Solvent-Free Synthesis of Cyanohydrin Derivatives Catalysed by Triethylamine

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Abstract: A very simple one-step environmentally friendly procedure for the synthesis of O-substituted cyanohydrins from aldehydes and ketones, in the absence of solvent, employing minimum amounts of the corresponding cyanides has been optimised. Aldehydes react more rapidly than ketones using triethylamine as catalyst offering in both cases almost quantitative yields of the corresponding *O*-trimethylsilyl, *O*-methoxycarbonyl, *O*-benzoyl and *O*-acetyl cyanohydrins.

Key words: addition reactions, catalysis, cyanohydrin derivatives, green chemistry, solvent-free reactions

The absence of solvent in organic synthesis makes procedures simpler, saves energy and prevents solvent wastes, hazards and toxicity. Waste prevention and environmental protection are major requirements nowadays in the world, the solvent-free organic synthesis being one of the most promising alternatives in order to reach these goals.[1] The environmental, safety and economical benefits of this strategy are associated with chemical advantages. The higher concentration of reactants in the absence of solvents usually leads to more favourable kinetics than in solution and, of course, the scalability of the procedures to an industrial level becomes more accessible.[1]

Particularly, the transformations involving cyanide ion surrogates are subjugated to this waste product control due to their high toxicity. An enormous number of synthesis of cyanohydrins and their derivatives have been developed for multiple purposes. The cyanohydrins are very important organic intermediates,[2] but, in most cases, their instability makes protection of the oxygen atom necessary. This protection is more advantageous when taking place in only one step reaction than when performed in a two-step sequence starting, in both cases, from aldehydes or ketones. Thus, the synthesis of racemic *O*-alkoxycarbonyl cyanohydrins,[3–9] *O*-acyl cyanohydrins[6,10,11] and cyanohydrin *O*-phosphates,[12,13] is preferred rather than the preparation of *O*-trimethylsilyl cyanohydrins due to the toxicity of the trimethylsilyl cyanide (TMSCN) and the lability of the O–TMS bond.[14–16]

Many efforts have been recently done in reducing solvent volumes and in the optimisation of the cyanide source amounts. For example, *O*-trimethylsilyl cyanohydrins have been obtained from aldehydes using a recyclable silica-based scandium(III) interphase catalyst[17] and an ionic liquid [omim][PF_6]$^-$ as efficient reaction media in the absence of any Lewis acid.[18] A solvent-free procedure, starting from both ketones and aldehydes, and using TMSCN and substoichiometric amounts of inorganic/organic salts as heterogeneous basic catalysts has been recently reported.[19] *O*-Alkyl cyanohydrins can be prepared from aldehydes using iron(III) chloride as catalyst, in the absence or in the presence of solvents under very mild reaction conditions.[20] *O*-Acyl or *O*-methoxycarbonyl cyanohydrins were prepared using tributyltin cyanide as catalyst in a homogeneous mixture with acetyl cyanide and methyl cyanoformate, respectively.[6]

Recently, we have described that cyanohydrin *O*-phosphates can be obtained from aldehydes or ketones and diethyl cyanophosphonate using triethylamine as catalyst without any solvent and avoiding excesses of lithium cyanide (not commercially available) apart from other reagents.[12,13]

During our studies on the synthesis of non-racemic *O*-benzoyl, *O*-methoxycarbonyl and *O*-trimethylsilyl cyanohydrins we required the pure racemic derivatives.[15a,16a,c,21] In this article, we complete the scope of the solvent-free triethylamine-catalysed synthesis of the above mentioned cyanohydrin derivatives from aldehydes and ketones using very low excess of trimethylsilyl cyanide, methyl cyanoformate and benzoyl cyanide or pyruvonitrile as cyanide sources.

The reaction of aldehydes and ketones with TMSCN (1.1–2.0 equiv) took place in the presence of substoichiometric amounts of triethylamine (10–20 mol%) at room temperature in very short reaction times and very good yields (Scheme 1 and Table 1). The reaction was monitored by ^{1}H NMR spectroscopy and when it was judged complete the catalyst and the small excess of reagent were evaporated obtaining derivatives **1** as crude pure compounds. The reactivity of whatever aldehyde (aromatic, heteroaromatic, aliphatic and α,β-unsaturated) can be considered instantaneous when employing 1.1 equivalents of the TMSCN and 10 mol% of triethylamine (Table 1, entries 1–13). Aromatic, aliphatic and α,β-unsaturated ketones are not so reactive substrates requiring longer reaction periods and higher amounts of both TMSCN (1.2–2.0 equiv) and triethylamine (20 mol%) (Table 1, entries 14–20). The fastest reactions corresponded to the most acces-

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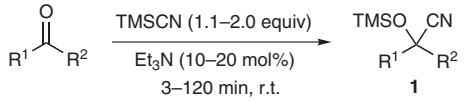
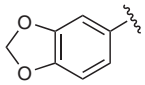
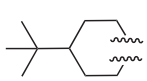
sible carbonyl groups in methyl vinyl ketone (MVK) and 4-*tert*-butylcyclohexanone. In the latter example the *cis:trans* diastereoselectivity was approximately 90:10, determined by ^{1}H NMR spectroscopy (COSY and NOESY). The reaction with cinnamaldehyde and MVK afforded very clean reaction products and any α,β-unsaturated nitrile formed was observed as a result of the isomerisation of the carbon–carbon double bond[12] (Table 1, entries 11 and 17).



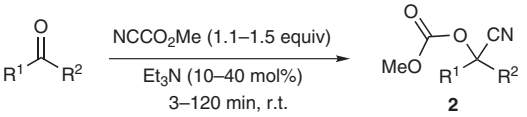
Scheme 1 Synthesis of *O*-trimethylsilyl cyanohydrins **1**.

Table 1 Synthesis of Racemic *O*-Trimethylsilyl Cyanohydrins **1**

Entry	R^1	R^2	TMSCN (equiv)	Et_3N (mol%)	Time (min)	**1**	Yield (%)[a]
1	Ph	H	1.1	10	3	**1a**	99
2	2-MeC_6H_4	H	1.1	10	3	**1b**	99
3	4-$MeOC_6H_4$	H	1.1	10	3	**1c**[b]	99
4	2-ClC_6H_4	H	1.1	10	3	**1d**	99
5	4-ClC_6H_4	H	1.1	10	3	**1e**	99
6		H	1.1	10	3	**1f**	99
7	3-$PhOC_6H_4$	H	1.1	10	3	**1g**	99
8	2-furyl	H	1.1	10	3	**1h**	92
9	3-pyridyl	H	1.1	10	3	**1i**	99
10	(*E*)-MeCH=CH	H	1.1	10	3	**1j**	99
11	(*E*)-PhCH=CH	H	1.1	10	3	**1m**	99
12	$Me(CH_2)_5$	H	1.1	10	3	**1n**	99
13	$PhCH_2CH_2$	H	1.1	10	3	**1o**	99
14	Ph	Me	1.5	20	120	**1p**	90
15	Ph	Cy[c]	1.2	20	100	**1q**	99
16	4-ClC_6H_4	Me	1.5	20	30	**1r**	99
17	CH_2=CH	Me	1.2	20	10	**1s**	99
18	(*E*)-PhCH=CH	Me	2.0	20	90	**1t**	99
19			1.2	20	15	**1u**[d]	99
20	$PhCH_2CH_2$	Me	1.2	20	25	**1v**	92

[a] Isolated crude pure compounds (>92% of purity by ^{1}H NMR spectroscopy).
[b] Unstable compound.
[c] Cy = cyclohexyl.
[d] Obtained as a 90:10 *cis/trans* mixture of diastereomers.

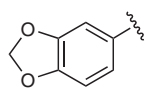
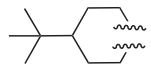
A very similar chemical behaviour was observed when aldehydes or ketones were treated under the same reaction conditions employing substoichiometric amounts of triethylamine (10–40 mol%) but using methyl cyanoformate (1.1–1.5 equiv) instead of TMSCN. The reaction was monitored by GC analysis and when it was judged complete, reagents were evaporated achieving the more stable crude pure compounds **2** in excellent chemical yields (Scheme 2 and Table 2). A set of assorted aldehydes was tested and in all of them the cyanoformylation reaction took less than 5 min (Table 2, entries 1–15). As in the former reaction, ketones underwent the cyanoformylation process in longer reaction times than the aldehydes. They also needed higher amounts of both triethylamine (20–40 mol%) and methyl cyanoformate (1.2–1.5 equiv) (Table 2, entries 16–22), MVK and *tert*-butylcyclohexanone being the more reactive (Table 2, entries 20 and 21). A slight higher proportion of the *cis*-stereoisomer **2u** was isolated from 4-*tert*-butylcyclohexanone and methyl cyanoformate Table 2, entry 21) in comparison with the analogous reaction performed with TMSCN (see above).



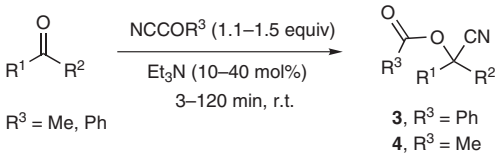
Scheme 2 Synthesis of *O*-methoxycarbonyl cyanohydrins **2**.

