

Fluorescence Properties of Donor Acceptor Chromophores on Newly Synthesized Pyridine-3-Carbonitriles

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Abstract A convenient route was successfully developed for the synthesis of novel heterocycles such as pyridine-3-carbonitriles **4** from chalcone **3** in good yields. The pyridine-3-carbonitrile derivatives synthesized were further studied for their photophysical properties and observed that absorption and emission was changed, due to the chromospheres at C₄-position in phenyl ring and C₂-position in pyridine-3-carbonitrile derivatives.

Keywords Pyridine-3-carbonitriles ·
Absorption and emission · Quantum yield ·
HOMO-LUMO · 3-Acetyl-4-hydroxy quinolone chalcones

Introduction

Promising progress in the development of stable, highly fluorescent candidates are urgently needed for technology upgrading. The polysubstituted pyridine-3-carbonitriles are the most potentially lead molecules to fulfill the cutting edge technology demand. These compounds are used as non-linear optical materials [1], electrical material [2], chelating agents in metal-ligand chemistry as fluorescent liquid crystals [3] and also used in preparation of security papers [4–7]. Fluorescent compounds are widely used as markers in biochemical and nucleic acid technologies and is the subject of intensive investigations [8].

There is increasing interest in the development of efficient fluorescence materials particularly those emitting in the blue

spectral region. These materials are potential candidates for use in optoelectronic devices, such as tunable lasers and amplifiers, optical fibers, switches or modulators with variety of applications in optical communication, photonics, medicine, optical spectroscopy and information display [9–12] e.g. organic electroluminescent devices. A full color display application mainly requires red, green and blue emission, which is more challenging. There are many activities focused on blue emitting OLEDs and wide variety of organic and organometallic compounds have been utilized for this purpose. Only few compounds like distyrylarylene [13] and silyl-substituted ter-(phenylene-vinylene) [14] appeared to be useful. Thus a suitable blue-emitting material with high brightness and good thermal stability still remains to be developed.

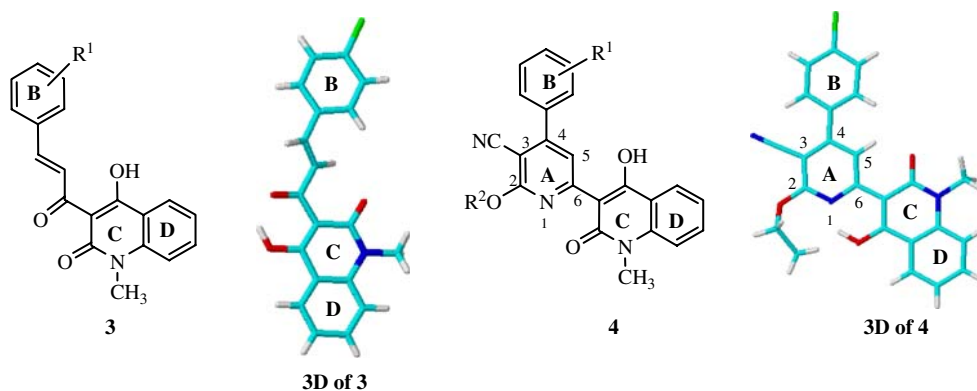
Recently, we have reported the synthesis of highly fluorescent Dipyrazolo [3,4-*b*:3,4-*d*] pyridines (DPP) [15], Pyrazolo[3,4-*b*]-pyrrolo-[2,3-*d*]-pyridines (PPP) [16] and 2,6-Diaryl-4-alkoxy pyridine-carbonitriles [17]. These reports and our ongoing work in this field prompted us to synthesize new pyridine-3-carbonitriles **4**. All these compounds show substituents dependent absorption and emission properties. In present paper we are reporting the effect of donor and acceptor chromospheres at C₄-position in aryl group and the effect of alkoxy group at C₂-position on absorption and emission properties of pyridine 3-carbonitriles shown by 3D picture of **3** and **4** (Fig. 1).

