Supporting Material

for

Reactions of β-Diketone Compounds with Nitriles Catalyzed by Lewis Acids: a simple approach to β-enaminone synthesis

Xu Cheng, a Shuchen Pei, a Chenchen Xue, a Kaifei Cao, b Li Hai a and Yong Wu* a

a Key Laboratory of Drug Targeting and Drug Delivery system of Education Ministry, Department of Medicinal Chemistry, West China School of Pharmacy, West China Hospital, Sichuan University, No. 37, GuoXue Road, Chengdu 610041, P.R. China. E-mail: wyong@scu.edu.cn; Fax: +862885503666
b Clinical Medicine School, Chengdu university of Traditional Chinese Medicine, No. 37 12-bridge road, Chengdu, 610075, P.R.China.

Experimental details and characterization data of synthesized compounds, ¹H NMR and ¹³C NMR

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General

Unless otherwise noted, materials were obtained from commercial suppliers and were used without further purification. All manipulations involving air-sensitive materials were performed under argon.

TLC was performed using precoated silica gel GF254 (0.2mm), while column chromatography was performed using silica gel (100-200 mesh). The melting point was measured on a YRT-3 melting point apparatus (Shantou Keyi instrument & Equipment Co. Ltd, Shantou, China). IR spectra were obtained on a Perkin Elmer983 (Perkin Elmer, Norwalk, CT, USA). 1H-NMR spectra were taken on a Varian INOVA400 (Varian, Palo Alto, CA, USA) using CDCl₃ as solvent. Chemical shifts are expressed in δ (ppm), with tetramethylsilane (TMS) functioning as the internal reference, and coupling constants (J) were expressed in Hz. Mass spectra were recorded on an Agilent 1946B ESI-MS instrument (Agilent, Palo Alto, CA, USA).

Characterization data

3-(amino(phenyl)methylene)pentane-2,4-dione (3a)
Yellow oil; ¹H NMR (CDCl₃, 400 MHz, δ ppm): 10.94 (brs, 1H), 7.54-7.27 (m, 5H), 5.50 (brs, 1H), 2.29 (s, 3H), 1.64 (s, 3H); ¹³C NMR (CDCl₃, 100 MHz, δ ppm): 197.60, 196.99, 168.19, 134.33, 128.65, 128.04, 127.83, 110.83, 29.74, 29.66. HRMS: m/z (+ESI) Calcd for C₁₂H₁₃NO₂, 204.1025, Found: 204.2306 [M+H]⁺.

3-(amino(4-nitrophenyl)methylene)pentane-2,4-dione (3b)
Yellow oil; ¹H NMR (CDCl₃, 400 MHz, δ ppm): 9.94 (brs, 1H), 8.32 (d, 2H, J = 8.8 Hz), 7.74 (d, 2H, J = 8.8 Hz), 5.19 (brs, 1H), 2.46 (s, 3H), 2.20 (s, 3H); ¹³C NMR (CDCl₃, 100 MHz, δ ppm): 198.90, 196.99, 166.18, 147.14, 140.04, 126.36, 123.04, 112.84, 29.97, 29.75. HRMS: m/z (+ESI) Calcd for C₁₂H₁₂N₂O₄, 249.0797, Found: 249.1906 [M+H]⁺.

3-(amino(2-nitrophenyl)methylene)pentane-2,4-dione (3c)
Yellow oil; ¹H NMR (CDCl₃, 400 MHz, δ ppm): 9.87 (brs, 1H), 7.95-7.94 (m, 1H), 7.70-7.46 (m, 3H), 5.08 (brs, 1H), 2.20 (s, 3H), 2.08 (s, 3H); ¹³C NMR (CDCl₃, 100 MHz, δ ppm): 199.30, 198.77, 167.19, 145.05, 134.74, 130.14, 128.87, 127.20, 123.80, 112.86, 29.74, 29.25. HRMS: m/z (+ESI) Calcd for C₁₂H₁₂N₂O₄, 249.0797, Found: 249.1906 [M+H]⁺.

