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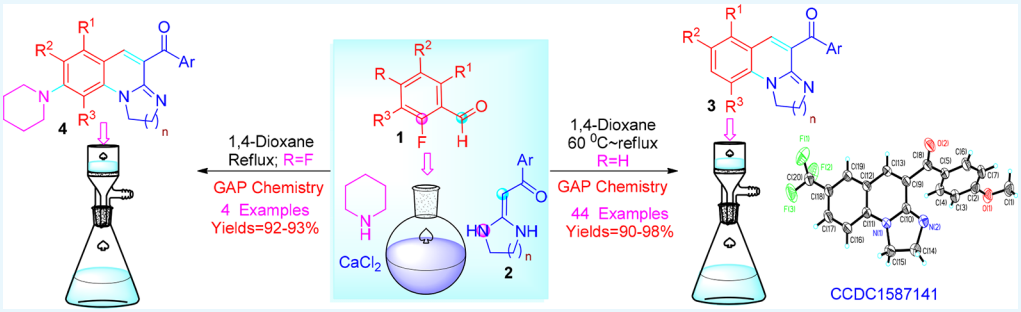
Facile Route to the Synthesis of 1,3-Diazahetero-Cycle-Fused [1,2-*a*]Quinoline Derivatives via Cascade Reactions

Liang Chen, Rong Huang, Ling-Bin Kong, Jun Lin,* and Sheng-Jiao Yan*

Key Laboratory of Medicinal Chemistry for Natural Resource (Yunnan University), Ministry of Education, School of Chemical Science and Technology, Yunnan University, Kunming 650091, P. R. China

Supporting Information



ABSTRACT: A one-step protocol without transition-metal catalysts with simple post-treatment for the synthesis of 1,3-diazaheterocycle-fused [1,2-*a*]quinoline derivatives via the cascade reaction of 2-fluorobenzaldehyde (**1**) and heterocyclic ketene aminals (**2**) was developed. In the one-step cascade reaction, C═C and C−N bonds were constructed, and the targeted compound can be efficiently obtained by filtering without column chromatography. This protocol describes a valuable route to concisely and feasibly obtain 1,3-diazaheterocycle-fused [1,2-*a*]quinoline derivatives. The synthetic methodology is particularly attractive because of the following features: low-cost solvent, mild temperature, atom economy, high yield, and potential biological activity of the product.

INTRODUCTION

One of the most important aspects of modern chemical synthesis is that it is necessary to develop methods with a low environmental impact.[1−4] The United States Environmental Protection Agency (EPA) defined the "green chemistry" concept as "the design of chemical products and processes that reduce or eliminate the use or generation of hazardous substances".[5] In the green chemistry field, the ideal synthesis[6,7] should be a combination of a number of environmental, health, safety, and economic factors. Among them, group-assisted purification[8−10] chemistry allows the synthesis of organic compounds without using traditional purification technologies, including column chromatography and recrystallization. This technology makes more efforts to find environmentally benign reagents and reactions so as to reduce the waste generated from silica and solvents, particularly toxic solvents.

Quinolines is an important class of well-known heterocyclic scaffolds; they are embedded in many biological systems and have interesting applications in agriculture, materials, chemical industry, and medicine, for instance, as antimalarial (Figure 1, quinine),[11,12] anticancer (Figure 1, camptothecin),[13] antibacterial,[14,15] insecticide (Figure 1, quinclorac), and so forth.[16−18] Consequently, various methods of synthesis of quinolines have been reported.[19−27] Among them, the transition-metal-catalyzed C−H bond or N−H bond activation approaches have provided numerous strategies for the synthesis of quinoline.[28−32]

Heterocyclic ketene aminals (HKAs) have been widely used as a type of versatile building blocks to construct various fused heterocyclic compounds including quinolones,[33,34] isoquinolin-1-imine,[35] indoles,[36] indolin-2-ones,[37,38] isocoumarins,[39] pyridines,[40−42] pyrroles, and so forth[43−47] Many of these compounds have a wide variety of biological activities, such as antitumor,[48−51] herbicidal, pesticidal,[52,53] antileishmanial,[54] and antibacterial.[55,56] Therefore, it is vital and urgent to develop a green synthetic methodology with benign conditions and straight-forward post-treatment for the synthesis of quinoline derivatives by construction of C═C and C−N bonds through the one-step cascade reaction.

Here, we describe a cascade strategy for the regioselective convergent synthesis of a series of 1,3-diazaheterocycle-fused [1,2-*a*]quinoline derivatives (**3**−**4**). To the best of our knowledge, the synthesis of the polycyclic[1,2-*a*]quinoline derivatives by the cascade reaction of 2-fluorobenzaldehyde **1** and HKAs **2** (Scheme 1) has not been reported to date.

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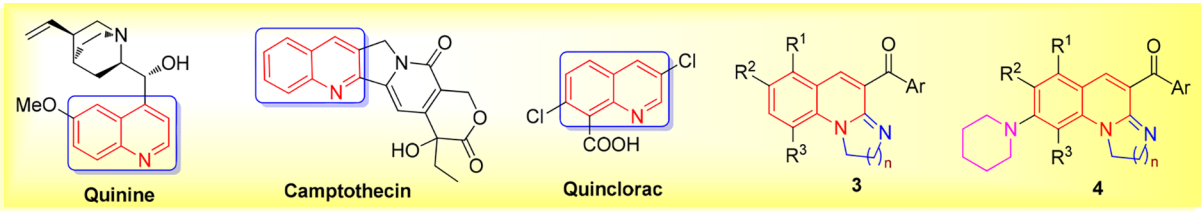
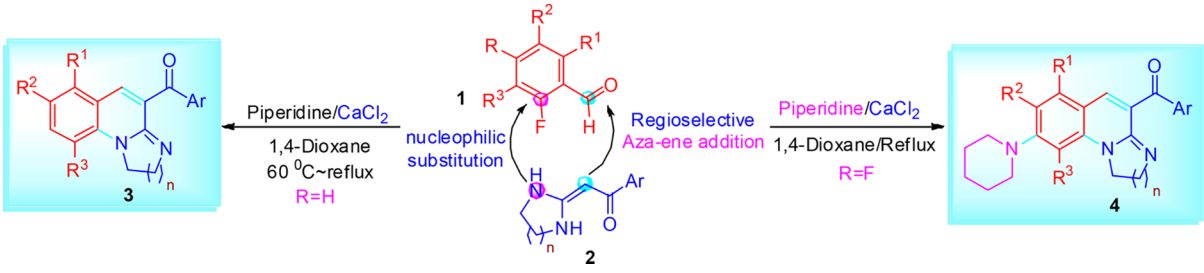


Figure 1. Biological activity of quinolines and the targeted compounds.

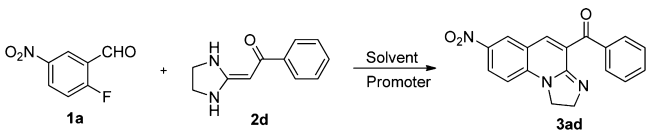
Scheme 1. Strategy for the Cascade Reaction Synthesis of [1,2-*a*]Quinolines 3 and 4



RESULTS AND DISCUSSION

In this work, we developed a one-pot protocol to synthesize a series of polycyclic quinoline derivatives. To obtain the optimal reaction conditions for the synthesis of 1,3-diazaheterocycle-fused [1,2-*a*]quinoline **3ad**, the reaction of 2-fluoro-5-nitrobenzaldehyde (**1a**) with HKA (**2d**) was chosen as the model reaction. First, the reaction mixture of **1a** with **2d** was ground under catalyst-free and solvent-free conditions at room temperature (Table 1, entry 1). Then, the reaction temperature reached the melting point of **1a** (mp 60 °C), (Table 1, entry 2), and the results showed that the reaction can proceed nonselectively to yield many byproducts. The solvent-free condition is a disadvantage to the reaction, and we cannot obtain a pure product. Subsequently, by performing the reaction in the stoichiometric amount of base, such as K_2CO_3, *t*-BuOK, Cs_2CO_3, Et_3N, and piperidine in the aprotic solvent 1,4-dioxane at reflux (Table 1, entries 3−7), the results revealed that piperidine was the optimal catalyst for this selective synthesis of [1,2-*a*]quinoline **3ad** with an excellent yield (91%) (Table 1, entry 7). Afterward, we screened several aprotic solvents, including acetonitrile (CH_3CN), tetrahydrofuran (THF), *N*,*N*-dimethylformamide (DMF), or the protonic solvents ethanol and water (Table 1, entries 8−12). The results indicated that the most suitable solvent for this defluorinaton and cyclization reaction was 1,4-dioxane. Next, we screened the temperature and found that the optimal temperature was 60 °C. In the postprocessing stage, after the reaction solution was cooled and filtered, we observed the hydrofluoric acid salt of piperidine mixed in the products. Considering the environmental hazards, we added $CaCl_2$ to absorb the hydrofluoric acid produced by the defluorination reaction with piperidine as a catalyst. Unexpectedly, the product **3ad** was obtained with a 97% yield (Table 1, entries 14) when the time of reaction was shortened to 30 min. Ultimately, the optimal reaction conditions for preparation of **3ad** were 1,4-dioxane as the solvent, with piperidine and $CaCl_2$ as promoters, at 60 °C for 30 min.

