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Full Paper

First Synthesis and Isolation of the *E*- and *Z*-Isomers of Some New Schiff Bases. Reactions of 6-Azido-5-Formyl-2-Pyridone with Aromatic Amines

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Abstract: Some novel Schiff bases have been prepared by reacting 6-azido-5-formyl-2-pyridone **1** with a series of aromatic amines **2a-f**. 5-Arylaminomethylene-6-(*E*)-aryl-iminopyridones **3a-e** were obtained by reaction of **1** with **2a-e** at room temperature, whereas with **2f**, the 6-azido-5-naphthalen-2-yl-iminomethylpyridone derivative **4** was formed. On the other hand, heating **1** with **2a-d** at 140-150°C yielded two sets of isomeric products, (*E*)-**3a-d** and (*Z*)-**5a-d**. Refluxing compounds (*Z*)-**3a,c** with hydroxyl-amine in methanol gave the corresponding hydroxyliminopyridones **8a,c**. Heating of (*E*)-**3a-d** with excess $POCl_3$ at reflux did not give the expected tricyclic compound **9**, but rather the isomeric products (*Z*)-**5a-d** were obtained. The structures of all these products have been characterized using IR and ^{1}H- and ^{13}C-NMR spectroscopy.

Keywords: 6-Azido-5-formyl-2-pyridones, arylamines, Schiff bases, NMR spectroscopy.

Introduction

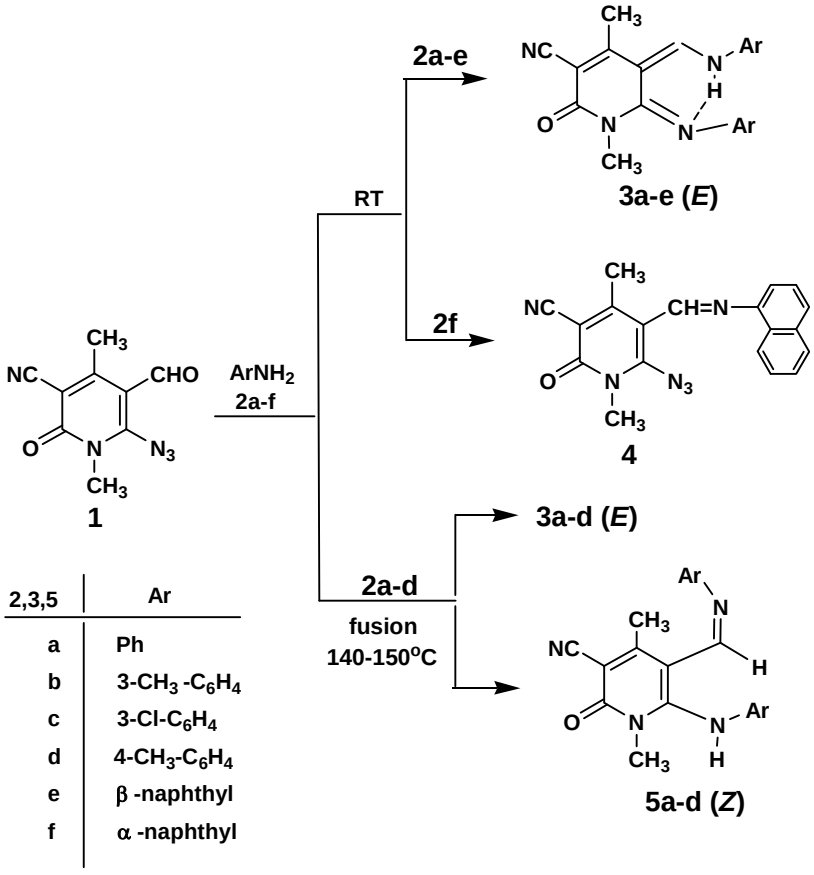
The importance of Schiff bases in organic synthesis has increased over the past few decades because they are among the most versatile organic synthetic intermediates [1] and they also present a broad range of biological activities such as herbicidal [2], antifungal [3], antimicrobial [4-7] and antitumor properties [8,9]. Moreover, Schiff bases have also attracted much attention because of their

ability to act as ligands for complexation of different metal ions in various oxidation states [10, 11]. In consideration of these facts and as a part of our continuing studies on the synthesis of pharmacologically interesting new heterocycles containing the pyridine moiety [12-16], herein we are gratified to report our first study on the reaction of 6-azidopyridone **1** [12] with aromatic amines at different temperatures in order to synthesize some novel Schiff bases with expected significant biological activity, which are often difficult to obtain by alternative routes.

