-Diethyl 2-methyl 3-cyano-2-(2-methoxy-2-oxoethyl)-4-(m-tolyl)pyrrolidine-2,3,5-tricarboxylate (4a):** White solid, 50%, m.p. 112-114°C;  $^1\text{H}$  NMR (400 MHz,  $\text{DMSO-}d_6$ )  $\delta$ : 7.29-7.26 (m, 1H, ArH), 7.18-7.15 (m, 3H, ArH), 4.62-4.57 (m, 1H, CH), 4.50-4.48 (m, 2H, CH), 4.36-4.31 (m, 1H, CH), 4.21-4.16 (m, 1H, CH), 4.04-3.99 (m, 2H, CH), 3.77 (s, 3H,  $\text{OCH}_3$ ), 3.58 (s, 3H,  $\text{OCH}_3$ ), 3.00 (d,  $J = 15.6$  Hz, 1H, CH), 2.85 (d,  $J = 16.0$  Hz, 1H, CH), 2.29 (s, 3H,  $\text{CH}_3$ ), 1.19 (t,  $J = 7.1$  Hz, 3H,  $\text{CH}_3$ ), 1.07 (t,  $J = 7.2$  Hz, 3H,  $\text{CH}_3$ );  $^{13}\text{C}$  NMR (100 MHz,  $\text{DMSO-}d_6$ )  $\delta$ : 172.5, 170.1, 169.8, 164.5, 138.3, 133.5, 129.8, 129.7, 129.0, 126.2, 115.4, 74.6, 64.1, 64.0, 61.9, 61.3, 54.9, 53.6, 52.2, 41.1, 21.4, 14.1; IR (KBr)  $\nu$ : 3349, 2987, 1742, 1443, 1366, 1291, 1249, 1192, 1159, 1075, 998  $\text{cm}^{-1}$ ; MS ( $m/z$ ): HRMS (ESI) Calcd. for  $\text{C}_{23}\text{H}_{28}\text{N}_2\text{NaO}_8$  ( $[\text{M}+\text{Na}]^+$ ): 483.1738. Found: 483.1752.

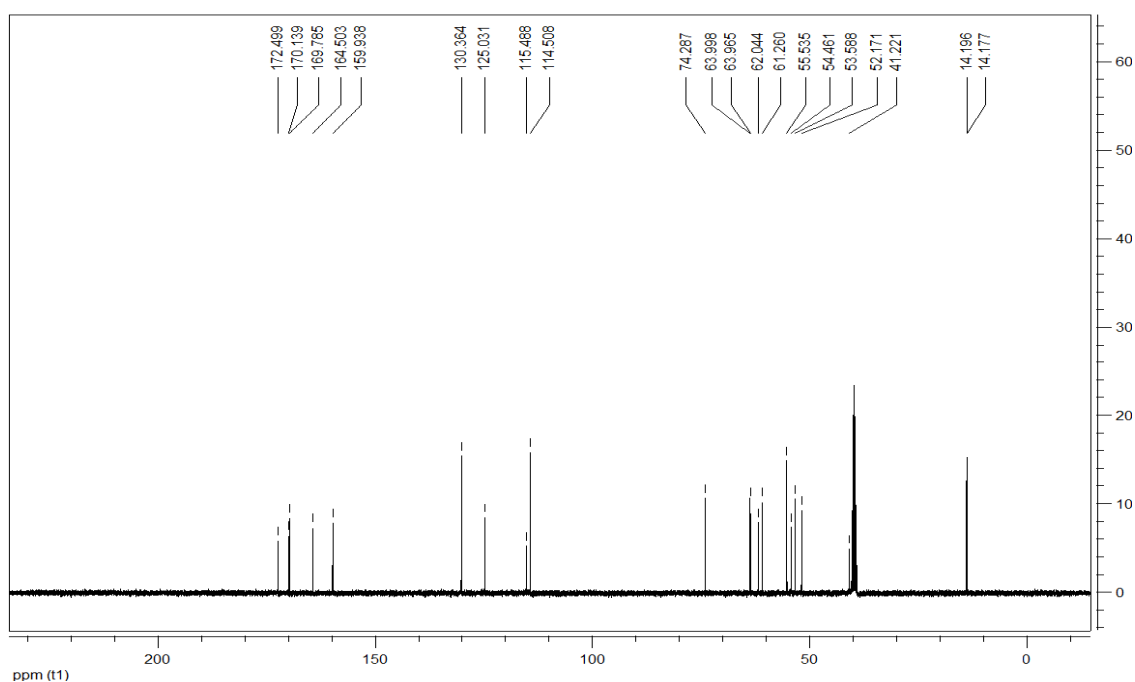
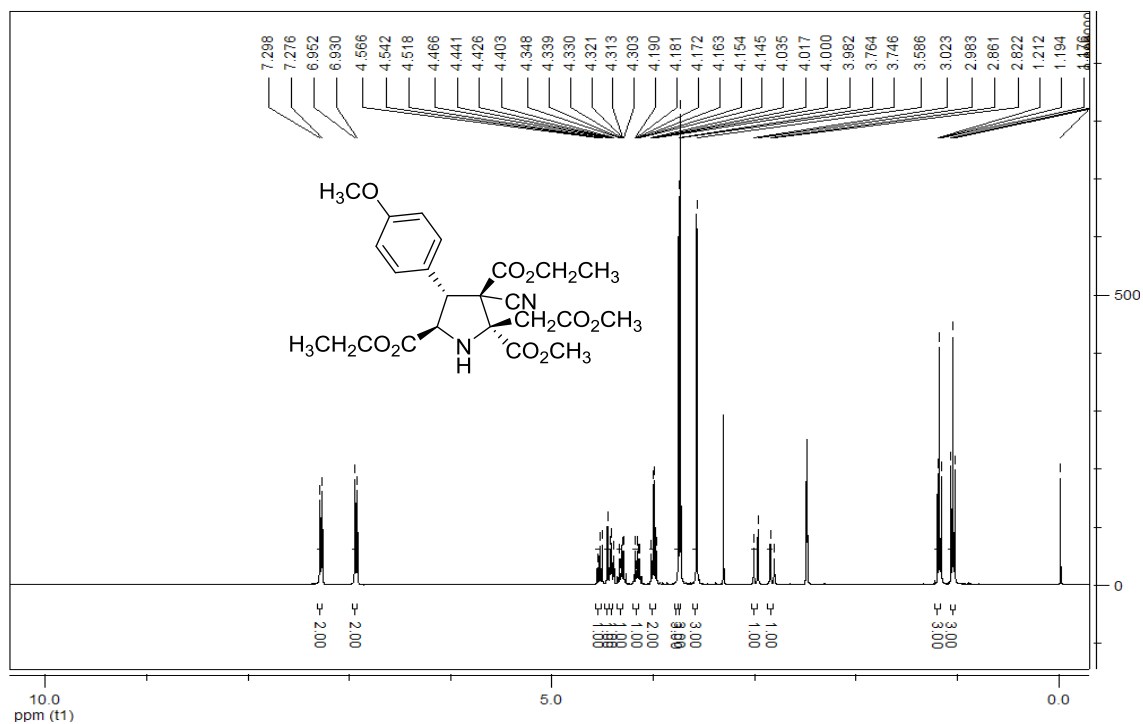




