L-Proline-catalyzed synthesis of highly functionalized multisubstituted 1,4-dihydropyridines†

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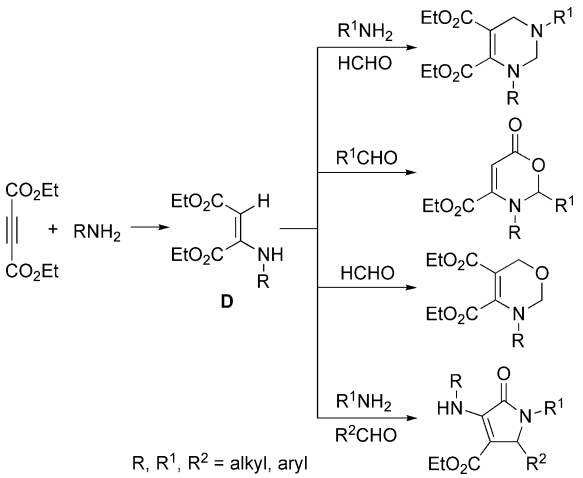
Highly functionalized multisubstituted 1,4-dihydropyridines **5** have been concisely synthesized in moderate to good yields *via* L-proline-catalyzed one-pot multicomponent reactions (MCRs) of alkynoates or alkynones **1**, amines **2**, β-dicarbonyl compounds **3** and aldehydes **4** under mild conditions. The MCR process involves hydroamination/Knoevenagel condensation/Michael-type addition/intramolecular cyclization processes and leads to the formation of 1,4-dihydropyridines **5**. The molecular structure of **5ckaa** was confirmed by single-crystal X-ray diffraction. This method is energy saving and environmentally friendly, providing easy access to diverse multisubstituted polyfunctional 1,4-dihydropyridines.

Introduction

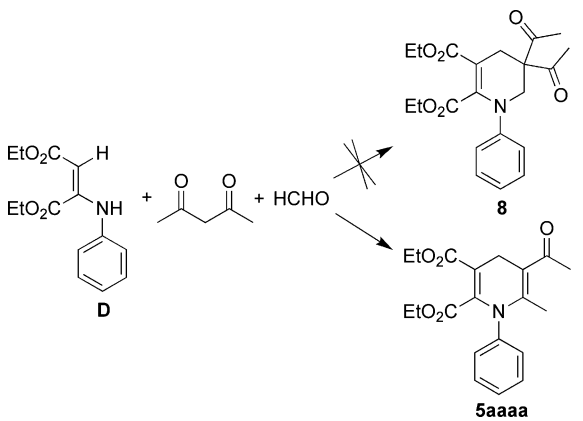
Multicomponent reactions (MCRs) have been steadily gaining importance in synthetic organic chemistry.[1] They offer the advantage of simplicity and synthetic efficiency over conventional chemical reactions, and have emerged as powerful efficient tools for the construction of complex and diverse organic molecules.[2]

On the other hand, dihydropyridines (DHPs) have exhibited a broad range of biological activities[3] and potential pharmaceutical applications.[4] They have also been recognized as versatile synthetic intermediates[5] and widely employed as a hydride source for reductive amination.[6] Since Hantzsch's pioneering work more than one century ago,[7] the construction of multisubstituted dihydropyridines has attracted considerable attention in synthetic organic chemistry. Many efficient synthetic methods for the preparation of these compounds have been reported for decades,[8-18] however, they are restricted to the use of expensive metal precursors, catalysts that are harmful to the environment, high reaction temperatures and long reaction times. Thus, it is an important and challenging goal of synthetic chemistry to develop new MCRs that construct highly functionalized multisubstituted dihydropyridines from easily available starting materials under mild conditions.[19]

Previously, we have reported the preparation of multisubstituted tetrahydropyrimidines,[20] 1,3-oxazine-6-ones,[21] 3,6-dihydro-2*H*-1,3-oxazines[22] and polyfunctional dihydropyrroles[23] through multicomponent domino reactions of alkynoates, amines, and aldehydes (Scheme 1). These inspiring results prompted us to search for a facile route for novel nitrogenous heterocycle tetrahydropyridines **8** (Scheme 2). It was unexpected that the 1,4-dihydropyridine compound instead of **8** was obtained after our considerable efforts to develop efficient protocols for **8**. In this paper, we present this efficient access to highly functionalized multisubstituted 1,4-dihydropyridines *via* the successful L-proline-catalyzed MCRs of alkynoates or alkynones, amines, β-dicarbonyl compounds and aldehydes under mild conditions.



Scheme 1 Divergent pathways for multicomponent domino reactions.



Scheme 2 Hypothetical route for the synthesis of **8**.

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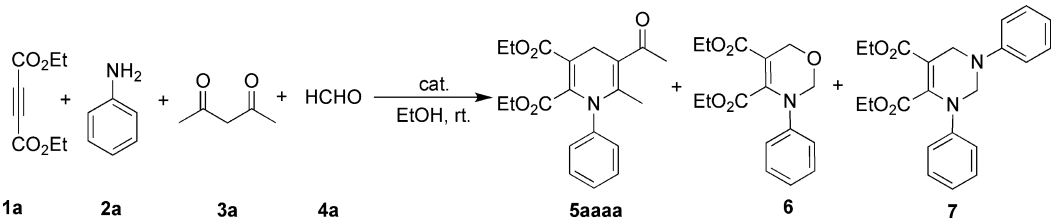
† Electronic supplementary information (ESI) available: Experimental procedures and characterization data. CCDC reference number 744016. For ESI and crystallographic data in CIF or other electronic format see DOI: 10.1039/b914659h

Table 1 The MCR for the synthesis of **5aaaa** with different catalysts[a]



Entry	Catalyst	Time (h)	Yield[b] (%) 5aaaa	6	7
1	5 mol% HCl	0.5	19	36	37
2	5 mol% HOAc	0.5	37	41	13
3	5 mol% $ZnCl_2$	3	43	33	trace
4	5 mol% $AlCl_3$	3	34	43	trace
5	5 mol% $FeCl_3$	3	25	52	trace
6	5 mol% $FeCl_2$	3	18	63	trace
7	5 mol% Iron(III) 2,4-pentanedionate	3	41	45	trace
8	5 mol% $SnCl_2$	3	16	62	trace
9	5 mol% Boron trifluoride etherate	3	13	72	trace
10	5 mol% L-Proline	6	52	3	trace
11	10 mol% L-Proline	12	75	4	trace
12	10 mol% L-phenylalanine	12	52	31	trace
13	10 mol% L-Valine	12	58	27	trace
14	10 mol% L-Leucine	12	53	27	trace
15	10 mol% L-Serine	12	42	43	trace

[a] Reaction conditions: diethyl butynedioate **1a** (1.0 mmol), aniline **2a** (1.0 mmol), acetylacetone **3a** (1.0 mmol), formaldehyde **4a** (1.0 mmol), ethanol (3 mL), RT. [b] Determined by GC.