Table 1. Optimized Conditions for the Synthesis of [1,2-*a*]Quinoline 3ad[a]



entry	solvent	promoter	*T* (°C)	time (h)	yield[b] (%)
1			rt	0.5	n.r.
2			60	0.5	trace
3	1,4-dioxane	K_2CO_3	reflux	2	23
4	1,4-dioxane	**Cs_2CO_3**	reflux	2	21
5	1,4-dioxane	*t*-BuOK	reflux	2	19
6	1,4-dioxane	Et_3N	reflux	2	75
7	1,4-dioxane	piperidine	reflux	2	91
8	acetonitrile	piperidine	reflux	2	54
9	THF	piperidine	reflux	3	68
10	DMF	piperidine	110	2	40
11	EtOH	piperidine	reflux	2	90
12	H_2O	piperidine	reflux	5	14
13	1,4-dioxane	piperidine	60	2	92
14	1,4-dioxane	**piperidine/$CaCl_2$**	**60**	**0.5**	**97**

[a]Reaction conditions: **1a** (1.1 mmol), **2d** (1.0 mmol), promoter (1.5 mmol), solvent (15 mL). [b]Isolated yield based on HKA **2d**. n.r. = no reaction.

With the optimized conditions at hand, we explored the scope and limitations of the reactions involving different 2-fluorobenzaldehydes (**1a**−**1c**) with various HKAs (**2a**−**2p**) (Table 2, entries 1−44). For HKAs **2**, the electron-withdrawing groups (Cl or Br) on the aromatic ring could accelerate the reaction rate, otherwise the electron-donating groups (CH_3 or CH_3O) were the opposite because of the influence of the substituting groups on the electrophilicity of the α-C of HKAs **2** (Scheme 1). Unexpectedly, the reaction rate showed that Cl > Br > H > **F** > CH_3 > OCH_3, which maybe attributed to the intermolecular hydrogen bonding of fluorineon HKAs (**2a** & **2h**) with the diamino group of piperidine. Moreover, the size of the diazaheterocycle of HKAs **2** showed that the five-membered ring provided the highest yields, and then the six-membered and seven-membered rings (e.g., Table 2, entries 2 vs 9 vs 15). Additionally, when the different groups (R_1 = NO_2, CF_3, and F) were introduced into the C5 position of 2-fluorobenzaldehyde **1**, the yields of **3** decreased (e.g., Table 2, entries 4, 20 & 34) as

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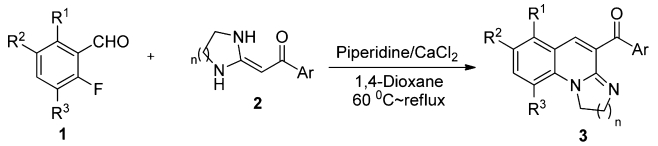
Table 2. Cascade Reaction Synthesis of [1,2-*a*]Quinoline Derivatives 3[a]



entry	1 ($R^1/R^2/R^3$)	2 (n/Ar)	T (°C)	time (h)	3	yield[b] (%)
1	**1a** (H/NO_2/H)	**2a** (1/4-FC_6H_4)	60	0.5	**3aa**	94
2	**1a** (H/NO_2/H)	**2b** (1/4-ClC_6H_4)	60	0.5	**3ab**	98
3	**1a** (H/NO_2/H)	**2c** (1/4-BrC_6H_4)	60	0.5	**3ac**	97
4	**1a** (H/NO_2/H)	**2d** (1/C_6H_5)	60	0.5	**3ad**	97
5	**1a** (H/NO_2/H)	**2e** (1/4-MeC_6H_4)	60	0.5	**3ae**	95
6	**1a** (H/NO_2/H)	**2f** (1/4-$MeOC_6H_4$)	60	0.5	**3af**	93
7	**1a** (H/NO_2/H)	**2g** (1/thiophene-2-yl)	60	0.5	**3ag**	92
8	**1a** (H/NO_2/H)	**2h** (2/4-FC_6H_4)	60	0.5	**3ah**	94
9	**1a** (H/NO_2/H)	**2i** (2/4-ClC_6H_4)	60	0.5	**3ai**	96
10	**1a** (H/NO_2/H)	**2j** (2/4-BrC_6H_4)	60	0.5	**3aj**	95
11	**1a** (H/NO_2/H)	**2k** (2/C_6H_5)	60	0.5	**3ak**	96
12	**1a** (H/NO_2/H)	**2l** (2/4-MeC_6H_4)	60	0.5	**3al**	92
13	**1a** (H/NO_2/H)	**2m** (2/4-$MeOC_6H_4$)	60	0.5	**3am**	91
14	**1a** (H/NO_2/H)	**2n** (2/thiophene-2-yl)	60	0.5	**3an**	91
15	**1a** (H/NO_2/H)	**2o** (3/4-ClC_6H_4)	60	0.5	**3ao**	93
16	**1a** (H/NO_2/H)	**2p** (3/4-MeC_6H_4)	60	0.5	**3ap**	92
17	**1b** (H/CF_3/H)	**2a** (1/4-FC_6H_4)	75	1	**3ba**	95
18	**1b** (H/CF_3/H)	**2b** (1/4-ClC_6H_4)	75	1	**3bb**	97
19	**1b** (H/CF_3/H)	**2c** (1/4-BrC_6H_4)	75	1	**3bc**	97
20	**1b** (H/CF_3/H)	**2d** (1/C_6H_5)	75	1	**3bd**	95
21	**1b** (H/CF_3/H)	**2e** (1/4-MeC_6H_4)	75	1	**3be**	92
22	**1b** (H/CF_3/H)	**2f** (1/4-$MeOC_6H_4$)	75	1	**3bf**	92
23	**1b** (H/CF_3/H)	**2g** (1/thiophene-2-yl)	75	1	**3bg**	93
24	**1b** (H/CF_3/H)	**2h** (2/4-FC_6H_4)	75	1	**3bh**	94
25	**1b** (H/CF_3/H)	**2i** (2/4-ClC_6H_4)	75	1	**3bi**	96
26	**1b** (H/CF_3/H)	**2j** (2/4-BrC_6H_4)	75	1	**3bj**	95
27	**1b** (H/CF_3/H)	**2k** (2/C_6H_5)	75	1	**3bk**	95
28	**1b** (H/CF_3/H)	**2l** (2/4-MeC_6H_4)	75	1	**3bl**	94
29	**1b** (H/CF_3/H)	**2m** (2/4-$MeOC_6H_4$)	75	1	**3bm**	93
30	**1b** (H/CF_3/H)	**2n** (2/thiophene-2-yl)	75	1	**3bn**	92
31	**1c** (F/F/F)	**2a** (1/4-FC_6H_4)	reflux	2	**3ca**	93
32	**1c** (F/F/F)	**2b** (1/4-ClC_6H_4)	reflux	2	**3cb**	95
33	**1c** (F/F/F)	**2c** (1/4-BrC_6H_4)	reflux	2	**3cc**	94
34	**1c** (F/F/F)	**2d** (1/C_6H_5)	reflux	2	**3cd**	94
35	**1c** (F/F/F)	**2e** (1/4-MeC_6H_4)	reflux	2	**3ce**	92
36	**1c** (F/F/F)	**2f** (1/4-$MeOC_6H_4$)	reflux	2	**3cf**	93
37	**1c** (F/F/F)	**2g** (1/thiophene-2-yl)	reflux	2	**3cg**	92
38	**1c** (F/F/F)	**2h** (2/4-FC_6H_4)	reflux	2	**3ch**	92
39	**1c** (F/F/F)	**2i** (2/4-ClC_6H_4)	reflux	2	**3ci**	95
40	**1c** (F/F/F)	**2j** (2/4-BrC_6H_4)	reflux	2	**3cj**	95
41	**1c** (F/F/F)	**2k** (2/C_6H_5)	reflux	2	**3ck**	94
42	**1c** (F/F/F)	**2l** (2/4-MeC_6H_4)	reflux	2	**3cl**	92
43	**1c** (F/F/F)	**2m** (2/4-$MeOC_6H_4$)	reflux	2	**3cm**	90
44	**1c** (F/F/F)	**2n** (2/thiophene-2-yl)	reflux	2	**3cn**	91

