

Supplementary Materials: Synthesis and Antimicrobial Characterization of Half-Calycanthaceous Alkaloid Derivatives

Shaojun Zheng, Xiping Zhou, Shixun Xu, Rui Zhu, Hongjin Bai and Jiwen Zhang

1. Spectroscopic Data

1-(3a,8-Dibenzyl-3,3a,8,8a-tetrahydropyrrolo[2,3-b]indol-1(2H)-yl)ethan-1-one (a1): Reagents: acetic anhydride. Orange oily liquid, $[\alpha]_D^{25} = -10.228$, petroleum ether:ethyl acetate = 3:1, 96% Yield, $^1\text{H-NMR}$ (CDCl_3 , 500 MHz), δ 7.21–7.16 (m, 6H), 7.06–7.04 (m, 2H), 7.02–6.99 (m, 1H), 6.93–6.89 (m, 3H), 6.67–6.64 (m, 1H), 6.18 (d, 1H, $J = 10.00$ Hz), 5.77 (s, 1H), 4.64, 4.52 (Abq, 2H, $J = 15.00$ Hz), 3.47–3.43 (m, 1H), 3.28–3.21 (m, 1H), 3.04, 2.87 (Abq, 2H, $J = 15.00$ Hz), 2.21–2.17 (m, 2H), 1.92 (s, 3H). $^{13}\text{C-NMR}$ (CDCl_3 , 125 MHz), δ 169.85 (C), 150.44 (C), 139.32 (C), 137.07 (C), 131.70 (C), 130.12 (CH \times 2), 128.56 (CH), 128.25 (CH \times 2), 128.08 (CH \times 2), 126.93 (CH \times 2), 126.58 (CH), 126.51 (CH), 123.11 (CH), 117.11 (CH), 106.52 (CH), 82.62 (CH), 56.51 (C), 49.96 (CH₂), 47.16 (CH₂), 44.47 (CH₂), 37.31 (CH₂), 22.71 (CH₃). ESI-MS: $[\text{M} + \text{Na}]^+$ Found 382.20.

1-(3a,8-Dibenzyl-3,3a,8,8a-tetrahydropyrrolo[2,3-b]indol-1(2H)-yl)propan-1-one (a2): Reagents: propionic anhydride. Orange oily liquid, $[\alpha]_D^{25} = -13.530$, petroleum ether:ethyl acetate = 4:1, 91% Yield, $^1\text{H-NMR}$ (CDCl_3 , 500 MHz), δ 7.21–7.16 (m, 6H), 7.08–7.04 (m, 2H), 7.02–6.99 (m, 1H), 6.93–6.91 (m, 2H), 6.88–6.87 (m, 1H), 6.66–6.63 (m, 1H), 6.20 (d, 1H, $J = 5.00$ Hz), 5.79 (s, 1H), 4.61, 4.54 (Abq, 2H, $J = 20.00$ Hz), 3.50–3.46 (m, 1H), 3.28–3.17 (m, 1H), 3.03, 2.85 (Abq, 2H, $J = 15.00$ Hz), 2.20–2.04 (m, 4H), 1.03 (s, 3H). $^{13}\text{C-NMR}$ (CDCl_3 , 125 MHz), δ 173.02 (C), 150.51 (C), 139.46 (C), 137.12 (C), 131.78 (C), 130.14 (CH \times 2), 128.54 (CH), 128.21 (CH \times 2), 128.04 (CH \times 2), 127.00 (CH \times 2), 126.55 (CH), 126.50 (CH), 123.18 (CH), 117.04 (CH), 106.51 (CH), 82.91 (CH), 56.29 (C), 50.12 (CH₂), 46.18 (CH₂), 44.55 (CH₂), 37.34 (CH₂), 27.98 (CH₂), 8.94 (CH₃). ESI-MS: $[\text{M} + \text{Na}]^+$ Found 396.22.

1-(3a,8-Dibenzyl-3,3a,8,8a-tetrahydropyrrolo[2,3-b]indol-1(2H)-yl)butan-1-one (a3): Reagents: butyric anhydride. Yellow oily liquid, $[\alpha]_D^{25} = 14.129$, petroleum ether:ethyl acetate = 3:1, 86% Yield, $^1\text{H-NMR}$ (CDCl_3 , 500 MHz), δ 7.21–7.14 (m, 6H), 7.07–7.05 (m, 2H), 7.01–6.98 (m, 1H), 6.93–6.91 (m, 2H), 6.89–6.87 (m, 1H), 6.66–6.63 (m, 1H), 6.17 (d, 1H, $J = 10.00$ Hz), 5.81 (s, 1H), 4.59, 4.53 (Abq, 2H, $J = 15.00$ Hz), 3.53–3.49 (m, 1H), 3.25–3.18 (m, 1H), 3.05, 2.86 (Abq, 2H, $J = 15.00$ Hz), 2.21–2.06 (m, 4H), 1.59–1.51 (m, 2H), 0.88 (s, 3H). $^{13}\text{C-NMR}$ (CDCl_3 , 125 MHz), δ 172.33 (C), 150.56 (C), 139.39 (C), 137.13 (C), 131.75 (C), 130.12 (CH \times 2), 128.53 (CH), 128.21 (CH \times 2), 128.04 (CH \times 2), 126.94 (CH \times 2), 126.55 (CH), 126.47 (CH), 123.19 (CH), 117.06 (CH), 106.49 (CH), 82.87 (CH), 56.32 (C), 50.14 (CH₂), 46.35 (CH₂), 44.62 (CH₂), 37.48 (CH₂), 36.77 (CH₂), 18.20 (CH₂), 13.88 (CH₃). ESI-MS: $[\text{M} + \text{Na}]^+$ Found 410.24.

1-(3a,8-Dibenzyl-3,3a,8,8a-tetrahydropyrrolo[2,3-b]indol-1(2H)-yl)-2-methylpropan-1-one (a4): Reagents: isobutyric anhydride. Orange oily liquid, $[\alpha]_D^{25} = -12.220$, mp 118–120 °C, petroleum ether:ethyl acetate = 3:1, 92% Yield, $^1\text{H-NMR}$ (CDCl_3 , 500 MHz), δ 7.20–7.14 (m, 6H), 7.06–7.05 (m, 2H), 7.01–6.98 (m, 1H), 6.94–6.92 (m, 2H), 6.89–6.87 (m, 1H), 6.66–6.63 (m, 1H), 6.15 (d, 1H, $J = 5.00$ Hz), 5.84 (s, 1H), 4.55, 4.48 (Abq, 2H, $J = 15.00$ Hz), 3.63–3.59 (m, 1H), 3.28–3.22 (m, 1H), 3.07, 2.87 (Abq, 2H, $J = 15.00$ Hz), 2.55–2.49 (m, 1H), 2.25–2.15 (m, 2H), 1.03, 0.95 (dd, 6H, $J = 5.00$ Hz). $^{13}\text{C-NMR}$ (CDCl_3 , 125 MHz), δ 176.14 (C), 150.75 (C), 139.50 (C), 137.18 (C), 131.69 (C), 130.08 (CH \times 2), 128.52 (CH), 128.17 (CH \times 2), 128.00 (CH \times 2), 126.88 (CH \times 2), 126.54 (CH), 126.43 (CH), 123.25 (CH), 117.01 (CH), 106.39 (CH), 83.18 (CH), 56.27 (C), 50.32 (CH₂), 46.04 (CH₂), 44.86 (CH₂), 37.84 (CH₂), 32.18 (CH), 19.11 (CH₃), 18.64 (CH₃). ESI-MS: $[\text{M} + \text{Na}]^+$ Found 410.24.

1-(3a,8-Dibenzyl-3,3a,8,8a-tetrahydropyrrolo[2,3-b]indol-1(2H)-yl)pentan-1-one (a5): Reagents: valeric acid. Colorless oil, $[\alpha]_D^{25} = -16.539$, petroleum ether:ethyl acetate = 4:1, 87% Yield, $^1\text{H-NMR}$ (CDCl_3 , 500 MHz), δ 7.21–7.15 (m, 6H), 7.07–7.06 (m, 2H), 7.01–6.98 (m, 1H), 6.93–6.91 (m, 2H), 6.89–6.87 (m, 1H), 6.66–6.63 (m, 1H), 6.18 (d, 1H, $J = 5.00$ Hz), 5.81 (s, 1H), 4.58, 4.53 (Abq, 2H, $J = 15.00$ Hz), 3.52–3.48 (m, 1H), 3.24–3.18 (m, 1H), 3.05, 2.86 (Abq, 2H, $J = 15.00$ Hz), 2.23–2.06 (m, 4H), 1.52–1.46 (m, 2H), 1.23–1.30 (m,

2H), 0.88 (s, 3H). ¹³C-NMR (CDCl₃, 125 MHz), δ 172.47 (C), 150.58 (C), 139.43 (C), 137.14 (C), 131.76 (C), 130.13 (CH × 2), 128.53 (CH), 128.21 (CH × 2), 128.04 (CH × 2), 126.94 (CH × 2), 126.55 (CH), 126.47 (CH), 123.18 (CH), 117.03 (CH), 106.46 (CH), 82.90 (CH), 56.32 (C), 50.14 (CH₂), 46.36 (CH₂), 44.62 (CH₂), 37.49 (CH₂), 34.60 (CH₂), 26.92 (CH₂), 22.46 (CH₂), 13.88 (CH₃). ESI-MS: [M + Na]⁺ Found 424.25.

1-(3a,8-Dibenzyl-3,3a,8,8a-tetrahydropyrrolo[2,3-b]indol-1(2H)-yl)hexan-1-one (a6): Reagents: caproic acid. Yellow oily liquid, [α]_D²⁰ = −14.338, petroleum ether:ethyl acetate = 3:1, 86% Yield, ¹H-NMR (CDCl₃, 500 MHz), δ 7.19–7.15 (m, 6H), 7.07–7.06 (m, 2H), 7.01–6.98 (m, 1H), 6.93–6.92 (m, 2H), 6.89–6.87 (m, 1H), 6.66–6.63 (m, 1H), 6.18 (d, 1H, J = 5.00 Hz), 5.81 (s, 1H), 4.58, 4.53 (Abq, 2H, J = 15.00 Hz), 3.52–3.48 (m, 1H), 3.24–3.18 (m, 1H), 3.05, 2.86 (Abq, 2H, J = 15.00 Hz), 2.19–2.05 (m, 4H), 1.54–1.48 (m, 2H), 1.30–1.22 (m, 4H), 0.86 (s, 3H). ¹³C-NMR (CDCl₃, 125 MHz), δ 172.49 (C), 150.60 (C), 139.46 (C), 137.16 (C), 131.78 (C), 130.13 (CH × 2), 128.54 (CH), 128.21 (CH × 2), 128.05 (CH × 2), 126.95 (CH × 2), 126.56 (CH), 126.48 (CH), 123.18 (CH), 117.04 (CH), 106.48 (CH), 82.94 (CH), 56.32 (C), 50.18 (CH₂), 46.35 (CH₂), 44.63 (CH₂), 37.52 (CH₂), 34.87 (CH₂), 31.56 (CH₂), 24.50 (CH₂), 22.45 (CH₂), 13.95 (CH₃). ESI-MS: [M + Na]⁺ Found 438.27.