Results and discussion

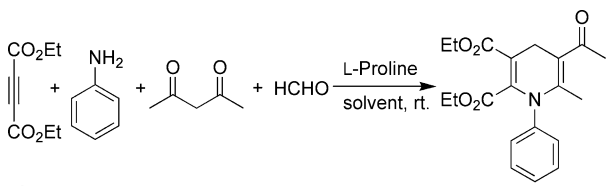
Optimization of reaction conditions for the synthesis of 5aaaa

In our initial studies, diethyl butynedioate **1a** (1.0 mmol), aniline **2a** (1.0 mmol), acetylacetone **3a** (1.0 mmol), and formaldehyde **4a** (1.0 mmol) were reacted in the presence of Brønsted acids in ethanol to test the hypothesis (Table 1, entries 1 and 2). The resulting mixtures afforded diethyl 5-acetyl-1,4-dihydro-6-methyl-1-phenylpyridine-2,3-dicarboxylate **5aaaa**, diethyl 3,6-dihydro-3-phenyl-2*H*-1,3-oxazine-4,5-dicarboxylate **6** and diethyl 1,3-diphenyl-1,2,3,6-tetrahydropyrimidine-4,5-dicarboxylate **7** in different yields respectively. No trace of the hypothetical product **8** was found.

As the result of further screening of the reaction conditions for the new target product **5aaaa**, a series of Lewis acids were found to vary the ratio of **5aaaa** and **6** (Table 1, entries 3–9), indicating competitive reactions in this catalytic system. We had to turn our attention to finding a new catalyst for the synthesis of **5aaaa**. Due to two functional groups in one molecule, L-proline has been found to be very effective in direct catalytic asymmetric reactions,[24] including the synthesis of 1,4-dihydropyridines.[25] Fortunately, when we used L-proline was as a catalyst, the reaction gave **5aaaa** in up to 52% yield (Table 1, entry 10). Further study indicated that increasing the amount of L-proline and prolonging the reaction time gave a good yield (Table 1, entry 11). Other amino acids such as L-phenylalanine, L-valine, L-leucine and L-serine gave relatively lower yields (Table 1, entries 12–15).

The effects of solvent and the mole ratio of reactants for the multicomponent reaction were also investigated. Among the various solvents, ethanol was the most effective (Table 2, entry 1).

Table 2 Further optimization of the MCR for the synthesis of **5aaaa**[a]



Entry	Solvent	1a:2a:3a:4a [mole ratio]	Yield[b](%)
1	EtOH	1:1:1:1	75
2	CH_2Cl_2	1:1:1:1	61
3	MeCN	1:1:1:1	57
4	THF	1:1:1:1	38
5	1,4-Dioxane	1:1:1:1	64
6	DMF	1:1:1:1	67
7	EtOH	1:1:1:2	72
8	EtOH	1:1:1:4	66
9	EtOH	1:1:2:2	74
10	EtOH	1:1:2:1	77
11	EtOH	1:1:1.5:1	77
12	EtOH	1:1:1.5:1.2	79
13[c]	EtOH	1:1:1.5:1.2	41

[a] All reactions were carried out using the substrates according to the indicated ratio in the mmol scale, solvent (3 mL), L-proline (10 mol%), RT, 12 h. [b] Determined by GC. [c] 50 °C, 2 h.

Other solvents such as CH_2Cl_2, MeCN, THF, 1,4-dioxane and DMF gave **5aaaa** in 38–67% yields (Table 2, entries 2–6). After screening the mole ratio of reactants, a 79% yield was obtained

in the mole ratio of **1a/2a/3a/4a** = 1:1:1.5:1.2 (Table 2, entry 12). However, when we used ethanol as the solvent and heated the reaction to 50 °C, it promoted the formation of **6** and only 41% of **5aaaa** was obtained (Table 2, entry 13).

Scope of the MCRs for the synthesis of 1,4-dihydropyridines

On the basis of the above optimization, we examined the scope of the multicomponent reaction (Table 3). We were pleased to find that the reaction proceeded smoothly, and the desired products were afforded in moderate to good yields. The electronic effects of the substituents on the aromatic ring of the aromatic amines had a slight influence on the reaction: the electron-donating groups (Table 3, entries 5–6) gave higher yields than the electron-withdrawing groups (Table 3, entries 2–4). Sterically hindered amines such as *o*-toluidine and naphthalen-1-amine also performed well (Table 3, entries 7–8). The results indicated that the activity of aliphatic primary amines was higher than that of the aromatic ones (Table 3, entries 9–10).

Alkynones with aryl- or alkyl-substituted groups were also employed as substrates for the multicomponent reaction and afforded moderate to good yields (Table 3, entries 11–18). The electronic effects of the substituents on the aromatic ring of the alkynones (Table 3, entries 14–15) did not significantly influence the yields. But the heterocyclic alkynone (Table 3, entry 16) and the cyclohexyl alkynone (Table 3, entry 17) gave slightly reduced yields. Other β-dicarbonyl compounds such as ethyl acetoacetate (Table 3, entries 19–22) and benzoyl acetone (Table 3, entry 23) were also tolerated under similar conditions, although it was necessary to increase the amount of ethyl acetoacetate (2 equiv.) and afforded the product in lower yields.

We also attempted to carry out the reaction with acetaldehyde **4b** (Table 3, entry 24). The reaction was successful but gave a racemic product **5bkab** in 84% yield. When the reaction temperature was lowered to 5 °C to perform the reaction, racemic **5bkab** was still obtained. More bulky **4c** was used, but also without chirality detected (Table 3, entry 25).

The molecular structure of **5ckaa** was determined by X-ray crystallography (Fig. 1).[26]

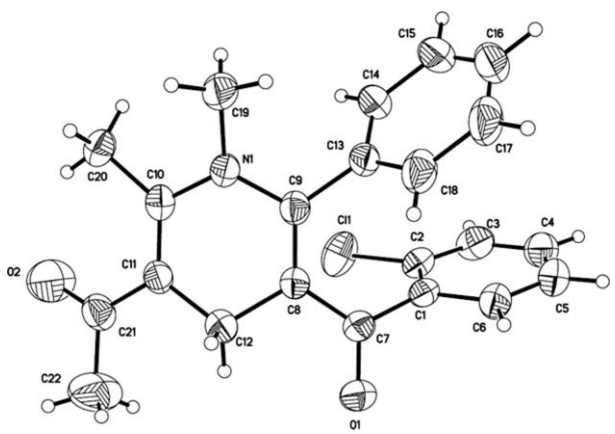


Fig. 1 X-Ray structure of **5ckaa**. Ellipses are shown at the 30% probability level.

Possible mechanism for the formation of 5

According to the experimental results mentioned above, a plausible reaction mechanism was proposed as shown in Scheme 3. The MCRs underwent the following sequences: the proline-catalyzed Knoevenagel condensation of **3** and **4**, the proline-catalyzed Michael-type addition of intermediates **D** to **C**, the tautomerization of **E** and **F**, and intramolecular cyclization of intermediate **F**. In the Knoevenagel condensation, the carboxyl group of proline activates the carbonyl acceptors **4** by hydrogen bonding. Then the nitrogen of proline attacks the carbonyl group with higher activity in **4**, followed by the formation of adduct **B**, and then the Knoevenagel product **C** with the regeneration of L-proline.[25c,27] The π (C–C) bond electrons instead of lone pair electrons on the nitrogen in the *Z*- and *E*-isomers **D**,[20c,23] which were obtained *via* the hydramination of **1** with **2**, attack the active carbon in intermediate **C** under the catalysis of bifunctional L-proline and give the intermediate **E**. This is followed by the tautomerization of **E** and **F**, and then the intermolecular cyclization of **F** to give the target products **5**.

