

## Supporting Information

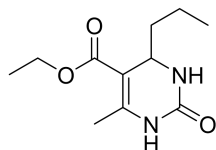
# Biginelli reaction of aliphatic aldehydes catalyzed by $\alpha$ -chymotrypsin: one-pot biocatalytic synthesis of dihydropyrimidinones

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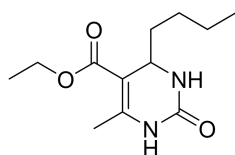
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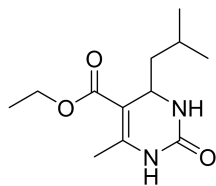
## 1. <sup>1</sup>H-NMR and <sup>13</sup>C-NMR data of DHPMs products



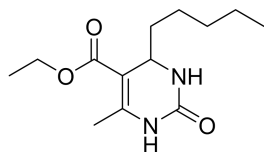
4a: 88% White solid, <sup>1</sup>H NMR (500 MHz, DMSO-*d*<sub>6</sub>): δ 8.95 (s, 1H), 7.35 (s, 1H), 4.52 – 3.71 (m, 3H), 2.16 (s, 3H), 1.44 – 1.25 (m, 4H), 1.19 (t, *J* = 7.1 Hz, 3H), 0.85 (t, *J* = 7.0 Hz, 3H); <sup>13</sup>C NMR (126 MHz, DMSO-*d*<sub>6</sub>): δ 165.92, 153.27, 148.77, 99.86, 59.52, 50.25, 18.17, 17.47, 14.69, 14.23.



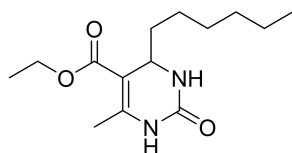
4b: 90% White solid, <sup>1</sup>H NMR (500 MHz, DMSO-*d*<sub>6</sub>): δ 8.95 (s, 1H), 7.34 (s, 1H), 4.12 – 3.98 (m, 3H), 2.15 (s, 3H), 1.46 – 1.20 (m, 6H), 1.18 (t, *J* = 7.0 Hz, 3H), 0.84 (t, *J* = 6.1 Hz, 3H); <sup>13</sup>C NMR (126 MHz, DMSO-*d*<sub>6</sub>): δ 165.48, 152.81, 148.35, 99.39, 59.07, 49.99, 36.52, 25.91, 21.95, 17.82, 14.26, 14.01.



4c: 87% White solid, <sup>1</sup>H NMR (500 MHz, DMSO-*d*<sub>6</sub>): δ 8.98 (s, 1H), 7.45 (s, 1H), 4.10 – 3.98 (m, 3H), 2.15 (s, 3H), 1.74 – 1.64 (m, 1H), 1.36 (ddd, *J* = 13.3, 9.7, 3.8 Hz, 1H), 1.18 (t, *J* = 7.1 Hz, 3H), 1.08 (ddd, *J* = 13.1, 9.9, 3.1 Hz, 1H), 0.85 (d, *J* = 6.5 Hz, 6H); <sup>13</sup>C NMR (126 MHz, DMSO-*d*<sub>6</sub>): δ 165.32, 152.77, 148.28, 100.39, 59.09, 48.07, 46.04, 23.74, 22.84, 21.38, 17.66, 14.21.

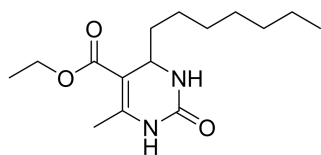


4d: 91% White solid, <sup>1</sup>H NMR (500 MHz, DMSO-*d*<sub>6</sub>): δ 8.95 (s, 1H), 7.35 (s, 1H), 4.13 – 3.93 (m, 3H), 2.15 (s, 3H), 1.43 – 1.32 (m, 2H), 1.31 – 1.21 (m, 6H), 1.18 (t, *J* = 7.1 Hz, 3H), 0.84 (t, *J* = 6.9 Hz, 3H); <sup>13</sup>C NMR (125 MHz, DMSO-*d*<sub>6</sub>): δ 165.48, 152.80, 148.31, 99.41, 59.07, 50.03, 36.63, 31.01, 23.38, 22.12, 17.73, 14.29, 13.92.



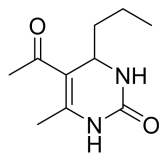
4e: 89%

White solid,  $^1\text{H}$  NMR (500 MHz,  $\text{DMSO-}d_6$ ):  $\delta$  8.94 (s, 1H), 7.33 (s, 1H), 4.06 (dtd,  $J = 21.9, 7.1, 3.7$  Hz, 3H), 2.15 (s, 3H), 1.46 – 1.33 (m, 2H), 1.26 (dd,  $J = 48.8, 9.4$  Hz, 7H), 1.18 (t,  $J = 7.1$  Hz, 3H), 0.85 (t,  $J = 6.6$  Hz, 3H);  $^{13}\text{C}$  NMR (126 MHz,  $\text{DMSO-}d_6$ ):  $\delta$  165.45, 152.80, 148.34, 99.40, 59.06, 50.10, 36.68, 31.26, 28.47, 23.67, 22.07, 17.73, 14.25, 14.00.

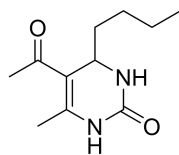


4f: 89%

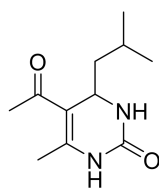
White solid,  $^1\text{H}$  NMR (600 MHz,  $\text{DMSO-}d_6$ ):  $\delta$  8.93 (s, 1H), 7.30 (s, 1H), 4.13 – 3.87 (m, 1H), 3.59 (s, 3H), 2.15 (s, 3H), 1.42 – 1.33 (m, 2H), 1.32 – 1.20 (m, 12H), 0.85 (t,  $J = 7.0$  Hz, 3H);  $^{13}\text{C}$  NMR (150 MHz,  $\text{DMSO-}d_6$ ):  $\delta$  165.92, 152.70, 148.42, 99.19, 50.68, 50.07, 36.66, 31.19, 28.76, 28.65, 23.62, 22.05, 17.71, 13.89.



4g: 92% Yellow solid,  $^1\text{H}$  NMR (500 MHz,  $\text{DMSO-}d_6$ ):  $\delta$  8.96 (s, 1H), 7.44 (s, 1H), 4.10 (dd,  $J = 7.4, 3.5$  Hz, 1H), 2.19 (s, 3H), 2.17 (s, 3H), 1.49 – 1.28 (m, 2H), 1.24 (ddd,  $J = 19.3, 9.9, 4.3$  Hz, 2H), 0.85 (t,  $J = 6.9$  Hz, 3H);  $^{13}\text{C}$  NMR (126 MHz,  $\text{DMSO-}d_6$ ):  $\delta$  194.57, 153.32, 147.91, 111.13, 50.47, 39.34, 30.69, 19.33, 17.68, 14.24.

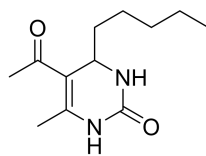


4h: 94% Yellow solid,  $^1\text{H}$  NMR (600 MHz,  $\text{DMSO-}d_6$ ):  $\delta$  8.94 (s, 1H), 7.40 (s, 1H), 4.09 (dd,  $J = 7.5, 3.5$  Hz, 1H), 2.18 (s, 3H), 2.17 (s, 3H), 1.32 – 1.13 (m, 6H), 0.84 (t,  $J = 6.8$  Hz, 3H);  $^{13}\text{C}$  NMR (150 MHz,  $\text{DMSO-}d_6$ ):  $\delta$  194.07, 159.49, 147.26, 110.68, 50.23, 36.25, 30.04, 26.04, 21.92, 18.72, 13.86.

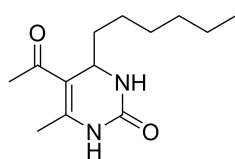


4i: 90% Yellow solid,  $^1\text{H}$  NMR (600 MHz,  $\text{DMSO-}d_6$ ):  $\delta$  8.93 (s, 1H), 7.47 (s, 1H), 4.13 (dt,  $J = 9.9, 3.3$  Hz, 1H), 2.18 (s, 3H), 2.17 (s, 3H), 1.78 – 1.64 (m, 1H), 1.38 (ddd,  $J = 13.6, 10.1, 3.7$

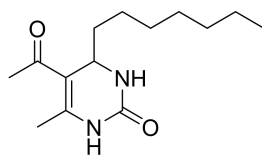
Hz, 1H), 1.00 (ddd,  $J = 13.2, 10.0, 3.0$  Hz, 1H), 0.87 (dd,  $J = 17.7, 6.6$  Hz, 6H);  $^{13}\text{C}$  NMR (150 MHz, DMSO- $d_6$ ):  $\delta$  193.78, 152.71, 147.35, 111.45, 48.25, 45.42, 30.06, 23.75, 22.82, 21.20, 18.83.



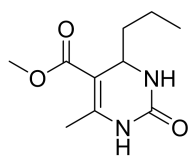
4j: 96% Yellow solid,  $^1\text{H}$  NMR (600 MHz, DMSO- $d_6$ ):  $\delta$  8.90 (s, 1H), 7.38 (s, 1H), 4.09 (dt,  $J = 6.8, 3.2$  Hz, 1H), 2.18 (s, 3H), 2.17 (s, 3H), 1.42 – 1.30 (m, 2H), 1.28 – 1.14 (m, 6H), 0.85 (t,  $J = 7.1$  Hz, 3H);  $^{13}\text{C}$  NMR (150 MHz, DMSO- $d_6$ ):  $\delta$  194.08, 152.76, 147.31, 110.70, 50.26, 36.53, 31.04, 30.15, 23.56, 22.06, 18.81, 13.84.



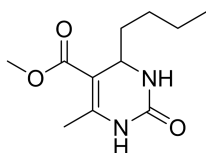
4k: 95% Yellow solid,  $^1\text{H}$  NMR (600 MHz, DMSO- $d_6$ ):  $\delta$  8.90 (s, 1H), 7.37 (s, 1H), 4.19 – 3.99 (m, 1H), 2.18 (s, 3H), 2.17 (s, 3H), 1.42 – 1.28 (m, 2H), 1.30 – 1.17 (m, 8H), 0.85 (t,  $J = 7.0$  Hz, 3H);  $^{13}\text{C}$  NMR (150 MHz, DMSO- $d_6$ ):  $\delta$  194.07, 152.75, 147.31, 110.69, 50.26, 36.59, 31.26, 30.15, 28.50, 23.86, 21.99, 18.81, 13.91.



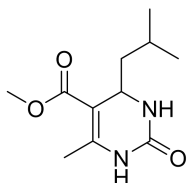
4l: 94% Yellow solid,  $^1\text{H}$  NMR (500 MHz, DMSO- $d_6$ ):  $\delta$  8.95 (s, 1H), 7.43 (s, 1H), 4.09 (d,  $J = 3.6$  Hz, 1H), 2.19 (s, 3H), 2.17 (s, 3H), 1.42 – 1.12 (m, 12H), 0.85 (t,  $J = 6.5$  Hz, 3H);  $^{13}\text{C}$  NMR (125 MHz, DMSO- $d_6$ ):  $\delta$  194.57, 153.32, 147.88, 111.16, 50.72, 37.06, 31.72, 30.66, 29.32, 29.21, 24.42, 22.57, 19.33, 14.42.



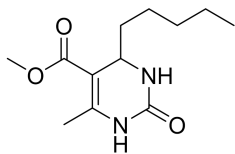
4m: 90% White solid,  $^1\text{H}$  NMR (600 MHz, DMSO- $d_6$ ):  $\delta$  8.94 (s, 1H), 7.31 (s, 1H), 4.04 (dt,  $J = 6.8, 3.2$  Hz, 1H), 3.60 (s, 3H), 2.15 (s, 3H), 1.43 – 1.32 (m, 2H), 1.32 – 1.16 (m, 2H), 0.84 (t,  $J = 7.0$  Hz, 3H);  $^{13}\text{C}$  NMR (150 MHz, DMSO- $d_6$ ):  $\delta$  165.92, 152.73, 148.44, 99.20, 50.69, 49.82, 39.05, 17.71, 16.94, 13.75.



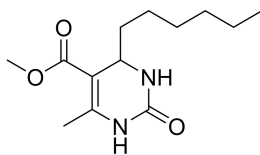
4n: 91% White solid,  $^1\text{H}$  NMR (500 MHz,  $\text{DMSO-}d_6$ ):  $\delta$  8.98 (s, 1H), 7.35 (s, 1H), 4.09 – 3.91 (m, 1H), 3.59 (s, 3H), 2.15 (s, 3H), 1.43 – 1.32 (m, 2H), 1.28 – 1.10 (m, 4H), 0.84 (t,  $J$  = 6.7 Hz, 3H);  $^{13}\text{C}$  NMR (12 MHz,  $\text{DMSO-}d_6$ ):  $\delta$  165.98, 152.78, 148.58, 99.18, 50.78, 50.11, 36.46, 25.90, 22.02, 17.79, 14.02.



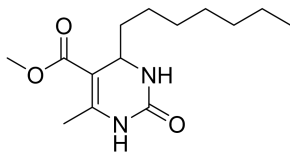
4o: 88% White solid,  $^1\text{H}$  NMR (600 MHz,  $\text{DMSO-}d_6$ ):  $\delta$  8.95 (s, 1H), 7.40 (s, 1H), 4.27 – 3.87 (m, 1H), 3.60 (s, 3H), 2.15 (s, 3H), 1.75 – 1.61 (m, 1H), 1.37 (ddd,  $J$  = 13.5, 9.4, 4.2 Hz, 1H), 1.09 (ddd,  $J$  = 13.2, 9.5, 3.5 Hz, 1H), 0.85 (d,  $J$  = 6.4 Hz, 6H);  $^{13}\text{C}$  NMR (150 MHz,  $\text{DMSO-}d_6$ ):  $\delta$  165.80, 152.74, 148.27, 100.20, 50.68, 48.19, 45.91, 23.59, 22.84, 21.42, 17.69.



4p: 92% White solid,  $^1\text{H}$  NMR (500 MHz,  $\text{DMSO-}d_6$ ):  $\delta$  8.98 (s, 1H), 7.35 (s, 1H), 4.02 (dd,  $J$  = 6.7, 3.5 Hz, 1H), 3.59 (s, 3H), 2.15 (s, 3H), 1.35 (ddd,  $J$  = 18.2, 10.8, 6.9 Hz, 2H), 1.29 – 1.14 (m, 6H), 0.84 (t,  $J$  = 6.9 Hz, 3H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{DMSO-}d_6$ ):  $\delta$  165.97, 152.77, 148.53, 99.20, 50.78, 50.11, 36.70, 31.07, 23.37, 22.12, 17.79, 14.04.

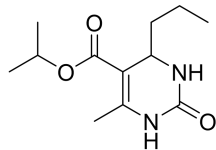


4q: 93% White solid,  $^1\text{H}$  NMR (600 MHz,  $\text{DMSO-}d_6$ ):  $\delta$  8.93 (s, 1H), 7.30 (s, 1H), 4.27 – 3.93 (m, 1H), 3.59 (s, 3H), 2.04 (s, 3H), 1.45 – 1.32 (m, 2H), 1.30 – 1.15 (m, 8H), 0.85 (t,  $J$  = 7.0 Hz, 3H);  $^{13}\text{C}$  NMR (150 MHz,  $\text{DMSO-}d_6$ ):  $\delta$  165.92, 152.68, 148.44, 99.20, 50.68, 50.08, 36.69, 31.23, 28.47, 23.60, 22.00, 17.68, 13.92.

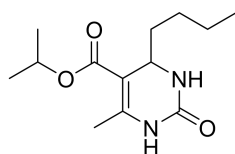


4r: 92% White solid,  $^1\text{H}$  NMR (500 MHz,  $\text{DMSO-}d_6$ ):  $\delta$  8.96 (s, 1H), 7.33 (s, 1H), 4.19 – 3.80 (m, 1H), 3.59 (s, 3H), 2.15 (s, 3H), 1.37 (dd,  $J$  = 7.1, 4.8 Hz, 2H), 1.24 (d,  $J$  =

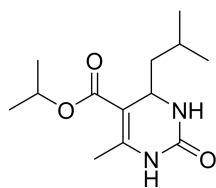
11.1 Hz, 10H), 0.85 (t,  $J = 6.9$  Hz, 3H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{DMSO-}d_6$ ):  $\delta$  166.40, 153.22, 148.95, 99.65, 51.18, 50.55, 37.16, 31.70, 29.26, 29.14, 24.12, 22.56, 18.21, 14.43.



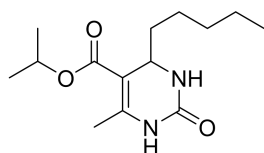
4s: 86% White solid,  $^1\text{H}$  NMR (500 MHz,  $\text{DMSO-}d_6$ ):  $\delta$  8.92 (s, 1H), 7.34 (s, 1H), 4.91 (dt,  $J = 12.4, 6.2$  Hz, 1H), 4.08 – 3.97 (m, 1H), 2.16 (s, 3H), 1.47 – 1.22 (m, 4H), 1.18 (dd,  $J = 6.0, 4.4$  Hz, 6H), 0.85 (t,  $J = 6.9$  Hz, 3H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{DMSO-}d_6$ ):  $\delta$  165.39, 153.30, 148.55, 100.16, 66.53, 50.15, 39.54, 22.29, 22.16, 18.11, 17.49, 14.20.



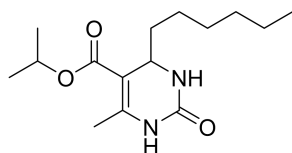
4t: 87% White solid,  $^1\text{H}$  NMR (500 MHz,  $\text{DMSO-}d_6$ ):  $\delta$  8.92 (s, 1H), 7.33 (s, 1H), 4.91 (dt,  $J = 12.4, 6.2$  Hz, 1H), 4.25 – 3.81 (m, 1H), 2.16 (s, 3H), 1.44 – 1.21 (m, 6H), 1.20 – 1.15 (m, 6H), 0.85 (t,  $J = 5.9$  Hz, 3H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{DMSO-}d_6$ ):  $\delta$  165.39, 153.29, 148.55, 100.13, 66.50, 50.42, 36.88, 26.42, 22.35, 22.28, 22.15, 18.11, 14.41.



4u: 90% White solid,  $^1\text{H}$  NMR (500 MHz,  $\text{DMSO-}d_6$ ):  $\delta$  8.95 (s, 1H), 7.44 (s, 1H), 5.33 – 4.66 (m, 1H), 4.04 (dt,  $J = 9.5, 3.4$  Hz, 1H), 2.16 (s, 3H), 1.77 – 1.64 (m, 1H), 1.37 (ddd,  $J = 13.4, 9.7, 3.8$  Hz, 1H), 1.18 (dd,  $J = 6.1, 4.4$  Hz, 6H), 1.07 (ddd,  $J = 14.5, 8.8, 3.8$  Hz, 1H), 0.86 (dd,  $J = 6.5, 2.4$  Hz, 6H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{DMSO-}d_6$ ):  $\delta$  165.19, 153.25, 148.56, 100.97, 66.48, 48.58, 46.51, 24.25, 23.25, 22.29, 22.20, 21.79, 18.03.

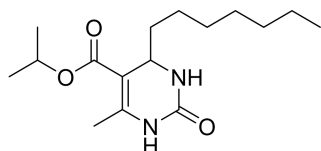


4v: 91% White solid,  $^1\text{H}$  NMR (500 MHz,  $\text{DMSO-}d_6$ ):  $\delta$  8.92 (s, 1H), 7.33 (s, 1H), 4.91 (dt,  $J = 12.5, 6.2$  Hz, 1H), 4.03 – 3.87 (m, 1H), 2.16 (s, 3H), 1.42 – 1.34 (m, 2H), 1.31 – 1.23 (m, 6H), 1.17 (dd,  $J = 11.6, 6.3$  Hz, 6H), 0.85 (t,  $J = 6.8$  Hz, 3H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{DMSO-}d_6$ ):  $\delta$  165.39, 153.28, 148.54, 100.15, 66.49, 50.45, 37.12, 31.43, 23.85, 22.48, 22.28, 22.15, 18.10, 14.32.



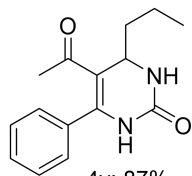
4w: 90%

White solid,  $^1\text{H}$  NMR (500 MHz,  $\text{DMSO-}d_6$ ):  $\delta$  8.92 (s, 1H), 7.33 (s, 1H), 5.05 – 4.74 (m, 1H), 4.02 (s, 1H), 2.16 (s, 3H), 1.38 (s, 2H), 1.23 (s, 8H), 1.20 – 1.15 (m, 6H), 0.85 (t,  $J = 6.2$  Hz, 3H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{DMSO-}d_6$ ):  $\delta$  165.38, 153.28, 148.54, 100.14, 66.49, 50.45, 37.16, 31.66, 28.88, 24.13, 22.49, 22.28, 22.14, 18.10, 14.41.



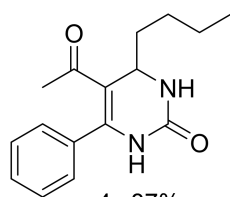
4x: 92%

White solid,  $^1\text{H}$  NMR (500 MHz,  $\text{DMSO-}d_6$ ):  $\delta$  8.91 (s, 1H), 7.32 (s, 1H), 4.91 (dt,  $J = 12.4, 6.2$  Hz, 1H), 4.16 – 3.88 (m, 1H), 2.15 (s, 3H), 1.45 – 1.33 (m, 2H), 1.23 (s, 10H), 1.18 (dd,  $J = 10.5, 4.6$  Hz, 6H), 0.85 (t,  $J = 6.8$  Hz, 3H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{DMSO-}d_6$ ):  $\delta$  165.38, 153.27, 148.55, 100.14, 66.49, 50.46, 37.15, 31.67, 29.17, 29.08, 24.16, 22.57, 22.28, 22.14, 18.10, 14.42.



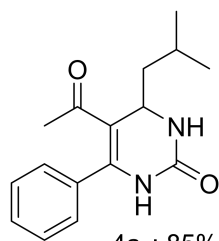
4y: 87%

Yellow solid,  $^1\text{H}$  NMR (500 MHz,  $\text{DMSO-}d_6$ ):  $\delta$  9.00 (s, 1H), 7.57 – 7.52 (m, 3H), 7.50 – 7.42 (m, 3H), 4.19 – 4.14 (m, 1H), 1.63 (s, 3H), 1.43 – 1.35 (m, 2H), 1.31 – 1.20 (m, 2H), 0.80 (t,  $J = 7.2$  Hz, 3H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{DMSO-}d_6$ ):  $\delta$  194.94, 153.26, 146.20, 141.57, 131.82, 129.06, 128.26, 110.22, 51.75, 18.84, 17.66, 14.23.



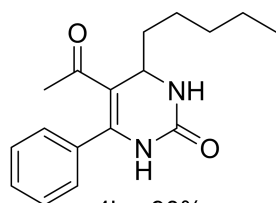
4z: 87%

Yellow solid,  $^1\text{H}$  NMR (500 MHz,  $\text{DMSO-}d_6$ ):  $\delta$  8.98 (s, 1H), 7.56 – 7.51 (m, 3H), 7.45 (dd,  $J = 20.0, 12.4$  Hz, 3H), 4.15 (dd,  $J = 9.0, 5.5$  Hz, 1H), 1.63 (s, 3H), 1.39 (dd,  $J = 14.1, 7.8$  Hz, 2H), 1.22 (m, 4H), 0.82 (t,  $J = 7.0$  Hz, 3H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{DMSO-}d_6$ ):  $\delta$  194.57, 152.89, 145.80, 141.17, 131.45, 128.68, 127.89, 109.83, 51.60, 36.89, 23.89, 22.11, 18.46, 14.02.