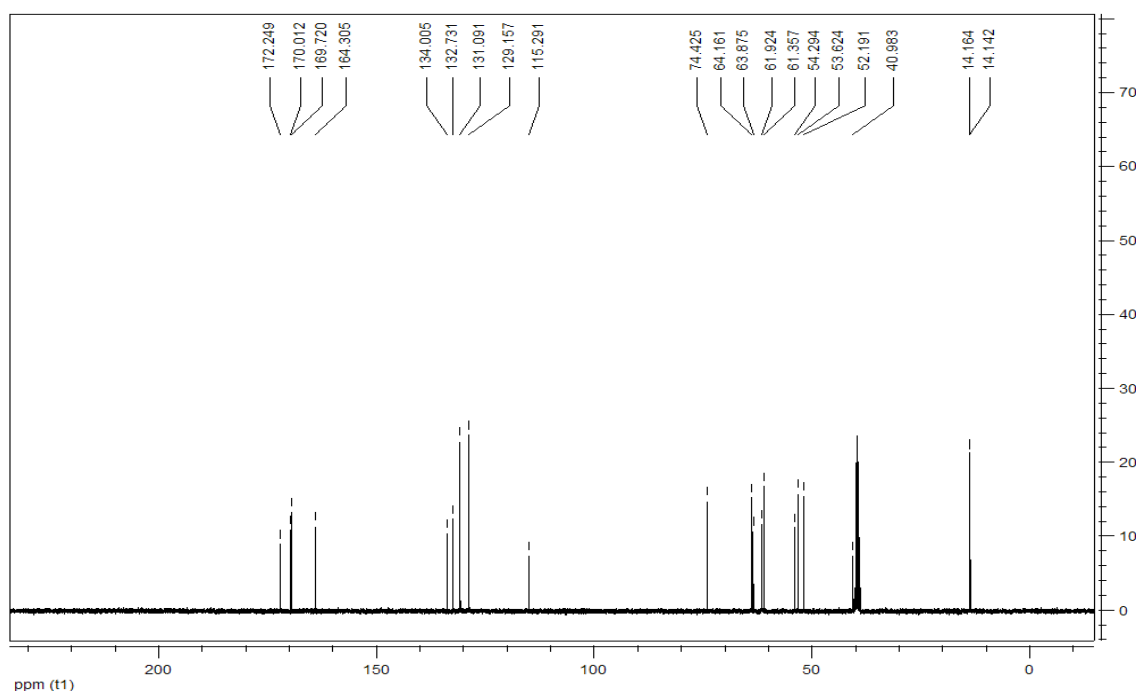
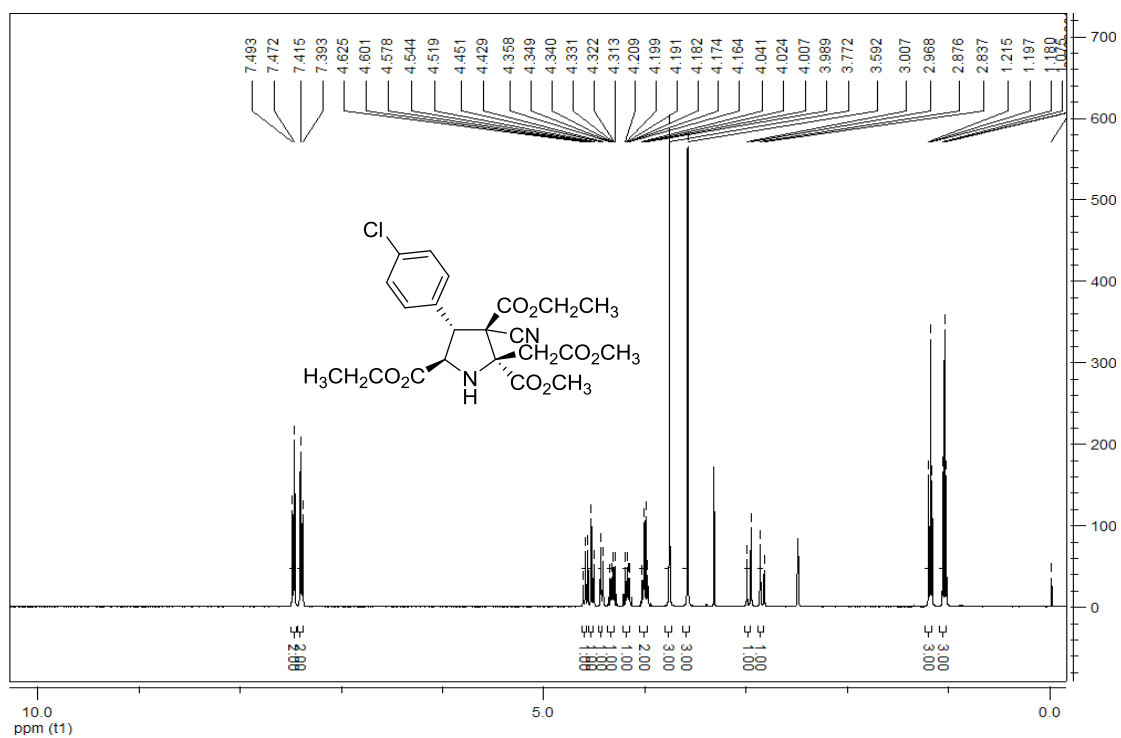
**3,5-Diethyl 2-methyl 3-cyano-2-(2-methoxy-2-oxoethyl)-4-(p-tolyl)pyrrolidine-2,3,5-tricarboxylate (4b):** White solid, 62%, m.p. 112-114°C;  $^1\text{H}$  NMR (400 MHz,  $\text{DMSO-}d_6$ )  $\delta$ : 7.25 (d,  $J = 8.0$  Hz, 2H, ArH), 7.19 (d,  $J = 8.0$  Hz, 2H, ArH), 4.60-4.55 (m, 1H, CH), 4.47 (d,  $J = 10.0$  Hz, 1H, CH), 4.44 (d,  $J = 9.2$  Hz, 1H, NH), 4.35-4.30 (m, 1H, CH), 4.19-4.14 (m, 1H, CH), 4.01 (q,  $J = 7.2$  Hz, 2H, CH), 3.76 (s, 3H,  $\text{OCH}_3$ ), 3.59 (s, 3H,  $\text{OCH}_3$ ), 3.00 (d,  $J = 15.6$  Hz, 1H, CH), 2.84 (d,  $J = 15.6$  Hz, 1H, CH), 2.29 (s, 3H,  $\text{CH}_3$ ), 1.19 (t,  $J = 7.2$  Hz, 3H,  $\text{CH}_3$ ), 1.06 (t,  $J = 7.2$  Hz, 3H,  $\text{CH}_3$ );  $^{13}\text{C}$  NMR (100 MHz,  $\text{DMSO-}d_6$ )  $\delta$ : 172.5, 170.1, 169.8, 164.5, 138.6, 130.4, 129.7, 129.0, 115.4, 74.4, 64.0, 64.0, 61.9, 61.3, 54.7, 53.6, 52.2, 41.2, 21.1, 14.2, 14.2; IR (KBr)  $\nu$ : 3349, 2972, 1743, 1516, 1440, 1373, 1292, 1236, 1109, 1059, 1001, 952, 865, 735  $\text{cm}^{-1}$ ; MS ( $m/z$ ): HRMS (ESI) Calcd. for  $\text{C}_{23}\text{H}_{28}\text{N}_2\text{NaO}_8$  ( $[\text{M}+\text{Na}]^+$ ): 483.1738. Found: 483.1740.



**3,5-Diethyl 2-methyl 3-cyano-2-(2-methoxy-2-oxoethyl)-4-(4-methoxyphenyl)pyrrolidine-2,3,5-tricarboxylate (4c):** White solid, 65%, m.p. 114-116°C;  $^1\text{H}$  NMR (400 MHz,  $\text{DMSO}-d_6$ )  $\delta$ : 7.29 (d,  $J = 8.8$  Hz, 2H, ArH), 6.94 (d,  $J = 8.8$  Hz, 2H, ArH), 4.57-4.52 (m, 1H, CH), 4.45 (d,  $J = 10.0$  Hz, 1H, CH), 4.42 (d,  $J = 9.2$  Hz, 1H, NH), 4.35-4.30 (m, 1H, CH), 4.19-4.14 (m, 1H, CH), 4.01 (q,  $J = 7.2$  Hz, 2H, CH), 3.76 (s, 3H,  $\text{OCH}_3$ ), 3.75 (s, 3H,  $\text{OCH}_3$ ), 3.59 (s, 3H,  $\text{OCH}_3$ ), 3.00 (d,  $J = 16.0$  Hz, 1H, CH), 2.84 (d,  $J = 15.6$  Hz, 1H, CH), 1.19 (t,  $J = 7.2$  Hz, 3H,  $\text{CH}_3$ ), 1.06 (t,  $J = 7.2$  Hz, 3H,  $\text{CH}_3$ );  $^{13}\text{C}$  NMR (100 MHz,  $\text{DMSO}-d_6$ )  $\delta$ : 172.5, 170.1, 169.8, 164.5, 160.0, 130.4, 125.0, 115.5, 114.5, 74.3, 64.0, 64.0, 62.0, 61.3, 55.5, 54.5, 53.6, 52.2, 41.2, 14.2, 14.2; IR (KBr)  $\nu$ : 3346, 2989, 1743, 1522, 1446, 1363, 1245, 1196, 1112, 1069, 1027, 851, 729  $\text{cm}^{-1}$ ; MS ( $m/z$ ): HRMS (ESI) Calcd. for  $\text{C}_{23}\text{H}_{28}\text{N}_2\text{NaO}_9$  ( $[\text{M}+\text{Na}]^+$ ): 499.1687. Found: 499.1706.



**3,5-Diethyl 2-methyl 4-(4-chlorophenyl)-3-cyano-2-(2-methoxy-2-oxoethyl)pyrrolidine-2,3,5-tricarboxylate (4d):** White solid, 54%, m.p. 136-138°C;  $^1\text{H}$  NMR (400 MHz,  $\text{DMSO}-d_6$ )  $\delta$ : 7.48 (d,  $J = 8.4$  Hz, 2H, ArH), 7.40 (d,  $J = 8.4$  Hz, 2H, ArH), 4.62-4.58 (m, 1H, CH), 4.53 (d,  $J = 10.0$  Hz, 1H, CH), 4.44 (d,  $J = 8.8$  Hz, 1H, NH), 4.36-4.31 (m, 1H, CH), 4.21-4.16 (m, 1H, CH), 4.02 (q,  $J = 6.8$  Hz, 2H, CH), 3.77 (s, 3H,  $\text{OCH}_3$ ), 3.59 (s, 3H,  $\text{OCH}_3$ ), 2.99 (d,  $J = 15.6$  Hz, 1H, CH), 2.86 (d,  $J = 15.6$  Hz, 1H, CH), 1.20 (t,  $J = 7.1$  Hz, 3H,  $\text{CH}_3$ ), 1.06 (t,  $J = 7.1$  Hz, 3H,  $\text{CH}_3$ );  $^{13}\text{C}$  NMR (100 MHz,  $\text{DMSO}-d_6$ )  $\delta$ : 172.2, 170.0, 169.7, 164.3, 134.0, 132.7, 131.1, 129.2, 115.3, 74.4, 64.2, 63.9, 61.9, 61.4, 54.3, 53.6, 52.2, 41.0, 14.2, 14.1; IR (KBr)  $\nu$ : 3348, 2972, 1740, 1492, 1441, 1373, 1296, 1101, 1059, 1004, 849, 737  $\text{cm}^{-1}$ ; MS ( $m/z$ ): HRMS (ESI) Calcd. for  $\text{C}_{22}\text{H}_{25}\text{ClN}_2\text{NaO}_8$  ( $[\text{M}+\text{Na}]^+$ ): 503.1192. Found: 503.1196.