3-(1-amino-2-phenylethylidene)pentane-2,4-dione (3d)
Yellow oil; ¹H NMR (CDCl₃, 400 MHz, δ ppm): 11.11 (brs, 1H), 7.40-7.18 (m, 5H), 5.64 (brs, 1H), 3.79 (s, 2H), 2.28 (s, 3H), 2.04 (s, 3H); ¹³C NMR (CDCl₃, 100 MHz, δ ppm): 198.18, 197.30, 163.18, 135.63, 128.04, 127.85, 125.37, 110.80, 38.61, 32.04, 31.96. HRMS: m/z (+ESI) Calcd for C₁₃H₁₅NO₂, 218.1103, Found: 218.1082 [M+H]⁺.

3-(1-amino-3-phenylallylidene)pentane-2,4-dione (3e)
Yellow oil; ¹H NMR (CDCl₃, 400 MHz, δ ppm): 10.12 (brs, 2H), 7.48-7.32 (m, 5H), 7.10 (d, 1H, J = 16.4 Hz), 6.80 (d, 1H, J = 16.4 Hz), 2.34 (s, 3H), 2.14 (s, 3H); ¹³C NMR (CDCl₃, 100 MHz, δ

3-(amino(furan-2-yl)methylene)pentane-2,4-dione (3f)
Yellow oil; $^1$H NMR (CDCl$_3$, 400 MHz, δ ppm): 10.46 (brs, 2H), 7.56 (s, 1H), 6.78 (s, 1H), 6.51 (s, 1H), 2.11 (s, 3H), 1.96 (s, 3H); $^{13}$C NMR (CDCl$_3$, 100 MHz, δ ppm): 198.57, 198.46, 165.62, 155.32, 143.83, 124.13, 112.78, 111.60, 30.48, 30.33. HRMS: m/z (+ESI) Calcd for C$_{10}$H$_{11}$NO$_3$, 194.0739, Found: 194.1452 [M+H]$^+$. 

3-(amino(2-methoxyphenyl)methylene)pentane-2,4-dione (3g)
Yellow oil; $^1$H NMR (CDCl$_3$, 400 MHz, δ ppm): 10.17 (brs, 1H), 7.46-7.37 (m, 4H), 5.98 (brs, 1H), 3.87 (s, 3H), 2.12 (s, 3H), 1.26 (s, 3H); $^{13}$C NMR (CDCl$_3$, 100 MHz, δ ppm): 197.30, 197.27, 169.18, 155.63, 130.65, 128.04, 127.13, 120.37, 110.80, 104.05, 59.50, 29.64, 29.25. HRMS: m/z (+ESI) Calcd for C$_{13}$H$_{15}$NO$_3$, 234.1052, Found: 234.2187 [M+H]$^+$. 

3-(1-aminoethylidene)pentane-2,4-dione (3h)
Yellow oil; $^1$H NMR (CDCl$_3$, 400 MHz, δ ppm): 8.61 (brs, 2H), 2.29 (s, 6H), 2.20 (s, 3H); HRMS: m/z (+ESI) Calcd for C$_7$H$_{11}$NO$_2$, 142.0790, Found: 142.2203 [M+H]$^+$. 

The observed data was consistent with that previously reported.[1] 

ethyl 4-acetyl-3-amino-5-oxohex-3-enoate (3i)
Yellow oil; $^1$H NMR (CDCl$_3$, 400 MHz, δ ppm): 15.11 (brs, 2H), 4.19 (q, 2H, $J = 7.2$ Hz), 3.22 (s, 2H), 2.24 (s, 3H), 2.07 (s, 3H), 1.27 (t, 3H, $J = 7.2$ Hz); $^{13}$C NMR (CDCl$_3$, 100 MHz, δ ppm): 198.77, 197.97, 168.03, 163.19, 116.71, 61.43, 32.04, 31.97, 29.89, 14.32. HRMS: m/z (+ESI) Calcd for C$_{10}$H$_{15}$NO$_4$, 214.1001, Found: 214.1546 [M+H]$^+$. 