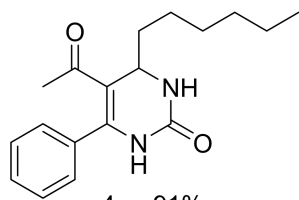
4a<sub>1</sub>: 85%

Yellow solid, <sup>1</sup>H NMR (500 MHz, DMSO-*d*<sub>6</sub>): δ 9.02 (s, 1H), 7.54 (dd, *J* = 10.5, 4.3 Hz, 4H), 7.47 (dd, *J* = 9.5, 5.4 Hz, 2H), 4.19 – 4.14 (m, 1H), 1.65 (s, 3H), 1.47 – 1.33 (m, 1H), 1.22 – 1.12 (m, 2H), 0.76 (dd, *J* = 9.9, 6.6 Hz, 6H); <sup>13</sup>C NMR (125 MHz, DMSO-*d*<sub>6</sub>): δ 194.76, 153.24, 146.34, 141.56, 131.75, 129.03, 128.21, 110.98, 49.97, 46.61, 23.79, 23.38, 22.01, 18.85.



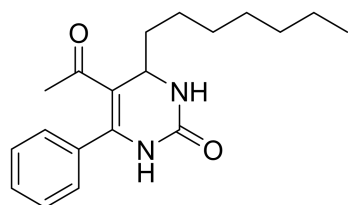
4b<sub>1</sub>: 90%

Yellow solid, <sup>1</sup>H NMR (500 MHz, DMSO-*d*<sub>6</sub>): δ 8.97 (s, 1H), 7.63 – 7.49 (m, 3H), 7.44 (dd, *J* = 20.0, 12.4 Hz, 3H), 4.14 (dd, *J* = 9.0, 5.5 Hz, 1H), 1.62 (s, 3H), 1.38 (dd, *J* = 14.1, 7.8 Hz, 2H), 1.20 (m, 6H), 0.81 (t, *J* = 7.0 Hz, 3H); <sup>13</sup>C NMR (125 MHz, DMSO-*d*<sub>6</sub>): δ 194.86, 153.18, 146.09, 141.46, 131.74, 128.97, 128.18, 110.12, 51.89, 37.18, 31.59, 24.18, 22.40, 18.75, 14.31.



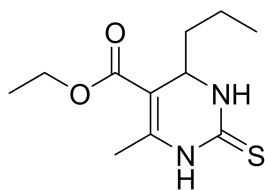
4c<sub>1</sub>: 91%

Yellow solid, <sup>1</sup>H NMR (500 MHz, DMSO-*d*<sub>6</sub>): δ 8.99 (s, 1H), 7.57 – 7.52 (m, 3H), 7.46 (dd, *J* = 20.0, 12.4 Hz, 3H), 4.16 (m, 1H), 1.64 (s, 3H), 1.40 (dd, *J* = 14.1, 7.8 Hz, 2H), 1.22 – 1.12 (m, 8H), 0.83 (t, *J* = 7.0 Hz, 3H); <sup>13</sup>C NMR (125 MHz, DMSO-*d*<sub>6</sub>): δ 194.93, 153.25, 146.16, 141.54, 131.82, 129.04, 128.25, 110.19, 51.96, 37.25, 31.66, 28.91, 24.25, 22.47, 18.82, 14.38.

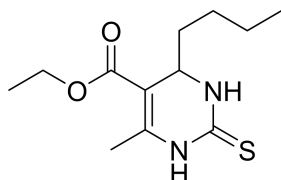


4d<sub>1</sub>: 89%

Yellow solid, <sup>1</sup>H NMR (500 MHz, DMSO-*d*<sub>6</sub>): δ 9.01 (s, 1H), 7.54 (dd, *J* = 6.8, 3.5 Hz, 3H), 7.46 (dd, *J* = 16.6, 8.9 Hz, 3H), 4.16 (dd, *J* = 8.9, 5.4 Hz, 1H), 1.64 (s, 3H), 1.40 (dd, *J* = 13.9, 7.6 Hz, 2H), 1.24 (s, 10H), 0.83 (t, *J* = 7.0 Hz, 3H); <sup>13</sup>C NMR (125 MHz, DMSO-*d*<sub>6</sub>): δ 194.91, 153.27, 146.11, 141.53, 131.81, 129.02, 128.25, 110.19, 51.97, 37.24, 31.65, 29.20, 29.08, 24.28, 22.53, 18.81, 14.40.



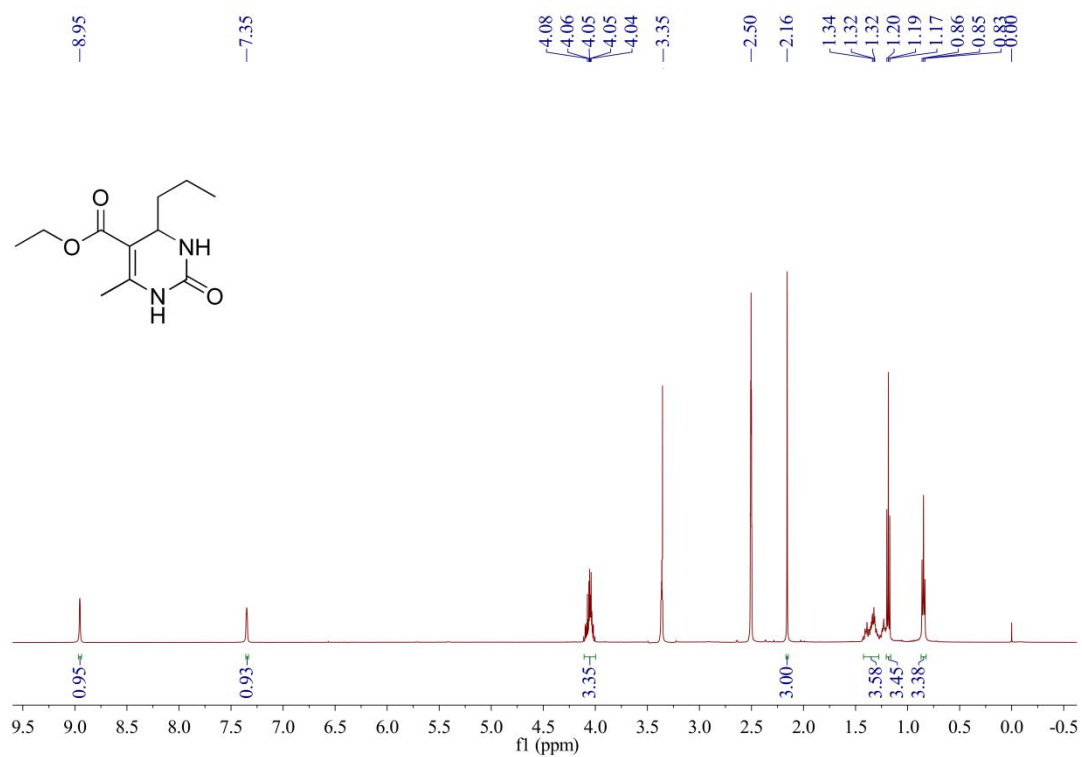
**4e<sub>1</sub>**: 86% Yellow solid, <sup>1</sup>H NMR (500 MHz, DMSO-d<sub>6</sub>): δ 9.65 (s, 1H), 8.1 (s, 1H), 4.51 – 3.72 (m, 3H), 2.16 (s, 3H), 1.46 – 1.23 (m, 4H), 1.19 (t, J = 7.1 Hz, 3H), 0.85 (t, J = 7.0 Hz, 3H); <sup>13</sup>C NMR (125 MHz, DMSO-d<sub>6</sub>): δ 174.35, 162.66, 136.288, 99.86, 59.52, 50.25, 18.17, 17.47, 14.69, 14.23.



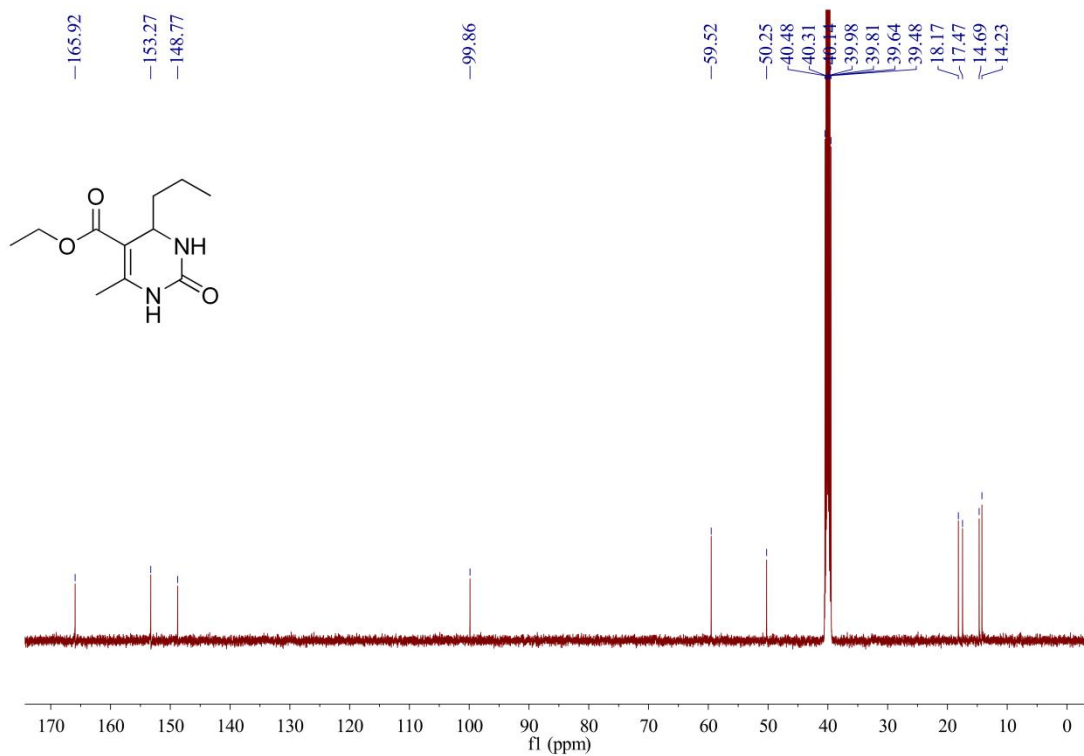
**4f<sub>1</sub>**: 87% Yellow solid, <sup>1</sup>H NMR (500 MHz, DMSO-d<sub>6</sub>): δ 9.75 (s, 1H), 8.23 (s, 1H), 4.11 – 3.88 (m, 3H), 2.15 (s, 3H), 1.46 – 1.21 (m, 6H), 1.18 (t, J = 7.0 Hz, 3H), 0.84 (t, J = 6.1 Hz, 3H); <sup>13</sup>C NMR (125 MHz, DMSO-d<sub>6</sub>): δ 177.38, 160.83, 136.40, 99.39, 59.07, 49.99, 36.52, 25.91, 21.95, 17.82, 14.26, 14.01.

## 2. <sup>1</sup>H-NMR and <sup>13</sup>C-NMR spectra of DHPMs products

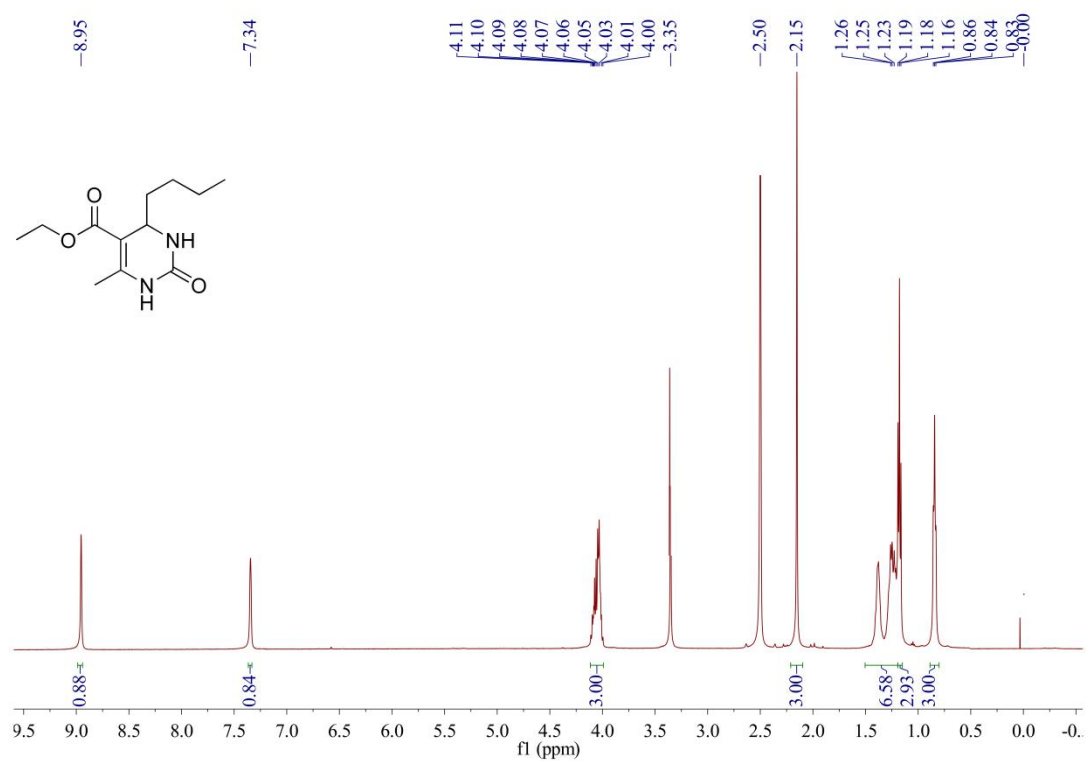
<sup>1</sup>H NMR spectra of compound **4a**



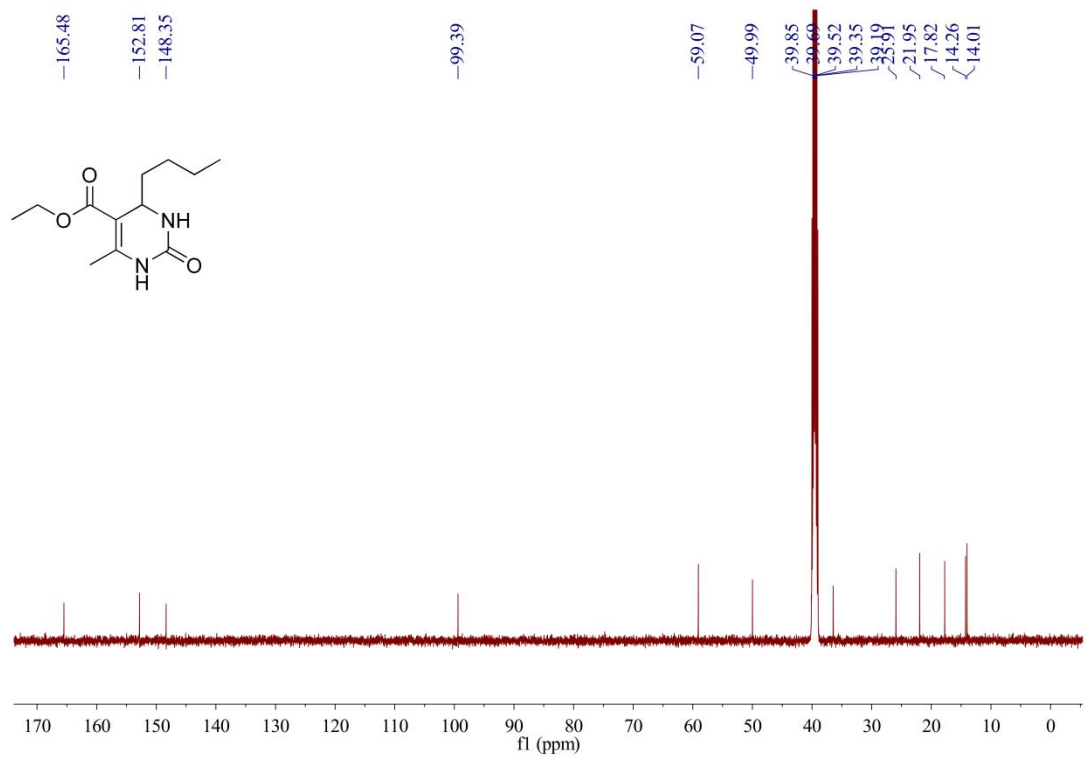
<sup>13</sup>C NMR spectra of compound **4a**



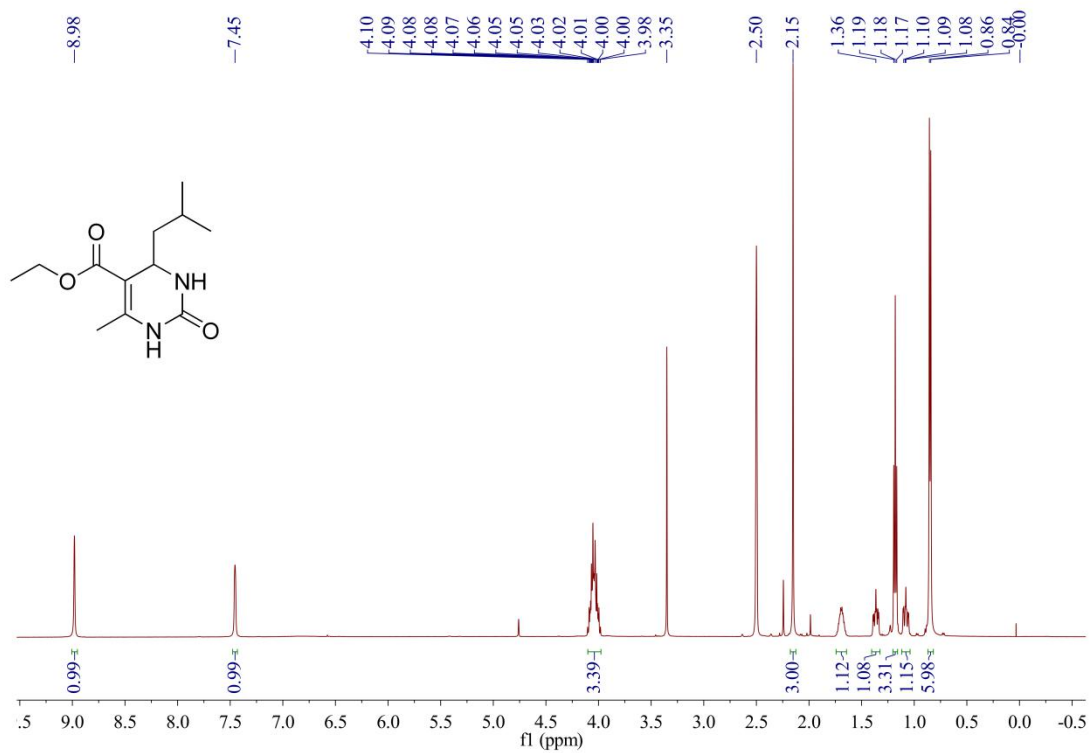
### <sup>1</sup>H NMR spectra of compound **4b**



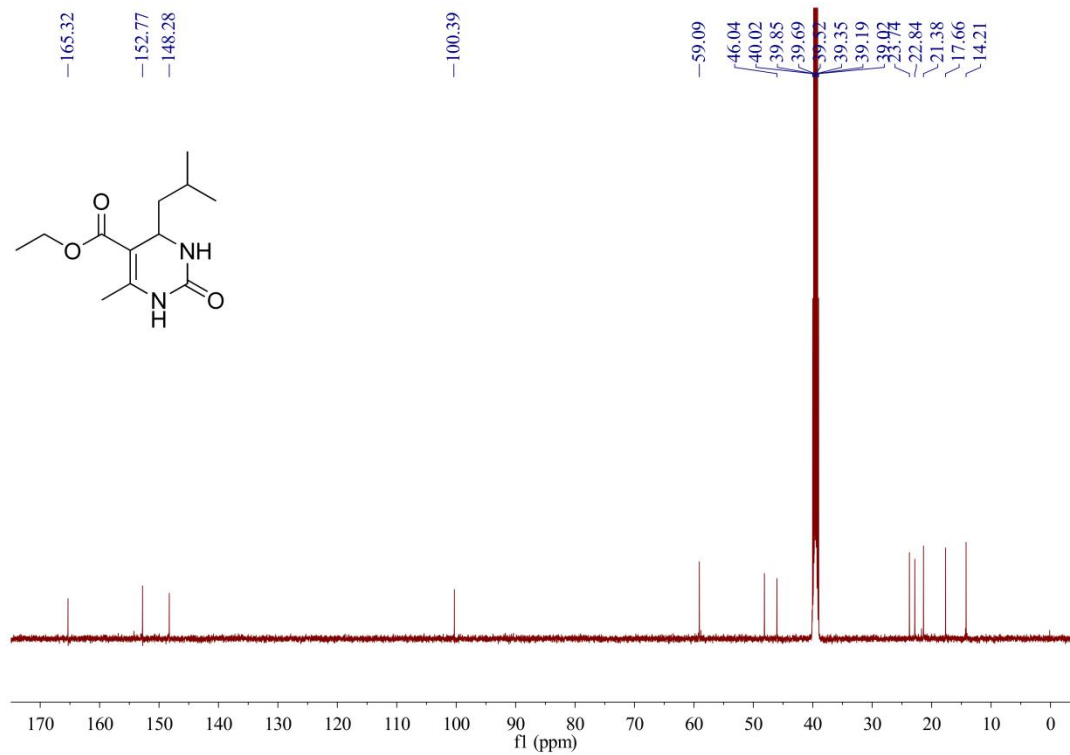
### <sup>13</sup>C NMR spectra of compound **4b**



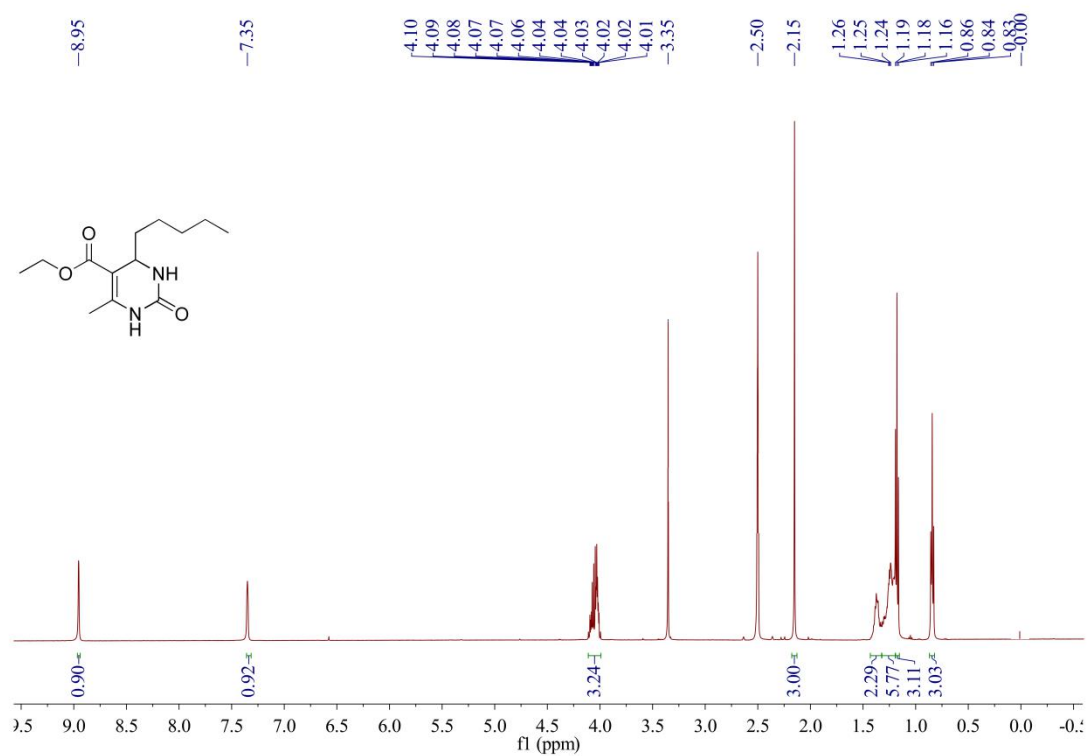
### $^1\text{H}$ NMR spectra of compound **4c**