[a]Conditions: **1** (1.1 mmol) and **2** (1.0 mmol) were heated in the solvent 1,4-dioxane (15 mL) with piperidine (1.5 mmol) and $CaCl_2$ (0.5 mmol) as catalysts. [b]Isolated yield based on HKAs **2**.

the electron-withdrawing ability of the substituent groups decreased (NO_2 > CF_3 > F). The starting material 2-fluorobenzaldehyde **1** bearing a moderately electron-withdrawing group (such as F, **1c**) had difficulty to react with HKAs **2**, unless the reaction was carried out under reflux conditions and $CaCl_2$ was indispensable. We conjectured that, for 2-fluorobenzaldehyde **1**, the strong electron-withdrawing substituent group at the C5 position could facilitate the removal of the fluorine atom at the C2 position. At the same time, this leads to the enhancement of the electrophilicity of the formyl group at the C1 position, which benefits the attack with ketocarbonyl at the α-C position of HKAs **2**.

Furthermore, when 2,3,4,5,6-pentafluorobenzaldehyde **1d** reacted with the five-membered ring HKAs **2**, we synthesized a new product **4**, which had the piperidine as the substituent (Table 3, entries 1−4). The possible reason is that the electron-

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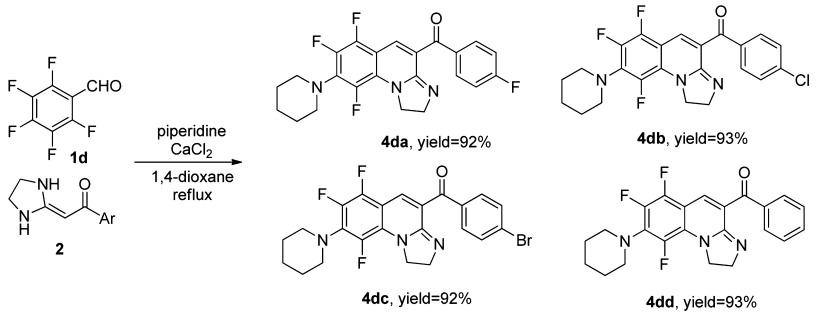
Table 3. Cascade Reaction Synthesis of [1,2-*a*]Quinoline Derivatives 4[a,b]



[a]Conditions: **1** (1.1 mmol) and **2** (1.0 mmol) were heated in the solvent 1,4-dioxane (15 mL) with piperidine (1.5 mmol) and $CaCl_2$ (0.5 mmol) as catalysts. [b]Isolated yield based on HKAs **2**.

withdrawing formyl group at the C1 position of **1d** makes the fluorine atom at the C4 position to be easily replaced by piperidine. The reaction was performed under reflux for 6 h, and that was more difficult than the synthesis of compounds **4**. Unfortunately, the six-membered and seven-membered rings HKAs **2** could not react with **1d**.

The chemical structures of polycyclic quinoline derivatives **3** and **4** were fully characterized by Fourier transform infrared (FTIR), proton nuclear magnetic resonance (^{1}H NMR), carbon-13 nuclear magnetic resonance (^{13}C NMR), and high-resolution mass spectroscopy (HRMS) spectral analysis. To further verify the structure of the target products, **3bf** was selected as a representative compound and unequivocally confirmed by X-ray diffraction analysis, as shown in Figure 2 (CCDC 1587141).

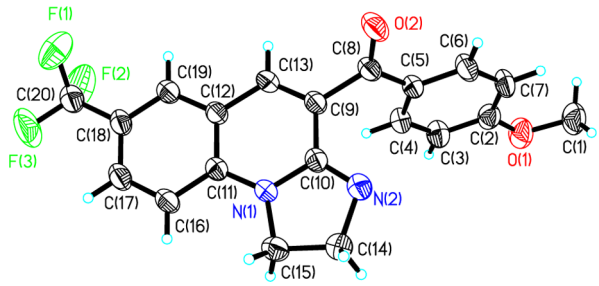
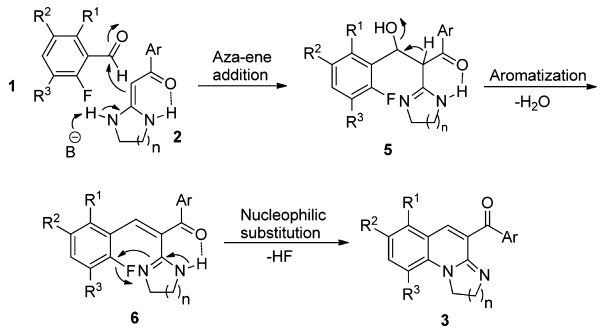


Figure 2. ORTEP diagram of **3bf**; ellipsoids are drawn at the 30% probability level.

A proposed mechanism for synthesis of 1,3-diazaheterocycle-fused [1,2-*a*]quinoline derivatives **3** by the cascade reaction of 2-fluorobenzaldehyde **1** and HKAs **2** is presented in Scheme 2.

Scheme 2. Mechanism Hypotheses for the Synthesis of Target Compounds 3



First, HKAs **2**, with a strong electron-withdrawing keto-carbonyl at the *α*-position and two electron-donating diamino groups on the diazaheterocycle, can serve as a nucleophilic component to react with the electrophilic formyl group of 2-fluorobenzaldehyde **1** to form the intermediate **5** via an aza−ene addition. Then, the intermediate **5** is converted into intermediate **6** via aromatization and results in the formation of one C=C bond. Thereafter, intramolecular nucleophilic substitution of fluorine intermediate **6** produces the target products **3**. The outcome of the cascade reaction is one C=C bond, one C−N bond, and one diazaheterocycle-fused ring.

To testify this mechanism, we perform the reaction in 1,4-dioxane at 60 °C promoted by piperidine and $CaCl_2$ for about 10 min, and the mixture was cooled to room temperature. Then, the reaction mixture was injected in high-performance liquid chromatography−HRMS system. The molecular ion peak appeared in high-resolution mass spectrometry (HRMS (TOF ES$^+$) *m*/*z*: calcd for $C_{18}H_{15}FN_3O_3$ [M + H]$^+$, 340.1092; found, 340.1089) (see the Supporting Information, which is the HRMS spectra of compound **6**). On the basis of the results, we believe that the proposed mechanism is reasonable.

CONCLUSIONS

To summarize, we developed a method for the efficient synthesis of 1,3-diazaheterocycle-fused [1,2-*a*]quinoline derivatives via one-step cyclization of 2-fluorobenzaldehyde **1** and HKAs **2**. This is a concise, rapid, and environmentally friendly method to prepare [1,2-*a*]quinoline derivatives without extra post-treatment. The reaction has some attractive features, including simple and mild conditions, atom economy, and operational simplicity. Moreover, these series of bicyclic[1,2-*a*]quinolines may possess potential biological activities for use in medical treatment of diseases. Our future investigations will be aimed at discovering in vitro biological activities of compounds **3** and **4**.