Conclusions

In conclusion, we have described a convenient and efficient one-pot synthesis of highly functionalized multisubstituted 1,4-dihydropyridines *via* multicomponent domino reactions. The notable advantages of this method are mild reaction conditions and the use of inexpensive, non-toxic ethanol and L-proline. This method is energy saving and environmentally friendly. Moreover, due to the easy availability of the starting materials, solvent and catalyst, this reaction may find applications in organic synthesis. Further studies and applications of this multicomponent reaction are ongoing in our laboratory and will be published in due course.

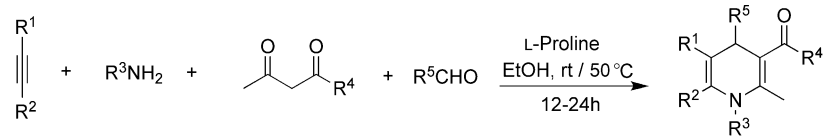
Experimental section

General

Melting points were measured with a BÜCHI B-545 melting point instrument and were uncorrected. ^{1}H and ^{13}C NMR spectra were recorded using a Bruker Avance 400 MHz NMR spectrometer. The chemical shifts are referenced to signals at 7.24 and 77.0 ppm, respectively, for chloroform solvent with TMS as the internal standard. IR spectra were obtained either as potassium bromide pellets or as liquid films between two potassium bromide pellets with a Bruker Vector 22 spectrometer. Mass spectra were recorded on a Shimadzu GCMS-QP5050A spectrometer at an ionization voltage of 70 eV equipped with a DB-WAX capillary column (internal diameter: 0.25 mm, length: 30 m). Elemental analyses were performed with a Vario EL elemental analyzer. TLC was performed by using commercially prepared 100–400 mesh silica gel plates (GF254) and visualization was effected at 254 nm. The alkynones were prepared by the Sonagashira couplings between acyl chlorides and terminal alkynes. All the other chemicals were purchased from Aldrich Chemicals.

General procedure for the synthesis of 1,4-dihydropyridine 5 (A). Amine **2** (1.0 mmol) was added to a stirring solution of alkyne **1** (1.0 mmol) in ethanol (3 mL). After the mixture was stirred at room temperature for 30 min, β-dicarbonyl compound **3** (1.5 mmol),

Table 3 Synthesis of multisubstituted polyfunctional 1,4-dihydropyridines *via* the MCR[a]



1a-1g **2a-2l** **3a-3c** **4a-4c** **5aaaa-5ajaa, 5baaa-5gkaa, 5aaba-5bkca, 5bkab-5bkac**

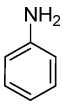
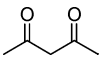
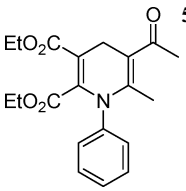
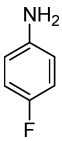
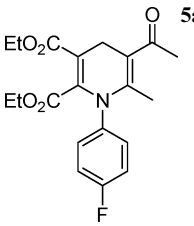
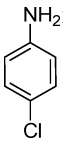
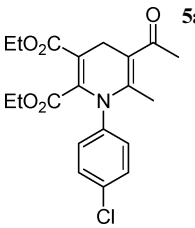
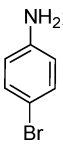
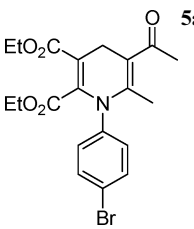
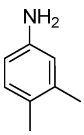
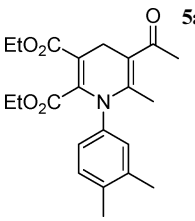
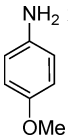
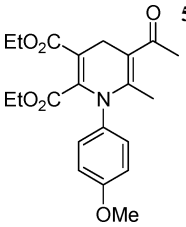
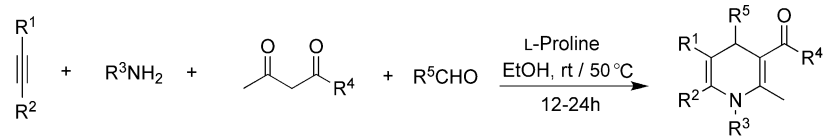
Entry	Alkynoate/Alkynone	Amine	β-Dicarbonyl compound	Aldehyde	Product	Yield[b](%)
1	CO_2Et **1a** 	NH_2 **2a** 	 **3a**	HCHO **4a**	 **5aaaa**	74
2	**1a**	NH_2 **2b** 	**3a**	**4a**	 **5abaa**	70
3	**1a**	NH_2 **2c** 	**3a**	**4a**	 **5acaa**	68
4	**1a**	NH_2 **2d** 	**3a**	**4a**	 **5adaa**	71
5	**1a**	NH_2 **2e** 	**3a**	**4a**	 **5aeaa**	74
6	**1a**	NH_2 **2f** 	**3a**	**4a**	 **5afaa**	72

Table 3 *(Contd.)*



1a-1g **2a-2l** **3a-3c** **4a-4c** **5aaaa-5ajaa, 5baaa-5gkaa, 5aaba-5bkca, 5bkab-5bkac**

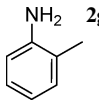
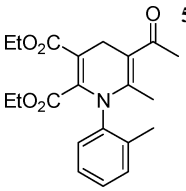
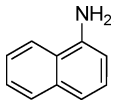
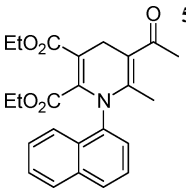
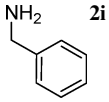
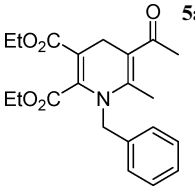
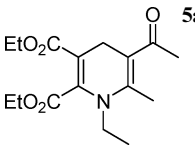
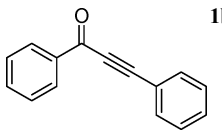
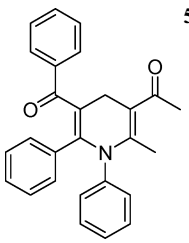
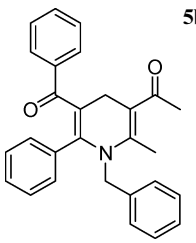
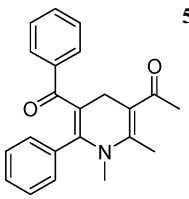
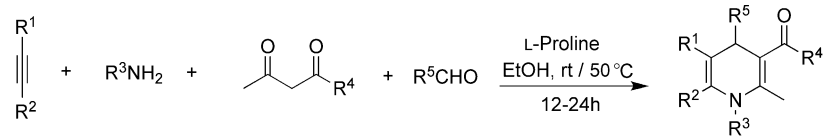
Entry	Alkynoate/Alkynone	Amine	β-Dicarbonyl compound	Aldehyde	Product	Yield[b](%)
7	**1a**	 **2g**	**3a**	**4a**	 **5agaa**	71
8	**1a**	 **2h**	**3a**	**4a**	 **5ahaa**	65
9	**1a**	 **2i**	**3a**	**4a**	 **5aiaa**	79
10	**1a**	 **2j**	**3a**	**4a**	 **5ajaa**	78
11	 **1b**	**2a**	**3a**	**4a**	 **5baaa**	76
12	**1b**	**2i**	**3a**	**4a**	 **5biaa**	83
13	**1b**	 **2k**	**3a**	**4a**	 **5bkaa**	85