Results and Discussion

In our studies we first investigated the reaction of 6-azidopyridone **1** with aromatic amines at room temperature. Thus, when **1** was allowed to react with two equivalents of the aromatic amines **2a-e** in absolute ethanol for 2 hours at room temperature, the interesting 5-arylaminomethylene-6-(*E*)-arylimino-pyridone derivatives **3a-e** were isolated in 84-89% yields as the only reaction products (Scheme 1).

Scheme 1.

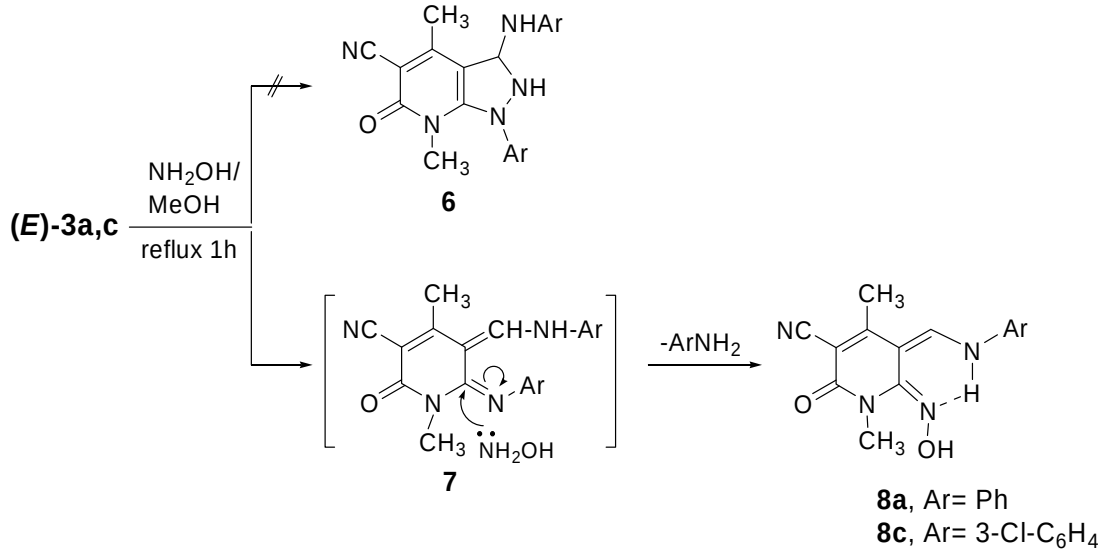


The configurations of (*E*)-**3a-e** were determined on the basis of their spectra, which showed two doublet signals at approx. $\delta \approx 8.43$ ppm (J = 13 Hz) and 12.71 ppm (J = 13 Hz), attributable to methylene (=CH-) and NH groups [17], respectively, besides the signals corresponding to the aryl and two sets of methyl protons. Considering the findings of Prasad *et al*. [18], the marked downfield shift of the N-H resonance signals in the ^{1}H-NMR spectra clearly indicates the formation of intramolecular hydrogen bonds (i.e. N-H···N-Ar bridges). In addition, the structures were substantiated by the ^{13}C-

NMR spectra. The assignment of all ring carbons of (*E*)-**3a** provided confirmation of the 5-anilinomethylene-1,2,5,6-tetrahydro-1,4-dimethyl-2-oxo-6-phenyl-imino-pyridin-3-carbonitrile ring system: 164.40 (CO), 162.81 (C-6), 161.37 (C-4), 129.65 (=CH-NH), 115.72 (CN), 112.81 (C-3), 109.73 (C-5), 27.36 (N-CH_3), 20.43 (CH_3 at C-4), in addition to the signals due to aromatic carbons (see Experimental).

