Supporting Information I

Nitrile-Assisted Oxidation over Oxidative-Annulation: Palladium-Catalyzed Oxidation of α-Cinnamyl β-Keto Nitriles

Rajender Nallagonda, Reddy Rajasekhar Reddy and Prasanta Ghorai*

Department of Chemistry, Indian Institute of Science Education and Research Bhopal, Bhouri, Bhopal-462066, India. *E-mail*: pghorai@iiserb.ac.in

Contents: **Page:**

I. Experimental Details and Compound Characterization Data

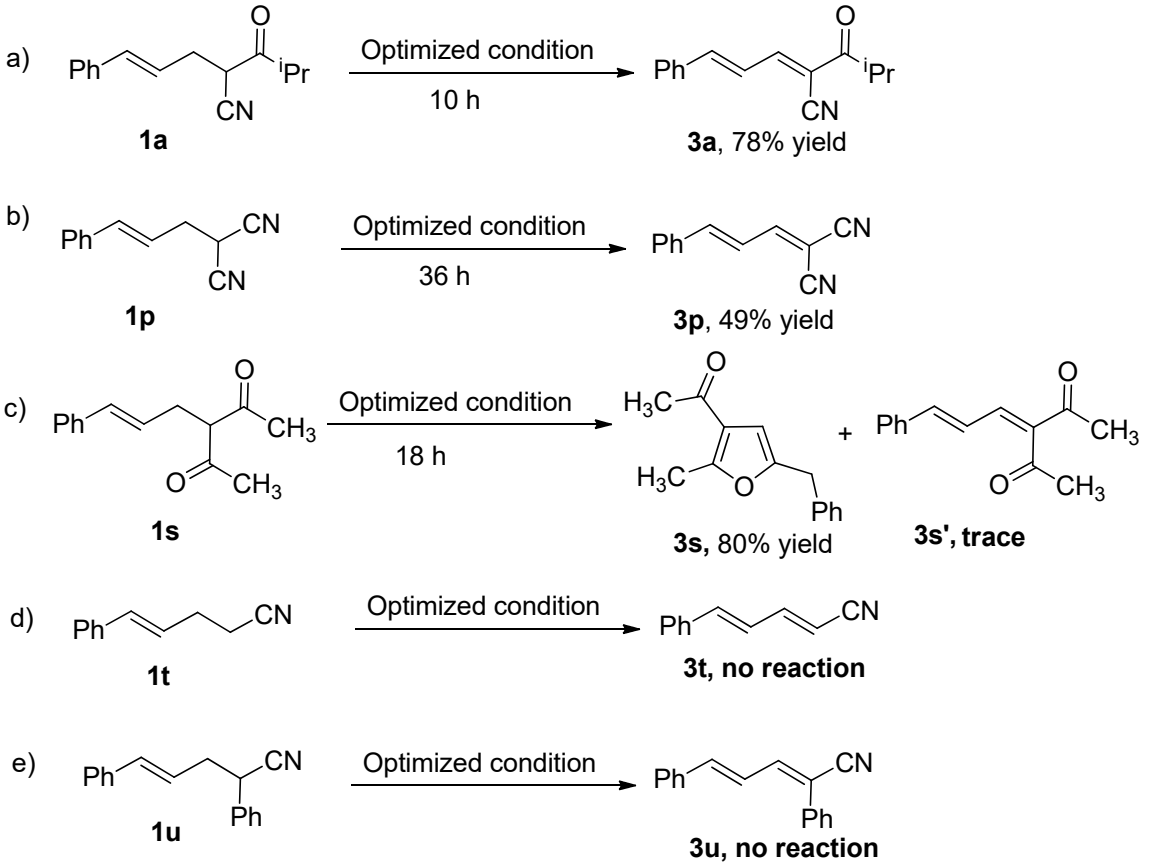
1. General information

All reagents and solvents were used as supplied commercially. Commercial $Pd(OAc)_2$ (98.0% purchased from Sigma-Aldrich) were stored in a desiccator over $CaCl_2$. Analytical thin-layer chromatography (TLC) were performed on 0.2 mm coated Science silica gel (EM 60-F254) plates. Visualization was accomplished with UV light (254 nm) and exposure to either ethanolic phosphomolybdic acid (PMA), anisaldehyde or $KMnO_4$, $CeSO_4$ + ammonium phosphomolybdate + 10% H_2SO_4, ninhydrine solution followed by heating. Melting points are uncorrected. ^1H NMR spectra were acquired on a 400 MHz or 500 MHz spectrometer and chemical shifts are reported relative to the residual solvent peak. ^{13}C NMR spectra were acquired on a 100 MHz or 125 MHz spectrometer and chemical shifts are reported in ppm relative to the residual solvent peak. Unless noted, NMR spectra were acquired in $CDCl_3$; individual peaks are reported as: multiplicity, integration, coupling constant in Hz. All IR spectra were obtained as neat films with FT-IR and selected absorbance are reported in cm^{-1}. Low resolution (LR) and High-resolution (HR) mass spectrometry data were acquired by the Central Instrumentation Facility, Indian Institute of Science Education and Research Bhopal on a MicroTOF-Q-II (quadrupole) Mass Spectrometer using CH_3CN/MeOH as a solvent.

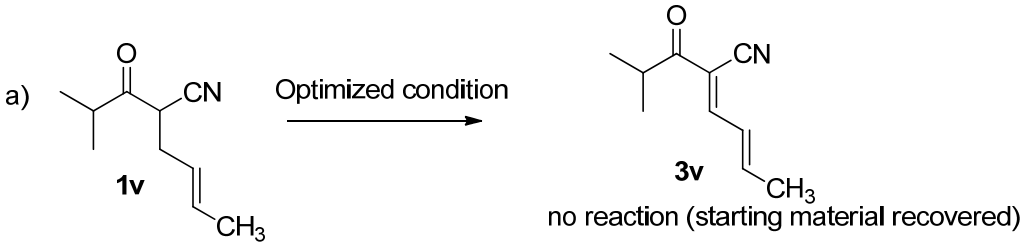
2. General procedure for the Palladium catalyzed oxidation: To a stirred solution of α-Cinnamyl-β-Keto-Nitriles **1/2** (0.12 mmol) in THF (1.0 mL), taken in a round-bottom flask attached to a refluxed condenser, $PdCl_2(CH_3CN)_2$ (5 mol %), PTS (1.0 equivalent) and BQ (1.0 equivalent) was added. The reaction was stirred at 80 ºC. After consumption of starting material (followed by TLC analysis), the mixture was cooled to room temperature. The solvent was removed under reduced pressure to provide the crude product **3/5** which was purified by flash chromatography on silica-gel using n-hexane/ethyl-acetate as eluent.

3. Control experiments:

Scheme 5:

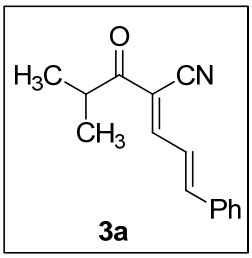


Scheme 6: *Reactions with non-cinnamyl substrates*



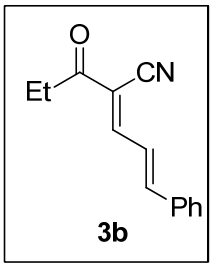
4. Characterization of α, β, γ, δ-unsaturated keto-nitrile products:

(2*E*, 4*E*)-2-isobutyryl-5-phenylpenta-2,4-dienenitrile (3a): 78% yield; R_f = 0.25 (05:95 = EtOAc/n-Hexane); Yellow solid; **mp** 75-76 °C; IR **(neat)**: 3026, 2984, 2928, 2360,1688, 1630, 1568, 1357, 1161, 754 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 7.98 (dd, *J* = 8.4, 2.4 Hz, 1H), 7.60-7.56 (m, 2H), 7.39-7.43 (3H, m), 7.30 (2H), 3.25 (m, 1H), 1.20 (d, *J* = 6.8 Hz, 6H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ, 197.3, 154.1, 149.8, 134.8, 131.2,



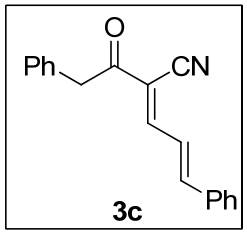
129.1, 128.5, 123.4, 116.3, 110.6, 38.2, 18.3; **HR-MS (ESI, *m/z*)**: $[M + H]^+$ calculated for $C_{15}H_{16}NO$: 226.1232; found: 226.1229.

(2*E*, 4*E*)-5-phenyl-2-propionylpenta-2,4-dienenitrile (3b): 80% yield; R_f = 0.30 (10:90 = EtOAc/Hexane); Yellow solid; **mp** 121-122 °C; **IR (neat)**: 3026, 2984, 2928, 2886, 2365, 1688, 1630, 1568, 1358, 1269, 1161, 734 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 7.94 (d, *J* = 10.4 Hz, 1H), 7.58 (dd, *J* = 6.0, 2.4 Hz, 2H), 7.40–7.41 (m, 3H), 7.30–7.24 (m, 2H), 2.84 (q, *J* = 7.2 Hz, 2H), 1.17 (t, *J* = 7.2 Hz,3H); **^{13}C NMR (100 MHz, $CDCl_3$):** δ, 193.9, 153.1, 149.8, 134.8, 131.2, 129.1, 128.5, 123.2, 116.1, 111.1, 34.1, 7.7; **HR-MS (ESI, *m/z*)**: $[M + H]^+$ calculated for $C_{14}H_{14}NO$: 212.1075 ; found: 212.1075.