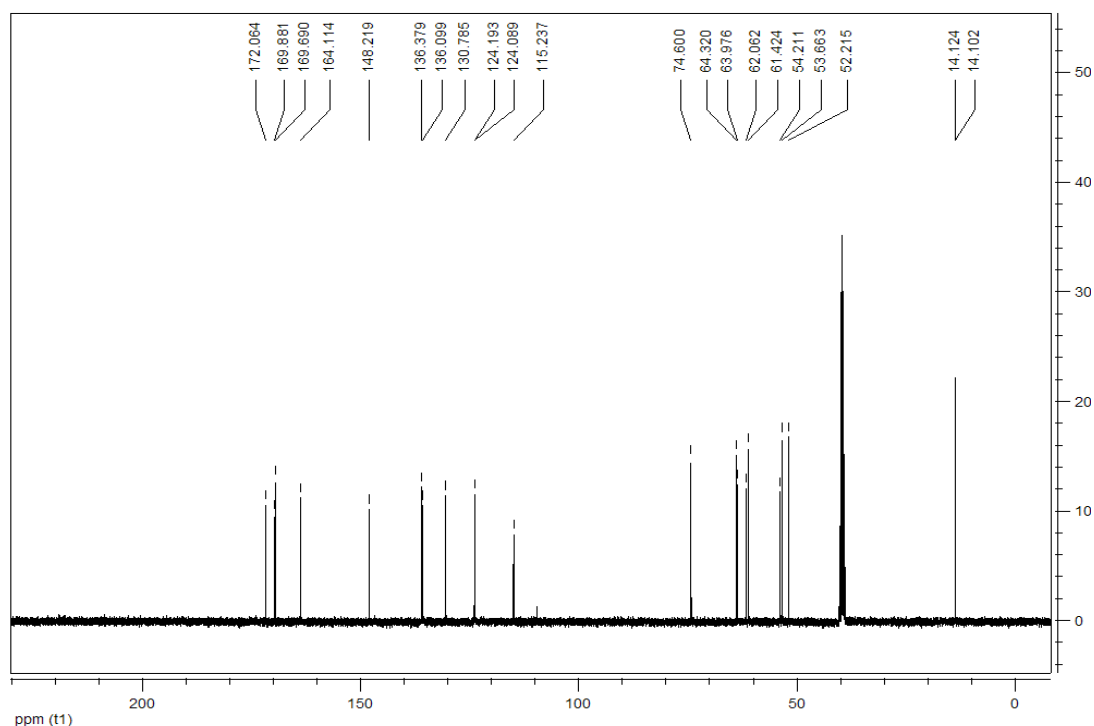
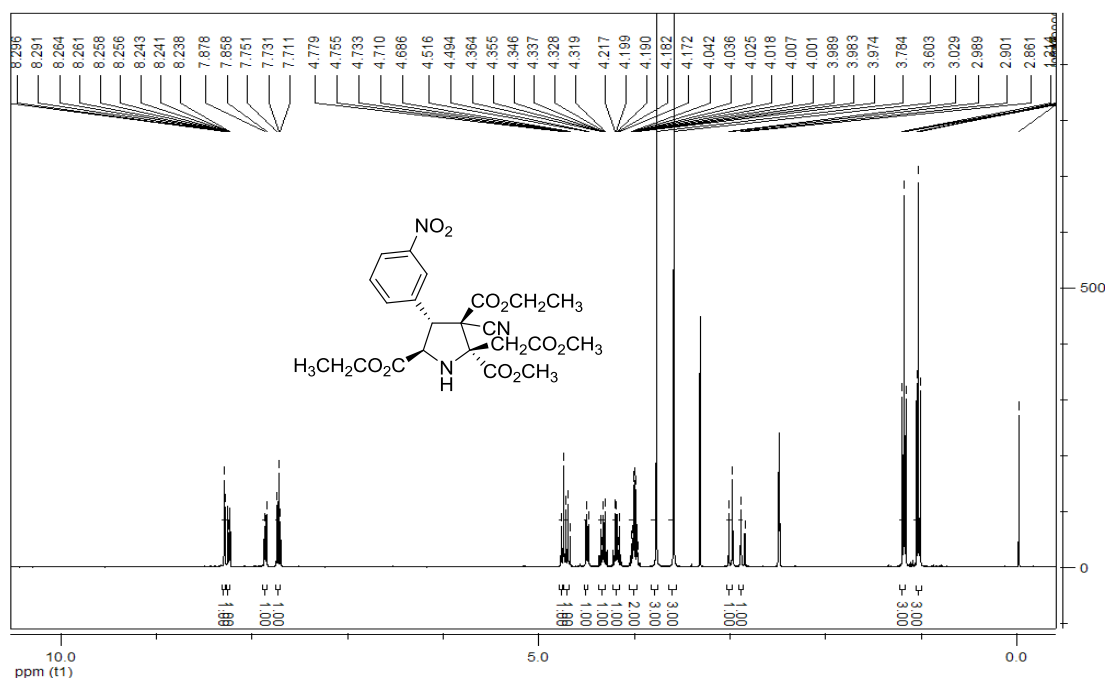
Chemical structure: CCOC(=O)[C@H]1C[C@@H](C(=O)OCC)[C@@H](C(=O)OCC)[C@H]1C(=O)C2=CC=C(C=C2)Br

<sup>1</sup>H NMR spectrum (CDCl<sub>3</sub>) showing peaks from 1.180 to 7.624 ppm. The spectrum includes integration values and a list of peak positions (ppm) on the right side.

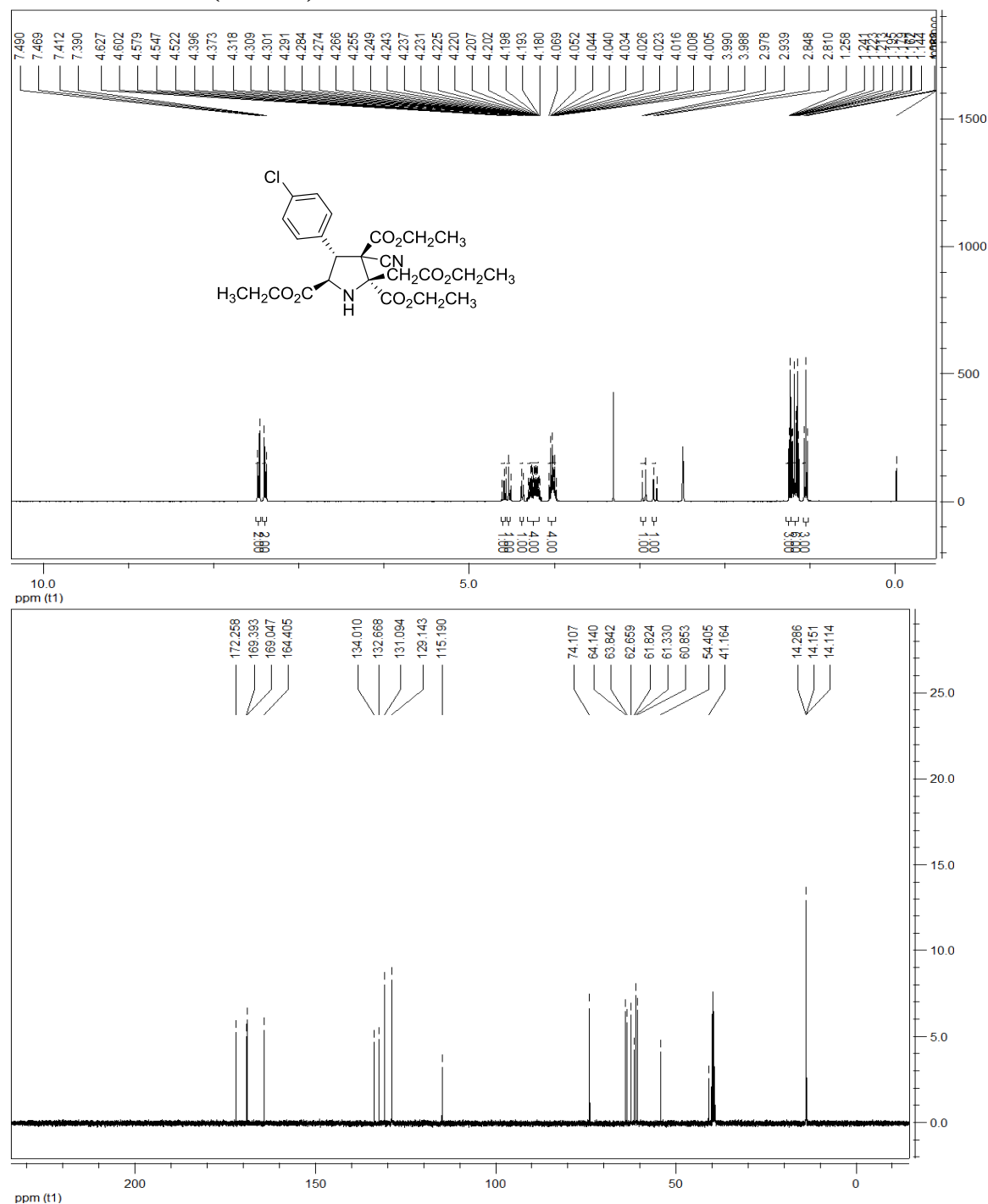
| Peak Position (ppm) | Integration |
|---------------------|-------------|
| 7.624               | 2.00        |
| 7.603               | 2.00        |
| 7.347               | 2.00        |
| 7.326               | 2.00        |
| 4.617               | 2.00        |
| 4.593               | 2.00        |
| 4.570               | 2.00        |
| 4.525               | 2.00        |
| 4.500               | 2.00        |
| 4.445               | 2.00        |
| 4.422               | 2.00        |
| 4.357               | 2.00        |
| 4.348               | 2.00        |
| 4.339               | 2.00        |
| 4.330               | 2.00        |
| 4.322               | 2.00        |
| 4.312               | 2.00        |
| 4.208               | 2.00        |
| 4.199               | 2.00        |
| 4.190               | 2.00        |
| 4.181               | 2.00        |
| 4.172               | 2.00        |
| 4.163               | 2.00        |
| 4.042               | 2.00        |
| 4.024               | 2.00        |
| 4.006               | 2.00        |
| 3.989               | 2.00        |
| 3.770               | 2.00        |
| 3.591               | 2.00        |
| 3.001               | 2.00        |
| 2.961               | 2.00        |
| 2.873               | 2.00        |
| 2.834               | 2.00        |
| 1.215               | 2.00        |
| 1.198               | 2.00        |
| 1.180               | 2.00        |