Results and Discussion

The pyridine-3-carbonitriles **4** were synthesized by condensation of chalcones **3** with malononitrile. Chalcones **3** were prepared by literature methods [18, 19]. The reaction of chalcones **3** with malononitrile in various alkoxides in corresponding alcohols furnished pyridine-3-carbonitriles **4** in 65–70% yields. The C₂-alkoxy in pyridine ring was in

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Fig. 1 Molecular modeling of Chalcone **3** and pyridine-3-carbonitrile **4**

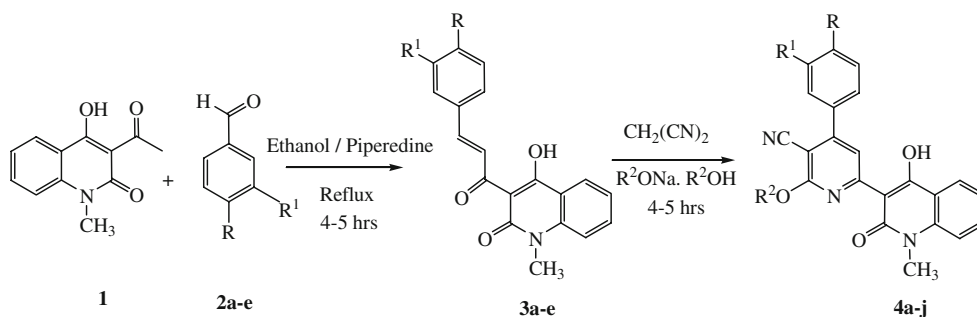


accordance with methyl alcohol or ethyl alcohol used in the reaction (Scheme 1). Compounds **4** were formed by Dimorth rearrangement and disproportionation (Fig. 2) and were characterized by IR, ^1H NMR, and Mass. The IR spectrum of compound **4a** showed the broad band at 3450 cm^{-1} for free OH, the CN appeared at 2250 cm^{-1} and amide carbonyl was observed at 1680 cm^{-1} . The ^1H NMR spectrum of compound **4a** showed characteristic sharp singlet at δ 9.22 for $\text{C}_5\text{-H}$ of pyridine ring. The aromatic protons were appeared as multiplet between δ 7.22–8.26. Two singlets at δ 3.70 and 4.20 were assigned for OCH_3 and N-CH_3 groups. The mass spectrum for pyridine-3-carbonitrile **4a** showed molecular ion peak at 418.0 (60%, $\text{M}+1$). Thermal analysis of **4** by differential scanning calorimetry (DSC) revealed that they are thermally stable compounds up to $350\text{ }^\circ\text{C}$ (Tables 1, 2).

Semi empirical study of **3** and **4**

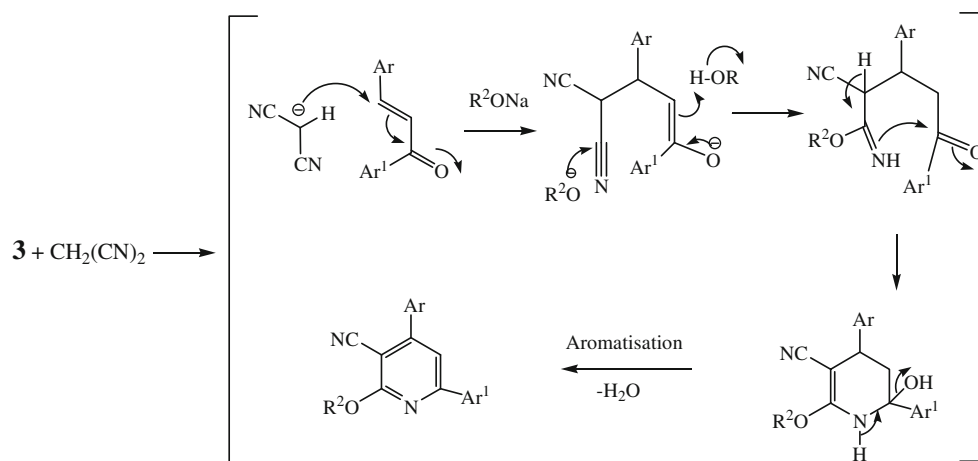
The chalcones **3b** and **3c** having donor group which shows low GAP values and high heat of formation and hence more stability. The compounds **3a** and **3d** are having high GAP values, comparatively low stability and low reactivity. There is more overlapping between the HOMO or LOMO for **3c** and **3b**, which shows high quantum yields (Table 3). The compounds **4c**, **4h**, **4b** and **4g** presented low GAP value, indicating higher overlapping of HOMO or LUMO orbital in these molecules. This is supported by high value of heat of formation. The charge is more concentrated on ring **A** compare to ring **C** and **D**. The donor chromophores on ring **B** is playing important role in increasing electron density of ring **A**. The ring **A** is having strong electron withdrawing CN, which make facile charge delocalization in the