EXPERIMENTAL SECTION

General Methods. All received reagents and solvents were used without further purification unless otherwise stated. Melting points were determined on an XT-4A melting point apparatus and were uncorrected. NMR spectra were recorded on Bruker DRX300 (^{1}H: 300 MHz, ^{13}C: 75 MHz), Bruker DRX400 (^{1}H: 400 MHz, ^{13}C: 100 MHz), Bruker DRX500 (^{1}H: 500 MHz, ^{13}C: 125 MHz), and Bruker DRX600 (^{1}H: 600 MHz, ^{13}C: 150 MHz) instruments with DMSO-d_6 and $CDCl_3$ as the solvents. The chemical shifts (δ) are expressed in parts per million relative to the residual deuterated solvent signal,

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and coupling constants (J) are given in hertz. IR spectra were recorded on an FT-IR Thermo Nicolet Avatar 360 instrument using KBr pellets. HRMS (electrospray ionization) was performed on an Agilent LC/MSD TOF instrument.

All received reagents and solvents were used without further purification unless otherwise stated. The materials (**1a−d**) were purchased from Aldrich Corporation Limited. HKAs **2** were prepared according to a procedure described in the literature.[39,40] The structure of HKAs **2** was confirmed by ^{1}H NMR, ^{13}C NMR, and HRMS spectra.

General Procedure for the Synthesis of Compounds 3−4. A mixture of 2-fluorobenzaldehyde **1** (1.1 mmol), HKAs **2** (1.0 mmol), and piperidine (1.5 mmol) is mixed by stirring at different temperatures (**1a** as starting material, the temperature of the reaction was 60 °C; **1b** was 75 °C; **1c** and **1d** at reflux) in 1,4-dioxane (15 mL). When the solution of the reaction was clear, $CaCl_2$ (0.5 mmol) was added. After completion of the reaction, as indicated by thin-layer chromatography (CH_2Cl_2−EtOAc, 1:10 v/v), the mixture was cooled to room temperature and filtered. The solid was then washed with a small amount of ethanol (ca. 5 mL) and dissolved in $CHCl_3$ (20 mL). Then, the organic phase was washed with saturated salt water (25 mL) and $NaHCO_3$ (25 mL), dried over anhydrous Na_2SO_4, concentrated, and petroleum ether was added for recrystallization to obtain the pure product **3** or **4**.

*4-(4′-Fluorophenyl)methanoneyl-7-nitro-1,2-dihydroimidazo[1,2-a]quinoline (**3aa**).* Yellow solid, mp 229−230 °C; IR (KBr): 3438, 1636, 1613, 1517, 1330, 1263, 1154, 853 cm^{-1}; ^{1}H NMR (300 MHz, DMSO-d_6) (δ, ppm): 3.88−3.95 (m, 2H, CH_2N), 4.01−4.08 (m, 2H, NCH_2), 6.98 (d, J = 9.3 Hz, 1H, ArH), 7.35 (t, J = 8.9 Hz, 2H, ArH), 7.80 (s, 1H, CH), 7.97−8.02 (m, 2H, ArH), 8.24−8.28 (m, 1H, ArH), 8.45 (d, J = 2.4 Hz, 1H, ArH); ^{13}C NMR (75 MHz, DMSO-d_6) (δ, ppm): 45.5, 53.5, 112.4, 115.8 (d, J = 21.8 Hz), 119.1, 124.9, 127.2, 129.4, 132.4, 132.6 (d, J = 9.8 Hz), 136.2, 139.5, 143.9, 152.8, 165.4 (d, J = 251.3 Hz), 190.9; HRMS (TOF ES$^+$) m/z: calcd for $C_{18}H_{13}FN_3O_3$ [M + H], 338.0935; found, 338.0935.

*4-(4′-Chlorophenyl)methanoneyl-7-nitro-1,2-dihydroimidazo[1,2-a]quinoline (**3ab**).* Yellow solid, mp 273−274 °C; IR (KBr): 2938, 1635, 1610, 1330, 1265, 1093, 871 cm^{-1}; ^{1}H NMR (300 MHz, DMSO-d_6) (δ, ppm): 3.92−3.95 (m, 2H, CH_2N), 4.02−4.05 (m, 2H, NCH_2), 7.00 (d, J = 9.0 Hz, 1H, ArH), 7.59 (d, J = 8.4 Hz, 2H, ArH), 7.84 (s, 1H, CH), 7.91 (d, J = 8.7 Hz, 2H, ArH), 8.26−8.29 (m, 1H, ArH), 8.48 (d, J = 2.7 Hz, 1H, ArH); ^{13}C NMR (75 MHz, DMSO-d_6) (δ, ppm): 45.5, 53.4, 112.5, 119.1, 125.1, 127.3, 128.8, 129.1, 131.4, 134.4, 136.8, 138.8, 139.6, 143.9, 152.8, 191.3; HRMS (TOF ES$^+$) m/z: calcd for $C_{18}H_{13}N_3O_3Cl$ [M + H], 354.0640; found, 354.0638.

*4-(4′-Bromophenyl)methanoneyl-7-nitro-1,2-dihydroimidazo[1,2-a]quinoline (**3ac**).* Yellow solid, mp 281−282 °C; IR (KBr): 3439, 2938, 1636, 1613, 1325, 1264, 1091, 868 cm^{-1}; ^{1}H NMR (300 MHz, DMSO-d_6) (δ, ppm): 3.89−3.95 (m, 2H, CH_2N), 4.02−4.09 (m, 2H, NCH_2), 7.01 (d, J = 9.0 Hz, 1H, ArH), 7.74 (d, J = 8.7 Hz, 2H, ArH), 7.83 (d, J = 6.9 Hz, 2H, ArH), 7.84 (s, 1H, CH), 8.27−8.31 (m, 1H, ArH), 8.49 (d, J = 2.4 Hz, 1H, ArH); ^{13}C NMR (75 MHz, DMSO-d_6) (δ, ppm): 45.5, 53.5, 112.5, 119.1, 125.1, 127.3, 128.1, 129.1, 131.4, 131.8, 134.8, 136.7, 139.6, 144.0, 152.8, 191.6; HRMS (TOF ES$^+$) m/z: calcd for $C_{18}H_{13}N_3O_3Br$ [M + H], 398.0134; found, 398.0137.

*4-(Phenyl)methanoneyl-7-nitro-1,2-dihydroimidazo[1,2-a]quinoline (**3ad**).* Yellow solid, mp 284−285 °C; IR (KBr): 3439, 2927, 1635, 1592, 1325, 1262, 1094, 729 cm^{-1}; ^{1}H NMR (300 MHz, DMSO-d_6) (δ, ppm): 3.90−3.96 (m, 2H, CH_2N), 4.03−4.09 (m, 2H, NCH_2), 7.01 (d, J = 9.3 Hz, 1H, ArH), 7.54 (t, J = 7.5 Hz, 2H, ArH), 7.69 (t, J = 7.4 Hz, 1H, ArH), 7.80 (s, 1H, CH), 7.91 (d, J = 7.5 Hz, ArH), 8.27−8.30 (m, 1H, ArH), 8.48 (d, J = 2.4 Hz, 1H, ArH); ^{13}C NMR (75 MHz, DMSO-d_6) (δ, ppm): 50.8, 58.8, 117.7, 124.4, 130.2, 132.4, 134.0, 134.8, 135.0, 139.2, 140.9, 141.1, 144.8, 149.2, 158.1, 197.7; HRMS (TOF ES$^+$) m/z: calcd for $C_{18}H_{14}N_3O_3$ [M + H], 320.1029; found, 320.1029.

*4-(p-Tolyl)methanoneyl-7-nitro-1,2-dihydroimidazo[1,2-a]quinoline (**3ae**).* Yellow solid, mp 283−284 °C; IR (KBr): 3439, 2935, 1657, 1635, 1610, 1517, 1325, 1288, 1264, 1090, 870 cm^{-1}; ^{1}H NMR (300 MHz, DMSO-d_6) (δ, ppm): 2.39 (s, 3H, CH_3), 3.92−3.95 (m, 2H, CH_2N), 4.02−4.05 (m, 2H, NCH_2), 7.00 (d, J = 9.0 Hz, 1H, ArH), 7.34 (d, J = 7.8 Hz, 2H, ArH), 7.75 (s, 1H, CH), 7.80 (d, J = 7.8 Hz, 2H, ArH), 8.27 (d, J = 8.7 Hz, 1H, ArH), 8.47 (s, 1H, ArH); ^{13}C NMR (75 MHz, DMSO-d_6) (δ, ppm): 21.2, 45.5, 53.5, 112.3, 119.1, 124.8, 127.0, 129.3, 129.7, 129.9, 133.1, 135.5, 139.5, 143.8, 144.6, 152.8, 191.9; HRMS (TOF ES$^+$) m/z: calcd for $C_{19}H_{16}N_3O_3$ [M + H], 334.1186; found, 334.1186.