1-(3a,8-Dibenzyl-3,3a,8,8a-tetrahydropyrrolo[2,3-b]indol-1(2H)-yl)heptan-1-one (a7): Reagents: heptanoic acid. Orange oily liquid, [α]_D²⁰ = −10.441, petroleum ether:ethyl acetate = 3:1, 87% Yield, ¹H-NMR (CDCl₃, 500 MHz), δ 7.19–7.15 (m, 6H), 7.07–7.05 (m, 2H), 7.01–6.98 (m, 1H), 6.93–6.92 (m, 2H), 6.89–6.87 (m, 1H), 6.65–6.63 (m, 1H), 6.17 (d, 1H, J = 10.00 Hz), 5.81 (s, 1H), 4.58, 4.53 (Abq, 2H, J = 15.00 Hz), 3.52–3.48 (m, 1H), 3.24–3.18 (m, 1H), 3.05, 2.86 (Abq, 2H, J = 15.00 Hz), 2.20–2.06 (m, 4H), 1.51–1.47 (m, 2H), 1.26–1.24 (m, 6H), 0.86 (s, 3H). ¹³C-NMR (CDCl₃, 125 MHz), δ 172.56 (C), 150.60 (C), 139.44 (C), 137.15 (C), 131.76 (C), 130.13 (CH × 2), 128.54 (CH), 128.21 (CH × 2), 128.05 (CH × 2), 126.95 (CH × 2), 126.56 (CH), 126.48 (CH), 123.18 (CH), 117.04 (CH), 106.48 (CH), 82.93 (CH), 56.33 (C), 50.16 (CH₂), 46.37 (CH₂), 44.63 (CH₂), 37.52 (CH₂), 34.92 (CH₂), 31.59 (CH₂), 29.04 (CH₂), 24.78 (CH₂), 22.50 (CH₂), 14.04 (CH₃). ESI-MS: [M + Na]⁺ Found 452.28.

1-(3a,8-Dibenzyl-3,3a,8,8a-tetrahydropyrrolo[2,3-b]indol-1(2H)-yl)octan-1-one (a8): Reagents: octanoic acid. Yellow oily liquid, [α]_D²⁰ = −15.900, petroleum ether:ethyl acetate = 3:1, 85% Yield, ¹H-NMR (CDCl₃, 500 MHz), δ 7.19–7.15 (m, 6H), 7.07–7.05 (m, 2H), 7.01–6.98 (m, 1H), 6.93–6.92 (m, 2H), 6.89–6.87 (m, 1H), 6.65–6.62 (m, 1H), 6.17 (d, 1H, J = 10.00 Hz), 5.81 (s, 1H), 4.58, 4.53 (Abq, 2H, J = 15.00 Hz), 3.52–3.48 (m, 1H), 3.24–3.18 (m, 1H), 3.05, 2.86 (Abq, 2H, J = 15.00 Hz), 2.20–2.04 (m, 4H), 1.51–1.48 (m, 2H), 1.26–1.24 (m, 8H), 0.87 (s, 3H). ¹³C-NMR (CDCl₃, 125 MHz), δ 172.56 (C), 150.59 (C), 139.44 (C), 137.15 (C), 131.76 (C), 130.13 (CH × 2), 128.54 (CH), 128.21 (CH × 2), 128.05 (CH × 2), 126.95 (CH × 2), 126.56 (CH), 126.48 (CH), 123.18 (CH), 117.04 (CH), 106.48 (CH), 82.92 (CH), 56.33 (C), 50.15 (CH₂), 46.38 (CH₂), 44.63 (CH₂), 37.51 (CH₂), 34.92 (CH₂), 29.33 (CH₂), 28.92 (CH₂), 24.82 (CH₂), 22.62 (CH₂), 14.08 (CH₃). ESI-MS: [M + Na]⁺ Found 466.30.

(3a,8-Dibenzyl-3,3a,8,8a-tetrahydropyrrolo[2,3-b]indol-1(2H)-yl)(phenyl)methanone (a9): Reagents: benzoic acid. Yellow oily liquid, [α]_D²⁰ = −10.441, mp 152–154 °C, petroleum ether:ethyl acetate = 3:1, 81% Yield, ¹H-NMR (CDCl₃, 500 MHz), δ 7.40–7.38 (m, 3H), 7.35–7.32 (m, 2H), 7.23–7.16 (m, 6H), 7.05–7.02 (m, 3H), 6.96–6.94 (m, 2H), 6.89–6.88 (m, 1H), 6.69–6.66 (m, 1H), 6.20 (d, 1H, J = 5.00 Hz), 6.08 (s, 1H), 4.68, 4.49 (Abq, 2H, J = 15.00 Hz), 3.55–3.51 (m, 1H), 3.38–3.32 (m, 1H), 3.14, 2.93 (Abq, 2H, J = 10.00 Hz), 2.19–2.08 (m, 2H). ¹³C-NMR (CDCl₃, 125 MHz), δ 170.49 (C), 150.83 (C), 139.19 (C), 137.18 (C), 136.09 (C), 131.24 (C), 130.29 (CH), 130.12 (CH × 2), 128.63 (CH), 128.30 (CH × 2), 128.15 (CH × 2), 128.05 (CH × 2), 127.50 (CH × 2), 126.80 (CH × 2), 126.56 (CH), 126.53 (CH), 123.47 (CH), 117.11 (CH), 106.29 (CH), 82.63 (CH), 56.64 (C), 49.48 (CH₂), 44.96 (CH₂), 37.97 (CH₂), 25.61 (CH₂). ESI-MS: [M + Na]⁺ Found 444.22.

1-(3a,8-Dibenzyl-3,3a,8,8a-tetrahydropyrrolo[2,3-b]indol-1(2H)-yl)-2-phenylethan-1-one (a10): Reagents: phenyl acetic acid. Yellow oily liquid, petroleum ether:ethyl acetate = 5:1, 80% Yield, [α]_D²⁰ = −3.093, ¹H-NMR (CDCl₃, 500 MHz), δ 7.30–7.26 (m, 1H), 7.24–7.17 (m, 8H), 7.09–7.05 (m, 4H), 7.01–6.98 (m, 1H), 6.93–6.91 (m, 2H), 6.89–6.87 (m, 1H), 6.66–6.63 (m, 1H), 6.17 (d, 1H, J = 5.00 Hz), 5.85 (s, 1H), 4.56 (s, 2H), 3.57–3.49 (m, 3H), 3.19–3.13 (m, 1H), 3.04, 2.85 (Abq, 2H, J = 10.00 Hz), 2.18–2.07 (m, 2H). ¹³C-NMR (CDCl₃, 125 MHz), δ 170.17 (C), 150.58 (C), 139.35 (C), 137.05 (C), 134.59 (C), 131.75 (C), 130.14 (CH × 2), 128.77 (CH × 2), 128.63 (CH × 2), 128.56 (CH), 128.25 (CH × 2), 128.08 (CH × 2), 126.95

(CH × 2), 126.71 (CH), 126.60 (CH), 126.50 (CH), 123.15 (CH), 117.16 (CH), 106.54 (CH), 83.22 (CH), 56.42 (C), 50.30 (CH₂), 46.62 (CH₂), 44.62 (CH₂), 37.46 (CH₂), 25.61 (CH₂). ESI-MS: [M + Na]⁺ Found 458.24.

1-(3a,8-Dibenzyl-3,3a,8,8a-tetrahydropyrrolo[2,3-b]indol-1(2H)-yl)-3-phenylpropan-1-one (a11): Reagents: benzene propanoic acid. Orange oily liquid, $[\alpha]_D^{25} = -7.622$, petroleum ether:ethyl acetate = 3:1, 88% Yield, ¹H-NMR (CDCl₃, 500 MHz), δ 7.23–7.14 (m, 11H), 7.08–7.07 (m, 2H), 7.02–6.99 (m, 1H), 6.92–6.91 (m, 2H), 6.87–6.85 (m, 1H), 6.65–6.62 (m, 1H), 6.20 (d, 1H, $J = 5.00$ Hz), 5.80 (s, 1H), 4.60, 4.51 (Abq, 2H, $J = 15.00$ Hz), 3.40–3.36 (m, 1H), 3.15–3.09 (m, 1H), 3.02 (m, 1H), 2.83 (m, 3H), 2.49–2.42 (m, 1H), 2.39–2.30 (m, 1H), 2.15–2.12 (m, 1H), 2.06–2.00 (m, 1H). ¹³C-NMR (CDCl₃, 125 MHz), δ 171.54 (C), 150.50 (C), 141.19 (C), 139.45 (C), 137.11 (C), 131.71 (C), 130.15 (CH × 2), 128.56 (CH), 128.48 (CH × 2), 128.39 (CH × 2), 128.25 (CH × 2), 128.07 (CH × 2), 126.99 (CH × 2), 126.58 (CH), 126.54 (CH), 126.11 (CH), 123.17 (CH), 117.11 (CH), 106.48 (CH), 83.85 (CH), 56.31 (C), 50.03 (CH₂), 46.35 (CH₂), 44.51 (CH₂), 37.28 (CH₂), 36.68 (CH₂), 31.07 (CH₂). ESI-MS: [M + Na]⁺ Found 472.25.

(3a,8-Dibenzyl-3,3a,8,8a-tetrahydropyrrolo[2,3-b]indol-1(2H)-yl)(4-fluorophenyl)methanone (a12): Reagents: *p*-fluorobenzoic acid. White powder, mp 146–148 °C, $[\alpha]_D^{25} = +70.611$, petroleum ether:ethyl acetate = 4:1, 85% Yield, ¹H-NMR (CDCl₃, 500 MHz), δ 7.40–7.37 (m, 2H), 7.48–7.45 (m, 2H), 7.23–7.15 (m, 6H), 7.17–7.14 (m, 2H), 7.05–7.00 (m, 5H), 6.95–6.94 (m, 2H), 6.89–6.87 (m, 1H), 6.06 (s, 1H), 4.65, 4.48 (Abq, 2H, $J = 15.00$ Hz), 3.52–3.46 (m, 1H), 3.37–3.32 (m, 1H), 3.12, 2.93 (Abq, 2H, $J = 15.00$ Hz), 2.20–2.09 (m, 2H). ¹³C-NMR (CDCl₃, 125 MHz), δ 169.43 (C), 163.79 (C) (¹ $J_{C-F} = 247.50$ Hz), 150.76 (C), 139.19 (C), 137.12 (C), 132.13 (C) (⁴ $J_{C-C-F} = 2.5$ Hz), 131.22 (C), 130.13 (CH × 2), 129.86 (CH × 2), (d, ³ $J_{C-C-F} = 8.75$ Hz), 128.70 (CH), 128.32 (CH × 2), 128.08 (CH × 2), 126.81 (CH × 2), 126.60 (CH × 2), 123.48 (CH), 117.23 (CH), 115.22 (CH × 2), (d, ² $J_{C-C-F} = 21.25$ Hz), 106.36 (CH), 82.75 (CH), 56.61 (C), 49.54 (CH₂), 49.54 (CH₂), 44.91 (CH₂), 37.90 (CH₂). ESI-MS: [M + Na]⁺ Found 462.21.