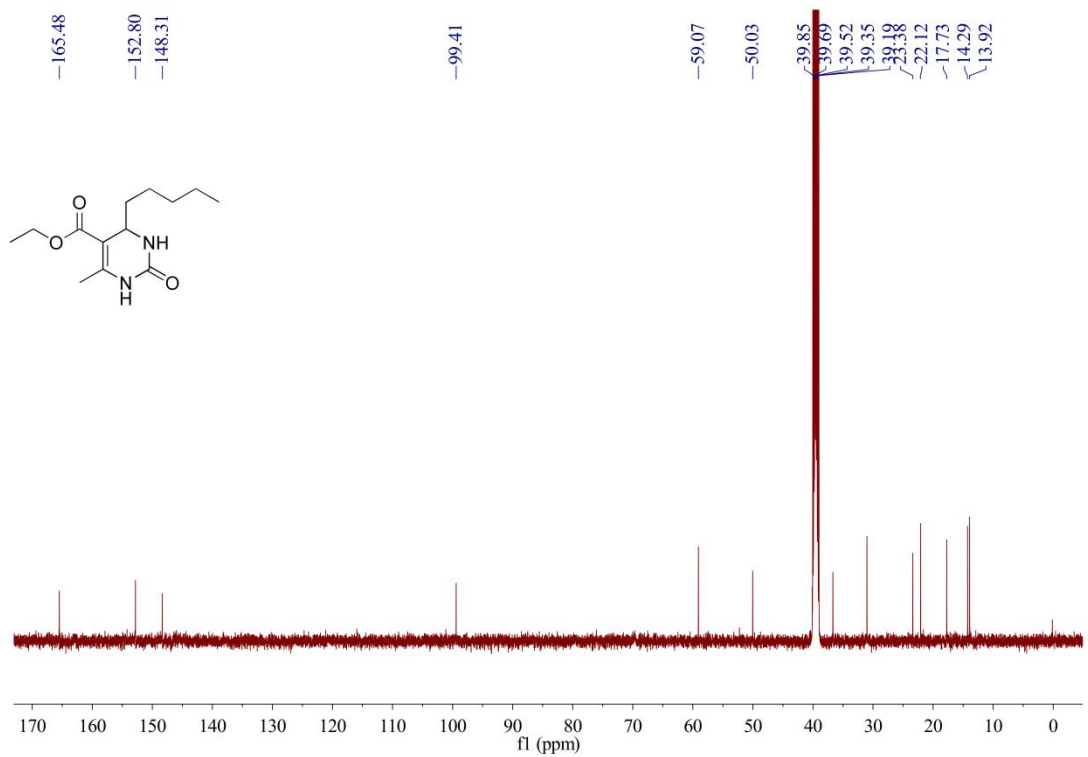
### $^{13}\text{C}$ NMR spectra of compound **4c**



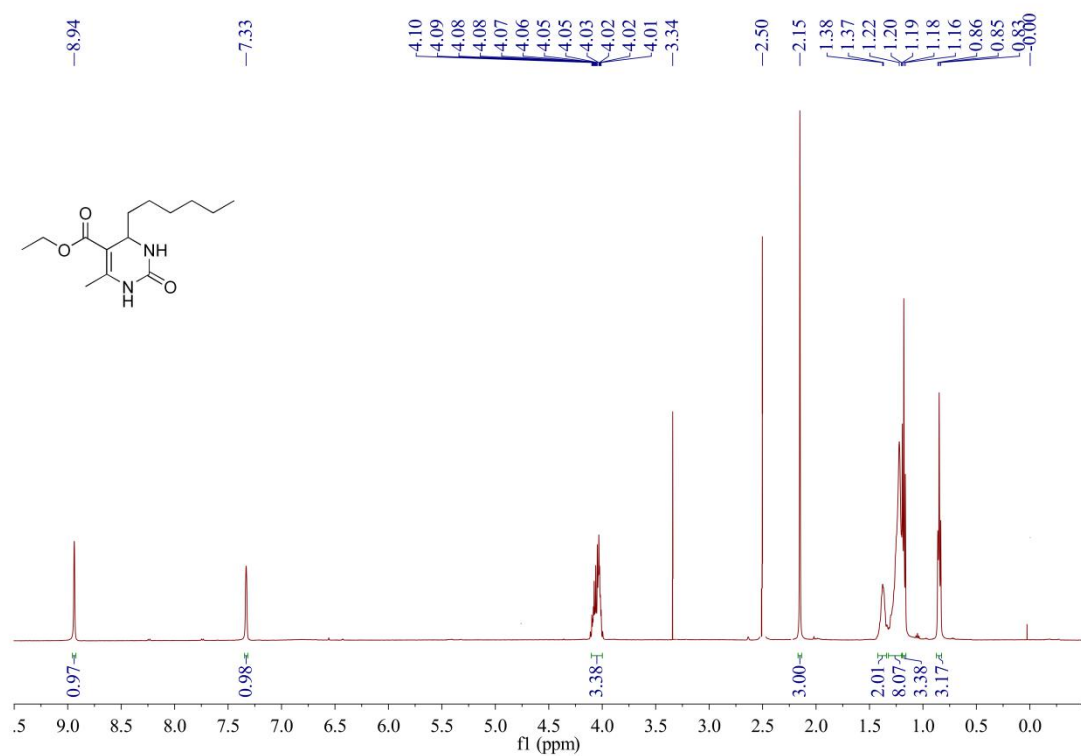
### <sup>1</sup>H NMR spectra of compound **4d**



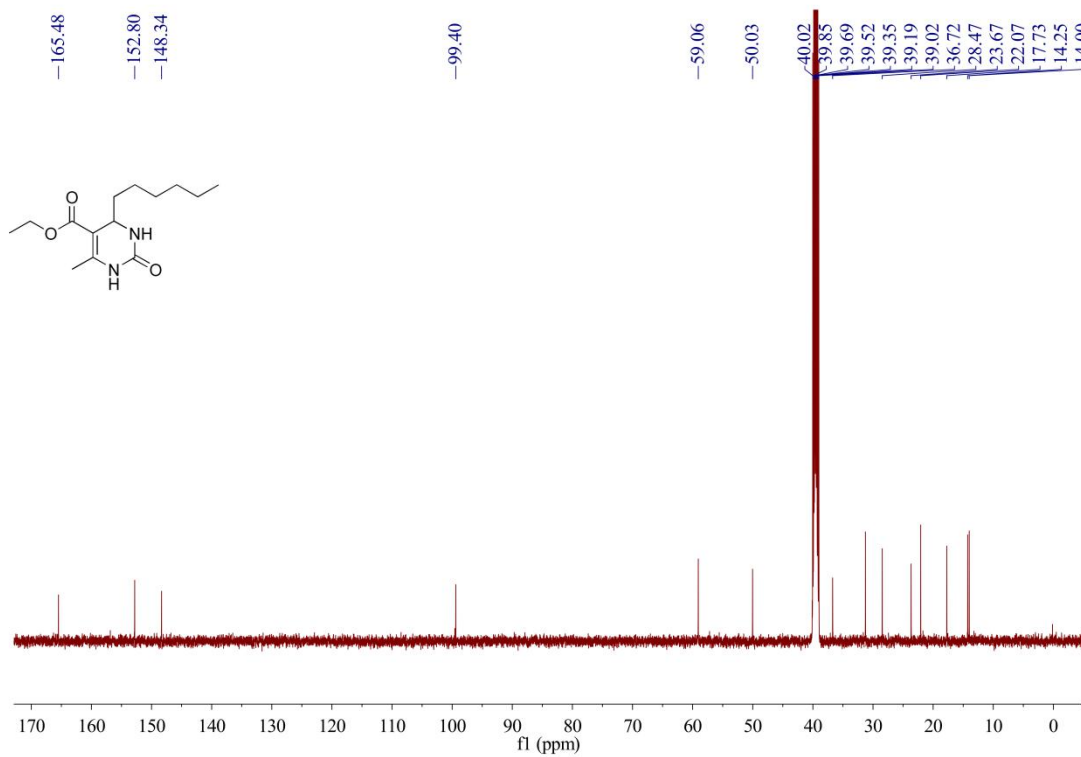
### <sup>13</sup>C NMR spectra of compound **4d**



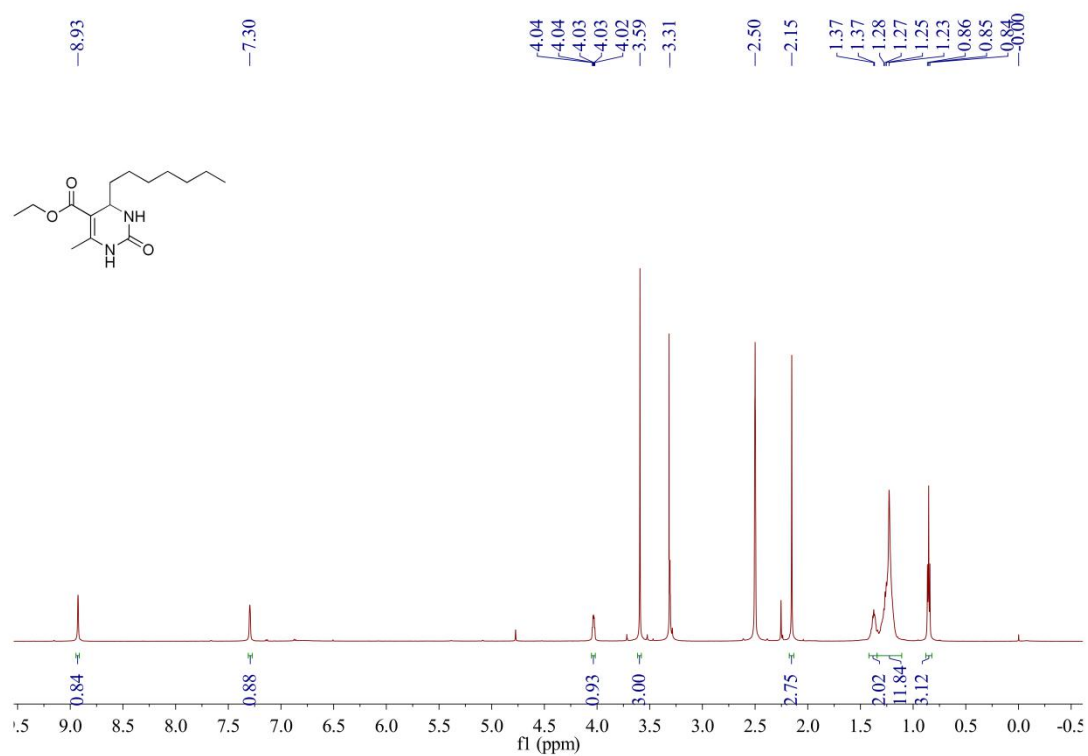
### <sup>1</sup>H NMR spectra of compound 4e



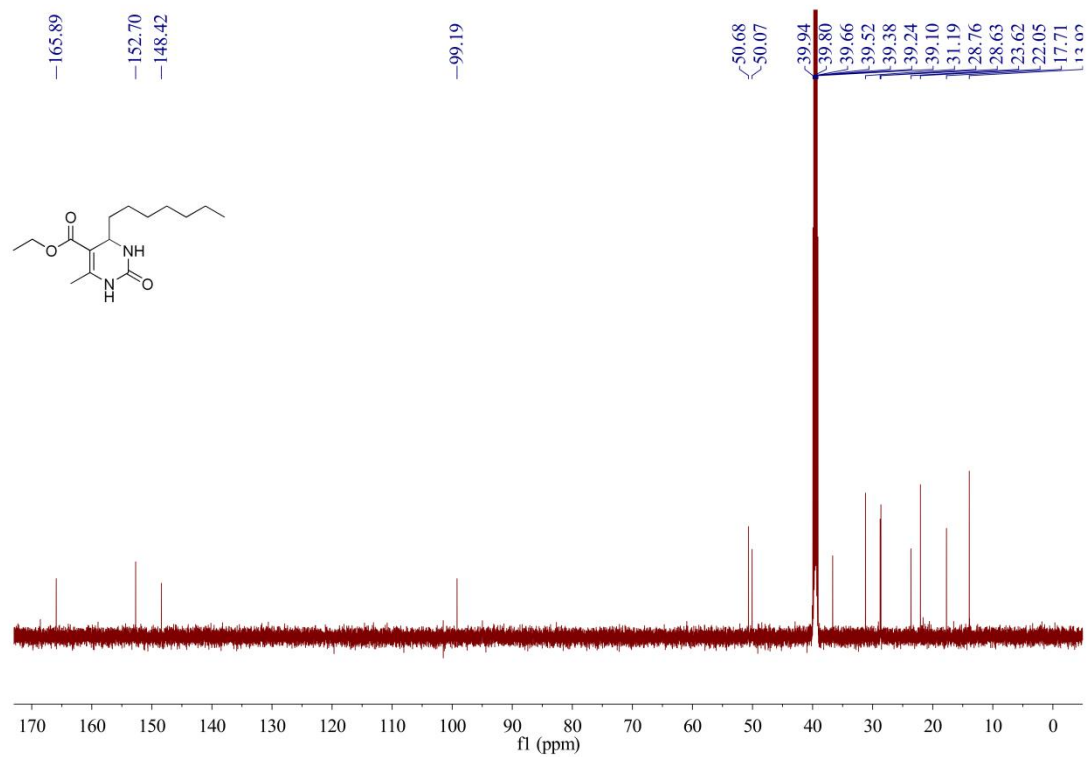
### <sup>13</sup>C NMR spectra of compound 4e



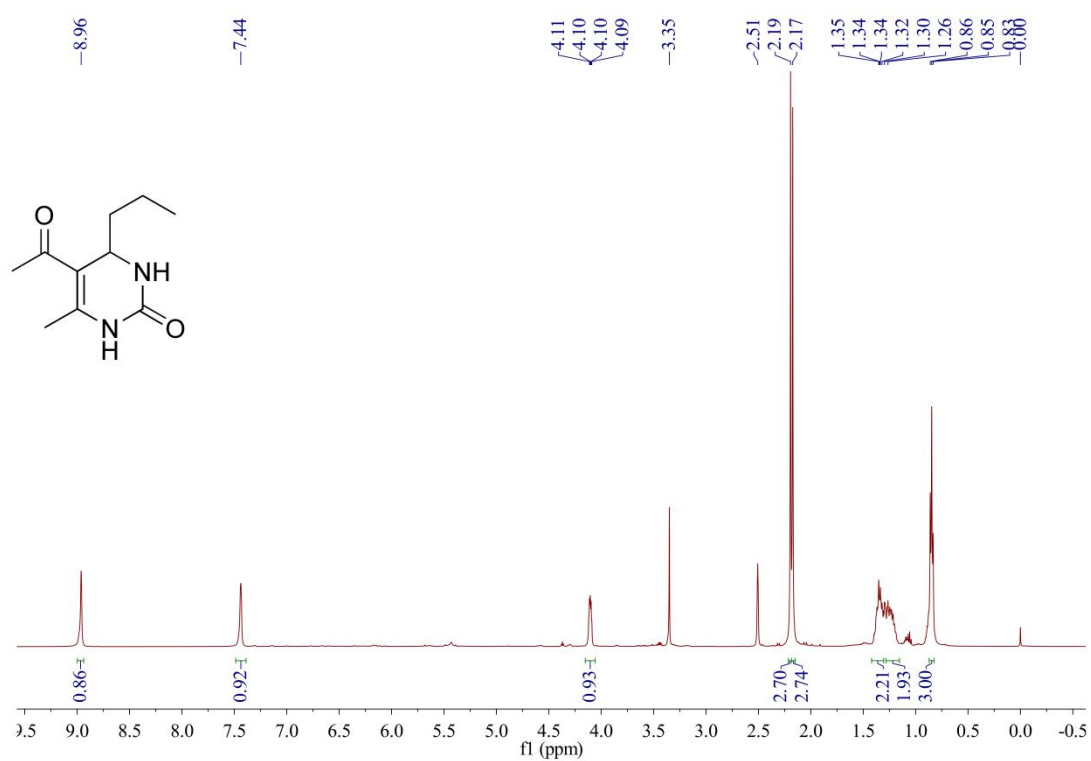
### <sup>1</sup>H NMR spectra of compound **4f**



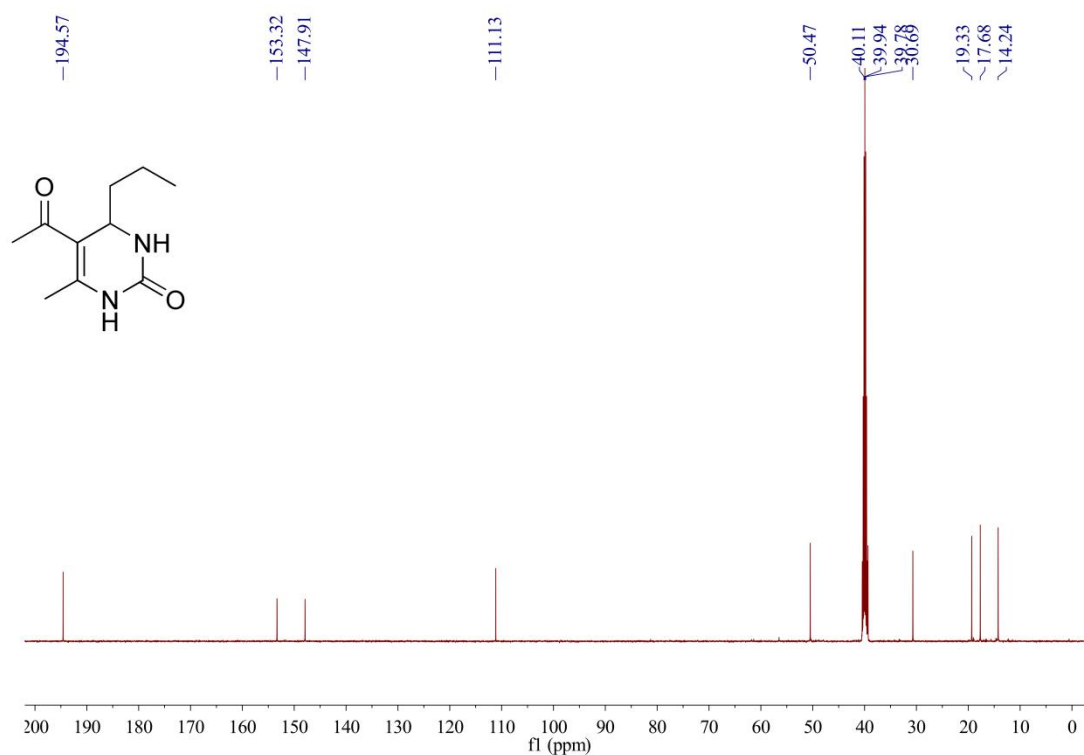
### <sup>13</sup>C NMR spectra of compound **4f**



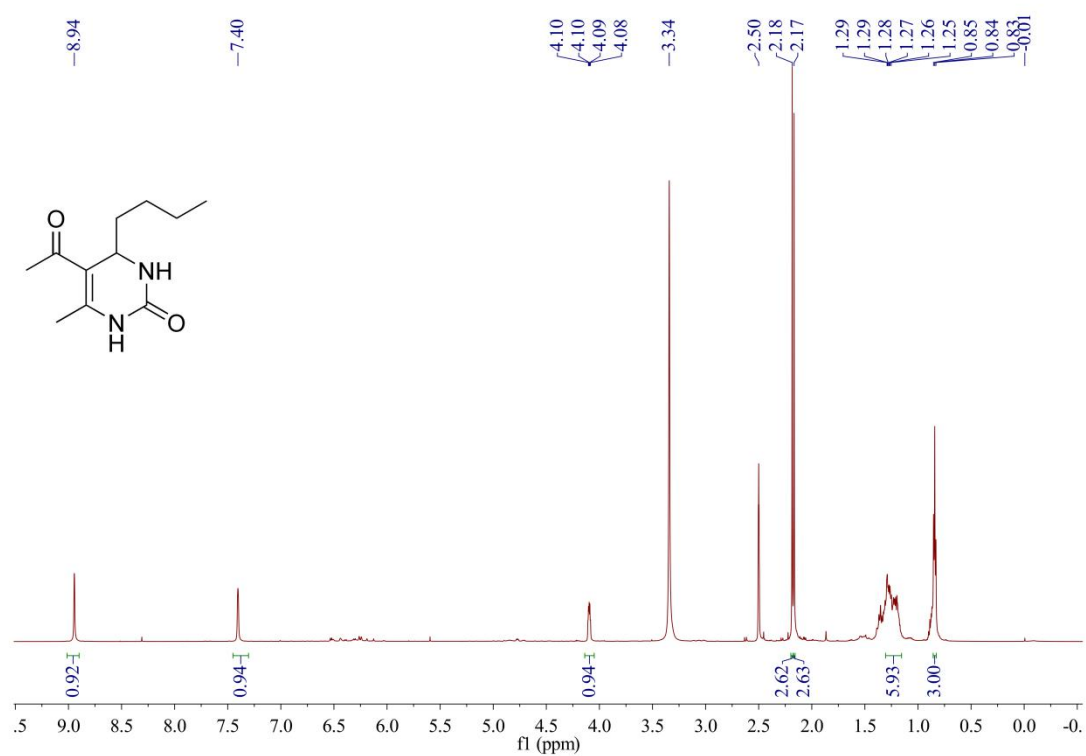
### <sup>1</sup>H NMR spectra of compound **4g**



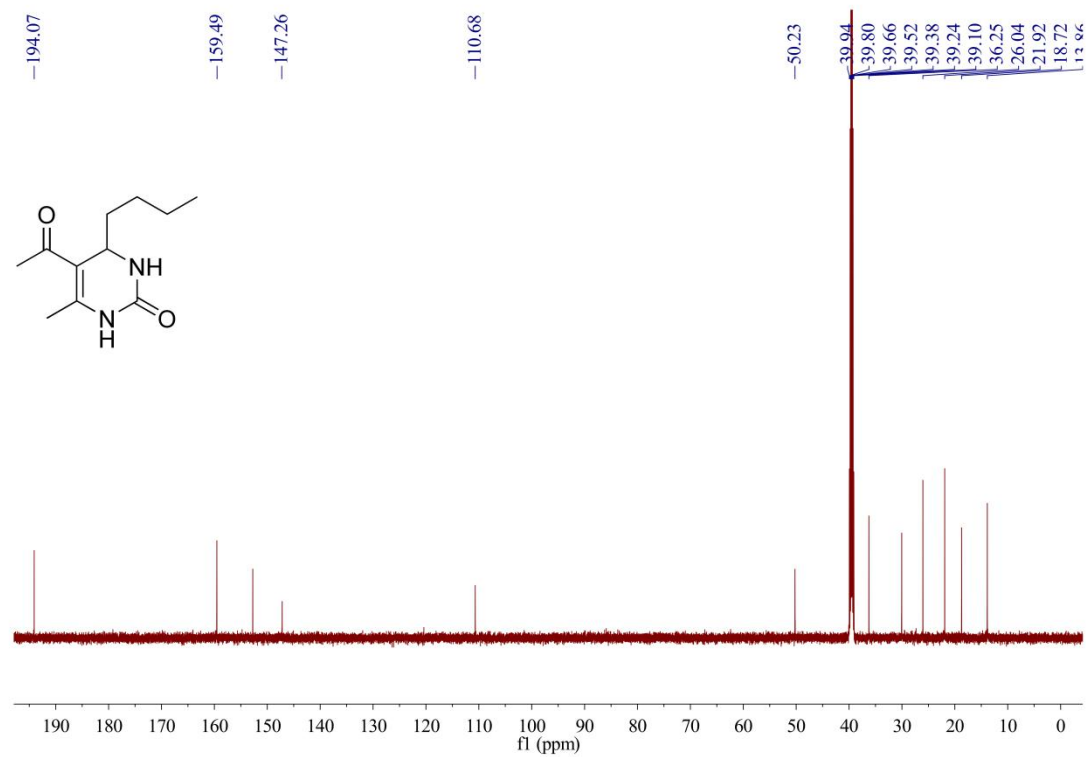
### <sup>13</sup>C NMR spectra of compound **4g**