When aldehydes and ketones were allowed to react with benzoyl cyanide or acetyl cyanide (1.1–1.5 equiv) in the presence of a substoichiometric amount of triethylamine (10–40 mol%) very good yields of products **3** or **4** (Scheme 3 and Table 3) were, in general, obtained. All type of aldehydes underwent the corresponding addition reaction instantaneously (monitored by GC) affording excellent yields of *O*-benzoyl **3** or *O*-acetyl cyanohydrins **4** (Table 3, entries 1–14). However, ketones gave not so good results in spite of using 20 or 40 mol% of triethylamine as occurred in the reaction with acetophenone (Table 3, entries 16 and 17). A similar effect was observed when MVK and dihydrochalcone were submitted to different reaction conditions with higher amounts of both triethylamine and benzoyl cyanide (Table 3, entries 18 and 20). Racemic *O*-acetyl cyanohydrins **4** are excellent substrates for biocatalytic transformations used in the preparation of pharmaceuticals.[22] Therefore, in selected cases, the addition reaction using pyruvonitrile was surveyed. Thus, pyruvonitrile reacted readily with aldehydes but ketones gave very disappointing results. *O*-Benzoyl cyanohydrins **3** always were obtained in better yields and as cleaner crude products than the analogous *O*-acetyl cyanohydrins **4**, which needed purification by flash chromatography (Table 3, compare entries 1,2; 11,12 and 14,15). 4-*tert*-Butylcyclohexanone yielded quantitatively compound **3u** with a 90:10 *cis*:*trans* diastereomeric ratio, identical to the value obtained for the reaction with TMSCN (Scheme 4 and Table 4).

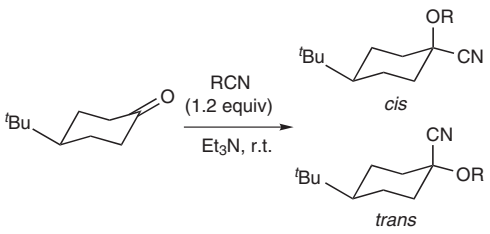
Table 2 Synthesis of Racemic *O*-Methoxycarbonyl Cyanohydrins **2**

Entry	R^1	R^2	$NCCO_2Me$ (equiv)	Et_3N (mol%)	Time (min)	**2**	Yield (%)[a]
1	Ph	H	1.1	10	3	**2a**	99
2	2-MeC_6H_4	H	1.1	10	3	**2b**	99
3	4-$MeOC_6H_4$	H	1.1	10	3	**2c**[b]	99
4	2-ClC_6H_4	H	1.1	10	3	**2d**	99
5	4-ClC_6H_4	H	1.1	10	3	**2e**	99
6		H	1.1	10	3	**2f**	99
7	3-$PhOC_6H_4$	H	1.1	10	3	**2g**	99
8	2-furyl	H	1.1	10	3	**2h**	99
9	3-pyridyl	H	1.1	10	3	**2i**	99
10	(*E*)-MeCH=CH	H	1.1	10	3	**2j**	99
11	(*E*)-$Me(CH_2)_2CH$=CH	H	1.1	10	3	**2k**	99
12	(*E*)-$Me(CH_2)_4CH$=CH	H	1.1	10	5	**2l**	99
13	(*E*)-PhCH=CH	H	1.1	10	3	**2m**	99
14	$Me(CH_2)_5$	H	1.1	10	3	**2n**	99
15	$PhCH_2CH_2$	H	1.1	10	3	**2o**	99
16	Ph	CH_3	1.5	20	90	**2p**	80[c]
17	Ph	Cy[d]	1.5	20	120	**2q**	70[c]
18	Ph	Cy[d]	1.2	40	120	**2q**	82
19	4-ClC_6H_4	CH_3	1.5	20	30	**2r**	70[c]
20	CH_2=CH	CH_3	1.2	20	7	**2s**	99
21			1.2	20	9	**2u**[e]	99
22	$PhCH_2CH_2$	CH_3	1.2	20	25	**2v**	99

[a] Isolated crude pure compounds (>92% purity by GC).
[b] Unstable compound.
[c] After purification by flash chromatography.
[d] Cy = cyclohexyl.
[e] Obtained as a 87:13 *cis/trans* mixture of diastereomers.



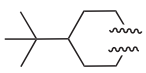
Scheme 3 Synthesis of *O*-benzoyl and *O*-acetyl cyanohydrins **3** and **4**.



Scheme 4 Addition reactions of several cyanide sources onto 4-*tert*-butylcyclohexanone.

Evaluating the results obtained in the reaction of 4-*tert*-butylcyclohexanone with every cyanide reagent (Table 4), the best diastereoselection was achieved for compound **5u**[13] using diethyl cyanophosphonate and a 10 mol% amount of triethylamine, possibly due to the bulkier

Table 3 Synthesis of Racemic *O*-Benzoyl and *O*-Acetyl Cyanohydrins **3** and **4**

Entry	R^1	R^2	R^3	R^3COCN (equiv)	Et_3N (mol%)	Time (min)	**3** or **4**	Yield (%)[a]
1	Ph	H	Ph	1.1	10	3	**3a**	99
2	Ph	H	Me	1.1	10	3	**4a**	90[b]
3	2-MeC_6H_4	H	Ph	1.1	10	3	**3b**	99
4	4-$MeOC_6H_4$	H	Ph	1.1	10	15	**3c**[c]	99
5	4-ClC_6H_4	H	Ph	1.1	10	5	**3e**	99
6	3-$PhOC_6H_4$	H	Me	1.1	10	60	**4g**	93[b]
7	2-furyl	H	Ph	1.1	10	3	**3h**	95
8	3-pyridyl	H	Ph	1.1	10	3	**3i**	99
9	(*E*)-MeCH=CH	H	Ph	1.1	10	3	**3j**	99
10	(*E*)-$Me(CH_2)_4CH$=CH	H	Me	1.1	10	5	**4l**	82[b]
11	(*E*)-PhCH=CH	H	Ph	1.1	10	5	**3m**	99
12	(*E*)-PhCH=CH	H	Me	1.1	10	30	**4m**	75[b]
13	$Me(CH_2)_5$	H	Ph	1.1	10	5	**3n**	99
14	$PhCH_2CH_2$	H	Ph	1.1	10	8	**3o**	99
15	$PhCH_2CH_2$	H	Me	1.1	10	25	**4o**	91[b]
16	Ph	Me	Ph	1.5	20	120	**3p**	<15
17	Ph	Me	Ph	1.5	40	75	**3p**	<15
18	CH_2=CH	Me	Ph	1.2	20	5	**3s**	<15
19			Ph	1.2	20	50	**3u**[d]	99
20	$PhCH_2CH_2$	Me	Ph	1.2	20	30	**3v**	<10

[a] Isolated crude pure compounds (>92% of purity by GC).
[b] After purification by flash chromatography.
[c] Unstable compound.
[d] Obtained as a 90:10 *cis/trans* mixture of diastereomers.

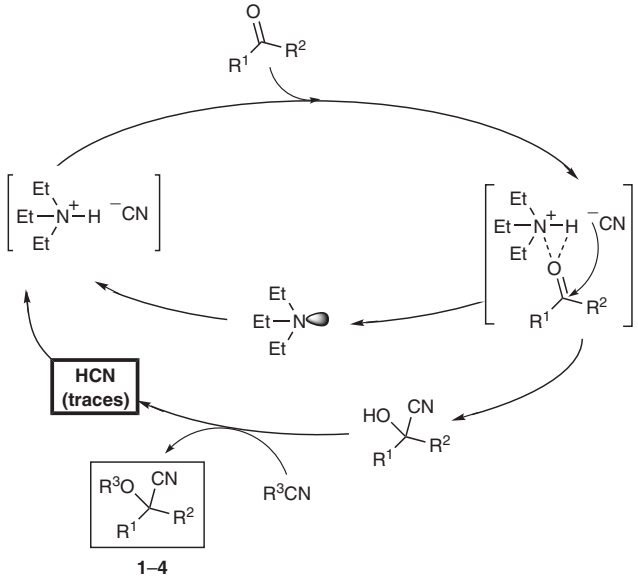
Table 4 Addition Reactions of Several Cyanide Sources onto 4-*tert*-Butylcyclohexanone

Entry	R	Et_3N (mol%)	Time (min)	Series **u**	Yield (%)[a]	*cis/trans*[b]
1	TMS	20	15	**1u**	99	90:10
2	CO_2Me	20	9	**2u**	99	87:13
3	COPh	20	50	**3u**	99	90:10
4	$PO(OEt)_2$[c]	10	30	**5u**	90	98:2

[a] Isolated crude pure compounds (>92% of purity by GC or ^1H NMR for compound **1u**).
[b] Determined by ^1H NMR experiments (COSY and NOESY).
[c] See Ref.[13]

phosphate residue of the cyanide source (Table 4, entry 4). The other three reagents afforded cyanohydrin derivative in the series **u** in better yield but with lower diastereoselectivity as it was described above.

The possible mechanism of these transformations would involve a first hydrocyanation addition followed by the subsequent O-protection. This hypothesis is strongly supported by the *ab initio* calculations[16c] and experimental results concerning to the non-racemic simple O-phosphorylation,[16c] O-trimethylsilylation,[21] O-methoxycarbonylation[14c] and O-acylation[15a] of racemic cyanohydrins by $(EtO)_2POCN$, TMSCN, MeOCOCN and PhCOCN/MeCOCN, respectively. All these data supported the previous interaction of hydrogen cyanide with the tertiary amine, thus activating the nucleophile. Traces of hydrogen cyanide are present in every cyanide-containing reagent, as it has been demonstrated by ^{13}C NMR spectroscopy.[14c,15a,16c,21] The resulting species $Et_3N{\cdot}HCN$ reacted with the aldehyde or with the ketone furnishing the



Scheme 5

corresponding cyanohydrin, which underwent a fast O-substitution in the presence of substoichiometric amounts of triethylamine, regenerating the catalytic active species $Et_3N{\cdot}HCN$ (Scheme 5).