2-(amino(phenyl)methylene)-1-phenylbutane-1,3-dione (3j)
Yellow oil; $^1$H NMR (CDCl$_3$, 400 MHz, δ ppm): 15.61 (brs, 1H), 8.12-7.99 (m, 4H), 7.63-7.51 (m, 6H), 6.75 (brs, 1H), 2.20 (s, 3H); $^{13}$C NMR (CDCl$_3$, 100 MHz, δ ppm): 198.63, 191.22, 166.50, 135.38, 133.58, 132.68, 132.35, 130.37, 129.40, 128.68, 128.65, 128.56, 128.19, 127.05, 109.65, 30.21. HRMS: m/z (+ESI) Calcd for C$_{17}$H$_{15}$NO$_2$, 266.1103, Found: 266.1912 [M+H]$^+$. 

3-(amino(2-chlorophenyl)methylene)pentane-2,4-dione (3m)
Yellow oil; $^1$H NMR (CDCl$_3$, 400 MHz, δ ppm): 9.61 (brs, 1H), 7.69-7.38 (m, 4H), 5.53 (brs, 1H), 3.29 (s, 3H), 2.11 (s, 3H); $^{13}$C NMR (CDCl$_3$, 100 MHz, δ ppm): 196.98, 196.10, 167.18, 136.58, 136.56, 133.85, 129.88, 127.09, 115.82, 113.11, 29.75, 29.24. HRMS: m/z (+ESI) Calcd for C$_{12}$H$_{13}$NO$_2$Cl, 238.0557, Found: 238.1139 [M+H]$^+$. 

3-(1-amino-3-bromopropylidene)pentane-2,4-dione (3n)
Yellow oil; $^1$H NMR (CDCl$_3$, 400 MHz, δ ppm): 5.41 (brs, 2H), 3.53 (t, 2H, $J = 6.4$ Hz), 2.99 (t, 2H, $J = 6.4$ Hz), 2.27 (s, 3H), 2.01 (s, 3H); $^{13}$C NMR (CDCl$_3$, 100 MHz, δ ppm): 198.70, 198.65, 167.71, 115.69, 38.50, 30.15, 29.98, 27.21. HRMS: m/z (+ESI) Calcd for C$_8$H$_{12}$NO$_2$Br, 234.0051, Found: 234.1671 [M+H]$^+$.
3-(amino(4-hydroxyphenyl)methylene)pentane-2,4-dione (3o)
Yellow oil; \(^1\)H NMR (DMSO-d₆, 400 MHz, \(\delta\) ppm): 11.05 (brs, 1H), 10.64 (s, 1H), 7.59 (d, 2H, \(J = 8.8\) Hz), 6.89 (d, 2H, \(J = 8.8\) Hz), 5.40 (brs, 1H), 2.26 (s, 3H), 1.71 (s, 3H). \(^{13}\)C NMR (DMSO-d₆, 100 MHz, \(\delta\) ppm): 199.01, 197.59, 167.28, 161.96, 134.52, 128.13, 116.74, 112.09, 29.97, 29.75. HRMS: m/z (+ESI) Calcd for C₁₂H₁₃NO₃, 220.0895, Found: 220.1901 [M+H]⁺.

3-(1-amino-2-(4-hydroxyphenyl)ethylidene)pentane-2,4-dione (3p)
Yellow oil; \(^1\)H NMR (DMSO-d₆, 400 MHz, \(\delta\) ppm): 9.54 (s, 1H), 7.14 (d, 2H, \(J = 8.4\) Hz), 6.79 (d, 2H, \(J = 8.4\) Hz), 5.24 (brs, 2H), 3.85 (s, 2H), 2.29 (s, 3H), 2.11 (s, 3H). \(^{13}\)C NMR (DMSO-d₆, 100 MHz, \(\delta\) ppm): 198.97, 198.76, 163.17, 155.51, 130.47, 128.19, 115.87, 112.01, 38.65, 29.10, 28.87. HRMS: m/z (+ESI) Calcd for C₁₃H₁₅NO₃, 234.1052, Found: 234.1787 [M+H]⁺.

