A Novel Approach to 1,2-Dihydro-2-Oxo-3-Pyridinecarboxylic Ester via Aromatization Induced by Deamidation

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Abstract: A novel approach was developed for the preparation of 4,6-disubstituted-1,2-dihydro-2-oxo-3-pyridinecarboxylic ester in moderate to good yields. This route involves a reaction sequence of Michael addition, transformation to ene-lactam, and aromatization, featuring easily available material, variable substituents, and good functional compatibility.

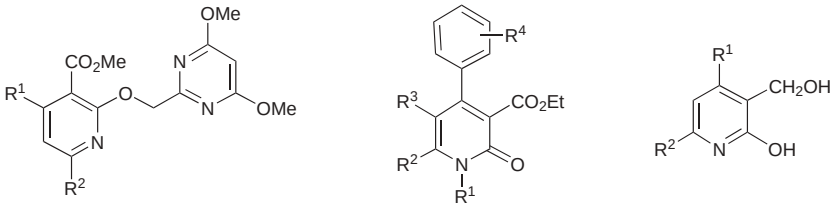
Key words: synthesis, ethyl acetamidocyanoacetate, aromatization via deamidation, sodium carbonate, 4,6-disubstituted-1,2-dihydro-2-oxo-3-pyridinecarboxylic ester

Functionalized 2(1*H*)-pyridones have long been of interest in pharmaceutical and agrochemical research, and their biological activities have attracted much attention. Substituted 1,2-dihydro-2-oxo-3-pyridinecarboxylates could serve as versatile precursors to synthesize herbicides such as **1**, [1] as well as drugs such as inhibitors of thrombin and human leukocyte elastase.[2] Some 4-aryl-2-oxo-3-pyridinecarboxylates **2** were also used to prevent growth of neoplastic cells and precancerous lesions and showed cytokine inhibitory activity.[3] In addition, pyridoxin isomers **3** obtained by reduction of the corresponding ester exhibited vitamin B_6 or anti-B_6 activity (Figure 1).[4]

Several methods were reported to synthesize 4,6-disubstituted-1,2-dihydro-2-oxo-3-pyridinecarboxylic esters, suffer from the limitation in the diversity of substituents in the 4- and 6-positions on the pyridine ring.[5] As a continuation of our agrochemical research projects, we developed a novel method to prepare the target compounds, substituted 1,2-dihydro-2-oxo-3-pyridinecarboxylic esters, from commercially available starting materials. This new approach involves a reaction sequence of Michael addition, transformation to ene-lactam and aromatization, starting from chalcones and ethyl acetamidocyanoacetate.

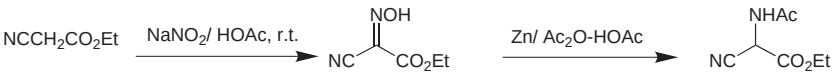
Ethyl acetamidocyanoacetate (**5**) is a multifunctional compound prepared from ethyl cyanoacetate by nitrosation, reduction, and acylation.[6] However, the published method suffered from either complicated work-up procedures or poor yields. The preparation of compound **5** could be scaled up when the reduction and acylation of oxime **4** is performed by using Zn/Ac_2O–HOAc in one pot (Scheme 1).

However, the Michael reaction between a chalcone and **5** has been rarely reported.[7] By analogy with addition procedures for compounds similar to **5**,[8] we obtained δ-ketonitriles in excellent yields under basic conditions (Scheme 2). As shown in Table 1, different substituted δ-ketonitriles were obtained in good to excellent yield (65–99%). When R^1 was electron-withdrawing substituent (F,



1 **2** **3**

Figure 1



4 **5**

Scheme 1

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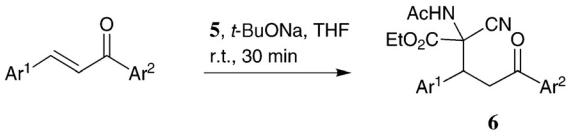
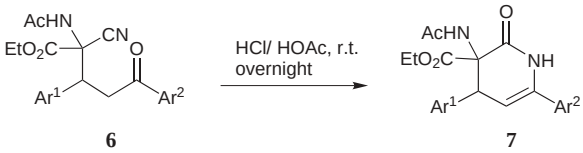
NO_2), especially for nitro group, the yield was higher; whereas in the presence of an elctron-donating substituent CH_3O, always resulted in a decreased yield. Presumably, the existence of the EWG led to an increase in the electrophilicity at C-3 of chalcones and promoted the attack by the carbanion of **5**. In addition, the steric effect of substituents was not significant.



6

Scheme 2

Although existing as two diastereomers, δ-ketonitrile **6** could be used without separation of the isomers. It is known that compound **6** could be transformed to ene-lactam under acid or neutral conditions. However, a high reaction temperature was necessary when acidic $SnCl_2$ [9] or $KHSO_4$[10] was employed. The transformation catalyzed by $RuH_2(PPh_3)_4$ also required relatively harsh conditions, the reaction was carried out in a sealed tube.[11] We successfully obtained the desired ene-lactam **7a** in 60% yield following the procedure reported by Kunstmann.[12] However, with the use of H_3PO_4/P_2O_5, the high viscosity of the reaction mixture resulted in an unsatisfactory yield. Fortunately, we found that when δ-ketonitrile was stirred overnight in the mixture with acetic acid and concentrated hydrochloric acid (10:1) at room temperature, the expected product **7a** was also afforded in high yield (84%) with the ester and amide group intact. Compounds **7b**–**m** were synthesized via the same procedure in 70–92% yield (Scheme 3, Table 2).



6 **7**

Scheme 3

After obtaining ene-lactam, we had two choices: one was dealkoxycarbonylation to give 3-acetamino-2-(1*H*)-pyridone, the other was deamidation to give 1,2-dihydro-2-oxo-3-pyridinecarboxylic ester (Scheme 4). Attempts at selective dealkoxycarbonylation according to Krapcho's method were unsuccessful.[13] When heated at 160 °C in DMSO/NaCl, ene-lactam **7a** was almost consumed after 4 hours (monitored by TLC). Unexpectedly, the ethyl 4,6-diphenyl-1,2-dihydro-2-oxo-3-pyridinecarboxylic ester **8a** was afforded in 60% yield (Scheme 5). The acetamido function rather than the ester group was eliminated under this condition, which was very similar to the result we reported before.[14] Therefore, we tried to utilize bases such as Cs_2CO_3 and K_2CO_3 to promote the reaction at 140 °C, and we found that the reaction rate was accelerated and was complete in 1 hour. However, this gave compound **8a** together with a byproduct which was identified as 4,6-diphenyl-2(1*H*)-pyridone (**9**), in 40% and 35% yield, respectively (Scheme 6).

