Supplementary Material (ESI) for Medicinal Chemistry Communications

Library synthesis and cytotoxicity of a family of 2-phenylacrylonitriles and discovery of an estrogen dependent, breast cancer lead compound

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Supplementary Data

Experimental Section

Materials

All starting materials were purchased from Aldrich Chemical Co. and Lancaster Synthesis. Solvents were bulk, and distilled from glass prior to use. Reaction progress was monitored by TLC, on aluminium plates coated with silica gel with fluorescent indicator (Merck 60 F_{254}) and flash chromatography was conducted utilizing SNAP Biotage KP-SIL columns.

Cell culture and stock solutions

Stock solutions were prepared as follows and stored at -20 °C: drugs were prepared as 40 mM solutions in DMSO. All cell lines with the exception of MCF10A were cultured at 37 °C, under 5 % CO_2 in air and were maintained in Dulbecco s modified Eagle s medium (Trace Biosciences, Australia) supplemented with 10 % foetal bovine serum, 10 mM sodium bicarbonate penicillin (100 µg mL^{-1}), streptomycin (100 µg mL^{-1}), and glutamine (4 mM). MCF10A were cultured as above and further supplemented with insulin (2mg/ml), hydrocortisone (0.25mg/ml), cholera toxin (1mg/ml), and epidermal growth factor

(100μg/ml).

In vitro growth inhibition assays

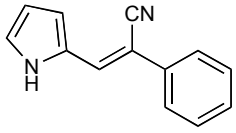
Cells in logarithmic growth were transferred to 96-well plates. Cytotoxicity was determined by plating cells in duplicate in medium (100 μL) at a density of 2500-4000 cells/well. On day 0 (24 h after plating), when the cells were in logarithmic growth, medium (100 μL) with or without the test agent was added to each well. After 72 h of drug exposure, growth inhibitory effects were evaluated using the MTT (3-[4,5-dimethyltiazol-2-yl]-2,5-diphenyl-tetrazolium bromide) assay and their absorbance was read at 540 nm. Percentage growth inhibition was determined at a fixed drug concentration of 100 μM. A value of 100 % is indicative of total cell growth inhibition. Those analogues showing appreciable percentage growth inhibition underwent further dose response analysis to allow the calculation of GI_{50} values. The GI_{50} value is defined as the drug concentration at which cell growth is 50 % inhibited based on the difference between the optical density values on day 0 and those at the end of drug exposure.[1,2]

Chemistry

General methods

THF was freshly distilled from sodium–benzophenone. Flash chromatography was carried out using silica gel 200–400 mesh (60 Å). ^{1}H and ^{13}CNMR were recorded at 300 MHz and 75 MHz respectively using a Bruker Avance 300 MHz spectrometer in $CDCl_3$ and DMSO-d_6. GCMS was performed using a Shimadzu GCMS-QP2100. The instrument uses a quadrupole mass spectrometer and detects samples via electron impact ionization (EI). The University of Wollongong, Australia, Biomolecular Mass Spectrometry Laboratory analyzed samples for HRMS. The spectra were run on the VG Autospec-oa-tof tandem high resolution mass spectrometer using CI (chemical ionization), with methane as the carrier gas and PFK (perfluorokerosene) as the reference.

*(Z)-2-Phenyl-3-(1H-pyrrol-2-yl)acrylonitrile (**1**)*[3]

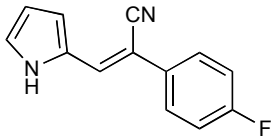


1*H*-pyrrole-2-carbaldehyde (165 mg, 1.74 mmol), was added to a vigorously stirred solution of water (10 mL) and heated to 50 °C up on which it dissolved. 2-

Phenylacetonirile (193 mg, 1.65 mmol) was then slowly added forming a suspension. Once a clear solution was evident, typically 5-10 minutes, 40 % $PhCH_2NMe_3(OH)$ (7 mL) was added dropwise. After complete addition, the reaction vessel was sealed and stirred at 50 °C for 5 hours. After this period, the solution was filtered hot, washed with warm water and dried under suction to yield a solid. The crude solid was then recrystallised from EtOH to afford **1** as a brown solid; 73%; 94–96 ºC.

^{1}H NMR ($CDCl_3$) (300 MHz): δ 9.81 (br, 1H, NH), 7.61-7.57 (m, 2H, Ar H2; Ar H6), 7.45-7.40 (m, 2H, Ar H3; Ar H5), 7.42 (s, 1H, HC=C), 7.35-7.30 (m, 1H, Ar H4), 7.08-7.06 (m, 1H, Pyr H-5), 6.73 (dd, *J* = 1.4, 3.7 Hz, 1H, Pyr H3), 6.37 (dd, *J* = 1.4, 3.7, 1H (Pyr H4); ^{13}C NMR ($CDCl_3$) (75 MHz): δ 133.4, 130.7, 128.5 (2 x Ar), 127.6, 127.2, 124.4 (2 x Ar), 123.5, 120.1, 118.5, 110.3, 100.8; υ_{max}(KBr)/cm^{-1}: 3396 (NH), 2205 (CN), 1683 (C=C), 1601 (Ar), 1589 (Ar), 1496 (Ar); LRMS (APCI M+1) 195.

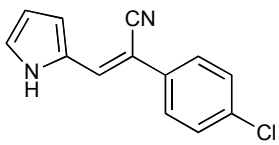
*(E)-2-(4-Fluorophenyl)-3-(1H-pyrrol-2-yl)acrylonitrile (**2**)*[3]



Synthesized using the general procedure as for **1**, from 1*H*-pyrrole-2-carbaldehyde and 4-fluorophenylacetonitrile to afford **2** as a yellow solid; 78%; mp 115-116 ºC.

^{1}H NMR ($CDCl_3$) (300 MHz): δ 9.82 (br, 1H, NH), 7.56-7.51 (m, 2H, Ar H2; Ar H6), 7.32 (s, 1H, HC=C), 7.13-7.06 (m, 3H, Ar H3; Ar H5; Pyr H5), 6.71-6.70 (m, 1H, Pyr H3), 6.36-6.34 (m, 1H, Pyr H4); ^{13}C NMR ($CDCl_3$) (75 MHz): δ 130.7, 129.6, 127.0, 126.1 (2 x Ar), 123.5, 119.9, 118.5, 115.7, 115.4, 110.3 (2 x Ar), 99.7; υ_{max}(KBr)/cm^{-1}: 3401 (NH), 2205 (CN), 1641 (C=C), 1597 (Ar), 1507 (Ar); LRMS (APCI M+1) 213.

*(Z)-2-(4-Chlorophenyl)-3-(1H-pyrrol-2-yl)acrylonitrile (**3**)*[3]

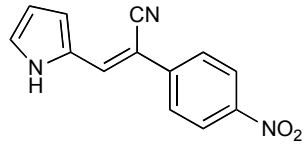


Synthesized using the general procedure as for **1**, from 1*H*-pyrrole-2-carbaldehyde and 4-chlorophenylacetonitrile to afford **3** as a yellow solid; 67%; mp 112–114 ºC.