methyl 4-(2-acetyl-1-amino-3-oxobut-1-en-1-yl)benzoate (3q)
Yellow oil; \(^1\)H NMR (CDCl₃, 400 MHz, \(\delta\) ppm): 10.02 (brs, 1H), 8.20 (d, 2H, \(J = 5.6\) Hz), 7.96 (d, 2H, \(J = 5.6\) Hz), 5.52 (brs, 1H), 3.97 (s, 3H), 2.11 (s, 3H), 1.94 (s, 3H). \(^{13}\)C NMR (CDCl₃, 100 MHz, \(\delta\) ppm): 198.90, 196.99, 166.18, 165.97, 138.54, 129.85, 129.36, 126.34, 112.84, 51.51, 29.97, 29.75. HRMS: m/z (+ESI) Calcd for C₁₄H₁₅NO₄, 262.1001, Found: 262.1625 [M+H]⁺.

4-amino-4-phenylbut-3-en-2-one (4a)
White solid; m.p 84-86 °C (lit.[2] 84-87 °C); \(^1\)H NMR (CDCl₃, 400 MHz, \(\delta\) ppm): 9.93 (brs, 1H), 7.55-7.26 (m, 5H), 5.45 (s, 1H), 5.25 (brs, 1H), 2.15 (s, 3H); HRMS: m/z (+ESI) Calcd for C₁₀H₁₁NO, 162.0841, Found: 162.1431 [M+H]⁺.

4-amino-4-(4-nitrophenyl)but-3-en-2-one (4b)
Yellow oil; \(^1\)H NMR (CDCl₃, 400 MHz, \(\delta\) ppm): 9.83 (brs, 1H), 8.29 (d, 2H, \(J = 8.8\) Hz), 7.72 (d, 2H, \(J = 8.8\) Hz), 5.47 (s, 1H), 5.08 (brs, 1H), 2.20 (s, 3H); HRMS: m/z (+ESI) Calcd for C₁₀H₁₀N₂O₃, 207.0691, Found: 207.1983 [M+H]⁺. The observed data was consistent with that previously reported.[3]

4-amino-4-(2-nitrophenyl)but-3-en-2-one (4c)
Colorless oil; \(^1\)H NMR (CDCl₃, 400 MHz, \(\delta\) ppm): 9.79 (brs, 1H), 7.96-7.94 (s 1H), 7.69-7.51 (m, 3H), 5.11 (s, 1H), 2.08 (s, 3H); \(^{13}\)C NMR (CDCl₃, 100 MHz, \(\delta\) ppm): 199.30, 155.88, 145.07, 134.75, 130.07, 128.88, 127.30, 123.85, 100.82, 29.22. HRMS: m/z (+ESI) Calcd for C₁₀H₁₀N₂O₃, 207.0691, Found: 207.1983 [M+H]⁺.

4-amino-5-phenylpent-3-en-2-one (4d)
Yellow oil; \(^1\)H NMR (CDCl₃, 400 MHz, \(\delta\) ppm): 9.70 (brs, 1H), 7.46-7.24 (m, 5H), 5.11 (s, 1H), 5.01 (brs, 1H), 3.46 (s, 2H), 2.09 (s, 3H); HRMS: m/z (+ESI) Calcd for C₁₁H₁₃NO, 176.0997, Found: 176.2143 [M+H]⁺. The observed data was consistent with that previously reported.[4]

4-amino-6-phenylhexa-3,5-dien-2-one (4e)
Yellow oil; \(^1\)H NMR (CDCl₃, 400 MHz, \(\delta\) ppm): 9.87 (brs, 2H), 7.51-7.47 (m, 5H), 7.04 (d, 1H, \(J = 16.4\) Hz), 6.43 (d, 1H, \(J = 16.4\) Hz), 5.32 (s, 1H), 2.17 (s, 3H); \(^{13}\)C NMR (CDCl₃, 100 MHz, \(\delta\) ppm): 199.01, 197.59, 167.28, 161.96, 134.52, 128.13, 116.74, 112.09, 29.97, 29.75. HRMS: m/z (+ESI) Calcd for C₁₂H₁₃NO₃, 220.0895, Found: 220.1901 [M+H]⁺.
ppm): 197.94, 153.76, 135.43, 134.98, 129.31, 128.73, 127.28, 124.39, 103.20, 30.16. HRMS: m/z (+ESI) Calcd for C_{12}H_{13}NO, 188.0997, Found: 188.0464 [M+H]^+.