Table 1 Preparation of δ-Ketonitriles

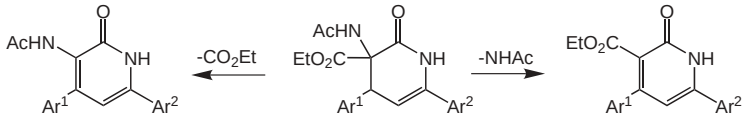
Product	Ar^1	Ar^2	Yield (%)[a]
6a	C_6H_5	C_6H_5	87
6b	4-$NO_2C_6H_4$	C_6H_5	88
6c	4-$MeOC_6H_4$	C_6H_5	74
6d	C_6H_5	4-$CH_3C_6H_4$	85
6e	4-$NO_2C_6H_4$	4-$CH_3C_6H_4$	99
6f	4-$MeOC_6H_4$	4-$CH_3C_6H_4$	98
6g	C_6H_5	4-FC_6H_4	78
6h	4-$NO_2C_6H_4$	4-FC_6H_4	93
6i	4-$MeOC_6H_4$	4-FC_6H_4	65
6j	3,4-$OCH_2OC_6H_3$	C_6H_5	83
6k	2-ClC_6H_4	C_6H_5	94
6l	3-$MeOC_6H_4$	C_6H_5	98
6m	4-MeC_6H_4	4-MeC_6H_4	95

[a] Yield of isolated purified products.

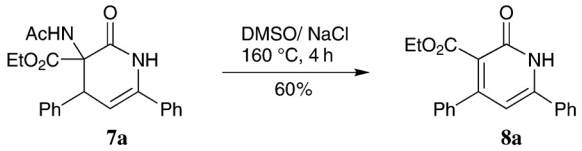
Table 2 Preparation of Ene-lactams **7**

Product	Ar^1	Ar^2	Yield (%)[a]
7a	C_6H_5	C_6H_5	84
7b	4-$NO_2C_6H_4$	C_6H_5	75
7c	4-$MeOC_6H_4$	C_6H_5	86
7d	C_6H_5	4-$CH_3C_6H_4$	74
7e	4-$NO_2C_6H_4$	4-$CH_3C_6H_4$	77
7f	4-$MeOC_6H_4$	4-$CH_3C_6H_4$	80
7g	C_6H_5	4-FC_6H_4	82
7h	4-$NO_2C_6H_4$	4-FC_6H_4	70
7i	4-$MeOC_6H_4$	4-FC_6H_4	92
7j	3,4-$OCH_2OC_6H_3$	C_6H_5	90
7k	2-ClC_6H_4	C_6H_5	84
7l	3-$MeOC_6H_4$	C_6H_5	88
7m	4-MeC_6H_4	4-MeC_6H_4	78

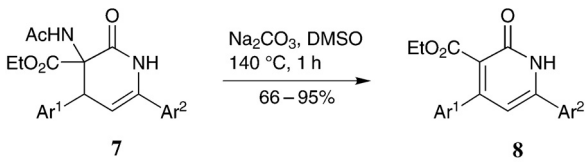
[a] Yield of isolated purified products after recrystallization.



Scheme 4



Scheme 5



Scheme 7

The formation of 3-unsubstituted 2(1*H*)-pyridone (**9**) resulted from hydrolysis and decarboxylation of ester **8a** under basic conditions. When the temperature was raised or the reaction time prolonged, the amount of **9** increased while the yield of **8a** reduced. Finally, when the weaker base Na_2CO_3 was used instead of Cs_2CO_3 or K_2CO_3, **8a** was obtained in 80% yield within 1 hour. Furthermore, the nitro group was tolerant of the reaction conditions. Other 1,2-dihydro-2-oxo-3-pyridinecarboxylic esters **8b**–**m** were conveniently prepared in the same manner in 66–95% (Scheme 7, Table 3).

In conclusion, we have developed a convenient alternative approach to 1,2-dihydro- 2-oxo-3-pyridine carboxylic ester in moderate to good yields. This sequence of Michael addition, transformation to ene-lactam, and aromatization with the key step, aromatization via deamidation, differed from the reported procedures mediated by oxidants such as DDQ,[15] $NaNO_2$/HOAc,[16] S_8[17] etc. This procedure was also characterized by using easily commercially available starting material and was compatible with a wide range of functional groups. The mechanism of the deamidation reaction and its further application are also being studied. We are currently investigating modifications to the reaction conditions in the above sequence in attempt to expand the method to aliphatic starting material.

Table 3 Preparation of 1,2-Dihydro-2-oxo-3-pyridinecarboxylic Esters

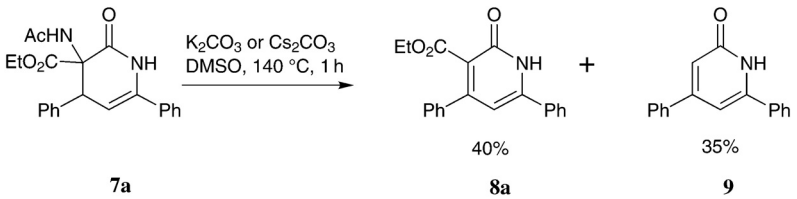
Product	Ar^1	Ar^2	Yield (%)[a]
8a	C_6H_5	C_6H_5	80
8b	4-$NO_2C_6H_4$	C_6H_5	75
8c	4-$MeOC_6H_4$	C_6H_5	88
8d	C_6H_5	4-$CH_3C_6H_4$	80
8e	4-$NO_2C_6H_4$	4-$CH_3C_6H_4$	76
8f	4-$MeOC_6H_4$	4-$CH_3C_6H_4$	95
8g	C_6H_5	4-F-C_6H_4	72
8h	4-$NO_2C_6H_4$	4-F-C_6H_4	66
8i	4-$MeOC_6H_4$	4-F-C_6H_4	80
8j	3,4-$OCH_2OC_6H_3$	C_6H_5	82
8k	2-ClC_6H_4	C_6H_5	74
8l	3-$MeOC_6H_4$	C_6H_5	76
8m	4-MeC_6H_4	4-MeC_6H_4	84

[a] Yield of isolated purified products after flash column chromatography.

All melting points were determined on a Yanaco apparatus and are uncorrected. The IR spectra were recorded on a Shimider IDP440 spectrometer with KBr pellets, ^{1}H NMR spectra on a Bruker ACF-300 spectrometer with TMS as internal reference and MS spectra on a VG-ZAB-HS mass spectrometer at 70 eV. The elemental analyses were performed on a Perkin-Elmer 240C instrument.