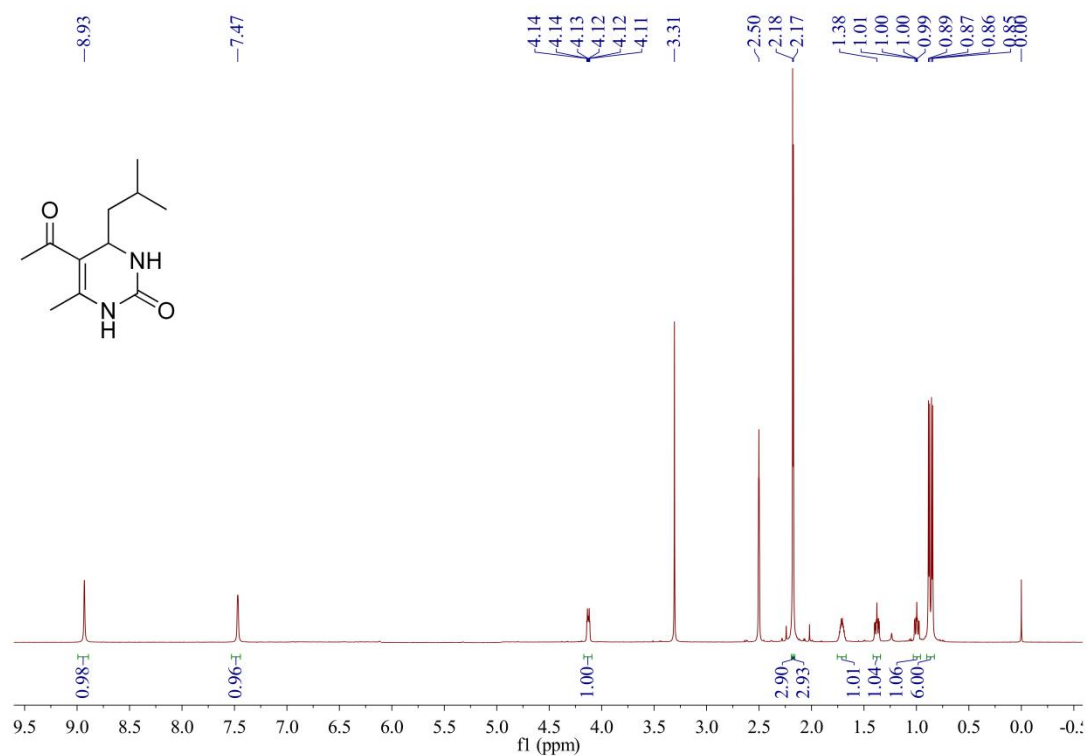
### <sup>1</sup>H NMR spectra of compound **4h**



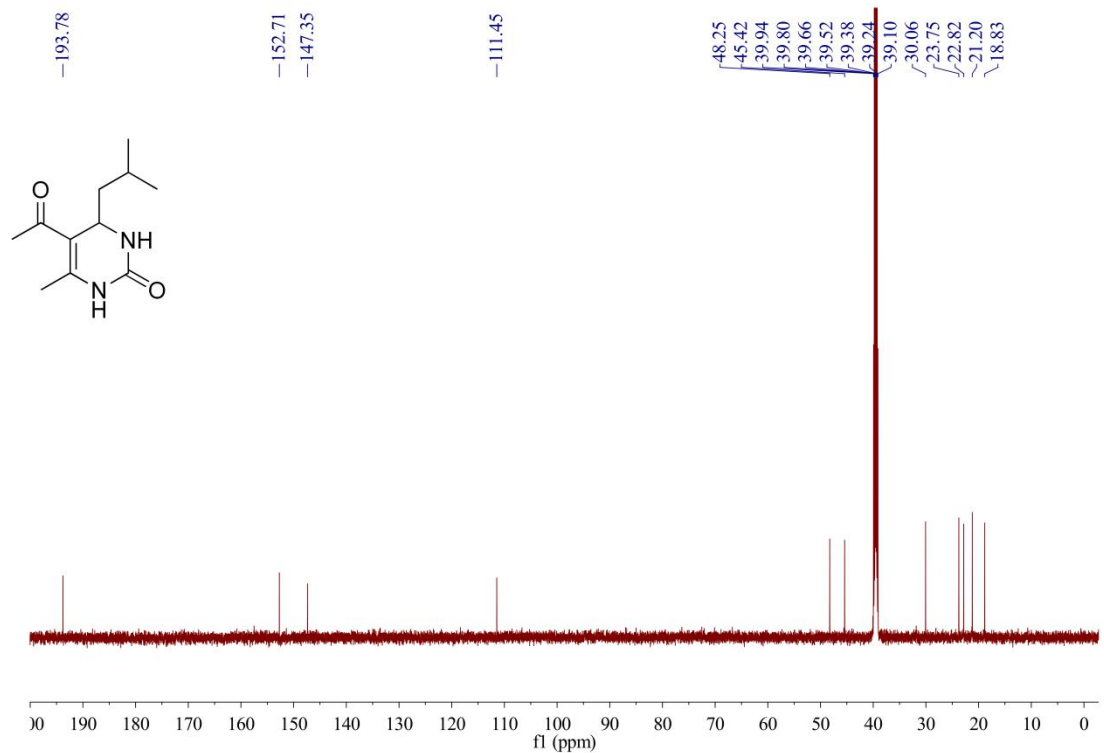
### <sup>13</sup>C NMR spectra of compound **4h**



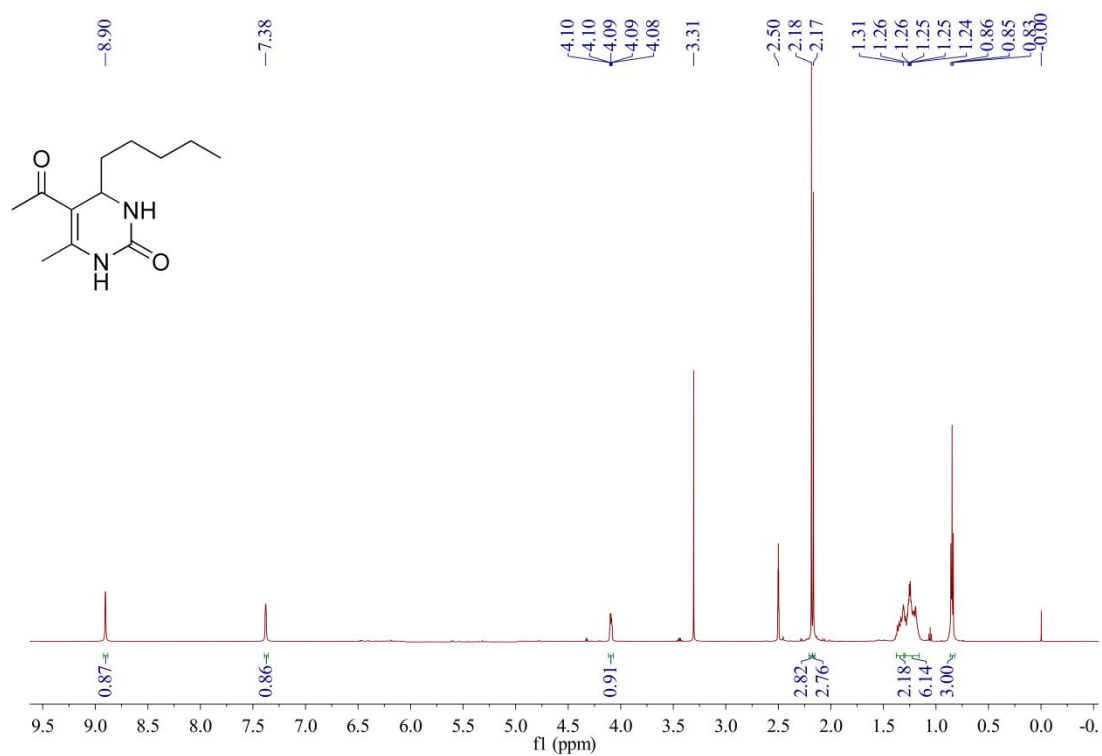
### <sup>1</sup>H NMR spectra of compound **4i**



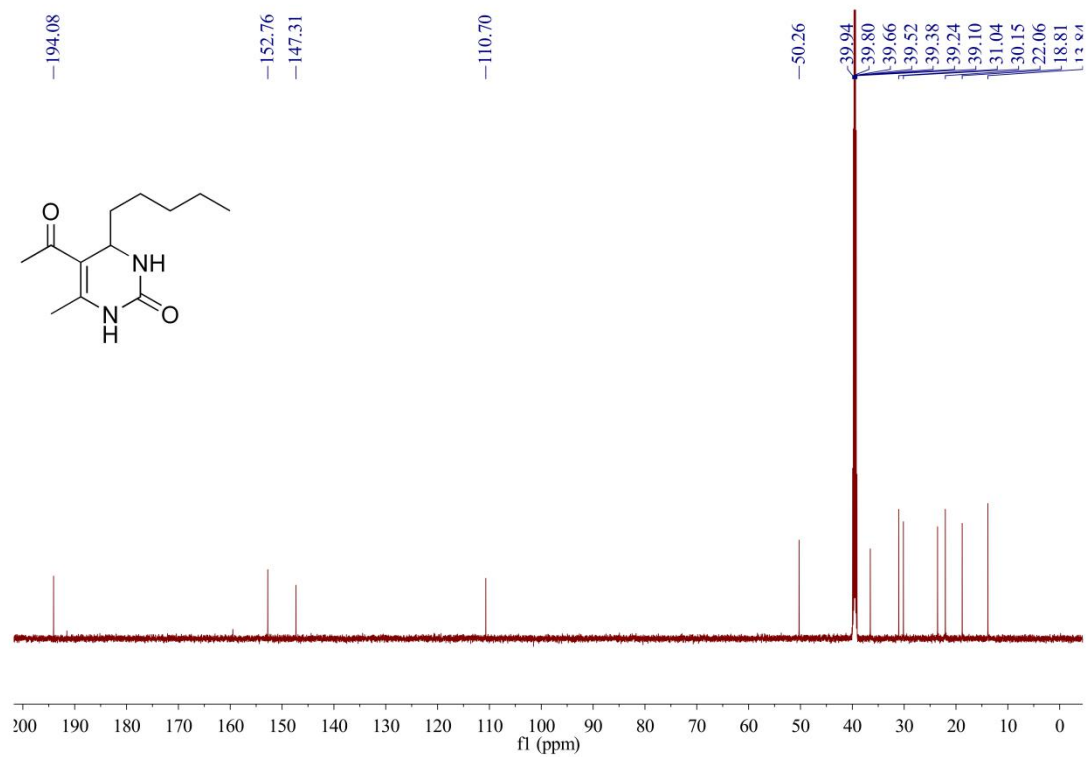
### <sup>13</sup>C NMR spectra of compound **4i**



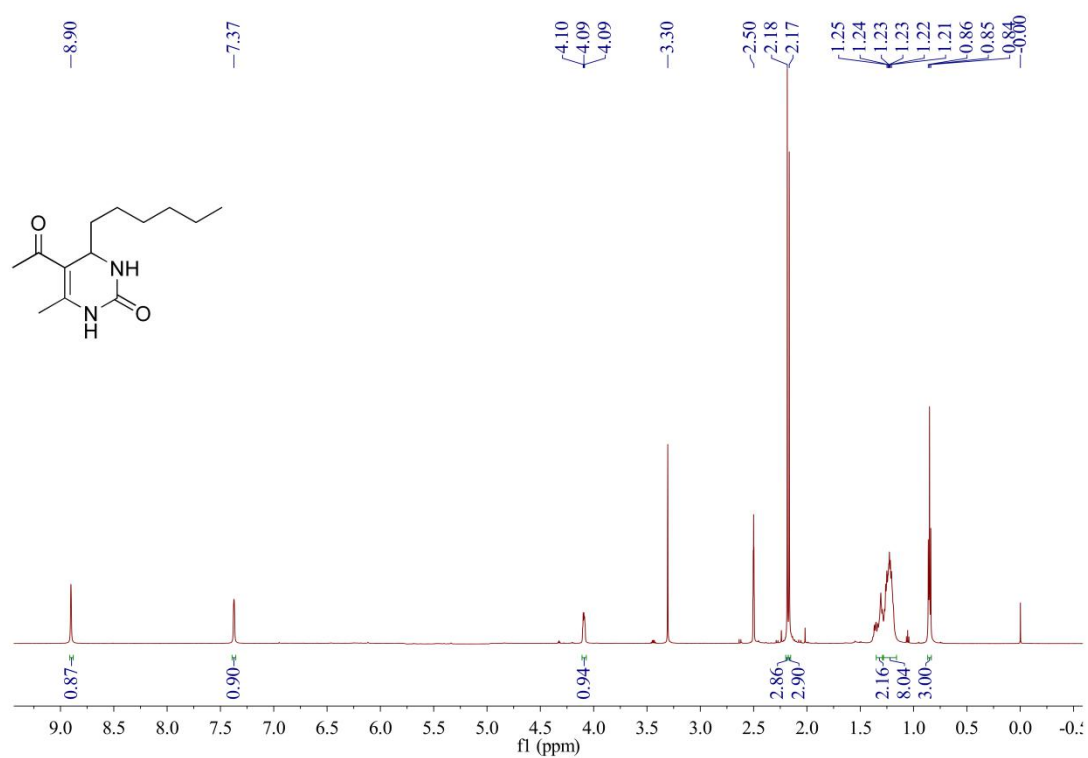
### <sup>1</sup>H NMR spectra of compound 4j



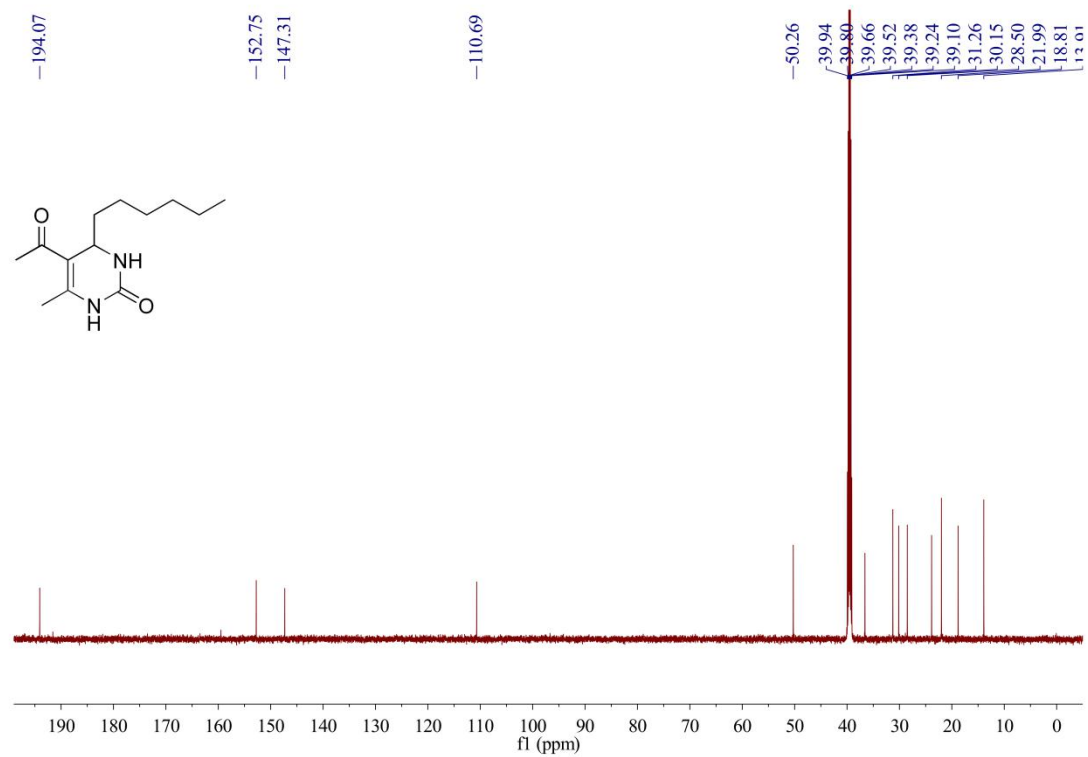
### <sup>13</sup>C NMR spectra of compound 4j



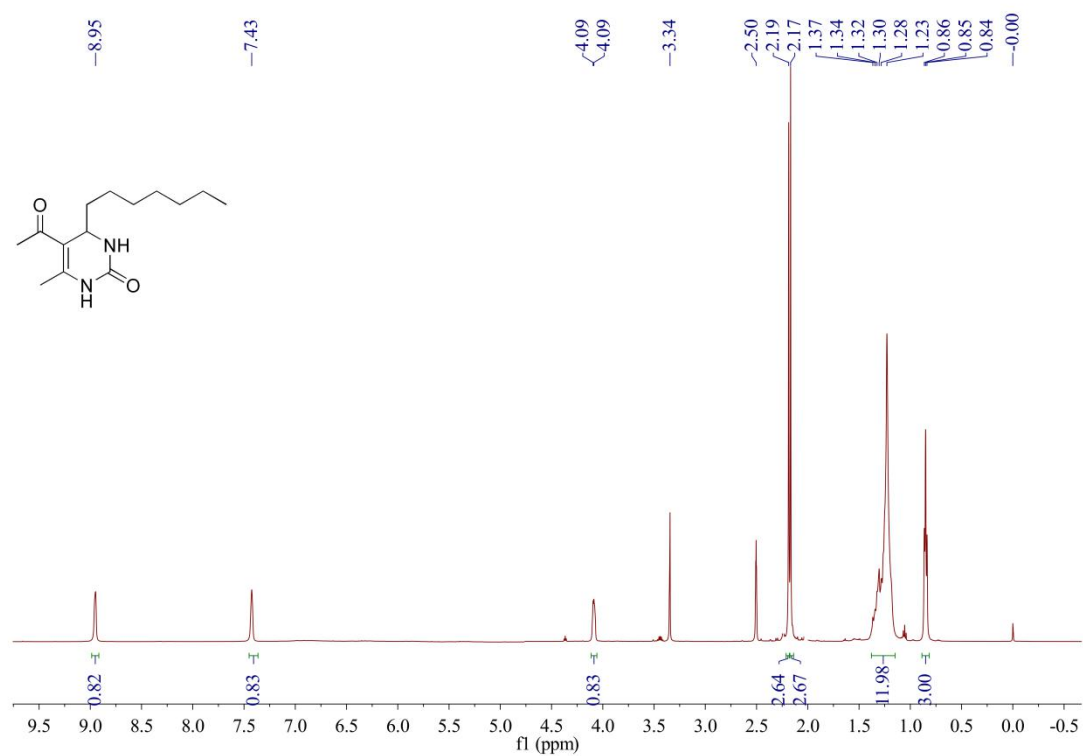
### <sup>1</sup>H NMR spectra of compound **4k**



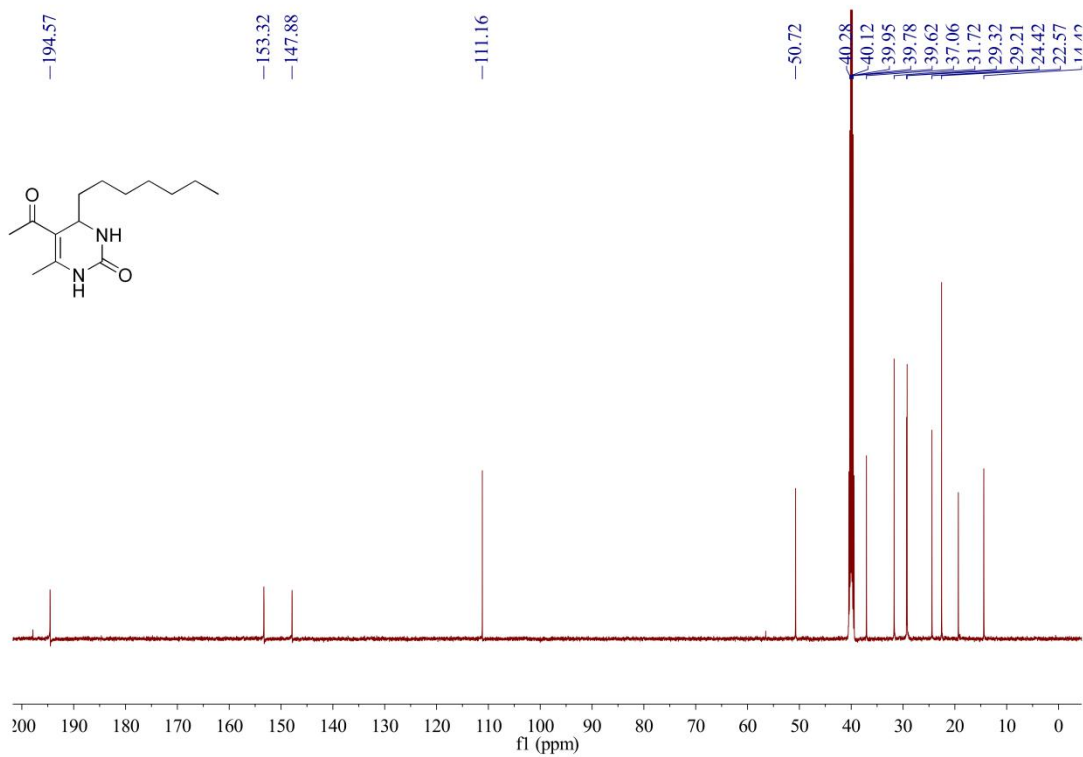
### <sup>13</sup>C NMR spectra of compound **4k**



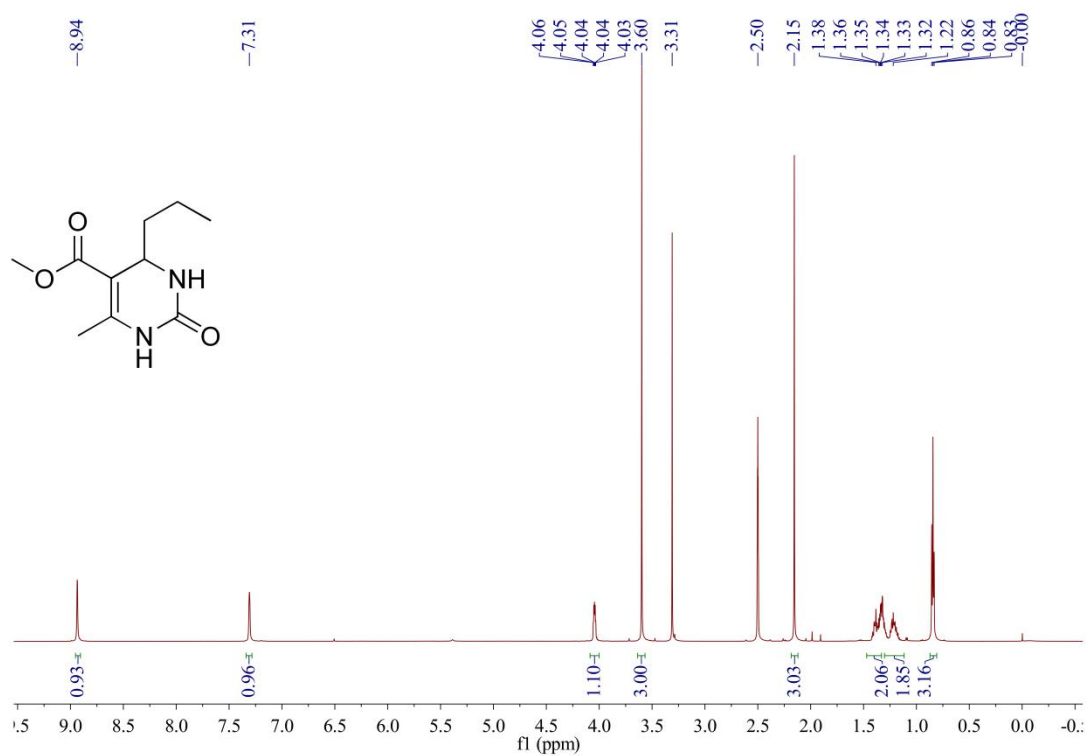
### <sup>1</sup>H NMR spectra of compound 4I