Unexpectedly, when azidopyridone derivative **1** reacted with α-naphthylamine (**2f**) under analogous experimental conditions, it did not give the corresponding 5-arylaminomethylene-6-aryliminopyridone, but instead gave the 6-azido-5-naphthalen-2-yl-iminomethyl-pyridone derivative **4**. The structure of **4** was assigned on the basis of analytical and spectral data. The IR spectrum showed an absorption band at 2140 cm^{-1}, corresponding to the azido group. The ^{1}H-NMR spectrum revealed the presence of a singlet at δ = 8.82 ppm, assignable to the methine proton (═CH─) at C-5, in addition to the signals of other groups (see Experimental). However, fusion of azidopyridone derivative **1** with an excess of arylamines **2a-d** at 140-150ºC for 10 minutes gave in each case a mixture of both the *E*- and *Z*- isomers **3a-d** and **5a-d**, respectively (Scheme 1), which was readily separated by PLC chromatography using silica gel. The structures of (*Z*)-**5a-d** were substantiated on the basis of IR, NMR and mass spectroscopy data. Thus, the IR spectra showed the absence of the azido and aldehyde carbonyl groups and the presence of an absorption band at υ = 3250 cm^{-1} for the NH function. The ^{1}H-NMR spectra showed the presence of two singlet signals for the methine proton (–CH=N) group and NH function, at approx. δ ≈ 8.14 and δ ≈ 9.13 ppm, respectively, in addition to the expected signals of the other groups. Additionally, their structures were supported by ^{13}C-NMR and correct mass spectra, which were all compatible with the assigned structures (see Experimental). Analytical data were also in accordance with the proposed structures. Attempts to convert (*E*)-**3** to (*Z*)-**5** thermally, under neutral conditions, by boiling for extended periods in different solvents such as DMF, bromobenzene and other high-boiling benzene derivatives, were made without success. It is obvious that Schiff bases can form as *E* and *Z* isomers and in our case, the interconversion between them is difficult to achieve, preseumably due to the high energy barrier for the interconversion.

Scheme 2.

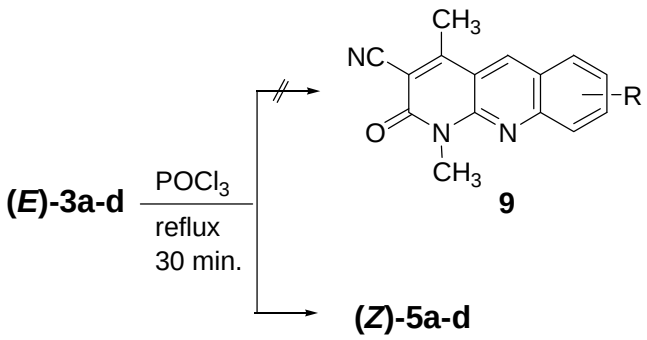


To study the chemical behavior of compound (*E*)-**3**, it was investigated as a potential good precursor for the synthesis of new derivatives of the interesting pyridones, analogous to arylaminomethylene derivatives of cyclic 1,3-dicarbonyl compounds, which are valuable key components for the synthesis of many heterocycles [19].

Thus, as depicted in Scheme 2, when 5-arylaminomethylene-6-arylimino-pyridone derivatives (*E*)-**3a,c**, for example, were refluxed in methanol with equimolar amounts of hydroxylamine for 1 hour, they failed to give the fused pyrazolopyridones **6**, but instead the unexpected novel 5-arylamino-methylene-6-hydroxyimino-pyridone derivatives **8a,c** were formed. The structures of the products were supported by correct elemental analyses and mass spectroscopy, as well as the IR and ^{1}H-NMR spectra, which were compatible with the assigned structures (see Experimental). The formation of **8a,c** is assumed to proceed *via* an initial nucleophilic attack of the hydroxylamine nitrogen atom on the pyridine C-6, followed by a loss of one molecule of arylamine to afford the final products **8a,c** (Scheme 2).