Many of these examples shown in Tables 1–3 have very close structural relationships with part of some natural or synthetic biologically active compounds. For example, the structure of series **a** constitutes part of the skeleton of various cyanogenic glycosides isolated from the leaves and roots of *Phyllagatis rotundifolia*.[23] Series **c** molecules are often employed in the synthesis of natural products as (–)-tembamide and (–)-aegeline,[16a,d,24] whilst compounds in the **e** series can be considered as intermediates in the synthesis of the anti-thrombotic agent clopidogrel.[25] Series **g** are interesting building blocks in the industrial production of pyrethroid insecticides,[26] whereas compounds of the **i** series are direct precursors of 2-amino-1-(3-pyridinyl)ethanol.[27] In addition, series **l** is employed in the preparation of sphingosines[28] and coriolic acid[29] and series **p** has been applied to the elaboration of hydantoins and other analogues, which exhibited activity as voltage-gated sodium channel ligands.[30] Products with the **r** skeleton were used in the preparation of acylaminopropyl-piperazines as α-1-adrenergic receptor antagonists.[31] Cyanohydrin derivatives from MVK **s** have been tested as soil fumigants and to stored-product pests[32] and, finally, series **q** can be considered as intermediates in the total synthesis of (*S*)-oxybutynin.[33]

According to the reactivity exhibited by aldehydes and ketones, we can conclude that inexpensive triethylamine efficiently catalysed the synthesis of cyanohydrin derivatives such as *O*-trimethylsilyl, *O*-methoxycarbonyl, *O*-benzoyl and *O*-acetyl cyanohydrins. This green reaction proceeded at room temperature, without solvent and, after a simple work-up, the crude reaction product did not require any further purification. This procedure, which reduces the massive amounts of the cyanide reagents to the minimum, is prone to be applied to an industrial level.

Cyanohydrin Derivatives 1–4; General Procedure

In a round-bottomed flask were placed the carbonyl compound (0.5 mmol) and Et_3N (10–40 mol%) and the mixture was stirred at r.t. The cyanide source (1.1–2 equiv) was slowly added at the same temperature. When the reaction was judged complete (^{1}H NMR or GC, see text and Tables 1–4), the Et_3N was evaporated under vacuum, giving the residue, which, generally, did not require any further purification. In a few cases, this residue had to be purified by flash chromatography eluting with mixtures of *n*-hexane–EtOAc (see Tables 1–4).

2-Phenyl-2-(trimethylsilyloxy)acetonitrile (1a)[34]

Colourless oil.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 0.25 (s, 9 H, 3 CH_3), 5.80 (s, 1 H, CHCN), 7.39–7.48 (m, 5 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = –0.27 (3 CH_3), 63.6 (*C*HCN), 119.1 (CN), 126.3, 129.0, 129.3, 136.2 (ArC).

2-(2-Methylphenyl)-2-(trimethylsilyloxy)acetonitrile (1b)[35]

Colourless oil.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 0.21 (s, 9 H, 3 CH_3), 2.40 (s, 3 H, CH_3), 5.56 (s, 1 H, CHCN), 7.18–7.29 (m, 3 H, ArH), 7.50–7.53 (m, 1 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = –0.30 (3 CH_3), 18.7 (CH_3), 61.9 (*C*HCN), 118.8 (CN), 126.4, 127.0, 129.4, 131.0, 134.0, 135.6 (ArC).

2-(4-Methoxyphenyl)-2-(trimethylsilyloxy)acetonitrile (1c)[34]

Colourless oil.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 0.21 (s, 9 H, 3 CH_3), 3.82 (s, 3 H, CH_3), 5.44 (s, 1 H, CHCN), 6.92, 7.93 (2 d, *J* = 8.7 Hz, 4 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = –0.2 (3 CH_3), 55.3 (*C*HCN), 63.3 (CH_3), 119.3 (CN), 114.2, 127.9, 128.4, 160.3 (ArC).

2-(2-Chlorophenyl)-2-(trimethylsilyloxy)acetonitrile (1d)[34]

Colourless oil.

^{1}H NMR (300 MHz, $CDCl_3$): δ =0.24 (s, 9 H, 3 CH_3), 5.50 (s, 1 H, CHCN), 7.33–7.42 (m, 3 H, ArH), 7.70–7.73 (m, 1 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = –0.34 (3 CH_3), 60.7 (*C*HCN), 118.3 (CN), 127.5, 128.3, 129.7, 130.6, 132.0, 133.8 (ArC).

2-(4-Chlorophenyl)-2-(trimethylsilyloxy)acetonitrile (1e)[34]

Colourless oil.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 0.17 (s, 9 H, 3 CH_3), 5.40 (s, 1 H, CHCN), 7.30–7.37 (m, 4 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = –0.30 (3 CH_3), 62.9 (*C*HCN), 118.8 (CN), 127.6, 129.1, 134.8, 135.3 (ArC).

2-(3,4-Methylenedioxyphenyl)-2-(trimethylsilyloxy)acetonitrile (1f)[36]

Pale yellow oil.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 0.21 (s, 9 H, 3 CH_3), 5.38 (s, 1 H, CHCN), 5.98 (s, 2 H, CH_2), 6.79 (d, *J* = 8.0 Hz, 1 H, ArH), 6.89–6.95 (m, 2 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = –0.34 (CH_3), 63.4 (*C*HCN), 101.4 (CH_2), 106.9, 108.3 (ArC), 119.1 (CN), 120.2, 130.2, 148.2, 148.4 (ArC).

2-(3-Phenoxyphenyl)-2-(trimethylsilyloxy)acetonitrile (1g)[37]
Colourless sticky oil.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 0.22 (s, 9 H, 3 CH_3), 5.46 (s, 1 H, CHCN), 6.99–7.03 (m, 3 H, ArH), 7.04–7.20 (m, 3 H, ArH), 7.33–7.38 (m, 3 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = –0.3 (3 CH_3), 63.2 (*C*HCN), 116.4 (ArC), 118.9 (CN), 119.2, 119.2, 120.7, 123.8, 129.9, 130.3, 138.1, 156.5, 157.9 (ArC).

2-(Furyl)-2-(trimethylsilyloxy)acetonitrile (1h)[34]
Colourless oil.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 0.18 (s, 9 H, 3 CH_3), 5.53 (s, 1 H, CHCN), 6.39 (dd, *J* = 1.9, 3.3 Hz, 1 H, CH=CO), 6.53 (d, *J* = 3.3 Hz, 1 H, CHCO), 7.44 (d, *J* = 1.9 Hz, 1 H, CHO).

^{13}C NMR (75 MHz, $CDCl_3$): δ = –0.43 (3 CH_3), 57.4 (*C*HCN), 109.7 (*C*HCO), 110.7 (*C*H=CO), 117.1 (CN), 143.9 (CHO), 148.2 (CO).

2-(3-Pyridyl)-2-(trimethylsilyloxy)acetonitrile (1i)[17]
Pale yellow oil.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 0.26 (s, 9 H, 3 CH_3), 5.54 (s, 1 H, CHCN), 7.37 (dd, *J* = 4.8, 7.8 Hz, 1 H, ArH), 7.83 (d, *J* = 7.8 Hz, 1 H, ArH), 8.64 (d, *J* = 4.8 Hz, 1 H, ArH), 8.69 (s, 1 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 1.87 (3 CH_3), 60.8 (*C*HCN), 118.9 (CN), 124.1, 132.8, 134.9, 147.4, 149.8 (ArC).

(*E*)-2-(Trimethylsilyloxy)pent-3-enenitrile (1j)[34]
Colourless oil.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 0.19 (s, 9 H, 3 CH_3), 1.74 (d, *J* = 6.5 Hz, 3 H, CH_3), 4.86 (d, *J* = 6.1 Hz, 1 H, CHCN), 4.86 (dd, *J* = 15.1, 6.1 Hz, 1 H, CH=C*H*CN), 5.97 (m, 1 H, CH_3C*H*).

^{13}C NMR (75 MHz, $CDCl_3$): δ = –0.27 (3 CH_3), 17.3 (CH_3), 62.0 (*C*HCN), 118.6 (CN), 126.1, 131.1 (CH=CH).

(*E*)-4-Phenyl-2-(trimethylsilyloxy)but-3-enenitrile (1m)[34]
Colourless oil.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 0.25 (s, 9 H, 3 CH_3), 5.12 (d, *J* = 6.0 Hz, 1 H, CHCN), 6.19 (dd, *J* = 15.9, 6.0 Hz, 1 H, CHC*H*=CH), 6.81 (d, *J* = 15.9 Hz, 1 H, CH=C*H*Ph), 7.31–7.43 (m, 5 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = –0.2 (3 CH_3), 62.2 (*C*CN), 118.3 (CN), 123.5, 126.9, 128.7, 128.7, 133.9, 134.9 (CH=CH, ArC).

2-(Trimethylsilyloxy)octanenitrile (1n)[17]
Colourless oil.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 0.21 (s, 9 H, 3 CH_3), 0.89 (m, 3 H, CH_2CH_3), 1.30 (m, 6 H, 3 CH_2), 1.44 (m, 2 H, CH_2), 1.77 (m, 2 H, CH_2), 4.38 (t, *J* = 6.5 Hz, 1 H, CHCN).

^{13}C NMR (75 MHz, $CDCl_3$): δ = –0.4 (3 CH_3), 14.0 (CH_3), 22.5, 24.5, 28.6, 31.5, 36.2 (5 CH_2), 49.2 (*C*HCN), 120.1 (CN).

4-Phenyl-2-(trimethylsilyloxy)butanenitrile (1o)[19c]
Colourless oil.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 0.20 (s, 9 H, 3 CH_3), 2.13 (m, 2 H, CH_2CH_2CH), 2.79 (t, *J* = 7.7 Hz, 2 H, CH_2CH_2Ph), 4.36 (t, *J* = 6.5 Hz, 1 H, C*H*CN), 7.17–7.24 (m, 3 H, ArH), 7.28–7.33 (m, 2 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = –0.4 (3 CH_3), 30.6 (CH_2CH_2Ph), 37.6 (CH_2CH_2CH), 60.6 (*C*HCN), 119.8 (CN), 126.3, 128.3, 128.4, 139.8 (ArC).