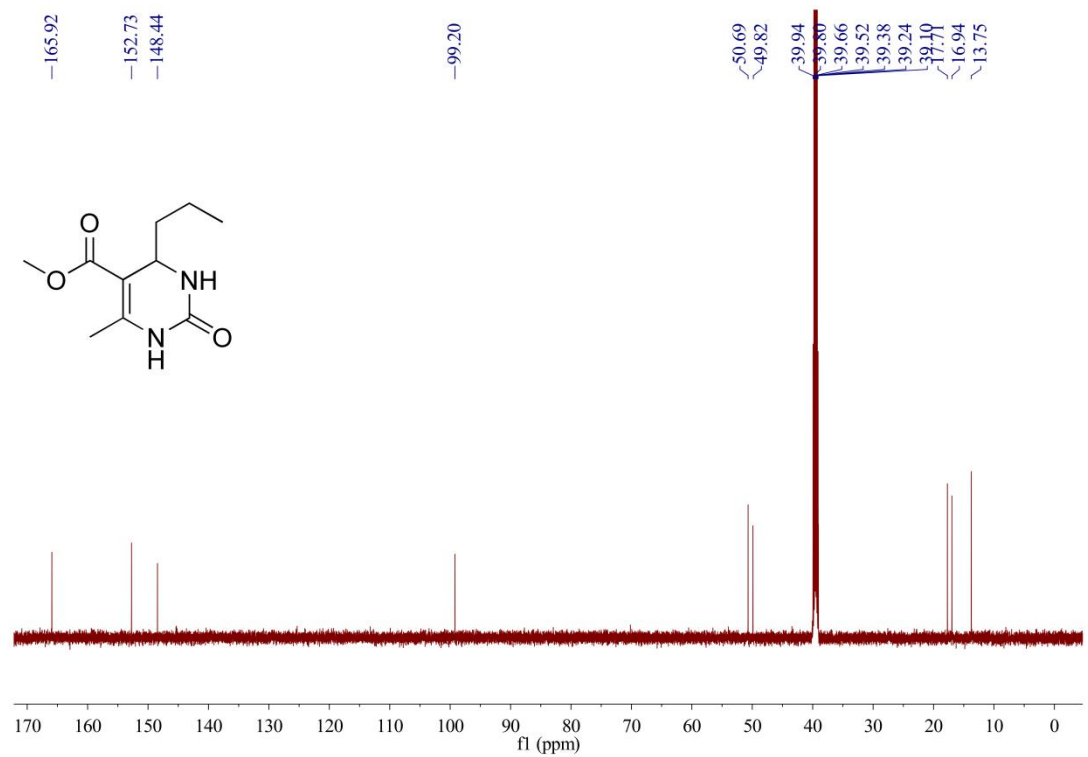
### <sup>13</sup>C NMR spectra of compound 4I



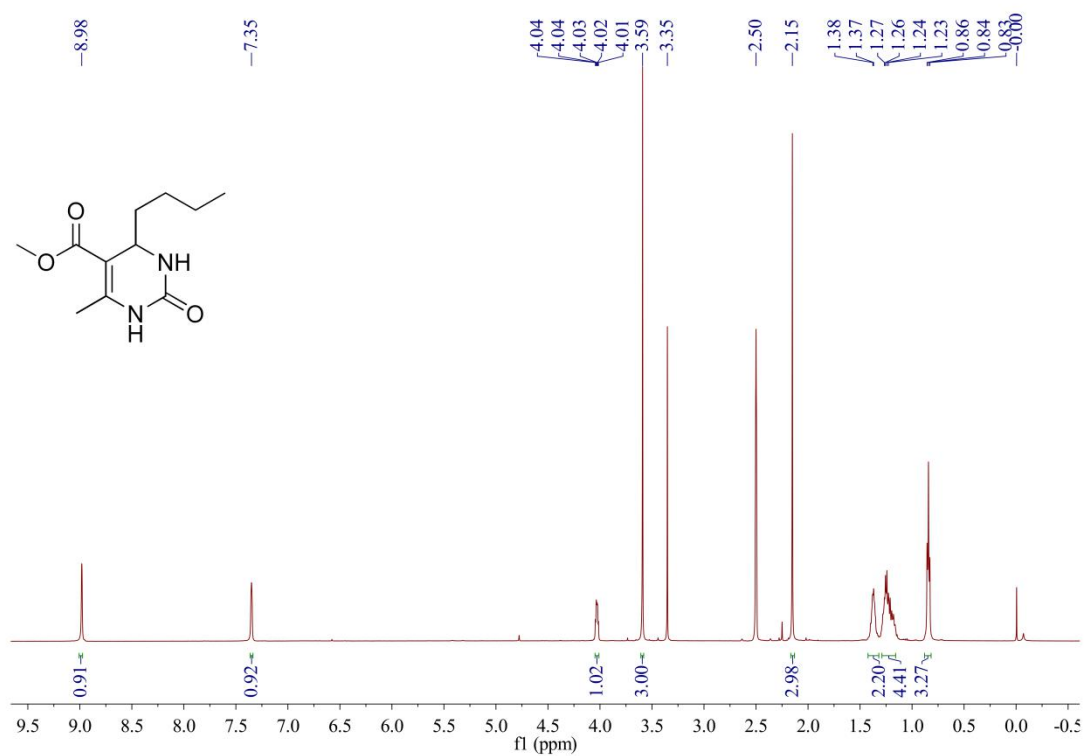
### <sup>1</sup>H NMR spectra of compound **4m**



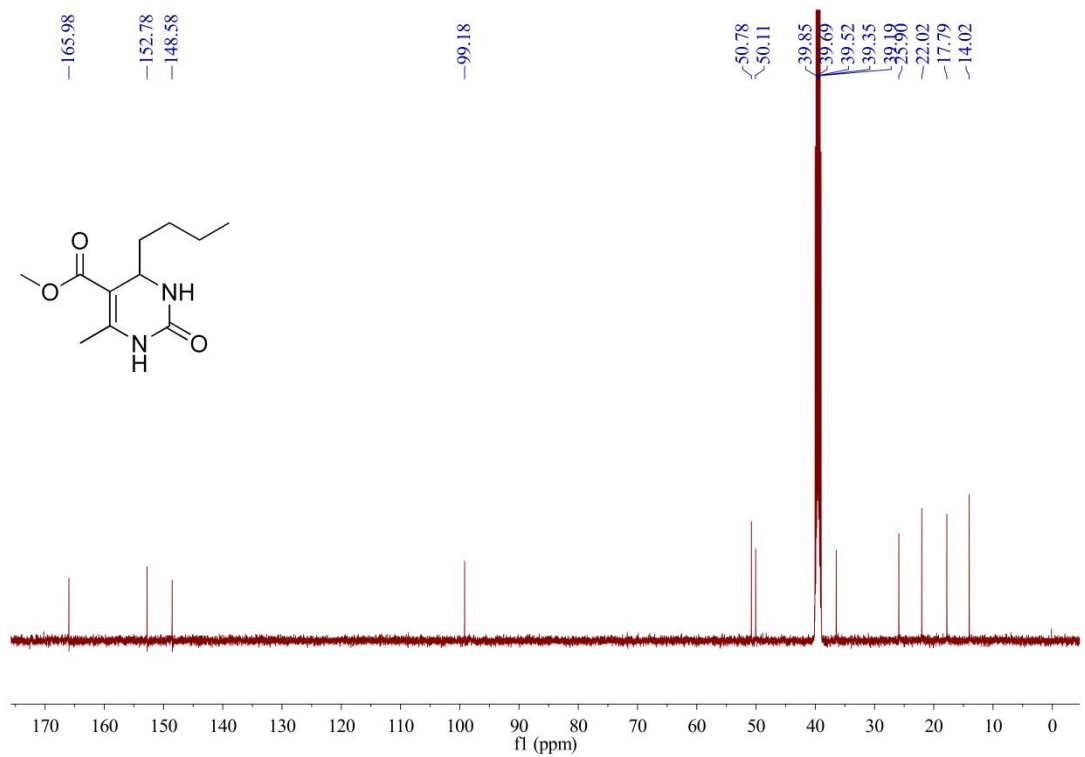
### <sup>13</sup>C NMR spectra of compound **4m**



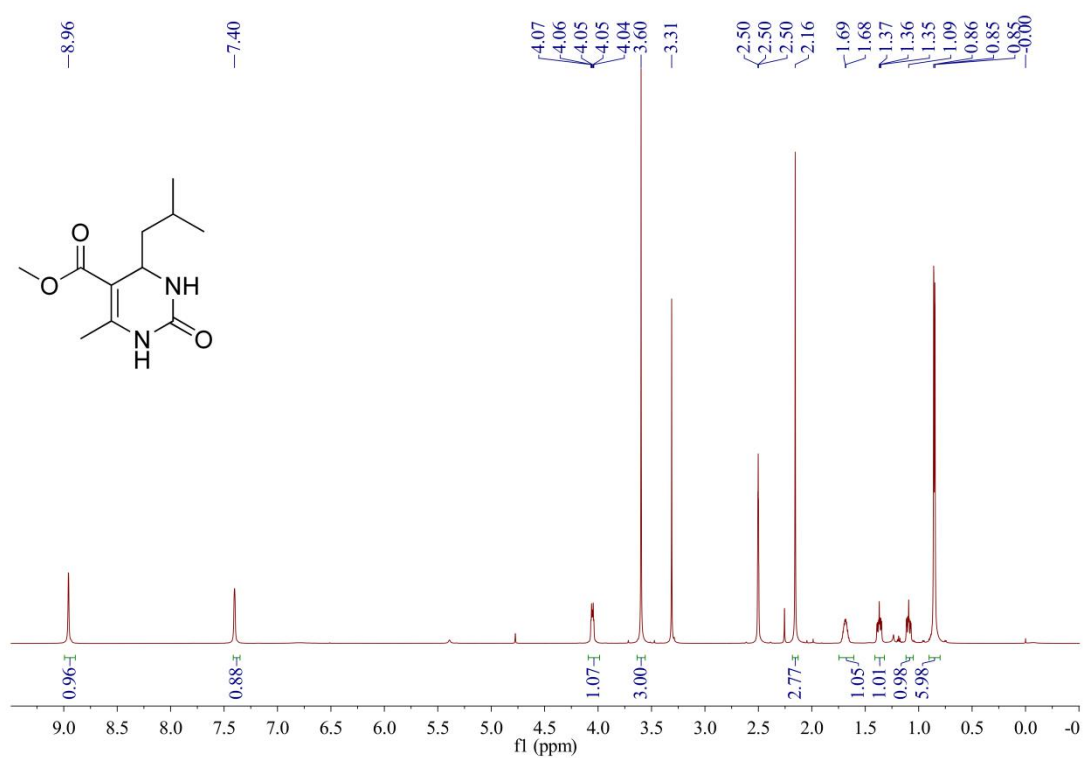
### $^1\text{H}$ NMR spectra of compound **4n**



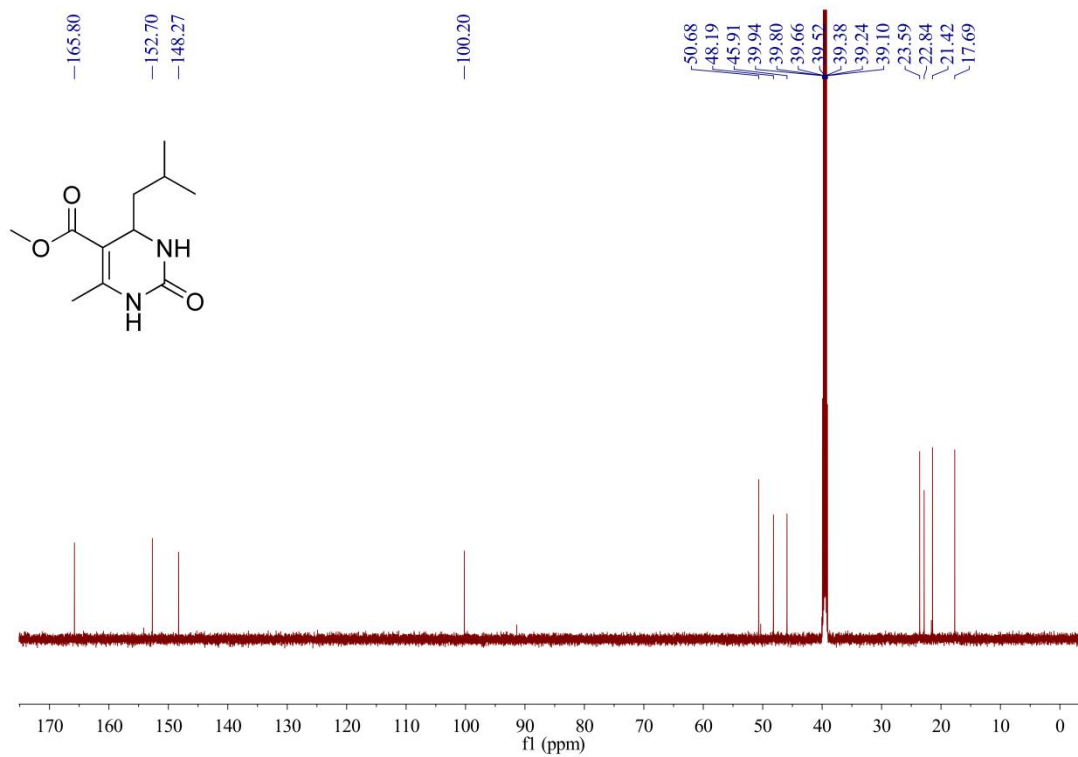
### $^{13}\text{C}$ NMR spectra of compound **4n**



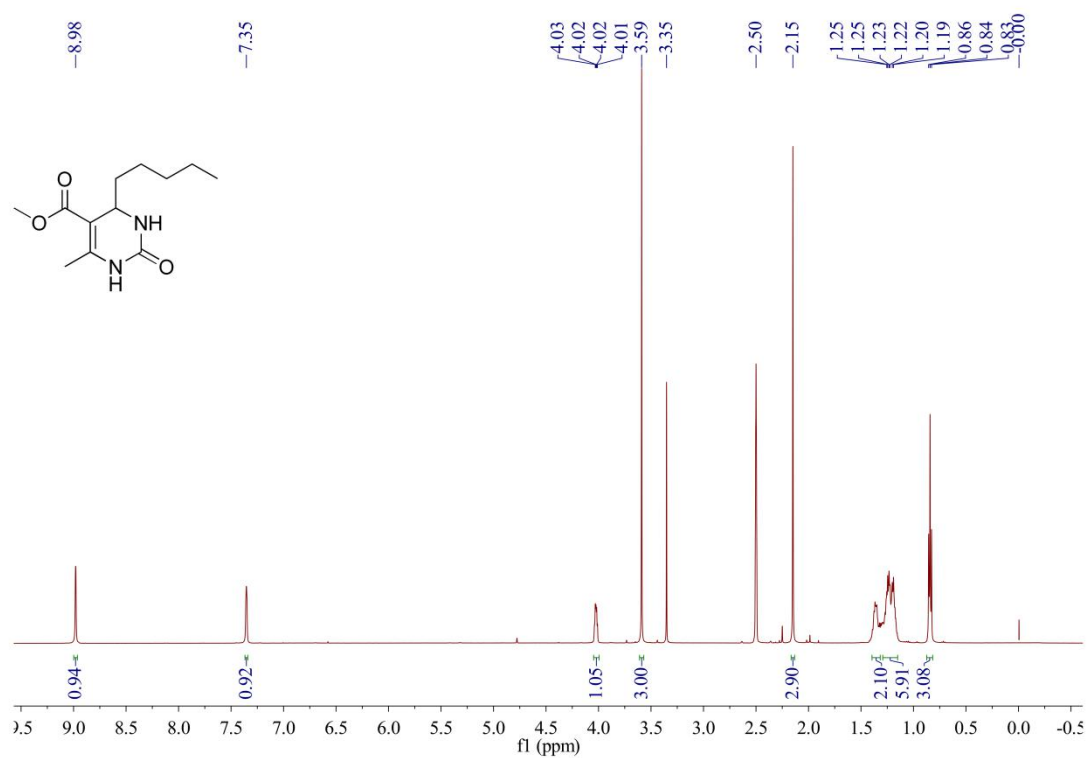
### <sup>1</sup>H NMR spectra of compound **4o**



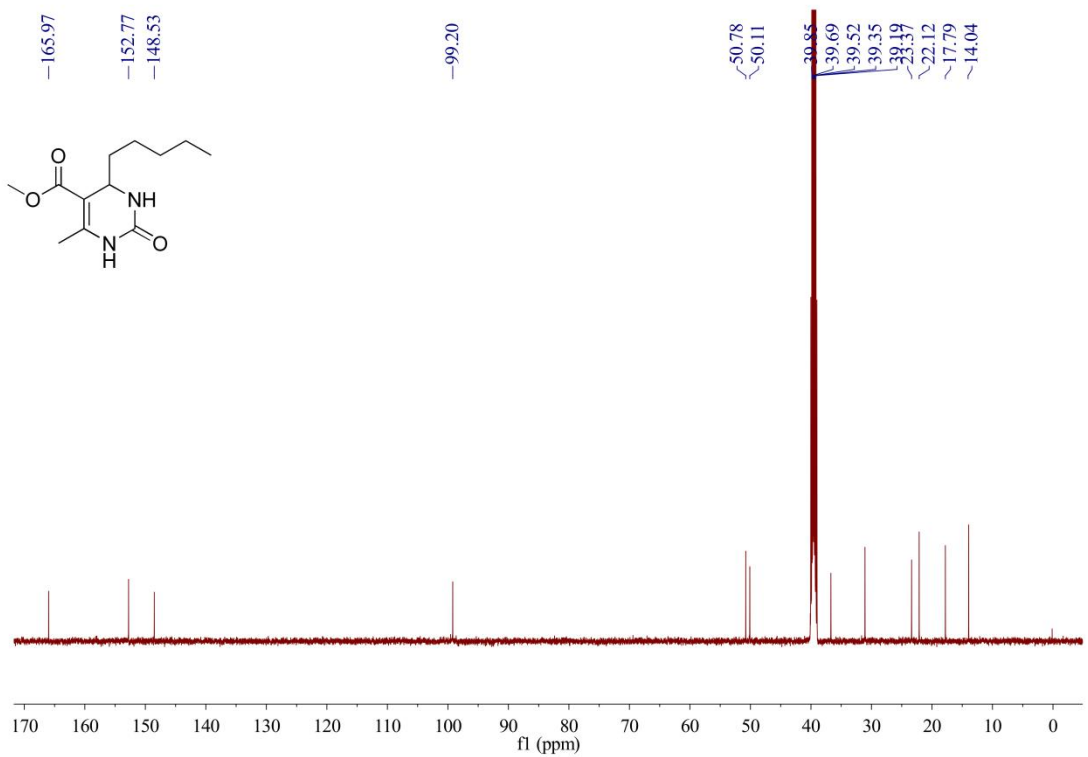
### <sup>13</sup>C NMR spectra of compound **4o**



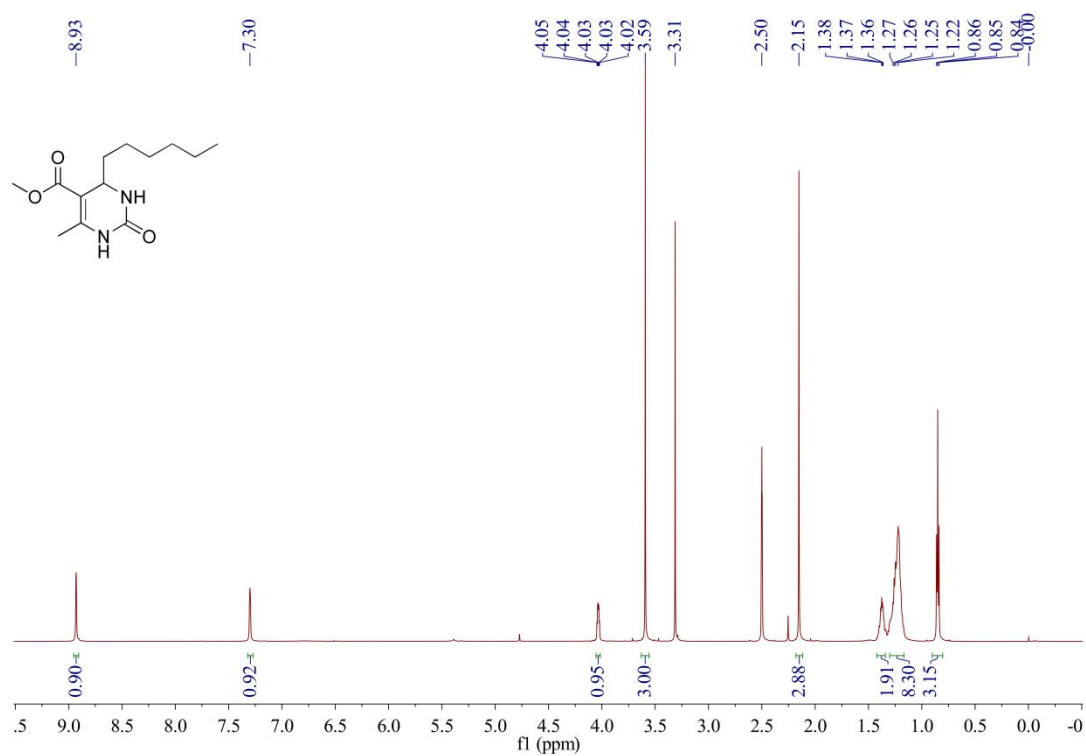
### <sup>1</sup>H NMR spectra of compound **4p**



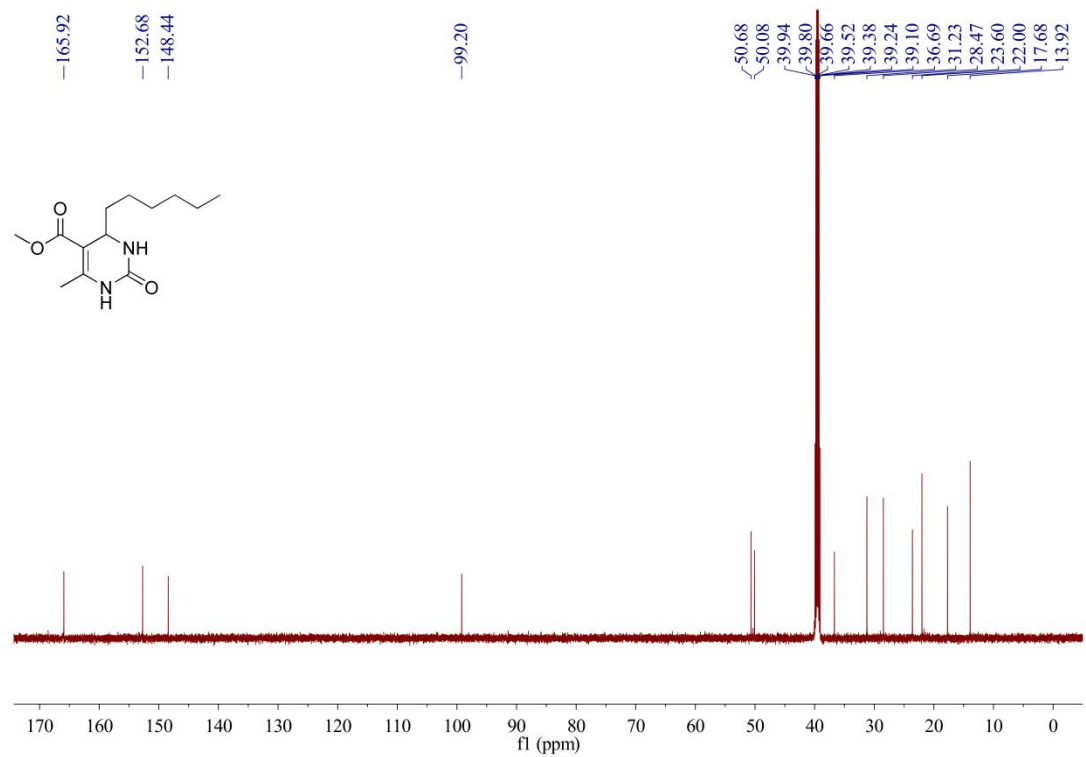
### <sup>13</sup>C NMR spectra of compound **4p**



