SYNTHESIS OF 2-AMINO-4-(2-HYDROXYNAPHTHYL)-4H-CHROMENE-3-CARBONITRILES BY MICHAEL ADDITION AND THEIR TRANSFORMAION INTO NEW HETEROCYCLIC COMPOUNDS

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Supplementary Material

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I. Analytical data of compounds

General procedure for the synthesis of 2-amino-4H-chromene (8-14)

A solution of β -naphthol (5 mmol) in 30 ml of chloroform with a catalytic amount of piperidine was stirred with equipped a magnetic stirrer. After 5 minutes, 3-cyano-iminocoumarin **1-7** (5 mmol) was added and the reaction mixture was stirred at room temperature during the time indicated in Table I. After complete reaction, the simple 2-amino-4H-chromene obtained was separated by filtration and washed with chloroform.

2-amino-4H-chromene (8)

white solid, IR (cm^{-1}): $\nu = 2186$ ($\text{C}\equiv\text{N}$), 3341-3450 (NH_2), 3517 (OH). ^1H NMR (DMSO-d_6): $\delta = 3.77$ (s, 3H, OCH_3), 5.61 (s, 1H, H_4), 6.42 (d, $J = 7.20$ Hz, 1H, H_5), 6.59 (t, $J = 7.80$ Hz, 1H, H_6), 6.71 (d, $J = 7.20$ Hz, 1H, H_7), 6.88 (s, 2H, NH_2), 7.30 (d, $J = 9$ Hz, 1H, H_{Ar}), 7.40-7.45 (m, 2H, H_{Ar}), 7.87-7.95 (m, 3H, H_{Ar}), 9.03 (s, 1H, OH). ^{13}C NMR (DMSO-d_6): $\delta = 31.24, 55.68, 57.59, 109.59, 116.63, 116.71, 119.26, 120.33, 120.51, 123.13, 124.77, 126.97, 128.34, 128.89, 130.53, 130.63, 132.21, 142.51, 146.90, 147.28, 160.10$. Calculated for $\text{C}_{21}\text{H}_{16}\text{N}_2\text{O}_3$: %C 73.24, %H 4.68, %N 8.13. Found: %C 73.29, %H 4.63, %N 8.10.

2-amino-4H-chromene (9)

white solid, IR (cm^{-1}): $\nu = 2222$ ($\text{C}\equiv\text{N}$), 3249 (NH_2), 3320 (OH). ^1H NMR (DMSO-d_6): $\delta = 3.30$ (s, 3H, OCH_3), 5.98 (s, 1H, H_4), 6.41 (d, $J = 2.40$ Hz, 1H, H_8), 6.52 (dd, $J = 2.40$ Hz, $J = 7.80$ Hz, 1H, H_6), 6.72 (d, $J = 7.80$ Hz, 1H, H_5), 6.78 (s, 2H, NH_2), 7.42 (d, $J = 7.20$ Hz, 1H, H_{Ar}), 7.49-7.52 (m, 2H, H_{Ar}), 8.15-8.25 (m, 3H, H_{Ar}), 8.69 (s, 1H, OH). ^{13}C NMR(DMSO-d_6): $\delta = 25.5, 48.8, 55, 105.5, 106.5, 111.5, 111.8, 115.5, 115.8, 116.0, 116.1, 128.7, 129, 129.8, 130, 131, 131.8, 146.9, 152, 155.8, 159$. Calculated for $\text{C}_{21}\text{H}_{16}\text{N}_2\text{O}_3$: %C 73.24, %H 4.68, %N 8.13. Found: %C 73.19, %H 4.74, %N 8.17.

2-amino-4H-chromene (10)

white solid, IR (cm^{-1}): $\nu = 2180$ ($\text{C}\equiv\text{N}$), 3340 (NH_2), 3464 (OH). ^1H NMR (DMSO-d_6): $\delta = 3.50$ (s, 3H, OCH_3), 5.53 (s, 1H, H_4), 6.31 (d, $J = 2.10$ Hz, 1H, H_5), 6.57 (dd, $J = 6.60$ Hz, $J = 2.10$ Hz, 1H, H_7), 6.73 (d, $J = 6.60$ Hz, 1H, H_8), 6.82 (s, 2H, NH_2), 7.30 (d, $J = 6.60$ Hz, 1H, H_{Ar}), 7.41-7.46 (m, 2H, H_{Ar}), 7.87-7.90 (m, 2H, H_{Ar}), 7.94 (d, $J = 6.3$ Hz, 1H, H_{Ar}), 9.36 (s, 1H, OH). ^{13}C NMR (DMSO-d_6): $\delta = 31.4, 55, 57.1, 112, 114.9, 115.9, 116.5, 116.7, 120.3, 123, 125, 127, 128.3, 129, 130.5, 131, 133, 146.9, 147.2, 152.2, 160$. Calculated for $\text{C}_{21}\text{H}_{16}\text{N}_2\text{O}_3$: %C 73.24, %H 4.68, %N 8.13. Found: %C 73.19, %H 4.62, %N 8.20.