Interestingly, heating compounds (*E*)-**3a-d** with $POCl_3$ at reflux temperature for 30 minutes, did not afford the tricyclic pyridoquinoline derivatives **9**, but instead, the unexpected isomeric products (*Z*)-**5a-d** were obtained, presumably through intramolecularly assisted proton transfer. The compounds (*Z*)-**5a-d** thus obtained were identical in all respects (mp, mixed mp, IR, ^{1}H-NMR) with those previously prepared (Scheme 3). This behavior turned our attention to investigate the isomerization of (*E*)-**3** to (*Z*)-**5** under acidic conditions. More details on this isomerization processes will be discussed in future publications.

Scheme 3.



Conclusions

In summary, we have developed for the first time, a new, simple and one-pot synthetic route for the construction of some new Schiff bases, which might be used in many different areas. Furthermore, the reported route is very convenient for its simplicity, the affordability of the starting materials and good yields obtained, and opens the way for synthesis of new examples of such compounds which are scarcely represented in the literature. Further studies in our laboratory aimed at the synthesis of a wide variety of novel heterocycles, utilizing 6-azidopyridones as the starting material, are under investigation and will be published in due course.

Experimental

General

Melting points were determined on a Gallenkamp melting point apparatus and are uncorrected. Infrared spectra were measured with a Shimadzu Model 470 spectrophotometer. The NMR spectra were recorded on a Bruker AM 400 spectrometer with $CDCl_3$, DMSO-d_6 as solvents and TMS as internal reference, chemical shifts are expressed as δ ppm. Mass spectra were measured on a GCMS-QP1000EX mass spectrometer operating at 70 eV. Analytical data were determined on the Microanalytical Data Unit at Cairo University. Analytical TLC was performed with silica gel plates using silica gel 60 PF_{254} (Merck).

Synthesis of 5-Arylaminomethylene-6-(E)-arylimino-1,2,5,6-tetrahydro-1,4-dimethyl-2-oxo-pyridin-3-carbonitriles **3a-e**, *6-arylamino-5-(Z)-aryliminomethyl-1,2-dihydro-1,4-dimethyl-2-oxo-pyridin-3-carbonitriles* **5a-d** *and 6-azido-1,2-dihydro-1,4-dimethyl-5-(naphthalen-2-yl-iminomethyl)-2-oxo-pyridin-3-carbonitrile* (**4**)

*Method **A** for compounds (E)*-**3a-e** *and* **4**: Aromatic amines **2a-f** (4.60 mmol) were added to a solution of compound **1** (0.50 g, 2.30 mmol) in absolute ethanol (10 mL) and the mixture was stirred for 2 h at room temperature (25°C). The resulting solid products were collected by filtration, washed with a small amount of EtOH, dried and recrystallized from EtOH to afford compounds (*E*)-**3a-e** and **4**.

*Method **B** for (E)*-**3a-d** *and (Z)*-**5a-d**: A mixture of aromatic amine **2a-d** (5 mL) and azidopyridone derivative **1** (0.50 g, 2.30 mmol) was heated at 140-150˚C for 10 min. After cooling at room temperature, the reaction mixture were treated with a small amount of EtOH and the resulting solid products were chromatographed on a preparative TLC plate using 10:2 toluene-acetone as eluent to give two zones. Extraction with acetone followed by recrystallization from EtOH gave compounds *(E)*-**3a-d** and *(Z)*-**5a-d**.

*Method **C** for compounds (Z)*-**5a-d**: A mixture of (*E*)-**3a-d** (1 mmol) and $POCl_3$ (7 mL) was refluxed for 30 min. The excess of $POCl_3$ was distilled off *in vacuo* and the residue was treated with cold H_2O. The resulting solid product that formed was collected by filtration, washed well with H_2O, dried and finally recrystallized from EtOH to afford *(Z)*-**5a-d**.