Ethyl Acetamidocyanoacetate (5)

To a stirred solution of ethyl cyanoacetate (35 g, 0.31 mol) and 45% aq HOAc (140 mL) at 0 °C was added portion-wise $NaNO_2$ (65 g, 0.94 mol) over 1.5 h. After the addition was completed, the stirring was continued at r.t. for 4 h. The reaction mixture was extracted with Et_2O (2 × 50 mL). The ethereal solution of ethyl isonitrosocyanoacetate (**4**) was immediately mixed with Ac_2O (86 g, 0.84 mol) and HOAc (225 mL, 40 mol) in a flask fitted with a mechanical stirrer. With vigorous stirring, zinc powder (65 g 1.0 mol) was added in small portions and the stirring was then continued for 1 h. After



Scheme 6

filtering, the solvent was evaporated at reduced pressure to give the product as a white solid (41 g, 80% yield based on ethyl cyanoacetate), mp 127 °C.

δ-Ketonitriles 6a–m; General Procedure

Chalcone (5.0 mmol) and **5** (7.5 mmol) were dissolved in anhyd THF (10 mL). To this mixture, t-BuONa (5% mol for **5**) was added and the mixture was stirred at r.t. (monitored by TLC). Upon removal of THF on a rotary evaporator, an oily residue was obtained. The residue was dissolved in EtOAc (60 mL), washed with cold sat. aq solution of Na_2CO_3 (2 × 20 mL), and brine (10 mL), successively. The organic layer was dried (Na_2SO_4) and solvent removed under vacuum. The residue was washed with Et_2O to give pure **6a**–**m**.

Ethyl 2-Acetylamino-2-cyano-3-phenyl-5-oxo-5-phenylpentanoate (6a)

White solid; mp 159–161 °C.

IR (KBr): 3380, 1762, 1690, 1670 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 0.87 (t, 3 H, *J* = 7.2 Hz), 2.09 (s, 3 H), 3.74–4.13 (m, 5 H), 7.35–7.65 (m, 8 H,), 8.03 (d, 2 H, *J* = 7.9 Hz), 8.31 (s, 1 H).

MS: *m*/*z* (%) = 378 (1), 208 (5), 105 (100).

Anal. Calcd for $C_{22}H_{22}N_2O_4$: C, 69.84; H, 5.86; N, 7.40; Found: C, 69.77; H, 5.76; N, 7.32.

Ethyl 2-Acetylamino-2-cyano-3-(4-nitrophenyl)-5-oxo-5-phenylpentanoate (6b)

Pale yellow solid; mp 143–145 °C.

IR (KBr): 3310, 1750, 1685, 1665 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 0.94 (t, 3 H, *J* = 7.14 Hz), 2.10 (s, 3 H), 3.80–4.18 (m, 5 H), 7.51–7.70 (m, 5 H), 8.03 (d, 2 H, *J* = 7.4 Hz), 8.13 (s, 1 H), 8.24 (d, 2 H, *J* = 4.3 Hz).

MS: *m*/*z* (%) = 423 (1), 253 (33), 43 (100).

Anal. Calcd for $C_{22}H_{21}N_3O_6$: C, 65.41; H, 5.00; N, 9.92. Found: C, 62.41; H, 5.13; N, 9.93.

Ethyl 2-Acetylamino-2-cyano-3-(4-methoxyphenyl)-5-oxo-5-phenylpentanoate (6c)

White solid; mp 134–138 °C.

IR (KBr): 3339, 1754, 1689, 1680 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 0.92 (t, 3 H, *J* = 14.3 Hz), 2.07 (s, 3 H), 3.76–4.07 (m, 5 H), 3.79 (s, 3 H), 6.87 (d, 2 H, *J* = 17.6 Hz), 7.33 (d, 2 H, *J* = 8.6 Hz), 7.50 (t, 2 H, *J* = 7.9 Hz), 7.66 (t, 1 H, *J* = 6.6 Hz), 8.01 (d, 2 H, *J* = 7.2 Hz), 8.27 (s, 1 H).

MS: *m*/*z* (%) = 408 (1), 238 (88), 43 (100).

Anal. Calcd for $C_{23}H_{24}N_2O_5$: C, 67.63; H, 5.92; N, 6.86. Found: C, 67.62; H, 6.09; N, 6.85.

Ethyl 2-Acetylamino-2-cyano-3-phenyl-5-oxo-5-(4-methylphenyl)pentanoate (6d)

White solid; mp 122–124 °C.

IR (KBr): 3319, 1756, 1690, 1665 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 0.84 (t, 3 H, *J* = 7.5 Hz), 2.07 (s, 3 H), 2.43 (s, 3 H), 3.72–4.07 (m, 5 H), 7.24–7.43 (m, 6 H), 7.91 (d, 2 H, *J* = 8.3 Hz), 8.42 (s, 1 H).

MS: *m*/*z* (%) = 392 (1), 222 (9), 119 (100).

Anal. Calcd for $C_{23}H_{24}N_2O_4$: C, 70.39; H, 6.16; N, 7.14. Found: C, 70.44; H, 6.15; N, 7.15.

Ethyl 2-Acetylamino-2-cyano-3-(4-nitrophenyl)-5-oxo-5-(4-methylphenyl)pentanoate (6e)

Pale yellow solid; mp 147–149 °C.

IR (KBr): 3289, 1740, 1685, 1666 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 0.94 (t, 3 H, *J* = 7.1 Hz), 2.11 (s, 3 H), 2.46 (s, 3 H), 3.77–4.14 (m, 5 H), 7.33 (d, 2 H, *J* = 7.9 Hz), 7.64 (d, 2 H, *J* = 8.7 Hz), 7.93 (d, 2 H, *J* = 8.3 Hz), 8.24 (s, 1 H), 8.25 (d, 2 H, *J* = 8.9 Hz).

MS: *m*/*z* (%) = 437 (1), 267 (66), 43 (100).

Anal. Calcd for $C_{23}H_{23}N_3O_6$: C, 63.15; H, 5.30; N, 9.61. Found: C, 63.18; H, 5.26; N, 9.59.

Ethyl 2-Acetylamino-2-cyano-3-(4-methoxyphenyl)-5-oxo-5-(4-methylphenyl)pentanoate (6f)

White solid; mp 126–128 °C.

IR (KBr): 3315, 1754, 1685, 1675 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 0.93 (t, 3 H, *J* = 7.6 Hz), 2.08 (s, 3 H), 2.44 (s, 3 H), 3.77–4.04 (m, 5 H), 3.87 (s, 3 H), 6.88 (d, 2 H, *J* = 9.0 Hz), 7.30 (d, 2 H, *J* = 8.7 Hz), 7.34 (d, 2 H, *J* = 8.7 Hz), 7.91 (d, 2 H, *J* = 8.5 Hz), 8.38 (s, 1 H).