2-Phenyl-2-(trimethylsilyloxy)propanenitrile (1p)[38]
Colourless oil.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 0.17 (s, 9 H, 3 CH_3), 1.86 (s, 3 H, CH_3), 7.34–7.40 (m, 3 H, ArH), 7.53–7.56 (m, 2 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 1.0 (3 CH_3), 33.6 (CH_3), 71.6 (CO), 121.6 (CN), 124.6, 128.6, 128.7, 141.9 (ArC).

2-Cyclohexyl-2-(trimethysilyloxy)-2-phenylacetonitrile (1q)[39]
Colourless oil.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 0.09 (s, 9 H, 3 CH_3), 1.08–1.44 (m, 6 H, 3 CH_2), 1.62–1.79 (m, 4 H, 2 CH_2), 2.00–2.03 (m, 1 H, CH), 7.35–7.38 (m, 3 H, ArH), 7.45–7.48 (m, 2 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 0.8 (3 *C*H_3), 25.8, 26.0, 27.2 (CH_2), 50.6 (CH), 79.5 (*C*CN), 120.2 (CN), 125.8, 128.2, 128.4, 140.1 (ArC).

2-(4-Chlorophenyl)-2-(trimethylsilyloxy)propanenitrile (1r)[38]
Colourless oil.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 0.19 (s, 9 H, 3 CH_3), 1.83 (s, 3 H, CHCH_3), 7.37, 7.48 (2 d, *J* = 8.7 Hz, 4 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 1.0 (3 CH_3), 33.5 (CH_3), 71.0 (CO), 121.2 (CN), 126.0, 128.8, 134.5, 140.6 (ArC).

(*E*)-2-Methyl-2-(trimethylsilyloxy)but-3-enenitrile (1s)[40]
Pale yellow oil.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 0.22 (s, 9 H, 3 CH_3), 1.64 (s, 3 H, CH_3), 5.27 (d, *J* = 10.2 Hz, 1 H, CH_{2cis}=CH), 5.57 (d, *J* = 17.1 Hz, 1 H, CH_{2trans}=CH), 5.89 (dd, *J* = 10.2, 17.1 Hz, 1 H, C=CH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 1.3 (3 CH_3), 30.4 (CH_3), 70.1 (*C*O), 115.9 (CH_2), 120.5 (CN), 138.7 (CH).

(*E*)-2-Methyl-4-phenyl-2-(trimethylsilyloxy)but-3-enenitrile (1t)[38]
Colourless sticky oil.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 0.24 (s, 9 H, 3 CH_3), 1.75 (s, 3 H, CH_3), 6.13 (d, *J* = 16.0, 1 H, C*H*=CHPh) 6.88 (d, *J* = 16.0, 1 H, CH=C*H*Ph), 7.28–7.44 (m, 5 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 1.4 (3 CH_3), 30.9 (CH_3), 70.0 (*C*CN), 120.7 (CN), 12.9, 128.2, 128.7 (ArC), 129.5 (PhCH=*C*H), 131.0 (Ph*C*H=CH), 135.1 (ArC).

4-*tert*-Butyl-1-(trimethylsilyloxy)cyclohexanecarbonitrile (1u)[41]
Pale yellow oil.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 0.22 [s, 9 H, 3 CH_3), 0.86 (s, 3 H, 3 CH_3), 1.04 [m, 1 H, C*H*C(CH_3)$_3$], 1.26–1.36 (m, 2 H, CH_2), 1.48–1.58 (m, 2 H, CH_2), 1.73–1.83 (m, 2 H, CH_2), 2.17–2.21 (m, 2 H, CH_2).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 1.5 (3 Si*C*H_3), 24.4 (CH_2), 27.4 [C(*C*H_3)$_3$], 32.2 [*C*(CH_3)$_3$], 39.8 (CH_2CO), 46.6 (CH), 71.7 (*C*CN), 121.6 (CN).

2-Methyl-4-phenyl-2-(trimethylsilyloxy)butanenitrile (1v)[38]
Pale yellow oil.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 0.27 (s, 9 H, 3 CH_3), 1.63 (s, 3 H, CHCH_3), 2.02 (m, 2 H, CH_2C), 2.83 (m, 2 H, CH_2Ar), 7.19–7.22 (m, 3 H, ArH), 7.25–7.32 (m, 2 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 1.3 (3 CH_3), 29.0 (CH_2), 30.7 (CH_2), 45.2 (CH_3), 121.8 (CN), 126.1, 128.3, 128.5 (ArC).

2-Phenyl-2-(methoxycarbonyloxy)acetonitrile (2a)[19b,42]
^{1}H NMR (300 MHz, $CDCl_3$): δ = 3.87 (s, 3 H, CH_3O), 6.27 (s, 1 H, CHCN), 7.47 (m, 3 H, ArH), 7.54 (m, 2 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 55.8 (CH_3O), 66.5 (*C*HCN), 115.6 (CN), 127.8, 129.2, 130.6, 131.1 (ArC), 154.0 (OCOO).

2-(Methoxycarbonyloxy)-2-(2-methylphenyl)acetonitrile (2b)
Colourless oil; R_f 0.49 (*n*-hexane–EtOAc, 4:1).

IR (neat): 2342, 1731, 1247 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 2.44 (s, 3 H, CH_3), 3.85 (s, 3 H, OCH_3), 6.38 (s, 1 H, CHCN), 7.22–7.29 (m, 2 H, ArH), 7.33–7.38 (m, 1 H, ArH), 7.55 (dd, *J* = 7.3, 1 Hz, 1 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 18.7 (OCH_3), 55.8 (CH_3), 64.7 (CH), 115.5 (CN), 126.6, 128.4, 129.1, 130.6, 131.2, 136.6 (ArC), 153.9 (C=O).

MS (EI): *m*/*z* (%) = 205 (M^+, 3.2), 130 (40), 129 (100), 103 (26), 102 (17).

HRMS: *m*/*z* calcd for $C_{11}H_{11}O_3N$: 205.0739; found: 205.0734.

2-(Methoxycarbonyloxy)-2-(4-methoxyphenyl)acetonitrile (2c)
Pale yellow oil; R_f 0.65 (*n*-hexane–EtOAc, 3:2).

IR (neat): 2244, 1758 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 3.86, 3.88 (2 s, 2 × 3 H, $ArOCH_3$, CO_2CH_3), 6.23 (s, 1 H, CHCN), 6.98 (d, *J* = 8.8 Hz, 2 H, ArH), 7.50 (d, *J* = 8.8 Hz, 2 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 55.3, 55.8 (CO_2CH_3, $ArOCH_3$), 66.3 (*C*HCN), 114.8 (ArC), 115.8 (CN), 123.1, 129.6 (ArC), 154.0 (OCOO), 161.3 (ArC_{ipso}–OCH_3).

MS (EI): *m*/*z* (%) = 221 (M^+, 15), 146 (100), 145 (92), 135 (11), 116 (11), 103 (12).

HRMS: *m*/*z* calcd for $C_{11}H_{11}NO_4$: 221.0688; found: 221.0684.

2-(2-Chlorophenyl)-2-(methoxycarbonyloxy)acetonitrile (2d)
Colourless oil; R_f 0.70 (*n*-hexane–EtOAc, 3:2).

IR (neat): 2247, 1765 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 3.89 (s, 3 H, CH_3O), 6.62 (s, 1 H, CHCN), 7.39–7.45 (m, 3 H, ArH), 7.71–7.74 (m, 1 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 55.9 (CH_3O), 63.7 (*C*HCN), 114.8 (CN), 127.6, 128.8, 129.3, 130.1, 131.9, 133.3 (ArC), 153.7 (OCOO).

MS (EI): *m*/*z* (%) = 225 (M^+, 3), 224 (25), 150 (100), 149 (76), 139 (72), 114 (42), 75 (16).

HRMS: *m*/*z* calcd for $C_{10}H_8ClNO_3$: 225.0192; found: 225.0193.

2-(4-Chlorophenyl)-2-(methoxycarbonyloxy)acetonitrile (2e)
Pale yellow oil; R_f 0.72 (*n*-hexane–EtOAc, 3:2).

IR (neat): 2254, 1760 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 3.90 (s, 3 H, CH_3O), 6.26 (s, 1 H, CHCN), 7.44–7.53 (m, 4 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 55.9 (CH_3O), 65.7 (*C*HCN), 115.2 (CN), 128.1, 129.2, 129.5, 130.8 (ArC), 153.8 (OCO).

MS (EI): *m*/*z* (%) = 225 (M^+, 3), 224 (25), 149 (98), 148 (100), 139 (40), 123 (17), 114 (42).

HRMS: *m*/*z* calcd for $C_{10}H_8ClNO_3$: 225.0192; found: 225.0188.

2-(Methoxycarbonyloxy)-2-(3,4-methylenedioxyphenyl)acetonitrile (2f)
Pale yellow oil; R_f 0.35 (*n*-hexane–EtOAc, 4:1).

IR (neat): 2204, 1759, 1251 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 3.82 (s, 3 H, OCH_3), 5.98 (s, 2 H, CH_2), 6.14 (s, 1 H, CH), 6.80 (d, *J* = 7.9 Hz, 1 H, ArH), 6.96–7.00 (m, 2 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 55.7 (OCH_3), 66.3 (CO), 101.7 (CH_2), 108.1, 108.5 (ArC), 115.6 (CN), 122.4, 124.6 (ArC), 148.3, 149.5 (ArC), 153.9 (C=O).

MS (EI): *m*/*z* = 235 (M^+, 54.0), 160 (100), 159 (91).