Scheme 1 Synthesis of pyridine-3-carbonitrile **4**



4 a-h	R	R¹	R²
a	Cl	H	CH ₃
b	OMe	H	CH ₃
c	OMe	OMe	CH ₃
d	NO ₂	H	CH ₃
e	H	H	CH ₃
f	Cl	H	CH ₂ CH ₃
g	OMe	H	CH ₂ CH ₃
h	OMe	OMe	CH ₂ CH ₃
i	NO ₂	H	CH ₂ CH ₃
j	H	H	CH ₂ CH ₃

Fig. 2 Mechanism for the formation of pyridine-3-carbonitrile



molecule, increases the stability and reactivity of the molecules and hence shows high quantum yields in these compounds. The HOMO-LUMO calculation of **4a**, **4d** and **4i** having inductively or mesomerically electron withdrawing chromophores increase the GAP values i.e. lower overlapping of atomic orbital (Table 3). This shows low stability (low heat of formation), less charge distribution. Therefore **4a**, **4d** and **4i** shows low quantum yield. It was also found that inductive effect is more predominant than mesomeric effect. These compounds have less stability and hence show low quantum yields. The practical results obtained are in agreement with the HOMO LUMO, Heat of formation obtained by semi empirical PM3/PM6 methods. Compound **4e** shows positive heat formation value, indicated that compound is less stable than other compounds.

Photophysical properties

Quinine sulphate is used as reference standard for the measurement of absorption and emission of compounds **3** and **4**. The results obtained are given in Tables 1, 2. Chalcones **3b** and **3c** having donor chromophores e.g. C₄-OCH₃ and C₃, 4-di-OCH₃ on phenyl ring showed absorption and emission maximum equal to 390, 460 and 395, 475 nm and quantum yields (Φ_F) 0.194 and 0.203 respectively. Compound **3d** having acceptor chromophore e.g. C₄-NO₂ on phenyl ring showed large decrease in absorption and emission maximum equal to 355 and 430 nm and quantum yield (Φ_F) 0.171.

Similarly, pyridine-3-carbonitriles **4b** and **4c** with C₄-OCH₃ and C₃, 4-di-OCH₃ as donor chromophores on phenyl ring and C₂-OCH₃ on pyridine ring showed absorption and emission maximum equal to 391, 440 nm and 392, 460 nm and quantum yields (Φ_F) 0.209, 0.231 respectively. Compound **4d** with acceptor chromophores C₄-NO₂ showed large decrease in absorption and emission maximum equal to 362 and 415 nm and quantum yield (Φ_F)

0.173 (Table 2). The effect of C₂-alkoxy group on pyridine-3-carbonitrile in compound **4a** and **4f** having C₂-OCH₃ and C₂-OCH₂CH₃ groups showed absorption and emission maximum equal to 362, 470 nm and 370, 485 nm and the quantum yields (Φ_F) 0.188 and 0.191 respectively. Further, other C₂-substituents e.g. -OCH₂CH₂CH₃, -O(CH₂)₄CH₃, -O(CH₂)₇CH₃ of pyridine-3-carbonitriles **4** showed absorption and emission maximum nearly equal to the values obtained for C₂-OCH₂CH₃ group. This indicating that bulky alkoxy group at C₂-position does not affect the photophysical properties of pyridine-3-carbonitriles. The qualitative and quantitative screening of **4a**, **4f**, **4g** and **4h** under fluorescent lamp is shown in Fig. 3.

Conclusion

The reactions reported here represent the synthesis of new class of fluorescent heterocyclic polysubstituted pyridine-3-carbonitriles having donor-acceptor chromophores to exhibit photophysical properties and high quantum yield (Φ_F). The donor chromophores e.g. C₄-OCH₃ and C₃, 4-diOCH₃ show absorption and emission maximum to red shift (bathochromic shift). While in the case of acceptor chromophore C₄-NO₂ the absorption and emission maximum showed to blue shift (hypsochromic shift).