5-Anilinomethylene-1,2,5,6-tetrahydro-1,4-dimethyl-2-oxo-6-(E)-phenylimino-pyridin-3-carbonitrile (**3a**). Yield: 87% (route A) or 43% (route B); m.p. 236-238˚C; IR (ν_{max}, KBr, cm^{-1}): 3050, 2950, 2200, 1645; ^{1}H-NMR (DMSO-d_6): δ 2.42 (3H, s, CH_3), 3.33 (3H, s, CH_3), 6.75 (2H, d, *J*=8.0 Hz, ArH), 6.97 (1H, t, *J*=8.0 Hz, ArH), 7.21 (2H, t, *J*=8.0 Hz, ArH), 7.26 (1H, t, *J*=8.0 Hz, ArH), 7.45 (2H, t, *J*=8.0 Hz, ArH), 7.59 (2H, d, *J*=8.0 Hz, ArH), 8.44 (1H, d, *J*=13.0 Hz, =CH-N), 12.70 (1H, d, *J*=13.0 Hz, NH); ^{13}C-NMR (DMSO-d_6): δ 20.43, 27.36, 109.73, 112.81, 115.72, 119.01, 121.34, 122.56, 127.41, 128.26, 129.65, 130.59, 143.17, 146.24, 161.37, 162.81, 164.40; Anal. calcd. for $C_{21}H_{18}N_4O$: C, 73.66; H, 5.30; N , 16.36. Found: C, 73.51; H, 5.44; N, 16.49.

1,2,5,6-Tetrahydro-1,4-dimethyl-2-oxo-5-(3-tolylaminomethylene)-6-(E)-(3-tolylimino)-pyridine-3-carbonitrile (**3b**). Yield: 85% (route A) or 45% (route B); m.p. 258-260˚C; IR (ν_{max}, KBr, cm^{-1}): 3050, 2950, 2900, 2200, 1645; ^{1}H-NMR (DMSO-d_6): δ 2.24 (3H, s, CH_3), 2.34 (3H, s, CH_3), 2.41 (3H, s, CH_3), 3.31 (3H, s, CH_3), 6.54 (1H, d, *J*=8.0 Hz, ArH), 6.57 (1H, s, ArH), 6.78 (1H, d, *J*=8.0 Hz, ArH), 7.07 (2H, d, *J*=8.0 Hz, ArH), 7.31 (2H, t, *J*=8.0 Hz, ArH), 7.42 (1H, s, 1ArH), 8.42 (1H, d, *J*=13.0 Hz, =CH-N), 12.70 (1H, d, *J*=13.0 Hz, NH); MS m/z (rel. int. %): 371 (M+1, 21), 370 (M^+, 86), 369 (100), 354 (4), 252 (19), 185 (16), 120 (5), 107 (33), 106 (31), 105 (11), 91 (13), 58 (3), 42 (10); Anal. calcd. for $C_{23}H_{22}N_4O$: C, 74.57; H, 5.99; N, 15.12. Found: C, 74.43; H, 6.12; N, 15.34.

5-(3-Chlorophenylaminomethylene)-6-(E)-(3-Chlorophenylimino)-1,2,5,6-tetrahydro-1,4-dimethyl-2-oxo-pyridine-3-carbonitrile (**3c**). Yield: 89% (route A) or 41% (route B); m.p. 242-244˚C; IR (ν_{max}, KBr, cm^{-1}): 3050, 2200, 1645; ^{1}H-NMR (DMSO-d_6): δ 2.45 (3H, s, CH_3), 3.36 (3H, s, CH_3), 6.73 (1H, d, *J*=8.0 Hz, ArH), 6.83 (1H, s, ArH), 7.01 (1H, d, *J*=8.0 Hz, ArH), 7.22 (1H, t, *J*=8.0 Hz, ArH), 7.29 (1H, d, *J*=8.0 Hz, ArH), 7.45 (1H, t, *J*=8.0 Hz, ArH), 7.54 (1H, d, *J*=8.0 Hz, ArH), 7.87 (1H, s, ArH), 8.46 (1H, d, *J*=13.0 Hz, =CH-N), 12.72 (1H, d, *J*=13.0 Hz, NH); Anal. calcd. for $C_{21}H_{16}Cl_2N_4O$: C, 61.31; H, 3.92; Cl,17.26; N, 13.62. Found: C, 61.10; H, 4.12; Cl, 17.31; N, 13.43.