MS: *m*/*z* (%) = 422 (1), 252 (69), 119 (100).

Anal. Calcd for $C_{24}H_{26}N_2O_5$: C, 68.23; H, 6.20; N, 6.63. Found: C, 68.49; H, 6.27; N, 6.57.

Ethyl 2-Acetylamino-2-cyano-3-phenyl-5-oxo-5-(4-fluorophenyl)pentanoate (6g)

White solid; mp 144–146 °C.

IR (KBr): 3277, 1756, 1690, 1665 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 0.87 (t, 3 H, *J* = 7.1 Hz), 2.09 (s, 3 H), 3.70–4.11 (m, 5 H), 7.20 (t, 2 H, *J* = 8.8 Hz), 7.37 (m, 5 H), 8.06–8.11 (m, 2 H), 8.23 (s, 1 H).

MS: *m*/*z* (%) = 396 (1), 226 (50), 124 (100).

Anal. Calcd for $C_{22}H_{21}FN_2O_4$: C, 66.66; H, 5.34; N, 7.07. Found: C, 66.68; H, 5.35; N, 7.19.

Ethyl 2-Acetylamino-2-cyano-3-(4-nitrophenyl)-5-oxo-5-(4-fluorophenyl)pentanoate (6h)

Pale yellow solid; mp 179–181 °C.

IR (KBr): 3324, 1754, 1689, 1656 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 0.95 (t, 3 H, *J* = 7.2 Hz), 2.11 (s, 1 H), 3.78–4.18 (m, 5 H), 7.19–7.26 (m, 2 H), 7.63 (d, 2 H, *J* = 7.6 Hz), 8.03–8.10 (m, 3 H), 8.25 (d, 2 H, *J* = 4.42 Hz).

MS: *m*/*z* (%) = 441 (1), 271 (28), 123 (100).

Anal. Calcd for $C_{22}H_{20}FN_3O_6$: C, 59.86; H, 4.57; N, 9.52. Found: C, 59.93; H, 4.50; N, 9.62.

Ethyl 2-Acetylamino-2-cyano-3-(4-methoxyphenyl)-5-oxo-5-(4-fluorophenyl)pentanoate (6i)

White solid; mp 142–144 °C.

IR (KBr): 3349, 1754, 1689, 1666 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 0.93 (t, 3 H, *J* = 7.11 Hz), 2.08 (s, 3 H), 3.79–4.08 (m, 5 H), 3.85 (s, 3 H), 6.89 (d, 2 H, *J* = 8.53 Hz), 7.19 (t, 2 H, *J* = 9.25 Hz), 7.33 (d, 2 H, *J* = 4.30 Hz), 8.05–8.09 (m, 2 H), 8.18 (s, 1 H).

MS: *m*/*z* (%) = 426 (1), 256 (37), 123 (100).

Anal. Calcd for $C_{23}H_{23}FN_2O_5$: C, 64.78; H, 5.44; N, 6.57. Found: C, 64.88; H, 5.48; N, 6.63.

Ethyl 2-Acetylamino-2-cyano-3-(3,4-piperyl)-5-oxo-5-phenylpentanoate (6j)
White solid; mp 111–113 °C.

IR (KBr): 3247, 1757, 1679, 1655 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.00 (t, 3 H, *J* = 7.1 Hz), 2.07 (s, 3 H), 3.88–4.06 (m, 5 H), 5.97 (s, 2 H), 6.75 (d, 1 H, *J* = 8.0 Hz), 6.81 (t, 1 H, *J* = 8.4 Hz), 6.97 (s, 1 H), 7.51 (t, 2 H, *J* = 8.1 Hz), 7.67 (t, 1 H, *J* = 7.0 Hz), 8.01(d, 2 H, *J* = 8.3 Hz), 8.21 (s, 1 H).

MS: *m*/*z* (%) = 422 (1), 252 (57), 43 (100).

Anal. Calcd for $C_{23}H_{22}N_2O_6$: C, 65.40; H, 5.25; N, 6.63. Found: C, 65.46; H, 5.46; N, 6.66.

Ethyl 2-Acetylamino-2-cyano-3-(2-chlorophenyl)-5-oxo-5-phenylpentanoate (6k)
White solid; mp 173–175 °C.

IR (KBr): 3259, 1755, 1686, 1660 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 0.95 (t, 3 H, *J* = 7.2 Hz), 2.11 (s, 3 H), 3.71–4.16 (m, 5 H), 7.27 (d, 1 H, *J* = 5.9 Hz), 7.38 (t, 2 H, *J* = 7.6 Hz), 7.52 (t, 2 H, *J* = 7.6 Hz), 7.89 (d, 2 H, *J* = 3.8 Hz), 8.02 (d, 2 H, *J* = 7.4 Hz), 8.28 (s, 1 H).

MS: *m*/*z* (%) = 412 (1), 242(5), 105 (100).

Anal. Calcd for $C_{22}H_{21}ClN_2O_4$: C, 64.00; H, 5.13; N, 6.79. Found: C, 63.86; H, 5.13; N, 6.80.

Ethyl 2-Acetylamino-2-cyano-3-(3-methoxyphenyl)-5-oxo-5-phenylpentanoate (6l)
White solid; mp 153–155 °C.

IR (KBr): 3381, 1740, 1693, 1666 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 0.92 (t, 3 H, *J* = 7.1 Hz), 2.10 (s, 3 H), 3.77–4.15 (m, 5 H), 3.83 (s, 3 H), 6.88–7.31 (m, 4 H), 7.53 (t, 2 H, *J* = 7.6), 7.69 (t, 1 H, *J* = 7.5 Hz), 8.05 (d, 2 H, *J* = 7.5 Hz), 8.29 (s, 1 H).

MS: *m*/*z* (%) = 408 (1), 238 (81), 43 (100).

Anal. Calcd for $C_{23}H_{24}N_2O_5$: C, 67.63; H, 5.92; N, 6.86. Found: C, 67.69; H, 5.95; N, 6.88.

Ethyl 2-Acetylamino-2-cyano-3-(4-methylphenyl)-5-oxo-5-(4-methylphenyl)pentanoate (6m)
White solid; mp 137–139 °C.