**3,5-Diethyl 2-methyl 3-cyano-2-(2-methoxy-2-oxoethyl)-4-(3-nitrophenyl)pyrrolidine-2,3,5-tricarboxylate (4f):** White solid, 61%, m.p. 136-138°C;  $^1\text{H}$  NMR (400 MHz,  $\text{DMSO}-d_6$ )  $\delta$ : 8.30-8.29 (m, 1H, ArH), 8.26-8.24 (m, 1H, ArH), 7.88-7.86 (m, 1H, ArH), 7.73 (t,  $J = 8.0$  Hz, ArH), 4.77 $\bar{}$  (d,  $J = 9.6$  Hz, 1H, CH), 4.73-4.76 (m, 1H, CH), 4.50 (d,  $J = 8.8$  Hz, 1H, NH), 4.36-4.32 (m, 1H, CH), 4.22-4.17 (m, 1H, CH), 4.04-3.97 (m, 2H, CH), 3.78 (s, 3H,  $\text{OCH}_3$ ), 3.60 (s, 3H,  $\text{OCH}_3$ ), 3.01 (d,  $J = 16.0$  Hz, 1H, CH), 2.88 (d,  $J = 16.0$  Hz, 1H, CH), 1.20 (t,  $J = 7.1$  Hz, 3H,  $\text{CH}_3$ ), 1.05 (t,  $J = 7.1$  Hz, 3H,  $\text{CH}_3$ );  $^{13}\text{C}$  NMR (100 MHz,  $\text{DMSO}-d_6$ )  $\delta$ : 172.1, 169.9, 169.7, 164.1, 148.2, 136.4, 136.1, 130.8, 124.2, 124.1, 115.2, 74.6, 64.3, 64.0, 62.1, 61.4, 54.2, 53.7, 52.2, 14.1, 14.0; IR (KBr)  $\nu$ : 3374, 2991, 1739, 1532, 1442, 1357, 1296, 1244, 1074, 1014, 867  $\text{cm}^{-1}$ ; MS ( $m/z$ ): HRMS (ESI) Calcd. for  $\text{C}_{22}\text{H}_{25}\text{N}_3\text{NaO}_{10}$  ( $[\text{M}+\text{Na}]^+$ ): 514.1432. Found: 514.1445.

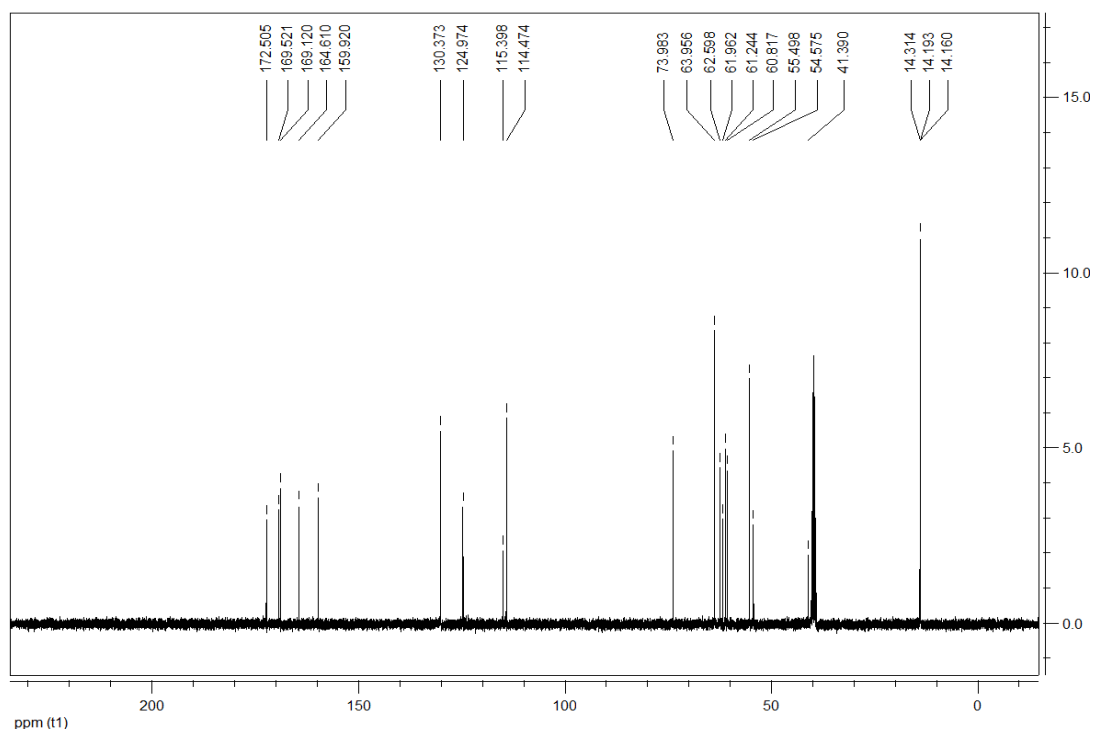
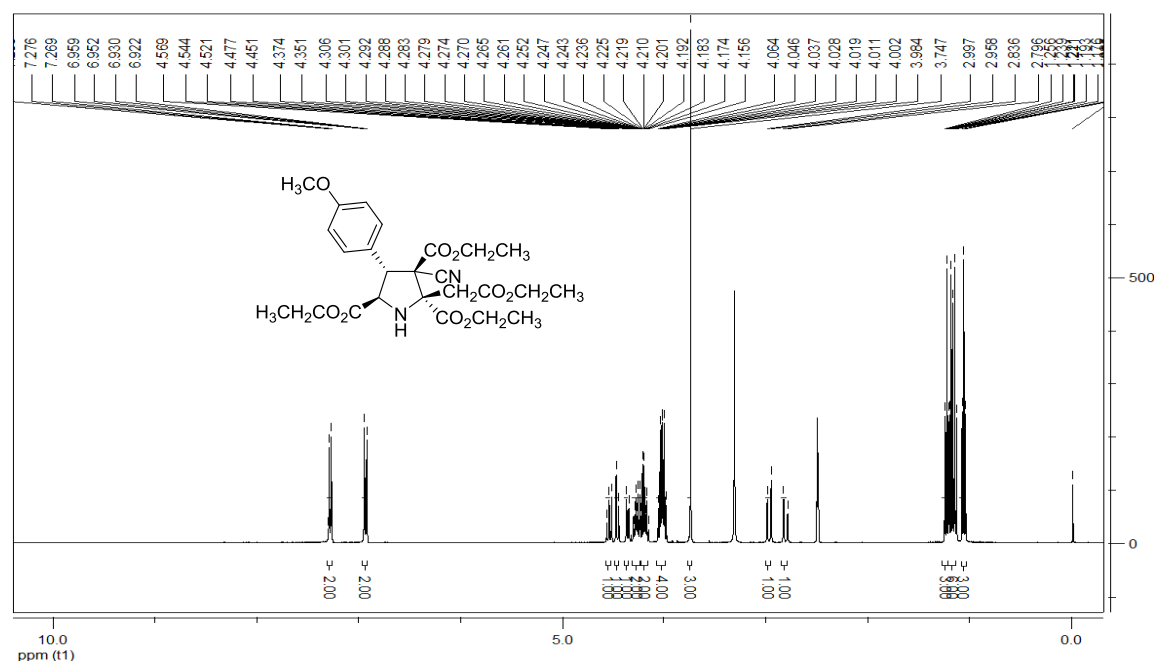