^{1}H NMR ($CDCl_3$) (300 MHz): δ 9.78 (br, 1H, NH), 7.51-7.49 (m, 2H, Ar H2; Ar H6), 7.38-7.35 (m, 3H, Ar H3; Ar H5; HC=C), 7.08 (s, 1H, Pyr H5), 6.72 (d, *J* = 2.7 Hz, 1H, Pyr H3), 6.36 (s, 1H, Pyr H4); ^{13}C NMR ($CDCl_3$) (75 MHz): δ 133.4, 131.9, 130.9, 128.7 (2 x

Ar), 126.9, 125.6 (2 x Ar), 123.8, 119.7, 118.9, 110.4, 99.5; υ_{max}(KBr)/cm^{-1}: 3380 (NH), 2213 (CN), 1636 (C=C), 1603 (Ar), 741 (Ar-Cl); LRMS (APCI M+1) 229.

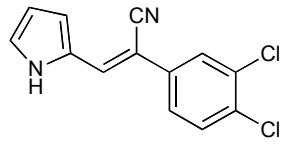
*(Z)-2-(4-Nitrophenyl)-3-(1H-pyrrol-2-yl)acrylonitrile (**4**)*[3]



Synthesized using the general procedure as for **1**, from 1*H*-pyrrole-2-carbaldehyde and 4-nitrophenylacetonitrile to afford **4** as a dark green solid; 70%; mp 130–134 ºC.

^{1}H NMR ($CDCl_3$) (300 MHz): δ 9.80 (br, 1H, NH), 8.23-8.26 (m, 2H, Ar H3; Ar H5), 7.74-7.70 (m, 2H, Ar H2; Ar H6), 7.56 (s, 1H, HC=C), 7.18-7.17 (m, 1H, Pyr H5), 6.84 (dd, *J* = 1.3, 3.8 Hz, 1H, Pyr H3), 6.42 (dd, *J* = 1.3, 3.8 Hz, 1H, Pyr H4); ^{13}C NMR ($CDCl_3$) (75 MHz): δ 133.1, 132.0, 129.3, 126.9, 125.4, 124.7 (2 x Ar), 124.0 (2 x Ar), 123.0 121.0, 119.3, 111.1; υ_{max}(KBr)/cm^{-1}: 3398 (NH), 2205 (CN), 1636 (C=C), 1602 (Ar), 1578 (Ar), 1508 (Ar) 1331 (NO); LRMS (APCI M+1) 210.

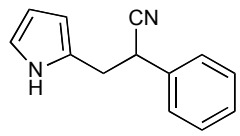
*(Z)-2-(3,4-Dichlorophenyl)-3-(1H-pyrrol-2-yl)acrylonitrile (**5**)*[3]



Synthesized using the general procedure as for **1**, from 1*H*-pyrrole-2-carbaldehyde and 3,4-dichlorophenylacetonitrile to afford **3** as a dark yellow solid; 72%; mp 140–142 ºC.

^{1}H NMR ($CDCl_3$) (300 MHz): δ 9.78 (br, 1H, NH), 7.88 (s, 1H, HC=C), 7.78 (d, *J* = 2.1 Hz, 1H, Ar H5), 7.64-7.56 (m, 2H, Ar H2; Ar H6), 7.26-7.24 (m, 1H, Pyr H5), 7.21-7.20 (m, 1H Pyr H3), 6.39-6.37 (m, 1H Pyr H4); ^{13}C NMR ($CDCl_3$) (75 MHz): δ 135.0, 132.7, 132.0, 130.5, 130.1, 127.1, 125.7, 124.1, 123.9, 117.8, 114.4, 110.8, 98.3; υ_{max} KBr)/cm^{-1}: 3415 (NH), 2199 (CN), 1636 (C=C), 1604 (Ar), 1588 (Ar); LRMS (APCI M+1) 263.

*2-Phenyl-3-(1H-pyrrol-2-yl)propanenitrile (**6**)*

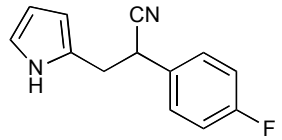


(*Z*)-2-Phenyl-3-(1*H*-pyrrol-2-yl)acrylonitrile (**1**) (5.1 mmol) was dissolved into sufficient freshly distilled dry acetone to form a 0.05 M solution. This solution hydrogenated using

the ThalesNano H-cube™ using a 10% Pd/C catalyst at 1 mL/min at 50 ºC and 50 bar H_2 pressure. The solvent was then removed *in vacuo* and the crude oil was subjected to flash silica chromatography (1:1 $CHCl_3$:Hexanes) to afford **6** as a brown oil; 98%.

^{1}H NMR ($CDCl_3$) (300 MHz): δ 8.03 (br, 1H, NH), 7.42-7.35 (m, 3H, Ar H3; Ar H4; Ar H5), 7.29-7.26 (m, 2H, Ar H2; Ar H6), 6.69-6.67 (m, 1H, Pyr H5), 6.15-6.13 (m, 1H, Pyr H3), 6.03-6.02 (m, 1H, Pyr H4), 4.01 (t, *J* = 7.4 Hz, 1H, CH), 3.28-3.14 (m, 2H, CH_2); ^{13}C NMR ($CDCl_3$) (75 MHz): 134.5, 128.6 (2 x Ar), 127.8, 126.8, 125.7 (2 x Ar), 120.4, 117.3, 108.1, 107.4, 38.4, 34.0; υ_{max}(film)/cm^{-1}: 3384 (NH), 2242 (CN), 1597 (Ar); LRMS (APCI M+1) 197; HRMS (ESI M+H) for $C_{13}H_{12}N_2$, calculated 197.1079; found 197.1083

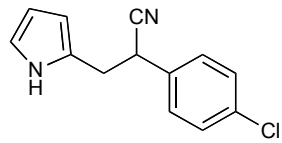
*2-(4-Fluorophenyl)-3-(1H-pyrrol-2-yl)propanenitrile (**7**)*



Synthesized using the general procedure as for **6**, from (*Z*)-2-(4-fluorophenyl)-3-(1*H*-pyrrol-2-yl)acrylonitrile (**2**) to afford **7** as a light brown oil; 95%.

^{1}H NMR ($CDCl_3$) (300 MHz): δ 8.06 (br, 1H, NH), 7.24-7.19 (m, 2H, Ar H2; Ar H5), 7.09-7.03 (m, 2H, Ar H3; Ar H5), 6.69 (d, *J* = 1.4 Hz, 1H, Pyr H5), 6.15-6.12 (m, 1H, Pyr H3), 5.98 (s, 1H, Pyr H4), 4.00 (t, *J* = 6.8 Hz, 1H, CH), 3.25-3.14 (m, 2H, CH_2); ^{13}C NMR ($CDCl_3$) (75 MHz): δ 163.6, 130.2, 128.6 (2 x Ar), 125.3, 120.2, 117.4, 115.4, 108.2 (2 x Ar), 107.6, 37.6, 34.0; υ_{max}(film)/cm^{-1}: 3404 (NH), 2244 (CN), 1602 (Ar), 1509 (Ar); LRMS (APCI M+1) 215; HRMS (ESI M+H) for $C_{13}H_{11}FN_2$, calculated 215.0985; found 215.0986

*2-(4-Chlorophenyl)-3-(1H-pyrrol-2-yl)propanenitrile (**8**)*

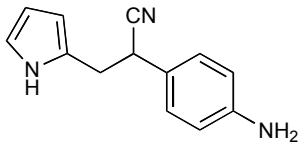


Synthesized using the general procedure as for **6**, from (*Z*)-2-(4-chlorophenyl)-3-(1*H*-pyrrol-2-yl)acrylonitrile (**3**) to afford **7** as a light yellow oil; 76%.