IR (KBr): 3359, 1751, 1694, 1686 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 0.89 (t, 3 H, *J* = 7.1 Hz), 2.09 (s, 3 H), 2.35 (s, 3 H), 2.45 (s, 3 H), 3.80–4.08 (m, 5 H), 7.17 (d, 2 H, *J* = 8.0 Hz), 7.28–7.38 (m, 4 H), 7.93 (d, 2 H, *J* = 8.3 Hz), 8.39 (s, 1 H).

MS: *m*/*z* (%) = 406 (1), 236 (9), 119 (100).

Anal. Calcd for $C_{24}H_{26}N_2O_4$: C, 70.92; H, 6.46; N, 6.89. Found: C, 70.75; H, 6.88; N, 7.08.

Ene-Lactams 7a–m; General Procedure
The δ-ketonitrile (**6a**–**m,** 1.0 mmol) was dissolved in a solution of HOAc (20 mL) and concentrated HCl (2 mL), after stirring at r.t. overnight, the mixture was poured into cold water. The precipitate was isolated by filtration, then washed with water and recrystallized from EtOH to afford product **7a**–**m**.

Ethyl 3-Acetylamino-3,4-dihydro-4,6-diphenyl-2(1*H*)pyridone-3-carboxylate (7a)
White solid; mp 212–216 °C.

IR (KBr): 1738, 1696, 1666 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.23 (t, 3 H, *J* = 7.2 Hz), 2.18 (s, 3 H), 4.03–4.19 (m, 2 H), 5.08 (d, 1 H, *J* = 2.5 Hz), 5.49 (t, 1 H, *J* = 2.2 Hz), 6.74 (s, 1 H), 7.32–7.48 (m, 11 H).

MS: *m*/*z* (%) = 378 (1), 319 (68), 305 (73), 263 (100), 247 (84).

Anal. Calcd for $C_{22}H_{22}N_2O_4$: C, 69.83; H, 5.86; N, 7.40. Found: C, 69.91; H, 5.95; N, 7.57.

Ethyl 3-Acetylamino-3,4-dihydro-4-(4-nitrophenyl)-6-phenyl-2(1*H*)pyridone-3-carboxylate (7b)
Pale yellow solid; mp 198–202 °C.

IR (KBr): 1741, 1704, 1644 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.26 (t, 3 H, *J* = 7.1 Hz), 2.20 (s, 3 H), 4.05–4.21 (m, 2 H), 5.25 (d, 1 H, *J* = 2.3 Hz), 5.41 (s, 1 H), 6.72 (s, 1 H), 7.39 (d, 2 H, *J* = 8.6 Hz), 7.40–7.54 (m, 6 H), 8.21 (d, 2 H, *J* = 8.6 Hz).

MS: *m*/*z* (%) = 423 (1), 364 (71), 350 (53), 308 (100), 292 (99).

Anal. Calcd for $C_{22}H_{21}N_3O_6$: C, 62.41; H, 5.00; N, 9.92. Found: C, 62.54; H, 5.08; N, 9.94.

Ethyl 3-Acetylamino-3,4-dihydro-4-(4-methoxyphenyl)-6-phenyl-2(1*H*)pyridone-3-carboxylate (7c)
White solid; mp 176–180 °C.

IR (KBr): 1744, 1690, 1669 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.24 (t, 3 H, *J* = 7.1 Hz), 2.18 (s, 3 H), 3.81 (s, 3 H), 4.06–4.18 (m, 2 H), 5.02 (d, 1 H, *J* = 2.5 Hz), 5.46 (d, 1 H, *J* = 4.3 Hz), 6.76 (s, 1 H), 6.86 (d, 2 H, *J* = 8.7 Hz), 7.12 (d, 2 H, *J* = 8.7 Hz), 7.39–7.50 (m, 6 H).

MS: *m*/*z* (%) = 408 (1), 349 (95), 335 (69), 293 (100), 277 (83).

Anal. Calcd for $C_{23}H_{24}N_2O_5$: C, 67.63; H, 5.92; N, 6.86. Found: C, 67.76; H, 5.94; N, 6.71.

Ethyl 3-Acetylamino-3,4-dihydro-4-phenyl-6-(4-methylphenyl)-2(1*H*)pyridone-3-carboxylate (7d)
White solid; mp 216–220 °C.

IR (KBr): 1732, 1702, 1665 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.23 (t, 3 H, *J* = 7.1 Hz), 2.19 (s, 3 H), 2.41 (s, 3 H), 4.03–4.21 (m, 2 H), 5.07 (s, 1 H), 5.45 (s, 1 H), 6.74 (s, 1 H), 7.19–7.59 (m, 10 H).

MS: *m*/*z* (%) = 392 (1), 333 (86), 319 (66), 277 (100), 261 (93).

Anal. Calcd for $C_{23}H_{24}N_2O_4$: C, 70.39; H, 6.16; N, 7.14. Found: C, 70.22; H, 6.18; N, 7.35.

Ethyl 3-Acetylamino-3,4-dihydro-4-(4-nitrophenyl)-6-(4-methylphenyl)-2(1*H*)pyridone-3-carboxylate (7e)
Pale yellow solid; mp 225–229 °C.

IR (KBr): 1753, 1695, 1671 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.25 (t, 3 H, *J* = 7.1 Hz), 2.20 (s, 3 H), 2.42 (s, 3 H), 4.02–4.24 (m, 2 H), 5.24 (d, 1 H, *J* = 2.4 Hz), 5.37 (d, 1 H, *J* = 2.0 Hz), 6.71 (s, 1 H), 7.25–7.62 (m, 7 H), 8.21 (d, 2 H, *J* = 8.7 Hz).

MS: *m*/*z* (%) = 437 (1), 378 (94), 364 (48), 322 (87), 306 (100).

Anal. Calcd for $C_{23}H_{23}N_3O_6$: C, 63.15; H, 5.30; N, 9.61. Found: C, 63.23; H, 5.32; N, 9.67.

Ethyl 3-Acetylmino-3,4-dihydro-4-(4-methoxyphenyl)-6-(4-methylphenyl)-2(1*H*)pyridone-3-carboxylate (7f)
White solid; mp 212–216 °C.

IR (KBr): 1754, 1695, 1667 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.24 (t, 3 H, *J* = 6.9 Hz), 2.17 (s, 3 H), 2.41 (s, 3 H), 3.88 (s, 3 H), 4.03–4.00 (m, 2 H), 5.01 (d, 1 H,

J = 2.4), 6.76 (s, 1 H), 6.83 (d, 2 H, *J* = 6.6 Hz), 7.11 (d, 2 H, *J* = 8.6 Hz), 7.24 (d, 2 H, *J* = 7.7 Hz), 7.37 (d, 3 H, *J* = 8.1 Hz), 7.45 (s, 1 H).