Table 1 The Photophysical data for electronic absorption (*Abs.*) and fluorescence (*Flu.*) of Chalcone (α , β -unsaturated ketones) **3** measured for 0.1 M Conc. in CHCl₃

3	R	R ¹	λ_{Abs} (CHCl ₃)	λ_{Fu} (CHCl ₃)	Φ_F
a	Cl	H	361	450	0.182
b	OMe	H	390	460	0.194
c	OMe	OMe	395	475	0.203
d	NO ₂	H	355	430	0.171
e	H	H	371	460	0.180

Table 2 The Photophysical data for electronic absorption (*Abs.*) and fluorescence (*Flu.*) of pyridine-3-carbonitrile **4a-j** measured for 0.1 M Conc. in CHCl₃

4a-j	Ar	R ²	λ _{Abs} (CHCl ₃)	λ _{Flu} (CHCl ₃)	Φ _F
4a	<i>p</i> -ClC ₆ H ₄	CH ₃	362	480	0.188
4b	<i>p</i> -OMeC ₆ H ₄	CH ₃	391	440	0.209
4c	<i>3,4-di</i> -OMeC ₆ H ₃	CH ₃	392	460	0.231
4d	<i>p</i> -NO ₂ C ₆ H ₄	CH ₃	362	415	0.173
4e	C ₆ H ₅	CH ₃	370	455	0.184
4f	<i>p</i> -ClC ₆ H ₄	CH ₂ CH ₃	370	485	0.191
4g	<i>p</i> -OMeC ₆ H ₄	CH ₂ CH ₃	390	460	0.216
4h	<i>3,4-di</i> -OMeC ₆ H ₃	CH ₂ CH ₃	394	470	0.226
4i	<i>p</i> -NO ₂ C ₆ H ₄	CH ₂ CH ₃	369	420	0.183
4j	C ₆ H ₅	CH ₂ CH ₃	390	460	0.186

Experimental

General

Melting points were determined on a Gallenkamp melting point apparatus, Mod. MFB595 in open capillary tubes and are uncorrected. ¹H and ¹³C NMR Spectra were recorded on Varian XL-300 spectrometer (300 MHz). Chemical shifts are reported in ppm from internal tetramethylsilane standard and are given δ units. The solvents for NMR spectra were deuterio-chloroform (CDCl₃). Infrared spectra were taken on Shimadzu FTIR-408, instrument in potassium bromide pellets. UV spectra were recorded on a Shimadzu UV-1601 UV-VIS Spectrophotometer. Fluorescence spectra were recorded using RF-5301 PC Spectrofluorophotometer. Compounds for UV and fluorescence measurements were dissolved in chloroform. UV and fluorescence scan were recorded from 200 to 600 nm. Elemental analyses were

performed on a Hosli CH-Analyzer and are within ± 0.3 of the theoretical percentage. High-resolution mass spectra were obtained with a Mat 112 Varian Mat Bremen (70 eV) mass spectrometer. Solutions were concentrated on a rotary evaporated under reduced pressure. All reactions were monitored by thin layer chromatography, carried out on 0.2 mm silica gel 60 F₂₅₄ (Merck) plates using UV light (254 and 366 nm) for detection. Common reagents grade chemicals are either commercially available and were used without further purification or prepared by standard literature procedures. The GAMESS software is used for HOMO-LUMO, Heat of formation etc. by semi empirical PM3/PM6 methods.

General procedure for synthesis of Pyridine-3-carbonitrile (**4**)