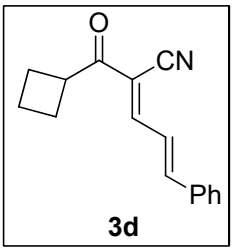
3b

(2*E*, 4*E*)-5-phenyl-2-(2-phenylacetyl)penta-2,4-dienenitrile (3c): 90% yield; R_f = 0.35 (10:90 = EtOAc/n-Hexane); Yellow solid; **mp** 160-161°C; **IR (neat)**: 3057, 2974, 2938, 2365, 1728, 1452, 1348, 1269, 1128, 1119, 760 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 7.97 (d, *J* = 10.4 Hz, 1H), 7.57 (dd, J = 6.5, 3.0 Hz, 2H), 7.41 (dd, *J* = 4.8, 2.0 Hz, 3H), 7.34-7.36 (m, 2H), 7.28-7.29 (m, 4H), 7.25 (d, *J* = 5.2 Hz, 1H), 4.10 (s, 2H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ, 190.7, 154.5, 150.4, 134.7, 132.6, 131.4, 129.7, 129.2, 128.8, 128.6, 127.4, 123.3, 116.2, 110.8, 47.2; **HR-MS (ESI, *m/z*)**: $[M + H]^+$ calculated for $C_{19}H_{15}NO$: 274.1232; found: 274.1211.



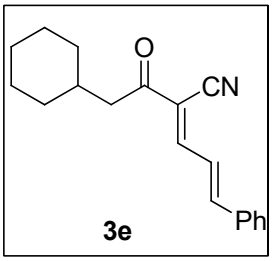
3c

(2*E*, 4*E*)-2-(cyclobutanecarbonyl)-5-phenylpenta-2,4-dienenitrile (3d): 76% yield; R_f = 0.35 (10:90 = EtOAc/n-Hexane); Yellow solid; **mp** 78-79 °C; **IR (neat)**: 2984, 2947, 2363, 2216, 1690, 1557, 1447, 1364, 1159 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 7.93 (dd, *J* = 9.6, 1.1 Hz, 1H), 7.57 (dd, *J* = 6.0, 2.4 Hz, 2H), 7.37-7.43 (m, 3H), 7.25-7.29 (m, 2H), 3.75 (p, *J* = 8.1 Hz, 1H), 2.34 (m, 4H), 2.08-2.05 (m, 1H), 1.95-1.81 (m, 1H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ, 194.3, 153.5, 149.5, 134.8, 131.2, 129.1, 128.5, 123.3, 115.9, 110.1, 43.9, 24.5, 17.8; **HR-MS (ESI, *m/z*)**: $[M + H]^+$ calculated for $C_{16}H_{16}NO$: 238.1232; found: 238.1240.



3d

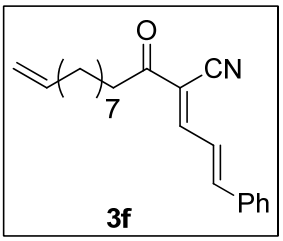
(2*E*, 4*E*)-2-(2-cyclohexylacetyl)-5-phenylpenta-2,4-dienenitrile (3e): 86% yield; R_f =0.35 (05:95= EtOAc/n-Hexane); Light yellow solid; **mp** 122-123 °C; **IR (neat)**: 2920, 2849, 2340, 2210, 1651, 1558, 1283, 1144 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 7.92 (d, *J* = 10.3 Hz, 1H), 7.58 (dd, *J* =



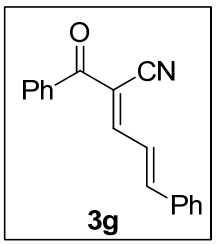
3e

6.6, 2.9 Hz, 2H), 7.46-7.42-7.39 (m, 3H), 7.28-7.25 (m, 2H), 2.66 (d, *J* = 6.8 Hz, 2H), 1.99-1.81 (m, 1H), 1.68 (m, 5H), 1.34-1.22 (m, 2H), 1.19-1.11 (m, 1H), 1.05-0.93 (m, 2H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ, 193.1, 153.3, 149.8, 134.8, 131.2, 129.1, 128.5, 123.3, 116.3, 111.7, 48.1, 34.3, 33.1, 26.1, 26.0; **HR-MS (ESI, *m/z*)**: $[M + H]^+$ calculated for $C_{19}H_{22}NO$: 280.1701; found: 280.1681.

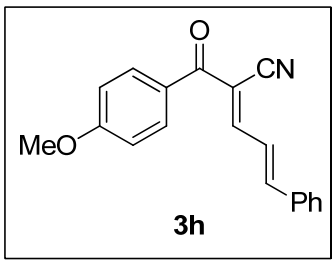
(*E*)-3-oxo-2-((*E*)-3-phenylallylidene)tridec-12-enenitrile (3f): 47% yield; R_f = 0.35 (10:90 = EtOAc/Hexane); Light yellow solid; **mp** 86-87 °C; **IR (neat)**: 2928, 2851, 2372, 1645, 1157, 748 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 7.93 (d, *J* = 10.1 Hz, 1H), 7.58 (dd, *J* = 7.2, 2.4 Hz, 2H), 7.42-7.39 (m, 3H), 7.29-7.26 (m, 2H), 5.88-4.84 (3H), 2.80 (t, *J* = 7.3 Hz, 2H), 2.06-1.95 (m, 2H), 1.65 (2H), 1.37-1.29 (m, 10H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ, 193.6, 153.2, 149.8, 139.2, 134.8, 131.2, 129.1, 128.5, 123.3, 116.2, 114.1, 111.3, 40.7, 33.7, 29.3, 29.2, 29.0, 28.9, 23.8; **HR-MS (ESI, *m/z*)**: $[M + H]^+$ calculated for $C_{22}H_{28}NO$: 322.2171; found: 322.2176.



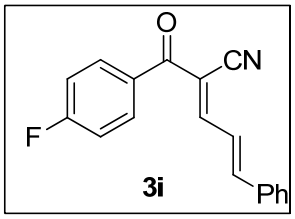
(2*E*, 4*E*)-2-benzoyl-5-phenylpenta-2,4-dienenitrile (3g):[1] 62% yield; R_f = 0.34 (05:95 = EtOAc/Hexane); Yellow solid; **mp** 96-97 °C; **IR (neat)**: 3063, 2922, 2860, 1661, 1599, 1452, 1269, 1171, 1076, 743 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 7.93 (d, *J* = 11.3 Hz, 1H), 7.86-7.83 (m, 2H), 7.64-7.56 (m, 3H), 7.50 (t, *J* = 7.6 Hz, 2H), 7.46-7.35 (m, 4H), 7.30 (1H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ, 188.2, 156.4, 149.6, 136.3, 134.7, 133.2, 131.3, 129.2, 129.0, 128.67, 128.63, 123.6, 116.0, 111.4; **LR-MS (ESI, *m/z*)**: $[M]^+$ calculated for $C_{18}H_{13}NO$: 259.09; found: 259.09.



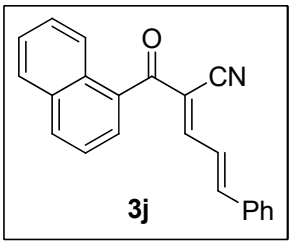
(2*E*, 4*E*)-2-(4-methoxybenzoyl)-5-phenylpenta-2,4-dienenitrile (3h):[2] 82% yield; R_f = 0.30 (10:90 = EtOAc/n-Hexane); Yellow solid; **mp** 145-146 °C; **IR (neat)**: 2849, 2365, 2355, 2203, 1661, 1603, 1541, 1312, 1254, 1171, 1036 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 7.93 (dd, *J* = 8.8, 2.8 Hz, 3H), 7.59 (dd, *J* = 6.4, 3.6 Hz, 2H), 7.44-7.40 (m, 3H), 7.38 (d, *J* = 11.3 Hz, 1H), 7.31-7.23 (1H), 6.97 (d, *J* = 8.8 Hz, 2H), 3.88 (s, 3H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ, 186.1, 163.8, 155.8, 148.9, 134.8, 131.6, 131.1, 129.1, 128.8, 128.5, 123.6, 116.4, 113.9, 111.3, 55.5; **LR-MS (ESI, *m/z*)**: $[M+H]^+$ calculated for $C_{19}H_{16}NO_2$: 290.1; found: 290.1.