(3-Chlorophenyl)(3a,8-dibenzyl-3,3a,8,8a-tetrahydropyrrolo[2,3-b]indol-1(2H)-yl)methanone (a13): Reagents: *m*-chlorobenzoic acid. Yellow solid, mp 150–152 °C, $[\alpha]_D^{25} = -15.523$, petroleum ether:ethyl acetate = 3:1, 82% Yield, ¹H-NMR (CDCl₃, 500 MHz), δ 7.36–7.34 (m, 1H), 7.29–7.26 (m, 2H), 7.23–7.15 (m, 7H), 7.07–7.03 (m, 3H), 6.95–6.94 (m, 2H), 6.89–6.88 (m, 1H), 6.70–6.67 (m, 1H), 6.24 (d, 1H, $J = 20.00$ Hz), 6.04 (s, 1H), 4.65, 4.49 (Abq, 2H, $J = 15.00$ Hz), 3.48–3.44 (m, 1H), 3.35–3.30 (m, 1H), 3.14, 2.91 (Abq, 2H, $J = 15.00$ Hz), 2.20–2.09 (m, 2H). ¹³C-NMR (CDCl₃, 125 MHz), δ 168.84 (C), 150.73 (C), 139.21 (C), 137.82 (C), 137.06 (C), 134.26 (C), 131.16 (C), 130.32 (CH), 130.12 (CH × 2), 129.55 (CH), 128.74 (CH), 128.35 (CH × 2), 128.10 (CH × 2), 127.59 (CH), 126.81 (CH × 2), 126.66 (CH), 126.64 (CH), 125.51 (CH), 123.49 (CH), 117.28 (CH), 106.31 (CH), 82.76 (CH), 56.65 (C), 49.53 (CH₂), 49.33 (CH₂), 44.90 (CH₂), 37.91 (CH₂). ESI-MS: [M + Na]⁺ Found 478.18.

(4-Chlorophenyl)(3a,8-dibenzyl-3,3a,8,8a-tetrahydropyrrolo[2,3-b]indol-1(2H)-yl)methanone (a14): Reagents: *p*-chlorobenzoic acid. Yellow powder, mp 170–172 °C, $[\alpha]_D^{25} = -13.183$, petroleum ether:ethyl acetate = 3:1, 82% Yield, ¹H-NMR (CDCl₃, 500 MHz), δ 7.30 (s, 4H), 7.23–7.16 (m, 6H), 7.06–7.03 (m, 3H), 6.95–6.93 (m, 2H), 6.89–6.87 (m, 1H), 6.69–6.66 (m, 1H), 6.22 (d, 1H, $J = 10.00$ Hz), 6.05 (s, 1H), 4.65, 4.48 (Abq, 2H, $J = 15.00$ Hz), 3.49–3.45 (m, 1H), 3.36–3.30 (m, 1H), 3.12, 2.92 (Abq, 2H, $J = 10.00$ Hz), 2.20–2.09 (m, 2H). ¹³C-NMR (CDCl₃, 125 MHz), δ 169.32 (C), 150.74 (C), 139.19 (C), 137.09 (C), 136.38 (C), 134.43 (C), 131.18 (C), 130.12 (CH × 2), 128.99 (CH × 2), 128.71 (CH), 128.43 (CH × 2), 128.33 (CH × 2), 128.08 (CH × 2), 126.81 (CH × 2), 126.61 (CH × 2), 123.48 (CH), 117.25 (CH), 106.35 (CH), 82.77 (CH), 56.63 (C), 49.55 (CH₂), 49.42 (CH₂), 44.91 (CH₂), 37.88 (CH₂). ESI-MS: [M + Na]⁺ Found 478.18.

*(3a,8-Dibenzyl-3,3a,8,8a-tetrahydropyrrolo[2,3-b]indol-1(2H)-yl)(*o*-tolyl)methanone (a15)*: Reagents: 2-methylbenzoic acid. Green powder, mp 142–144 °C, $[\alpha]_D^{25} = -10.883$, petroleum ether:ethyl acetate = 3:1, 85% Yield, ¹H-NMR (CDCl₃, 500 MHz), δ 7.23–7.18 (m, 6H), 7.15–7.07 (m, 5H), 7.04–6.98 (m, 3H), 6.92–6.91 (m, 2H), 6.68–6.65 (m, 1H), 6.21 (d, 1H), 6.06 (s, 1H), 4.73, 4.57 (Abq, 2H, $J = 15.00$ Hz), 3.22–3.18 (m, 1H), 3.15, 2.96 (Abq, 2H, $J = 10.00$ Hz), 3.12–3.07 (m, 1H), 2.15 (s, 3H), 2.12–2.09 (m, 2H). ¹³C-NMR (CDCl₃, 125 MHz), δ 170.41 (C), 150.90 (C), 139.25 (C), 137.09 (C), 136.75 (C), 134.15 (C), 131.50 (C), 130.35 (CH), 130.20 (CH × 2), 128.95 (CH), 128.65 (CH), 128.32 (CH × 2), 128.14 (CH × 2), 126.91 (CH × 2), 126.62 (CH), 126.59 (CH), 125.85 (CH), 125.71 (CH), 123.40 (CH), 117.21 (CH), 106.16

(CH), 82.16 (CH), 57.07 (C), 49.78 (CH₂), 47.83 (CH₂), 45.01 (CH₂), 37.99 (CH₂), 18.87 (CH₃). ESI-MS: [M + Na]⁺ Found 458.24.

(3*a*,8-Dibenzyl-3*a*,8,8*a*-tetrahydropyrrolo[2,3-*b*]indol-1(2*H*)-yl)(*m*-tolyl)methanone (**a16**): Reagents: *m*-toluic acid. Green solid, mp 134–136 °C, [α]_D²⁰ = −11.951, petroleum ether:ethyl acetate = 4:1, 85% Yield, ¹H-NMR (CDCl₃, 500 MHz), δ 7.22–7.15 (m, 10H), 7.06–7.02 (m, 3H), 6.94–6.94 (m, 2H), 6.88–6.87 (m, 2H), 6.21 (d, 1H), 6.07 (s, 1H), 4.68, 4.48 (Abq, 2H, *J* = 15.00 Hz), 3.55–3.51 (m, 1H), 3.36–3.30 (m, 1H), 3.13, 2.93 (Abq, 2H, *J* = 15.00 Hz), 2.32 (s, 3H), 2.18–2.07 (m, 2H). ¹³C-NMR (CDCl₃, 125 MHz), δ 170.71 (C), 150.88 (C), 139.25 (C), 137.21 (C), 136.05 (C), 134.35 (C), 130.98 (C), 130.67 (C), 130.14 (CH × 2), 128.63 (CH), 128.35 (CH), 128.30 (CH × 2), 128.05 (CH × 2), 127.32 (CH), 126.87 (CH × 2), 126.56 (CH), 126.54 (CH), 124.50 (CH), 123.49 (CH), 117.09 (CH), 106.26 (CH), 82.61 (CH), 56.66 (C), 49.47 (CH₂), 49.47 (CH₂), 44.99 (CH₂), 38.01 (CH₂), 21.28 (CH₃). ESI-MS: [M + Na]⁺ Found 458.24.

(3*a*,8-Dibenzyl-3*a*,8,8*a*-tetrahydropyrrolo[2,3-*b*]indol-1(2*H*)-yl)(*p*-tolyl)methanone (**a17**): Reagents: 4-methylbenzoic acid. White powder, mp 120–122 °C, [α]_D²⁰ = −9.018, petroleum ether:ethyl acetate = 4:1, 87% Yield, ¹H-NMR (CDCl₃, 500 MHz), δ 7.31–7.30 (m, 2H), 7.20–7.13 (m, 8H), 7.04–7.01 (m, 3H), 6.95–6.94 (m, 2H), 6.88–6.86 (m, 1H), 6.68–6.65 (m, 1H), 6.18 (d, 1H), 6.08 (s, 1H), 4.68, 4.47 (Abq, 2H, *J* = 20.00 Hz), 3.57–3.54 (m, 1H), 3.38–3.32 (m, 1H), 3.13, 2.93 (Abq, 2H, *J* = 15.00 Hz), 2.35 (s, 3H), 2.18–2.07 (m, 2H). ¹³C-NMR (CDCl₃, 125 MHz), δ 170.71 (C), 150.88 (C), 139.25 (C), 137.21 (C), 136.05 (C), 134.35 (C), 130.98 (CH), 130.14 (CH × 2), 128.75 (CH × 2), 128.61 (CH), 128.28 (CH × 2), 128.04 (CH × 2), 127.67 (CH × 2), 126.83 (CH × 2), 126.54 (CH), 126.52 (CH), 123.47 (CH), 117.08 (CH), 106.31 (CH), 82.66 (CH), 56.62 (C), 49.55 (CH₂), 49.49 (CH₂), 44.98 (CH₂), 37.99 (CH₂), 21.40 (CH₃). ESI-MS: [M + Na]⁺ Found 458.24.

(3*a*,8-Dibenzyl-3*a*,8,8*a*-tetrahydropyrrolo[2,3-*b*]indol-1(2*H*)-yl)(4-methoxyphenyl)methanone (**a18**): Reagents: *p*-methoxyl benzoic acid. Orange oily liquid, [α]_D²⁰ = −17.999, petroleum ether:ethyl acetate = 5:1, 83% Yield, ¹H-NMR (CDCl₃, 500 MHz), δ 7.21–7.16 (m, 6H), 7.06–7.05 (m, 2H), 6.95–6.94 (m, 2H), 7.00–6.97 (m, 3H), 6.93–6.6.91 (m, 2H), 6.88–6.87 (m, 1H), 6.79–6.77 (m, 2H), 6.65–6.62 (m, 1H), 6.16 (d, 1H), 5.84 (s, 1H), 4.55 (s, 2H), 3.77 (s, 3H), 3.57–3.52 (m, 1H), 3.18–3.13 (m, 1H), 3.04, 2.85 (Abq, 2H, *J* = 15.00 Hz), 2.17–2.06 (m, 2H). ¹³C-NMR (CDCl₃, 125 MHz), δ 170.52 (C), 158.37 (C), 150.59 (C), 139.39 (C), 137.09 (C), 131.80 (C), 130.15 (CH × 2), 129.80 (CH), 128.55 (CH), 128.07 (CH × 2), 128.24 (CH × 2), 128.07 (CH × 2), 126.98 (CH × 2), 126.59 (CH), 126.49 (CH), 123.15 (CH), 117.16 (CH), 114.08 (CH × 2), 106.55 (CH), 83.26 (CH), 56.40 (C), 55.24 (CH₃), 50.32 (CH₂), 44.63 (CH₂), 41.32 (CH₂), 37.50 (CH₂). ESI-MS: [M + Na]⁺ Found 474.23.

3*a*,8-Dibenzyl-1-(methylsulfonyl)-1,2,3,3*a*,8,8*a*-hexahydropyrrolo[2,3-*b*]indole (**a19**): Reagents: mesyl chloride. Yellow solid, mp 148–150 °C, [α]_D²⁰ = −16.158, petroleum ether:ethyl acetate = 5:1, 87% Yield, ¹H-NMR (CDCl₃, 500 MHz), δ 7.29–7.26 (m, 2H), 7.23–7.22 (m, 3H), 7.17–7.15 (m, 2H), 7.09–7.06 (m, 1H), 6.98–6.96 (m, 1H), 6.91–6.89 (m, 2H), 6.73–6.70 (m, 1H), 6.36 (d, 1H), 5.33 (s, 1H), 4.61, 4.47 (Abq, 2H, *J* = 15.00 Hz), 3.60–3.57 (m, 1H), 3.08–3.01 (m, 1H), 2.93, 2.89 (Abq, 2H, *J* = 15.00 Hz), 2.31 (s, 3H), 2.27–2.16 (m, 2H), 1.28–1.24 (m, 1H). ¹³C-NMR (CDCl₃, 125 MHz), δ 150.10 (C), 138.61 (C), 136.73 (C), 131.54 (C), 130.53 (CH × 2), 128.91 (CH), 128.52 (CH × 2), 128.38 (CH × 2), 127.31 (CH × 2), 127.05 (CH), 126.88 (CH), 123.21 (CH), 117.86 (CH), 106.72 (CH), 85.04 (CH), 58.69 (C), 48.47 (CH₂), 47.56 (CH₂), 43.94 (CH₂), 37.95 (CH₂), 37.03 (CH₃). ESI-MS: [M + Na]⁺ Found 45817.