HRMS: *m*/*z* calcd for $C_6H_6O_3N$: 235.0481; found: 235.0496.

2-(Methoxycarbonyloxy)-2-(3-phenoxyphenyl)acetonitrile (2g)
Sticky oil; R_f 0.30 (*n*-hexane–EtOAc, 4:1).

IR (neat): 2360, 1767, 1255 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 3.9 (s, 3 H, OCH_3), 6.22 (s, 1 H, CHCN), 7.01–7.08 (m, 3 H, ArH), 7.14–7.19 (m, 2 H, ArH), 7.24–7.27 (m, 1 H, ArH), 7.34–7.43 (m, 3 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 55.9 (OCH_3), 66.1 (CCN), 115.4 (CN), 117.6, 119.4, 120.3, 122.1, 124.1, 130.0, 130.7, 132.7 (ArC), 153.9 (C=O), 156.1, 158.2 (ArC).

MS (EI): *m*/*z* (%) = 283 (M^+, 100), 208 (21), 198 (37), 197 (46), 181 (37), 170 (24), 114 (41).

HRMS: *m*/*z* calcd for $C_{16}H_{13}O_4N$: 283.0845; found: 283.0853.

2-Furyl-2-(methoxycarbonyloxy)acetonitrile (2h)
Pale yellow oil; R_f 0.78 (*n*-hexane–EtOAc, 3:2).

IR (neat): 2254, 1763 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 3.89 (s, 3 H, OCH_3), 6.36 (s, 1 H, CHCN), 6.46 (dd, *J* = 3.3, 1.9 Hz, 1 H, OCH=C*H*), 0.75 (d, *J* = 3.3 Hz, 1 H, OC=CH), 7.53 (d, *J* = 1.9 Hz, 1 H, OCH=CH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 55.9 (CO_2CH_3), 59.3 (*C*HCN), 111.1 (OCH=*C*H), 113.0 (OC=*C*H), 113.6 (*C*N), 143.4 (OC=CH), 145.2 (O*C*H=CH), 153.8 (OCOO).

MS (EI): *m*/*z* (%) = 181 (M^+, 18), 106 (100), 95 (14), 77 (40).

HRMS: *m*/*z* calcd for $C_8H_7NO_4$: 181.0375; found: 181.0376.

2-(Methoxycarbonyloxy)-2-(3-pyridyl)acetonitrile (2i)
Colourless oil; R_f 0.17 (*n*-hexane–EtOAc, 3:2).

IR (neat): 2247, 1767 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 3.90 (s, 3 H, OCH_3), 6.32 (s, 1 H, CHCN), 7.43 (dd, *J* = 7.9, 4.8 Hz, 1 H, NCH=C*H*, pyridyl), 7.92 (d, *J* = 7.9 Hz, 1 H, C=CH, pyridyl), 8.74 (d, *J* = 4.8 Hz, 1 H, N=CH, pydridyl), 8.79 (s, 1 H, N=CH=C, pyridyl).

^{13}C NMR (300 MHz, $CDCl_3$): δ = 55.9 (OCH_3), 64.2 (*C*HCN), 114.8 (CN), 123.8, 127.2, 135.3, 148.8, 151.6 (pyridyl CH, C), 153.6 (OCOO).

MS (EI): *m*/*z* (%) = 192 (M^+, 42), 137 (13), 133 (17), 117 (100), 106 (81), 90 (27), 78 (22), 63 (34), 51 (22).

HRMS: *m*/*z* calcd for $C_9H_8N_2O_3$: 192.0535; found: 192.0539.

(*E*)-2-(Methoxycarbonyloxy)pent-3-enenitrile (2j)
Pale yellow oil; R_f 0.83 (*n*-hexane–EtOAc, 3:2).

IR (neat): 2254, 1759 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 1.83 (d, *J* = 6.6 Hz, 3 H, C*H*$_3$CH), 3.87 (s, 3 H, $COCH_3$), 5.58–5.68 (m, 2 H, CHCN, CNCHC*H*=), 6.22 (m, 1 H, CHCH=C*H*).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 17.6 (*C*H$_3$CH), 55.6 (C*C*H$_3$), 65.0 (*C*HCN), 115.2 (CN), 120.8 (OCH*C*H), 136.4 (CH_3CH), 153.9 (OCOO).

MS (EI): *m*/*z* (%) = 155 (M^+, 7), 96 (19), 80 (95), 69 (40), 59 (45), 53 (100).

HRMS: *m*/*z* calcd for $C_7H_9NO_3$: 155.0582; found 155.0582.

(*E*)-2-(Methoxycarbonyloxy)hept-3-enenitrile (2k)[8]
Colourless oil.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 0.92 (t, *J* = 7.3 Hz, 3 H, CH_2CH_3), 1.46 (qt, *J* = 22.0, 7.3 Hz, 2 H, CH_2CH_3), 2.12 (m, 2 H, $CH_2CH_2CH_3$), 3.86 (s, 3 H, OCH_3), 5.55–5.69 (m, 2 H, CHCN, CNCHCH), 6.18 (m, 1 H, CH_2CH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 13.4 (CH_3CH_2), 21.4 (CH_3CH_2), 33.9 ($CH_3CH_2CH_2$), 55.6 ($COCH_3$), 65.1 (CHCN), 115.2 (CN), 119.6 (CHCHCN), 141.2 (CH_2CH), 153.9 (OCOO).

(*E*)-2-(Methoxycarbonyloxy)non-3-enenitrile (2l)
Colourless oil; R_f 0.72 (*n*-hexane–EtOAc, 3:2).

IR (neat): 2249, 1763 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 0.89 (t, *J* = 6.7 Hz, 3 H, CH_3CH_2), 1.25–1.30 (m, 4 H, 2 CH_2), 1.40–1.45 (m, 2 H, CH_2), 2.13 (m, 2 H, CH_2CH), 3.86 (s, 3 H, OCH_3), 5.54–5.61 (m, 1 H, CNCHCH), 5.66–5.68 (m, 1 H, CHCN), 6.20 (dt, *J* = 14.6, 7.2 Hz, 1 H, CH_2CH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 13.8 (CH_3CH_2), 22.3, (CH_3CH_2), 27.8 (CH_3CH_2C H_2), 31.1 ($CHCH_2CH_2$), 31.9 ($CHCH_2$), 55.6 ($COCH_3$), 65.1 (CHCN), 115.2 (CN), 119.4 (CNCHCH), 141.5 (CH_2CH), 154.0 (OCOO).

MS (EI): *m*/*z* (%) = 211 (M^+, 2), 154 (34), 136 (22), 120 (31), 106 (38), 93 (46), 80 (99), 69 (57), 55 (100).

HRMS: *m*/*z* calcd for $C_{11}H_{17}NO_3$: 211.1208; found: 211.1212.

(*E*)-2-(Methoxycarbonyloxy)-4-phenylbut-3-enenitrile (2m)
Colourless oil; R_f 0.71 (*n*-hexane–EtOAc, 3:2).

IR (neat): 2255, 1769 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 3.89 ($COCH_3$), 5.90 (d, *J* = 6.8 Hz, 1 H, CHCN), 6.22 (dd, *J* = 16.0, 6.8 Hz, 1 H, CHCHCN), 7.00 (d, *J* = 16.0 Hz, 1 H, CHPh), 7.35–7.42 (m, 5 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 55.8 ($COCH_3$), 65.2 (CHCN), 115.0 (CN), 117.7 (OCHCH), 127.2, 128.8, 129.5, 134.2 (ArC), 138.4 (PhCH), 154.0 (OCOO).

MS (EI): *m*/*z* (%) = 217 (M^+, 5), 185 (8), 158 (44), 141 (100), 131 (18), 115 (84), 103 (18), 89 (10).

HRMS: *m*/*z* calcd for $C_{12}H_{11}NO_3$: 217.0738; found: 217.0718.

2-(Methoxycarbonyloxy)octanenitrile (2n)[7]
Colourless oil.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 0.87 (t, *J* = 6.7 Hz, 3 H, CH_2CH_3), 1.29–1.38 (m, 6 H, 3 CH_2), 1.44–1.54 (m, 2 H, CH_2), 1.92 (dd, *J* = 15.5, 6.8 Hz, CH_2CH), 3.84 (s, 3 H, OCH_3), 5.18 (t, *J* = 6.8 Hz, 1 H, CHCN).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 13.8 (CH_3CH_2), 22.3 (CH_3CH_2), 24.2 ($CH_3CH_2CH_2$), 28.3 ($CH_3CH_2CH_2CH_2$), 31.3 (CNCH-CH_2CH_2), 32.2 ($CNCHCH_2$), 55.6 ($COCH_3$), 64.8 (CHCN), 116.4 (CN), 154.2 (OCOO).

2-(Methoxycarbonyloxy)-4-phenylbutanenitrile (2o)[8,14a]
Colourless oil.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 2.27 (m, 2 H, CH_2CH), 2.85 (t, *J* = 7.7 Hz, 2 H, CH_2Ph), 3.87 (s, 1 H, OCH_3), 5.14 (t, *J* = 6.8 Hz, 1 H, CHCN), 7.17–7.32 (m, 5 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 30.5 (CH_2CH), 33.8 (CH_2Ph), 55.7 (OCH_3), 64.1 (CHCN), 116.2 (CN), 126.7, 128.3, 128.7, 138.7 (ArC), 154.1 (OCOO).

2-(Methoxycarbonyloxy)-2-phenylpropanenitrile (2p)
Colourless sticky oil; R_f 0.41 (*n*-hexane–EtOAc, 4 :1).