^{1}H NMR ($CDCl_3$) (300 MHz): δ 8.04 (br, 1H, NH), 7.38-7.32 (m, 2H, Ar H3; Ar H5), 7.19-7.16 (m, 2H, Ar H2; Ar H6), 6.70-6.68 (m, 1H, Pyr H5), 6.15-6.12 (m, 1H, Pyr H3), 5.99-5.98 (m, 1H, Pyr H4), 3.99 (t, *J* = 6.7 Hz, 1H, CH), 3.25-3.12 (m, 2H, CH_2); ^{13}C NMR ($CDCl_3$) (75 MHz): δ 132.9, 128.7 (2 x Ar), 128.6, 128.2, 126.8 (2 x Ar), 229.9, 117.4,

108.2, 107.7, 37.8, 33.9; υ_{max}(KBr)/cm^{-1}: 3398 (NH), 2215 (CN), 1598 (Ar), 1511 (Ar); LRMS (APCI M+1) 231; HRMS (ESI M+H) for $C_{13}H_{11}ClN_2$, calculated 231.0689; found 231.0694.

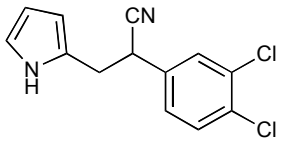
*2-(4-Aminophenyl)-3-(1H-pyrrol-2-yl)propanenitrile (**9**)*



Synthesized using the general procedure as for **6**, from (*Z*)-2-(4-nitrophenyl)-3-(1*H*-pyrrol-2-yl)acrylonitrile (**4**) to afford **9** as a dark brown oil; 12%.

^{1}H NMR ($CDCl_3$) (300 MHz): δ 7.96 (br, 1H, NH), 7.04-7.01 (m, 2H, Ar H2; Ar H6), 6.68-6.64 (m, 3H, Ar H3; Ar H5; Pyr H5), 6.14-6.10 (m, 1H, Pyr H3), 6.01 (s, 1H, Pyr H4), 3.88 (t, *J* = 7.2 Hz, 1H, CH), 3.75 (br, 2H, NH_2), 3.22-3.09 (m, 2H, CH_2); ^{13}C NMR ($CDCl_3$) (75 MHz): δ 145.9, 127.8 (2 x Ar), 126.1, 124.1, 120.8, 117.2, 114.8 (2 x Ar), 107.9, 107.3, 37.6, 34.1; υ_{max}(KBr)/cm^{-1}: 3434 (NH), 3402 (NH), 2235 (CN), 1602 (Ar), 1505 (Ar); LRMS (APCI M+1) 212; HRMS (ESI M+H) for $C_{13}H_{11}N_3O_2$, calculated 242.0930; found 242.0933.

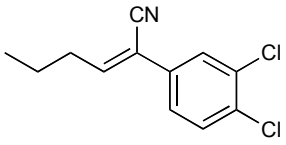
*2-(3,4-Dichlorophenyl)-3-(1H-pyrrol-2-yl)propanenitrile (**10**)*



Synthesized using the general procedure as for **6**, from (*Z*)-2-(3,4-dichlorophenyl)-3-(1*H*-pyrrol-2-yl)acrylonitrile (**2**) to afford **10** as a yellow oil; 65%.

^{1}H NMR ($CDCl_3$) (300 MHz): δ 8.10 (br, 1H, NH), 7.45-7.33 (m, 2H, Ar H2; Ar H5), 7.07-7.04 (m, 1H, Ar H6), 6.72-6.70 (m, 1H, Pyr H5), 6.16-6.13 (m, 1H, Pyr H3), 5.98 (s, 1H, Pyr H4), 3.97 (t, *J* = 6.6Hz, 1H, CH), 3.25-3.12 (m, 2H, CH_2); ^{13}C NMR ($CDCl_3$) (75 MHz): δ 134.4, 132.7, 132.2, 130.4, 128.8, 126.2, 124.7, 119.4, 117.6, 108.3, 107.9, 37.6, 33.7; υ_{max}(KBr)/cm^{-1}: 3392 (NH), 2221 (CN), 1600 (Ar); LRMS (APCI M+1) 267; HRMS (ESI M+H) for $C_{13}H_{10}Cl_2N_2$, calculated 265.0299; found 265.0305.

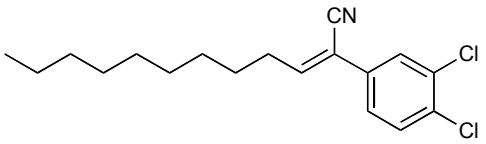
*(Z)-2-(3,4-Dichlorophenyl)hept-2-enenitrile (**11**)*



Pentanal (97 mg, 1.13 mmol) was dissolved in distilled ethanol (10 mL) to this was added 2-(3,4-dichlorophenyl)acetonitrile (199 mg, 1.07 mmol) in ethanol (10 mL). The resultant solution was stirred and heated to 70 °C upon which piperidine was added (2 drops). The solution was then heated under reflux for 2 hours. After this time, the solution was cooled in the to 0 °C and the solvent removed *in vacuo* to yield an oil. Subsequent flash chromatography (1:19 EtOAc:Hexanes) to afford **11** as a clear oil; 35%.

^{1}H NMR ($CDCl_3$) (300 MHz): δ 7.62-7.61 (m, 1H, Ar H5), 7.48-7.45 (m, 1H, Ar H2), 7.38-7.34 (m, 1H, Ar H6), 6.85 (t, *J* = 7.7 Hz, 1H, HC=C), 2.60 (q, *J* = 7.7 Hz, 2H, CH_2CH=C), 1.60-1.33 (m, 4H, CH_2CH_2), 0.96 (t, *J* = 7.2 Hz, 3H, CH_3); ^{13}C NMR ($CDCl_3$) (75 MHz): δ 148.4, 132.8, 132.7, 132.5, 130.3, 126.8, 124.3, 115.3, 113.4, 31.5, 30.0, 21.8, 13.3; υ_{max}(film)/cm^{-1}: 2958 (CH), 2957 (CH), 2870 (CH), 2218 (CN), 1615 (C=C), 1473 (Ar); LRMS (APCI M-1) 252; HRMS (ESI M+H) for $C_{13}H_{10}N_2$, calculated 254.0503; found 254.0501.