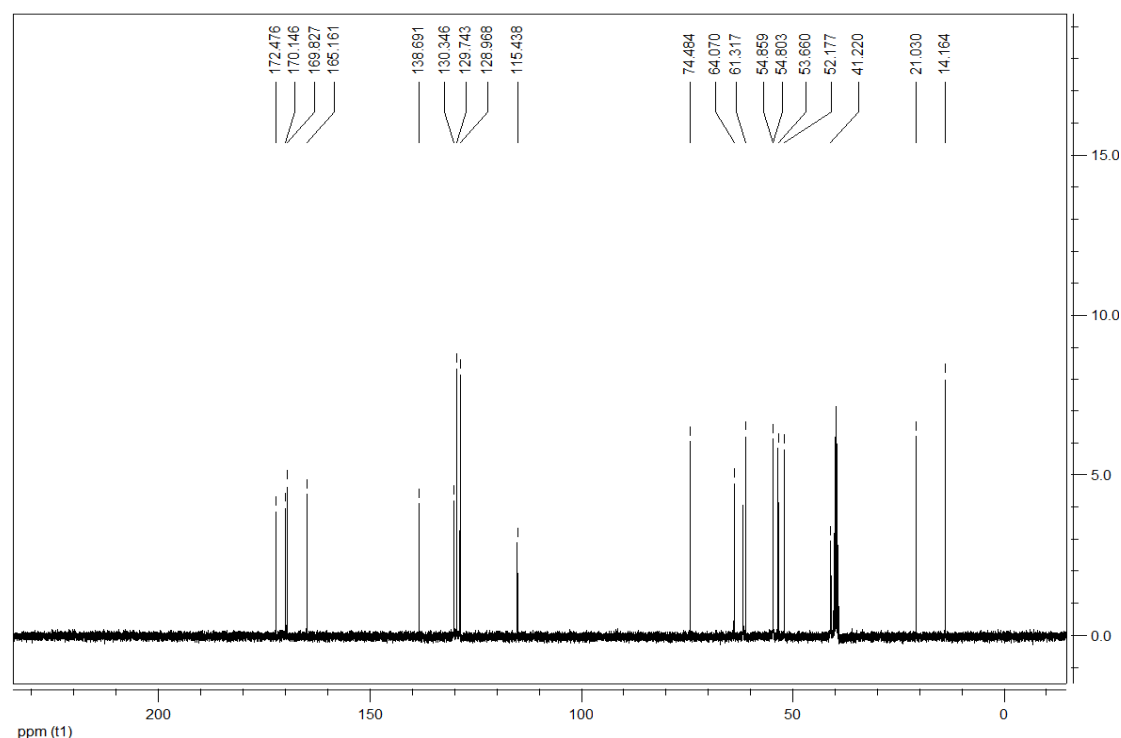
**Triethyl 4-(4-chlorophenyl)-3-cyano-2-(2-ethoxy-2-oxoethyl)pyrrolidine-2,3,5-tricarboxylate (**4g**):** White solid, 48%, m.p. 126-128 °C;  $^1\text{H}$  NMR (400 MHz, DMSO- $d_6$ )  $\delta$ : 7.49-7.47 (m, 2H, ArH), 7.41-7.39 (m, 2H, ArH), 4.63-4.58 (m, 1H, CH), 4.53 (d,  $J$  = 10.0 Hz, 1H, CH), 4.38 (d,  $J$  = 9.2 Hz, 1H, NH), 4.32-4.18 (m, 4H, CH), 4.07-3.99 (m, 4H, CH), 2.96 (d,  $J$  = 15.6 Hz, 1H, CH), 2.84 (d,  $J$  = 15.6 Hz, 1H, CH), 1.24 (t,  $J$  = 6.8 Hz, 3H, CH<sub>3</sub>), 1.20 (t,  $J$  = 7.2 Hz, 3H, CH<sub>3</sub>), 1.16 (t,  $J$  = 7.1 Hz, 3H, CH<sub>3</sub>), 1.06 (t,  $J$  = 7.2 Hz, 3H, CH<sub>3</sub>);  $^{13}\text{C}$  NMR (100 MHz, DMSO- $d_6$ )  $\delta$ : 172.3, 169.4, 169.0, 164.4, 134.0, 132.7, 131.1, 129.1, 115.2, 74.1, 64.1, 63.8, 62.7, 61.8, 61.3, 60.9, 54.4, 41.2, 14.3, 14.2, 14.1; IR (KBr)  $\nu$ : 3326, 2988, 1756, 1737, 1497, 1477, 1446, 1378, 1352, 1286, 1238, 1195, 1114, 1092, 1071, 1030, 956, 887, 866, 875, 737  $\text{cm}^{-1}$ ; MS ( $m/z$ ): HRMS (ESI) Calcd. for C<sub>24</sub>H<sub>29</sub>ClN<sub>2</sub>NaO<sub>8</sub> ([M+Na]<sup>+</sup>): 531.1505. Found: 531.1519.



**Triethyl**

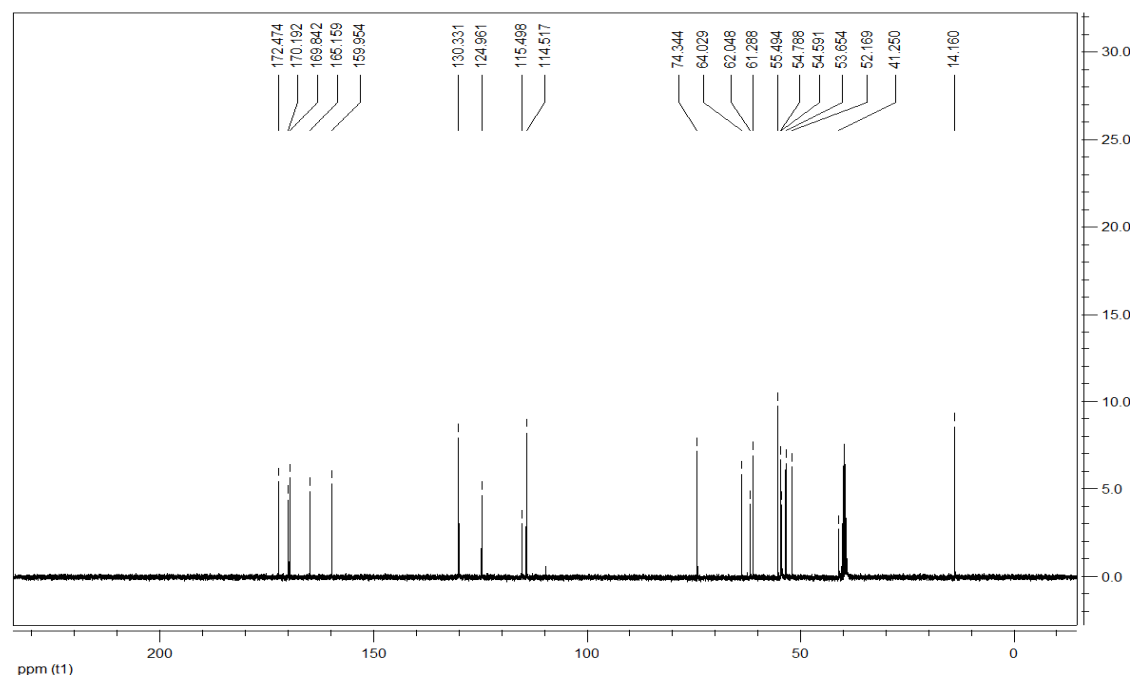
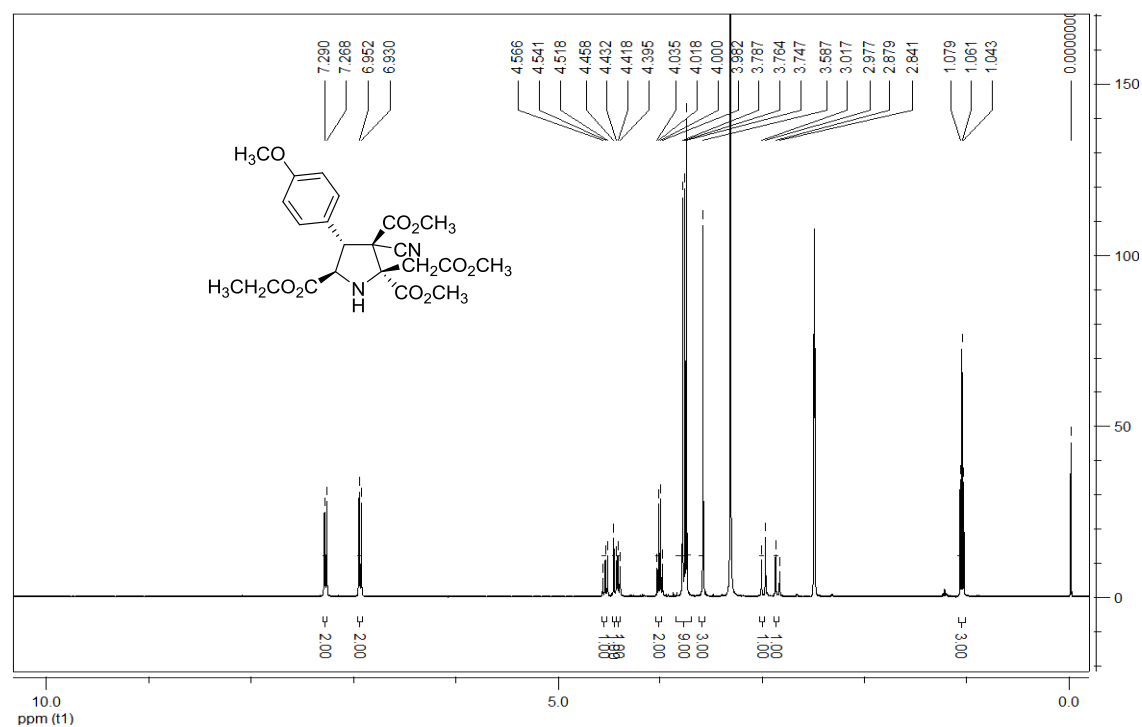
**3-cyano-2-(2-ethoxy-2-oxoethyl)-4-(4-methoxyphenyl)pyrrolidine-2,3,5-tricarboxylate (4h):** White solid, 49%, m.p. 122-124°C;  $^1\text{H}$  NMR (400 MHz,  $\text{DMSO}-d_6$ )  $\delta$ : 7.30-7.27 (m, 2H, ArH), 6.96-6.92 (m, 2H, ArH), 4.57-4.52 (m, 1H, CH), 4.46 (d,  $J = 10.4$  Hz, 1H, CH), 4.36 (d,  $J = 9.2$  Hz, 1H, NH), 4.31-4.24 (m, 2H, CH), 4.22-4.16 (m, 2H, CH), 4.06-3.98 (m, 4H, CH), 3.75 (s, 3H,  $\text{OCH}_3$ ), 2.98 (d,  $J = 15.6$  Hz, 1H, CH), 2.82 (d,  $J = 16.0$  Hz, 1H, CH), 1.24 (t,  $J = 7.1$  Hz, 3H,  $\text{CH}_3$ ), 1.19 (t,  $J = 6.8$  Hz, 3H,  $\text{CH}_3$ ), 1.16 (t,  $J = 7.1$  Hz, 3H,  $\text{CH}_3$ ), 1.07 (t,  $J = 7.1$  Hz, 3H,  $\text{CH}_3$ );  $^{13}\text{C}$  NMR (100 MHz,  $\text{DMSO}-d_6$ )  $\delta$ : 172.5, 169.5, 169.1, 164.6, 159.9, 130.4, 125.0, 115.4, 114.5, 74.0, 64.0, 62.6, 62.0, 61.2, 60.8, 55.5, 54.6, 41.4, 14.3, 14.2, 14.1; IR (KBr)  $\nu$ : 3333, 2986, 1737, 1610, 1515, 1466, 1444, 1376, 1350, 1289, 1245, 1186, 1118, 1095, 1066, 1029, 865, 847, 782, 736  $\text{cm}^{-1}$ ; MS ( $m/z$ ): HRMS (ESI) Calcd. for  $\text{C}_{25}\text{H}_{32}\text{N}_2\text{NaO}_9$  ( $[\text{M}+\text{Na}]^+$ ): 527.2000. Found: 527.2010.