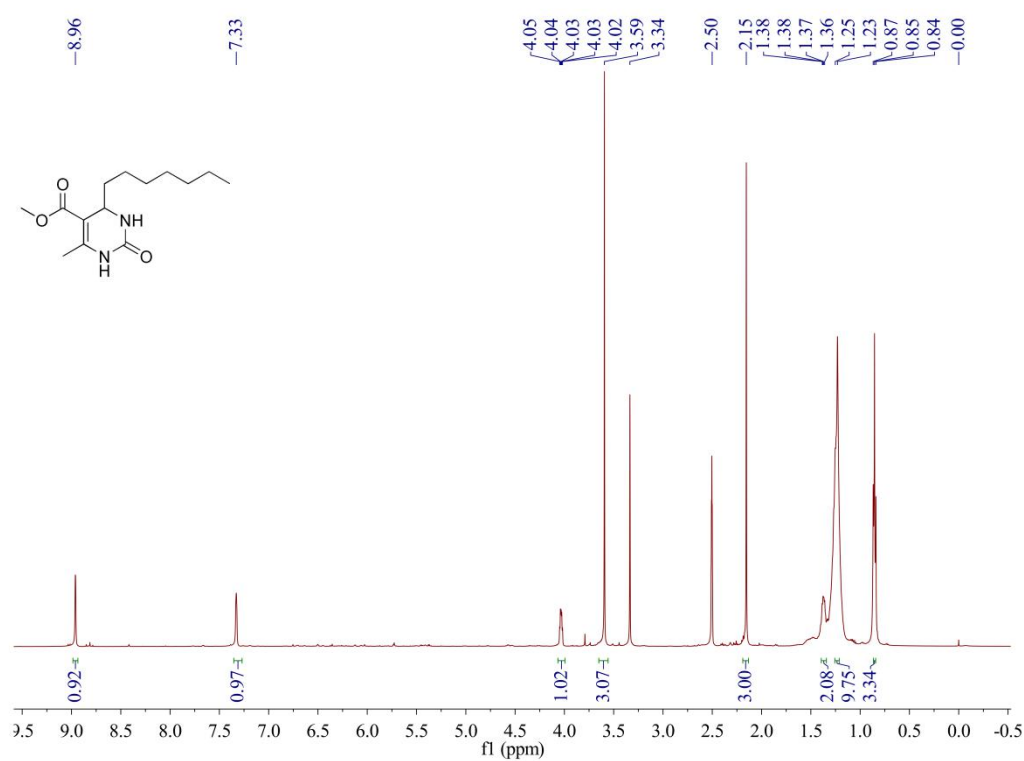
### <sup>1</sup>H NMR spectra of compound **4q**



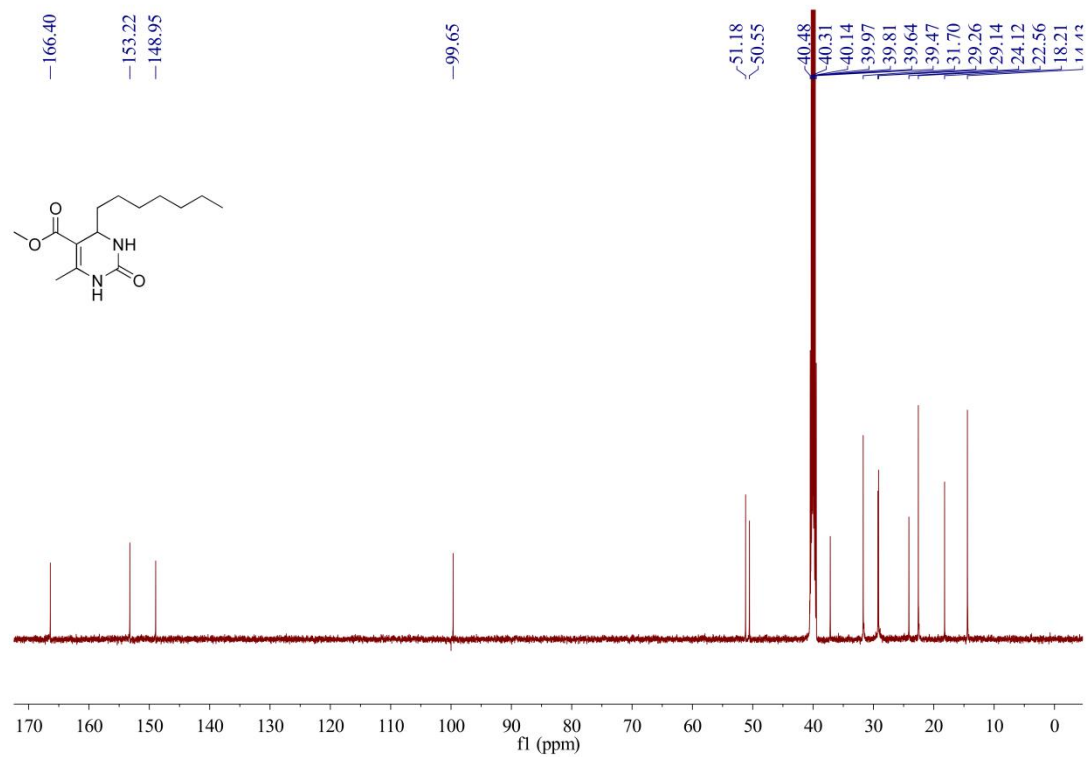
### <sup>13</sup>C NMR spectra of compound **4q**



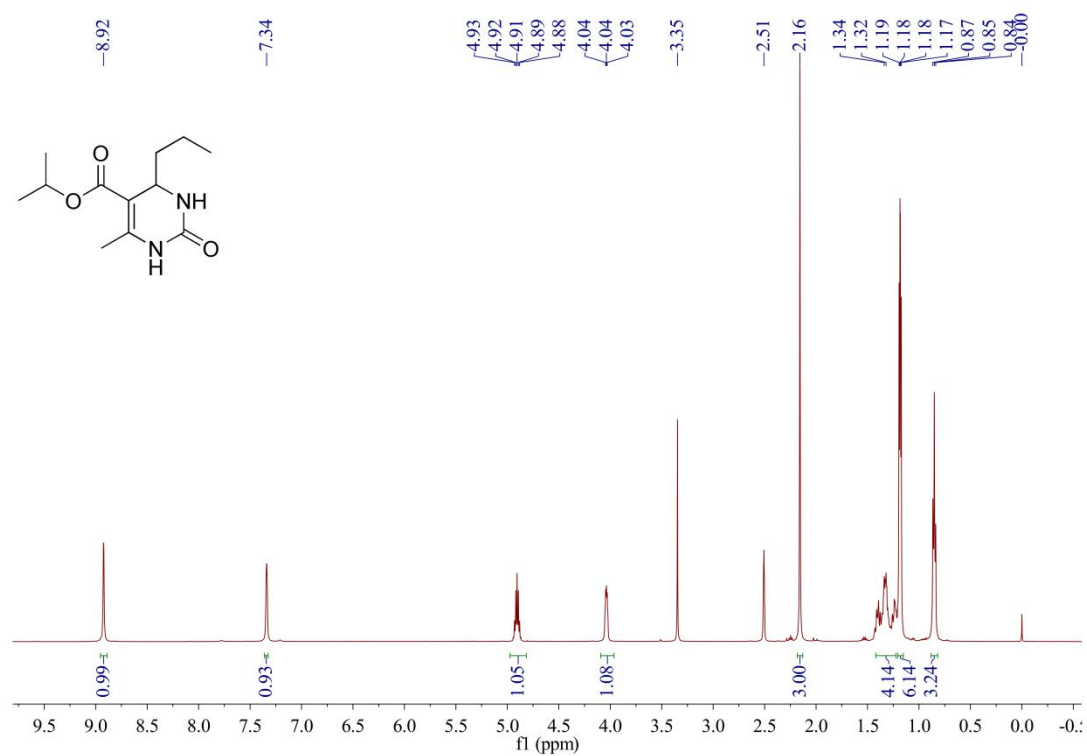
### <sup>1</sup>H NMR spectra of compound 4r



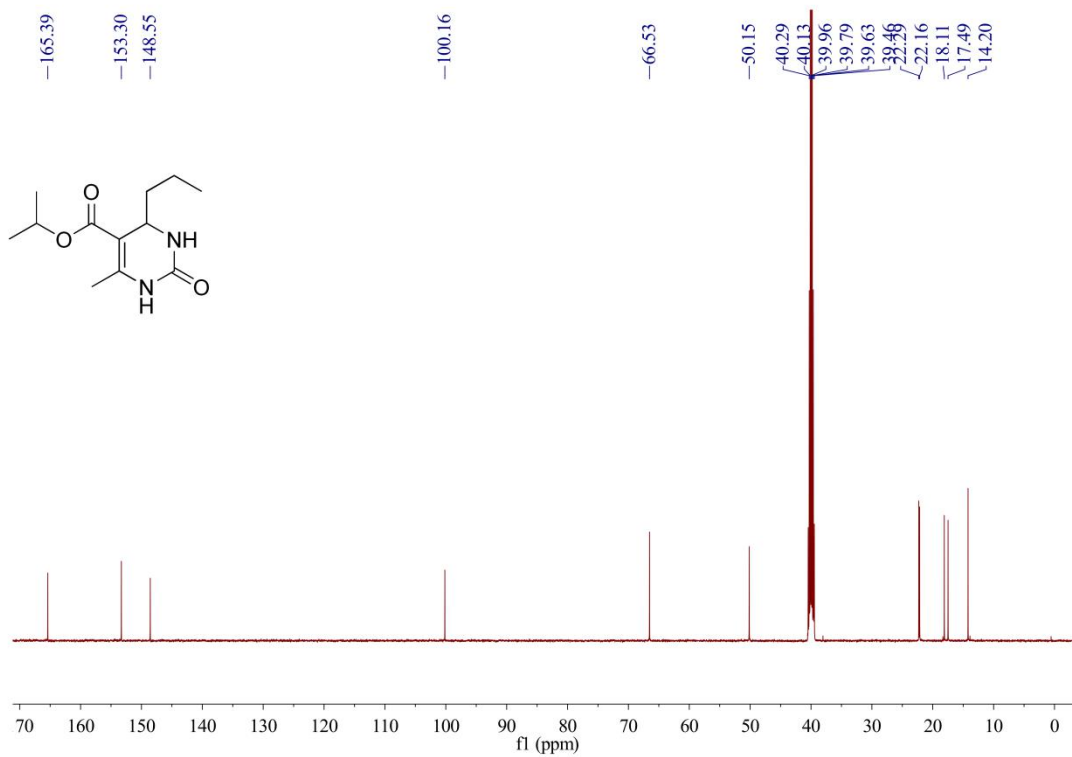
### <sup>13</sup>C NMR spectra of compound 4r



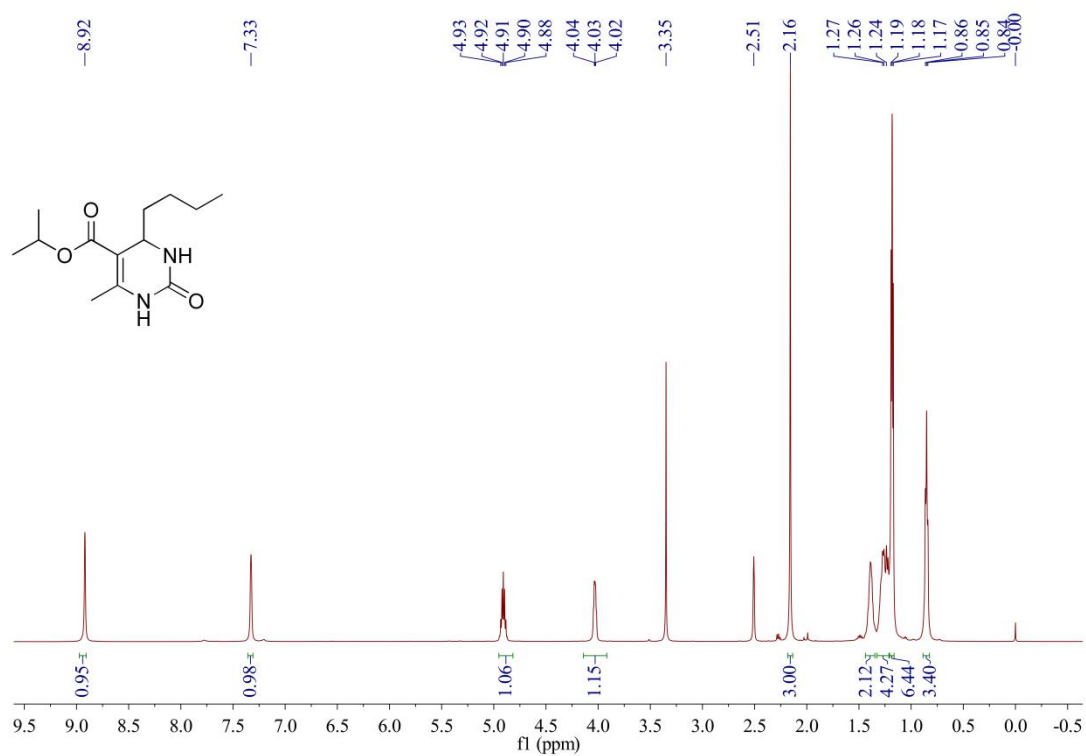
### <sup>1</sup>H NMR spectra of compound 4s



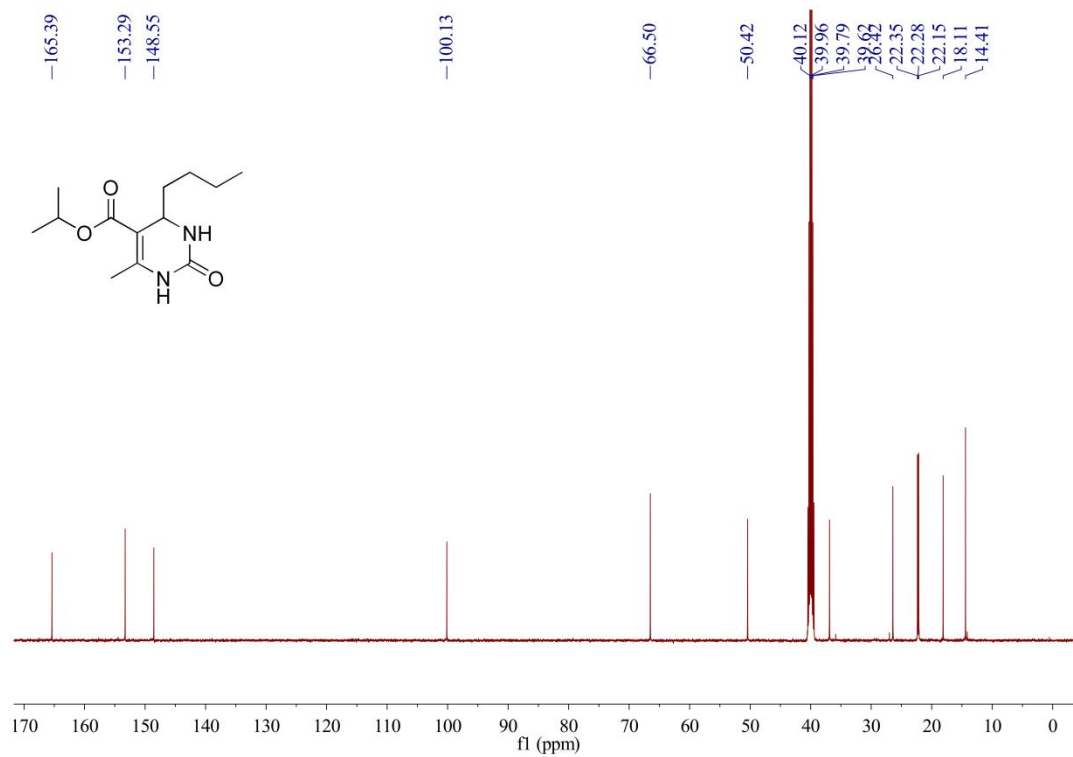
### <sup>13</sup>C NMR spectra of compound 4s



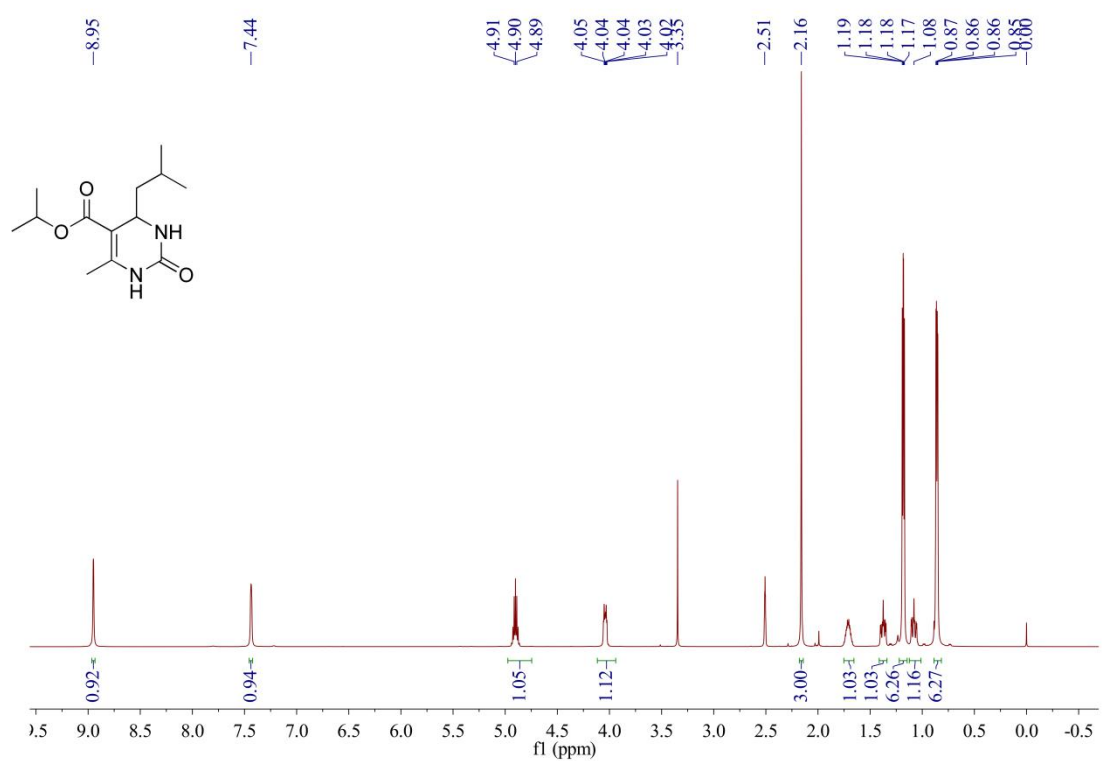
### <sup>1</sup>H NMR spectra of compound 4t



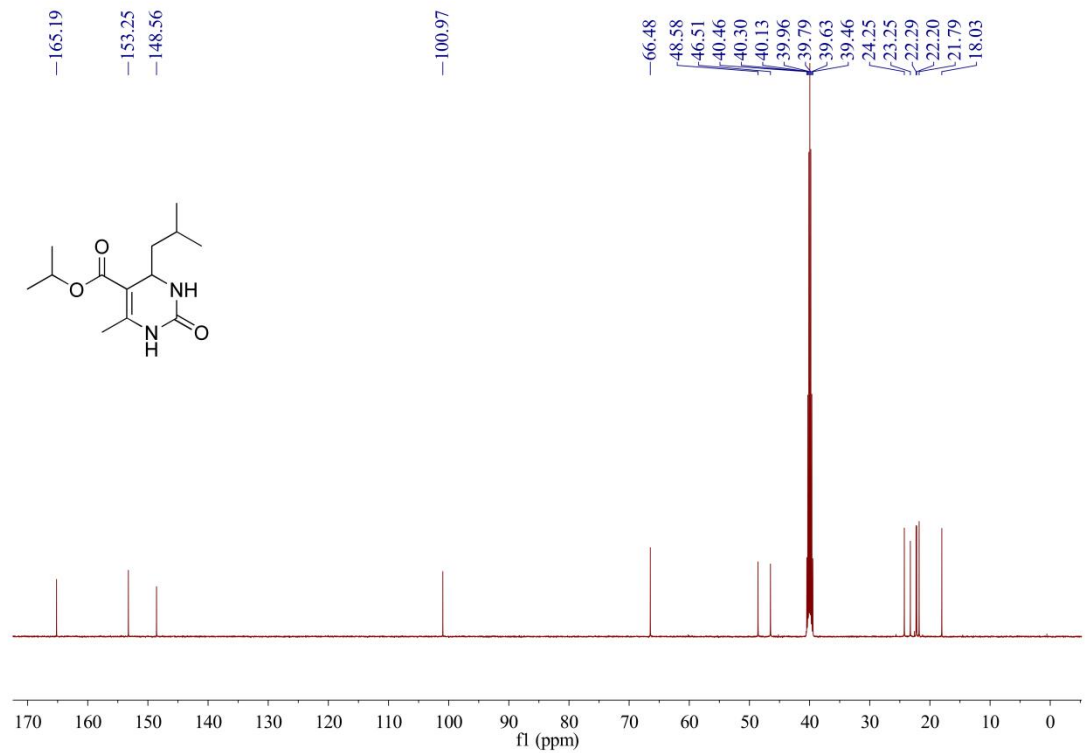
### <sup>13</sup>C NMR spectra of compound 4t



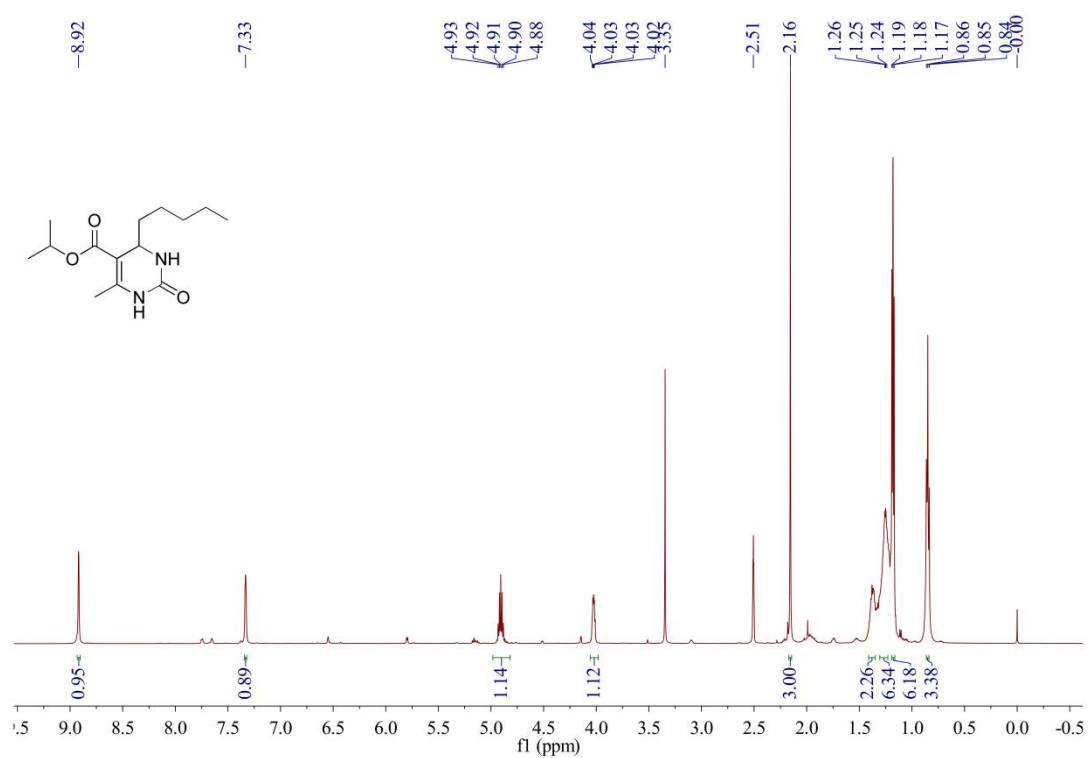
### <sup>1</sup>H NMR spectra of compound **4u**