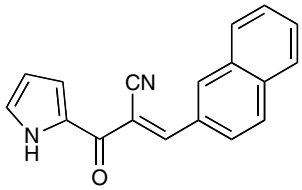
*(E)-2-(3,4-Dichlorophenyl)dodec-2-enenitrile (**12**)*



Synthesized using the general procedure as for **11**, from decanal and 2-(3,4-dichlorophenyl)acetonitrile to afford **12** as a clear oil; 21%.

^{1}H NMR ($CDCl_3$) (300 MHz): 7.62-7.61 (m, 1H, Ar H5), 7.49-7.46 (m, 1H, Ar H2), 7.37 (dd, *J* = 8.4, 2.2 Hz, 1H, Ar H6), 6.87-6,82 (m, 1H, CH=C), 2.63-2.52 (m, 4H, CH_2CH_2CH=C), 2.34-2.14 (m, 4H, CH_2CH_2), 1.59-1.52 (m, 6H, $CH_2CH_2CH_2$), 0.91-0.85 (m, 5H, CH_2CH_3); ^{13}C NMR ($CDCl_3$) (75 MHz): 148.4, 132.8, 132.5, 130.3, 126.1, 125.2, 124.9, 115.3, 113.4, 31.9, 31.3, 31.2, 29.1, 28.8, 28.7, 28.0, 22.2, 13.5; υ_{max}(film)/cm^{-1}: 2957 (CH), 2930 (CH), 2860 (CH), 2219 (CN), 1619 (C=C), 1482 (CH); LRMS (APCI M-1) 322 HRMS (ESI M+H) for $C_{18}H_{23}Cl_2N_2$, calculated 324.1286; found 324.1289.

*(E)-3-(Naphthalen-2-yl)-2-(1H-pyrrole-2-carbonyl)acrylonitrile (**14**)*

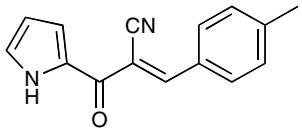


Cyano acetic acid (1.360g, 16 mmol) was added to Ac_2O (8 mL) and the resultant suspension was stirred and heated to 50 °C upon which the solid material dissolved. Pyrrole (1.073g, 16 mmol) was then added and the solution was heated at 75 °C for 35 minutes. The solution was then diluted with EtOAc (20 mL) and washed with 0.1M NaOH (3 x 10 mL). The organic layer was then collected and dried using $MgSO_4$. The solvent was then removed under vacuum and the residue purified by flash silica chromatography (1:10 EtOAc:Hexanes to 1:1 EtOAc:Hexanes) to afford 3-oxo-3-(1*H*-pyrrol-2-yl)propanenitrile, 70%.

Next, to an ethanolic solution (10 mL) of 2-naphthaldehyde (1.56 mmol) was added an ethanolic solution (10 mL) of 3-oxo-3-(1*H*-pyrrol-2-yl)propanenitrile (1.56 mmol). This mixture was heated to 70 ºC at which time, piperidine (2 drops) was added, and the solution was then heated under reflux for an additional 2 hours. After this time, the solution was cooled and the solvent removed *in vacuo* to afford a brown oil which was purified by flash chromatography (1:10 EtOAc:Hexanes) to afford **14** as a brown solid; 35%; mp 140-142 ºC.

^{1}H NMR (DMSO-d_6) (300 MHz): δ 12.27 (br, 1H, NH), 8.57 (s, 1H, Ar H1), 8.44-8.42 (s, 1H, CH=C), 8.23-8.21 (m, 1H, Ar H5), 8.11-7.99 (m, 3H, Ar H3; Ar H4; Ar H8), 7.70-7.60 (m, 2H, Ar H7; Pyr H5), 7.35-7.31 (m, 2H, Ar H6; Pyr H3), 6.35-6.34 (m, 1H, Pyr H4); ^{13}C NMR (DMSO-d_6) (75 MHz): δ 174.8, 153.2, 134.4, 133.4, 132.4, 129.7, 129.0, 128.9, 128.8, 128.7, 128.0, 127.7, 127.2, 124.7, 119.5, 119.2, 110.8, 109.1; υ_{max}(KBr)/cm^{-1}: 3291 (NH), 2215 (CN), 1617 (C=O); LRMS (APCI M+1) 273; HRMS (ESI M+H) for $C_{18}H_{12}N_2$, calculated 272.0950; found 272.0954.

*(E)-2-(1H-Pyrrole-2-carbonyl)-3-p-tolylacrylonitrile (**15**)*

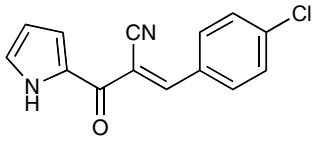


Synthesized using the general procedure as for **14**, from 4-methylbenzaldehyde to afford **15** as a yellow solid, 81%; mp 242-244 ºC.

^{1}H NMR (DMSO-d_6) (300 MHz): δ 12.22 (br, 1H, NH), 8.24 (s, 1H, CH=C), 7.95 (d, J = 8.0Hz, 2H, Ar H2; Ar H6), 7.37 (d, J = 8.0Hz, 2H, Ar H3; Ar H5), 7.29-7.26 (m, 2H, Pyr H5; Pyr H3), 6.33-6.30 (m, 1H, Pyr H4), 2.37 (s, 3H, $ArCH_3$); ^{13}C NMR (DMSO-d_6) (75

MHz): δ 174.8, 153.2, 143.5, 130.6 (2 x Ar), 129.7 (2 x Ar), 129.3, 129.0, 127.9, 119.3, 117.7, 110.8, 107.8, 21.2; υ_{max}(KBr)/cm^{-1}: 3291 (NH), 2210 (CN), 1622 (C=O); LRMS (APCI M+1) 237; HRMS (ESI M+H) for $C_{14}H_{12}N_2$, calculated 209.1079; found 209.1082.

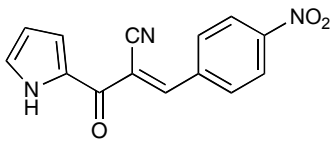
*(E)-3-(4-Chlorophenyl)-2-(1H-pyrrole-2-carbonyl)acrylonitrile (**16**)*



Synthesized using the general procedure as for **14**, from 4-chlorobenzaldehyde to afford **16** as a yellow solid, 39%; mp 192-194 ºC.

^{1}H NMR (Acetone-d_6) (300 MHz): δ 11.30 (br, 1H, NH), 8.28 (s, 1H, CH=C), 8.13-8.11 (m, 2H, Ar H2; Ar H6), 7.66-7.63 (m, 2H, Ar H3; Ar H5), 7.45-7.44 (m, 1H, Pyr H5), 7.35-7.34 (m, 1H, Pyr H3), 6.38-6.36 (m, 1H, Pyr H4); ^{13}C NMR (Acetone-d_6) (75 MHz): δ 173.6, 151.1, 137.4, 131.7 (2 x Ar), 130.8, 128.8 (2 x Ar), 126.9, 119.7, 118.7, 116.6, 110.4, 109.5; υ_{max}(KBr)/cm^{-1}: 3284 (NH), 2211 (CN), 1627 (C=O), 760 (Ar-Cl); LRMS (APCI M+1) 257; HRMS (ESI M+H) for $C_{13}H_9ClN_2$, calculated 229.0533; found 229.0537.