*4-(4′-Methoxyphenyl)methanoneyl-7-nitro-1,2-dihydroimidazo[1,2-a]quinoline (**3af**).* Yellow solid, mp 260−261 °C; IR (KBr): 1651, 1613, 1592, 1330, 1260, 1172, 585 cm^{-1}; ^{1}H NMR (300 MHz, DMSO-d_6) (δ, ppm): 3.85 (s, 3H, OCH_3), 3.89−3.96 (m, 2H, CH_2N), 4.03−4.09 (m, 2H, NCH_2), 7.00 (d, J = 9.3 Hz, 1H, ArH), 7.05 (d, J = 8.7 Hz, 2H, ArH), 7.72 (s, 1H, CH), 7.88 (d, J = 8.7 Hz, 2H, ArH), 8.25−8.29 (m, 1H, ArH), 8.46 (d, J = 2.4 Hz, 1H, ArH); ^{13}C NMR (75 MHz, DMSO-d_6) (δ, ppm): 45.5, 53.5, 55.6, 112.3, 114.0, 119.2, 124.7, 126.9, 128.4, 130.1, 132.0, 135.0, 139.5, 143.7, 152.9, 163.8, 190.7; HRMS (TOF ES$^+$) m/z: calcd for $C_{19}H_{16}N_3O_4$ [M + H], 350.1135; found, 350.1132.

*4-(Thiophen-2′-yl)methanoneyl-7-nitro-1,2-dihydroimidazo[1,2-a]quinoline (**3ag**).* Orange solid, mp 274−275 °C; IR (KBr): 3076, 2975, 1641, 1589, 1410, 1324, 1262, 1054, 742 cm^{-1}; ^{1}H NMR (300 MHz, DMSO-d_6) (δ, ppm): 3.97−4.00 (m, 2H, CH_2N), 4.04−4.06 (m, 2H, NCH_2), 7.00 (d, J = 9.0 Hz, 1H, ArH), 7.25−7.28 (m, 1H, CH), 7.86 (s, 1H, CH), 7.89−7.90 (m, 1H, CH), 8.14−8.16 (m, 1H, CH), 8.26−8.30 (m, 1H, ArH), 8.48 (d, J = 2.4 Hz, 1H, ArH); ^{13}C NMR (75 MHz, DMSO-d_6) (δ, ppm): 45.6, 53.5, 112.4, 119.0, 125.0, 127.3, 129.0, 135.7, 136.6, 136.9, 139.5, 142.5, 143.9, 152.5, 184.1; HRMS (TOF ES$^+$) m/z: calcd for $C_{16}H_{12}N_3O_3S$ [M + H], 326.0593; found, 326.0595.

*5-(4′-Fluorophenyl)methanoneyl-8-nitro-2,3-dihydro-1H-pyrimido[1,2-a]quinoline (**3ah**).* Yellow solid, mp 224−225 °C; IR (KBr): 2934, 1634, 1596, 1508, 1327, 1277, 907, 585 cm^{-1}; ^{1}H NMR (300 MHz, DMSO-d_6) (δ, ppm): 1.90−1.92 (m, 2H, CH_2), 3.27−3.31 (m, 2H, CH_2N), 3.97−3.99 (m, 2H, NCH_2), 7.30−7.42 (m, 3H, ArH), 7.63 (s, 1H, CH), 7.95−8.00 (m, 2H, ArH), 8.25−8.29 (m, 1H, ArH), 8.44 (d, J = 2.4 Hz, 1H, ArH); ^{13}C NMR (75 MHz, DMSO-d_6) (δ, ppm): 19.3, 42.9, 44.4, 112.4, 115.8 (d, J = 22.5 Hz), 119.5, 124.2, 125.8, 130.8, 132.2 (d, J = 9.8 Hz), 132.7, 136.2, 140.4, 145.1, 146.7, 165.2 (d, J = 250.5 Hz), 192.5; HRMS (TOF ES$^+$) m/z: calcd for $C_{19}H_{15}N_3O_3F$ [M + H], 352.1091; found, 352.1088.

*5-(4′-Chlorophenyl)methanoneyl-8-nitro-2,3-dihydro-1H-pyrimido[1,2-a]quinoline (**3ai**).* Yellow solid, mp 272−273 °C; IR (KBr): 2928, 1662, 1640, 1324, 1277, 1094, 899, 834 cm^{-1}; ^{1}H NMR (300 MHz, DMSO-d_6) (δ, ppm): 1.86−1.90 (m, 2H, CH_2), 3.25−3.28 (m, 2H, CH_2N), 3.92−3.96 (m, 2H, NCH_2),

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7.36 (d, J = 9.3 Hz, 1H, ArH), 7.59 (s, 1H, CH), 7.70 (d, J = 8.7 Hz, 2H, ArH), 7.89 (d, J = 8.4 Hz, 2H, ArH), 8.24−8.28 (m, 1H, ArH), 8.42 (d, J = 2.7 Hz, 1H, ArH); ^{13}C NMR (75 MHz, DMSO-d_6) (δ, ppm): 19.4, 43.1, 44.3, 112.1, 119.4, 124.2, 125.8, 128.8, 130.3, 130.9, 134.7, 136.7, 138.4, 140.2, 145.3, 146.5, 193.0; HRMS (TOF ES$^+$) m/z: calcd for $C_{19}H_{15}N_3O_3Cl$ [M + H], 368.0796; found, 368.0795.

*5-(4′-Bromophenyl)methanoneyl-8-nitro-2,3-dihydro-1H-pyrimido[1,2-a]quinoline (**3aj**).* Yellow solid, mp 264−265 °C; IR (KBr): 2966, 1653, 1613, 1326, 1273, 743 cm^{-1}; ^{1}H NMR (300 MHz, DMSO-d_6) (δ, ppm): 1.86−1.90 (m, 2H, CH_2), 3.25−3.28 (m, 2H, CH_2N), 3.92−3.96 (m, 2H, NCH_2), 7.36 (d, J = 9.3 Hz, 1H, ArH), 7.59 (s, 1H, CH), 7.70 (d, J = 8.7 Hz, 2H, ArH), 7.81 (d, J = 8.4 Hz, 2H, ArH), 8.24−8.28 (m, 1H, ArH), 8.42 (d, J = 2.7 Hz, 1H, ArH); ^{13}C NMR (75 MHz, DMSO-d_6) (δ, ppm): 19.4, 43.1, 44.3, 112.1, 119.5, 124.2, 125.8, 127.6, 130.3, 131.0, 131.8, 135.1, 136.7, 140.3, 145.3, 146.5, 193.2; HRMS (TOF ES$^+$) m/z: calcd for $C_{19}H_{15}N_3O_3Br$ [M + H], 412.0291; found, 412.0291.

*5-(Phenyl)methanoneyl-8-nitro-2,3-dihydro-1H-pyrimido-[1,2-a]quinoline (**3ak**).* Yellow solid, mp 285−286 °C; IR (KBr): 2954, 2849, 1640, 1595, 1324, 1277, 1095, 904, 718 cm^{-1}; ^{1}H NMR (300 MHz, DMSO-d_6) (δ, ppm): 1.88 (m, 2H, CH_2), 3.27 (m, 2H, CH_2N), 3.95 (m, 2H, NCH_2), 7.37 (d, J = 9.3 Hz, 1H, ArH), 7.51 (t, J = 7.5 Hz, 2H, ArH), 7.56 (s, 1H, CH), 7.64 (t, J = 7.1 Hz, 1H, ArH), 7.90 (d, J = 7.5 Hz, ArH), 8.27−8.25 (m, 1H, ArH), 8.42 (s, 1H, ArH); ^{13}C NMR (75 MHz, DMSO-d_6) (δ, ppm): 19.4, 43.1, 44.3, 112.1, 119.5, 124.1, 125.6, 128.7, 129.1, 129.8, 133.6, 135.9, 137.2, 140.3, 145.2, 146.5, 194.0; HRMS (TOF ES$^+$) m/z: calcd for $C_{19}H_{16}N_3O_3$ [M + H], 334.1186; found, 334.1186.