3*a*,8-Dibenzyl-1-(phenylsulfonyl)-1,2,3,3*a*,8,8*a*-hexahydropyrrolo[2,3-*b*]indole (**a20**): Reagents: benzene sulfonyl chloride. Green solid, mp 158–160 °C, [α]_D²⁰ = −14.675, petroleum ether:ethyl acetate = 4:1, 91% Yield, ¹H-NMR (CDCl₃, 500 MHz), δ 7.71–7.70 (m, 2H), 7.59–7.56 (m, 1H), 7.48–7.45 (m, 2H), 7.24–7.20 (m, 4H), 7.18–7.15 (m, 2H), 7.02–6.99 (m, 1H), 6.96–6.94 (m, 2H), 6.88–6.86 (m, 1H), 6.77–6.75 (m, 2H), 6.66–6.64 (m, 1H), 6.18 (d, 1H,), 5.43 (s, 1H), 4.77, 4.39 (Abq, 2H, *J* = 15.00 Hz), 3.61–3.57 (m, 1H), 3.09–3.03 (m, 1H), 2.90, 2.53 (Abq, 2H, *J* = 15.00 Hz), 1.97–1.94 (m, 1H), 1.52–1.46 (m, 1H). ¹³C-NMR (CDCl₃, 125 MHz), δ 150.22 (C), 139.71 (C), 138.47 (C), 136.92 (C), 132.71 (C), 130.67 (CH), 130.00 (CH × 2), 129.25 (CH × 2), 128.76 (CH), 128.40 (CH × 2), 128.26 (CH × 2), 127.15 (CH × 2), 126.90 (CH × 2), 126.72 (CH), 126.66 (CH), 123.10 (CH), 117.40 (CH), 106.27 (CH), 86.37 (CH), 58.57 (C), 47.97 (CH₂), 47.72 (CH₂), 44.34 (CH₂), 38.05 (CH₂). ESI-MS: [M + Na]⁺ Found 480.19.

3a,8-Dibenzyl-1-tosyl-1,2,3,3a,8,8a-hexahydropyrrolo[2,3-b]indole (a21): Reagents: *p*-toluensulfonyl chloride. Yellow solid, mp 164–166 °C, $[\alpha]_D^{25} = -16.158$, petroleum ether:ethyl acetate = 3:1, 95% Yield, $^1\text{H-NMR}$ (CDCl_3 , 500 MHz), δ 7.60 (d, 2H, $J = 10.00$ Hz), 7.26 (m, 1H), 7.48–7.45 (m, 2H), 7.24–7.18 (m, 4H), 7.17–7.14 (m, 2H), 7.01–6.98 (m, 1H), 6.94–6.92 (m, 2H), 6.88–6.87 (m, 1H), 6.77–6.76 (m, 2H), 6.66–6.63 (m, 1H), 6.16 (d, 2H, $J = 20.00$ Hz), 5.41 (s, 1H), 4.77, 4.37 (Abq, 2H, $J = 15.00$ Hz), 3.60–3.57 (m, 1H), 3.08–3.02 (m, 1H), 2.92, 2.52 (Abq, 2H, $J = 10.00$ Hz), 1.96–1.93 (m, 1H), 1.53–1.46 (m, 1H). $^{13}\text{C-NMR}$ (CDCl_3 , 125 MHz), δ 150.28 (C), 143.51 (C), 138.51 (C), 136.99 (C), 136.76 (C), 130.71 (C), 130.00 (CH \times 2), 129.84 (CH \times 2), 128.73 (CH), 128.37 (CH \times 2), 128.22 (CH \times 2), 127.20 (CH \times 2), 126.87 (CH \times 2), 126.66 (CH), 126.60 (CH), 123.07 (CH), 117.33 (CH), 106.22 (CH), 86.32 (CH), 58.58 (C), 47.99 (CH₂), 47.68 (CH₂), 44.38 (CH₂), 38.15 (CH₂), 21.56 (CH₃). ESI-MS: $[\text{M} + \text{Na}]^+$ Found 494.20.

1-(3a,8-Diethyl-3,3a,8,8a-tetrahydropyrrolo[2,3-b]indol-1(2H)-yl)ethan-1-one (b1): Reagents: acetic anhydride. Picine oil, $[\alpha]_D^{25} = -14.549$, petroleum ether:ethyl acetate = 3:1, 94% Yield, $^1\text{H-NMR}$ (CDCl_3 , 500 MHz), δ 7.10–7.07 (m, 1H), 6.97–6.95 (m, 1H), 6.65–6.62 (m, 1H), 6.36 (d, 1H, $J = 5.00$ Hz), 5.64 (s, 1H), 3.63–3.59 (m, 1H), 3.56–3.47 (m, 2H), 3.29–3.23 (m, 1H), 2.14–2.10 (m, 1H), 2.07 (s, 3H), 2.01–1.95 (m, 1H), 1.84–1.76 (m, 1H), 1.73–1.65 (m, 1H), 1.14 (t, 3H, $J = 10.00$ Hz), 0.82 (t, 3H, $J = 10.00$ Hz). $^{13}\text{C-NMR}$ (CDCl_3 , 125 MHz), δ 169.73 (C), 150.23 (C), 132.05 (C), 128.32 (CH), 122.79 (CH), 116.67 (CH), 105.39 (CH), 81.98 (CH), 55.90 (C), 46.86 (CH₂), 40.14 (CH₂), 38.34 (CH₂), 31.87 (CH₂), 22.87 (CH₃), 12.39 (CH₃), 9.41 (CH₃). ESI-MS: $[\text{M} + \text{Na}]^+$ Found 258.17.

1-(3a,8-Diethyl-3,3a,8,8a-tetrahydropyrrolo[2,3-b]indol-1(2H)-yl)propan-1-one (b2): Reagents: propionic anhydride. Picine oil, petroleum ether:ethyl acetate = 3:1, 94% Yield, $^1\text{H-NMR}$ (CDCl_3 , 500 MHz), δ 7.10–7.07 (m, 1H), 6.97–6.95 (m, 1H), 6.64–6.61 (m, 1H), 6.36 (d, 1H, $J = 5.00$ Hz), 5.66 (s, 1H), 3.66–3.62 (m, 1H), 3.57–3.46 (m, 2H), 3.25–3.20 (m, 1H), 2.38–2.23 (m, 2H), 2.14–2.10 (m, 1H), 1.99–1.93 (m, 1H), 2.01–1.95 (m, 1H), 1.84–1.76 (m, 1H), 1.72–1.65 (m, 1H), 1.16 (t, 3H, $J = 5.00$ Hz), 1.13 (t, 3H, $J = 5.00$ Hz), 0.82 (t, 3H, $J = 10.00$ Hz). $^{13}\text{C-NMR}$ (CDCl_3 , 125 MHz), δ 173.05 (C), 150.24 (C), 132.12 (C), 128.29 (CH), 122.78 (CH), 116.62 (CH), 105.36 (CH), 82.15 (CH), 55.64 (C), 45.90 (CH₂), 40.15 (CH₂), 38.39 (CH₂), 31.85 (CH₂), 28.11 (CH₂), 12.33 (CH₃), 9.42 (CH₃), 9.08 (CH₃). ESI-MS: $[\text{M} + \text{Na}]^+$ Found 272.19.

1-(3a,8-Diethyl-3,3a,8,8a-tetrahydropyrrolo[2,3-b]indol-1(2H)-yl)butan-1-one (b3): Reagents: butyric anhydride. Picine oil, petroleum ether:ethyl acetate = 4:1, 91% Yield, $^1\text{H-NMR}$ (CDCl_3 , 500 MHz), δ 7.10–7.07 (m, 1H), 6.97–6.95 (m, 1H), 6.64–6.61 (m, 1H), 6.36 (d, 1H, $J = 5.00$ Hz), 5.67 (s, 1H), 3.67–3.63 (m, 1H), 3.55–3.47 (m, 2H), 3.26–3.20 (m, 1H), 2.34–2.21 (m, 2H), 2.14–2.10 (m, 1H), 1.99–1.92 (m, 1H), 1.84–1.76 (m, 1H), 1.72–1.64 (m, 3H), 1.14 (t, 3H, $J = 5.00$ Hz), 0.97 (t, 3H, $J = 5.00$ Hz), 0.81 (t, 3H, $J = 5.00$ Hz). $^{13}\text{C-NMR}$ (CDCl_3 , 125 MHz), δ 172.38 (C), 150.28 (C), 132.11 (C), 128.29 (CH), 122.79 (CH), 116.62 (CH), 105.32 (CH), 82.07 (CH), 55.65 (C), 46.08 (CH₂), 40.16 (CH₂), 38.44 (CH₂), 36.90 (CH₂), 31.90 (CH₂), 18.39 (CH₃), 12.39 (CH₃), 9.42 (CH₃). ESI-MS: $[\text{M} + \text{Na}]^+$ Found 286.20.

1-(3a,8-Diethyl-3,3a,8,8a-tetrahydropyrrolo[2,3-b]indol-1(2H)-yl)-2-methylpropan-1-one (b4): Reagents: isobutyric anhydride. Picine oil, petroleum ether:ethyl acetate = 4:1, 92% Yield, $^1\text{H-NMR}$ (CDCl_3 , 500 MHz), δ 7.10–7.07 (m, 1H), 6.97–6.96 (m, 1H), 6.64–6.61 (m, 1H), 6.36 (d, 1H, $J = 5.00$ Hz), 5.69 (s, 1H), 3.74–3.70 (m, 1H), 3.53–3.45 (m, 2H), 3.27–3.22 (m, 1H), 2.69–2.57 (m, 1H), 2.15–2.11 (m, 1H), 1.99–1.93 (m, 1H), 1.84–1.77 (m, 1H), 1.73–1.66 (m, 3H), 1.15–1.12 (m, 9H), 0.81 (t, 3H, $J = 5.00$ Hz). $^{13}\text{C-NMR}$ (CDCl_3 , 125 MHz), δ 176.27 (C), 150.39 (C), 132.06 (C), 128.29 (CH), 122.82 (CH), 116.54 (CH), 105.10 (CH), 82.19 (CH), 55.53 (C), 45.77 (CH₂), 40.13 (CH₂), 38.66 (CH₂), 32.25 (CH₂), 32.06 (CH₂), 19.22 (CH₃), 18.83 (CH₃), 12.52 (CH₃), 9.41 (CH₃). ESI-MS: $[\text{M} + \text{Na}]^+$ Found 286.20.

1-(3a,8-Dipropyl-3,3a,8,8a-tetrahydropyrrolo[2,3-b]indol-1(2H)-yl)ethan-1-one (c1): Reagents: acetic anhydride. Picine oil, petroleum ether:ethyl acetate = 3:1, 93% Yield, $^1\text{H-NMR}$ (CDCl_3 , 500 MHz), δ 7.08–7.05 (m, 1H), 6.96–6.95 (m, 1H), 6.63–6.60 (m, 1H), 6.34 (d, 1H, $J = 5.00$ Hz), 5.65 (s, 1H), 3.62–3.58 (m, 1H), 3.43–3.38 (m, 1H), 3.35–3.29 (m, 1H), 3.25–3.20 (m, 1H), 2.14–2.10 (m, 1H), 2.07 (s, 3H), 2.00–1.94 (m, 1H), 1.76–1.52 (m, 4H), 1.38–1.22 (m, 1H), 1.16–1.06 (m, 1H), 0.91 (t, 3H, $J = 5.00$ Hz), 0.85 (t, 3H, $J = 5.00$ Hz). $^{13}\text{C-NMR}$ (CDCl_3 , 125 MHz), δ 169.73 (C), 150.67 (C), 132.12 (C), 128.25 (CH), 122.72 (CH), 116.48 (CH), 105.14 (CH), 82.70 (CH), 55.52 (C), 47.50 (CH₂), 46.80 (CH₂), 41.71 (CH₂), 38.84 (CH₂), 22.86 (CH₃), 20.85 (CH₂), 18.41 (CH₂), 14.48 (CH₃), 11.57 (CH₃). ESI-MS: $[\text{M} + \text{Na}]^+$ Found 286.20.