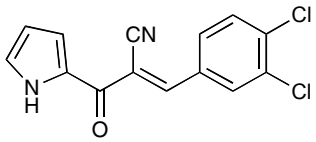
*(E)-3-(4-Nitrophenyl)-2-(1H-pyrrole-2-carbonyl)acrylonitrile (**17**)*



Synthesized using the general procedure as for **14**, from 4-nitrobenzaldehyde to afford **17** as a purple solid, 37%; mp 199-200 ºC.

^{1}H NMR (DMSO-d_6) (300 MHz): δ 12.32 (br, 1H, NH), 8.40-8.38 (m, 3H, Ar H3; Ar H5; Pyr H5), 8.24-8.21 (m, 2H, Ar H2; Ar H6), 7.24 (m, 2H, Pyr H5; Pyr H3), 6.34 (s, 1H, Pyr H4); ^{13}C NMR (DMSO-*d6*) (75 MHz): δ 174.2, 150.6, 148.8, 138.2, 131.3 (2 x Ar), 130.6, 128.7, 124.0 (2 x Ar), 120.3, 116.6, 113.1, 111.1; υ_{max}(KBr)/cm^{-1}: 3308 (NH), 2228 (CN), 1633 (C=O), 1517 (NO) 1343 (NO); LRMS (APCI M+1) 238; HRMS (ESI M+H) for $C_{13}H_9N_3O_2$, calculated 240.0773; found 240.0777.

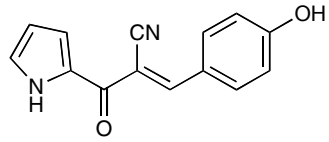
*(E)-3-(3,4-Dichlorophenyl)-2-(1H-pyrrole-2-carbonyl)acrylonitrile (**18**)*



Synthesized using the general procedure as for **14**, from 3,4-dichlorobenzaldehyde to afford **18** as a yellow solid; 66%; mp 178-181 ºC.

^{1}H NMR (Acetone-d_6) (300 MHz): δ 11.31 (br, 1H, NH), 8.29-8.27 (m, 2H, Ar H5; CH=C), 8.11-8.08 (m, 1H, Ar H6), 7.84-7.81 (m, 1H, Ar H2), 7.45-7.36 (m, 2H, Pyr H5; Pyr H3), 6.39-6.37 (m, 1H, Pyr H4); ^{13}C NMR (Acetone-d_6) (75 MHz): δ 173.4, 149.6, 135.0, 132.4, 132.1, 131.7, 130.8, 129.3, 127.2, 127.0, 119.0, 116.3, 111.0, 110.5; υ_{max}(KBr)/cm^{-1}: 3310 (NH), 2222 (CN), 1632 (C=O); LRMS (APCI M+1) 290; HRMS (ESI M+H) for $C_{13}H_8Cl_2N_2$, calculated 263.0143; found 263.0144.

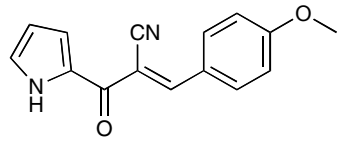
*(E)-3-(4-Hydroxyphenyl)-2-(1H-pyrrole-2-carbonyl)acrylonitrile (**19**)*



Synthesized using the general procedure as for **14**, from 4-hydroxybenzaldehyde to afford **1** as a orange solid; 43%; mp 240-243 ºC.

^{1}H NMR (DMSO-d_6) (300 MHz): δ 12.07 (br, 1H, NH), 8.68 (br, 1H, OH), 8.18 (s, 1H, CH=C), 7.99 (d, J = 8.7Hz, 2H, Ar H2; Ar H6), 7.28-7.23 (m, 2H, Pyr H5; Pyr H3), 6.94 (d, J = 8.7Hz, 2H, Ar H3; Ar H5), 6.30-6.27 (m, 1H, Pyr H4); ^{13}C NMR (DMSO-d_6) (75 MHz): δ 175.0, 162.3, 153.3, 133.6 (2 x Ar), 129.2, 127.3, 123.1, 118.6, 118.4, 116.2 (2 x Ar), 110.5, 104.1; υ_{max}(KBr)/cm^{-1}: 3419 (OH), 3290 (NH), 2218 (CN), 1617 (C=O), 1603 (Ar); LRMS (APCI M+1) 239; HRMS (ESI M+H) for $C_{13}H_{10}N_2O$, calculated 211.0871; found 211.0875.

*(E)-3-(4-Methoxyphenyl)-2-(1H-pyrrole-2-carbonyl)acrylonitrile (**20**)*

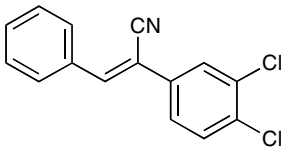


Synthesized using the general procedure as for **14**, from 4-methoxybenzaldehyde to afford **20** as a yellow solid; 83%; mp 166-168 ºC.

^{1}H NMR (DMSO-d_6) (300 MHz): δ 12.14 (br, 1H, NH), 8.24 (s, 1H, CH=C), 8.08 (d, J = 8.9Hz, 2H, Ar H2; Ar H6), 7.28-7.25 (m, 2H, Pyr H5; Pyr H3), 7.13 (d, J = 8.9Hz, 2H, Ar H3; Ar H5), 6.31 (s, 1H, Pyr H4), 3.85 (s, 3H, OCH_3); ^{13}C NMR (DMSO-d_6) (75 MHz): δ 174.9, 163.0, 153.0, 133.1 (2 x Ar), 129.1, 127.5, 124.6, 118.9, 118.2, 114.8 (2 x Ar), 110.6, 105.5, 55.6; υ_{max}(KBr)/cm^{-1}: 3306 (NH), 2209 (CN), 1617 (C=O), 1507 (Ar); LRMS

(APCI M+1) 253; HRMS (ESI M+H) for $C_{14}H_{12}N_2O$, calculated 225.1028; found 225.1029.

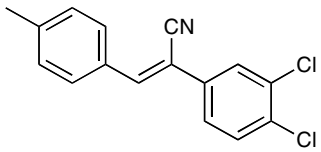
*(Z)-2-(3,4-Dichlorophenyl)-3-phenylacrylonitrile (**21**)*[4]



Synthesized using the general procedure as for **1**, from benzaldehyde and 3,4-dichlorophenylacetonitrile to afford **21** as a white solid; 89%; mp 146-147 ºC.

^{1}H NMR ($CDCl_3$) (300 MHz): δ 7.91-7.87 (m, 2H, Ar H2; Ar H5), 7.77-7.76 (m, 1H, Ar H6), 7.53-7.47 (m, 6H, Ar2 H2; Ar2 H3; Ar2 H4; Ar2 H5; Ar2 H6; CH=C); ^{13}C NMR ($CDCl_3$) (75 MHz): δ 143.0, 133.9, 133.0, 132.8, 132.6, 130.6, 130.4, 128.9 (2 x Ar), 128.5 (2 x Ar), 127.2, 124.6, 116.7, 108.8; υ_{max}(KBr)/cm^{-1}: 2212 (CN), 1636 (C=C), 1590 (Ar), 1568 (Ar), 1496 (Ar), 676 (Ar-Cl); LRMS (APCI M-1) 273.