1,2,5,6-Tetrahydro-1,4-dimethyl-2-oxo-5-(4-tolylaminomethylene)-6-(E)-(4-tolylimino)-pyridine-3-carbonitrile (**3d**). Yield: 88% (route A) or 42% (route B); m.p. 252-254˚C; IR (ν_{max}, KBr, cm^{-1}): 3050, 2950, 2900, 2200, 1640; ^{1}H-NMR (DMSO-d_6): δ 2.25 (3H, s, CH_3), 2.31 (3H, s, CH_3), 2.40 (3H, s, CH_3), 3.33 (3H, s, CH_3), 6.63 (2H, d, *J*=8.0 Hz, ArH), 7.01 (2H, d, *J*=8.0 Hz, ArH), 7.25 (2H, d, *J*= 8.0 Hz, ArH), 7.47 (2H, d, *J*=8.0 Hz, ArH), 8.39 (1H, d, *J*=13.0 Hz, =CH-N), 12.72 (1H, d, *J*=13.0 Hz, NH); ^{13}C-NMR (DMSO-d_6): δ 20.41, 21.04, 21.33, 26.76, 109.45, 112.67, 115.74, 118.96, 121.22, 127.03, 128.14, 128.36, 129.63, 136.73, 139.82, 143.43, 162.23, 163.09, 164.46; MS m/z (rel. int. %): 371 (M+1, 26), 370 (M^+, 97), 369 (100), 354 (5), 252 (22), 185 (23), 120 (5), 107 (26), 106 (34), 105 (22), 91 (13); Anal. calcd. for $C_{23}H_{22}N_4O$: C, 74.57; H, 5.99; N, 15.12. Found: C, 74.44; H, 6.14; N, 14.95.

1,2,5,6-Tetrahydro-1,4-dimethyl-5-(naphthalen-3-yl-aminomethylene)-6-(E)-(naphthalen-3-yl-imino)-2-oxo-pyridine-3-carbonitrile (**3e**). Yield: 84% (route A); m.p. 292-294˚C; IR (ν_{max}, KBr, cm^{-1}): 3050, 2200, 1640; ^{1}H-NMR (DMSO-d_6): δ 2.44 (3H, s, CH_3), 3.38 (3H, s, CH_3), 7.04 (1H, d, *J*=8.0 Hz, ArH), 7.18 (1H, s, ArH), 7.31-7.57 (4H, m, ArH), 7.73-7.94 (6H, m, ArH), 8.01 (1H, d, *J*=8.0 Hz, ArH), 8.11 (1H, s, ArH), 8.59 (1H, d, *J*=13.0 Hz, =CH-N), 12.99 (1H, d, *J*=13.0 Hz, NH); MS m/z (rel. int. %): 442 (M^+, 100), 441 (M-1, 91), 301 (7), 288 (14), 155 (4),142 (39), 141 (57), 127 (47); Anal. calcd. for $C_{29}H_{22}N_4O$: C, 78.84; H, 4.98; N, 12.49. Found: C, 78.71; H, 5.01; N, 12.66.