1-(3a,8-Dipropyl-3,3a,8,8a-tetrahydropyrrolo[2,3-b]indol-1(2H)-yl)propan-1-one (c2): Reagents: propionic anhydride. Picine oil, petroleum ether:ethyl acetate = 3:1, 91% Yield, $^1\text{H-NMR}$ (CDCl_3 , 500 MHz), δ 7.08–7.05 (m, 1H), 6.96–6.95 (m, 1H), 6.62–6.59 (m, 1H), 6.34 (d, 1H, $J = 5.00$ Hz), 5.67 (s, 1H), 3.65–3.61 (m, 1H), 3.45–3.39 (m, 1H), 3.36–3.30 (m, 1H), 3.21–3.16 (m, 1H), 2.38–2.22 (m, 2H), 2.14–2.10 (m, 1H), 1.98–1.92 (m, 1H), 1.75–1.52 (m, 5H), 1.38–1.28 (m, 1H), 1.15 (t, 3H, $J = 5.00$ Hz), 0.91 (t, 3H, $J = 5.00$ Hz), 0.85 (t, 3H, $J = 5.00$ Hz). $^{13}\text{C-NMR}$ (CDCl_3 , 125 MHz), δ 173.03 (C), 150.72 (C), 132.21 (C), 128.23 (CH), 122.73 (CH), 116.43 (CH), 105.15 (CH), 82.90 (CH), 55.31 (C), 47.48 (CH_2), 45.84 (CH_2), 41.76 (CH_2), 38.88 (CH_2), 28.15 (CH_2), 20.87 (CH_2), 18.43 (CH_2), 14.48 (CH_3), 11.58 (CH_3), 9.17 (CH_3). ESI-MS: $[\text{M} + \text{Na}]^+$ Found 300.22.

1-(3a,8-Dipropyl-3,3a,8,8a-tetrahydropyrrolo[2,3-b]indol-1(2H)-yl)butan-1-one (c3): Reagents: butyric anhydride. Picine oil, petroleum ether:ethyl acetate = 4:1, 92% Yield, $^1\text{H-NMR}$ (CDCl_3 , 500 MHz), δ 7.08–7.05 (m, 1H), 6.96–6.94 (m, 1H), 6.62–6.59 (m, 1H), 6.34 (d, 1H, $J = 5.00$ Hz), 5.68 (s, 1H), 3.66–3.62 (m, 1H), 3.43–3.30 (m, 2H), 3.21–3.16 (m, 1H), 2.34–2.20 (m, 2H), 2.13–2.09 (m, 1H), 1.97–1.91 (m, 1H), 1.77–1.52 (m, 6H), 1.38–1.27 (m, 1H), 1.17–1.06 (m, 1H), 0.97 (t, 3H, $J = 5.00$ Hz), 0.90 (t, 3H, $J = 5.00$ Hz), 0.85 (t, 3H, $J = 5.00$ Hz). $^{13}\text{C-NMR}$ (CDCl_3 , 125 MHz), δ 172.35 (C), 150.77 (C), 132.18 (C), 128.23 (CH), 122.74 (CH), 116.41 (CH), 105.08 (CH), 82.77 (CH), 55.31 (C), 47.45 (CH_2), 46.02 (CH_2), 41.80 (CH_2), 38.93 (CH_2), 36.93 (CH_2), 28.15 (CH_2), 20.89 (CH_2), 18.46 (CH_2), 18.42 (CH_2), 14.48 (CH_3), 13.94 (CH_3), 11.58 (CH_3). ESI-MS: $[\text{M} + \text{Na}]^+$ Found 314.24.

1-(3a,8-Dipropyl-3,3a,8,8a-tetrahydropyrrolo[2,3-b]indol-1(2H)-yl)-2-methylpropan-1-one (c4): Reagents: isobutyric anhydride. Picine oil, petroleum ether:ethyl acetate = 5:1, 93% Yield, $^1\text{H-NMR}$ (CDCl_3 , 500 MHz), δ 7.08–7.05 (m, 1H), 6.96–6.95 (m, 1H), 6.62–6.59 (m, 1H), 6.33 (d, 1H, $J = 5.00$ Hz), 5.69 (s, 1H), 3.73–3.69 (m, 1H), 3.40–3.30 (m, 2H), 3.23–3.17 (m, 1H), 2.70–2.62 (m, 1H), 2.14–2.10 (m, 1H), 1.97–1.91 (m, 1H), 1.76–1.49 (m, 5H), 1.36–1.29 (m, 1H), 1.13 (t, 6H, $J = 5.00$ Hz), 0.90 (t, 3H, $J = 5.00$ Hz), 0.85 (t, 3H, $J = 5.00$ Hz). $^{13}\text{C-NMR}$ (CDCl_3 , 125 MHz), δ 176.16 (C), 150.88 (C), 132.20 (C), 128.22 (CH), 122.77 (CH), 116.39 (CH), 105.00 (CH), 82.88 (CH), 55.21 (C), 47.42 (CH_2), 45.69 (CH_2), 41.95 (CH_2), 39.16 (CH_2), 32.25 (CH_3), 21.00 (CH_2), 19.30 (CH_3), 18.83 (CH_3), 18.43 (CH_2), 14.47 (CH_3), 11.59 (CH_3). ESI-MS: $[\text{M} + \text{Na}]^+$ Found 314.24.

2. ^1H - and ^{13}C -NMR Spectra

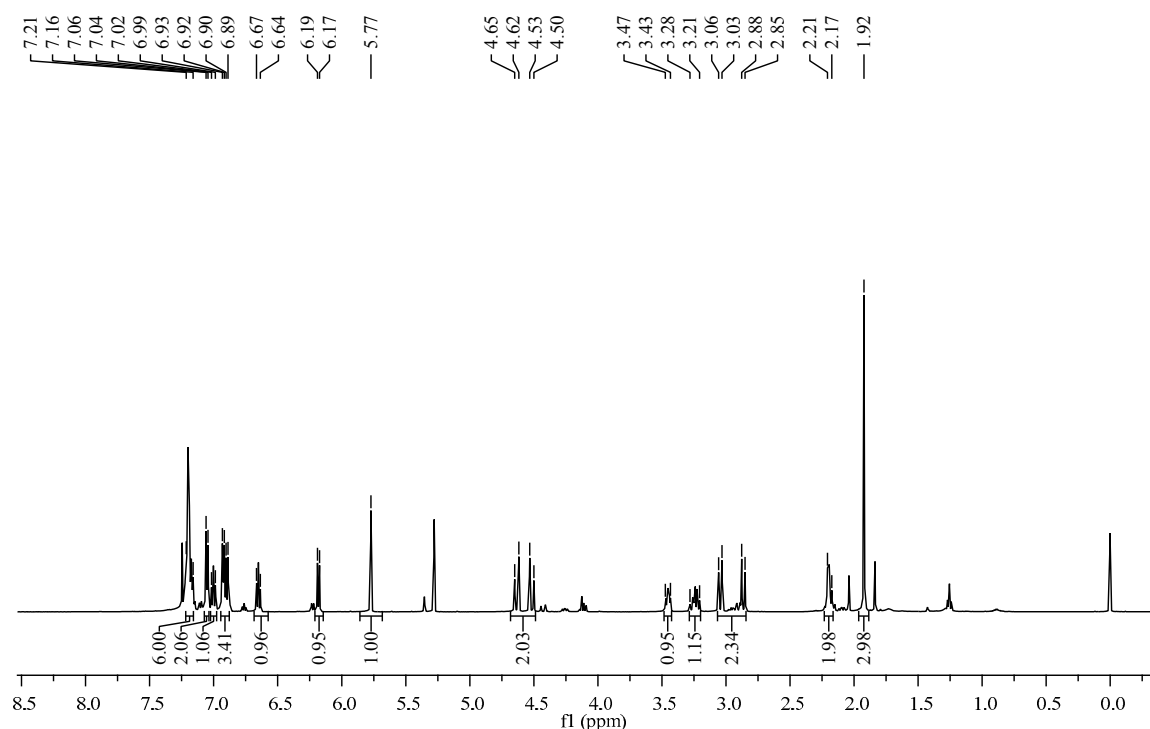
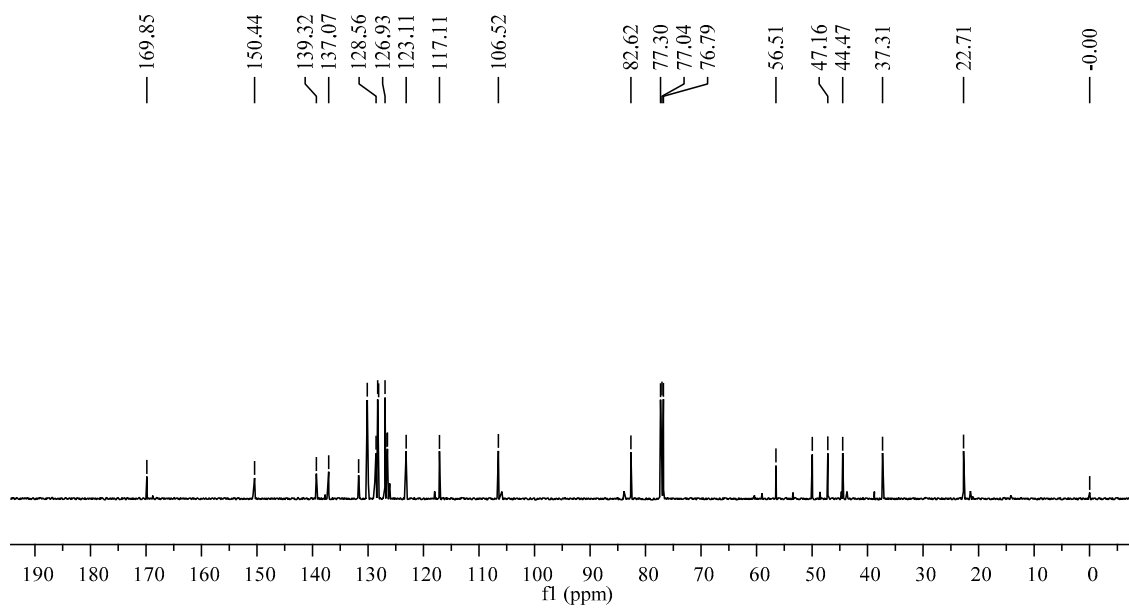
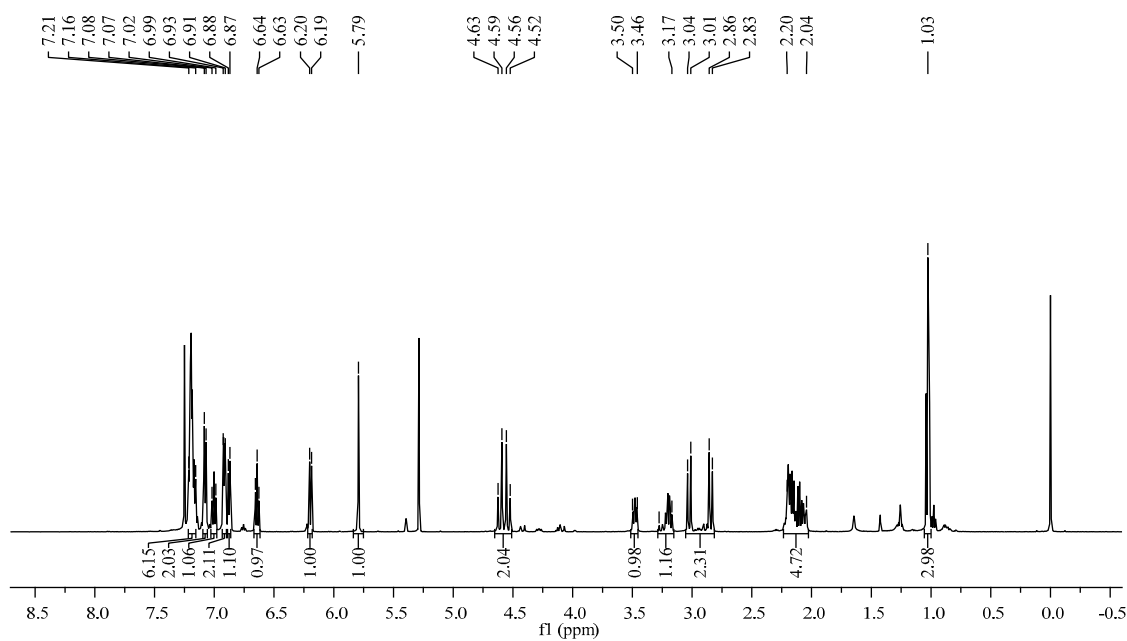