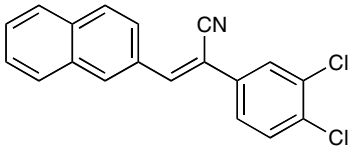
*(Z)-2-(3,4-dichlorophenyl)-3-p-tolylacrylonitrile (**22**)*



Synthesized using the general procedure as for **1**, from 4-methylbenzaldehyde and 2-(3,4-dichlorophenyl)acetonitrile to afford **22** as a yellow solid; 71%; mp 164-165 ºC.

^{1}H NMR ($CDCl_3$) (300 MHz): δ 7.80 (d, *J* = 8.1 Hz, 2H, Ar2 H2; Ar2 H6), 7.74 (m, 1H, Ar H5), 7.50-7.7.49 (m, 3H, Ar H2; Ar H6; CH=C), 7.28 (d, *J* = 8.1 Hz, 2H, Ar2 H3; Ar2 H5), 2.42 (s, 3H, $ArCH_3$); ^{13}C NMR ($CDCl_3$) (75 MHz): δ 143.0, 141.4, 134.1, 132.9, 132.5, 130.4, 129.8, 129.3 (2 x Ar), 129.0 (2 x Ar), 127.0, 124.5, 117.0, 107.4, 21.1; υ_{max}(KBr)/cm^{-1}: 2214 (CN), 1637 (C=C), 1594 (Ar), 1509 (Ar), 811 (Ar-Cl); LRMS (APCI M-1) 287; HRMS (ESI M+H) for $C_{16}H_{11}NCl_{22}$, calculated 288.0347; found 288.0350.

*(Z)-2-(3,4-dichlorophenyl)-3-(naphthalen-2-yl)acrylonitrile (**23**)*

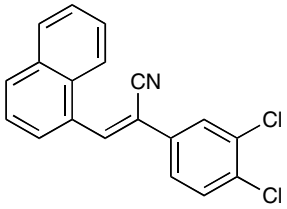


Synthesized using the general procedure as for **1**, from 2-naphthaldehyde and 3,4-dichlorophenylacetonitrile to afford **23** as a yellow solid; 71%; mp 170-171 ºC.

^{1}H NMR (DMSO-d_6) (300 MHz): δ 8.42 (s, 1H, Ar2 H1), 8.32 (s, 1H, CH=C), 8.12-7.97

(m, 5H, Ar2 H3; Ar2 H5; Ar2 H6; Ar2 H7; Ar2 H8), 7.76 (m, 2H, Ar2 H4; Ar H5), 7.61 (m, 2H, Ar H2; Ar H6); ^{13}C NMR (DMSO-d_6) (75 MHz): δ 144.7, 134.5, 133.7, 132.4, 132.0, 131.7, 131.2, 130.9, 128.8, 128.7, 128.6, 128.0, 127.7, 127.3, 127.1, 126.1, 124.7, 117.4, 107.9; υ_{max}(KBr)/cm^{-1}: 2210 (CN), 1626 (C=C), 1598 (Ar), 1591 (Ar), 1477 (Ar), 1466 (Ar), 809 (Ar-Cl), 743 (Ar-Cl); LRMS (APCI M-1) 323; HRMS (ESI M+H) for $C_{19}H_{11}Cl_2N$, calculated 324.0347; found 325.0353.

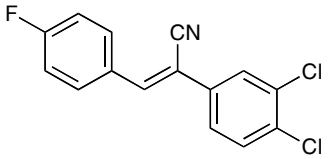
*(Z)-2-(3,4-dichlorophenyl)-3-(naphthalen-1-yl)acrylonitrile (**24**)*



Synthesized using the general procedure as for **1**, from 1-naphthaldehyde and 3,4-dichlorophenylacetonitrile to afford **24** as a yellow solid; 72%; mp 218-219 ºC.

^{1}H NMR (DMSO-d_6) (300 MHz): δ 8.84 (s, 1H, CH=C), 8.19-8.18 (m, 2H, Ar2 H4; Ar2 H8), 8.10-7.99 (m, 3H, Ar2 H2; Ar2 H5; Ar2 H7), 7.82-7.81 (m, 2H, Ar2 H3; Ar2 H6), 7.67-7.61 (m, 3H, Ar H2; Ar H5 Ar H6); ^{13}C NMR (DMSO-d_6) (75 MHz): δ 143.5, 134.0, 133.0, 132.0, 131.9, 131.1, 130.9, 130.8, 128.5, 127.8, 127.0, 126.8, 126.6, 126.5, 125.3, 125.2, 124.3, 117.0, 112.3; υ_{max}(KBr)/cm^{-1}: 2216 (CN), 1636 (C=C), 1508 (Ar), 1474 (Ar), 776 (Ar-Cl); LRMS (APCI M-1) 323; HRMS (ESI M+H) for $C_{19}H_{11}Cl_2N$, calculated 324.0347; found 324.03523.

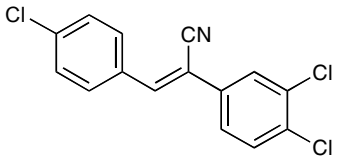
*(E)-2-(3,4-dichlorophenyl)-3-(4-fluorophenyl)acrylonitrile (**25**)*[5]



Synthesized using the general procedure as for **1**, from 4-fluorobenzaldehyde and 4-chlorophenylacetonitrile to afford **25** as a white solid; 94%; mp 156-157 ºC.

^{1}H NMR ($CDCl_3$) (300 MHz): δ 7.93-7.88 (m, 2H, Ar2 H2; Ar2 H6), 7.75-7.74 (m, 1H, Ar H5), 7.51-7.48 (m, 3H, Ar2 H3; Ar2 H5; CH=C), 7.20-7.15 (m 2H, Ar H5; Ar H6); ^{13}C NMR ($CDCl_3$) (75 MHz): δ 141.5, 133.7, 133.0 (2 x Ar), 132.9, 131.1, 131.0, 130.5, 128.9, 127.1, 124.6 (2 x Ar), 116.6, 115.9, 115.7; υ_{max}(KBr)/cm^{-1}: 2213 (CN), 1636 (C=C), 1596 (Ar), 809 (Ar-Cl); LRMS (APCI M-1) 291.

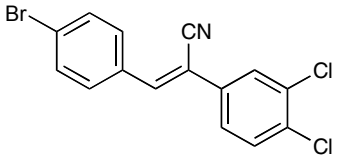
*(Z)-3-(4-chlorophenyl)-2-(3,4-dichlorophenyl)acrylonitrile (**26**)*[6]



Synthesized using the general procedure as for **1**, from 4-chlorobenzaldehyde and 3,4-dichlorophenylacetonitrile to afford **26** as a white solid; 66%; mp 167-168 ºC.