6-Azido-1,2-dihydro-1,4-dimethyl-5-(naphthalen-2-yl-iminomethyl)-2-oxo-pyridine-3-carbonitrile (**4**). Yield: 79%; m.p. 174-176˚C; IR (ν_{max}, KBr, cm^{-1}): 3050, 2925, 2220, 2140, 1660; ^{1}H-NMR (DMSO-d_6): δ 2.88 (3H, s, CH_3), 3.45 (3H, s, CH_3), 7.10 (1H, d, *J*=7.0 Hz, ArH), 7.50-7.58 (3H, m, ArH), 7.80 (1H, d, *J*=8.0 Hz, ArH), 7.93 (1H, d, *J*=7.0 Hz, ArH), 8.17 (1H, d, *J*=8.0 Hz, ArH), 8.82 (1H, s, =CH-N); Anal. calcd. for $C_{19}H_{14}N_6O$: C, 66.66; H, 4.12; N, 24.55. Found: C, 66.78; H, 4.28; N, 24.37.

6-Anilino-1,2-dihydro-1,4-dimethyl-2-oxo-5-(Z)-(phenyliminomethyl)-pyridine-3-carbonitrile (**5a**). Yield: 38% (route B) or 73% (route C); m.p. 256-258˚C; IR (ν_{max}, KBr, cm^{-1}): 3250, 3050, 2950, 1645; ^{1}H-NMR, (DMSO-d_6): δ 2.26 (3H, s, CH_3), 3.24 (3H, s, CH_3), 6.76 (1H, d, *J*=8.0 Hz, ArH), 6.84 (1H, d, *J*=8.0 Hz, ArH), 6.94-7.04 (2H, m, ArH), 7.19-7.39 (6H, m, ArH), 8.04 (1H, s, -CH=N-), 9.07 (1H, s, NH); ^{13}C-NMR (DMSO-d_6): δ 20.83, 27.61, 112.21, 113.34, 115.67, 120.08, 121.52, 123.02, 127.62, 128.73, 130.94, 143.78, 146.54, 148.27, 151.84, 161.91, 163.37; MS m/z (rel. int. %): 42 (M^+, 10), 341 (12), 239 (64), 210 (11), 147 (54), 93 (100), 91 (58), 78 (35), 77 (13); Anal. calcd. for $C_{21}H_{18}N_4O$: C, 73.66; H, 5.30; N, 16.36. Found: C, 73.82; H, 5.16; N, 16.27.

1,2-Dihydro-1,4-dimethyl-2-oxo-6-(3-tolylamino)-5-(Z)-(3-tolyliminomethyl)-pyridine-3-carbonitrile (**5b**). Yield: 28% (route B) or 78% (route C); m.p. 288-290˚C; IR (ν_{max}, KBr, cm^{-1}): 3250, 3050, 2900, 2200, 1640; ^{1}H-NMR (DMSO-d_6): δ 2.02 (3H, s, CH_3). 2.24 (3H, s, CH_3), 2.29 (3H, s, CH_3), 3.37 (3H, s, CH_3), 6.59-7.30 (8H, m, ArH), 8.37 (1H, s, -CH=N-), 9.19 (1H, s, NH); Anal. calcd. for $C_{23}H_{22}N_4O$: C, 74.57; H, 5.99; N, 15.12. Found: C, 74.38; H, 5.82; N, 15.01.

6-(3-Chlorophenylamino)-5-(Z)-(3-chlorophenyliminomethyl)-1,2-dihydro-1,4-dimeth-yl-2-oxo-pyridine-3-carbonitrile (**5c**). Yield: 29% (route B) or 73% (route C); m.p. 195-197˚C; IR (ν_{max}, KBr, cm^{-1}): 3250, 3050, 2200, 1640; ^{1}H-NMR (DMSO-d_6): δ 2.31 (3H, s, CH_3), 3.31 (3H, s, CH_3), 6.74-7.41 (8H, m, ArH), 8.13 (1H, s, -CH=N-), 9.26 (1H, s, NH); ^{13}C-NMR (DMSO-d_6): δ 20.88, 27.69, 114.10, 115.65, 117.20, 124.91, 125.93, 127.06, 127.44, 129.02, 129.52, 130.32, 131.06, 134.23, 135.10, 143.38, 145.09, 148.34, 152.30, 161.97, 164.08; MS (70 eV); m/z (rel int. %) 410/414 (M^+, 6), 273 (44), 147 (39), 127 (100); Anal. calcd. for $C_{21}H_{16}Cl_2N_4O$: C, 61.31; H, 3.92; Cl, 17.26; N, 13.62. Found: C, 61.46; H, 4.05; Cl, 17.36; N, 13.49.