Figure S1. $^1\text{H-NMR}$ spectroscopic data for compound a1.

**Figure S2.** ¹³C-NMR spectroscopic data for compound a1.**Figure S3.** ¹H-NMR spectroscopic data for compound a2.

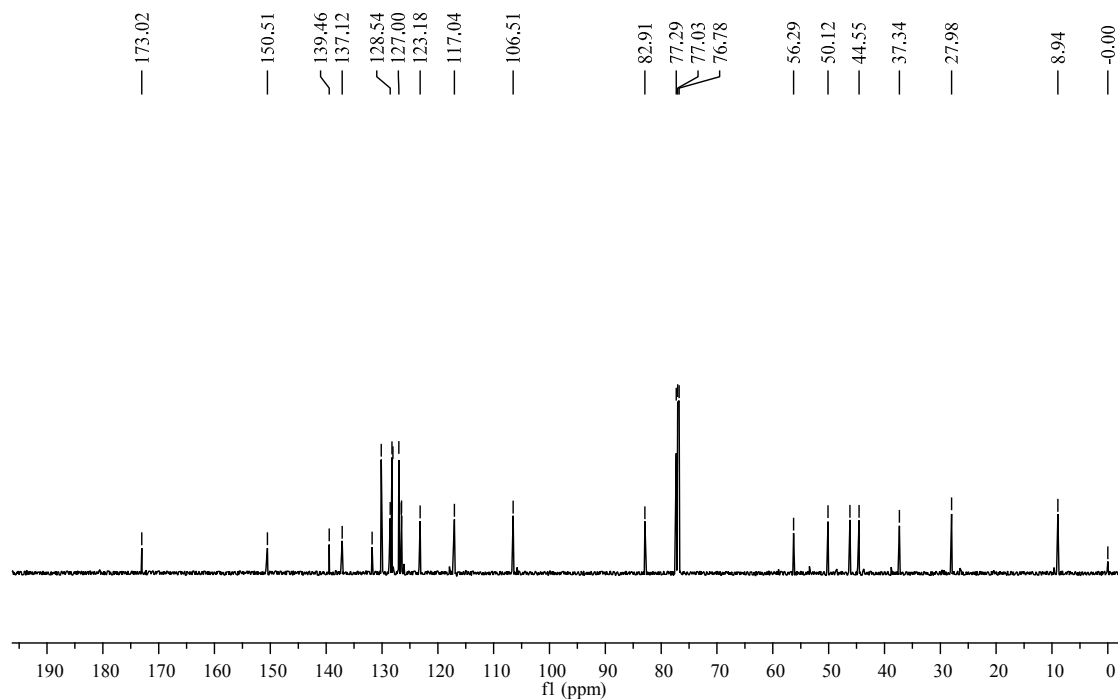


Figure S4. ¹³C-NMR spectroscopic data for compound a2.

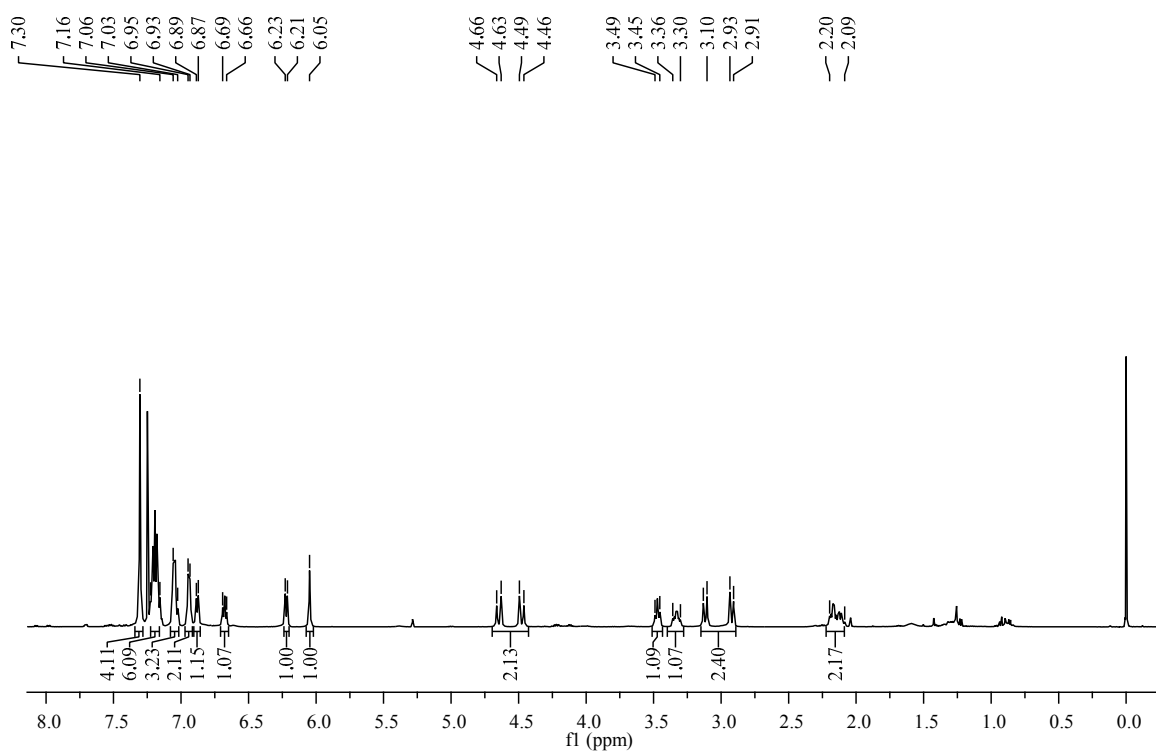
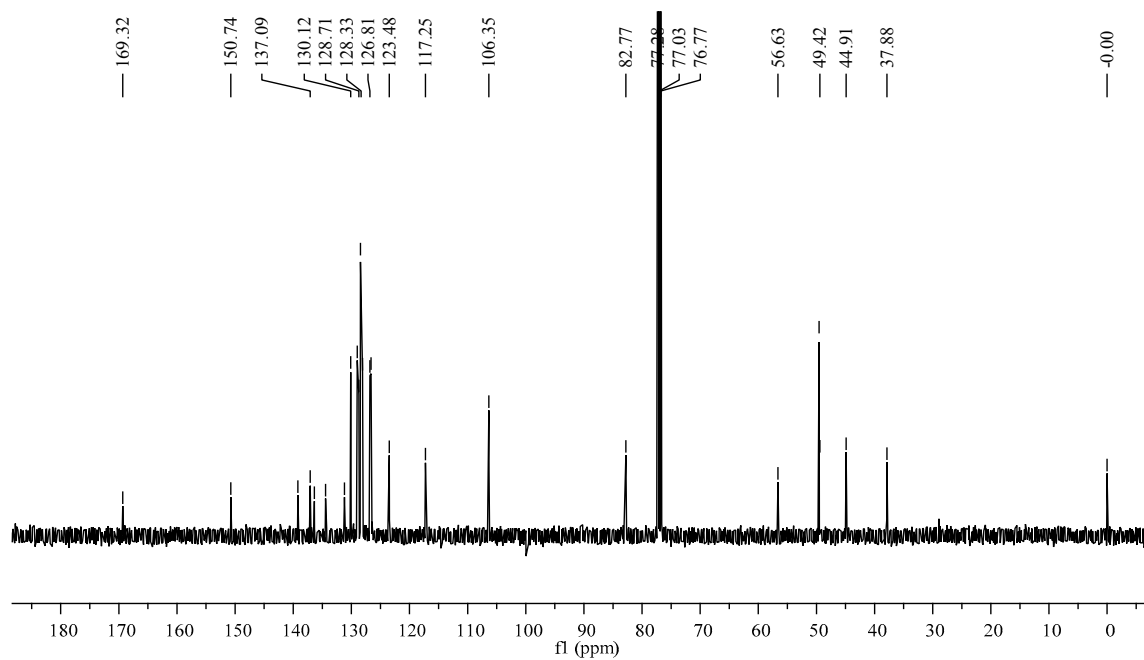
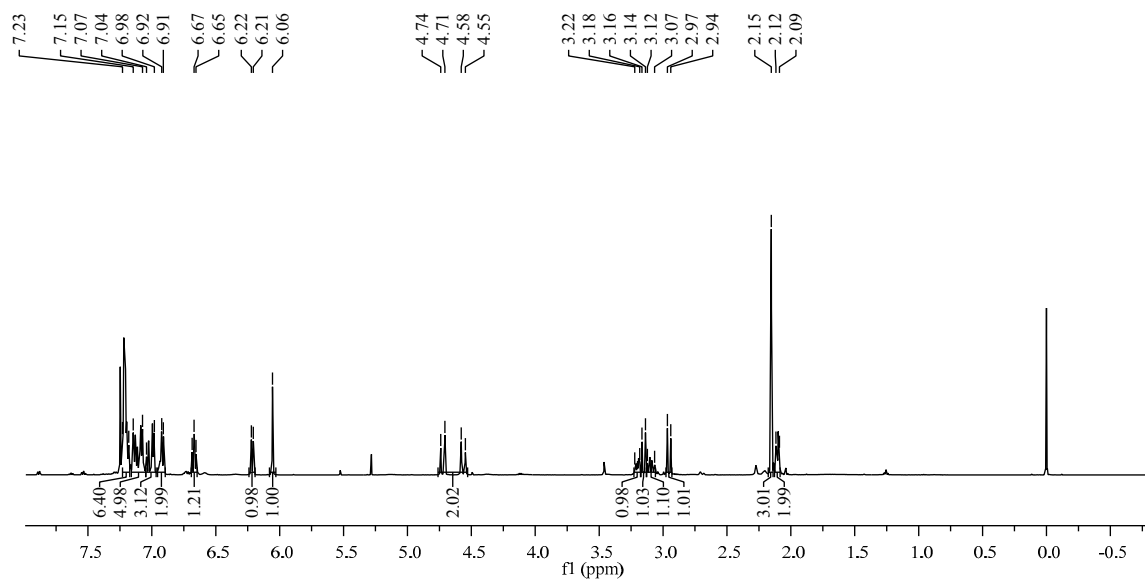


Figure S5. ¹H-NMR spectroscopic data for compound a14.