4-amino-4-(furan-2-yl)but-3-en-2-one (4f)
White solid; m.p 80-82 °C (lit.[5] 80.0-80.5 °C); ^1H NMR (CDCl$_3$, 400 MHz, δ ppm): 9.69 (brs, 1H), 7.49 (s, 1H), 6.82 (s, 1H), 6.47 (s, 1H), 5.80 (brs, 1H), 5.56 (s, 1H), 2.11 (s, 3H); HRMS: m/z (+ESI) Calcd for C$_6$H$_9$NO, 152.0633, Found: 152.1872 [M+H]^+.

4-amino-4-(2-methoxyphenyl)but-3-en-2-one (4g)
Colorless oil; ^1H NMR (CDCl$_3$, 400 MHz, δ ppm): 11.08 (brs, 1H), 7.21-6.96 (m, 4H), 5.66 (brs, 1H), 5.35 (s, 1H), 3.86 (s, 3H), 1.30 (s, 3H); ^13C NMR (CDCl$_3$, 100 MHz, δ ppm): 190.31, 169.20, 155.64, 131.57, 128.04, 127.13, 120.38, 110.83, 104.05, 59.51, 29.63. HRMS: m/z (+ESI) Calcd for C$_{11}$H$_{13}$NO$_2$, 192.0946, Found: 192.2021 [M+H]^+.

4-aminopent-3-en-2-one (4h)
White solid; m.p 30-32 °C (lit.[6] 31-32 °C); ^1H NMR (CDCl$_3$, 400 MHz, δ ppm): 8.59 (brs, 2H), 5.01 (s, 1H), 2.26 (s, 3H), 1.97 (s, 3H); HRMS: m/z (+ESI) Calcd for C$_5$H$_9$NO, 100.0684, Found: 100.1197 [M+H]^+.

ethyl 3-amino-5-oxohex-3-enoate (4i)
Yellow oil; ^1H NMR (CDCl$_3$, 400 MHz, δ ppm): 15.03 (brs, 2H), 5.60 (s, 1H), 4.20 (q, 2H, J = 7.2 Hz), 3.34 (s, 2H), 1.99 (s, 3H), 1.27 (t, 3H, J = 7.2 Hz); ^13C NMR (CDCl$_3$, 100 MHz, δ ppm): 196.90, 169.54, 167.54, 102.70, 59.85, 32.41, 30.35, 13.99. HRMS: m/z (+ESI) Calcd for C$_8$H$_{13}$NO$_3$, 172.0895, Found: 172.2547 [M+H]^+.

3-amino-1,3-diphenylprop-2-en-1-one (4j / 4l)
Yellow oil; ^1H NMR (CDCl$_3$, 400 MHz, δ ppm): 16.8 (brs, 1H), 8.00-7.98 (m, 4H), 7.57-7.47 (m, 6H), 6.86 (s, 1H), 6.83 (brs, 1H); HRMS: m/z (+ESI) Calcd for C$_{15}$H$_{13}$NO, 224.0997, Found: 224.3112 [M+H]^+.

The observed data was consistent with that previously reported.[7]

1-amino-4,4-dimethyl-1-phenylpent-1-en-3-one (4k)
White solid; m.p 73-75 °C (lit.[7] 72-74 °C); ^1H NMR (CDCl$_3$, 400 MHz, δ ppm): 7.55-7.41 (m, 5H), 5.45 (s, 1H), 2.03 (brs, 2H), 1.27 (s, 9H); HRMS: m/z (+ESI) Calcd for C$_{13}$H$_{17}$NO, 204.1310, Found: 204.3212 [M+H]^+.