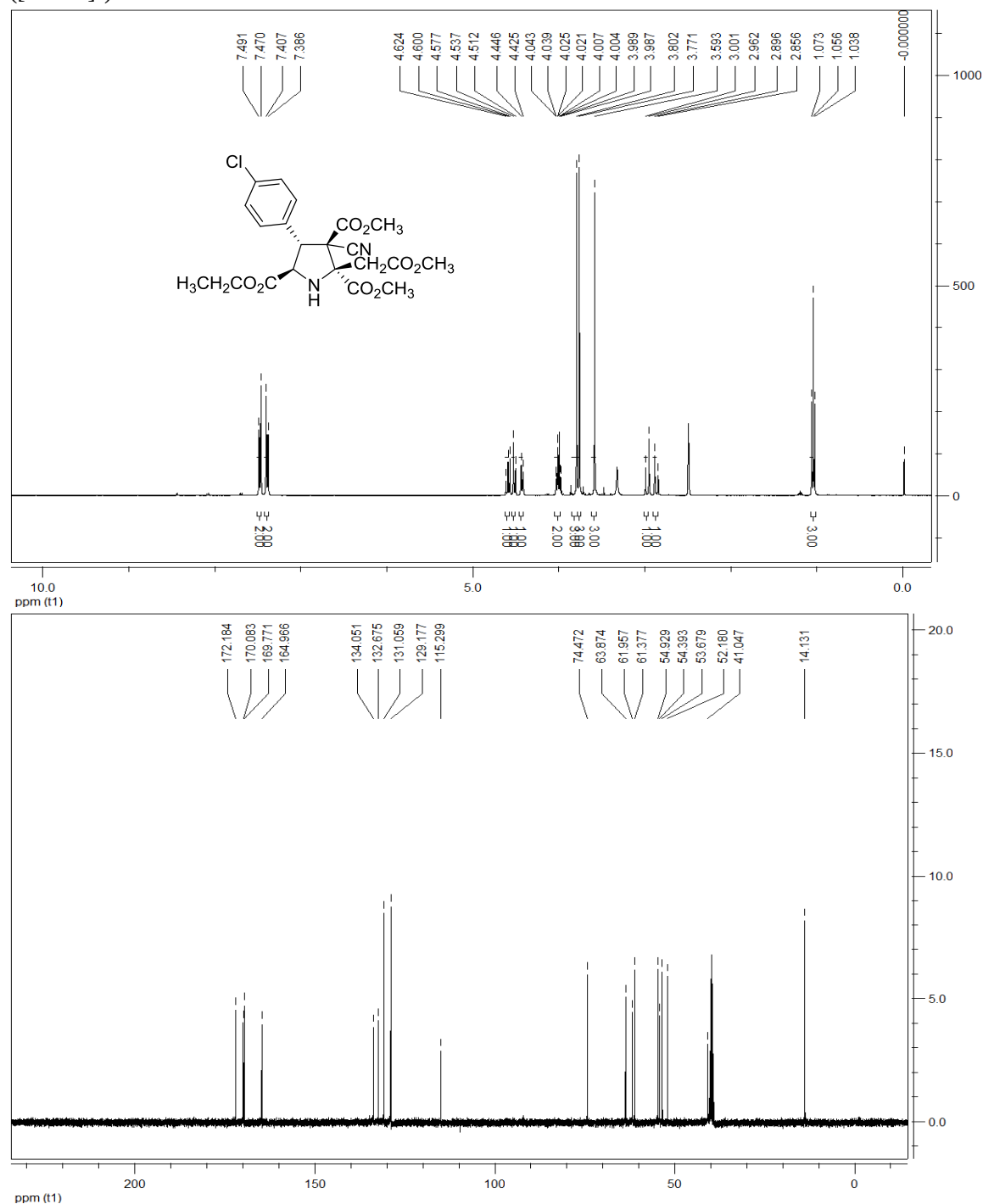
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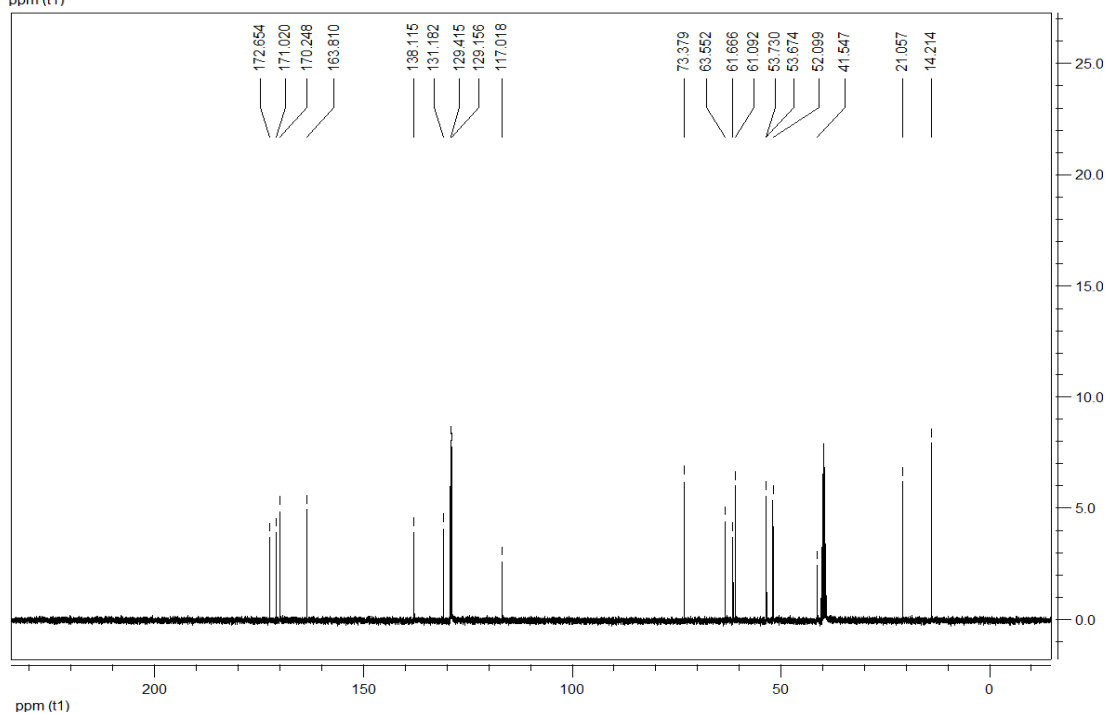
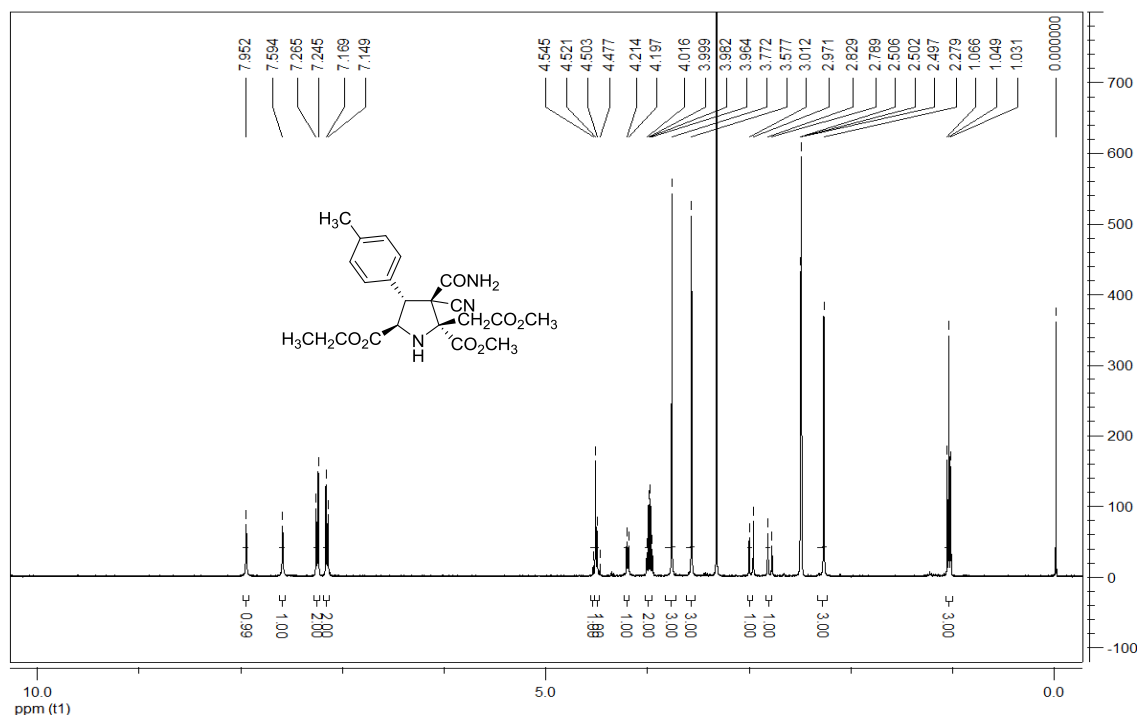
**5-Ethyl 2,3-dimethyl 3-cyano-2-(2-methoxy-2-oxoethyl)-4-(4-methoxyphenyl)pyrrolidine-2,3,5-tricarboxylate (4j):** White solid, 54%, m.p. 108-110 °C;  $^1\text{H}$  NMR (400 MHz,  $\text{DMSO-}d_6$ )  $\delta$ : 7.29-7.27 (m, 2H, ArH), 6.95-6.93 (m, 2H, ArH), 4.57-4.52 (m, 1H, CH), 4.44 (d,  $J = 10.4$  Hz, 1H, CH), 4.41 (d,  $J = 9.2$  Hz, 1H, NH), 4.01 (q,  $J = 7.2$  Hz, 2H, CH), 3.79 (s, 3H,  $\text{OCH}_3$ ), 3.76 (s, 3H,  $\text{OCH}_3$ ), 3.75 (s, 3H,  $\text{OCH}_3$ ), 3.59 (s, 3H,  $\text{OCH}_3$ ), 3.00 (d,  $J = 16.0$  Hz, 1H, CH), 2.86 (d,  $J = 15.2$  Hz, 1H, CH), 1.06 (t,  $J = 7.2$  Hz, 3H,  $\text{CH}_3$ );  $^{13}\text{C}$  NMR (100 MHz,  $\text{DMSO-}d_6$ )  $\delta$ : 172.5, 170.2, 169.8, 165.2, 160.0, 130.3, 125.0, 115.5, 114.5, 74.3, 64.0, 62.0, 61.3, 55.5, 54.8, 54.6, 53.7, 52.2, 41.2, 14.2; IR (KBr)  $\nu$ : 3338, 2959, 2838, 1740, 1646, 1597, 1489, 1464, 1432, 1338, 1259, 1235, 1176, 1125, 1098, 1072, 1037, 948, 889, 841, 790, 770, 746, 719  $\text{cm}^{-1}$ ; MS ( $m/z$ ): HRMS (ESI) Calcd. for  $\text{C}_{22}\text{H}_{26}\text{N}_2\text{NaO}_9$  ( $[\text{M}+\text{Na}]^+$ ): 485.1531. Found: 485.1544.