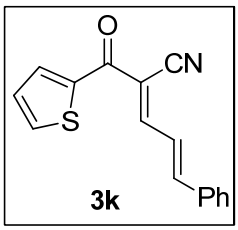
(2E,4E)-2-(4-fluorobenzoyl)-5-phenylpenta-2,4-dienenitrile (3i): 75% yield; R_f =0.43 (10:90 = EtOAc/n-Hexane); Yellow solid; **mp** 129-130 °C; **IR (neat)**: 3059, 3026, 2920, 2218, 1663, 1595, 1555, 1285, 1229, 1167, 1096 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 7.99-7.90 (m, 3H), 7.61 (dd, *J* = 5.6, 2.0 Hz, 2H), 7.45-7.40 (m, 3H), 7.38 (d, J = 11.0 Hz,1H), 7.32 (1H), 7.18 (t, *J* = 8.6 Hz, 2H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ, 186.3, 165.78 (d, *J* = 255.8 Hz), 156.5, 149.9, 134.7, 132.56 (d, *J* = 3.1 Hz), 131.80 (d, *J* = 9.4 Hz), 131.4, 129.2, 128.6, 123.5 116.1, 115.93 (d, *J* = 22.1 Hz), 110.8; **HR-MS (ESI, *m/z*)**: $[M + H]^+$ calculated for $C_{18}H_{13}FNO$: 278.0981; found: 278.0967.



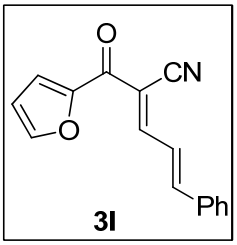
(2*E*, 4*E*)-2-(1-naphthoyl)-5-phenylpenta-2,4-dienenitrile (3j): 85 % yield; R_f =0.38 (10:90 = EtOAc/n-Hexane); Yellow solid; **mp** 146-147 °C; **IR (neat)**: 3063, 2916, 2860, 2371, 2214, 1666, 1603, 1462, 1354, 1287, 1186, 754 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 8.44 (s, 1H), 8.0-7.89 (m, 5H), 7.63-7.60 (m, 4H), 7.45-7.41(m, 4H), 7.31 (1H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ, 188.0, 156.3, 149.5, 135.5, 134.8, 133.5, 132.2, 131.3, 130.7, 129.6, 129.2, 128.8, 128.7, 128.6, 127.8, 127.1, 124.7, 123.6, 116.1, 111.5; **HR-MS (ESI, *m/z*):** $[M + H]^+$ calculated for $C_{22}H_{16}NO$: 310.1232; found: 310.1238.



(2*E*, 4*E*)-5-phenyl-2-(thiophene-2-carbonyl)penta-2,4-dienenitrile (3k): 66% yield; R_f = 0.25 (05:95 = EtOAc/n-Hexane); Yellow solid; **mp** 116-117 °C; **IR (neat)**: 2988, 2926, 2315, 1651, 1543, 1416, 1261, 1175 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 8.35 – 8.28 (m, 1H), 8.21 (s, 1H), 7.82–7.76 (m, 1H), 7.66 (dd, *J* = 6.6, 3.0 Hz, 2H), 7.47 (dd, *J* = 6.6, 3.0 Hz, 3H), 7.42 (d, *J* = 4.9 Hz, 2H), 7.26 – 7.21 (m, 1H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ, 177.2, 156.6, 150.0, 142.5, 135.5, 134.8, 134.1, 131.3, 129.2, 128.6, 126.9, 123.5, 116.7, 109.3; **HR-MS (ESI, *m/z*)**: $[M + H]^+$ calculated for $C_{16}H_{12}NOS$: 266.0640; found: 266.0609.

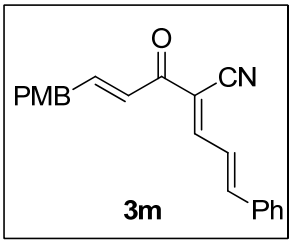


(2*E*, 4*E*)-2-(furan-2-carbonyl)-5-phenylpenta-2,4-dienenitrile (3l): 67% yield; R_f = 0.23 (10:90 = EtOAc/n-Hexane); Yellow solid; **mp** 184-185 °C;**IR (neat)**: 3121, 2359, 2058, 1645, 1290 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 8.24 (dd, *J* = 8.8, 0.8 Hz, 1H), 7.73-7.71 (m, 2H), 7.61 (dd, *J* = 6.0, 2.4 Hz, 2H), 7.47-7.37 (m, 5H), 6.62 (dd, *J* = 3.2, 2.0 Hz, 1H); **^{13}C NMR**

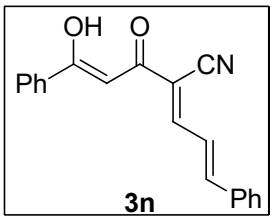


(100 MHz, $CDCl_3$): δ, 172.4, 156.5, 151.0, 150.1, 147.8, 134.8, 131.4, 129.2, 128.7, 123.5, 120.9, 116.2, 112.7, 108.8; **HR-MS (ESI, *m/z*)**: $[M + H]^+$ calculated for $C_{16}H_{12}NO_2$: 250.0868; found: 250.0854.

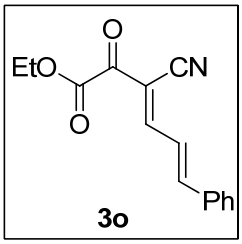
(2*E*, 4*E*)-6-(4-methoxyphenyl)-3-oxo-2-((E)-3-phenylallylidene)hex-4-enenitrile (3m): 89% yield; R_f = 0.30 (20:80 = EtOAc/Hexane); Yellow solid; **mp** 155-156 °C; **IR (neat):** 2924, 2843, 1665, 1589, 1512, 1292, 1258, 1158, 1027, 824, 752 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 8.10 (dd, *J* = 7.2, 3.6 Hz, 1H), 7.85 (d, *J* = 15.6 Hz, 1H), 7.61 (d, *J* = 8.8 Hz, 4H), 7.45-7.37 (m, 3H), 7.35 (d, *J* = 3.6 Hz, 1H), 7.32-7.30 (m, 2H), 6.93 (d, *J* = 8.8 Hz, 2H), 3.85 (s, 3H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ, 181.7, 162.4, 154.0, 149.5, 146.4, 134.9, 131.2, 130.9, 129.1, 128.5, 127.0, 123.7, 118.7, 116.6, 114.5, 112.3, 55.4; **HR-MS (ESI, *m/z*)**: $[M + Na]^+$ calculated for $C_{21}H_{17}NNaO_2$: 338.1157; found; 338.1176.



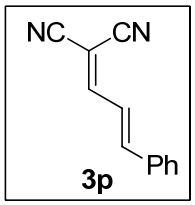
(2*E*, 4*E*)-2-((Z)-3-hydroxy-3-phenylacryloyl)-5-phenylpenta-2,4-dienenitrile (3n): 75% yield; R_f = 0.40 (10:95 = EtOAc/Hexane); Yellow solid; **mp** 201-202 °C; **IR (neat):** 2930, 2852, 1596, 1518, 1458, 1313, 1265, 1162, 1053, 983, 755, 682 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 8.05 (d, *J* = 10.8 Hz, 1H), 7.97 (d, *J* = 7.2 Hz, 2H), 7.62-7.54 (m, 3H), 7.48 (t, *J* = 7.5 Hz, 2H), 7.44-7.38 (m, 3H), 7.34 (d, *J* = 10.8 Hz, 1H), 7.28 (1H), 7.24 (s, 1H), 6.73 (s, 1H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ, 186.9, 177.7, 163.5, 151.1, 148.3, 135.0, 134.7, 133.1, 131.0, 129.1, 128.8, 128.4, 127.5, 123.8, 109.5, 95.5; **DEPT-135 (100 MHz, $CDCl_3$)**: δ, 151.1, 148.3, 133.2, 131.0, 129.1, 128.8, 128.4, 127.5, 123.7, 95.5; **HR-MS (ESI, *m/z*)**: $[M - H]^+$ calculated for $C_{20}H_{14}NO_2$: 300.1030; found: 300.1049.



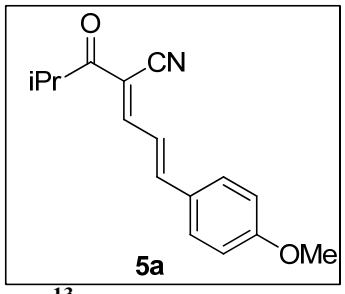
(3*E*, 5*E*)-ethyl 3-cyano-2-oxo-6-phenylhexa-3,5-dienoate (3o): 71% yield; R_f = 0.30 (10:90 = EtOAc/Hexane); Yellow solid; **mp** 80-81°C;**IR (neat):** cm^{-1}**;** **^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 8.18 (d, *J* = 10.4 Hz, 1H), 7.62 (dd, *J* = 7.2, 1.2 Hz, 2H), 7.48-7.38 (m, 5H), 4.42 (q, *J* = 7.1 Hz, 2H), 1.41 (t, *J* = 7.1 Hz, 3H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ, 179.1, 161.0, 158.3, 152.6, 134.4, 132.1, 129.3, 129.1, 123.6, 113.8, 108.9, 63.1, 13.9; **HR-MS (ESI, *m/z*)**: $[M + H]^+$ calculated for $C_{15}H_{14}NO_3$: 256.0974; found; 256.0969.