Table 3 *(Contd.)*



1a-1g **2a-2l** **3a-3c** **4a-4c** **5aaaa-5ajaa, 5baaa-5gkaa, 5aaba-5bkca, 5bkab-5bkac**

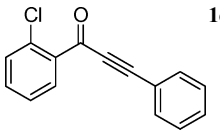
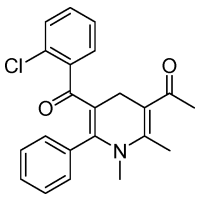
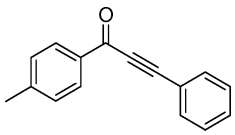
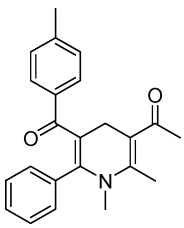
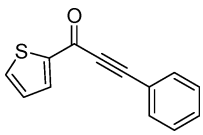
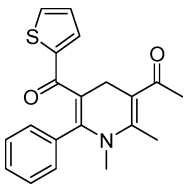
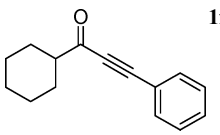
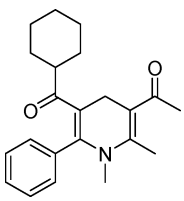
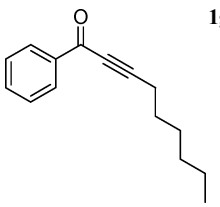
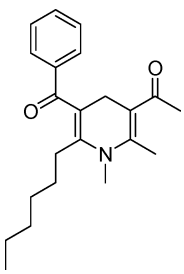
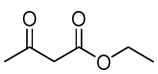
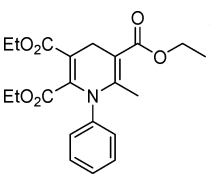
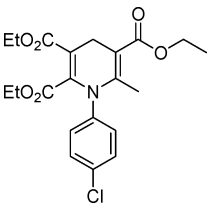
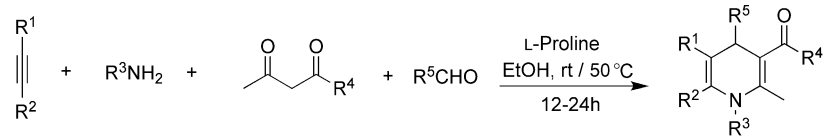
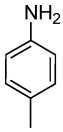
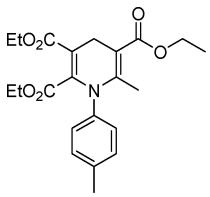
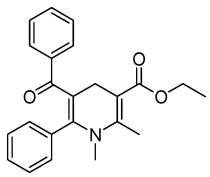
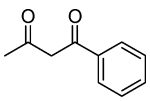
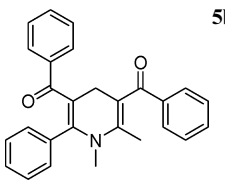
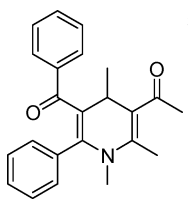
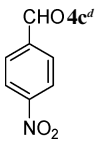
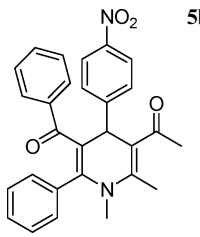
Entry	Alkynoate/Alkynone	Amine	β-Dicarbonyl compound	Aldehyde	Product	Yield[b](%)
14	 **1c**	**2k**	**3a**	**4a**	 **5ckaa**	82
15	 **1d**	**2k**	**3a**	**4a**	 **5dkaa**	86
16	 **1e**	**2k**	**3a**	**4a**	 **5ekaa**	76
17	 **1f**	**2k**	**3a**	**4a**	 **5fkaa**	78
18	 **1g**	**2k**	**3a**	**4a**	 **5gkaa**	62
19	**1a**	**2a**	 **3b**[c]	**4a**	 **5aaba**	65
20	**1a**	**2c**	**3b**[c]	**4a**	 **5acba**	64

Table 3 *(Contd.)*



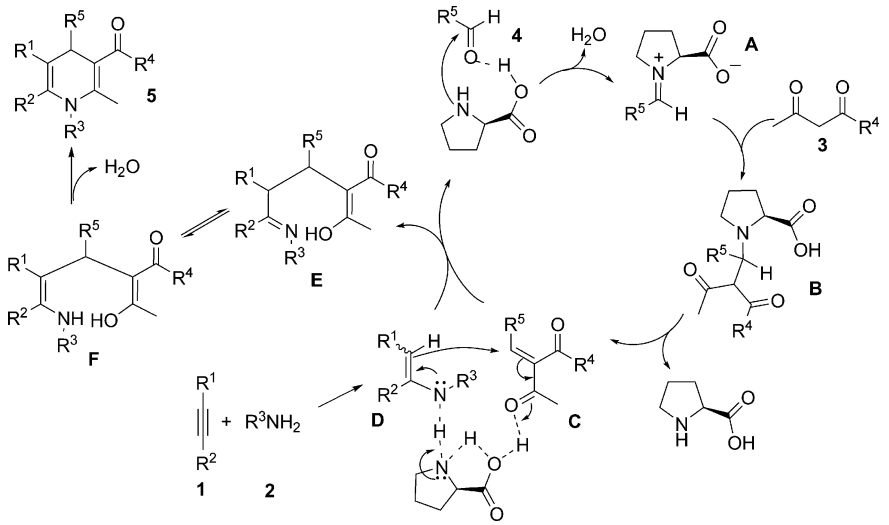
1a-1g **2a-2l** **3a-3c** **4a-4c** **5aaaa-5ajaa, 5baaa-5gkaa, 5aaba-5bkca, 5bkab-5bkac**

Entry	Alkynoate/Alkynone	Amine	β-Dicarbonyl compound	Aldehyde	Product	Yield[b](%)
21	**1a**	 **2l**	**3b**[c]	**4a**	 **5alba**	67
22	**1b**	**2k**	**3b**[c]	**4a**	 **5bkba**	71
23	**1b**	**2k**	 **3c**	**4a**	 **5bkca**	83
24	**1b**	**2k**	**3a**	MeCHO **4b**	 **5bkab**	84
25	**1b**	**2k**	**3a**	 **4c**[d]	 **5bkac**	67

[a] Reaction conditions: alkynoate/alkynone (1.0 mmol), amine (1.0 mmol), β-dicarbonyl compound (1.5 mmol), aldehyde (1.2 mmol), ethanol (3 mL), L-proline (10 mol%), RT, 12 h. [b] Isolated yield. [c] 2.0 mmol. [d] 50 °C, 24 h.

aldehyde **4** (1.2 mmol) and L-proline (12 mg, 10 mol%) were added successively, and stirring continued for another 12 h. The progress of the reaction was followed by TLC. After completion of the reaction, the solvent was removed under reduced pressure, then the mixture was diluted with water and extracted with diethyl ether (15 mL × 3). The organic phase was washed with saturated brine, and dried with anhydrous $MgSO_4$. The solvent was removed *in vacuo* and the crude product was purified by silica gel chromatography (petroleum ether/ethyl acetate = 2:1) to afford the products **5aaaa–5ajaa**, **5baaa–5gkaa**, **5bkca** and **5bkab** in 62–86% yields.