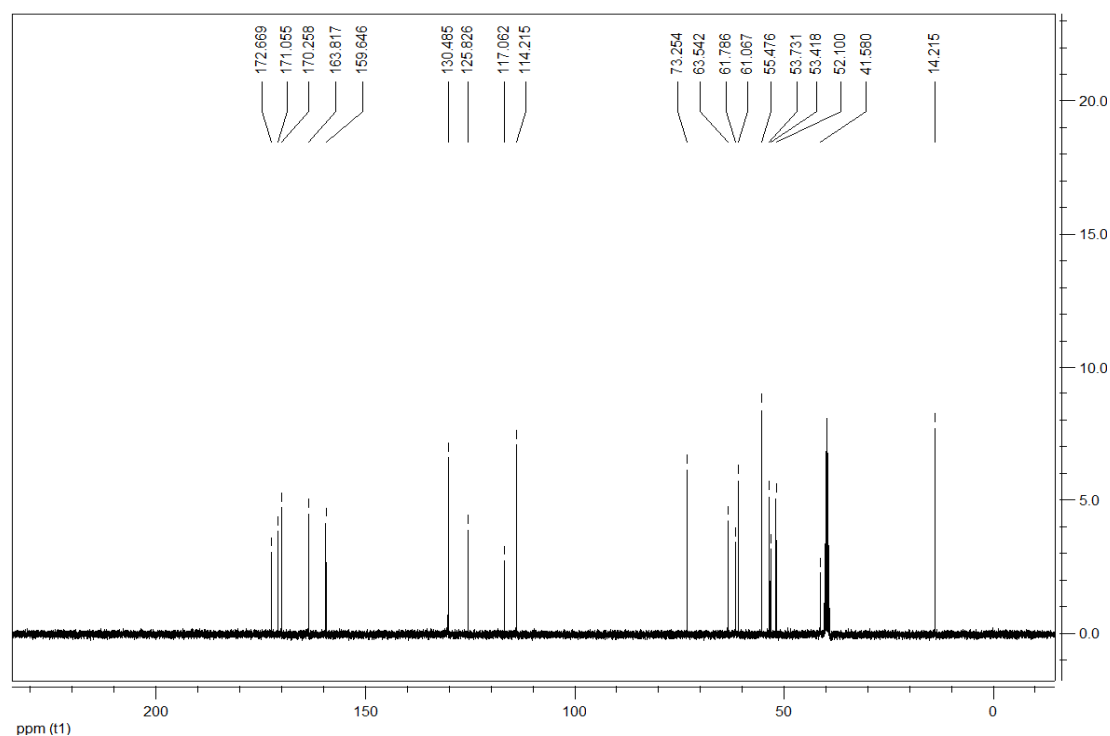
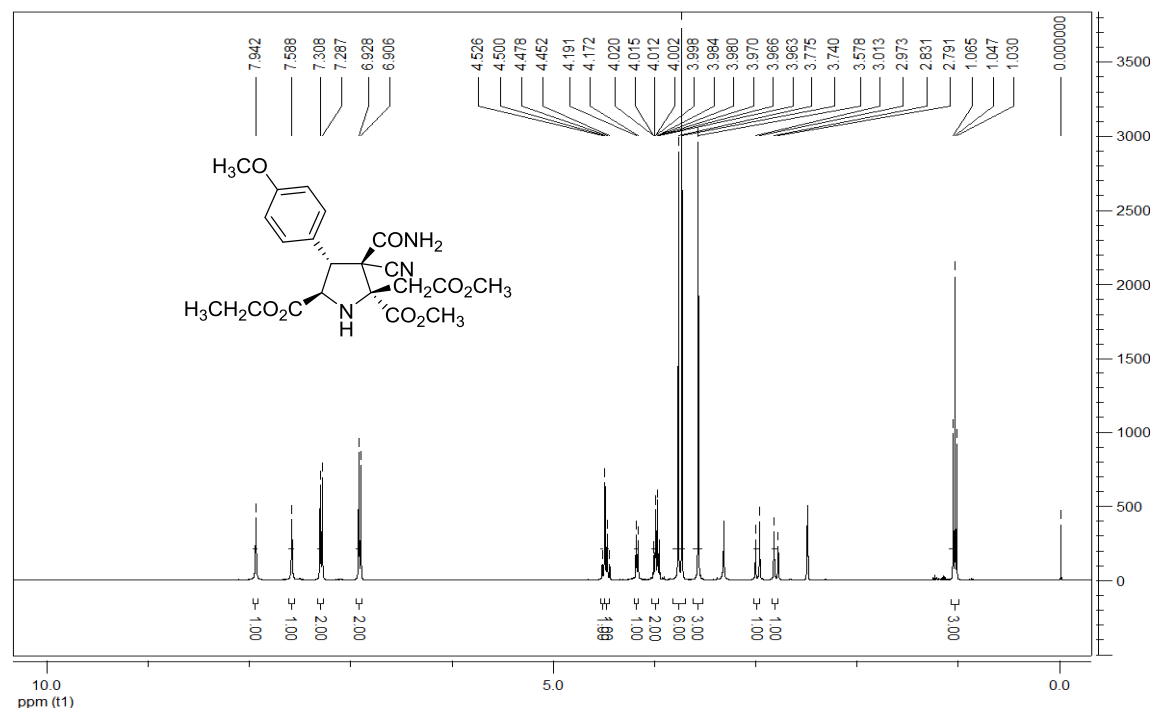
**5-Ethyl 2,3-dimethyl 4-(4-chlorophenyl)-3-cyano-2-(2-methoxy-2-oxoethyl)pyrrolidine-2,3,5-tricarboxylate (4k):** White solid, 52%, m.p. 132-134°C;  $^1\text{H}$  NMR (400 MHz,  $\text{DMSO-}d_6$ )  $\delta$ : 7.49-7.47 (m, 2H, ArH), 7.41-7.39 (m, 2H, ArH), 4.62-4.58 (m, 1H, CH), 4.52 (d,  $J = 10.0$  Hz, 1H, CH), 4.44 (d,  $J = 8.4$  Hz, 1H, NH), 4.05-3.99 (m, 2H, CH), 3.80 (s, 3H,  $\text{OCH}_3$ ), 3.77 (s, 3H,  $\text{OCH}_3$ ), 3.59 (s, 3H,  $\text{OCH}_3$ ), 2.98 (d,  $J = 15.6$  Hz, 1H, CH), 2.88 (d,  $J = 16.0$  Hz, 1H, CH), 1.06 (t,  $J = 7.2$  Hz, 3H,  $\text{CH}_3$ );  $^{13}\text{C}$  NMR (100 MHz,  $\text{DMSO-}d_6$ )  $\delta$ : 172.2, 170.1, 169.8, 165.0, 134.1, 132.7, 131.1, 129.2, 115.3, 74.5, 63.9, 62.0, 61.4, 54.9, 54.4, 53.7, 52.2, 41.0, 14.1; IR (KBr)  $\nu$ : 3345, 2993, 2955, 1746, 1737, 1517, 1497, 1442, 1373, 1296, 1243, 1209, 1166, 1114, 1091, 1059, 1037, 988, 957, 880, 840, 794, 741, 719  $\text{cm}^{-1}$ ; MS ( $m/z$ ): HRMS (ESI) Calcd. for  $\text{C}_{21}\text{H}_{23}\text{ClN}_2\text{NaO}_8$  ( $[\text{M}+\text{Na}]^+$ ): 489.1035. Found: 489.1051.