2-amino-4H-chromene (11)

white solid, IR (cm^{-1}): $\nu = 2198$ ($\text{C}\equiv\text{N}$), 3301-3373 (NH_2), 3471 (OH). ^1H NMR (DMSO-d_6): $\delta = 5.58$ (s, 1H, H_4), 6.77 (d, $J = 2.10$ Hz, 1H, H_5), 6.84 (d, $J = 8.7$ Hz, 1H, H_8), 6.94 (s, 2H, NH_2), 7.01 (dd, $J = 2.40$ Hz, $J = 8.7$ Hz, 1H, H_7), 7.32 (d, 1H, H_{Ar}), 7.40-7.51 (m, 2H, H_{Ar}), 7.86-7.93 (m, 3H, H_{Ar}), 10.19 (s, 1H, OH). ^{13}C NMR (DMSO-d_6): $\delta = 31.44$, 56.71, 115.64, 116.74, 117.17, 120.25, 122.70, 122.80, 124.93, 127.21, 127.38, 128.12, 128.51, 129.30, 130.25, 130.63, 134.07, 146.97, 152.53, 160.13. Calculated for $\text{C}_{20}\text{H}_{13}\text{ClN}_2\text{O}_2$: %C 68.87, %H 3.76, %N 8.03. Found: %C 68.82, %H 3.69, %N 8.09.

2-amino-4H-chromene (12)

green solid, IR (cm^{-1}): $\nu = 2195$ ($\text{C}\equiv\text{N}$), 3342 (NH_2), 3450 (OH). ^1H NMR (DMSO-d_6): $\delta = 1.10$ (t, $J = 6.9$ Hz, 6H, CH_3), 3.46 (q, $J = 6.9$ Hz, 4H, CH_2), 5.45 (s, 1H, H_4), 6.29 (s, 1H, H_8), 6.34 (d, $J = 7.2$ Hz, 1H, H_6), 6.70 (s, 2H, NH_2), 6.80 (d, $J = 7.2$ Hz, 1H, H_5), 7.22 (d, 1H, $J = 6.6$ Hz, H_{Ar}), 7.30-7.35 (m, 2H, H_{Ar}), 7.45-7.50 (m, 2H, H_{Ar}), 7.70 (d, $J = 6.6$ Hz, 1H, H_{Ar}), 9.40 (s, 1H, OH). Calculated for $\text{C}_{24}\text{H}_{23}\text{N}_3\text{O}_2$: %C 74.78, %H 6.01, %N 10.90. Found: %C 74.84, %H 5.95, %N 10.94.

2-amino-4H-chromene (13)

White solid, IR (cm^{-1}): $\nu = 2197$ ($\text{C}\equiv\text{N}$), 3341 (NH_2), 3423 (OH). ^1H NMR (DMSO-d_6): $\delta = 5.90$ (s, 1H, H_4), 6.44 (s, 1H, H_8), 6.53 (d, $J = 7.2$ Hz, 1H, H_6), 6.70 (s, 2H, NH_2), 6.81 (d, $J = 7.2$ Hz, 1H, H_5), 7.26 (d, 1H, H_{Ar}), 7.29-7.36 (m, 2H, H_{Ar}), 7.42-7.49 (m, 3H, H_{Ar}), 9.40 (s, 1H, OH), 9.73 (s, 1H, OH). Calculated for $\text{C}_{20}\text{H}_{14}\text{N}_2\text{O}_3$: %C 72.72, %H 4.27, %N 8.48. Found: %C 72.66, %H 4.31, %N 8.51.

2-amino-4H-chromene (14)

white solid, IR (cm^{-1}): $\nu = 2205$ ($\text{C}\equiv\text{N}$), 3340 (NH_2), 3429 (OH). ^1H NMR (DMSO-d_6): $\delta = 5.88$ (s, 1H, H_4), 6.80 (s, 2H, NH_2), 7.08 (d, $J = 6.9$ Hz, 1H, $\text{H}_{5'}$), 7.12 (d, $J = 6.9$ Hz, 1H, $\text{H}_{6'}$), 7.40 (d, $J = 7.2$ Hz, 1H, H_8), 7.45 (d, $J = 7.2$ Hz, 1H, H_{Ar}), 7.48 (t, $J = 6.9$ Hz, 1H, $\text{H}_{6''}$), 7.53-7.63 (m, 2H, H_{Ar}), 7.66 (t, $J = 6.9$ Hz, 1H, $\text{H}_{5''}$), 7.88 (d, $J = 7.2$ Hz, 1H, H_7), 8.18 (d, $J = 7.2$ Hz, 1H, H_{Ar}), 8.20-8.25 (m, 2H, H_{Ar}), 9.86 (s, 1H, OH). Calculated for $\text{C}_{24}\text{H}_{16}\text{N}_2\text{O}_2$: %C 79.11, %H 4.43, %N 7.69. Found: %C 79.07, %H 4.50, %N 7.63.