General procedure for the synthesis of 1,4-dihydropyridine 5 (B). Amine **2** (1.0 mmol) was added to a stirring solution of alkyne **1** (1.0 mmol) in ethanol (3 mL). After the mixture was stirred at room temperature for 30 min, ethyl acetoacetate **3b** (260mg, 2.0 mmol), 35% formaldehyde **4a** (103 mg, 1.2 mmol) and L-proline (12 mg, 10 mol%) were added successively, and stirring continued for another 12 h. The progress of the reaction was followed by TLC. After completion of the reaction, the solvent was removed under reduced pressure, then the mixture was diluted with water and extracted with diethyl ether (15 mL × 3). The organic phase was washed with saturated brine, and dried with anhydrous



Scheme 3 A plausible mechanism for this MCR.

$MgSO_4$. The solvent was removed *in vacuo* and the crude product was purified by silica gel chromatography (petroleum ether/ethyl acetate = 4:1) to afford the products **5aaba**, **5acba**, **5alba** and **5bkba** in 64–71% yields.

General procedure for the synthesis of 1,4-dihydropyridine 5 (C). 30% methanamine **2k** (103mg, 1.0 mmol) was added to a stirring solution of alkynone **1b** (206mg, 1.0 mmol) in ethanol (3 mL). After the mixture was stirred at room temperature for 30 min, acetylacetone **3a** (150mg, 1.5 mmol), 4-nitrobenzaldehyde **4c** (181 mg, 1.2 mmol) and L-proline (12 mg, 10 mol%) were added successively, and stirring continued for another 24 h at 50 °C. The progress of the reaction was followed by TLC. After completion of the reaction, the solvent was removed under reduced pressure, then the mixture was diluted with water and extracted with diethyl ether (15 mL × 3). The organic phase was washed with saturated brine, and dried with anhydrous $MgSO_4$. The solvent was removed *in vacuo* and the crude product was purified by silica gel chromatography (petroleum ether/ethyl acetate = 2:1) to afford the product **5bkac** in 67% yield.

Diethyl 5-acetyl-1,4-dihydro-6-methyl-1-phenylpyridine-2,3-dicarboxylate (5aaaa). Yellow oil; IR (KBr): V_{max} = 2992, 1765, 1699, 1458, 1376, 1243, 1107, 1055 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ = 7.32–7.30(m, 3H), 7.18–7.16(m, 2H), 4.11(q, *J* = 7.2 Hz, 2H), 3.75(q, *J* = 7.2 Hz, 2H), 3.43(s, 2H), 2.19(s, 3H), 1.78(s, 3H), 1.18 (t, *J* = 7.2 Hz, 3H), 0.87 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 199.5, 165.9, 163.8, 145.9, 143.7, 138.6, 130.9, 129.1, 129.0, 110.0, 101.5, 61.5, 60.6, 30.0, 24.9,18.0, 14.2,13.4; EI-MS: m/z = 357(M^+, 8), 314(37), 268(45), 240(61), 168(34), 28(100); Anal. Calcd for $C_{20}H_{23}NO_5$: C, 67.21; H, 6.49; N, 3.92; Found: C, 67.43; H, 6.58; N, 4.01.

Diethyl 5-acetyl-1-(4-fluorophenyl)-1,4-dihydro-6-methylpyridine-2,3-dicarboxylate (5abaa). Yellow oil; IR (KBr): V_{max} = 2991, 1740, 1699, 1456, 1372, 1245, 1114, 1053 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ = 7.18–7.14(m, 2H), 6.98–7.02(m, 2H), 4.11(q, *J* = 7.2 Hz, 2H), 3.80(q, *J* = 7.2 Hz, 2H), 3.41(s, 2H), 2.19(s, 3H), 1.77(s, 3H), 1.18 (t, *J* = 7.2 Hz, 3H), 0.93 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 199.5, 165.7, 163.7, 161.3, 145.4, 143.6, 134.6, 132.8,132.7, 116.1, 115.9, 110.4, 101.9, 61.7, 60.7, 29.9, 24.9, 17.9, 14.2,13.4; EI-MS: m/z = 375(M^+, 18), 332(62), 286(73), 258(100), 186(56); Anal. Calcd for $C_{20}H_{22}FNO_5$: C, 63.99; H, 5.91; N, 3.73; Found: C, 63.82; H, 6.03; N, 3.68.

Diethyl 5-acetyl-1-(4-chlorophenyl)-1,4-dihydro-6-methylpyridine-2,3-dicarboxylate (5acaa). Yellow oil; IR (KBr): V_{max} = 2984, 1766, 1698, 1489, 1373, 1244, 1112, 1053 cm-1; ^1H NMR (400 MHz, $CDCl_3$): δ = 7.31–7.28(m, 2H), 7.13–7.11(m, 2H), 4.11(q, *J* = 7.2 Hz, 2H), 3.81(q, *J* = 7.2 Hz, 2H), 3.41(s, 2H), 2.19(s, 3H), 1.77(s, 3H), 1.19 (t, *J* = 7.2 Hz, 3H), 0.93 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 199.5, 165.7, 163.7, 145.2, 143.3, 137.1, 135.2, 132.2, 129.3, 110.4, 101.9, 61.7, 60.7, 30.0, 24.8, 18.0, 14.2, 13.4; EI-MS: m/z = 391(M^+, 14), 348(28), 302(23), 274(24), 202(17), 28(100); Anal. Calcd for $C_{20}H_{22}ClNO_5$: C, 61.30; H, 5.66; N, 3.57; Found: C, 61.08; H, 5.81; N, 3.49.

Diethyl 5-acetyl-1-(4-bromophenyl)-1,4-dihydro-6-methylpyridine-2,3-dicarboxylate (5adaa). Yellow oil; IR (KBr): V_{max} = 2991, 1765, 1699, 1458, 1375, 1244, 1108, 1054 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ = 7.46–7.44(m, 2H), 7.06–7.04(m, 2H), 4.11(q, *J* = 7.2 Hz, 2H), 3.81(q, *J* = 7.2 Hz, 2H), 3.41(s, 2H), 2.19(s, 3H), 1.77(s, 3H), 1.18 (t, *J* = 7.2 Hz, 3H), 0.93 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 199.4, 165.7, 163.7, 145.1, 143.3, 137.7, 132.5, 132.3, 123.3, 110.5, 102.0, 61.7, 60.7, 29.9, 24.9, 18.0, 14.2, 13.4; EI-MS: m/z = 435(M^+, 17), 392(41), 318(62), 246(21), 28(100); Anal. Calcd for $C_{20}H_{22}BrNO_5$: C, 55.06; H, 5.08; N, 3.21; Found: C, 55.24; H, 5.16; N, 3.07.

Diethyl 5-acetyl-1,4-dihydro-6-methyl-1-(3,4-dimethylphenyl)-pyridine-2,3-dicarboxylate (5aeaa). Yellow oil; IR (KBr): V_{max} = 2992, 1766, 1699, 1457, 1376, 1244, 1108, 1057 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ = 7.05–7.03(d, *J* = 8 Hz, 1H), 6.92–6.86(m, 2H), 4.10(q, *J* = 7.2 Hz, 2H), 3.79(q, *J* = 7.2 Hz, 2H), 3.41(s, 2H), 2.18(s, 6H), 2.17(s, 3H), 1.79(s, 3H), 1.18 (t, *J* = 7.2 Hz, 3H), 0.90 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 199.5, 165.9, 163.8, 146.4, 143.9, 137.8, 137.5, 136.0, 131.5, 130.0, 127.9, 109.7, 101.2, 61.4, 60.6, 30.0, 24.9, 19.6, 19.4, 18.0, 14.2,13.4; EI-MS:

m/z = 385(M^+, 25), 342(17), 296(12), 268(34), 196(9), 28(100); Anal. Calcd for $C_{22}H_{27}NO_5$: C, 68.55; H, 7.06; N, 3.63; Found: C, 68.42; H, 7.12; N, 3.56.