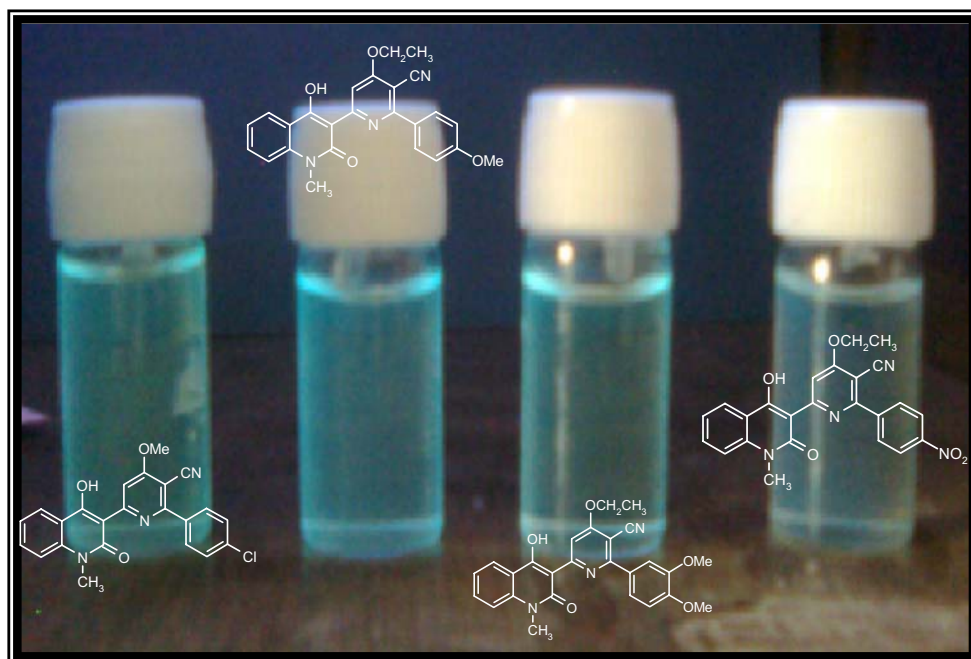
A mixture of chalcone **3** (0.01mole), malononitrile (0.01 mole, 0.66 g), in methanol/ethanol (10 ml) and sodium

Table 3 The molecular electronic properties (HOMO-LUMO energy, GAP) of the pyridine-3-carbonitriles (**4a-j**) and its precursors (**3a-e**)

Compd.	Ar	R ²	Heat of Formation (K CAL.)	Ionization Potential	HOMO	LUMO	GAP
3a	<i>p</i> -ClC ₆ H ₄	–	–70.11	9.209	–9.209	–1.298	10.50
3b	<i>p</i> -OMeC ₆ H ₄	–	–85.73	8.594	–8.594	–1.120	9.71
3c	<i>3,4-di</i> OMeC ₆ H ₃	–	–136.24	8.432	–8.433	–1.129	9.56
3d	<i>p</i> -NO ₂ C ₆ H ₄	–	–50.25	9.549	–9.549	–1.486	11.03
3e	C ₆ H ₅	–	–59.99	9.128	–9.129	–1.181	10.31
4a	<i>p</i> -ClC ₆ H ₄	CH ₃	–7.74	9.267	–9.268	–1.327	10.59
4b	<i>p</i> -OMeC ₆ H ₄	CH ₃	–38.85	8.844	–8.844	–1.172	10.01
4c	<i>3,4-di</i> OMeC ₆ H ₃	CH ₃	–79.90	8.362	–8.363	–1.253	9.61
4d	<i>p</i> -NO ₂ C ₆ H ₄	CH ₃	–2.592	9.432	–9.433	–1.510	10.94
4e	C ₆ H ₅	CH ₃	2.390	9.183	–9.184	–1.243	10.42
4f	<i>p</i> -ClC ₆ H ₄	CH ₂ CH ₃	–20.57	9.315	–9.315	–1.284	10.46
4g	<i>p</i> -OMeC ₆ H ₄	CH ₂ CH ₃	–52.08	8.827	–8.828	–1.172	10.00
4h	<i>3,4-di</i> OMeC ₆ H ₃	CH ₂ CH ₃	–87.68	8.340	–8.341	–1.231	9.57
4i	<i>p</i> -NO ₂ C ₆ H ₄	CH ₂ CH ₃	–15.40	9.437	–9.437	–1.484	10.92
4j	C ₆ H ₅	CH ₂ CH ₃	–10.73	9.244	–9.244	–1.229	10.47

GAP = $E_{LUMO} - E_{HOMO}$

Fig. 3 “Hits” identified by the qualitative and subsequent quantitative screening of the Fluorescence under fluorescence lamp: of compound **4a**, **4g**, **4h** and **4i** respectively



alkoxide, (prepared from sodium metal 50 mg, 0.02 mole in 5 ml absolute methanol /ethanol) was refluxed for 4–5 h. (TLC check, n-hexane: ethylacetate 8:2) After cooling reaction mixture was stirred in ice-cold water (50 mL). The product was then extracted with chloroform (3 × 30 mL). The organic layer was dried over sodium sulphate, evaporated under reduced pressure. The obtained solid product was purified on column using n-hexane and ethyl acetate (8:2 v/v) as eluent to afford **4** in 50–60% yields.