4-amino-4-(2-chlorophenyl)but-3-en-2-one (4m)
Yellow oil; ^1H NMR (CDCl$_3$, 400 MHz, δ ppm): 9.80 (brs, 1H), 7.68-7.37 (m, 4H), 5.70 (s, 1H), 5.53 (brs, 1H), 2.30 (s, 3H); ^13C NMR (CDCl$_3$, 100 MHz, δ ppm): 109.01, 167.17, 136.58, 136.57, 133.85, 129.89, 127.10, 116.73, 113.11, 29.25. HRMS: m/z (+ESI) Calcd for C$_{10}$H$_{10}$NOCl, 196.0451, Found: 196.1132 [M+H]^+.

4-amino-6-bromohex-3-en-2-one (4n)
Yellow oil; ^1H NMR (CDCl$_3$, 400 MHz, δ ppm): 5.42 (s, 1H), 5.31 (brs, 2H), 3.53 (t, 2H, J = 6.4
Hz), 2.99 (t, 2H, J = 6.4 Hz), 2.13 (s, 3H); $^{13}$C NMR (CDCl$_3$, 100 MHz, δ ppm): 198.81, 167.70, 115.78, 38.41, 29.80, 27.30. HRMS: m/z (+ESI) Caled for C$_6$H$_{10}$NOBr, 191.9946, Found: 192.0038 [M+H]$^+$.  

4-amino-4-(4-hydroxyphenyl)but-3-en-2-one (4o)  
Yellow oil; $^1$H NMR (DMSO-d$_6$, 400 MHz, δ ppm): 11.06 (brs, 1H), 10.64 (s, 1H), 7.59 (d, 2H, J = 4.8 Hz), 6.89 (d, 2H, J = 4.8 Hz), 5.79 (s, 1H), 5.57 (brs, 1H), 2.27 (s, 3H). $^{13}$C NMR (DMSO-d$_6$, 100 MHz, δ ppm): 199.10, 167.27, 162.02, 134.53, 128.21, 116.75, 112.10, 28.75. HRMS: m/z (+ESI) Caled for C$_{10}$H$_{11}$NO$_2$, 178.0790, Found: 178.0920 [M+H]$^+$.  

4-amino-5-(4-hydroxyphenyl)pent-3-en-2-one (4p)  
Yellow oil; $^1$H NMR (DMSO-d$_6$, 400 MHz, δ ppm): 9.55 (s, 1H), 7.15 (d, 2H, J = 8.0 Hz), 6.79 (d, 2H, J = 8.0 Hz), 5.47 (s, 1H), 5.20 (brs, 2H), 3.85 (s, 2H), 2.12 (s, 3H). $^{13}$C NMR (DMSO-d$_6$, 100 MHz, δ ppm): 198.87, 163.21, 155.51, 130.56, 127.98, 116.01, 112.07, 38.70, 29.07. HRMS: m/z (+ESI) Caled for C$_{11}$H$_{13}$NO$_2$, 192.0946, Found: 192.1405 [M+H]$^+$.  

methyl 4-(1-amino-3-oxobut-1-en-1-yl)benzoate (4q)  
Yellow oil; $^1$H NMR (CDCl$_3$, 400 MHz, δ ppm): 10.03 (s, 1H), 8.20 (d, 2H, J = 5.6 Hz), 7.96 (d, 2H, J = 5.6 Hz), 5.71 (s, 1H), 5.50 (brs, 1H), 3.97 (s, 3H), 2.11 (s, 3H). $^{13}$C NMR (CDCl$_3$, 100 MHz, δ ppm): 198.91, 166.20, 165.98, 138.54, 129.85, 129.36, 126.34, 112.85, 51.53, 29.76. HRMS: m/z (+ESI) Caled for C$_{12}$H$_{13}$NO$_3$, 219.0895, Found: 219.1136 [M+H]$^+$.  