Figure S6. ¹³C-NMR spectroscopic data for compound **a14**.Figure S7. ¹H-NMR spectroscopic data for compound **a15**.

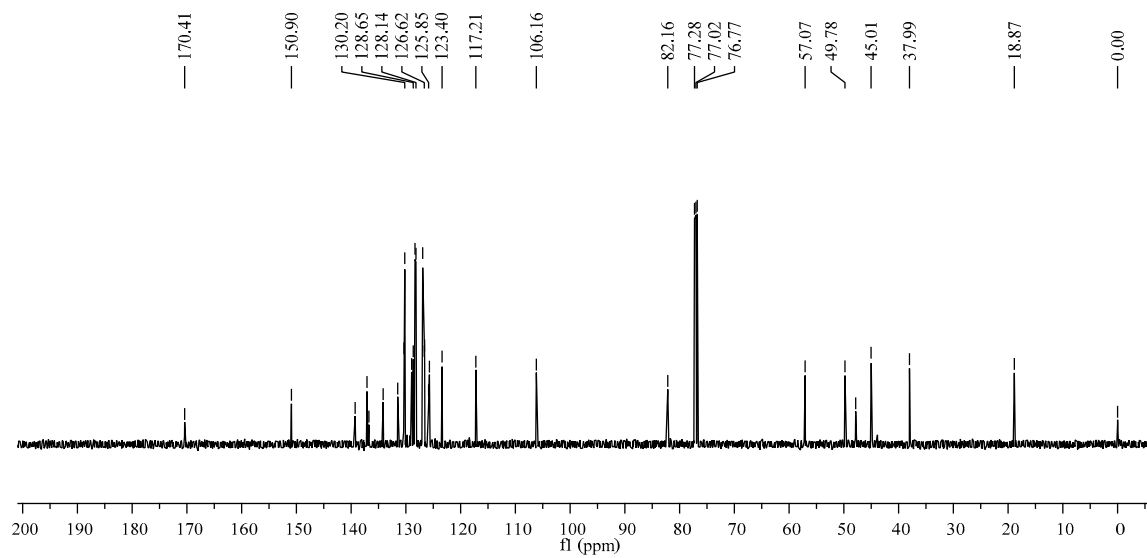


Figure S8. ¹³C-NMR spectroscopic data for compound a15.

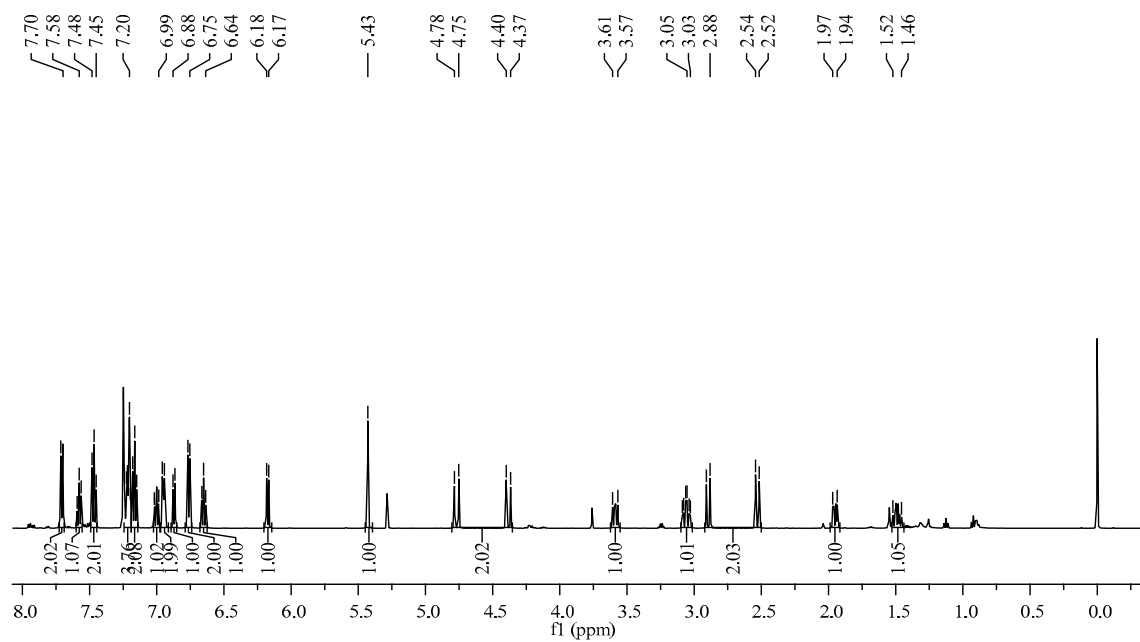
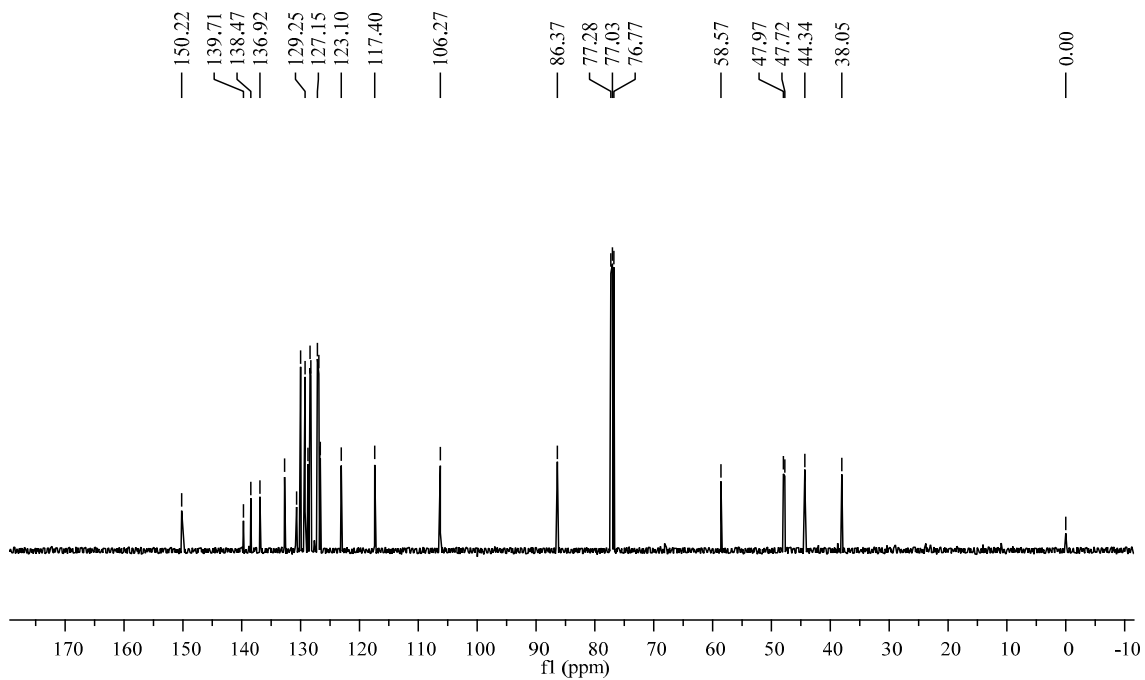
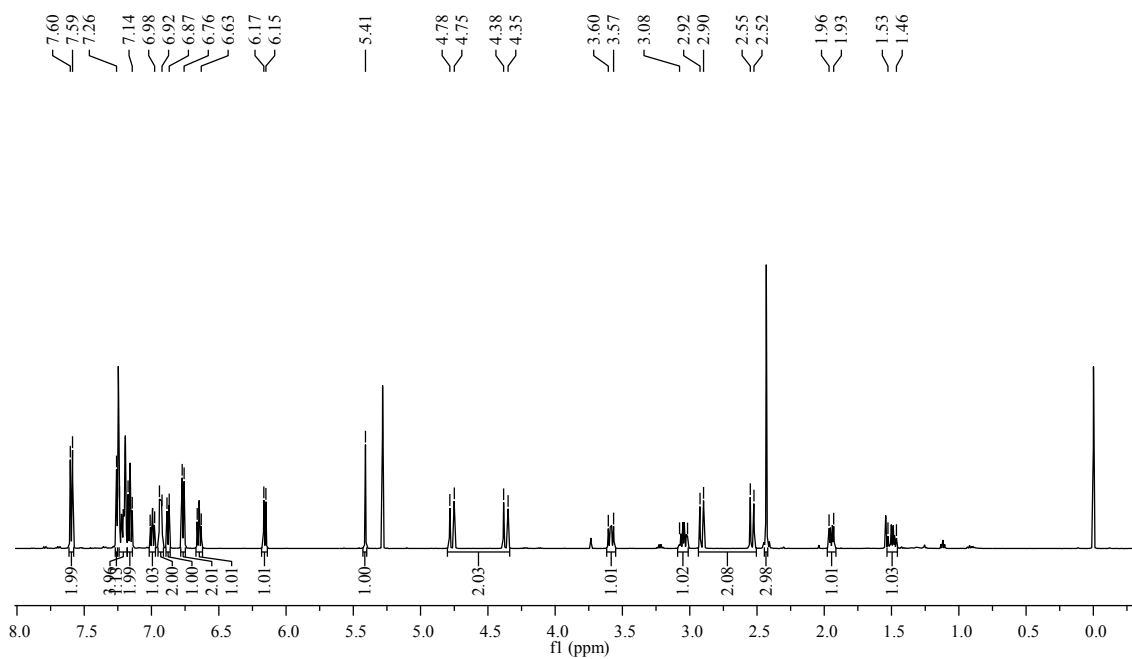
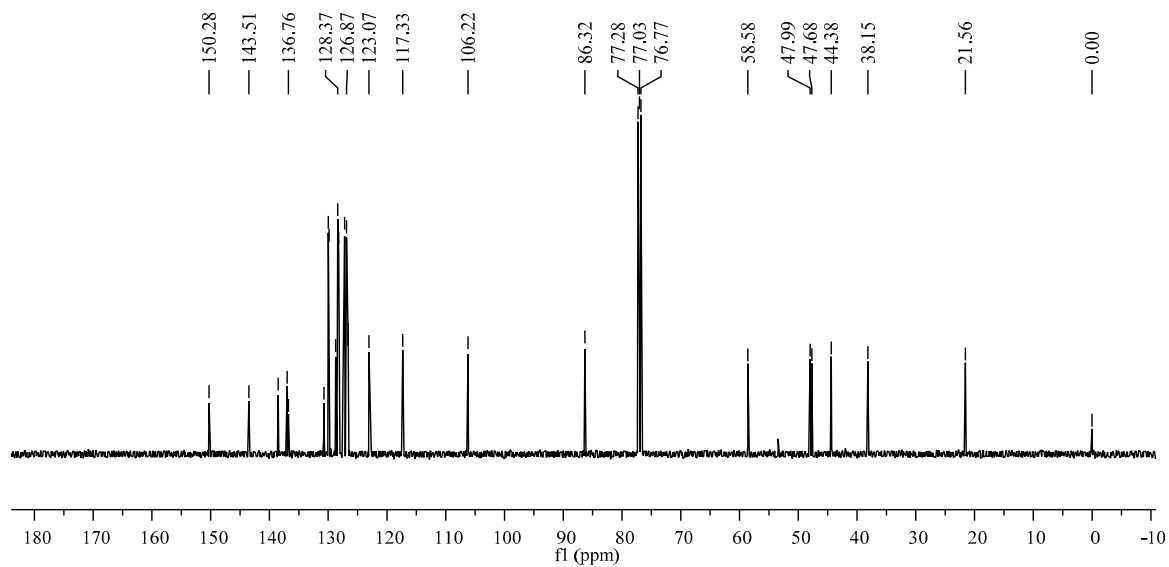
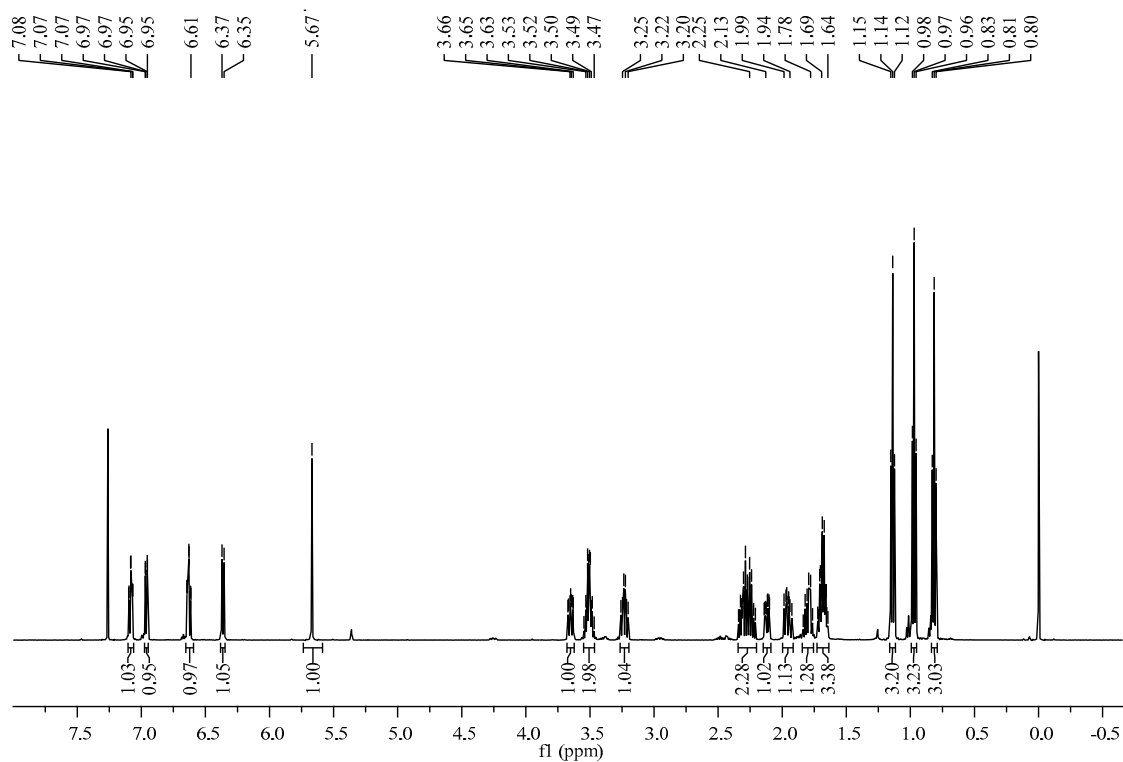
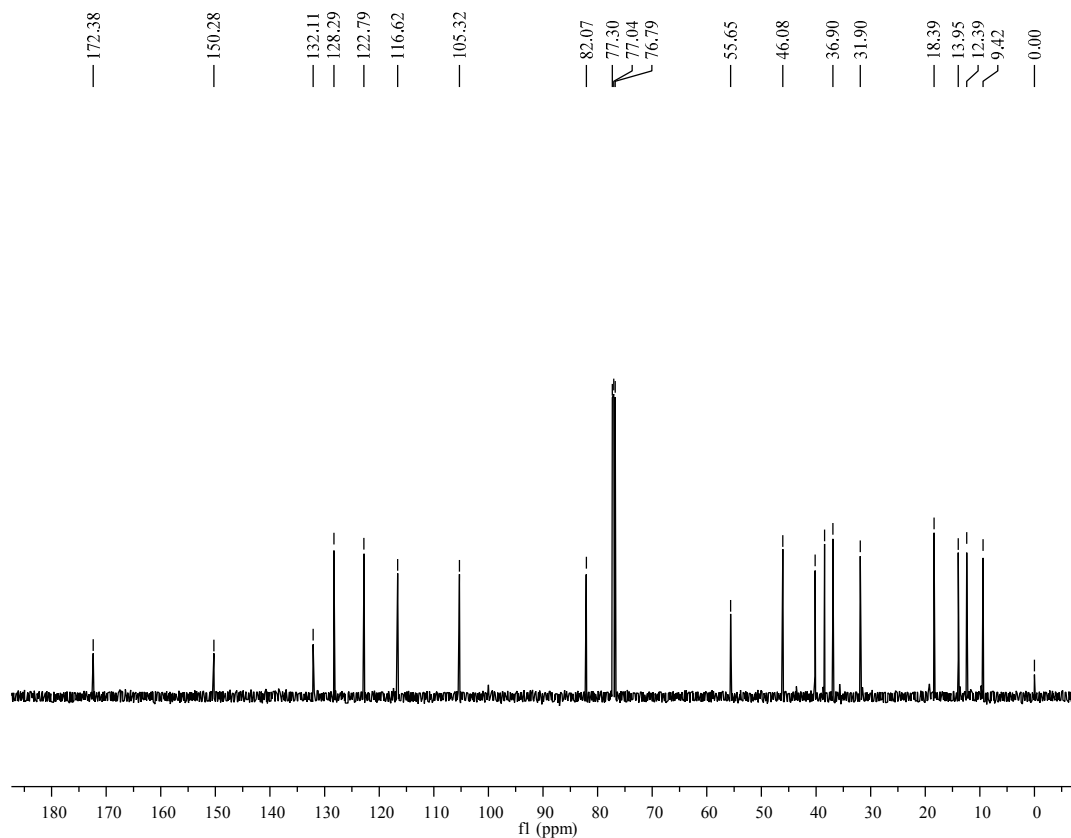
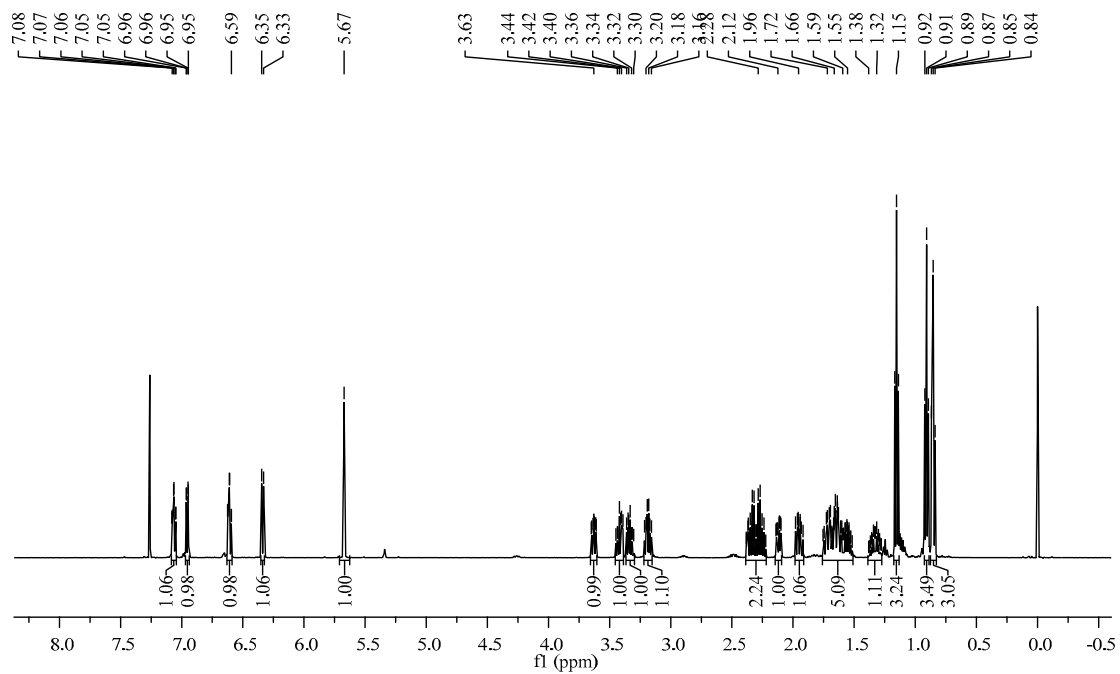