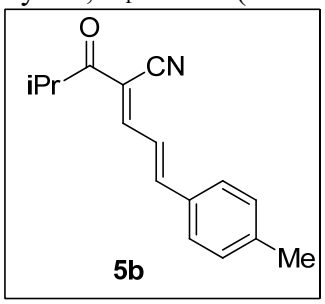
(*E*)-2-(3-phenylallylidene)malononitrile (3p):[3] 49 % yield; R_f = 0.30 (05:95 = EtOAc/n-Hexane); Brown solid; **mp** 114-115 °C; **IR (neat)**: 3007, 2658, 2237, 1614, 1564, 1450, 1267, 1179, 980 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 7.60 (dd, *J* = 3.6, 1.6 Hz, 1H), 7.58 (t, *J* = 1.9 Hz, 2H), 7.46-7.41 (m, 3H), 7.27 (s, 2H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ, 160.0, 150.4, 133.9, 132.1, 129.3, 128.9, 122.3, 113.5, 111.6, 83.0; **LR-MS (ESI, *m/z*)**: $[M]^+$ calculated for $C_{12}H_8N_2$: 180.06; found: 180.05.



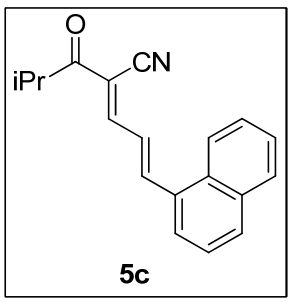
(2*E*, 4*E*)-2-isobutyryl-5-(4-methoxyphenyl)penta-2,4-dienenitrile (5a): 80% yield; R_f = 0.32 (10:90 = EtOAc/Hexane); Yellow solid; **mp** 88-89 °C; **IR (neat)**: 2968, 2922, 2843, 2355, 2208, 1672, 1593, 1547, 1479, 1302, 1260, 1171 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 7.96 (d, *J* = 11.5 Hz, 1H), 7.55 (d, *J* = 8.7 Hz, 2H), 7.33–7.19 (m, 1H), 7.15 (dd, *J* = 15.2, 11.5 Hz, 1H), 6.93 (d, *J* = 8.7 Hz, 2H), 3.86 (s, 3H), 3.25 (dt, *J* = 13.6, 6.8 Hz, 1H), 1.21 (d, *J* = 6.9 Hz, 6H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ, 197.4, 162.4, 154.7, 149.9, 130.5, 127.7, 121.2, 116.7, 114.7, 108.9, 55.5, 38.1, 18.4; **HR-MS (ESI, *m/z*)**: $[M + H]^+$ calculated for $C_{16}H_{18}NO_2$: 256.1338; found: 256.1321.



(2*E*, 4*E*)-2-isobutyryl-5-(p-tolyl)penta-2,4-dienenitrile (5b): 92 % yield; R_f = 0.38 (5:95 = EtOAc/n-Hexane); Yellow solid; **mp** 84-86 °C;**IR (neat):** 3080, 2930, 2359, 2102, 1942, 1645, 1472, 1130 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 7.97 (d, *J* = 10.3 Hz, 1H), 7.48 (d, *J* = 8.1 Hz, 2H), 7.25 (dd, J = 10.3, 2.0 Hz, 2H), 7.21 (d, *J* = 8.3 Hz, 2H), 3.32-3.17 (m, 1H), 2.38 (s, 3H), 1.20 (d, *J* = 6.8 Hz, 6H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ, 197.3, 154.4, 150.0, 142.1, 132.2, 129.9, 128.6, 122.5, 116.5, 109.8, 38.1, 21.6, 18.3; **HR-MS (ESI, *m/z*)**: $[M + Na]^+$ calculated for $C_{16}H_{17}NNaO$: 262.1208; found: 262.1222.

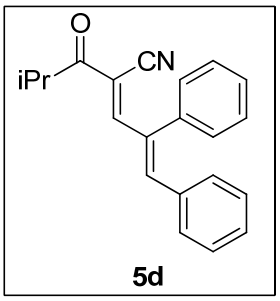


(2*E*, 4*E*)-2-isobutyryl-5-(naphthalen-1-yl)penta-2,4-dienenitrile (5c): 86% yield; R_f = 0.34 (05:95 = EtOAc/Hexane); Yellowsolid; **mp** 107-109 °C; **IR (neat)**: 2976, 2212, 1690, 1612, 1466, 1387, 1283, 1141, 1095, 976, 815, 747 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 8.02 (d, *J* = 10.8 Hz, 1H), 7.96 (s, 1H), 7.89-7.80 (m, 3H), 7.72 (dd, *J* = 8.8, 1.2 Hz, 1H), 7.54-7.51 (m, 2H), 7.43-7.37 (m, 2H), 3.27 (m, 1H), 1.22 (d, *J* = 6.8 Hz, 6H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ, 197.3,

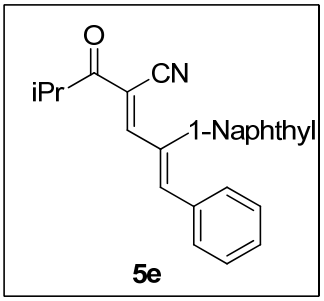


154.1, 149.8, 134.6, 133.2, 132.4, 130.7, 129.0, 128.8, 127.9, 127.9, 127.0, 123.6, 116.5, 110.3, 38.2, 18.3; **HR-MS (ESI, *m/z*)**: $[M + H]^+$ calculated for $C_{19}H_{18}NO$: 276.1388; found: 276.1377.

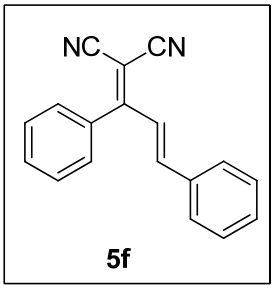
(2*E*,4*Z*)-2-isobutyryl-4,5-diphenylpenta-2,4-dienenitrile (5d): 84% yield; R_f = 0.30 (05:95 = EtOAc/Hexane); Yellow solid; **mp** 95-97 °C;**IR (neat)**: 3058, 2972, 2930, 1693, 1548, 1450, 1385, 1181, 1134, 1093, 980, 757 cm^{-1}**; ^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 8.08 (s, 1H), 7.48 (dd, *J* = 4.8, 1.6 Hz, 3H), 7.31 (s, 1H), 7.24-7.21 (m, 3H), 7.16 (t, *J* = 8.0 Hz, 2H), 7.03 (d, *J* = 7.6 Hz, 2H), 3.31-3.17 (m, 1H), 1.14 (d, *J* = 6.8 Hz, 6H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ, 198.2, 157.3, 147.5, 138.1, 135.4, 134.7, 131.0, 130.1, 129.49, 129.46, 129.2, 128.5, 115.0, 109.0, 37.3, 18.4; **HR-MS (ESI, *m/z*)**: $[M + H]^+$ calculated for $C_{21}H_{20}NO$: 302.1545; found: 302.1546.



(2*E*,4*Z*)-2-isobutyryl-4-(naphthalen-1-yl)-5-phenylpenta-2,4-dienenitrile (5e): 84% yield; R_f = 0.23 (05:95 = EtOAc/Hexane); Yellow solid; **mp** 100-101 °C; **IR (neat)**: 2085, 1638, 1548, 1463, 1385, 1181, 1132, 968, 779 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 8.25 (s, 1H), 8.03 (d, *J* = 8.4 Hz, 1H), 7.96 (d, *J* = 8.0 Hz, 1H), 7.66 (d, *J* = 8.0 Hz, 1H), 7.59-7.49 (m, 3H), 7.43 (1H), 7.35 (d, *J* = 6.4 Hz, 1H), 7.17 (t, *J* = 7.6 Hz, 1H), 7.05 (t, *J* = 8.0 Hz, 2H), 6.94 (d, *J* = 7.6 Hz, 2H), 3.16-3.06 (m, 1H), 1.09 (d, *J* = 6.8 Hz, 3H), 1.04 (d, *J* = 6.8 Hz, 3H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ, 198.3, 157.3, 149.2, 136.3, 134.5, 133.8, 132.9, 131.8, 130.9, 130.3, 129.9, 128.9, 128.5, 127.4, 126.9, 126.5, 125.9, 124.1, 114.7, 108.8, 37.2, 18.4, 18.2; **HR-MS (ESI, *m/z*)**: $[M + H]^+$ calculated for $C_{25}H_{22}NO$: 352.1701; found: 352.1707.

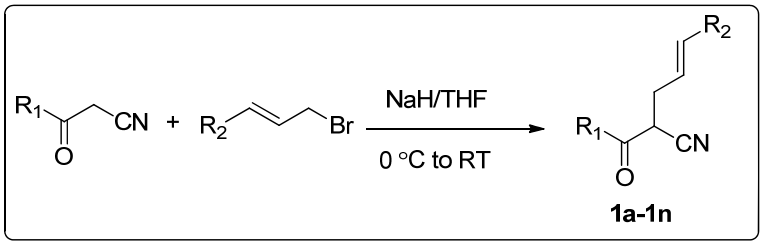


(*E*)-2-(1,3-diphenylallylidene)malononitrile (5f): 46% yield; R_f = 0.30 (05:95 = EtOAc/n-Hexane); Brown semisolid; **IR (neat)**: 3017, 2240, 1619, 1564, 1455, 1290, 1180, 980 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 7.62 (1H), 7.55 (d, *J* = 7.5 Hz, 2H), 7.52-7.50 (m, 2H), 7.42-7.34 (m, 5H), 7.23 (1H), 6.87 (d, *J* = 15.6 Hz, 1H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ, 171.2, 149.2, 134.3, 133.0, 131.7, 131.2, 129.2, 129.0, 128.9, 128.8, 128.1, 124.5, 113.3, 112.7, 29.7 (grease peak); **HR-MS (ESI, *m/z*)**: $[M + H]^+$ calculated for $C_{18}H_{13}N_2$: 257.1079; found: 257.1050.