^{1}H NMR ($CDCl_3$) (300 MHz): δ 7.80 (d, *J* = 8.1Hz, 2H, Ar2 H2; Ar2 H6), 7.75-7.74 (m, 1H, Ar H5), 7.51-7.49 (m, 3H Ar H2; Ar H6; CH=C), 7.29 (d, *J* = 8.1Hz, 2H, Ar2 H3; Ar2 H5); ^{13}C NMR ($CDCl_3$) (75 MHz): δ 143.0, 141.4, 134.1, 132.9, 132.6, 130.4, 129.9, 129.3 (2 x Ar), 129.0 (2 x Ar), 127.1, 124.5, 117.0, 107.5; υ_{max}(KBr)/cm^{-1}: 2214 (CN), 1637 (C=C), 1594 (Ar), 1478 (Ar), 810 (Ar-Cl); LRMS (APCI M-1) 307.

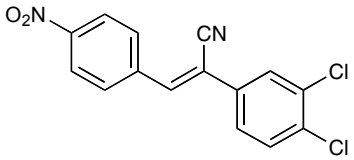
*(Z)-3-(4-bromophenyl)-2-(3,4-dichlorophenyl)acrylonitrile (**27**)*



Synthesized using the general procedure as for **1**, from 4-bromobenzaldehyde and 3,4-dichlorophenylacetonitrile to afford **27** as a yellow solid; 85%; mp 120-121 ºC.

^{1}H NMR ($CDCl_3$) (300 MHz): δ 7.75 (m, 3H, Ar2 H2; Ar2 H6; CH=C), 7.61 (d, *J* = 8.56 Hz, 2H, Ar2 H3; Ar2 H5), 7.50 (m, 2H, Ar H2; Ar H5), 7.46 (d, *J* = 8.45 Hz, 1H, Ar H6); ^{13}C NMR ($CDCl_3$) (75 MHz): δ 141.8, 134.1, 133.6, 133.6, 132.2, 131.9, 131.0, 130.7 (2 x Ar), 127.6 (2 x Ar), 125.6, 125.1, 116.9, 110.1; υ_{max}(KBr)/cm^{-1}: 2214 (CN), 1635 (C=C), 1598 (Ar); LRMS (APCI M-1) 351; HRMS (ESI M+H) for $C_{15}H_8BrCl_2N$, calculated 351.9295; found 351.9298.

*(Z)-2-(3,4-dichlorophenyl)-3-(4-nitrophenyl)acrylonitrile (**28**)*

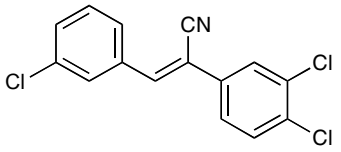


Synthesized using the general procedure as for **1**, from 4-nitrobenzaldehyde and 3,4-dichlorophenylacetonitrile to afford **28** as a purple solid; 75%; mp 133-134 ºC.

^{1}H NMR ($CDCl_3$) (300 MHz): δ 8.34 (d, *J* = 8.8Hz, 2H, Ar2 H3; Ar2 H5), 8.03 (d, *J* = 8.8Hz, 2H, Ar2 H2; Ar2 H6), 7.81-7.80 (m, 1H, Ar H5), 7.58-7.56 (m, 2H, Ar H2 + Ar H6),

7.26 (s, 1H, CH=C), ; ^{13}C NMR ($CDCl_3$) (75 MHz): δ 139.6, 138.3, 133.3, 132.8, 132.1, 130.7, 129.5 (2 x Ar), 129.1, 127.4, 124.9, 123.7 (2 x Ar), 115.8, 113.2; υ_{max}(KBr)/cm^{-1}: 2215 (CN), 1674 (C=C), 1592 (Ar), 1513 (NO), 1345 (NO); LRMS (APCI M+1) 289; HRMS (ESI M+H) for $C_{15}H_8Cl_2N_2O_2$, calculated 319.0041; found 319.0048.

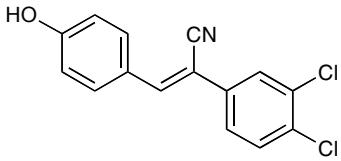
*(Z)-3-(3-chlorophenyl)-2-(3,4-dichlorophenyl)acrylonitrile (**29**)*[5]



Synthesized using the general procedure as for **1**, from 3-chlorobenzaldehyde and 3,4-dichlorophenylacetonitrile to afford **29** as a white solid; 65%; mp 138-140 ºC.

^{1}H NMR ($CDCl_3$) (300 MHz): δ 7.84-7.81 (m, 2H, Ar2 H2; Ar2 H6), 7.76 (s, 1H, CH=C), 7.52-7.51 (m, 2H, Ar2 H4; Ar2 H5), 7.45-7.42 (m, 3H, Ar H2; Ar H5; Ar H6); ^{13}C NMR ($CDCl_3$) (75 MHz): δ 141.0, 134.6, 134.2, 133.4, 133.3, 133.1, 130.5, 130.4, 129.8, 128.9, 127.3, 126.6, 124.7, 116.2, 110.5; υ_{max}(KBr)/cm^{-1}: 2212 (CN), 1636 (C=C), 1601 (Ar), 677 (Ar-Cl); LRMS (APCI M-1) 307.

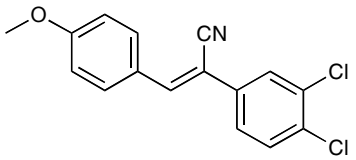
*(Z)-2-(3,4-dichlorophenyl)-3-(4-hydroxyphenyl)acrylonitrile (**30**)*



Synthesized using the general procedure as for **11**, from 4-hydroxybenzaldehyde and 2-(3,4-dichlorophenyl)acetonitrile to afford **30** as a yellow solid; 90%; mp 153-154 ºC.

^{1}H NMR ($CDCl_3$) (300 MHz): δ 7.90-7.89 (m, 4H, Ar2 H2; Ar2 H6; CH=C; Ar H5), 7.67-7.66 (m, 2H, Ar H2; Ar H6), 6.97-6.94 (m, 2H, Ar2 H3; Ar2 H5), 5.98 (br, 1H, OH); ^{13}C NMR ($CDCl_3$) (75 MHz): δ 161.1, 143.6, 135.3, 132.0, 131.4 (2 x Ar), 130.9, 130.5, 126.5, 124.8, 123.9, 117.3, 115.6 (2 x Ar), 103.0; υ_{max}(KBr)/cm^{-1}: 3467 (OH), 2210 (CN), 1580 (Ar); LRMS (APCI M-1) 288; HRMS (ESI M+H) for $C_{15}H_9Cl_2NO$, calculated 290.0139; found 290.0144.

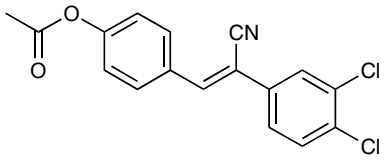
*(Z)-2-(3,4-dichlorophenyl)-3-(4-methoxyphenyl)acrylonitrile (**31**)*[6]



Synthesized using the general procedure as for **1**, from 4-methoxybenzaldehyde and 3,4-dichlorophenylacetonitrile to afford **31** as a yellow solid; 79%; mp 166-167 ºC.