General procedure for the synthesis of polycyclic compounds 15-19

A mixture of 2-amino-4H-chromene **8-12** (5mmol), methanol (6 ml) and toluene (15 ml) in the presence of formic acid (20 ml) was heated at 65°C for 12 h. The mixture cooled and the precipitate filtered off, then washed with methanol.

Compound (15)

white solid, IR (cm⁻¹): ν = 1592 (C=C), 1616 (C=N), 1752 (C=O), 3394 (NH). ¹H NMR (DMSO-d₆): δ = 3.78 (s, 3H, OCH₃), 5.50 (d, J = 7.2 Hz, 1H, H_{Ar}), 5.75 (d, J = 7.2 Hz, 1H, H_{Ar}), 6.55 (d, J = 7.3 Hz, 1H, H₅), 6.69 (t, J = 7.8, 1H, H₆), 6.87 (d, J = 7.8, 1H, H₇), 7.42-7.57 (m, 2H, H_{Ar}), 7.90-8.02 (m, 2H, H_{Ar}), 9.46 (s, 1H, NH). Calculated for C₂₁H₁₃NO₄: %C 73.46, %H 3.82, %N 4.08. Found: %C 73.40, %H 3.90, %N 4.04.

Compound (16)

white solid, IR (cm⁻¹): ν = 1592 (C=C), 1636 (C=N), 1749 (C=O), 3377 (NH). ¹H NMR (DMSO-d₆): δ = 3.34 (s, 3H, OCH₃), 5.42 (d, J = 6.8 Hz, 1H, H_{Ar}), 5.90 (d, J = 6.8 Hz, 1H, H_{Ar}), 6.52 (s, 1H, H₈), 6.70 (d, J = 7.5 Hz, 1H, H₆), 6.89 (d, J = 7.2 Hz, 1H, H₅), 7.53-7.59 (m, 2H, H_{Ar}), 8.25-8.35 (m, 2H, H_{Ar}), 8.90 (s, 1H, NH). Calculated for C₂₁H₁₃NO₄: %C 73.46, %H 3.82, %N 4.08. Found: %C 73.51, %H 3.74, %N 4.12.

Compound (17)

white solid, IR (cm⁻¹): ν = 1585 (C=C), 1640 (C=N), 1756 (C=O), 3355 (NH). ¹H NMR (DMSO-d₆): δ = 3.70 (s, 3H, OCH₃), 5.48 (d, J = 7.2 Hz, 1H, H_{Ar}), 5.52 (d, J = 7.2 Hz, 1H, H_{Ar}), 6.50 (d, J = 7.8 Hz, 1H, H₈), 6.72 (d, J = 7.8 Hz, 1H, H₇), 6.88 (s, 1H, H₅), 7.46-7.55 (m, 2H, H_{Ar}), 7.99-8.10 (m, 2H, H_{Ar}), 9.40 (s, 1H, NH). Calculated for C₂₁H₁₃NO₄: %C 73.46, %H 3.82, %N 4.08. Found: %C 73.39, %H 3.89, %N 4.11.

Compound (18)

white solid, IR (cm^{-1}): $\nu = 1589$ (C=C), 1643 (C=N), 1750 (C=O), 3360 (NH). ^1H NMR (DMSO- d_6): $\delta = 5.53$ (d, $J = 6.9\text{ Hz}$, 1H, H_{Ar}), 5.58 (d, $J = 7.0\text{ Hz}$, 1H, H_{Ar}), 6.47 (d, $J = 9.0\text{ Hz}$, 1H, H_8), 6.66 (d, $J = 9.0\text{ Hz}$, 1H, H_7), 6.80 (s, 1H, H_5), 7.34-7.49 (m, 2H, H_{Ar}), 7.90-7.99 (m, 2H, H_{Ar}), 9.37 (s, 1H, NH). Calculated for $\text{C}_{20}\text{H}_{10}\text{ClNO}_3$: %C 69.08, %H 2.90, %N 4.03. Found: %C 69.13, %H 2.86, %N 3.99.

Compound (19)

white solid, IR (cm^{-1}): $\nu = 1590$ (C=C), 1642 (C=N), 1749 (C=O), 3362 (NH). ^1H NMR (DMSO- d_6): $\delta = 1.20$ (t, $J = 6.9\text{ Hz}$, 6H, CH_3), 3.45 (q, $J = 6.9\text{ Hz}$, 4H, CH_2), 5.60 (d, $J = 7.2\text{ Hz}$, 1H, H_{Ar}), 5.64 (d, $J = 7.2\text{ Hz}$, 1H, H_{Ar}), 6.43 (s, 1H, H_8), 6.46 (d, $J = 8.7\text{ Hz}$, 1H, H_6), 6.92 (d, $J = 8.7\text{ Hz}$, 1H, H_5), 7.36-7.42 (m, 2H, H_{Ar}), 7.56-7.66 (m, 2H, H_{Ar}), 9.34 (s, 1H, NH). Calculated for $\text{C}_{24}\text{H}_{20}\text{N}_2\text{O}_3$: %C 74.98, %H 5.24, %N 7.29. Found: %C 75.04, %H 5.19, %N 7.33.

II. Selected of IR and ^1H NMR spectra