MS: *m*/*z* (%) = 422 (1), 363 (100), 349 (56), 307 (82), 291 (81).

Anal. Calcd for $C_{24}H_{26}N_2O_5$: C, 68.23; H, 6.20; N, 6.63. Found: C, 68.52; H, 6.55; N, 6.66.

Ethyl 3-Acetylamino-3,4-dihydro-4-phenyl-6-(4-fluorophenyl)-2(1*H*)pyridone-3-carboxylate (7g)
White solid; mp 201–205 °C.

IR (KBr): 1737, 1702, 1659 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.24 (t, 3 H, *J* = 7.1 Hz), 2.18 (s, 3 H), 4.04–4.19 (m, 2 H), 5.06 (d, 1 H, *J* = 2.4 Hz), 5.43 (d, 1 H, *J* = 2.1 Hz), 6.74 (s, 1 H), 7.14–7.50 (m, 10 H).

MS: *m*/*z* (%) = 397 (1), 337 (64), 323 (67), 281 (100), 265 (79).

Anal. Calcd For $C_{22}H_{21}FN_2O_4$: C, 66.66; H, 5.34; N, 7.07. Found: C, 66.48; H, 5.80; N, 7.48.

Ethyl 3-Acetylamino-3,4-dihydro-4-(4-nitrophenyl)-6-(4-fluorophenyl)-2(1*H*)pyridone-3-carboxylate (7h)
Yellow solid; mp 244–248 °C.

IR (KBr): 1734, 1712, 1661 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.26 (t, 3 H, *J* = 7.2 Hz), 2.19 (s, 3 H), 4.05–4.22 (m, 2 H), 5.24 (d, 1 H, *J* = 2.3 Hz), 5.35 (d, 1 H, *J* = 1.9 Hz), 6.72 (s, 1 H), 7.18 (t, 2 H, *J* = 8.5 Hz), 7.38 (d, 2 H, *J* = 8.7 Hz), 7.48 (q, 2 H, *J* = 3.5 Hz), 7.57 (s, 1 H), 8.21 (d, 2 H, *J* = 8.7 Hz).

MS: *m*/*z* (%) = 441 (1), 382 (100), 368 (12), 326 (21), 310 (60).

Anal. Calcd for $C_{22}H_{20}FN_3O_6$: C, 59.86; H, 4.57; N, 9.52. Found: C, 59.71; H, 4.62; N, 9.55.

Ethyl 3-Acetylamino-3,4-dihydro-4-(4-methoxyphenyl)-6-(4-fluorophenyl)-2(1*H*)pyridone-3-carboxylate (7i)
White solid; mp 182–186 °C.

IR (KBr): 1745, 1692, 1670 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.24 (t, 3 H, *J* = 7.1 Hz), 2.18 (s, 3 H), 3.81 (s, 3 H), 4.07–4.20 (m, 2 H), 5.01 (d, 1 H, *J* = 2.5), 5.40 (s, 1 H), 6.75 (s, 1 H), 6.86 (d, 2 H, *J* = 8.6 Hz), 7.08–7.16 (m, 4 H), 7.36 (s, 1 H), 7.44–7.49 (m, 2 H).

MS: *m*/*z* (%) = 426 (1), 367 (99), 353 (64), 311 (100), 295 (72).

Anal. Calcd for $C_{23}H_{23}FN_2O_5$: C, 64.78; H, 5.44; N, 6.57. Found: C, 64.83; H, 5.58; N, 6.56.

Ethyl 3-Acetylamino-3,4-dihydro-4-(3,4-piperyl)-6-phenyl-2(1*H*)pyridone-3-carboxylate (7j)
White solid; mp 200–202 °C.

IR (KBr): 1740, 1712, 1657 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.25 (t, 3 H, *J* = 7.1 Hz), 2.19 (s, 3 H), 4.06–4.23 (m, 2 H), 4.98 (d, 1 H, *J* = 2.5 Hz), 5.43 (t, 1 H, *J* = 2.1 Hz), 5.97 (s, 2 H), 6.65–6.67 (m, 2 H), 6.75 (s, 1 H), 6.78 (s, 1 H), 7.36 (s, 1 H), 7.42–7.48 (m, 5 H).

MS: *m*/*z* (%) = 422 (1), 363 (100), 349 (60), 307 (91), 291 (73).

Anal. Calcd for $C_{23}H_{22}N_2O_6$: C, 65.40; H, 5.25; N, 6.63. Found: C, 65.24; H, 5.21; N, 6.67.

Ethyl 3-Acetylamino-3,4-dihydro-4-(2-chlorophenyl)-6-phenyl-2(1*H*)pyridone-3-carboxylate (7k)
White solid; mp 208–212 °C.

IR (KBr): 1731, 1705, 1657 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): = 1.26 (t, 3 H, *J* = 7.2 Hz), 2.13 (s, 3 H), 4.09–4.25 (m, 2 H), 5.29 (s, 1 H), 5.65 (d, 1 H, *J* = 2.4 Hz), 6.69 (s, 1 H,), 7.22–7.28 (m, 3 H), 7.41–7.48 (m, 7 H).

MS: *m*/*z* (%) = 412 (1), 339 (68), 318 (49), 297 (90), 290 (100).

Anal. Calcd for $C_{22}H_{21}N_2O_4$: C, 64.00; H, 5.13; N, 6.79. Found: C, 64.11; H, 5.17; N, 6.62.

Ethyl 3-Acetylamino-3,4-dihydro-4-(3-methoxyphenyl)-6-phenyl-2(1*H*)pyridone-3-carboxylate (7l)
White solid; mp 184–188 °C.

IR (KBr): 1741, 1714, 1650 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.24 (t, 3 H, *J* = 7.1 Hz), 2.19 (s, 3 H), 3.80 (s, 3 H), 4.05–4.21 (m, 2 H), 5.05 (d, 1 H, *J* = 2.4 Hz), 5.48 (d, 1 H, *J* = 4.3 Hz), 6.74–6.79 (m, 4 H), 7.23–7.50 (m, 7 H).

MS: *m*/*z* (%) = 408 (1), 349 (66), 335 (75), 293 (100), 277 (37).

Anal. Calcd for $C_{23}H_{24}N_2O_5$: C, 67.63; H, 5.92; N, 6.86. Found: C, 67.63; H, 5.89; N, 7.20.

Ethyl 3-Acetylamino-3,4-dihydro-4-(4-methylphenyl)-6-(4-methylphenyl)-2(1*H*)pyridone-3-carboxylate (7m)
White solid; mp 214-218 °C.

IR (KBr): 1758, 1691, 1666 cm^{-1}.