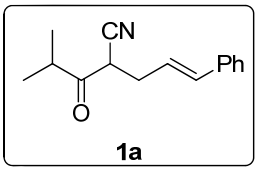
5. Preparation of starting materials

5.1 Preparation of α-Cinnamyl-β-Keto-Nitriles[5]

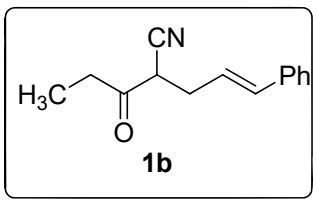


To a solution of NaH (1.2 mmol, 1.2 equiv) in THF (5 mL) at 0 °C was added β-keto nitrile [4] (1.0 mmol, 1.0 equiv) in THF (3 mL) dropwisely, and the mixture was stirred at 0 °C for 1 h. A solution of cinnamyl bromide (1.2 mmol, 1.2 equiv) in THF (3 mL) was added to the solution over 5 mins and the reaction mixture was further stirred for several hours (5-10 hrs) at room temperature. Upon completion as indicated by TLC, the reaction was quenched with saturated NH_4Cl and extracted with ethyl acetate. The combined organic layers were washed with water, brine, and dried over Na_2SO_4. The crude material was purified by column chromatography using hexane - ethyl acetate to afford the corresponding product.

(*E*)-2-isobutyryl-5-phenylpent-4-enenitrile (1a): R_f = 0.20 (5:95 = EtOAc/Hexane); Yellow liquid; **IR (neat)**: 2982, 2945, 2263, 1734, 1564, 1462, 1395, 1302, 1045 cm^{-1}**; ^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 7.35-7.27 (m, 4H), 7.26-7.22 (m, 1H), 6.55 (d, *J* = 15.6 Hz, 1H), 6.19-6.08 (m, 1H), 3.63 (dd, *J* = 7.6, 6.0 Hz, 1H), 3.03 (m, 1H), 2.76 (m, 2H), 1.18 (d, *J* = 4.0 Hz, 3H), 1.17 (d, *J* = 3.9 Hz, 3H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ, 204.0, 136.3, 134.8, 128.6, 127.9, 126.4, 123.0, 117.2, 42.2, 39.9, 32.4, 18.3, 18.0; **LR-MS (ESI, *m/z*)**: $[M]^+$ calculated for $C_{15}H_{17}NO$: 227.13; found: 227.15.

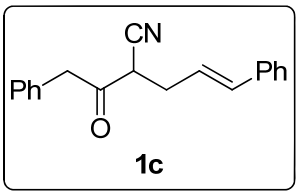


(*E*)-5-phenyl-2-propionylpent-4-enenitrile (1b): R_f = 0.25 (10:90 = EtOAc/Hexane); Colourless liquid; **IR (neat)**: 3057, 2990, 2938, 2365, 2245, 1740, 1599, 1452, 1342, 1265, 1119, 739 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 7.35-7.27 (m, 4H), 7.25 (1H), 6.55 (d, *J* = 15.6 Hz, 1H), 6.22-6.03 (m, 1H), 3.51 (dd, *J* = 7.6, 5.9 Hz, 1H), 2.79-2.70



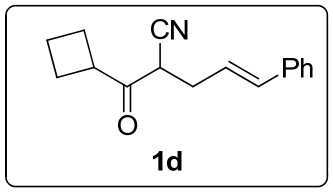
(m, 4H), 1.11 (t, *J* = 7.2 Hz, 3H); **^{13}C NMR (100 MHz, $CDCl_3$)**: 200.9, 136.3, 134.8, 128.6, 127.9, 126.4, 122.8, 117.2, 43.8, 35.0, 32.4, 7.4; **HR-MS (ESI, *m/z*)**: $[M - H]^+$ calculated for $C_{14}H_{14}NO$: 212.1081; found: 212.1096.

(*E*)-5-phenyl-2-(2-phenylacetyl)pent-4-enenitrile (1c): R_f = 0.31 (10:90 = EtOAc/Hexane); Yellow liquid; **IR (neat)**: 3061, 3036, 2936, 2853, 2500, 2253, 2214, 1699, 1450, 1265, 1078, 1026 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 7.39-7.26 (m, 7H), 7.23-7.20 (m, 3H), 6.50 (d, *J* = 15.6 Hz, 1H), 6.15-6.00 (m, 1H), 3.98 (d, *J* = 3.6 Hz, 2H), 3.60 (dd, *J* = 7.4, 6.1 Hz, 1H), 2.73 (m, 2H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ, 197.7, 136.2, 134.9, 131.8, 129.6, 129.0, 128.6, 127.9, 127.8, 126.4, 122.6, 116.9, 48.3, 42.9, 32.2; **LR-MS (ESI, *m/z*)**: $[M + H]^+$ calculated for $C_{19}H_{18}NO$: 276.13; found: 276.09.



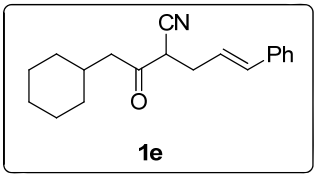
1c

(*E*)-2-(cyclobutanecarbonyl)-5-phenylpent-4-enenitrile (1d): R_f = 0.25(05:95 = EtOAc/Hexane); Colourless liquid; **IR (neat)**: 2984, 2943, 2870, 2251, 2208, 1724, 1624, 1447, 1348, 1109, 968 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 7.35 (d, *J* = 7.2 Hz, 2H), 7.30 (t, *J* = 7.4 Hz, 2H), 7.24 (d, *J* = 7.0 Hz, 1H), 6.54 (d, *J* = 15.6 Hz, 1H), 6.16-6.07 (m, 1H), 3.65-3.55 (m, 1H), 3.50 (dd, *J* = 7.6, 5.8 Hz, 1H), 2.75-2.70 (m, 2H), 2.34-2.21 (m, 4H), 2.03-1.96 (m, 1H), 1.88-1.79 (m, 1H); **^{13}C NMR (100 MHz, $CDCl_3$)**: 201.2, 136.4, 134.6, 128.6, 127.9, 126.4, 123.1, 117.1, 44.6, 42.0, 32.2, 24.8, 24.7, 17.7; **HR-MS (ESI, *m/z*)**: $[M + H]^+$ calculated for $C_{16}H_{18}NO$: 240.1388; found: 240.1372.



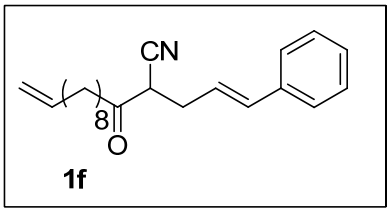
1d

(*E*)-2-(2-cyclohexylacetyl)-5-phenylpent-4-enenitrile (1e): R_f = 0.30 (05:95 = EtOAc/Hexane); Light yellow liquid; **IR (neat)**: 2928, 2860, 2671, 2208, 1786, 1719, 1645, 1495, 1447, 1265, 1161 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 7.35-7.28 (m, 4H), 7.24 (d, *J* = 7.0 Hz, 1H), 6.55 (d, *J* = 15.6 Hz, 1H), 6.19- 6.08 (m, 1H), 3.47 (dd, *J* = 7.6, 6.0 Hz, 1H), 2.78-2.69 (m, 2H), 2.56 (dd, *J* = 6.7, 2.7 Hz, 2H), 1.89-1.84 (m, 1H), 1.67 (5H), 1.24 (m, 2H), 1.19-1.06 (m, 1H), 1.02-0.87 (m, 2H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ, 199.9, 136.3, 134.8, 128.6, 127.9, 126.4, 122.8, 117.2, 49.0, 44.4, 33.4, 33.0, 32.9, 32.2, 26.0, 25.9, 25.9; **HR-MS (ESI, *m/z*)**: $[M + H]^+$ calculated for $C_{19}H_{24}NO$: 282.1858; found: 282.1870.



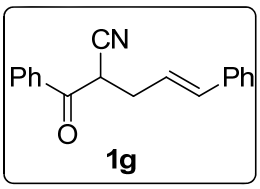
1e

2-cinnamyl-3-oxotridec-12-enenitrile (1f): R_f = 0.30 (05:95 = EtOAc/Hexane); Light yellow liquid; **IR (neat)**: 3102, 2889, 2673, 2212, 1790, 1719, 1655, 1495, 1477, 1278, 1161 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 7.36-7.28 (m, 5H), 6.55 (d, *J* = 15.7 Hz, 1H), 6.18–6.08 (m, 1H), 5.79 (m, 1H), 4.95 (ddd, *J* = 13.6, 11.1, 1.3 Hz, 2H), 3.50 (dd, *J* = 7.5, 5.9 Hz, 1H), 2.78-2.70 (m, 4H), 2.02 (dd, *J* = 14.3, 6.9 Hz, 2H), 1.60 (2H), 1.38 – 1.23 (10H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ, 200.4, 139.1, 136.6, 134.2, 128.6, 127.7, 126.3, 124.1, 122.8, 114.1, 44.0, 41.6, 35.0, 33.7, 32.3, 32.0, 29.2, 29.0, 28.8, 23.2; **HR-MS (ESI, *m/z*)**: $[M + H]^+$ calculated for $C_{22}H_{30}NO$: 324.2327; found: 324.2341.