*5-(p-Tolyl)methanoneyl-8-nitro-2,3-dihydro-1H-pyrimido-[1,2-a]quinoline (**3al**).* Yellow solid, mp 282−283 °C; IR (KBr): 2959, 1642, 1595, 1323, 1277, 1093, 904 cm^{-1}; ^{1}H NMR (300 MHz, DMSO-d_6) (δ, ppm): 1.86−1.89 (m, 2H, CH_2), 2.37 (s, 3H, CH_3), 3.26−3.29 (m, 2H, CH_2N), 3.92−3.96 (m, 2H, NCH_2), 7.30 (d, J = 8.1 Hz, 2H, ArH), 7.35 (d, J = 9.3 Hz, 1H, ArH), 7.51 (s, 1H, CH), 7.78 (d, J = 8.1 Hz, 2H, ArH), 8.22−8.26 (m, 1H, ArH), 8.40 (d, J = 2.7 Hz, 1H, ArH); ^{13}C NMR (75 MHz, DMSO-d_6) (δ, ppm): 19.4, 21.2, 43.1, 44.3, 112.0, 119.5, 124.0, 125.6, 129.2, 129.2, 129.5, 133.5, 137.4, 140.2, 144.1, 145.2, 146.4, 193.5; HRMS (TOF ES$^+$) m/z: calcd for $C_{20}H_{18}N_3O_3$ [M + H], 348.1342; found, 348.1341.

*5-(4′-Methoxyphenyl)methanoneyl-8-nitro-2,3-dihydro-1H-pyrimido[1,2-a]quinoline (**3am**).* Yellow solid, mp 221−222 °C; IR (KBr): 2934, 1641, 1595, 1328, 1277, 1162, 986 cm^{-1}; ^{1}H NMR (300 MHz, DMSO-d_6) (δ, ppm): 1.87−1.90 (m, 2H, CH_2), 3.27−3.30 (m, 2H, CH_2N), 2.83 (s, 3H, OCH_3), 3.92−3.96 (m, 2H, NCH_2), 7.02 (d, J = 8.7 Hz, 2H, ArH), 7.35 (d, J = 9.3 Hz, 1H, ArH), 7.49 (s, 1H, CH), 7.85 (d, J = 8.7 Hz, 2H, ArH), 8.22−8.26 (m, 1H, ArH), 8.40 (d, J = 2.7 Hz, 1H, ArH); ^{13}C NMR (75 MHz, DMSO-d_6) (δ, ppm): 19.4, 43.1, 44.3, 55.6, 112.0, 113.9, 119.6, 123.9, 125.5, 128.9, 129.2, 131.6, 137.5, 140.2, 145.2, 146.4, 163.4, 192.4; HRMS (TOF ES$^+$) m/z: calcd for $C_{20}H_{18}N_3O_4$ [M + H], 364.1291; found, 364.1293.

*5-(Thiophen-2′-yl)methanoneyl-8-nitro-2,3-dihydro-1H-pyrimido[1,2-a]quinoline (**3an**).* Yellow solid, mp 224−225 °C; IR (KBr): 2960, 1645, 1594, 1511, 1329, 1279, 1054, 737 cm^{-1}; ^{1}H NMR (300 MHz, DMSO-d_6) (δ, ppm): 1.89−1.92 (m, 2H, CH_2), 3.31−3.35 (m, 2H, CH_2N), 3.92−3.96 (m, 2H, NCH_2), 7.20−7.23 (m, 1H, CH), 7.34 (d, J = 9.3 Hz, 1H, ArH), 7.58 (s, 1H, CH), 7.77−7.79 (m, 1H, CH), 8.05−8.07 (m, 1H, CH), 8.22−8.40 (m, 1H, ArH), 8.40 (d, J = 2.7 Hz, 1H, ArH); ^{13}C NMR (75 MHz, DMSO-d_6) (δ, ppm): 19.4, 43.1, 44.4, 112.0, 119.4, 124.2, 125.8, 128.9, 129.7, 135.5, 135.8, 136.6, 140.2, 143.1, 145.3, 146.1, 186.1; HRMS (TOF ES$^+$) m/z: calcd for $C_{17}H_{14}N_3O_3S$ [M + H], 340.0750; found, 340.0752.

*6-(4′-Chlorophenyl)methanoneyl-9-nitro-1,2,3,4-tetrahydro-[1,3]diazepino[1,2-a]quinoline (**3ao**).* Yellow solid, mp 232−233 °C; IR (KBr): 2930, 1657, 1626, 1597, 1340, 1285, 1087, 840 cm^{-1}; ^{1}H NMR (300 MHz, DMSO-d_6) (δ, ppm): 1.78 (m, 2H, CH_2), 2.04−2.07 (m, 2H, CH_2), 3.62−3.66 (m, 2H, CH_2N), 4.11−4.15 (m, 2H, NCH_2), 7.38 (d, J = 9.3 Hz, 1H, ArH), 7.56 (d, J = 8.7 Hz, 2H, ArH), 7.62 (s, 1H, CH), 7.90 (d, J = 8.4 Hz, 2H, ArH), 8.22−8.26 (m, 1H, ArH), 8.45 (d, J = 2.7 Hz, 1H, ArH); ^{13}C NMR (75 MHz, DMSO-d_6) (δ, ppm): 23.6, 25.0, 47.2, 49.2, 112.8, 120.0, 124.1, 125.6, 128.8, 130.6, 130.8, 134.8, 137.0, 138.2, 140.1, 146.9, 148.5, 192.9; HRMS (TOF ES$^+$) m/z: calcd for $C_{20}H_{17}ClN_3O_3$ [M + H], 382.0953; found, 382.0952.

*6-(p-Tolyl)methanoneyl-9-nitro-1,2,3,4-tetrahydro-[1,3]-diazepino[1,2-a]quinoline (**3ap**).* Yellow solid, mp 236−237 °C; IR (KBr): 1663, 1636, 1594, 1500, 1486, 1327, 1265, 1206, 1090, 861, 819 cm^{-1}; ^{1}H NMR (300 MHz, DMSO-d_6) (δ, ppm): 1.79 (m, 2H, CH_2), 2.04−2.08 (m, 2H, CH_2), 3.63−3.66 (m, 2H, CH_2N), 4.11−4.15 (m, 2H, NCH_2), 7.31 (d, J = 8.1 Hz, 1H, ArH), 7.37 (d, J = 9.3 Hz, 2H, ArH), 7.54 (s, 1H, CH), 7.79 (d, J = 8.1 Hz, 2H, ArH), 8.21−8.25 (m, 1H, ArH), 8.43 (d, J = 2.7 Hz, 1H, ArH); ^{13}C NMR (75 MHz, DMSO-d_6) (δ, ppm): 21.2, 23.6, 25.1, 47.2, 49.2, 112.8, 120.2, 123.9, 125.3, 129.1, 129.2, 129.7, 133.5, 137.8, 140.0, 143.9, 146.8, 148.5, 193.5; HRMS (TOF ES$^+$) m/z: calcd for $C_{21}H_{20}N_3O_3$ [M + H], 362.1499; found, 362.1500.

*4-(4′-Fluorophenyl)methanoneyl-7-(trifluoromethyl)-1,2-dihydroimidazo[1,2-a]quinoline (**3ba**).* Yellow solid, mp 198−199 °C; IR (KBr): 3438, 1663, 1636, 1599, 1386, 1336, 1207, 1155, 1115, 1077, 998, 859, 610 cm^{-1}; ^{1}H NMR (300 MHz, DMSO-d_6) (δ, ppm): 3.85−3.93 (m, 2H, CH_2N), 3.98−4.04 (m, 2H, NCH_2), 7.01 (d, J = 8.7 Hz, 1H, ArH), 7.30−7.38 (m, 2H, ArH), 7.72 (s, 1H, CH), 7.72−7.76 (dd, J_1 = 9.0 Hz, J_2 = 1.8 Hz, 1H, ArH), 7.92 (d, J = 1.5 Hz, 1H, ArH), 7.94−8.01 (m, 2H, ArH); ^{13}C NMR (75 MHz, DMSO-d_6) (δ, ppm): 45.3, 53.3, 112.5, 115.8 (d, J_2 = 21.8 Hz), 119.3, 119.8−120.7 (m), 124.4 (d, J_1 = 269.3 Hz), 126.4, 128.2, 129.0, 132.5 (d, J_3 = 9.8 Hz), 136.3, 142.1, 153.2, 165.3 (d, J_1 = 251.3 Hz), 191.2; HRMS (TOF ES$^+$) m/z: calcd for $C_{19}H_{13}N_2OF_4$ [M + H], 361.0958; found, 361.0958.