2-(amino(phenyl)methylene)cyclohexane-1,3-dione (3r)  
Yellow oil; $^1$H NMR (CDCl$_3$, 400 MHz, δ ppm): 9.67 (brs, 2H), 7.96-7.94 (m, 2H), 7.47-7.39 (m, 3H), 2.55 (t, 2H, J = 6.4 Hz), 2.44 (t, 2H, J = 6.4 Hz), 2.07-2.03 (m, 2H); HRMS: m/z (+ESI) Caled for C$_{13}$H$_{13}$NO$_2$, 216.0946, Found: 216.2211 [M+H]$^+$.  

The observed data was consistent with that previously reported.[8]  

7-amino-5-oxo-7-phenylhept-6-enoic acid (4r)  
Yellow oil; $^1$H NMR (CDCl$_3$, 400 MHz, δ ppm): 11.11 (s, 1H), 9.58 (brs, 2H), 7.41-7.30 (m, 2H), 5.35 (s, 1H), 2.40 (t, 2H, J = 6.4 Hz), 2.35 (t, 2H, J = 6.4 Hz), 2.01-1.95 (m, 2H); $^{13}$C NMR (CDCl$_3$, 100 MHz, δ ppm): 201.29, 178.43, 160.71, 139.75, 128.31, 127.96, 126.97, 100.73, 42.35, 32.71, 18.29. HRMS: m/z (+ESI) Caled for C$_{13}$H$_{13}$NO$_3$, 234.1052, Found: 234.2136 [M+H]$^+$.  

Synthesis of (5-methylisoxazol-3-yl)methanamine (23)  
2-(1,3-dioxoisindolin-2-yl)acetonitrile (20)  
To a stirring solution of glycinonitrile hydrochloride 19 (2g, 21.6mmol, 1.0eq) in chloroform (20ml) at 0°C was added triethylamine (2.19g, 21.6mmol, 1.0eq) dropwise. The reaction mixture was allowed to attain room temperature for 30min and phthalic anhydride (3.2g, 21.6mmol, 1.0eq) was added. The reaction mixture was heat at 60°C for a period of 6h. After cooling, the organic layer was washed with water and brine and dried over Na$_2$SO$_4$, filtered, and concentrated under reduced pressure. The residue was recrystallized from petroleum ether and ethyl acetate, to afford the pure white solid 20 (2.4g, 60%). M.p. 126-127°C. $^1$H NMR (CDCl$_3$, 400 MHz, δ ppm): 7.95-
To a solution of 20 (500mg, 2.7mmol, 1.0eq), AlCl₃ (360mg, 2.7mmol, 1.0eq) and acetylacetone (323mg, 3.2mmol, 1.2eq) were added at room temperature with stirring. The mixture was heated at 100°C with stirring for 4 h. After cooling to room temperature, saturated sodium carbonate solution was added, and the mixture was extracted with EtOAc. The combined organic phases were washed with brine, dried over Na₂SO₄, and concentrated in vacuo. The residue was purified by flash column chromatography on silica gel to give 21 (495mg, 75.1%) as a white solid. M.p 150-152°C.

1H NMR (CDCl₃, 400 MHz, δ ppm): 14.63 (brs, 2H), 7.91-7.88 (m, 2H), 7.77-7.75 (m, 2H), 5.57 (s, 1H), 4.51 (s, 2H), 2.05 (s, 3H).

13C NMR (CDCl₃, 100 MHz, δ ppm): 196.38, 169.52, 167.75, 160.02, 132.25, 132.23, 132.21, 132.19, 123.74, 123.68, 98.83, 55.42, 27.53. HRMS: m/z (+ESI) Calcd for C₁₃H₁₂N₂O₃, 245.0848, Found: 245.1354 [M+H]+

2-((5-methylisoxazol-3-yl)methyl)isoindoline-1,3-dione (22)

To a stirring solution of 21 (200mg, 0.82mmol, 1.0eq) in ethanol (10ml) was added hydroxylamine hydrochloride (69mg, 0.99mmol, 1.2eq). The mixture reaction was heated at 80°C with stirring for 2 h. Ethanol was removed under vacuo and the residue was extracted with ethyl acetate, the combined organic phases were washed with brine, dried over Na₂SO₄, and concentrated in vacuo. The crude product was used for the next reaction without any further purification.