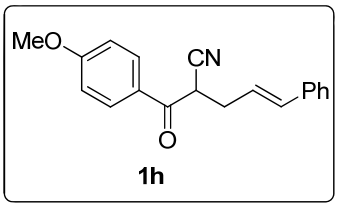
1f

(*E*)-2-benzoyl-5-phenylpent-4-enenitrile (1g): R_f = 0.32(10:90 = EtOAc/Hexane); Colourless liquid; **IR (neat)**: 3069, 3028, 2926, 2920, 2247, 1697, 1605, 1497, 1450, 1271, 1221, 1076 cm^{-1}**; ^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 8.02 (d, *J* = 7.9 Hz, 2H), 7.69 (t, *J* = 7.4 Hz, 1H), 7.56 (t, *J* = 7.6 Hz, 2H), 7.39–7.31 (m, 4H), 7.28 (d, *J* = 6.2 Hz, 1H), 6.60 (d, *J* = 15.8 Hz, 1H), 6.34–6.19 (m, 1H), 4.46 (t, *J* = 7.0 Hz, 1H), 3.11–2.87 (m, 2H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ, 190.0, 136.4, 134.8, 134.6, 134.1, 129.2, 128.8, 128.6, 127.9, 126.4, 123.1, 116.9, 40.1, 33.1; **HR-MS (ESI, *m/z*)**: $[M - H]^+$ calculated for $C_{18}H_{14}NO$: 260.1081; found: 260.1099.



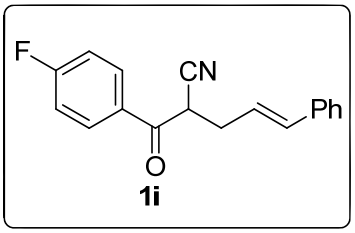
1g

(*E*)-2-(4-methoxybenzoyl)-5-phenylpent-4-enenitrile (1h): R_f = 0.28 (20:80 = EtOAc/Hexane); Colourless solid; **IR (neat)**: 3073, 3026, 2965, 2932, 2843, 2251, 1682, 1603, 1510, 1410, 1317, 1265, 1171 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 7.96 (d, *J* = 8.9 Hz, 2H), 7.37-7.26 (m, 4H), 7.25-7.20 (m, 1H), 6.97 (d, *J* = 8.8 Hz, 2H), 6.55 (d, *J* = 15.7 Hz, 1H), 6.28-6.15 (m, 1H), 4.37 (dd, *J* = 7.9, 6.3 Hz, 1H), 3.87 (s, 3H), 2.92-2.81 (m, 2H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ, 188.3, 164.6, 136.4, 134.5, 131.3, 128.6, 127.8, 126.9, 126.4, 123.4, 117.3, 114.4, 55.6, 39.6, 33.1; **HR-MS (ESI, *m/z*)**: $[M + H]^+$ calculated for $C_{19}H_{18}NO_2$: 292.1338; found: 292.1315.



1h

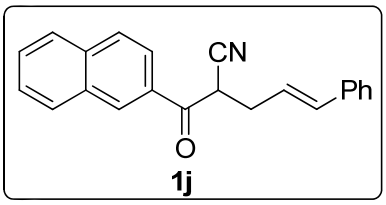
(*E*)-2-(4-fluorobenzoyl)-5-phenylpent-4-enenitrile (1i): R_f = 0.40 (10:90 = EtOAc/Hexane); Light yellow solid; **IR (neat)**: 3078, 3036, 2916, 2604, 2365, 2251, 1703, 1599, 1504, 1410, 1229, 1161



1i

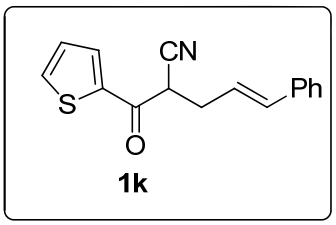
cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 8.02 (dd, *J* = 8.9, 5.2 Hz, 2H), 7.34-7.27 (m, 4H), 7.24 (d, *J* = 6.9 Hz, 1H), 7.19 (t, *J* = 8.5 Hz, 2H), 6.56 (d, *J* = 15.6 Hz, 1H), 6.25-6.11 (m, 1H), 4.38 (dd, *J* = 7.8, 6.2 Hz, 1H), 3.02-2.79 (m, 2H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ, 188.4, 166.54 (d, *J* = 258.0 Hz), 136.3, 134.8, 131.67 (d, J = 9.7 Hz), 130.50 (d, J = 3.0 Hz), 128.6, 127.9, 126.4, 122.9, 116.8, 116.49 (d, J = 22.2 Hz), 40.0, 32.9; **HR-MS (ESI, *m/z*)**: $[M + H]^+$ calculated for $C_{18}H_{15}FNO$: 280.1138; found: 280.1122.

(*E*)-2-(2-naphthoyl)-5-phenylpent-4-enenitrile (1j): R_f = 0.18 (05:95 = EtOAc/Hexane); Light yellow solid; **IR (neat)**: 3063, 3021, 2928, 2849, 2371, 2359, 2239, 1688, 1636, 1462, 1358, 1287, 1192 cm^{-1}**; ^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 8.50 (s, 1H), 7.98-7.91 (m, 3H), 7.89 (d, *J* = 7.7 Hz, 1H), 7.64 (dd, *J* = 13.9, 6.8 Hz, 1H), 7.60-7.56 (m, 1H), 7.35 (d, *J* = 7.4 Hz, 2H), 7.30 (t, *J* = 7.3 Hz, 2H), 7.24 (d, *J* = 7.1 Hz, 1H), 6.58 (d, *J* = 15.6 Hz, 1H), 6.32-6.21 (m, 1H), 4.60 (t, *J* = 6.9 Hz, 1H), 3.10-2.70 (m, 2H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ, 189.9, 136.3, 136.1, 134.7, 132.3, 131.4, 131.0, 129.8, 129.5, 129.2, 128.6, 127.9, 127.3, 126.4, 123.8, 123.1, 117.0, 40.0, 33.2; **HR-MS (ESI, *m/z*)**: $[M - H]^+$ calculated for $C_{22}H_{16}NO$: 310.1237; found: 310.1244.



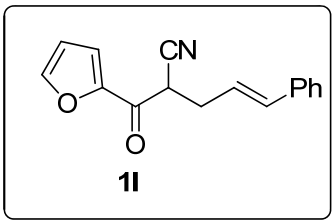
1j

(*E*)-5-phenyl-2-(thiophene-2-carbonyl)pent-4-enenitrile (1k): R_f = 0.18 (10:90 = EtOAc/Hexane); colourless liquid; **IR (neat)**: 2932, 2820, 2355, 2245, 1655, 1592, 1458, 1391, 1222, 1161, 1051, 1020 cm^{-1}**; ^{1}H NMR (500 MHz, $CDCl_3$)**: δ, 7.92 (dd, *J* = 3.9, 1.1 Hz, 1H), 7.81 (dd, *J* = 4.9, 1.1 Hz, 1H), 7.40–7.36 (m, 2H), 7.36–7.32 (m, 2H), 7.30–7.26 (m, 1H), 7.22 (dd, *J* = 4.9, 3.9 Hz, 1H), 6.62 (d, *J* = 15.8 Hz, 1H), 6.25 (dt, *J* = 15.7, 7.3 Hz, 1H), 4.31 (dd, *J* = 7.8, 6.4 Hz, 1H), 3.12–2.74 (m, 2H); **^{13}C NMR (125 MHz, $CDCl_3$)**: δ, 182.7, 140.9, 136.4, 136.4, 134.9, 133.9, 128.8, 128.7, 128.0, 126.5, 123.0, 116.9, 41.0, 33.5; **HR-MS (ESI, *m/z*)**: $[M - H]^+$ calculated for $C_{16}H_{12}NOS$: 266.0645; found: 266.0663.



1k

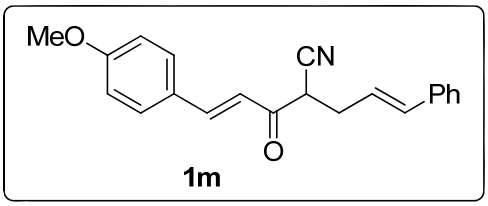
(*E*)-2-(furan-2-carbonyl)-5-phenylpent-4-enenitrile (1l): R_f = 0.18 (10:90 = EtOAc/Hexane); colourless liquid; **IR (neat)**: 2922, 2849, 2365, 2245, 1682, 1562, 1458, 1391, 1281, 1161, 1088, 1020 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 7.66 (d, *J* = 1.0 Hz, 1H), 7.41 (d, *J*



1l

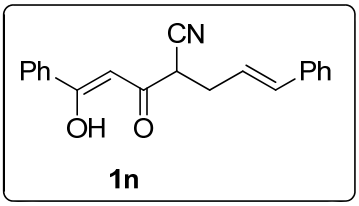
= 3.6 Hz, 1H), 7.33 (dd, *J* = 10.9, 3.9 Hz, 2H), 7.30–7.20 (m, 3H), 6.73–6.45 (m, 2H), 6.32 – 6.02 (m, 1H), 4.40–4.21 (m, 1H), 3.07–2.74 (m, 2H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ, 178.6, 150.3, 147.8, 136.3, 134.8, 128.6, 127.9, 126.4, 122.9, 120.0, 116.5, 113.3, 40.3, 32.9; **HR-MS (ESI, *m/z*)**: $[M - H]^+$ calculated for $C_{16}H_{13}NO_2$: 250.0874; found: 250.0868.