1,2-Dihydro-1,4-dimethyl-2-oxo-6-(4-tolylamino)-5-(Z)-(4-tolyliminomethyl)pyridine-3-carbonitrile (**5d**). Yield: 30% (route B) or 72% (route C); m.p. 236-238˚C; IR (ν_{max}, KBr, cm^{-1}): 3250, 3050, 2900, 2200, 1645; ^{1}H-NMR (DMSO-d_6): δ 2.23 (3H, s, CH_3), 2.25 (3H, s, CH_3), 2.27 (3H, s, CH_3), 3.35 (3H, s, CH_3), 6.67 (2H, d, *J*=7.0 Hz, ArH), 6.79 (2H, d, *J*=7.0 Hz, ArH), 7.03 (2H, d, *J*=8.0 Hz, ArH), 7.08 (2H, d, *J*=8.0 Hz, ArH), 8.00 (1H, s, -CH=N-), 9.00 (1H, s, NH); MS m/z (rel. int. %) 370 (M^+, 17), 369 (M-1, 19), 253 (35), 147 (27), 106 (100), 105 (46), 91 (18); Anal. calcd. for $C_{23}H_{22}N_4O$: C, 74.57; H, 5.99; N, 15.12. Found: C, 74.64; H, 5.78; N, 15.01.

Synthesis of 5-arylaminomethylene-1,2,5,6-tetrahydro-6-hydroxyimino-1,4-dimethyl-2-oxo-pyridine-3-carbonitrile (**8a,c**)

A mixture of **3a,c** (1.44 mmol) and hydroxylamine hydrochloride (0.10 g, 1.44 mmol) in MeOH (15 mL) was refluxed for 1 h. After cooling and concentration, the resulting solid products were collected by filtration, washed with a small amount of EtOH, dried and recrystallized from EtOH to afford compounds **8a,c**.

5-Anilinomethylene-1,2,5,6-tetrahydro-6-hydroxyimino-1,4-dimethyl-2-oxo-pyridine-3-carbonitrile (**8a**). Yield: 91%; m.p. 260-262˚C; IR (ν_{max}, KBr, cm^{-1}): 3336, 2220, 1739, 1660; ^{1}H-NMR (DMSO-

d_6): δ 2.28 (3H, s, CH_3), 3.35 (3H, s, CH_3), 7.23-7.63 (5H, m, ArH), 8.46 (1H, d, *J*=20.0 Hz, CH), 11.19 (1H, s, OH), 12.73 (1H, d, *J*=20.0 Hz, NH); Anal. calcd. for $C_{15}H_{14}N_4O_2$: C, 63.82; H, 5.00; N, 19.85. Found: C, 63.75; H, 5.12; N, 19.68.

5-(3-Chlorophenylaminomethylene)-1,2,5,6-tetrahydro-6-hydroxyimino-1,4-dimethyl-2-oxo-pyridine-3-carbonitrile (**8c**). Yield: 82%; m.p. 270-272˚C; IR (ν_{max}, KBr, cm^{-1}): 3370, 2220, 1735, 1660; ^{1}H-NMR (DMSO-d_6): δ 2.29 (3H, s, CH_3), 3.34 (3H, s, CH_3), 7.11-7.84 (4H, m, ArH), 8.43 (1H, d, *J*= 20.0 Hz, CH), 11.18 (1H, s, OH), 12.67 (1H, d, *J*= 20 Hz, NH); MS m/z (rel int. %) 316/318 (M^+, 25), 303 (52), 302 (100), 276 (31), 246 (57), 204 (1), 139 (2), 127 (11). Anal. calcd. for $C_{15}H_{13}ClN_4O_2$: C, 56.87; H, 4.14; Cl, 11.21; N, 17.68. Found: C, 56.74; H, 4.23; Cl, 11.36; N, 17.57.

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