IR (neat): 2366, 1766, 1270 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 2.03 (s, 3 H, CH_3), 3.78 (s, 3 H, OCH_3), 7.40–7.47 (m, 3 H, ArH), 7.54–7.58 (m, 2 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 29.8 (CH_3), 55.4 (OCH_3), 75.7 (CO), 117.8 (CN), 124.5, 129.0, 129.5, 137.5 (ArC), 152.8 (C=O).

MS (EI): *m*/*z* (%) = 205 (M^+, 46.2), 173 (19), 160 (32), 146 (58), 130 (100), 129 (23), 105 (36), 103 (55).

HRMS: *m*/*z* calcd for $C_{11}H_{11}O_3N$: 205.0739; found: 205.0734.

2-Cyclohexyl-2-(methoxycarbonyloxy)-2-phenylacetonitrile (2q)
Colourless needles; mp 119 °C (*n*-hexane–EtOAc); R_f 0.45 (*n*-hexane–EtOAc, 4 :1).

IR (KBr): 2366, 1766, 1267 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 1.10–1.44 (m, 6 H, CH_2), 1.64–1.72 (m, 6 H, CH_2), 1.10–1.86 (d, *J* = 12 Hz, 1 H, CH_2), 1.96–2.03 (m, 1 H, CH_2), 2.20 (d, *J* = 12.6 Hz, 1 H, CH_2), 3.74 (s, 3 H, CH_3), 7.38–7.49 (m, 5 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 25.7, 26.8, 27.7 (3 CH_2), 48.5 (CH), 55.3 (CH_3), 83.5 (CO), 116.2 (CN), 125.2, 128.7, 129.2, 136.0 (ArC), 153.0 (C=O).

MS (EI): *m*/*z* (%) = 273 (M^+, 4.4), 191 (100), 115 (15), 106 (17), 105 (28).

Anal. Calcd for $C_{16}H_{19}NO_3$: C, 70.3; H, 7.0; N, 5.1. Found: C, 70.1; H, 6.9; N, 5.2.

2-(4-Chlorophenyl)-2-(methoxycarbonyloxy)propanenitrile (2r)
Colourless oil; R_f 0.53 (*n*-hexane–EtOAc, 4:1).

IR (neat): 2356, 1766, 1267 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 1.97 (s, 3 H, CH_3), 3.75 (s, 3 H, OCH_3), 7.47 (d, *J* = 8.6 Hz, 2 H, ArH), 7.86 (d, *J* = 8.6 Hz, 2 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 20.8 (CH_3), 55.4 (OCH_3), 74.9 (CCN), 117.4 (CN), 126.0, 128.7, 129.1, 129.6 (ArC), 152.7 (C=O).

MS (EI): *m*/*z* (%) = 239 (M^+, 33), 180 (33), 166 (33), 164 (100), 139 (36), 137 (21), 128 (23).

HRMS: *m*/*z* calcd for $C_{16}H_{13}O_4N$: 239.0349; found: 239.0340.

2-(Methoxycarbonyloxy)-2-methylbut-3-enenitrile (2s)
Colourless oil; R_f 0.46 (*n*-hexane–EtOAc, 4:1).

IR (neat): 2213, 1766, 1274 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 1.83 (s, 3 H, CH_3), 3.82 (s, 3 H, OCH_3), 5.47 (d, *J* = 10.1 Hz, 1 H, CH_{2cis}=CH), 5.73 (d, *J* = 17.0 Hz, 1 H, CH_{2trans}=CH), 5.89 (dd, *J* = 10.1, 17.0 Hz, 1 H, =CH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 26.4 (CH_3), 55.3 (OCH_3), 73.8 (CO), 116.9 (CN), 119.5 (CH_2), 133.6 (CH), 152.9 (C=O).

MS (EI): *m*/*z* = 140 (M^+ – 15, 1.0), 96 (58), 80 (100), 79 (21).

HRMS: *m*/*z* calcd for $C_6H_6O_3N$: 140.0348 (M^+ – 15); found: 140.0348.

4-*tert*-Butyl-1-(methoxycarbonyloxy)cyclohexanecarbonitrile (2u)
Colourless prisms; mp 71 °C (*n*-hexane–EtOAc); R_f 0.59 (*n*-hexane–EtOAc, 4:1).

IR (KBr): 2364, 1761, 1291, 1277, 1252 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 0.88 (s, 9 H, 3 CH_3), 1.02–1.11 (m, 1 H, CH), 1.40–1.49 (m, 2 H, CH_2), 1.57–1.67 (m, 2 H, CH_2), 1.87–1.92 (m, 2 H, CH_2), 2.55–2.60 (m, 2 H, CH_2), 3.83 (s, 3 H, CH_3).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 23.9 (CH_2), 27.4 [C(CH_3)$_3$], 32.2 [C(CH$_3$)$_3$], 35.4 (CH_2C), 46.6 (CH), 55.2 (OCH_3), 76.2 (CCN), 117.7 (CN), 153.1 (C=O).

MS (EI): m/z = 239 (M^+, 0.1), 183 (20), 148 (47), 138 (92), 124 (93), 121 (22), 108 (34), 107 (62), 106 (32).

Anal. Calcd for $C_{13}H_{21}NO_3$: C, 65.2; H, 8.8; N, 5.8. Found: C, 65.3; H 8.9; N, 5.9.

2-Methyl-2-(methoxycarbonyloxy)-4-phenylbutanenitrile (2v)
Colourless oil; R_f 0.33 (*n*-hexane–EtOAc, 4:1).

IR (neat): 2208, 1759, 1278 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 1.84 (s, 3 H, CH_3), 2.27, 2.88 (2 m, 4 H, PhCH_2CH_2), 3.85 (s, 3 H, OCH_3), 7.20–7.34 (m, 5 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 24.5 (CH_3), 30.1, 41.5 (PhCH_2CH_2), 55.3 (OCH_3), 73.9 (CCN), 118.1 (CN), 126.4, 128.3, 128.6, 139.6 (ArC), 153.1 (C=O).

MS (EI): m/z = 233 (M^+, 0.04), 157 (79), 156 (100), 142 (29), 91 (58).

HRMS: m/z calcd for $C_{13}H_{15}O_3N$: 233.1052; found: 233.0991.

2-(Benzoyloxy)-2-phenylacetonitrile (3a)[19b]
Colourless oil.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 6.7 (s, 1 H, CHO), 7.44–7.49 (m, 5 H, ArH), 7.60–7.64 (m, 3 H, ArH), 8.06–8.08 (m, 2 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 63.3 (CH), 116.2 (CN), 127.8, 128.1, 128.6, 129.3, 130.1, 130.4, 131.8, 134.1 (ArC), 164.6 (CO).

2-(Benzoyloxy)-2-(2-methylphenyl)acetonitrile (3b)
Colourless oil; R_f 0.39 (*n*-hexane–EtOAc, 4:1).

IR (neat): 2360, 1767, 1259 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 2.48 (s, 3 H, CH_3), 6.75 (s, 1 H, CHCN), 7.23–7.38 (m, 3 H, ArH), 7.43 (d, J = 7.7 Hz, 2 H, ArH), 7.58 (t, J = 7.3, 1 H, ArH), 7.65 (m, 1 H, ArH), 8.03 (m, 1 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 18.8 (CH_3), 61.5 (CH), 115.9 (CN), 126.6, 127.9, 128.4, 128.5, 129.7, 129.8, 130.4, 131.2, 133.9, 136.6 (ArC), 164.4 (C=O).

MS (EI): m/z = 251 (M^+, 28), 130 (42), 129 (100), 119 (21), 105 (64), 103 (35), 102 (13).

HRMS: m/z calcd for $C_{16}H_{13}O_2N$: 251.0946; found: 251.0945.

2-(Benzoyloxy)-2-(4-methoxyphenyl)acetonitrile (3c)[19b]
Colourless oil.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 3.84 (s, 3 H, OCH_3), 6.62 (s, 1 H, CHCN), 6.98 (d, J = 8.8 Hz, 2 H, ArH), 7.45 (t, J = 7.6, 1 H, ArH), 7.55 (d, J = 8.8 Hz, 2 H, ArH), 7.60–7.65 (m, 1 H, ArH), 8.04 (m, 3 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 55.4 (CH_3), 63.1 (CHCN), 114.6 (ArC), 116.4 (CN), 123.9, 128.6, 129.7, 130.0, 132.0, 134.0, 161.1 (ArC), 164.7 (CO).

2-(Benzoyloxy)-2-(4-chlorophenyl)acetonitrile (3e)[19b]
Colourless oil.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 6.60 (s, 1 H, CHO), 7.37–7.43 (m, 4 H, ArH), 7.51–7.56 (m, 3 H, ArH), 7.98 (d, J = 7.2 Hz, 2 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 62.6 (CH), 115.8 (CN), 128.4, 128.7, 129.3, 129.6, 130.1, 130.4, 134.2, 136.7 (ArC), 164.5 (CO).

2-(Benzoyloxy)-2-furylacetonitrile (3h)[19b]
Colourless oil.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 6.46–6.48 (m, 1 H, CH=CHO), 6.75 (s, 1 H, CHCN), 6.77 (d, J = 3.4 Hz, 1 H, CH=C), 7.47 (t, J = 7.6 Hz, 2 H, ArH), 7.54 (m, 1 H, C=CHO), 7.60–7.65 (m, 1 H, ArH), 8.07 (d, J = 7.2 Hz, 2 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 61.6 (CHCN), 111.1 (CH=C), 112.8 (CH=CHO), 114.2 (CN), 127.8, 128.6, 130.1, 134.2 (ArC), 144.2 (CCHCN), 145.1 (C=CO), 164.4 (CO).

2-(Benzoyloxy)-2-(3-pyridyl)acetonitrile (3i)
White powder; mp 66 °C (*n*-hexane–EtOAc); R_f 0.31 (*n*-hexane–EtOAc, 3:2).