4-(4-Chlorophenyl)-2-methoxy-6-(1,2-dihydro-4-hydroxyl-1-methyl-2-oxoquinolin-3-yl)-pyridine-3-carbonitrile (4a)
Yield: 2.10 g, (50%), pale yellow prism m.p. 211–212 °C. IR (KBr): 3450 m, 2250 s, 1680 s, 1560 s, 1310 m, cm^{-1} . ^1H NMR (CDCl_3): δ 3.70 (s, 3H, N- CH_3), 4.20(s, 3H, OCH_3), 7.22–8.26(m, 8H, Ar-H), 9.22(s, 1H, Ar-H). MS (70 eV): m/z 418.0(M+1). Anal.Calcd for $\text{C}_{23}\text{H}_{16}\text{ClN}_3\text{O}_3$ (418.0): C, 66.11; H, 3.86; N, 10.06. Found C, 66.32; H, 4.02; N,10.12.

4-(4-Methoxyphenyl)-2-methoxy-6-(1,2-dihydro-4-hydroxyl-1-methyl-2-oxoquinolin-3-yl)-pyridine-3-carbonitrile (4b)
Yield: 2.0 g, (55%), pale yellow prism, m.p. 224–225 °C. IR (KBr): 3500 m, 2240 s, 1670 s, 1450 m, 1300 m, cm^{-1} . ^1H NMR (CDCl_3): δ 3.80(s, 3H, N- CH_3), 4.05(s, 3H, OCH_3), 4.20(s, 3H, OCH_3), 7.22–8.40 (m, 8H, Ar-H), 9.20 (s, 1H, Ar-H). MS(70 eV): m/z 413.0(M+1). Anal.Calcd for $\text{C}_{24}\text{H}_{19}\text{N}_3\text{O}_4$ (413.0): C, 69.72; H, 4.63; N, 10.16. Found C, 69.65; H, 4.52; N, 10.23.

4-(3,4-Dimethoxyphenyl)-2-methoxy-6-(1,2-dihydro-4-hydroxyl-1-methyl-2-oxoquinolin-3-yl)-pyridine-3-carbonitrile

(*4c*) Yield: 2.30 g, (60%), pale yellow prism m.p. 214–216 °C. IR (KBr): 3460 m, 2236 s, 1678 s, 1454 m, 1302 m, cm^{-1} . ^1H NMR (CDCl_3): δ 3.70(s, 3H, N- CH_3), 3.90, 4.05, 4.15(s, 6H, 2 × OCH_3), 4.15(s, 3H, OCH_3), 6.90–8.30(m, 7H, Ar-H), 9.10(s, 1H, Ar-H). MS(70 eV): m/z 444.0(M+1). Anal.Calcd for $\text{C}_{25}\text{H}_{21}\text{N}_3\text{O}_5$ (444.0): C, 66.18; H, 4.59; N, 10.07. Found C, 66.15; H, 4.62; N, 10.23.

4-(4-Nitrophenyl)-2-methoxy-6-(1,2-dihydro-4-hydroxyl-1-methyl-2-oxoquinolin-3-yl)-pyridine-3-carbonitrile (4d)
Yield: 2.10 g, (55%), pale yellow prism, m.p. 201–203 °C. IR (KBr): 3490 s, 2240 s, 1680 s, 1500 m, 1310 s, cm^{-1} . ^1H NMR (CDCl_3): δ 3.80(s, 3H, N- CH_3), 4.10(s, 3H, OCH_3), 6.80–8.20(m, 8H, Ar-H), 9.02(s, 1H, Ar-H). MS(70 eV): m/z 430.0(M+1). Anal.Calcd for $\text{C}_{23}\text{H}_{16}\text{N}_4\text{O}_5$: C, 64.48; H, 3.76; N, 13.08. Found C, 64.65; H, 3.62; N, 13.23.