Figure S9. ¹H-NMR spectroscopic data for compound a20.

Figure S10. ¹³C-NMR spectroscopic data for compound a20Figure S11. ¹H-NMR spectroscopic data for compound a21.

Figure S12. ^{13}C -NMR spectroscopic data for compound a21.Figure S13. ^1H -NMR spectroscopic data for compound b3.

Figure S14. ¹³C-NMR spectroscopic data for compound **b3**.Figure S15. ¹H-NMR spectroscopic data for compound **c2**.

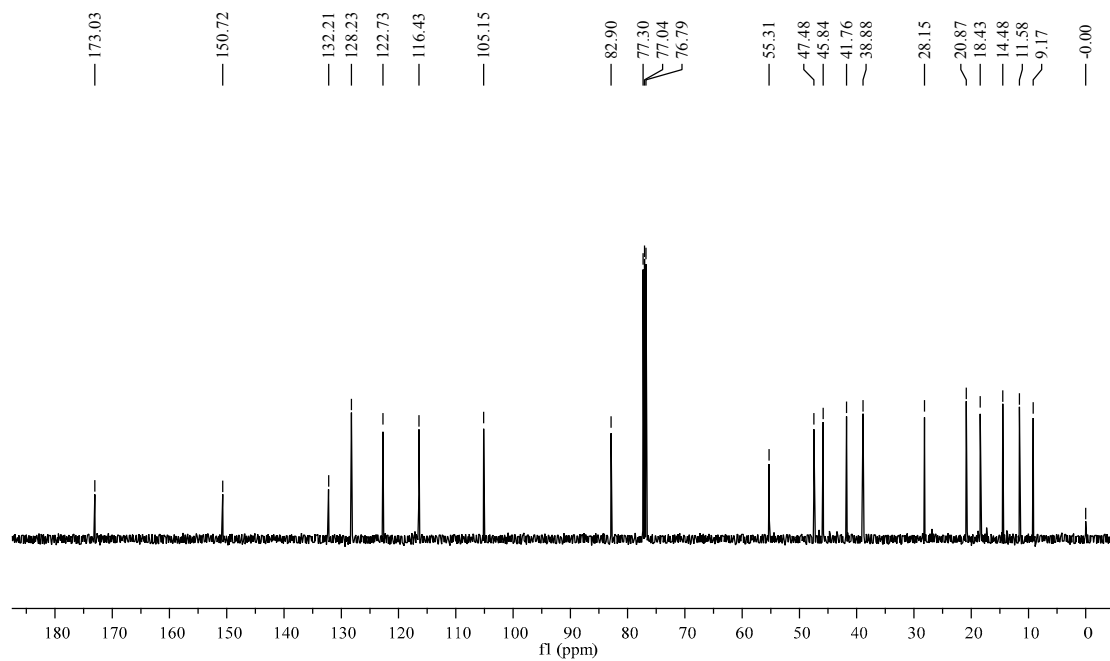


Figure S16. ^{13}C -NMR spectroscopic data for compound **c2**.