*4-(4′-Chlorophenyl)methanoneyl-7-(trifluoromethyl)-1,2-dihydroimidazo[1,2-a]quinoline (**3bb**).* Yellow solid, mp 232−233 °C; IR (KBr): 3442, 1661, 1635, 1580, 1334, 1206, 1159, 1112, 1076, 997, 840, 519 cm^{-1}; ^{1}H NMR (500 MHz, DMSO-d_6) (δ, ppm): 3.87−3.91 (m, 2H, CH_2N), 3.98−4.02 (m, 2H, NCH_2), 7.02 (d, J = 8.6 Hz, 1H, ArH), 7.59 (d, J = 8.3 Hz, 2H, ArH), 7.75 (s, 1H, ArH), 7.76 (s, 1H, ArH), 7.90 (d, J = 8.5 Hz, 2H, ArH), 7.94 (s, 1H, ArH); ^{13}C NMR (125 MHz, DMSO-d_6) (δ, ppm): 45.7, 53.7, 112.9, 119.6, 120.5 (d, J_2 = 32.5 Hz), 124.8 (d, J_1 = 270.0 Hz), 126.9, 128.8, 129.1, 129.2, 131.7, 135.1, 137.2, 139.1, 142.6, 153.6, 192.0; HRMS (TOF ES$^+$) m/z: calcd for $C_{19}H_{13}N_2OF_3Cl$ [M + H], 377.0663; found, 377.0664.

*4-(4′-Bromophenyl)methanoneyl-7-(trifluoromethyl)-1,2-dihydroimidazo[1,2-a]quinoline (**3bc**).* Yellow solid, mp 237−238 °C; IR (KBr): 1662, 1635, 1582, 1399, 1334, 1206, 1159, 1111, 1075, 996, 837, 765 cm^{-1}; ^{1}H NMR (400 MHz, $DCCl_3$) (δ, ppm): 4.22−4.27 (t, J = 12.2 Hz, 2H, CH_2N), 4.35−4.42 (t,

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J = 12.4 Hz, 2H, NCH_2), 7.04 (d, J = 11.2 Hz, 1H, ArH), 7.66 (s, 1H, CH), 7.82 (m, 2H, ArH), 7.85−7.88 (m, 2H, ArH), 8.02 (d, J = 10.0 Hz, 2H, ArH); ^{13}C NMR (125 MHz, $DCCl_3$) (δ, ppm): 45.8, 53.9, 111.9, 119.2, 122.5 (m), 125.3, 126.7, 128.6, 129.0, 129.2, 131.4, 131.9, 134.9, 138.1, 142.0, 154.0, 191.5; HRMS (TOF ES$^+$) m/z: calcd for $C_{19}H_{13}N_2OF_3Br$ [M + H], 421.0157; found, 421.0158.

*4-(Phenyl)methanoneyl-7-(trifluoromethyl)-1,2-dihydroimidazo[1,2-a]quinoline (**3bd**).* Yellow solid, mp 212−213 °C; IR (KBr): 1666, 1635, 1578, 1387, 1333, 1204, 1160, 1117, 1073, 996, 817, 519 cm^{-1}; ^{1}H NMR (300 MHz, DMSO-d_6) (δ, ppm): 3.85−3.92 (m, 2H, CH_2N), 3.98−4.05 (m, 2H, NCH_2), 7.02 (d, J = 8.7 Hz, 1H, ArH), 7.51−7.56 (m, 2H, ArH), 7.67 (d, J = 7.2 Hz, 1H, ArH), 7.71 (s, 1H, CH), 7.73−7.76 (dd, J_1 = 8.7 Hz, J_2 = 1.5 Hz, 1H, ArH), 7.89 (s, 1H, ArH), 7.92 (d, J = 5.4 Hz, 2H, ArH); ^{13}C NMR (75 MHz, DMSO-d_6) (δ, ppm): 45.3, 53.3, 112.5, 119.3, 120.0 (d, J = 32.3 Hz), 124.4 (d, J = 277.5 Hz), 126.3, 128.2, 128.7, 129.3, 129.5, 133.8, 135.8, 135.9, 142.1, 153.2, 192.6; HRMS (TOF ES$^+$) m/z: calcd for $C_{19}H_{14}N_2OF_3$ [M + H], 343.1052; found, 343.1050.

*4-(p-Tolyl)methanoneyl-7-(trifluoromethyl)-1,2-dihydroimidazo[1,2-a]quinoline (**3be**).* Yellow solid, mp 249−250 °C; IR (KBr): 1660, 1637, 1333, 1206, 1157, 1110, 1075, 997, 828, 762 cm^{-1}; ^{1}H NMR (300 MHz, DMSO-d_6) (δ, ppm): 2.38 (s, 3H, CH_3), 3.85−3.91 (m, 2H, CH_2N), 3.97−4.04 (m, 2H, NCH_2), 7.00 (d, J = 8.7 Hz, 1H, ArH), 7.32 (d, J = 8.7 Hz, 2H, ArH), 7.66 (s, 1H, CH), 7.73 (d, J = 8.4 Hz, 1H, ArH), 7.78 (d, J_1 = 8.1 Hz, 2H, ArH), 7.92 (s, 1H, ArH); ^{13}C NMR (75 MHz, DMSO-d_6) (δ, ppm): 21.2, 45.3, 53.3, 112.4, 119.3, 119.7, 124.4 (d, J = 269.3 Hz), 126.2, 128.1, 129.3, 129.5, 129.6, 133.3, 135.5, 142.0, 144.4, 153.2, 192.1; HRMS (TOF ES$^+$) m/z: calcd for $C_{20}H_{16}N_2OF_3$ [M + H], 357.1209; found, 357.1210.

*4-(4′-Methoxyphenyl)methanoneyl-7-(trifluoromethyl)-1,2-dihydroimidazo[1,2-a]quinoline (**3bf**).* Yellow solid, mp 228−229 °C; IR (KBr): 2945, 1658, 1635, 1596, 1387, 1334, 1265, 1205, 1155, 1109, 856 cm^{-1}; ^{1}H NMR (500 MHz, DMSO-d_6) (δ, ppm): 3.85 (s, 3H, CH_3), 3.88−3.92 (m, 2H, CH_2N), 4.00−4.04 (m, 2H, NCH_2), 7.03 (d, J = 9.0 Hz, 1H, ArH), 7.05 (d, J = 8.6 Hz, 2H, ArH), 7.65 (s, 1H, CH), 7.75 (d, J = 8.5 Hz, 1H, ArH), 7.88 (d, J_1 = 8.5 Hz, 2H, ArH), 7.92 (s, 1H, ArH); ^{13}C NMR (125 MHz, DMSO-d_6) (δ, ppm): 45.7, 53.6, 56.0, 112.8, 114.4, 119.8, 120.2, 125.9, 126.5, 128.4, 129.0, 130.1, 132.4, 135.5, 142.3, 153.7, 164.2, 192.4; HRMS (TOF ES$^+$) m/z: calcd for $C_{20}H_{16}N_2O_2F_3$ [M + H], 373.1158; found, 373.1160.