^{1}H NMR ($CDCl_3$) (300 MHz): δ 7.89 (d, *J* = 8.9 Hz, 2H, Ar2 H2; Ar2 H6), 7.73 (m, 1H, Ar H5), 7.49-7.44 (m, 3H, Ar H2; Ar H6; CH=C), 6.99 (d, *J* = 8.9 Hz, 2H, Ar2 H3; Ar2 H5), 3.88 (s, 3H, OCH_3); ^{13}C NMR ($CDCl_3$) (75 MHz): δ 161.4, 142.5, 134.4, 132.9, 132.3, 130.9 (2 x Ar), 130.3, 126.9, 125.4, 124.4, 117.2, 114.0 (2 x Ar), 105.7, 54.9; υ_{max}(KBr)/cm^{-1}: 2212 (CN), 1638 (C=C), 1609 (Ar), 1593 (Ar), 1513 (Ar); LRMS (APCI M-1) 303.

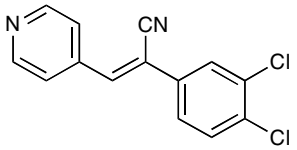
*(Z)-4-(2-cyano-2-(3,4-dichlorophenyl)vinyl)phenyl acetate (**32**)*



(*Z*)-2-(3,4-dichlorophenyl)-3-(4-hydroxyphenyl)acrylonitrile (**30**) (290 mg, 1.0 mmol) was dissolved in Ac_2O (5 mL), and 3 drops of conc. H_2SO_4 were added and the solution stirred overnight. The reaction was quenched with H_2O (10 mL) and the resultant precipitate was collected under suction, and recrystallised from EtOH to afford **32** as a yellow solid; 35%; mp 154-155 ºC.

^{1}H NMR ($CDCl_3$) (300 MHz): δ 7.92 (d, *J* = 8.7 Hz, 2H, Ar2 H2; Ar2 H6), 7.75 (m, 1H, Ar H5), 7.51-7.49 (m 3H, Ar H2; Ar H6; CH=C), 7.23 (d, *J* = 8.7 Hz, 2H, Ar2 H3; Ar2 H5), 2.33 (s, 3H, $COCH_3$); ^{13}C NMR ($CDCl_3$) (75 MHz): δ 168.4, 152.0, 141.7, 133.8, 133.0, 132.9, 131.1, 130.4, 130.2 (2 x Ar), 127.1, 124.6, 121.8 (2 x Ar), 116.6, 108.8, 20.6; υ_{max}(KBr)/cm^{-1}: 2210 (CN), 1764 (C=O), 1597 (Ar), 1507 (Ar), 1221 (CO); LRMS (APCI M-1) 331; HRMS (ESI M+H) for $C_{17}H_{11}Cl_2NO_2$, calculated 332.0245; found 332.0249.

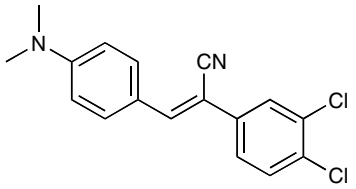
*(Z)-2-(3,4-dichlorophenyl)-3-(pyridin-4-yl)acrylonitrile (**33**)*



Synthesized using the general procedure as for **1**, from 4-pyridinecarboxaldehyde and 3,4-dichlorophenylacetonitrile to afford **33** as a white solid; 66%; mp 188-189 ºC.

^{1}H NMR ($CDCl_3$) (300 MHz): δ 8.77 (d, *J* = 6.2 Hz, 2H, Ar2 H3; Ar2 H5), 7.79 (m, 1H, Ar H5), 7.69 (d, *J* = 6.2 Hz, 2H, Ar2 H2; Ar2 H6), 7.55-7.54 (m, 2H, Ar H2; Ar H6), 7.47 (s, 1H, CH=C); ^{13}C NMR ($CDCl_3$) (75 MHz): δ 150.3 (2 x Ar), 139.6, 139.4, 134.1, 133.3, 132.7, 130.7, 127.5, 124.9, 122.0 (2 x Ar), 115.6, 113.7; υ_{max}(KBr)/cm^{-1}: 2217 (CN), 1636 (C=C), 816 (Ar-Cl); LRMS (APCI M+1) 275; HRMS (ESI M+H) for $C_{14}H_8Cl_2N_2$, calculated 275.0143; found 275.0144.

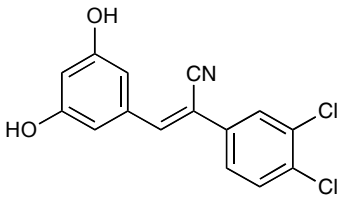
*(Z)-2-(3,4-dichlorophenyl)-3-(4-(dimethylamino)phenyl)acrylonitrile (**34**)*[6]



Synthesized using the general procedure as for **1**, from 4-*N,N*-dimethylaminobenzaldehyde and 3,4-dichlorophenylacetonitrile to afford **34** as a yellow solid; 40%; mp 210-212ºC.

^{1}H NMR ($CDCl_3$) (300 MHz): δ 7.86 (d, *J* = 9.0 Hz, 2H, Ar2 H2; Ar2 H6), 7.71- 6.69 (m, 1H, Ar H5), 7.46-7.45 (m, 2H, Ar H2; Ar H6), 7.37 (s, 1H, CH=C), 6.72 (d, *J* = 9.0 Hz, 2H, Ar2 H3; Ar2 H5), 3.08 (s, 6H, $N(CH_3)_2$); ^{13}C NMR ($CDCl_3$) (75 MHz): δ 151.5, 143.0, 135.2, 134.2, 132.6, 131.1 (2 x Ar), 130.2, 126.4, 124.0, 120.4, 118.3, 111.0 (2 x Ar), 101.1, 29.5; υ_{max}(KBr)/cm^{-1}: 2208 (CN), 1614 (C=C), 1580 (Ar), 805 (Ar-Cl); LRMS (APCI M+1) 317.

*(Z)-2-(3,4-dichlorophenyl)-3-(3,5-dihydroxyphenyl)acrylonitrile (**35**)*



Synthesized using the general procedure as for **11**, from 3,5-dihydroxybenzaldehyde and 2-(3,4-dichlorophenyl)acetonitrile to afford **35** as a brown solid; 25%; mp >300 ºC.

^{1}H NMR ($CDCl_3$) (300 MHz): 8.76 (br, 2H, 2 x OH), 7.92-7.91 (m, 1H, Ar H5), 7.82 (s, 1H, CH=C), 7.69-7.67 (m, 2H, Ar H2; Ar H5), 6.99 (m, 2H, Ar2 H2; Ar2 H5), 6.52-6.51 (m, 1H, Ar2 H6); ^{13}C NMR ($CDCl_3$) (75 MHz): 158.3 (2 x Ar), 144.0, 134.7, 132.1, 131.7, 130.5, 129.7, 127.7, 127.0, 125.3, 116.5 (2 x Ar), 107.5, 105.2; υ_{max}(KBr)/cm^{-1}: 3437 (OH), 2218 (CN), 1582 (Ar), 804 (Ar-Cl); LRMS (APCI M-2) 304; HRMS (ESI M+H) for

$C_{15}H_9Cl_2NO_2$, calculated 306.0089; found 306.0095.

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