(*E*)-2-cinnamyl-5-(4-methoxyphenyl)-3-oxopent-4-enenitrile (1m): R_f = 0.24 (20:80 = EtOAc/Hexane); Light yellow liquid; **IR (neat)**: 3103, 3048, 2365, 2334, 1599, 1516, 1260, 1180 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 7.74 (d, *J* = 15.7 Hz, 1H), 7.55 (d, *J* = 8.8 Hz, 2H), 7.35 (d, J = 7.2 Hz, 2H), 7.29 (t, *J* = 7.3 Hz, 2H), 7.26 -7.21 (1H), 6.91 (3H), 6.58 (d, *J* = 15.7 Hz, 1H), 6.23-6.15 (m, 1H), 3.84 (s, 3H), 3.76 (dd, *J* = 7.8, 6.0 Hz, 1H), 2.85 (dd, *J* = 12.9, 6.4 Hz, 2H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ, 188.8, 162.5, 146.6, 136.4, 134.6, 130.9, 128.6, 127.8, 126.4, 126.3, 123.2, 118.7, 117.5, 114.6, 55.4, 43.2, 32.8; **HR-MS (ESI, *m/z*)**: $[M + H]^+$ calculated for $C_{21}H_{20}NO_2$: 318.1494; found: 318.1477.



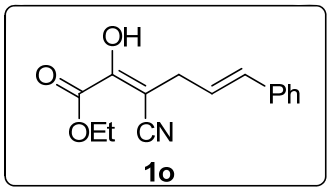
1m

(*Z*)-2-cinnamyl-5-hydroxy-3-oxo-5-phenylpent-4-enenitrile (1n): R_f = 0.38 (10:90 = EtOAc/Hexane); Light yellow liquid; **IR (neat)**: 2924, 2851, 2363, 2338, 1661, 1597, 1250 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 15.67 (s, 1H), 7.90 (d, *J* = 7.2 Hz, 2H), 7.56 (t, *J* = 7.4 Hz, 1H), 7.46 (t, *J* = 7.6 Hz, 2H), 7.36 (d, *J* = 7.2 Hz, 2H), 7.30 (t, *J* = 7.4 Hz, 2H), 7.26-7.22 (1H), 6.61 (d, *J* = 15.6 Hz, 1H), 6.53 (s, 1H), 6.26-6.15 (m, 1H), 3.65 (dd, *J* = 7.8, 5.7 Hz, 1H), 2.94-2.70 (m, 2H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ, 188.9, 182.7, 136.4, 134.9, 133.2, 133.2, 128.8, 128.6, 127.9, 127.3, 126.4, 122.8, 117.4, 94.6, 41.6, 33.8; **HR-MS (ESI, *m/z*)**: $[M + H]^+$ calculated for $C_{20}H_{18}NO_2$: 304.1338; found: 304.1312.



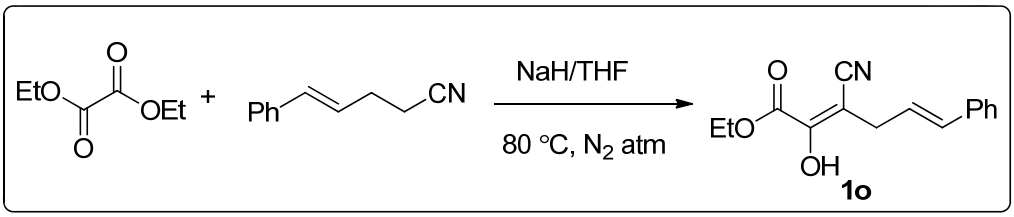
1n

(2*E*,5*E*)-ethyl 3-cyano-2-hydroxy-6-phenylhexa-2,5-dienoate (1o): R_f = 0.28 (10:90 = EtOAc/Hexane); Colourless solid; **IR (neat)**: 3339, 2365, 2218, 1724, 1645, 1447, 1333, 1229, 1020, 858 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 7.35 (d, *J* = 7.2 Hz, 2H), 7.29 (t, *J* = 7.4 Hz, 2H), 7.22 (dd, *J* = 13.5, 6.3 Hz, 1H), 6.95 (s, 1H), 6.55 (d, *J* = 15.6 Hz, 1H), 6.22-6.14 (m, 1H), 4.45 (q, *J* = 7.1 Hz, 2H), 3.27 (dd, *J* = 7.0, 1.1 Hz, 2H), 1.43 (t, *J* = 7.1 Hz, 3H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ, 162.3, 149.4, 136.7, 133.4, 128.5,



1o

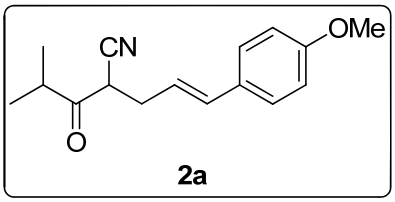
127.6, 126.3, 122.9, 117.3, 95.7, 64.4, 32.1, 13.9; **HR-MS (ESI, *m/z*)**: $[M + H]^+$ calculated for $C_{15}H_{16}NO_3$: 258.1130; found: 258.1127.



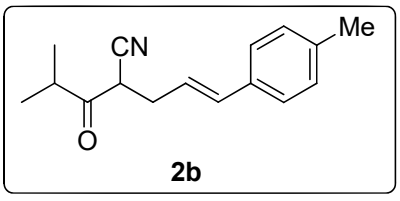
A solution of aliphatic nitrile (3 mmol) in THF (5 mL) was treated with Diethyloxalate (1 mmol), then sodium hydride (3 mmol, 60%) was added. The reaction mixture was refluxed (12-16 hr) until TLC indicated the total consumption of the ester. After cooling, the mixture was treated with ice-water (5 mL), acidified with 2 N HCl (to pH 2~3) and extracted with EA (10 mL x 3). The combined organic layer was dried over sodium sulfate and evaporated under reduced pressure to remove the solvent. The given residue was purified by column chromatography using a mixture of PE and EA as eluent to afford corresponding ketonitrile in 27% yield.

Compound 1p[6], 1q-1r[8], 1s[9], 1t[10], 1u[11] were prepared using following reported procedure.

(*E*)-2-isobutyryl-5-(4-methoxyphenyl)pent-4-enenitrile (2a): R_f = 0.50 (20:80 = EtOAc/Hexane); Colourless solid; **IR (neat)**: 2995, 2932, 2371, 2239, 1724, 1609, 1458, 1254, 1180, 1024, 968 cm^{-1}**;** **^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 7.27 (d, *J* = 8.4 Hz, 2H), 6.83 (d, *J* = 8.8 Hz, 2H), 6.48 (d, *J* = 15.6 Hz, 1H), 6.02-5.95 (m, 1H), 3.78 (s, 3H), 3.62 (dd, *J* = 7.5, 6.1 Hz, 1H), 3.03-2.96 (m, 1H), 2.78-2.70 (m, 2H), 1.17 (d, *J* = 2.8 Hz, 3H), 1.15 (d, *J* = 2.4 Hz, 3H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ, 204.1, 159.4, 134.1, 129.1, 127.5, 120.7, 117.2, 114.0, 55.3, 42.4, 39.9, 32.5, 18.3, 18.0; **HR-MS (ESI, *m/z*)**: $[M - H]^+$ calculated for $C_{16}H_{18}NO_2$: 256.1343; found: 256.1321.

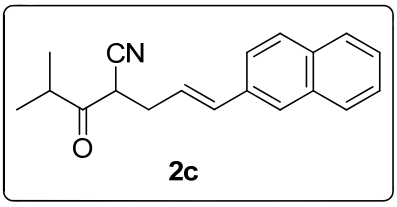


(*E*)-2-isobutyryl-5-(p-tolyl)pent-4-enenitrile (2b): R_f = 0.33 (05:95 = EtOAc/Hexane); Colourless liquid; **IR (neat)**: 2974, 2916, 2371, 2245, 2214, 1728, 1630, 1520, 1458, 1265, 1082 cm^{-1}**;** **^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 7.23 (d, *J* = 8.4 Hz, 2H), 7.11 (d, *J* = 8.0 Hz, 2H), 6.51 (d, *J* = 15.6 Hz, 1H), 6.14-6.01 (m, 1H), 3.62 (dd, *J* = 7.5, 6.1 Hz, 1H), 3.05-2.98 (m, 1H), 2.79-2.70 (m, 2H), 2.32 (s, 3H), 1.18 (d, *J* = 3.6 Hz, 3H), 1.16 (d, *J* = 3.6 Hz, 3H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ, 204.1, 137.7, 134.6,



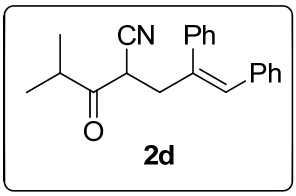
133.6, 129.3, 126.3, 121.9, 117.2, 42.3, 39.9, 32.4, 21.2, 18.3, 18.0; **HR-MS (ESI, *m/z*)**: [M - H]$^+$ calculated for $C_{16}H_{18}NO$: 240.1394; found: 240.1396.