1H NMR (300 MHz, $CDCl_3$): = 1.24 (t, 3 H, *J* = 7.1 Hz), 2.17 (s, 3 H), 2.35 (s, 3 H), 2.41 (s, 3 H), 4.01-4.19 (m, 2 H), 5.03 (d, 1 H, *J* = 2.4 Hz), 5.43 (t, 1 H, *J* = 2.2 Hz), 6.74 (s, 1 H), 7.06-7.28 (m, 6 H), 7.36–7.39 (d, 3 H, *J* = 8.1 Hz).

MS: *m*/*z* (%) = 406 (1), 347 (98), 333 (70), 291 (100), 275 (85).

Anal. Calcd for $C_{24}H_{26}N_2O_4$: C, 70.92; H, 6.45; N, 6.89; Found: C, 70.99; H, 6.79; N, 6.97.

1,2-Dihydro-2-oxo-3-pyridinecarboxylic Ester 8a–m; General Procedure
Ene-Lactam (**7a**–**m,** 1.0 mmol), Na_2CO_3 (1.0 mmol) and a mixture of DMSO–H_2O (5:1, 12 mL) were placed in a three-necked flask equipped with a reflux condenser and an internal thermometer. The mixture was heated at 140 °C for 1 h, then cooled and added to cold water (50 mL). The solution was extracted with EtOAc (3 × 50 mL). The combined organic layers were washed with brine (50 mL), dried (Na_2SO_4), and concentrated under vacuum. The residue was purified by flash column chromatography (EtOAc–petroleum ether, 1:2) on silica gel to afford the product **8a**–**m**.

Ethyl 1,2-Dihydro-4,6-diphenyl-2-oxo-3-pyridinecarboxylate (8a)
White solid; mp 200–202 °C.

IR (KBr): 1723 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.05 (t, 3 H, *J* = 7.1 Hz), 4.17 (q, 2 H, *J* = 7.1 Hz), 6.67 (s, 1 H), 7.28–7.56 (m, 8 H), 7.81–7.88 (m, 2 H).

MS: *m*/*z* (%) = 319 (100), 245 (96).

Anal. Calcd for $C_{20}H_{17}NO_3$: C, 75.22; H, 5.37; N, 4.39. Found: C, 75.23; H, 5.39; N, 4.43.

Ethyl 1,2-Dihydro-4-(4-nitrophenyl)-6-phenyl-2-oxo-3-pyridinecarboxylate (8b)
Yellow solid; mp 274–276 °C.

IR (KBr): 1735 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): σ = 1.06 (t, 3 H, *J* = 7.0 Hz), 4.17 (q, 2 H, *J* = 7.1 Hz), 6.72 (s, 1 H), 7.55 (s, 3 H), 7.64 (d, 2 H, *J* = 8.5 Hz), 7.87 (d, 2 H, *J* = 3.6 Hz), 8.34 (d, 2 H, *J* = 8.3 Hz).

MS: *m*/*z* (%) = 364 (100), 290 (70).

Anal. Calcd for $C_{20}H_{16}N_2O_5$: C, 65.93; H, 4.43; N, 7.69. Found: C, 65.87; H, 4.27; N, 7.89.

Ethyl 1,2-Dihydro-4-(4-methoxyphenyl)-6-phenyl-2-oxo-3-pyridinecarboxylate (8c)
White solid; mp 206–208 °C.

IR (KBr): 1723 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.14 (t, 3 H, *J* = 7.1 Hz), 3.88 (s, 3 H), 4.24 (q, 2 H, *J* = 7.1 Hz), 6.99 (d, 2 H, *J* = 8.5 Hz), 7.48 (d, 2 H, *J* = 7.2 Hz), 7.56 (s, 3 H), 8.04 (s, 2 H).

MS: *m*/*z* (%) = 349 (100), 275 (72).

Anal. Calcd for $C_{21}H_{19}NO_4$: C, 72.19; H, 5.48; N, 4.01. Found: C, 72.16; H, 5.50; N, 4.03.

Ethyl 1,2-Dihydro-4-phenyl-6-(4-methylphenyl)-2-oxo-3-pyridinecarboxylate (8d)
White solid; mp 204–206 °C.

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

^1H NMR (300 MHz, $CDCl_3$): δ = 1.03 (t, 3 H, *J* = 7.1 Hz), 2.44 (s, 3 H), 4.17 (q, 2 H, *J* = 7.1 Hz), 6.77 (s, 1 H), 7.29 (d, 2 H, *J* = 4.4 Hz), 7.47 (s, 5 H), 7.72 (d, 2 H, *J* = 8.2 Hz).

MS: *m*/*z* (%) = 333 (100), 259 (68).

Anal. Calcd for $C_{21}H_{19}NO_3$: C, 75.66; H, 5.74; N, 4.20. Found: C, 75.66; H, 5.79; N, 4.30.

Ethyl 1,2-Dihydro-4-(4-nitrophenyl)-6-(4-methylphenyl)-2-oxo-3-pyridinecarboxylate (8e)
Yellow solid; mp 259–261 °C.

IR (KBr): 1725 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.06 (t, 3 H, *J* = 7.1 Hz), 2.44 (s, 3 H), 4.16 (q, 2 H, *J* = 7.1 Hz), 6.62 (s, 1 H), 7.33 (d, 2 H, *J* = 8.0 Hz), 7.64 (d, 2 H, *J* = 8.6 Hz), 7.75 (d, 2 H, *J* = 8.1 Hz), 8.33 (d, 2 H, *J* = 8.6 Hz).

MS: *m*/*z* (%) = 378 (100), 304 (50).

Anal. Calcd for $C_{21}H_{18}N_2O_5$: C, 66.66; H, 4.79; N, 7.40. Found: C, 66.45; H, 4.87; N, 7.40.

Ethyl 1,2-Dihydro-4-(4-methoxyphenyl)-6-(4-methylphenyl)-2-oxo-3-pyridinecarboxylate (8f)
White solid; mp 255–257 °C.

IR (KBr): 1724 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.12 (t, 3 H, *J* = 7.0 Hz), 2.44 (s, 3 H), 3.88 (s, 3 H), 4.21 (q, 2 H, *J* = 7.1 Hz), 6.66 (s, 1 H), 6.98 (d, 2 H, *J* = 8.5), 7.33 (d, 2 H, *J* = 3.9 Hz), 7.44 (d, 2 H, *J* = 8.4 Hz), 7.67 (d, 2 H, *J* = 7.9 Hz).

MS: *m*/*z* (%) = 363 (100), 289 (73).

Anal. Calcd for $C_{22}H_{21}NO_4$: C, 72.71; H, 5.82; N, 3.85. Found: C, 72.69; H, 5.73; N, 3.86.