**5-Ethyl 2-methyl 3-carbamoyl-3-cyano-2-(2-methoxy-2-oxoethyl)-4-(p-tolyl)pyrrolidine-2,5-dicarboxylate (4l):** White solid, 56%, m.p. 172-174 °C;  $^1\text{H}$  NMR (400 MHz,  $\text{DMSO-}d_6$ )  $\delta$ : 7.95 (s, 1H, NH), 7.59 (s, 1H, NH), 7.26-7.24 (m, 2H, ArH), 7.17-7.15 (m, 2H, ArH), 4.53 (d,  $J$  = 9.6 Hz, 1H, CH), 4.52-4.48 (m, 1H, CH), 4.21 (d,  $J$  = 6.8 Hz, 1H, NH), 3.99 (q,  $J$  = 7.2 Hz, 2H, CH), 3.77 (s, 3H,  $\text{OCH}_3$ ), 3.58 (s, 3H,  $\text{OCH}_3$ ), 2.99 (d,  $J$  = 16.4 Hz, 1H, CH), 2.81 (d,  $J$  = 16.0 Hz, 1H, CH), 2.28 (s, 3H,  $\text{CH}_3$ ), 1.05 (t,  $J$  = 6.8 Hz, 3H,  $\text{CH}_3$ );  $^{13}\text{C}$  NMR (100 MHz,  $\text{DMSO-}d_6$ )  $\delta$ : 172.7, 171.0, 170.2, 163.8, 138.1, 131.2, 129.4, 129.2, 117.0, 73.4, 63.6, 61.7, 61.1, 53.7, 53.6, 52.1, 41.5, 21.0, 14.2; IR (KBr)  $\nu$ : 3348, 2959, 1744, 1712, 1603, 1516, 1440, 1364, 1282, 1220, 1186, 1092, 982, 898, 719  $\text{cm}^{-1}$ ; MS ( $m/z$ ): HRMS (ESI) Calcd. for  $\text{C}_{21}\text{H}_{25}\text{N}_3\text{NaO}_7$  ( $[\text{M}+\text{Na}]^+$ ): 454.1585. Found: 454.1600.



**5-Ethyl 2-methyl 3-carbamoyl-3-cyano-2-(2-methoxy-2-oxoethyl)-4-(4-methoxyphenyl)-pyrrolidine-2,5-dicarboxylate (4m):** White solid, 51%, m.p. 155-157°C;  $^1\text{H}$  NMR (400 MHz,  $\text{DMSO-}d_6$ )  $\delta$ : 7.94 (s, 1H, NH), 7.59 (s, 1H, NH), 7.31-7.29 (m, 2H, ArH), 6.93-6.91 (m, 2H, ArH), 4.51 (d,  $J = 10.4$  Hz, 1H, CH), 4.50-4.45 (m, 1H, CH), 4.18 (d,  $J = 7.6$  Hz, 1H, NH), 4.02-3.96 (m, 2H, CH), 3.78 (s, 3H,  $\text{OCH}_3$ ), 3.74 (s, 3H,  $\text{OCH}_3$ ), 3.58 (s, 3H,  $\text{OCH}_3$ ), 2.99 (d,  $J = 16.0$  Hz, 1H, CH), 2.81 (d,  $J = 16.0$  Hz, 1H, CH), 1.05 (t,  $J = 7.1$  Hz, 3H,  $\text{CH}_3$ );  $^{13}\text{C}$  NMR (100 MHz,  $\text{DMSO-}d_6$ )  $\delta$ : 172.7, 171.1, 170.3, 163.8, 159.6, 130.5, 125.8, 117.1, 114.2, 73.3, 63.5, 61.8, 61.1, 55.5, 53.7, 53.4, 52.1, 41.6, 14.2; IR (KBr)  $\nu$ : 3384, 3359, 2982, 2941, 1728, 1697, 1615, 1518, 1436, 1409, 1354, 1298, 1281, 1256, 1215, 1190, 1157, 1105, 1033, 989, 973, 878, 843, 802, 722  $\text{cm}^{-1}$ ; MS ( $m/z$ ): HRMS (ESI) Calcd. for  $\text{C}_{21}\text{H}_{25}\text{N}_3\text{NaO}_8$  ( $[\text{M}+\text{Na}]^+$ ): 470.1534. Found: 470.1554.



**Diethyl 3-carbamoyl-3-cyano-2-(2-ethoxy-2-oxoethyl)-4-(4-methoxyphenyl)pyrrolidine-2,5-dicarboxylate (4n):** White solid, 55%, m.p. 158-160°C;  $^1\text{H}$  NMR (400 MHz,  $\text{DMSO-}d_6$ )  $\delta$ : 7.95 (s, 1H, NH), 7.54 (s, 1H, NH), 7.31-7.29 (m, 2H, ArH), 6.93-6.91 (m, 2H, ArH), 4.51 (d,  $J$  = 10.8 Hz, 1H, CH), 4.50-4.46 (m, 1H, CH), 4.26-4.20 (m, 2H, CH), 4.16 (d,  $J$  = 7.6 Hz, 1H, NH), 4.06-3.97 (m, 4H, CH), 3.74 (s, 3H,  $\text{OCH}_3$ ), 2.98 (d,  $J$  = 16.0 Hz, 1H, CH), 2.79 (d,  $J$  = 15.6 Hz, 1H, CH), 1.24 (t,  $J$  = 7.2 Hz, 3H,  $\text{CH}_3$ ), 1.15 (t,  $J$  = 7.2 Hz, 3H,  $\text{CH}_3$ ), 1.05 (t,  $J$  = 7.1 Hz, 3H,  $\text{CH}_3$ );  $^{13}\text{C}$  NMR (100 MHz,  $\text{DMSO-}d_6$ )  $\delta$ : 172.7, 170.4, 169.6, 163.9, 159.6, 130.5, 125.8, 117.0, 114.2, 73.0, 63.7, 62.7, 61.7, 61.0, 60.7, 55.5, 53.4, 41.7, 14.3, 14.2, 14.1; IR (KBr)  $\nu$ : 3339, 2993, 2839, 1740, 1701, 1611, 1517, 1468, 1368, 1295, 1261, 1198, 1124, 1031, 954, 856, 838, 806, 744, 721  $\text{cm}^{-1}$ ; MS ( $m/z$ ): HRMS (ESI) Calcd. for  $\text{C}_{23}\text{H}_{29}\text{N}_3\text{NaO}_8$  ( $[\text{M}+\text{Na}]^+$ ): 498.1847. Found: 498.1857.