IR (KBr): 2244, 1724, 1258, 1091, 1600 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 6.74 (s, 1 H, CHCN), 7.46–7.51 (m, 2 H, ArH and 1 H ArH$_{py}$), 7.59–7.67 (m, 1 H, ArH), 8.01–8.13 (m, 2 H, ArH and 1 H ArH$_{py}$), 8.78 (br s, 1 H, ArH$_{py}$), 8.92 (br s, 1 H, ArH$_{py}$).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 61.2 (CHCN), 115.3 (CN), 127.6, 128.3, 128.7, 130.1, 133.1, 134.4, 135.8, 148.8, 151.3 (ArC), 164.3 (CO).

MS (EI): m/z = 238 (M^+, 3.4), 183 (35), 117 (35), 105 (100).

Anal. Calcd for $C_{14}H_{10}N_2O_2$: C, 70.6; H, 4.2; N, 11.8. Found: C, 70.3; H, 4.3; N, 11.4.

(*E*)-2-(Benzoyloxy)pent-3-enenitrile (3j)
Colourless oil; R_f 0.55 (*n*-hexane–EtOAc, 4 :1)

IR (neat): 2240, 1732 1259, 1090, 1600 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 1.79 (d, J = 6.2 Hz, 3 H, CH_3), 6.10 (dd, J = 6.6, 1.6. Hz, 1 H, C=CHCO), 6.18 (d, J = 6.7 Hz, 1 H, CHCN), 6.20–6.32 (m, 1 H, CH_3CH=C), 7.47 (t, J = 7.6 Hz, 2 H, ArH), 7.60–7.65 (m, 1 H, ArH), 8.06 (d, J = 7.2 Hz, 2 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 17.7 (CH_3), 61.9 (CHCN), 115.8 (CN), 121.4 (C=CHCO), 128.2, 128.6, 130.0, 133.9 (ArC), 135.9 (CH_2CH=CH), 164.6 (CO).

MS (EI): m/z = 201 (M^+, 2.3), 105 (100), 77 (27).

HRMS: m/z calcd for $C_{12}H_{11}NO_2$: 201.0790; found: 201.0790.

(*E*)-2-(Benzoyloxy)-4-phenylbut-3-enenitrile (3m)[19b]
Colourless oil.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 6.28–6.37 (m, 2 H, CHCN, CH=CHCO), 7.07 (m, 1 H, CHPh), 7.35–7.65 (m, 8 H, ArH), 8.08 (deform d, J = 8.1 Hz, 2 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 62.0 (CH), 115.5 (CN), 118.4, 127.2, 128.3, 128.6, 128.8, 129.4, 130.2, 134.1, 134.4, 138.0 (ArC), 164.6 (CO).

2-(Benzoyloxy)octanenitrile (3n)
Colourless oil; R_f 0.29 (*n*-hexane–EtOAc, 4:1).

IR (neat): 2345, 1739, 1266 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 0.90 (t, J = 6.7 Hz, 3 H, CH_3), 1.26–1.45 (m, 6 H, 3 CH_2), 1.53–1.63 (m, 2 H, CH_2), 2.04 (dd, J = 15.6, 6.7 Hz, 2 H, CH_2CH), 5.58 (t, J = 6.7 Hz, 1 H, CHO), 7.48 (t, J = 7.4 Hz, 2 H, ArH), 7.63 (t, J = 7.4 Hz, 1 H, ArH), 8.06 (d, J = 7.2 Hz, 2 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 14 (CH_3), 22.4, 24.6, 28.5, 31.4, 32.4 (CH_2), 61.6 (CH), 117.0 (CN), 128.3, 128.6, 130.0, 134.0 (ArC), 164.8 (CO).

MS (EI): m/z = 246 (M^+ + 1, 0.1), 123 (36), 122 (34), 105 (100).

HRMS: m/z calcd for $C_{19}H_{14}NO_2$: 245.1416; found: 245.1417.

2-(Benzoyloxy)-4-phenylbutanenitrile (3o)
Colourless oil.; R_f 0.40 (*n*-hexane–EtOAc, 4:1).

IR (neat): 2333, 1731, 1263 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 2.35–2.43 (m, 2 H, CH_2CHO), 2.93 (t, *J* = 7.6 Hz, 2 H, CH_2Ph), 5.53 (d, *J* = 6.7 Hz, 1 H, CHO), 7.19–7.25 (m, 3 H, ArH), 7.31–7.34 (m, 2 H, ArH), 7.47 (t, *J* = 7.5, 2 H, ArH), 7.60–7.65 (m, 1 H, ArH), 8.01 (d, *J* = 7.2, 2 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 30.8 (*C*H_2CHO), 33.9 (*C*H_2Ar), 61.0 (*C*H), 116.7 (CN), 126.7, 128.1, 128.3, 128.6, 129.8, 130.0, 134.0, 139.0 (ArC), 164.7 (CO).

MS (EI): *m*/*z* = 266 (M^+ + 1, 0.05), 143 (100), 116 (20), 105 (32).

HRMS: *m*/*z* calcd for $C_{17}H_{16}NO_2$ (M^+ + 1): 266.2181; found: 266.2183.

1-(Benzoyloxy)-4-*tert*-butylcyclohexanecarbonitrile (3u)
White prisms; mp 109 °C (*n*-hexane–EtOAc); R_f 0.55 (*n*-hexane–EtOAc, 4:1).

IR (KBr): 2366, 1729, 1278 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 0.91 (s, 9 H, 3 CH_3), 1.06–1.17 (m, 1 H, CH), 1.46–1.60 (m, 2 H, CH_2), 1.69–1.79 (m, 2 H, CH_2), 1.91–1.96 (m, 2 H, CH_2), 2.70–2.74 (m, 2 H, CH_2), 7.46 (t, *J* = 7.6 Hz, 2 H, ArH), 7.60 (m, 1 H, ArH), 8.03 (m, 2 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 23.9 (CH_2), 27.5 [C(*C*H_3)$_3$], 32.3 [*C*(CH_3)$_3$], 35.6 (CH_2C), 46.8 (CH), 74.2 (*C*CN), 118.1 (CN), 128.5, 129.2, 129.8, 133.6 (ArC), 164.4 (C=O).

MS (EI): *m*/*z* = 285 (M^+ + 1, 0.2), 163 (22), 124 (16), 106 (26), 105 (100).

Anal. Calcd for $C_{18}H_{23}NO_3$: C, 75.7; H, 8.1; N, 4.9. Found: C, 75.8; H, 8.2; N, 4.9.

2-(Acetoxy)-2-phenylacetonitrile (4a)[14e,19b]
Colourless sticky oil.

^1H NMR (300 MHz, $CDCl_3$): δ = 2.16 (s, 3 H, CH_3), 6.40 (s, 1 H, CHCN), 7.44–7.47 (m, 3 H, ArH), 7.50–7.53 (m, 2 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 20.4 (CH_3), 62.8 (*C*HCN), 116.1 (CN), 127.8, 129.2, 130.4, 131.7 (ArC), 168.9 (C=O).

2-(Acetoxy)-2-(3-phenoxyphenyl)acetonitrile (4g)[15d]
Colourless oil.

^1H NMR (300 MHz, $CDCl_3$): δ = 2.17 (s, 3 H, CH_3), 6.35 (s, 1 H, CHCN), 7.01–7.07 (m, 3 H, ArH), 7.14–7.26 (m, 3 H, ArH), 7.35–7.42 (m, 3 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 20.4 (CH_3), 62.3 (*C*HCN), 117.6 (CN), 119.3, 119.4, 120.0, 122.0, 124.1, 129.9, 130.0, 130.6, 133.4, 156.1, 168.8 (C=O).

(*E*)-2-(Acetoxy)non-3-enenitrile (4l)[43]
Colourless oil.

^1H NMR (300 MHz, $CDCl_3$): δ = 0.89 (t, *J* = 6.7 Hz, 3 H, C$H_3$$CH_2$), 1.26–1.32 (m, 4 H, 2 CH_2), 1.38–1.43 (m, 2 H, CH_2), 2.09–2.16 (m, 2 H, CH_2CH), 2.14 (s, 3 H, CH_3CO), 5.51–5.59 (m, 1 H, C*H*CH-CN), 5.79 (d, *J* = 6.6 Hz, 1 H, CHCN), 6.10–6.20 (m, 1 H, CH_2C*H*).

^{13}C RMN (75 MHz, $CDCl_3$): δ = 13.8 (*C*$H_3$$CH_2$), 20.3 ($CH_3$CO), 22.3 ($CH_2$), 27.8 ($CH_2$), 31.1 ($CH_2$), 31.9 ($CH_2$), 61.4 (*C*HCN), 115.7 (CN), 119.8 (*C*HCHCN), 140.7 (CH_2*C*H), 168.9 (C=O).

(*E*)-2-(Acetoxy)-4-phenylbut-3-enenitrile (4m)[44]
Colourless oil.

^1H NMR (300 MHz, $CDCl_3$): δ = 2.18 (s, 3 H, CH_3), 6.03 (d, *J* = 6.7 Hz, 1 H, CHCN), 6.20 (dd, *J* = 6.7, 15.7 Hz, 1 H, CH=C*H*CH), 6.97 (d, *J* = 15.7 Hz, 1 H, PhC*H*), 7.35–7.45 (m, 5 H, ArH).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 20.4 (CH_3), 61.5 (*C*CN), 118.2 (CN), 127.1, 128.8, 129.1, 129.4, 134.3, 137.8 (C=C, ArC), 168.9 (C=O).