Diethyl 5-acetyl-1,4-dihydro-1-(4-methoxyphenyl)-6-methylpyridine-2,3-dicarboxylate (5afaa). Yellow oil; IR (KBr): V_{max} = 2992, 1767, 1698, 1472, 1376, 1243, 1107, 1054 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ = 7.13–7.11(m, 2H), 6.86–6.84(m, 2H), 4.15(q, *J* = 7.2 Hz, 2H), 3.85(q, *J* = 7.2 Hz, 2H), 3.79(s, 3H), 3.47(s, 2H), 2.24(s, 3H), 1.83(s, 3H), 1.23 (t, *J* = 7.2 Hz, 3H), 0.98 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 199.5, 165.9, 163.8, 159.8, 146.5, 144.1, 131.9, 131.1, 114.1, 110.0, 101.4, 61.5, 60.6, 55.5, 29.5, 24.9, 17.9, 14.2,13.5; EI-MS: m/z = 387(M^+, 22), 344(46), 298(73), 270(100), 198(33); Anal. Calcd for $C_{21}H_{25}NO_6$: C, 65.10; H, 6.50; N, 3.62; Found: C, 65.36; H, 6.64; N, 3.51.

Diethyl 5-acetyl-1,4-dihydro-6-methyl-1-*o*-tolylpyridine-2,3-dicarboxylate (5agaa). Yellow oil; IR (KBr): V_{max} = 2991, 1766, 1698, 1458, 1375, 1244, 1108, 1056 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ = 7.30–7.15 (m, 4H), 4.18(q, *J* = 7.2 Hz, 2H), 3.85–3.75(m, 2H), 3.53(q, *J* = 17.6 Hz, 2H), 2.31(s, 3H), 1.81(s, 3H), 2.27(s, 3H), 1.26 (t, *J* = 7.2 Hz, 3H), 0.92 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 199.5, 166.0, 163.6, 145.9, 143.4, 138.9, 137.3, 131.3, 130.8, 129.5, 126.5, 109.7, 101.6, 61.5, 60.7, 30.1, 25.0, 17.7, 17.3, 14.2,13.4; EI-MS: m/z = 371(M^+, 32), 328(37), 282(87), 254(100), 182(31); Anal. Calcd for $C_{21}H_{25}NO_5$: C, 67.91; H, 6.78; N, 3.77; Found: C, 68.06; H, 6.64; N, 3.85.

Diethyl 5-acetyl-1,4-dihydro-6-methyl-1-(naphthalen-1-yl)pyridine-2,3-dicarboxylate (5ahaa). Yellow oil; IR (KBr): V_{max} = 2991, 1764, 1698, 1457, 1375, 1244, 1111, 1053 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ = 8.02–8.00(d, *J* = 8 Hz, 1H), 7.90–7.87(m, 2H), 7.62–7.42(m, 4H), 4.18(q, *J* = 7.2 Hz, 2H), 3.64(q, *J* = 17.6 Hz, 2H), 3.62–3.51(m, 2H), 2.31(s, 3H), 1.79(s, 3H), 1.24 (t, *J* = 7.2 Hz, 3H), 0.48 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 199.6, 165.9, 163.6, 146.5, 144.1, 134.9, 134.0, 132.3, 129.9, 129.5, 128.2, 127.6, 126.8, 124.9, 123.0, 109.9, 101.8, 61.2, 60.7, 30.2, 25.1, 17.3, 14.2,12.9; EI-MS: m/z = 407(M^+, 14), 364(29), 318(32), 290(25), 218(53), 28(100); Anal. Calcd for $C_{24}H_{25}NO_5$: C, 70.74; H, 6.18; N, 3.44; Found: C, 70.98; H, 6.27; N, 3.35.

Diethyl 5-acetyl-1-benzyl-1,4-dihydro-6-methylpyridine-2,3-dicarboxylate (5aiaa). Yellow oil; IR (KBr): V_{max} = 2992, 1765, 1698, 1459, 1376, 1243, 1112, 1056 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ = 7.35–7.22(m, 5H), 4.62(s, 2H), 4.13–4.20(m, 4H), 3.36(s, 2H), 2.23(s, 3H), 2.19(s, 3H), 1.26 (t, *J* = 7.2 Hz, 3H), 1.13 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 199.4, 165.7, 164.8, 146.4, 144.5, 137.2, 128.8, 127.6, 126.0, 111.7, 102.7, 62.1, 60.7, 50.4, 30.0, 24.6, 15.9, 14.2, 13.5; EI-MS: m/z = 371(M^+, 12), 328(39), 282(32), 254(46), 192(45), 28(100); Anal. Calcd for $C_{21}H_{25}NO_5$: C, 67.91; H, 6.78; N, 3.77; Found: C, 67.82; H, 6.85; N, 3.84.

Diethyl 5-acetyl-1-ethyl-1,4-dihydro-6-methylpyridine-2,3-dicarboxylate (5ajaa). Yellow oil; IR (KBr): V_{max} = 2992, 1766, 1700, 1457, 1376, 1243, 1099, 1056 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ = 4.34(q, *J* = 7.2 Hz, 2H), 4.16(q, *J* = 7.2 Hz, 2H), 3.42(q, *J* = 17.6 Hz, 2H), 3.29(s, 2H), 2.24(s, 3H), 2.22(s, 3H), 1.36 (t, *J* = 7.2 Hz, 3H), 1.25 (t, *J* = 7.2 Hz, 3H), 1.20 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 199.6, 165.8, 165.0, 145.6, 144.0, 111.5, 102.3, 62.2, 60.6, 42.0, 30.0, 24.5, 16.0, 15.5, 14.2, 13.8; EI-MS: m/z = 309(M^+, 19), 266(44), 220(41), 192(61), 120(22), 28(100); Anal. Calcd for $C_{16}H_{23}NO_5$: C, 62.12; H, 7.49; N, 4.53; Found: C, 62.29; H, 7.62; N, 4.45.

5-Acetyl-3-benzoyl-1,4-dihydro-1,2-diphenyl-6-methylpyridine (5baaa). Reddish brown oil; IR (KBr): V_{max} = 2923, 2852, 1740, 1640, 1457, 1108, 939, 533 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ = 7.52-7.50(m, 2H), 7.27-7.01 (m, 8H), 6.86-6.77(m, 5H), 3.70(s, 2H), 2.30(s, 3H), 2.07(s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 199.6, 198.0, 148.6, 147.3, 140.7, 138.9, 134.3, 131.3, 131.1, 131.0, 128.7, 128.6, 128.1, 127.6, 127.2, 114.2, 110.1, 30.1, 28.0, 18.7; EI-MS: m/z = 393(M^+, 21), 350(9), 316(14), 288(12), 245(11) 28(100); Anal. Calcd for $C_{27}H_{23}NO_2$: C, 82.42; H, 5.89; N, 3.56; Found: C, 82.23; H, 5.99; N, 3.48.