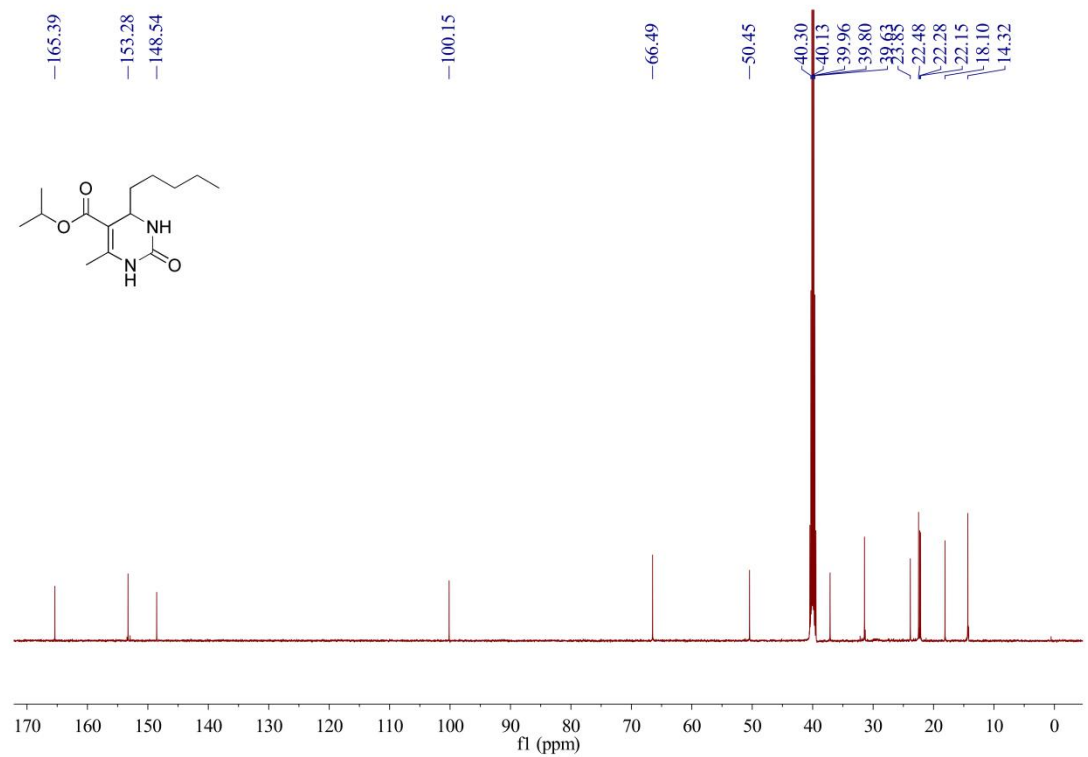
### <sup>13</sup>C NMR spectra of compound **4u**



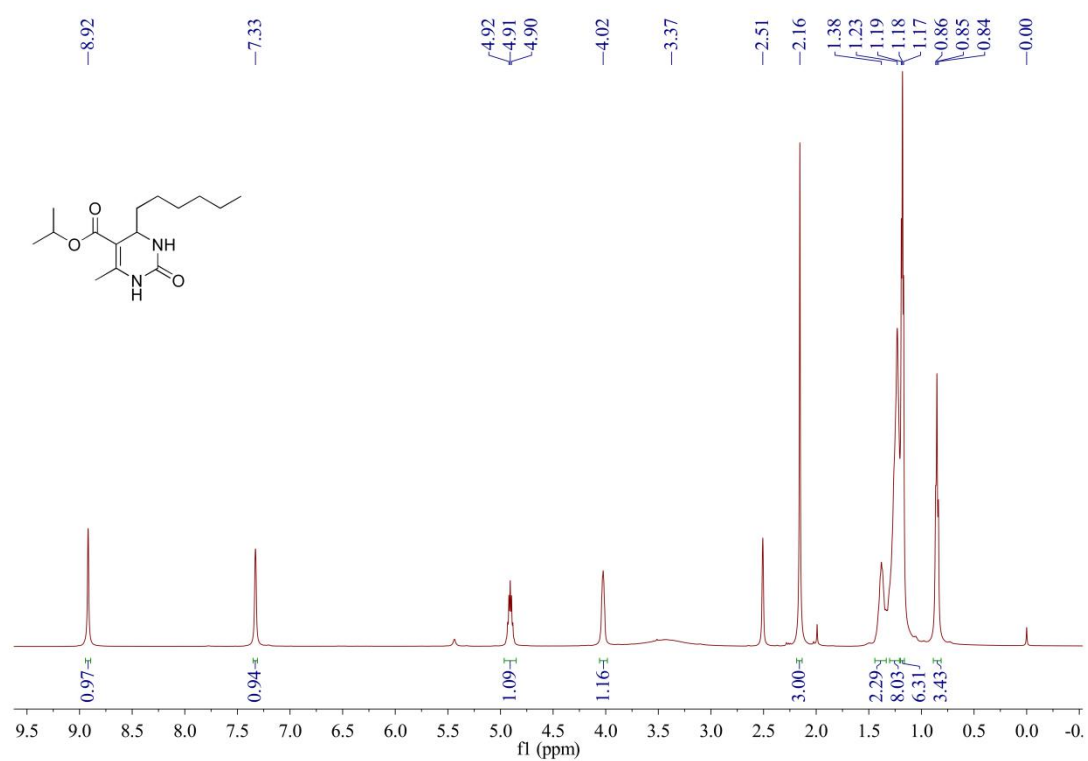
### <sup>1</sup>H NMR spectra of compound 4v



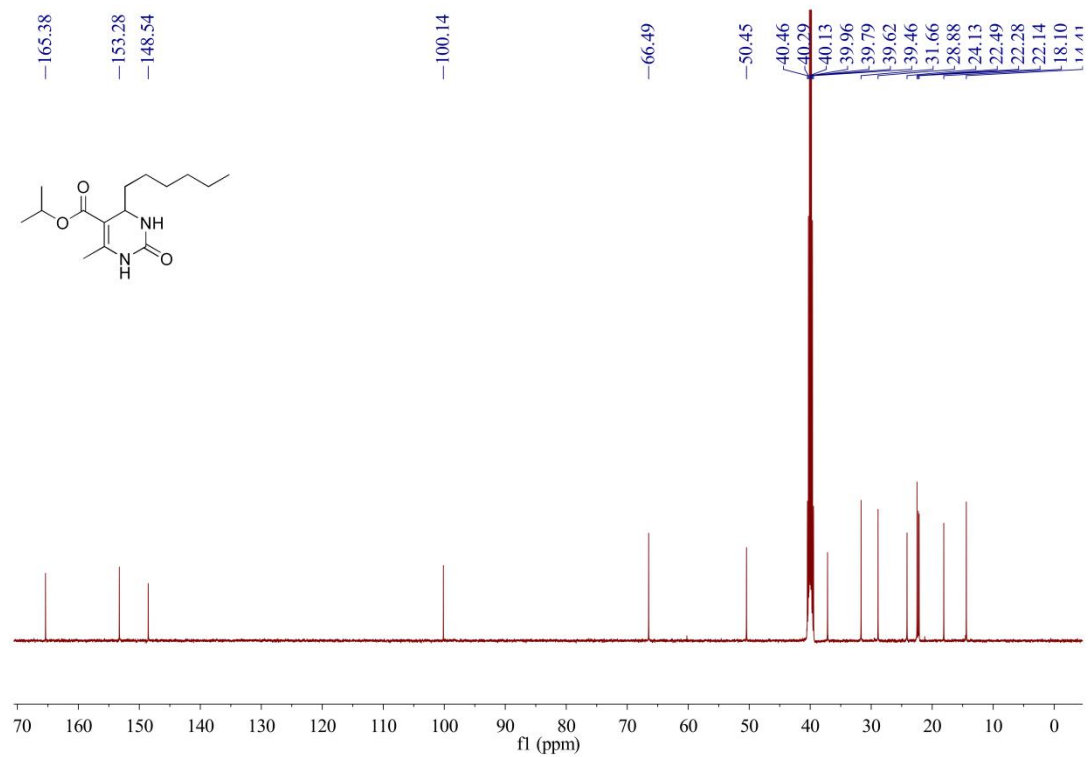
### <sup>13</sup>C NMR spectra of compound 4v



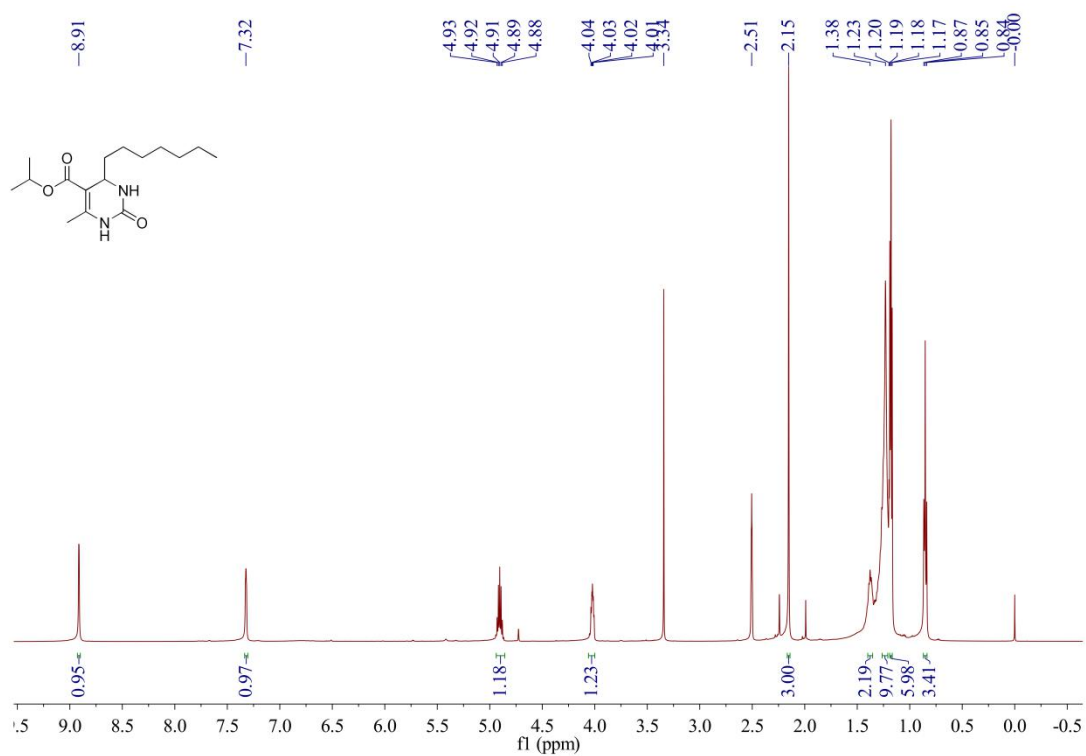
<sup>1</sup>H NMR spectra of compound **4w**



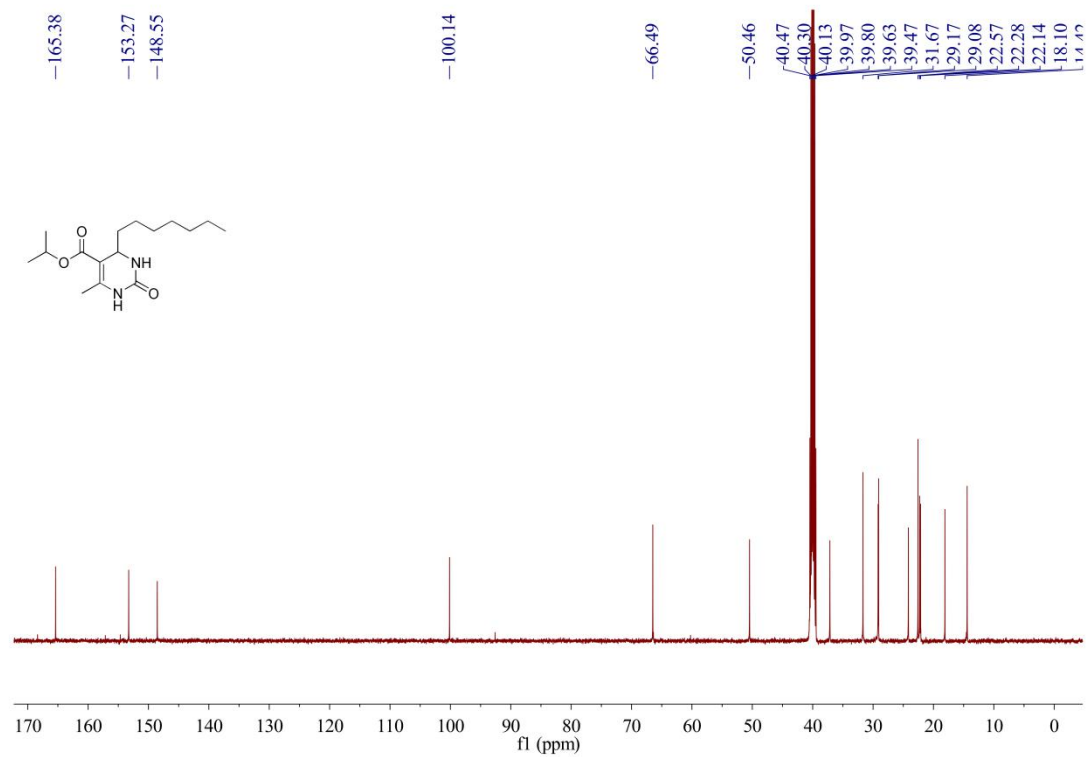
<sup>13</sup>C NMR spectra of compound **4w**



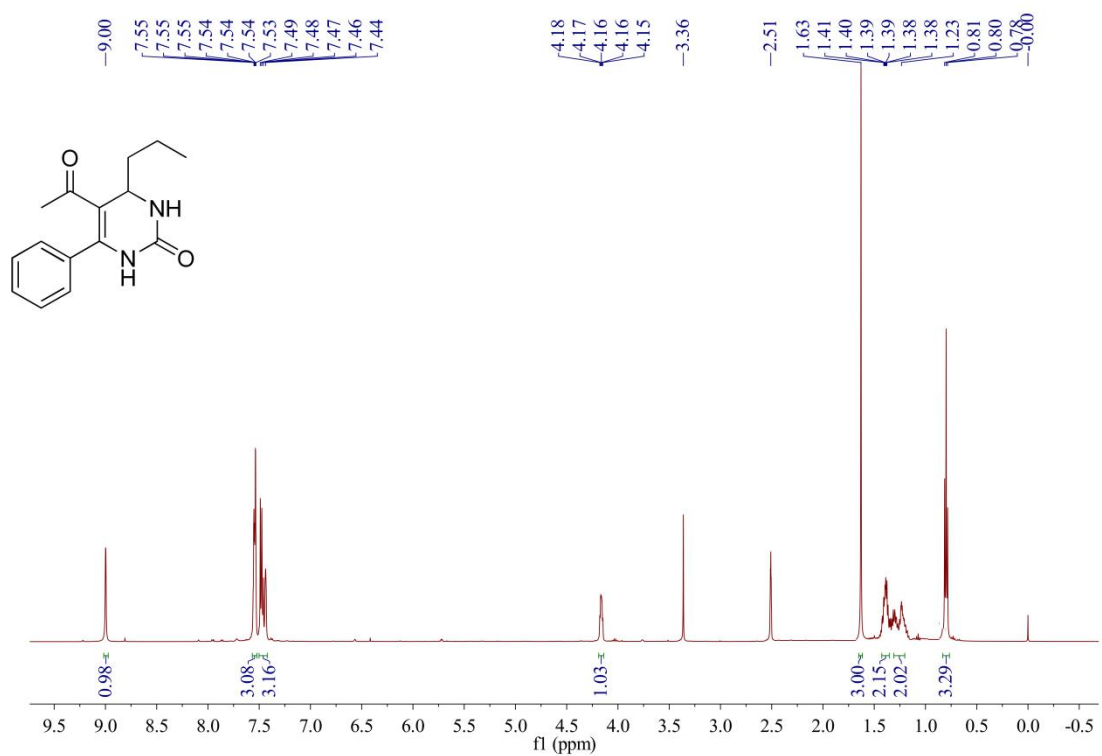
### <sup>1</sup>H NMR spectra of compound 4x



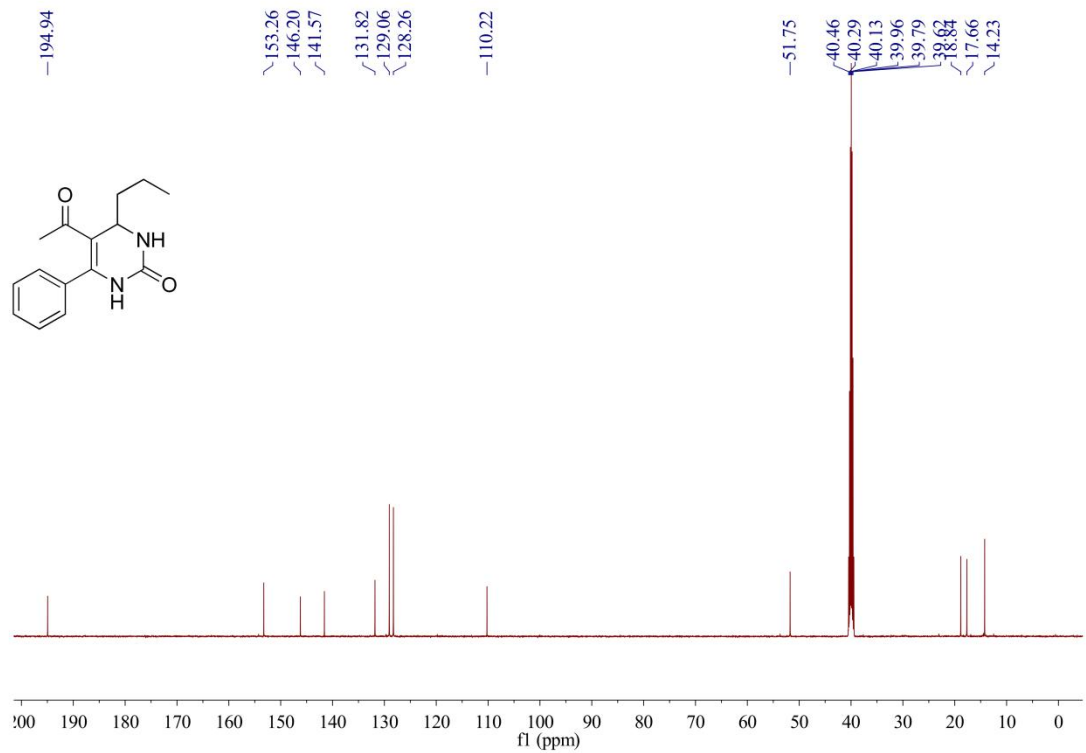
### <sup>13</sup>C NMR spectra of compound 4x



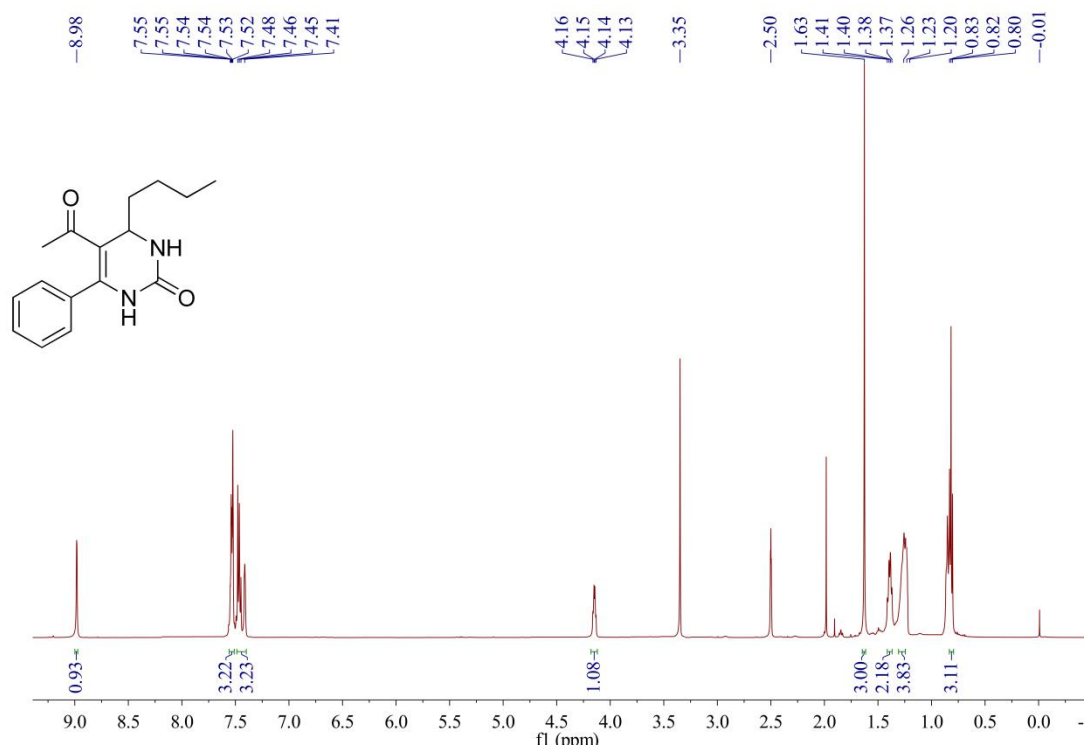
### <sup>1</sup>H NMR spectra of compound 4y



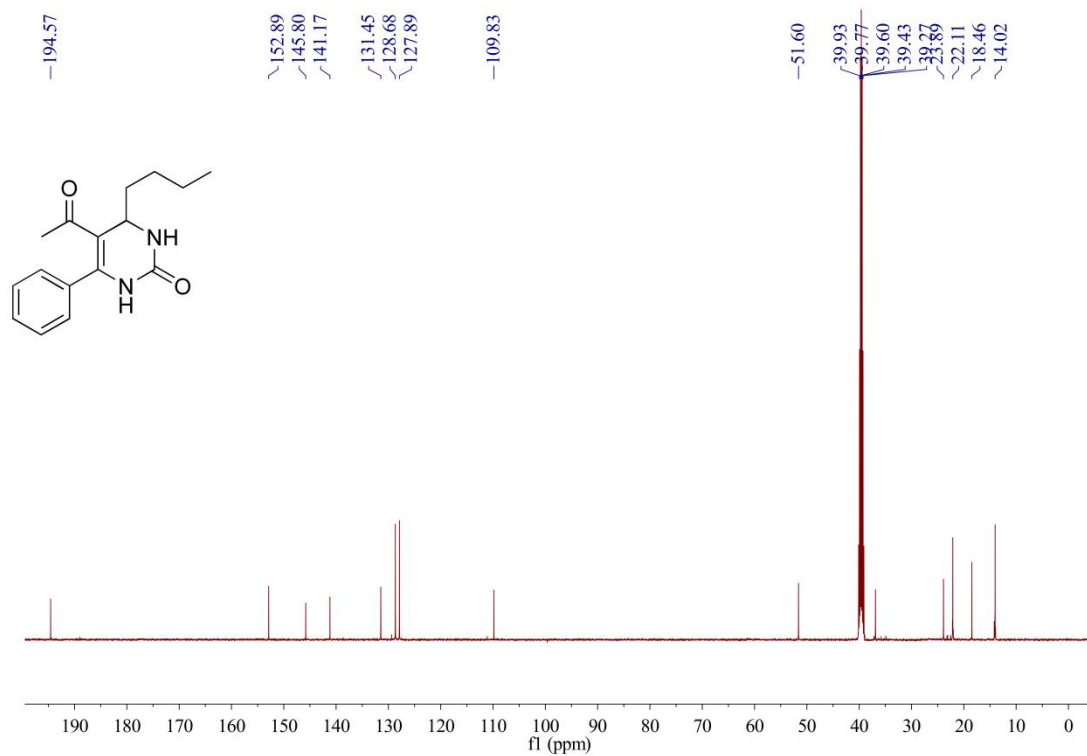
### <sup>13</sup>C NMR spectra of compound 4y