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References

(1) Tanaka, K. *Solvent-Free Organic Synthesis*; Wiley-VCH: Weinheim, **2003**.
(2) (a) Chen, F.-X.; Feng, X. *Synlett* **2005**, 892. (b) *Synthesis and Applications of Non-Racemic Cyanohydrins and α-Amino Acids,* Tetrahedron Symposium in Print, Vol. 60; North, M., Ed.; Elsevier: London, **2004**, 10371–10568. (c) Brunel, J.-M.; Holmes, I. P. *Angew. Chem. Int. Ed.* **2004**, *43*, 2752. (d) North, M. *Tetrahedron: Asymmetry* **2003**, *14*, 147.
(3) Au, A. T. *Synth. Commun.* **1984**, *14*, 743.
(4) Thanasa, N.; Prachyawarakorn, V.; Tontoolarug, S.; Ruchirawat, S. *Tetrahedron Lett.* **2003**, *44*, 1019.
(5) Shin, D.-S.; Jung, Y.-S.; Kim, J.-J.; Ahn, C. *Bull. Korean Chem. Soc.* **1998**, *19*, 119.
(6) Scholl, M.; Lim, C.-K.; Fu, G. C. *J. Org. Chem.* **1995**, *60*, 6229.
(7) Deardorff, D. R.; Taniguchi, C. M.; Tafti, S. A.; Kim, H. Y.; Choi, S. Y.; Downey, K. J.; Nguyen, T. V. *J. Org. Chem.* **2001**, *66*, 7191.
(8) Berthiaume, D.; Poirier, D. *Tetrahedron* **2000**, *56*, 5995.
(9) Linghu, X.; Nicewicz, D. A.; Johnson, J. S. *Org. Lett.* **2002**, *4*, 2957.
(10) Okimoto, M.; Chiba, T. *Synthesis* **1996**, 1188.
(11) Hoffmann, H. M. R.; Ismail, Z. M.; Hollweg, R.; Zein, A. R. *Bull. Chem. Soc. Jpn.* **1990**, *63*, 1807.
(12) Micó, I.; Nájera, C. *Tetrahedron* **1993**, *49*, 4327.
(13) Baeza, A.; Nájera, C.; Sansano, J. M. *Arkivoc* **2005**, *ix*, 353; www.arkat-usa.org.
(14) For the synthesis of non-racemic *O*-alkoxycarbonyl cyanohydrins: (a) Tian, S.-K.; Deng, L. *J. Am. Chem. Soc.* **2001**, *123*, 6195. (b) Tian, J.; Yamagiwa, N.; Matsunaga, S.; Shibasaki, M. *Angew. Chem. Int. Ed.* **2002**, *41*, 3636. (c) Casas, J.; Baeza, A.; Sansano, J. M.; Nájera, C.; Saá, J. M. *Tetrahedron: Asymmetry* **2003**, *14*, 197. (d) Belokon', Y. N.; Blacker, A. J.; Clutterbuck, L. A.; North, M. *Org. Lett.* **2003**, *5*, 4505. (e) Belokon', Y. N.; Blacker, A. J.; Carta, P.; Clutterbuck, L. A.; North, M. *Tetrahedron* **2004**, *60*, 10433. (f) Yamagiwa, N.; Tian, J.; Matsunaga, S.; Shibasaki, M. *J. Am. Chem. Soc.* **2005**, *127*, 3413.
(15) For the synthesis of non-racemic *O*-acyl or *O*-benzoyl cyanohydrins, see: (a) Baeza, A.; Nájera, C.; Sansano, J. M. *Tetrahedron: Asymmetry,* in press. (b) Huang, W.; Song, Y.; Bai, C.; Cao, G.; Zheng, Z. *Tetrahedron Lett.* **2004**, *45*, 4763. (c) Belokon', Y. N.; Carta, P.; North, M. *Lett. Org. Chem.* **2004**, *1*, 81. (d) Belokon', Y. N.; Carta, P.; Gutnov, A. V.; Maleev, V.; Moskalenko, M. A.; Yashkina, L. V.; Ikonnikov, N. S.; Voskoboev, N. V.; Khrustalev, V. N.; North, M. *Helv. Chim. Acta* **2002**, *85*, 3301. (e) Belokon', Y. N.; Gutnov, A. V.; Moskalenko, M. A.; Yashkina, L. V.; Lesovoy, D. E.; Ikonnikov, N. S.; Larichev, V. S.; North, M. *Chem. Commun.* **2002**, 244.

(16) For the synthesis of non-racemic cyanohydrin *O*-phosphates, see: (a) Baeza, A.; Casas, J.; Nájera, C.; Sansano, J. M.; Saá, J. M. *Angew. Chem. Int. Ed.* **2003**, *42*, 3143. (b) Abiko, Y.; Yamagiwa, N.; Sugita, M.; Tian, J.; Matsunaga, S.; Shibasaki, M. *Synlett* **2004**, 2434. (c) Baeza, A.; Nájera, C.; Sansano, J. M.; Saá, J. M. *Chem. Eur. J.* **2005**, *11*, 3849.
(17) Karini, B.; Ma'Mani, L. *Org. Lett.* **2004**, *6*, 4813.
(18) Shen, Z.-L.; Ji, S.-J.; Loh, T.-P. *Tetrahedron Lett.* **2005**, *46*, 3137.
(19) (a) He, B.; Li, Y.; Feng, X.; Zhang, G. *Synlett* **2004**, 1776. (b) Okimoto, M.; Chiba, T. *Synthesis* **1996**, 1188. (c) Azizi, N.; Saidi, M. R. *J. Organomet. Chem.* **2003**, *688*, 283.
(20) Iwanami, K.; Oriyama, T. *Chem. Lett.* **2004**, 1324.
(21) (a) Casas, J.; Nájera, C.; Sansano, J. M.; Saá, J. M. *Org. Lett.* **2002**, *4*, 2589. (b) Casas, J.; Nájera, C.; Sansano, J. M.; Saá, J. M. *Tetrahedron* **2004**, *60*, 10487.
(22) (a) Gotor, V. *J. Biotechnol.* **2002**, *96*, 35. (b) Gotor, V. *Org. Process Res. Dev.* **2002**, *6*, 420.
(23) Ling, S.-K.; Tanaka, T.; Kouno, I. *J. Nat. Prod.* **2002**, *65*, 131.
(24) (a) Cho, B. T.; Kang, S. K.; Shin, S. H. *Tetrahedron: Asymmetry* **2002**, *13*, 1209. (b) Brown, R. F. C.; Donohue, A. C.; Jackson, W. R.; McCarthy, T. D. *Tetrahedron* **1994**, *50*, 13739. (c) Brown, R. F. C.; Jackson, W. R.; McCarthy, T. D. *Tetrahedron: Asymmetry* **1993**, *4*, 205.
(25) (a) Beckmann, M.; Haack, K.-J. *Chem. Unserer Zeit* **2003**, *37*, 88. (b) Breuer, M.; Ditrich, K.; Habicher, T.; Hauer, B.; Keβeler, M.; Stürmer, R.; Zelinski, T. *Angew. Chem. Int. Ed.* **2004**, *43*, 788.
(26) van Langen, L. M.; van Rantwijk, F.; Sheldon, R. A. *Org. Process Res. Dev.* **2003**, *7*, 828.
(27) Duquette, J.; Zhang, M.; Zhu, L.; Reeves, R. S. *Org. Process Res. Dev.* **2003**, *7*, 285.
(28) Johnson, D. V.; Felfer, U.; Griengl, H. *Tetrahedron* **2000**, *56*, 781.
(29) Johnson, D. V.; Griengl, H. *Tetrahedron* **1997**, *53*, 617.
(30) Zha, C.; Brown, G. B.; Brouillette, W. J. *J. Med. Chem.* **2004**, *47*, 6519.
(31) Bigg, D.; Charbier, D. L.; Etienne, P.; Auvin, S.; Anget, M. US Patent 96628276, **1997**; *Chem. Abstr.* **1997**, *127*, 684395.
(32) Park, D.-S.; Peterson, C.; Zhao, S.; Coats, J. R. *Pest. Manag. Sci.* **2004**, *60*, 833.
(33) (a) Matsumoto, S.; Suzuki, M.; Kanai, M.; Shibasaki, M. *Tetrahedron* **2004**, *60*, 10497. (b) Matsumoto, S.; Suzuki, M.; Kanai, M.; Shibasaki, M. *Tetrahedron Lett.* **2002**, *43*, 8647.
(34) Li, Y.; He, B.; Qin, B.; Feng, X.; Zhang, G. *J. Org. Chem.* **2004**, *69*, 7910.
(35) Ryu, D.; Corey, E. J. *J. Am. Chem. Soc.* **2004**, *126*, 8106.
(36) Effenberger, F.; Jäger, J. *Chem. Eur. J.* **1997**, *3*, 1370.
(37) Yang, W.-B.; Fang, J.-M. *J. Org. Chem.* **1998**, *63*, 1356.
(38) Hamashima, Y.; Kanai, M.; Shibasaki, M. *J. Am. Chem. Soc.* **2000**, *122*, 7412.
(39) Masumoto, S.; Suzuki, M.; Kanai, M.; Shibasaki, M. *Tetrahedron* **2004**, *60*, 10497.
(40) Kruchok, I. S.; Gerus, I. I.; Kukhar, V. P. *Tetrahedron* **2000**, *56*, 6533.
(41) Wang, Z.; Fetterly, B.; Verkade, J. G. *J. Organomet. Chem.* **2002**, *646*, 161.
(42) Wuts, P. G. M.; Ashford, S. W.; Anderson, A. M.; Atkins, J. R. *Org. Lett.* **2003**, *5*, 1483.
(43) Huang, W.; Song, Y.; Wang, J.; Cao, G.; Zheng, Z. *Tetrahedron* **2004**, *60*, 10469.
(44) Fadnavis, N. W.; Radhika, K. R.; Kasiraman, R.; Madhuri, K. V. *Tetrahedron: Asymmetry* **2004**, *15*, 385.