5-Acetyl-3-benzoyl-1-benzyl-1,4-dihydro-6-methyl-2-phenylpyridine (5biaa). Reddish brown oil; IR (KBr): V_{max} = 2921, 2853, 1739, 1649, 1459, 1103, 941, 530 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ = 7.43–7.41(m, 2H), 7.29–7.03(m, 13H), 4.54(s, 2H), 3.45(s, 2H), 2.42(s, 3H), 2.27(s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 199.1, 197.0, 151.2, 149.3, 139.2, 138.2, 133.8, 131.0, 130.6, 129.4, 128.9, 128.8, 128.2, 127.5, 126.2, 113.3, 50.8, 30.2, 27.3,16.2; EI-MS: m/z = 407(M^+, 6), 364(12), 316(42), 269(33), 91(100); Anal. Calcd for $C_{28}H_{25}NO_2$: C, 82.53; H, 6.18; N, 3.44; Found: C, 82.74; H, 6.33; N, 3.37.

5-Acetyl-3-benzoyl-1,4-dihydro-1,6-dimethyl-2-phenylpyridine (5bkaa). Reddish brown oil; IR (KBr): V_{max} = 2923, 2853, 1740, 1645, 1456, 1110, 938, 530 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ = 7.34–7.32(m, 2H), 7.11–6.96(m, 8H), 3.34(s, 2H), 2.86(s, 3H), 2.43(s, 3H), 2.22(s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 198.5, 196.5, 151.2, 150.1, 139.3, 133.6, 130.7, 130.3, 129.1, 128.7, 127.9, 127.3, 111.8, 110.5, 36.3, 29.9, 27.0, 15.9; EI-MS: m/z = 331(M^+, 26), 288(21), 254(37), 226(25), 183(17), 28(100); Anal. Calcd for $C_{22}H_{21}NO_2$: C, 79.73; H, 6.39; N, 4.23; Found: C, 79.87; H, 6.46; N, 4.19.

5-Acetyl-1,4-dihydro-1,6-dimethyl-3-(2-chlorobenzoyl)-2-phenylpyridine (5ckaa). Reddish brown solid; m.p.:145–147 °C; IR (KBr): V_{max} = 2921, 2851, 1738, 1652, 1466, 1088, 941, 528 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ = 7.06–6.84(m, 9H), 3.47(s, 2H), 2.82(s, 3H), 2.43(s, 3H), 2.35(s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 199.2, 193.4, 155.5, 147.9, 141.0, 133.5, 130.8, 129.8, 129.4, 129.2, 128.1, 125.5, 112.4, 111.5, 36.3, 30.0, 25.3, 15.8; EI-MS: m/z = 365(M^+, 10), 322(8), 288(16), 139(15), 28(100); Anal. Calcd for $C_{22}H_{20}ClNO_2$: C, 72.22; H, 5.51; N, 3.83; Found: C, 72.31; H, 5.56; N, 3.76.

5-Acetyl-1,4-dihydro-1,6-dimethyl-3-(4-methylbenzoyl)-2-phenylpyridine (5dkaa). Reddish brown oil; IR (KBr): V_{max} = 2928, 2851, 1742, 1650, 1460, 1106, 940, 529 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ = 7.36–7.34(d, *J* = 8 Hz, 2H), 7.10–7.06(m, 5H), 6.88–6.86(d, *J* = 8 Hz, 2H), 3.37(s, 2H), 2.92(s, 3H), 2.49(s, 3H), 2.26(s, 3H), 2.20(s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 198.5, 196.2, 150.6, 150.0, 141.4, 136.2, 133.6, 130.2, 129.0, 128.9, 128.1, 127.9, 112.2, 110.0, 36.2, 30.0, 27.3, 21.2, 16.0; EI-MS: m/z = 345(M^+, 40), 302(46), 268(39), 226(42), 28(100); Anal. Calcd for $C_{23}H_{23}NO_2$: C, 79.97; H, 6.71; N, 4.05; Found: C, 79.80; H, 6.82; N, 3.99.

5-Acetyl-1,4-dihydro-1,6-dimethyl-2-phenyl-3-(thiophene-2-carbonyl)pyridine (5ekaa). Reddish brown oil; IR (KBr): V_{max} = 2924, 2851, 1739, 1647, 1465, 1109, 939, 530 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ = 7.32–7.31(m, 1H), 7.18–7.14(m, 6H), 6.72–6.70(m, 1H), 3.40(s, 2H), 2.96(s, 3H), 2.48(s, 3H), 2.26(s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 198.4, 187.9, 150.7, 149.1, 144.6, 133.7, 132.7, 132.2, 130.1, 129.2, 128.2, 126.8, 112.6, 110.2, 36.3, 30.0, 27.5,16.1; EI-MS: m/z = 337(M^+, 62), 294(55), 260(52), 226(56), 111(100); Anal. Calcd for $C_{20}H_{19}NO_2S$: C, 71.19; H, 5.68; N, 4.15; Found: C, 71.43; H, 5.78; N, 4.04.

5-Acetyl-1,4-dihydro-1,6-dimethyl-3-cyclohexanecarbonyl-2-phenylpyridine (5fkaa). Reddish brown oil; IR (KBr): V_{max} = 2927, 2853, 1742, 1655, 1448, 1112, 940, 530 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ = 7.49–7.43(m, 3H), 7.26–7.24(m, 2H), 3.23(s, 2H), 2.89(s, 3H), 2.42(s, 3H), 2.28(s, 3H), 1.62–0.94(m, 8H), 0.67–0.57(m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 205.5, 198.9, 150.6, 149.3, 135.0, 129.7, 128.7, 112.2, 110.9, 48.3, 36.1, 30.0, 29.5, 26.0, 25.7, 25.6,15.9; EI-MS: m/z = 337(M^+,65), 294(63), 260(100), 226(79), 212(87); Anal. Calcd for $C_{22}H_{27}NO_2$: C, 78.30; H, 8.06; N, 4.15; Found: C, 78.21; H, 8.13; N, 4.10.

5-Acetyl-3-benzoyl-1,4-dihydro-2-hexyl-1,6-dimethylpyridine (5gkaa). Reddish brown oil; IR (KBr): V_{max} = 2925, 2852, 1744, 1649, 1461, 1101, 938, 529 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ = 7.75–7.40(m, 5H), 3.25(s, 3H), 3.05(s, 2H), 2.44(s, 3H), 2.13(s, 3H), 1.41–0.80(m, 13H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 198.2, 197.6, 151.5, 150.8, 139.4, 131.9, 128.7, 128.4, 111.3, 108.9, 33.4, 31.3, 30.0, 29.1, 29.0, 28.9, 27.6, 22.5, 16.1, 13.9; EI-MS: m/z = 339(M^+, 14), 296(23), 254(21), 234(16), 28(100); Anal. Calcd for $C_{22}H_{29}NO_2$: C, 77.84; H, 8.61; N, 4.13; Found: C, 78.06; H, 8.78; N, 4.01.