Ethyl 1,2-Dihydro-4-phenyl-6-(4-fluorophenyl)-2-oxo-3-pyridinecarboxylate (8g)
White solid; mp 215–217 °C.

IR (KBr): 1724 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.04 (t, 3 H, *J* = 7.0 Hz), 4.16 (q, 2 H, *J* = 7.1 Hz), 6.66 (s, 1 H), 7.21 (t, 2 H, *J* = 8.5 Hz), 7.46 (s, 5 H), 7.90 (q, 2 H, *J* = 3.5 Hz).

MS: *m*/*z* (%) = 337 (100), 263 (94).

Anal. Calcd for $C_{20}H_{16}FNO_3$: C, 71.21; H, 4.78; N, 4.15. Found: C, 71.27; H, 4.75; N, 4.11.

Ethyl 1,2-Dihydro-4-(4-nitrophenyl)-6-(4-fluorophenyl)-2-oxo-3-pyridinecarboxylate (8h)
Yellow solid; mp 209–211 °C.

IR (KBr): 1739 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.03 (t, 3 H, *J* = 6.9 Hz), 4.16 (q, 2 H, *J* = 7.0 Hz), 6.68 (1 H), 7.22 (t, 2 H, *J* = 8.0 Hz), 7.62 (d, 2 H, *J* = 8.3 Hz), 7.91 (s, 2 H), 8.33 (d, 2 H, *J* = 8.1 Hz).

MS: *m*/*z* (%) = 382 (100), 308 (74).

Anal. Calcd for $C_{21}H_{15}FN_2O_5$: C, 62.83; H, 3.95; N, 7.33. Found: C, 62.85; H, 3.92; N, 7.37.

Ethyl 1,2-Dihydro-4-(4-methoxyphenyl)-6-(4-fluorophenyl)-2-oxo-3-pyridinecarboxylate (8i)
White solid; mp 212–214 °C.

IR (KBr): 1732 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.13 (t, 3 H, *J* = 7.1 Hz), 3.88 (s, 3 H), 4.22 (q, 2 H, *J* = 7.1 Hz), 6.79 (s, 1 H), 6.95 (d, 2 H, *J* = 7.2 Hz), 7.22 (d, 2 H, *J* = 8.5 Hz), 7.44 (d, 2 H, *J* = 8.7 Hz), 7.87 (q, 2 H, *J* = 3.5 Hz).

MS: *m*/*z* (%) = 367 (100), 293 (80).

Anal. Calcd for $C_{21}H_{18}FNO_3$: C, 68.66; H, 4.94; N, 3.81. Found: C, 68.56; H, 4.86; N, 3.85.

Ethyl 1,2-Dihydro-4-(3,4-piperyl)-6-phenyl-2-oxo-3-pyridinecarboxylate (8j)
White solid; mp 242–244 °C.

IR (KBr): 1735 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.17 (t, 3 H, *J* = 7.1 Hz), 4.25 (q, 2 H, *J* = 6.7 Hz), 6.05 (s, 2 H), 6.67 (s, 1 H), 6.89 (d, 1 H, *J* = 8.4 Hz), 7.52 (s, 1 H), 7.53 (s, 1 H), 7.54 (s, 1 H), 7.77–7.82 (m, 2 H).

MS: *m*/*z* (%) = 363 (100), 289 (56).

Anal. Calcd for $C_{21}H_{17}NO_5$: C, 69.41; H, 4.72; N, 3.85. Found: C, 69.47; H, 4.72; N, 3.70.

Ethyl 1,2-Dihydro-4-(2-chlorophenyl)-6-phenyl-2-oxo-3-pyridinecarboxylate (8k)
White solid; mp 199–201 °C.

IR (KBr): 1728 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 0.92 (t, 3 H, *J* = 7.1 Hz), 4.13 (q, 2 H, *J* = 8.4 Hz), 6.86 (s, 1 H), 7.31–7.41 (m, 3 H), 7.48–7.52 (m, 4 H), 7.94–7.96 (m, 2 H).

MS: *m*/*z* (%) = 353 (2), 290 (100).

Anal. Calcd for $C_{20}H_{16}ClNO_3$: C, 67.90; H, 4.56; N, 3.96. Found: C, 67.97; H, 4.55; N, 3.86.

Ethyl 1,2-Dihydro-4-(3-methoxyphenyl)-6-phenyl-2-oxo-3-pyridinecarboxylate (8l)
White solid; mp 192–194 °C.

IR (KBr): 1719 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): = 1.09 (t, 3 H, *J* = 7.0 Hz), 3.87 (s, 3 H), 4.19 (q, 2 H, *J* = 7.1 Hz), 6.71 (s, 1 H), 6.98–7.08 (m, 3 H), 7.37 (t, 1 H, *J* = 7.8 Hz), 7.51 (s, 1 H), 7.52 (s, 1 H), 7.53 (s, 1 H, *J* = 7.8 Hz), 7.84 (s, 1 H), 7.86 (s, 1 H).

MS: *m*/*z* (%) = 349 (100), 275 (91).

Anal. Calcd for $C_{21}H_{19}NO_4$: C, 72.19; H, 5.48; N, 4.01. Found: C, 72.10; H, 5.66; N, 4.14.

Ethyl 1,2-Dihydro-4-(4-methylphenyl)-6-(4-methylphenyl)-2-oxo-3-pyridinecarboxylate (8m)
White solid; mp 238–240 °C.

IR (KBr): 1728 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.09 (t, 3 H, *J* = 7.2 Hz), 2.42 (s, 6 H), 4.19 (q, 2 H, *J* = 3.6 Hz), 6.61 (s, 1 H), 7.25 (d, 2 H, *J* = 7.9 Hz), 7.32 (d, 2 H, *J* = 7.9), 7.38 (d, 2 H, *J* = 8.0 Hz), 7.71 (d, 2 H, *J* = 8.2 Hz).

MS: *m*/z (%) = 347 (100), 273 (79).

Anal. Calcd for $C_{22}H_{21}NO_3$: C, 76.06; H, 6.09; N, 4.03%, Found: C, 76.13; H, 6.05; N, 4.07.

4,6-Diphenylpyridin-2(1*H*)-one (9)
White solid; mp 210–212 °C [lit.[18] 209–212 ° C].

^1H NMR (300 MHz, $CDCl_3$): δ = 6.92 (d, 1 H, *J* = 1.2 Hz), 6.98 (d, 1 H, *J* = 1.3 Hz), 7.50–7.55 (m, 6 H), 7.67–7.70 (m, 2 H), 7.84–7.87 (m, 2 H).

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