(*E*)-2-isobutyryl-5-(naphthalen-2-yl)pent-4-enenitrile (2c): R_f = 0.20(05:95 = EtOAc/Hexane); Light yellow solid; **IR (neat):** 3057, 2980, 2928, 2359, 2245, 1724, 1636, 1593, 1468, 1379, 1275, 1186, 1097 cm^{-1}**; ^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 7.80-7.64 (m, 3H), 7.70 (s, 1H), 7.55 (d, *J* = 9.3 Hz, 1H), 7.48-7.42 (m, 2H), 6.71 (d, *J* = 15.6 Hz, 1H), 6.33-6.19 (m, 1H), 3.66 (dd, *J* = 7.5, 6.1 Hz, 1H), 3.06-2.99 (m, 1H), 2.85-2.76 (m, 2H), 1.20 (d, *J* = 2.8 Hz, 3H), 1.18 (d, *J* = 2.8 Hz, 3H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ, 204.0, 134.9, 133.7, 133.5, 133.1, 128.3, 128.0, 127.6, 126.4, 126.3, 126.0, 123.3, 123.3, 117.2, 42.2, 39.9, 32.5, 18.3, 18.0; **HR-MS (ESI, *m/z*)**: [M - H]$^+$ calculated for $C_{19}H_{18}NO$: 276.1394; found: 276.1391.



2c

(*Z*)-2-isobutyryl-4,5-diphenylpent-4-enenitrile (2d): R_f = 0.28 (5:95 = EtOAc/Hexane); Colourless liquid; **IR (neat):** 3058, 3030, 2925, 2878, 2499, 2253, 2210, 1699, 1455, 1265, 1078, 1026 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ, 7.32 (3H), 7.18 (dd, *J* = 7.6, 1.7 Hz, 2H), 7.11-7.07 (3H), 6.94 (dd, *J* = 6.6, 2.9 Hz, 2H), 6.64 (s, 1H), 3.43 (dd, *J* = 9.5, 5.6 Hz, 1H), 3.17 (ddd, *J* = 14.1, 5.6, 1.0 Hz, 1H), 2.97-2.83 (m, 2H), 1.11 (d, *J* = 6.8 Hz, 3H), 1.08 (d, *J* = 6.9 Hz, 3H); **^{13}C NMR (100 MHz, $CDCl_3$)**: δ, 204.2, 138.2, 136.3, 136.1, 130.9, 129.2, 129.1, 128.8, 127.99, 127.96, 127.0, 117.0, 40.8, 39.9, 39.7, 18.3, 18.1; **HR-MS (ESI, *m/z*)**: [M + H]$^+$ calculated for $C_{21}H_{22}NO$: 304.1701; found; 304.1654.



2d

Compound **2e and 2f** were prepared using following reported procedure.[2,7]

6. Reference:

1. J. O. Guevara-Pulido, J. M. Andrés and R. Pedrosa, *Eur. J. Org. Chem*. 2014, 8072.
2. N. Kim Son, P. Raoul and M. Yves, *Bulletin de la Societe Chimique de France* 1974, *3-4*, 471-4.
3. Yang, Xianghua et .al. *Org. Biomol. Chem.* 2012, **10**, 852.
4. β-Keto-Nitriles prepared using reported procedures: (a) W. Q. Yu, Y. F. Du and K. Zhao, *Org. Lett*. 2009, **11**, 2417; (b) J. Shen, D. Yang, Y. Liu, S. Qin, J. Zhang, J. Sun, C. Liu, C. Liu, X. Zhao, C. Chu and R. Liu, *Org. Lett.* 2014, **16**, 350; (c) Y. Ji, W.

C. Trenkle and J. V. Vowles, *Org. Lett.* 2006, **8**, 1161; (d) L. Johnson, J. Powers, F. Ma, K. Jendza, B. Wang, E. Meredith and N. Mainolfi, *Synthesis* 2013, **45**, 0171.

5. Y. Jiang, C.-M. Park and T.-P. Loh, *Org. Lett.* 2014, **16**, 3432.
6. G. Dickmeiss, K. L. Jensen, D. Worgull, P. T. Franke and K. A. Jørgensen, *Angew. Chem., Int. Ed.* 2011, **50**,1580.
7. M.-B. Li, H. Li, J. Wang, C.-R Liu and S.-K. Tian, *Chem. Commun.* 2013, **49**, 8190.
8. M. D. Bachi and D. G. Lasanow, *Synlett* 1990, **9**, 551.
9. R. Nallagonda, R. R. Reddy and P. Ghorai, *Chem. Eur. J.* 2015, **21**, 14732.
10. N. T. Vikas, N. P. Kavit, S. K. Harish and K. C. Hemchandra, *Tetrahedron Lett*. 2008, **49**, 2213.
11. J. Wang, Y. Masui and M. Onaka, *ACS Catal*., 2011, **5**, 446.

checkCIF/PLATON report

You have not supplied any structure factors. As a result the full set of tests cannot be run.

THIS REPORT IS FOR GUIDANCE ONLY. IF USED AS PART OF A REVIEW PROCEDURE FOR PUBLICATION, IT SHOULD NOT REPLACE THE EXPERTISE OF AN EXPERIENCED CRYSTALLOGRAPHIC REFEREE.

No syntax errors found. CIF dictionary Interpreting this report

Datablock: TRYA1_a

```
Bond precision:  C-C = 0.0014 A          Wavelength=0.71073

Cell:          a=7.4180(1)       b=7.5529(1)      c=10.9647(2)
               alpha=80.836(1)   beta=86.503(1)   gamma=84.074(1)
Temperature:   296 K
```

	Calculated	Reported
Volume	602.621(16)	602.621(16)
Space group	P -1	P -1
Hall group	-P 1	-P 1
Moiety formula	C16 H11 N O2	?
Sum formula	C16 H11 N O2	C16 H11 N O2
Mr	249.26	249.26
Dx,g cm-3	1.374	1.374
Z	2	2
Mu (mm-1)	0.091	0.091
F000	260.0	260.0
F000’	260.12	
h,k,lmax	10,10,15	10,10,15
Nref	3618	3589
Tmin,Tmax	0.988,0.992	
Tmin’	0.986	

```
Correction method= Not given

Data completeness= 0.992          Theta(max)= 30.267

R(reflections)= 0.0430( 3102)     wR2(reflections)= 0.1481( 3589)

S = 1.147                 Npar= 172
```

The following ALERTS were generated. Each ALERT has the format
test-name_ALERT_alert-type_alert-level.
Click on the hyperlinks for more details of the test.

Alert level G

```
PLAT154_ALERT_1_G The su's on the Cell Angles are Equal .........    0.00100 Degree
PLAT230_ALERT_2_G Hirshfeld Test Diff for    C005   --  C00C    ..        6.5 su
PLAT720_ALERT_4_G Number of Unusual/Non-Standard Labels .........         30 Note
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   0 ALERT level A = Most likely a serious problem - resolve or explain
   0 ALERT level B = A potentially serious problem, consider carefully
   0 ALERT level C = Check. Ensure it is not caused by an omission or oversight
   3 ALERT level G = General information/check it is not something unexpected

   1 ALERT type 1 CIF construction/syntax error, inconsistent or missing data
   1 ALERT type 2 Indicator that the structure model may be wrong or deficient
   0 ALERT type 3 Indicator that the structure quality may be low
   1 ALERT type 4 Improvement, methodology, query or suggestion
   0 ALERT type 5 Informative message, check
```

It is advisable to attempt to resolve as many as possible of the alerts in all categories. Often the minor alerts point to easily fixed oversights, errors and omissions in your CIF or refinement strategy, so attention to these fine details can be worthwhile. In order to resolve some of the more serious problems it may be necessary to carry out additional measurements or structure refinements. However, the purpose of your study may justify the reported deviations and the more serious of these should normally be commented upon in the discussion or experimental section of a paper or in the "special_details" fields of the CIF. checkCIF was carefully designed to identify outliers and unusual parameters, but every test has its limitations and alerts that are not important in a particular case may appear. Conversely, the absence of alerts does not guarantee there are no aspects of the results needing attention. It is up to the individual to critically assess their own results and, if necessary, seek expert advice.

Publication of your CIF in IUCr journals

A basic structural check has been run on your CIF. These basic checks will be run on all CIFs submitted for publication in IUCr journals (*Acta Crystallographica, Journal of Applied Crystallography, Journal of Synchrotron Radiation*); however, if you intend to submit to *Acta Crystallographica Section C* or *E*, you should make sure that full publication checks are run on the final version of your CIF prior to submission.

Publication of your CIF in other journals

Please refer to the *Notes for Authors* of the relevant journal for any special instructions relating to CIF submission.

PLATON version of 21/06/2015; check.def file version of 21/06/2015

Datablock TRYA1_a - ellipsoid plot