4-(4-Phenyl)-2-methoxy-6-(1,2-dihydro-4-hydroxyl-1-methyl-2-oxoquinolin-3-yl)-pyridine-3-carbonitrile (4e)
Yield: 1.88 g, (55%), pale yellow prism, m.p. 188–189 °C. IR (KBr): 3360 s, 2241 s, 1670 s, 1485 m, 1296 s, cm^{-1} . ^1H NMR (CDCl_3): δ 3.44(s, 3H, N- CH_3), 4.17(s, 3H, OCH_3), 7.13–8.16(m, 9H, Ar-H), 8.97(s, 1H, Ar-H). Anal.Calcd for $\text{C}_{23}\text{H}_{17}\text{N}_3\text{O}_3$: C, 72.05; H, 4.47; N, 10.96. Found C, 71.82; H, 4.34; N, 11.23.

4-(4-Chlorophenyl)-2-ethoxy-6-(1,2-dihydro-4-hydroxyl-1-methyl-2-oxoquinolin-3-yl)pyridine-3-carbonitrile (4f)
Yield: 2.20 g, (50%), pale yellow prism m.p. 211–212 °C. IR (KBr): 3450br, 2250 s, 1680 s, 1560 m, 1280 m, cm^{-1} . ^1H NMR (CDCl_3): δ 1.50(t, 3H, J = 6.8 Hz, CH_3); 3.70(s, 3H,

N-CH₃), 4.40(q, 2H, J = 6.8 Hz, OCH₂), 7.22–8.20(m, 8H, Ar-H), 9.22(s, 1H, Ar-H). MS(70 eV): m/z 433.0(M+1). Anal.Calcd for C₂₄H₁₈ClN₃O₃(433.0): C, 66.75; H, 4.20; N, 9.73. Found C, 66.62; H, 4.02; N, 9.52.

4-(4-Methoxyphenyl)-2-ethoxy-6-(1,2-dihydro-4-hydroxy-1-methyl-2-oxoquinolin-3-yl)pyridine-3-carbonitrile (4g)
Yield: 2.45 g, (60%), pale yellow prism, m.p. 224–225 °C. IR (KBr): 3500br, 2230 s, 1670 s, 1450 m, 1330 m, cm.⁻¹ ¹H NMR (CDCl₃): δ 1.60(t, 3H, J = 6.7 Hz, CH₃), 3.80(s, 3H, N-CH₃), 3.90(s, 3H, OCH₃), 4.20(q, 2H, J = 6.7 Hz, OCH₂), 7.22–8.40(m, 8H, Ar-H), 9.20(s, 1H, Ar-H). MS(70 eV): m/z 428.0(M+1). Anal.Calcd for C₂₅H₂₁N₃O₄(428.0): C, 70.25; H, 4.95; N, 9.83. Found C, 70.32; H, 4.88; N, 10.02.

4-(4-Dimethoxyphenyl)-2-ethoxy-6-(1,2-dihydro-4-hydroxy-1-methyl-2-oxoquinolin-3-yl)pyridine-3-carbonitrile (4h)
Yield: 2.20 g, (50%), pale yellow prism m.p. 311–312 °C. IR (KBr): 3400br, 2245 s, 1690 m, 1480 m, 1320 m, cm.⁻¹ ¹H NMR (CDCl₃): δ 1.75(t, 3H, J = 6.7 Hz, CH₃), 3.70(s, 3H, N-CH₃), 3.90–4.05(s, 6H, 2 x OCH₃), 4.15(q, 2H, J = 6.7 Hz, CH₂), 6.90–8.30(m, 7H, Ar-H), 9.10(s, 1H, Ar-H). MS(70 eV): m/z 458.0(M+1). Anal.Calcd for C₂₆H₂₃N₃O₅(458.0): C, 68.26; H, 5.07; N, 9.19. Found C, 68.88; H, 5.17; N, 9.23.

4-(4-Nitrophenyl)-2-ethoxy-6-(1,2-dihydro-4-hydroxy-1-methyl-2-oxoquinolin-3-yl)pyridine-3-carbonitrile (4i)
Yield: 2.40 g, (55%), pale yellow prism, m.p. 201–203 °C. IR (KBr): 3490br, 2240 s, 1680 s, 1500 m, 1310 m, cm.⁻¹ ¹H NMR (CDCl₃): δ 1.80(t, 3H, J = 6.6 Hz, CH₃), 3.80(s, 3H, N-CH₃), 4.14(q, 2H, J = 6.6 Hz, CH₂), 6.80–8.20(m, 8H, Ar-H), 9.00(s, 1H, Ar-H). MS (70 eV): m/z 443.0(M+1). Anal. Calcd for C₂₄H₁₈N₄O₅(443.0): C, 65.15; H, 4.10; N, 12.66. Found C, 65.20; H, 4.22; N, 12.42.