(5-methylisoxazol-3-yl)methanamine (23)

To a stirring solution of 22 (150mg, 0.62mmol, 1.0eq) in ethanol (5ml) was added 80% hydrazine hydrate (78mg, 1.2mmol, 2.0eq). The mixture reaction was heated at 80°C with stirring for 2 h. Ethanol was removed under vacuo and the residue was extracted with ethyl acetate, the combined organic phases were washed with brine, dried over Na₂SO₄, and concentrated in vacuo. The residue was purified by flash column chromatography on silica gel to give 23 (53mg, 76.8%) as a yellow oil.

1H NMR (CDCl₃, 400 MHz, δ ppm): 9.15 (brs, 2H), 6.33 (s, 1H), 3.83 (s, 2H), 2.39 (s, 3H); 13C NMR (CDCl₃, 100 MHz, δ ppm): 169.36, 150.02, 102.32, 38.64, 11.85. HRMS: m/z (+ESI) Calcd for C₅H₈N₂O, 113.1298, Found: 113.2349 [M+H]+

References

$^1$H NMR and $^{13}$C NMR spectra for synthesized compounds

$^1$H NMR spectra for compound 3a

$^1$H NMR spectra for compound 3b
$^1$H NMR spectra for compound 3c

$^1$H NMR spectra for compound 3d
$^1$H NMR spectra for compound 3e

$^1$H NMR spectra for compound 3f
$^1$H NMR spectra for compound 3g

$^1$H NMR spectra for compound 3m
$^{1}$H NMR spectra for compound $3n$

$^{1}$H NMR spectra for compound $3o$
$^1$H NMR spectra for compound 3p

$^1$H NMR spectra for compound 3q
$^1$H NMR spectra for compound 4a

$^1$H NMR spectra for compound 4b
$^{1}$H NMR spectra for compound 4c

$^{1}$H NMR spectra for compound 4d
H NMR spectra for compound 4e

\[
\text{NH}_2 \quad \text{O}
\]

4e

\[
\text{NH}_2 \quad \text{O}
\]

4f

H NMR spectra for compound 4f
$^1$H NMR spectra for compound 4g

$^1$H NMR spectra for compound 4i
$^1$H NMR spectra for compound 4j (4l)

$^1$H NMR spectra for compound 4k
$^1$H NMR spectra for compound 4m

$^1$H NMR spectra for compound 4n
$^1$H NMR spectra for compound 4o

$^1$H NMR spectra for compound 4p
$^{1}$H NMR spectra for compound 4q

$^{1}$H NMR spectra for compound 3r
$^1$H NMR spectra for compound 4r

$^{13}$C NMR spectra for compound 3a
$^{13}$C NMR spectra for compound 3b

$^{13}$C NMR spectra for compound 3c
$^{13}$C NMR spectra for compound 3d

$^{13}$C NMR spectra for compound 3e
$^{13}$C NMR spectra for compound 3f

$^{13}$C NMR spectra for compound 3g
\( ^{13}C\) NMR spectra for compound 3j

\( ^{13}C\) NMR spectra for compound 3m
$^{13}$C NMR spectra for compound 3o

$^{13}$C NMR spectra for compound 3q
$^{13}$C NMR spectra for compound 4a

$^{13}$C NMR spectra for compound 4c
$^{13}$C NMR spectra for compound 4e

$^{13}$C NMR spectra for compound 4g
$^{13}$C NMR spectra for compound 4i

$^{13}$C NMR spectra for compound 4m
$^{13}$C NMR spectra for compound 4o

$^{13}$C NMR spectra for compound 4q
$^1$H NMR spectra for compound 21

$^1$H NMR spectra for compound 22
$\text{H NMR spectra for compound 23}$

$\text{13C NMR spectra for compound 23}$