### $^1\text{H}$ NMR spectra of compound **4z**

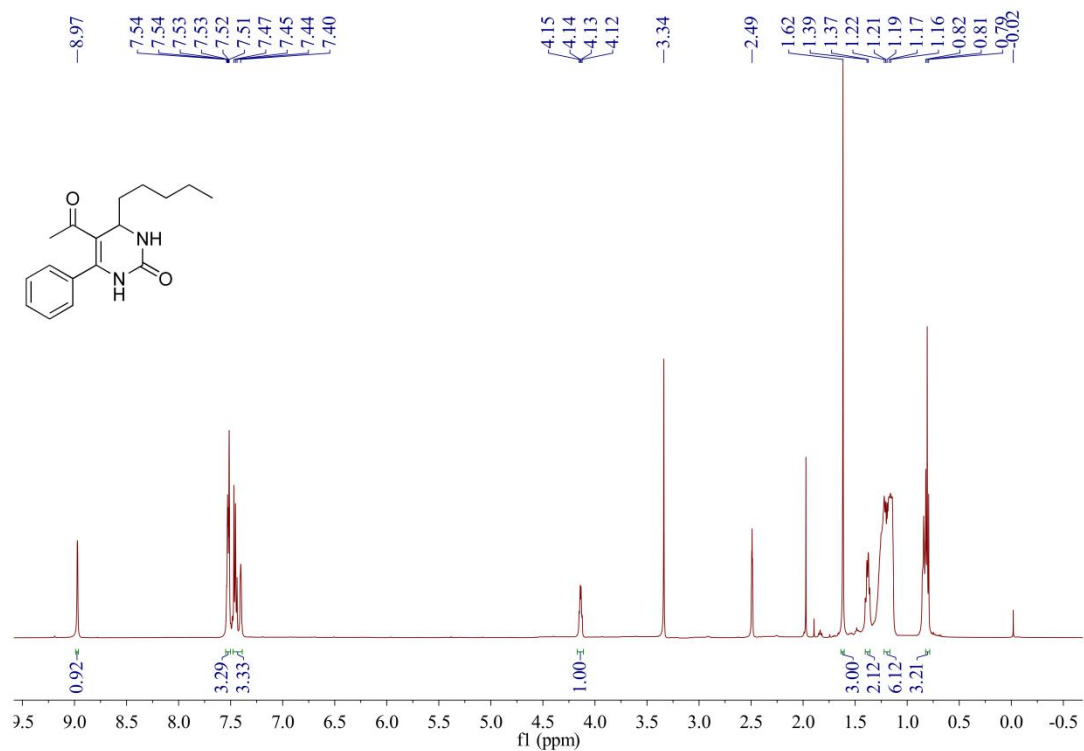


### $^{13}\text{C}$ NMR spectra of compound **4z**

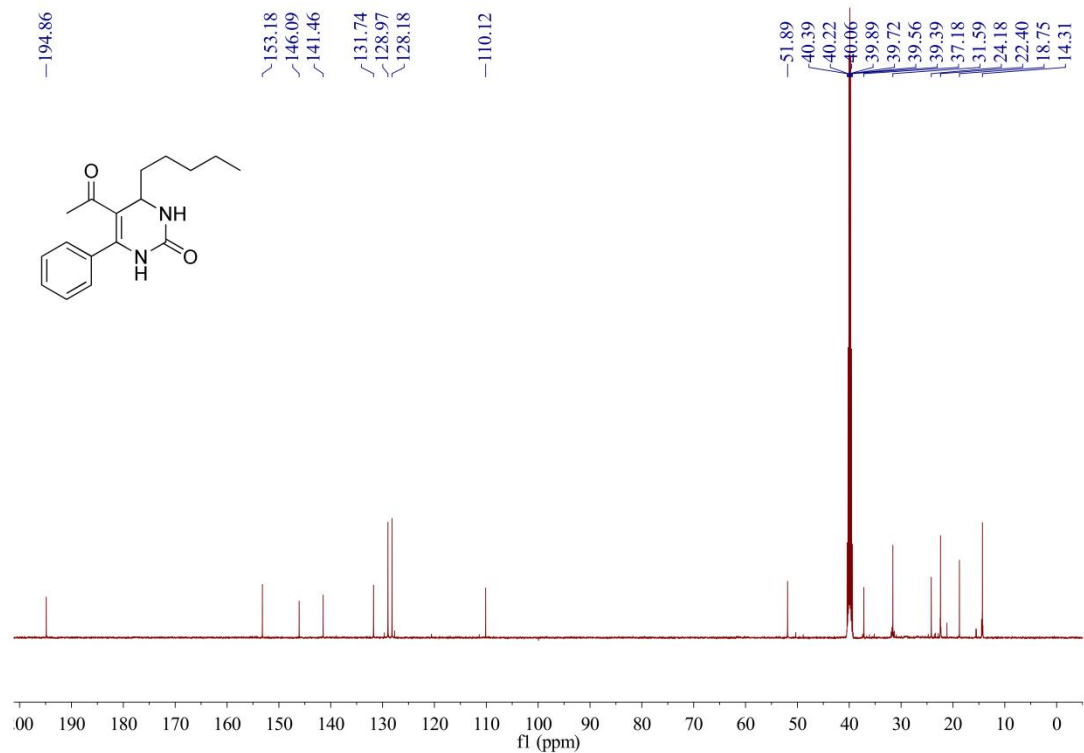




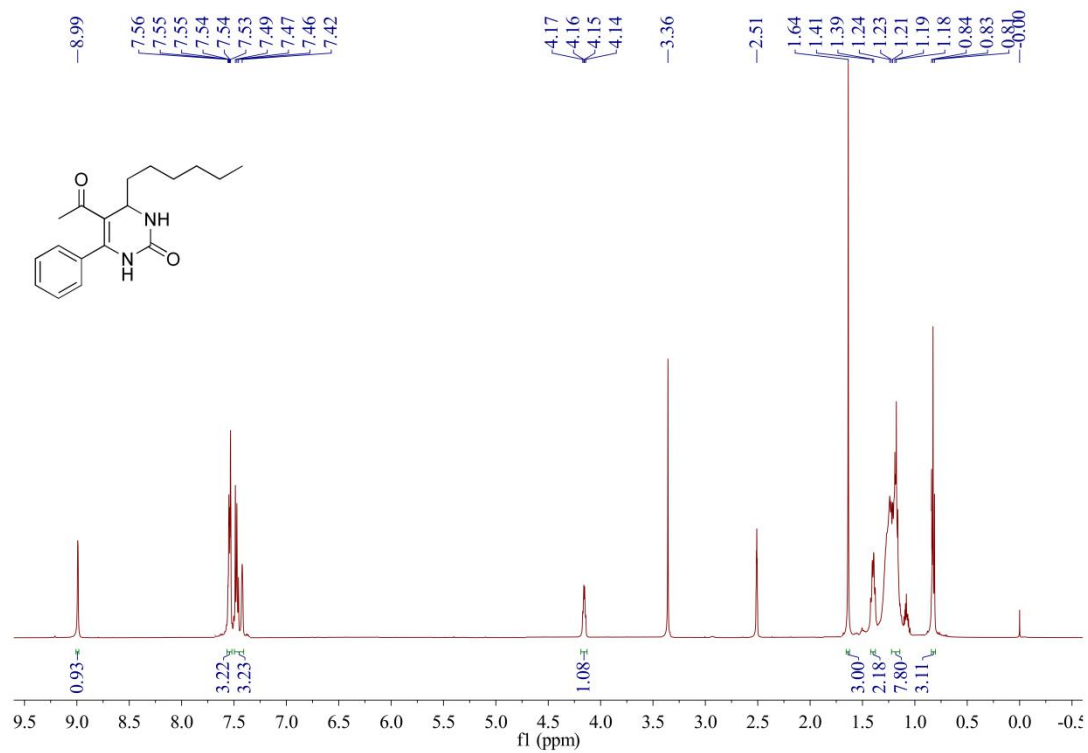
### $^1\text{H}$ NMR spectra of compound **4b<sub>1</sub>**



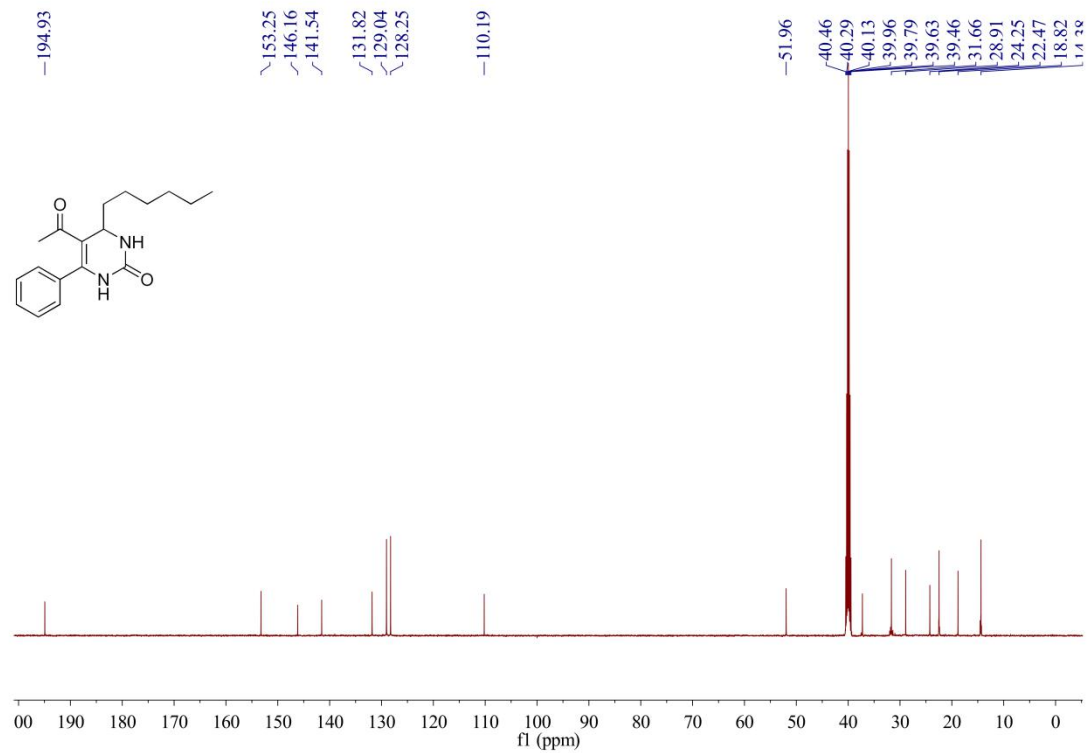
### $^{13}\text{C}$ NMR spectra of compound **4b<sub>1</sub>**



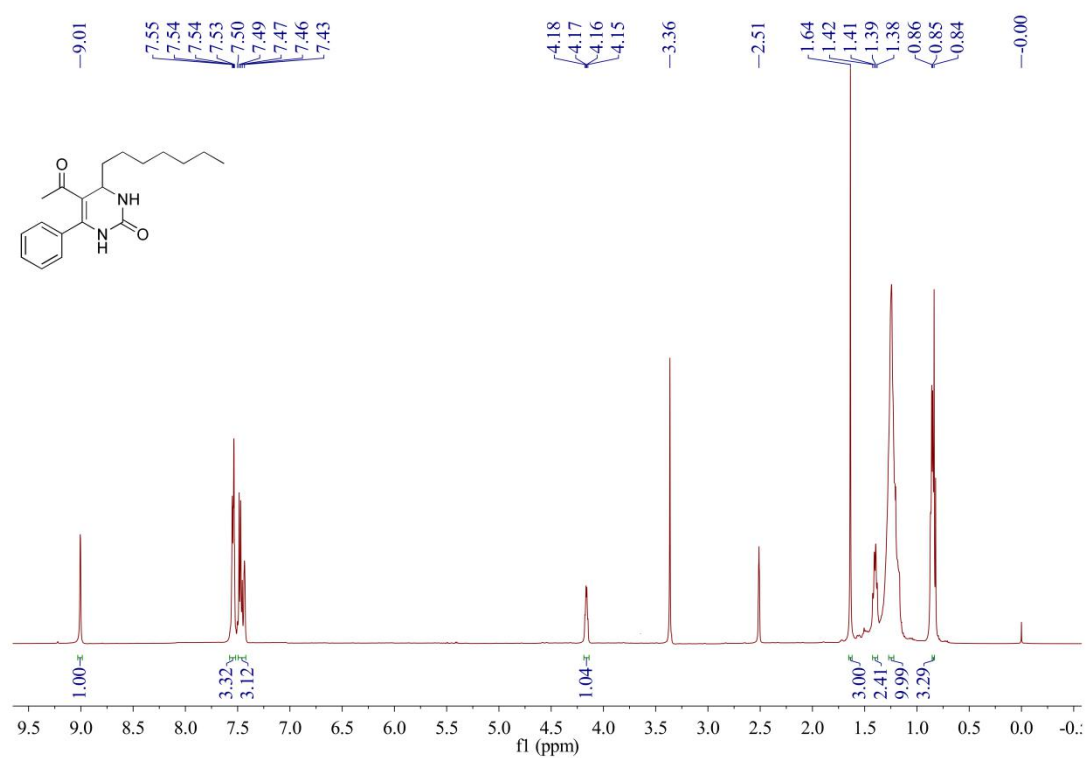
### $^1\text{H}$ NMR spectra of compound **4c<sub>1</sub>**



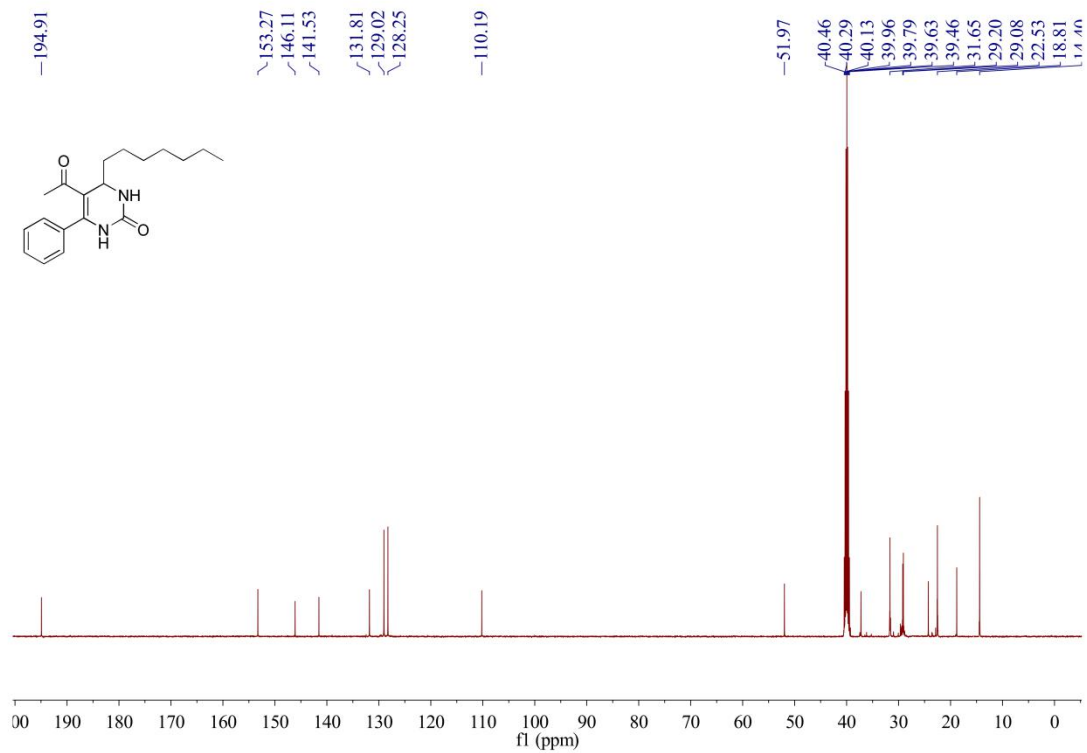
### $^{13}\text{C}$ NMR spectra of compound **4c<sub>1</sub>**



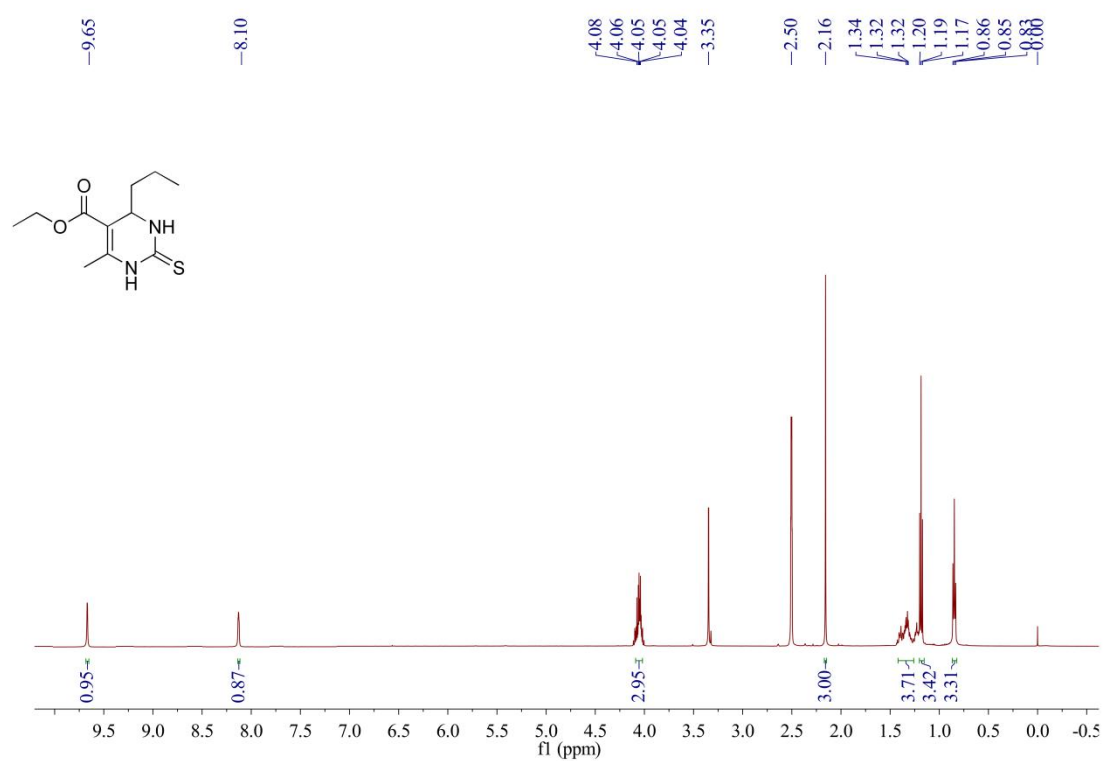
### $^1\text{H}$ NMR spectra of compound **4d<sub>1</sub>**



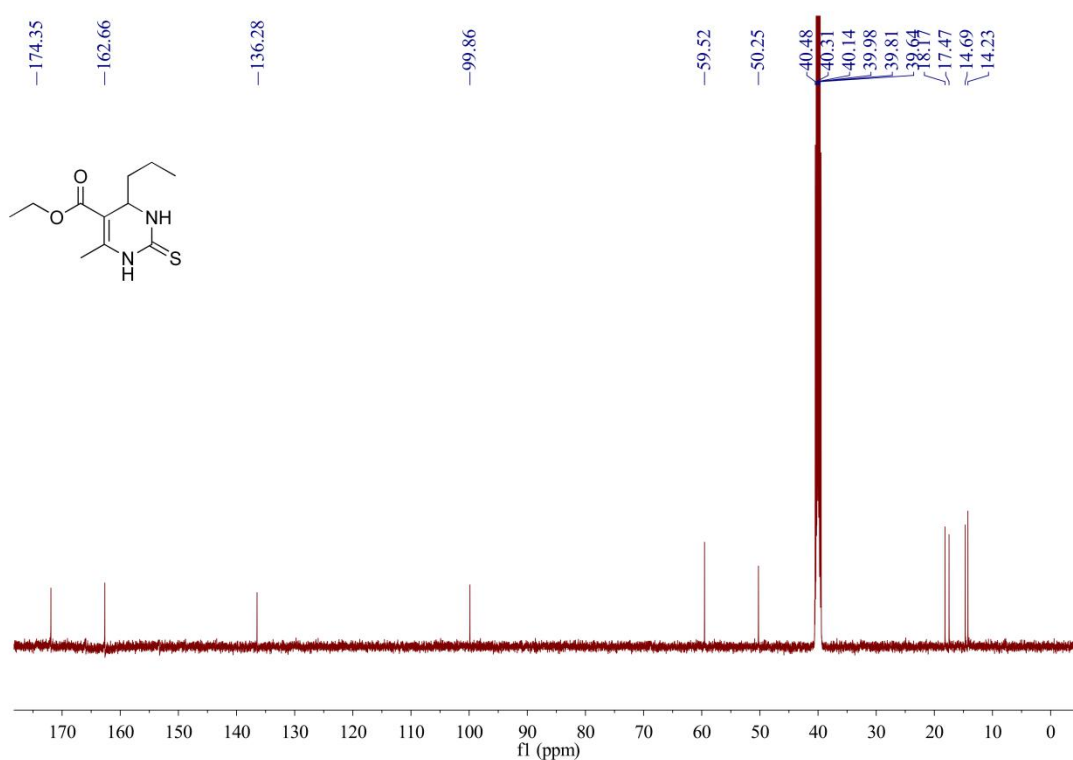
### $^{13}\text{C}$ NMR spectra of compound **4d<sub>1</sub>**



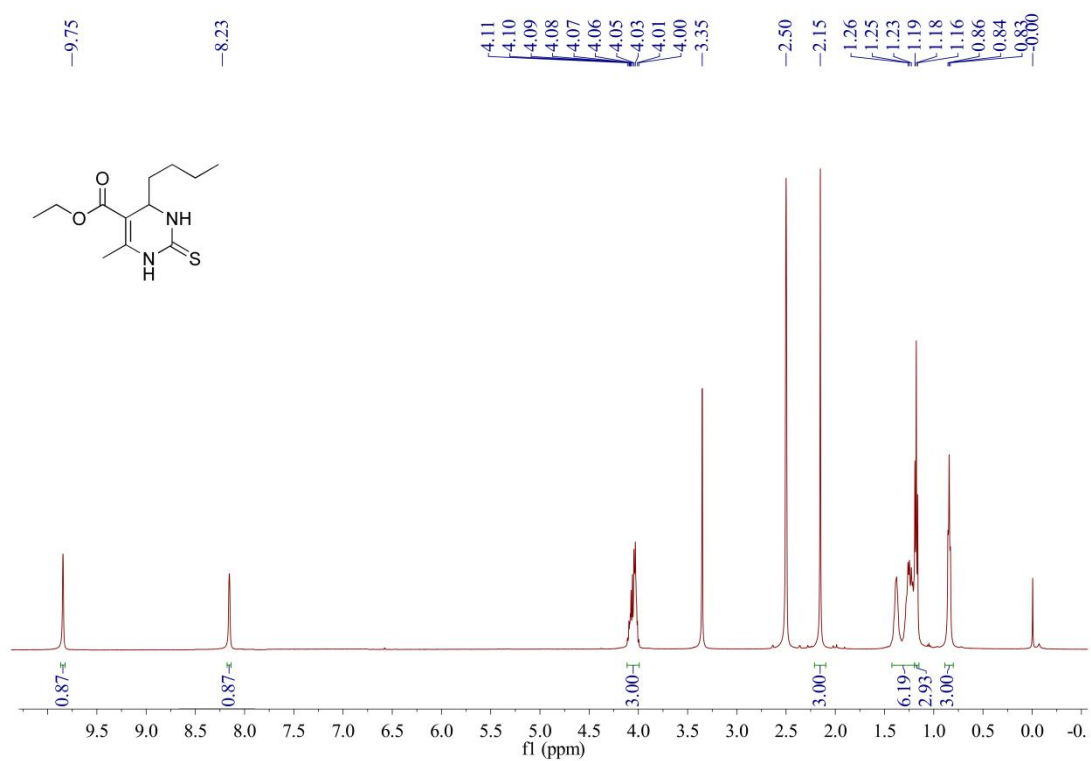
### $^1\text{H}$ NMR spectra of compound **4e<sub>1</sub>**



### $^{13}\text{C}$ NMR spectra of compound **4e<sub>1</sub>**



### $^1\text{H}$ NMR spectra of compound **4f<sub>1</sub>**



### $^{13}\text{C}$ NMR spectra of compound **4f<sub>1</sub>**