4-(4-Phenyl)-2-ethoxy-6-(1,2-dihydro-4-hydroxy-1-methyl-2-oxoquinolin-3-yl)pyridine-3-carbonitrile (4j) Yield: 1.60 g, (50%), pale yellow prism, m.p. 196–197 °C. IR (KBr): 3440br, 2232 s, 1675 s, 1514 m, 1302 m, cm.⁻¹ ¹H NMR (CDCl₃): δ 2.10(t, 3H, J = 6.7 Hz, CH₃), 3.46(s, 3H, N-CH₃), 4.52(q, 2H, J = 6.7 Hz, CH₂), 7.20–8.14(m, 9H, Ar-H), 9.10(s, 1H, Ar-H). Anal.Calcd for C₂₄H₁₉N₃O₃(397.43): C, 72.53; H, 4.82; N, 10.57. Found C, 72.44; H, 4.62; N, 10.42.

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References

- Kambara T, Koshida K, Sato N, Kuwajima I, Kubota K, Yamamoto T, (1992) Preparation and properties of highly electron-accepting poly (pyrimidine-2, 5-diyl), Chem. Lett 583–586
- Meyer TJ (1989) Chemical approaches to artificial photosynthesis. Acc Chem Res 22:1636
- Pavluchenko AI, Petrov VF, Smirnova NI (1995) Liquid crystalline 2, 5-disubstituted pyridine derivatives. Liq Cryst 19:811–821
- Basta AH, Giris AS, El HS (2002) Fluorescence behavior of new 3-pyridinecarbonitrile containing compounds and their application in security paper. Dyes Pigm 54:1–10
- Kricka LJ (1992) Nonisotopic DNA probe techniques. Academic, New York
- Symons RH (1989) Nucleic acid probes. CRC
- Connolly BA, Newman PC (1989) Synthesis and properties of oligonucleotides containing 4-thiothymidine, 5-methyl-2-pyrimidinone-1-β-D(2'-dexoyriboside) and 2-thiothymidine. Nucleic Acids Res 17:4957–4971
- Bloor HD (1991) Organic material for nonlinear optics II, (eds) Royal Society of Chemistry, Cambridge, UK
- Kanbara H, Asode M, Kubidera K, Kaino T (1992) Appl Phys Lett 21:2292
- Durate FJ (1994) Solid-state multiple-prism grating dye-laser oscillators. Appl Opt 33:3857
- Tang CW, VanSlyke SA (1987) Organic electroluminescent diodes. Appl Phys Lett 51:913
- Burroughs JH, Bradley DDC, Brown AR, Marks RN, Mackey K, Friend RH, Burns PL, Holmes AB (1990) Solid C60: a new form of carbon. Nature 347:539
- Hosokawa C, Higashi H, Nakamura H, Kusumoto T (1995) Highly efficient blue electroluminescence from a distyrylarylene emitting layer with a new dopant. Appl Phys Lett 67:3853
- Gao ZQ, Lee CS, Bello I, Lee ST, Chen RM, Luh TY, Shri J, Tang CW (1999) Bright-blue electroluminescence from a silyl-substituted ter- (phenylene–vinylene) derivative. Appl Phys Lett 74:865
- Kendre DB, Toche RB, Jachak MN (2007) Synthesis of novel Dipyrzolo [3, 4-b: 3, 4-d] pyridines and study of their fluorescence behavior. Tetrahedron 63:11000
- Ghotekar BK, Kazi MA, Toche RB, Jachak MN (2008) Effect of substituents on absorption and fluorescence properties of pyrazolo [3, 4-b] pyrrolo [2, 3-d]pyridines. Can J Chem 86:1070–1076
- Jachak MN, Bagul SM, Ghotekar BK, Toche RB (2009) Synthesis and study of fluorescence behavior of 3-pyridinecarbonitrile. Montash Chem 140(6):655–662
- Abbas M (2000) Chemistry of substituted quinolinones, Part II synthesis of novel 4-pyrazolylquinolinone derivatives. Synth Commun 30(15):2735–2757
- Ibrahim SS, Allimony HA, Othman ES (1997) Chem Papers 51:33