Triethyl 1,4-dihydro-6-methyl-1-phenylpyridine-2,3,5-tricarboxylate (5aaba). Yellow oil; IR (KBr): V_{max} = 2994, 1765, 1699, 1459, 1375, 1243, 1108, 1056 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ = 7.36–7.21(m, 5H), 4.20–4.11(m, 4H), 3.80(q, *J* = 7.2 Hz, 2H), 3.41(s, 2H), 1.91(s, 3H), 1.28 (t, *J* = 7.2 Hz, 3H), 1.23 (t, *J* = 7.2 Hz, 3H), 0.92 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 167.9, 166.1, 164.0, 147.3, 143.6, 138.9, 131.0, 129.0, 102.1, 101.7, 61.5, 60.5, 60.0, 23.9, 17.7, 14.3, 14.2, 13.4; EI-MS: m/z = 387(M^+, 23), 342(25), 314(100), 268(45), 240(97), 196(77); Anal. Calcd for $C_{21}H_{25}NO_6$: C, 65.10; H, 6.50; N, 3.62; Found: C, 65.38; H, 6.66; N, 3.50.

Triethyl 1-(4-chlorophenyl)-1,4-dihydro-6-methylpyridine-2,3,5-tricarboxylate (5acba). Yellow oil; IR (KBr): V_{max} = 2992, 1766, 1698, 1486, 1375, 1244, 1110, 1053 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ = 7.35–7.35(m, 2H), 7.21–7.18(m, 2H), 4.23–4.15(m, 4H), 3.88(q, J = 7.2 Hz, 2H), 3.41(s, 2H), 1.93(s, 3H), 1.30 (t, J = 7.2 Hz, 3H), 1.25 (t, J = 7.2 Hz, 3H), 1.00 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 167.7, 165.9, 163.9, 146.7, 143.1, 137.3, 135.1, 132.3, 129.2, 102.6, 102.1, 61.7, 60.6, 60.2, 23.8, 17.7, 14.3, 14.2, 13.4; EI-MS: m/z = 421(M^+, 11), 376(10), 348(32), 302(13), 274(26), 230(17), 28(100); Anal. Calcd for $C_{21}H_{24}ClNO_6$: C, 59.79; H, 5.73; N, 3.32; Found: C, 59.56; H, 5.89; N, 3.23.

Triethyl 1,4-dihydro-6-methyl-1-*p*-tolylpyridine-2,3,5-tricarboxylate (5alba). Yellow oil; IR (KBr): V_{max} = 2991, 1766, 1699, 1460, 1375, 1243, 1108, 1056 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ = 7.18–7.10(m, 4H), 4.22–4.14(m, 4H), 3.85(q, *J* = 7.2 Hz, 2H), 3.42(s, 2H), 2.36(s, 3H), 1.93(s, 3H), 1.30 (t, *J* = 7.2 Hz, 3H), 1.25 (t, *J* = 7.2 Hz, 3H), 0.97 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 167.9, 166.1, 164.0, 147.6, 143.7, 139.1, 136.1, 130.6, 129.5, 101.9, 101.4, 61.4, 60.5, 60.0, 23.8, 21.1, 17.6, 14.3, 14.2, 13.4; EI-MS: m/z = 401(M^+, 7), 356(5), 328(24), 282(12), 254(17), 210(20), 28(100); Anal. Calcd for $C_{22}H_{27}NO_6$: C, 65.82; H, 6.78; N, 3.49; Found: C, 65.62; H, 6.93; N, 3.38.

Ethyl 3-benzoyl-1,4-dihydro-1,6-dimethyl-2-phenylpyridine-5-carboxylate (5bkba). Reddish brown oil; IR (KBr): V_{max} = 2995, 2852, 1764, 1650, 1458, 1370, 1242, 1105, 939, 529 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ = 7.43–7.03(m, 10H), 4.19(q, J = 7.2 Hz, 2H), 3.38(s, 2H), 2.90 (s, 3H), 2.53(s, 3H), 1.28 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 196.8, 167.7, 151.4, 150.7, 139.4, 134.0, 130.8, 130.4, 129.0, 128.9, 128.0, 127.3, 112.1, 102.3, 59.8, 36.4, 26.0, 15.9, 14.3; EI-MS: m/z = 361(M^+, 48), 332(43), 284(64), 256(100), 212(47); Anal. Calcd for $C_{23}H_{23}NO_3$: C, 76.43; H, 6.41; N, 3.88; Found: C, 76.60; H, 6.54; N, 3.78.

3,5-Dibenzoyl-1,4-dihydro-1,6-dimethyl-2-phenylpyridine (5bkca). Reddish brown solid; m.p.:120–122 °C; IR (KBr): V_{max} = 2992, 2854, 1743, 1652, 1458, 1108, 940, 529 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ = 7.74(d, *J* = 8 Hz, 2H), 7.45–7.33(m, 5H), 7.13–7.01(m, 8H), 3.32(s, 2H), 2.95(s, 3H), 2.20 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 196.9, 196.2, 152.0, 148.1, 139.5, 139.2, 133.8, 131.8, 130.7, 130.5, 129.2, 128.7, 128.6, 128.4, 128.3, 128.1, 127.4, 111.0, 110.6, 36.2, 28.3, 16.7; EI-MS: m/z = 393(M^+, 6), 377(32), 348(55), 300(18), 105(100); Anal. Calcd for $C_{27}H_{23}NO_2$: C, 82.42; H, 5.89; N, 3.56; Found: C, 82.60; H, 5.95; N, 3.50.

5-Acetyl-3-benzoyl-1,4-dihydro-2-phenyl-1,4,6-trimethylpyridine (5bkab). Yellowish green solid; m.p.: 109–110 °C; IR (KBr): V_{max} = 2991, 2836, 1765, 1606, 1445, 1367, 1243, 1057, 868, cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ = 7.32–7.30(m, 2H), 7.11–6.96(m, 8H), 3.68 (t, *J* = 6.8 Hz, 1H), 2.94(s, 3H), 2.52(s, 3H), 2.32(s, 3H), 1.18 (d, *J* = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 199.0, 196.7, 150.1, 148.6, 139.8, 133.8, 130.8, 130.5, 129.3, 128.8, 128.0, 127.2, 117.5, 116.9, 36.5, 31.3, 29.5, 21.8, 16.5; EI-MS: m/z = 345(M^+, 5), 330(100), 302(13), 268(4), 240(12); Anal. Calcd for $C_{23}H_{23}NO_2$: C, 79.97; H, 6.71; N, 4.05; Found: C, 80.08; H, 6.78; N, 4.01.

5-Acetyl-3-benzoyl-1,4-dihydro-1,6-dimethyl-4-*p*-nitrophenyl-2-phenylpyridine (5bkac). Yellowish green oil; IR (KBr): V_{max} = 2835, 1707, 1616, 1453, 1345, 1236, 1164, 781, 589cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ = 8.14(d, *J* = 8.8 Hz, 2H), 7.61(d, *J* = 8.8 Hz, 2H), 7.25(d, *J* = 8.8 Hz, 2H), 7.09–6.95(m, 8H), 5.08(s, 1H), 2.87(s, 3H), 2.65(s, 3H), 2.28(s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 198.1, 196.5, 152.7, 152.3, 149.6, 146.4, 139.8, 132.8, 130.5, 129.8, 128.6, 128.1, 127.8, 127.2, 123.5, 114.4, 114.3, 40.1,16.5, 36.6, 29.8; EI-MS: m/z = 452(M^+, 4), 409(9), 375(13), 347(8), 28(100); Anal. Calcd for $C_{28}H_{24}N_2O_4$: C, 74.32; H, 5.35; N, 6.19; Found: C, 74.41; H, 5.39; N, 6.11.

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