*4-(Thiophen-2′-yl)methanoneyl-7-(trifluoromethyl)-1,2-dihydroimidazo[1,2-a]quinoline (**3bg**).* Orange solid, mp 208−209 °C; IR (KBr): 3069, 1650, 1633, 1413, 1334, 1204, 1159, 1118, 1073, 821, 743 cm^{-1}; ^{1}H NMR (500 MHz, DMSO-d_6) (δ, ppm): 3.92−3.96 (m, 2H, CH_2N), 4.00−4.04 (m, 2H, NCH_2), 7.00 (d, J = 8.7 Hz, 1H, CH), 7.26 (t, J = 4.3 Hz, 1H, CH), 7.73−7.75 (m, 1H, CH), 7.78 (s, 1H, CH), 7.88 (d, J = 3.7 Hz, 1H, ArH), 7.93 (s, 1H, ArH), 8.13 (d, J = 4.8 Hz, 1H, ArH); ^{13}C NMR (125 MHz, DMSO-d_6) (δ, ppm): 45.8, 53.6, 56.0, 112.8, 119.6, 120.4 (d, J = 32.5 Hz), 124.8 (d, J = 270.0 Hz), 126.8, 128.7, 129.0, 129.3, 136.2, 136.6, 136.9, 142.4, 143.0, 153.4, 184.7; HRMS (TOF ES$^+$) m/z: calcd for $C_{17}H_{12}N_2OF_3S$ [M + H], 349.0616; found, 349.0614.

*5-(4′-Fluorophenyl)methanoneyl-8-(trifluoromethyl)-2,3-dihydro-1H-pyrimido[1,2-a]-quinoline (**3bh**).* Yellowy solid, mp 172−173 °C; IR (KBr): 1668, 1642, 1596, 1319, 1210, 1154, 1116, 846, 814 cm^{-1}; ^{1}H NMR (500 MHz, DMSO-d_6) (δ, ppm): 1.87−1.89 (m, 2H, CH_2), 3.25−3.27 (m, 2H, CH_2N), 3.90−3.92 (m, 2H, NCH_2), 7.32 (t, J = 8.6 Hz, 2H, ArH), 7.37 (d, J = 8.9 Hz, 1H, ArH), 7.49 (s, 1H, CH), 7.75 (d, J_1 = 8.7 Hz, 1H, ArH), 7.89 (s, 1H, ArH), 7.95−7.98 (m, 2H, ArH); ^{13}C NMR (123 MHz, DMSO-d_6) (δ, ppm): 19.9, 43.5, 44.3, 112.4, 116.1 (d, J = 22.5 Hz), 119.9, 121.3 (d, J = 33.8 Hz), 124.7 (d, J = 268.8 Hz), 126.1 (d, J = 3.8 Hz), 127.4 (d, J = 2.5 Hz), 130.4, 132.4 (d, J = 10.0 Hz), 133.3, 137.0, 143.8, 147.2, 165.5 (d, J = 252.5 Hz), 193.2; HRMS (TOF ES$^+$) m/z: calcd for $C_{20}H_{15}N_2OF_4$ [M + H], 375.1115; found, 375.1113.

*5-(4′-Chlorophenyl)methanoneyl-8-(trifluoromethyl)-2,3-dihydro-1H-pyrimido[1,2-a]-quinoline (**3bi**).* Yellowy solid, mp 181−182 °C; IR (KBr): 2931, 1670, 1640, 1592, 1319, 1208, 1161, 1115, 815 cm^{-1}; ^{1}H NMR (300 MHz, DMSO-d_6) (δ, ppm): 1.85−1.88 (m, 2H, CH_2), 3.22−3.26 (m, 2H, CH_2N), 3.89−3.92 (m, 2H, NCH_2), 7.37 (d, J = 8.7 Hz, 1H, ArH), 7.51 (s, 1H, CH), 7.55 (d, J = 8.4 Hz, 2H, ArH), 7.75 (d, J = 9.0 Hz, 1H, ArH), 7.87−7.90 (m, 3H, ArH); ^{13}C NMR (75 MHz, DMSO-d_6) (δ, ppm): 19.5, 43.0, 43.9, 112.1, 119.5, 121.0 (d, J = 33.0 Hz), 124.3 (d, J = 270.0 Hz), 125.8, 127.0, 128.8, 130.4, 130.8, 134.9, 136.2, 138.2, 143.4, 146.8, 193.2; HRMS (TOF ES$^+$) m/z: calcd for $C_{20}H_{15}N_2OF_3Cl$ [M + H], 391.0819; found, 391.0816.

*5-(4′-Bromophenyl)methanoneyl-8-(trifluoromethyl)-2,3-dihydro-1H-pyrimido[1,2-a]-quinoline (**3bj**).* Yellowy solid, mp 195−196 °C; IR (KBr): 2951, 1671, 1641, 1590, 1318, 1277, 1112, 814 cm^{-1}; ^{1}H NMR (300 MHz, DMSO-d_6) (δ, ppm): 1.86 (m, 2H, CH_2), 3.23 (m, 2H, CH_2N), 3.88−3.92 (m, 2H, NCH_2), 7.37 (d, J = 9.0 Hz, 1H, ArH), 7.51 (s, 1H, CH), 7.70 (d, J = 8.4 Hz, 2H, ArH), 7.76 (d, J = 9.3 Hz, 1H, ArH), 7.80 (d, J = 8.4 Hz, 2H, ArH), 7.90 (s, 1H, ArH); ^{13}C NMR (75 MHz, DMSO-d_6) (δ, ppm): 19.5, 43.0, 43.8, 112.1, 119.5, 120.5 (d, J_2 = 32.3 Hz), 124.3 (d, J_1 = 269.3 Hz), 125.8, 127.1, 127.5, 130.4, 130.9, 131.8, 135.2, 136.2, 143.4, 146.8, 193.5; HRMS (TOF ES$^+$) m/z: calcd for $C_{20}H_{15}N_2OF_3Br$ [M + H], 435.0314; found, 435.0317.

*5-(Phenyl)methanoneyl-8-(trifluoromethyl)-2,3-dihydro-1H-pyrimido[1,2-a]quinoline (**3bk**).* Yellowy solid, mp 187−188 °C; IR (KBr): 1667, 1640, 1589, 1343, 1320, 1213, 1160, 1099, 814 cm^{-1}; ^{1}H NMR (500 MHz, DMSO-d_6) (δ, ppm): 1.87−1.89 (m, 2H, CH_2), 3.24−3.26 (m, 2H, CH_2N), 3.90−3.93 (m, 2H, NCH_2), 7.37 (d, J = 8.9 Hz, 1H, ArH), 7.48−7.52 (m, 3H, CH), 7.63 (t, J = 7.4 Hz, 1H, ArH), 7.75 (d, J = 8.8 Hz, 1H, ArH), 7.88−7.90 (m, 3H, ArH); ^{13}C NMR (125 MHz, DMSO-d_6) (δ, ppm): 19.9, 43.4, 44.3, 112.4, 120.0, 121.4 (d, J = 32.5 Hz), 124.8 (d, J = 267.5 Hz), 126.0, 127.3, 129.0, 129.4, 130.3, 133.8, 136.5, 137.2, 143.7, 147.3, 194.6; HRMS (TOF ES$^+$) m/z: calcd for $C_{20}H_{16}N_2OF_3$ [M + H], 357.1209; found, 357.1205.

*5-(p-Tolyl)methanoneyl-8-(trifluoromethyl)-2,3-dihydro-1H-pyrimido[1,2-a]quinoline (**3bl**).* Yellowy solid, mp 226−227 °C; IR (KBr): 1663, 1642, 1319, 1209, 1160, 1112, 1083, 828 cm^{-1}; ^{1}H NMR (500 MHz, DMSO-d_6) (δ, ppm): 1.86−1.88 (m, 2H, CH_2), 2.37 (s, 3H, CH_3), 3.24−3.26 (m, 2H, CH_2N), 3.89−3.92 (m, 2H, NCH_2), 7.30 (d, J = 8.0 Hz, 2H, ArH), 7.36 (d, J = 8.9 Hz, 1H, ArH), 7.43 (s, 1H, CH), 7.74 (d, J = 8.7 Hz, 1H, ArH), 7.78 (d, J = 8.1 Hz, 2H, ArH), 7.88 (s, 1H, ArH); ^{13}C NMR (125 MHz, DMSO-d_6) (δ, ppm): 19.9, 21.6, 43.4, 44.3, 112.4, 120.0, 121.3 (d, J = 32.5 Hz), 124.8 (d, J = 270.0 Hz), 125.9, 127.1, 127.2, 129.6, 129.9, 134.1, 137.4, 143.7, 144.4, 147.2, 194.2; HRMS (TOF ES$^+$) m/z: calcd for $C_{21}H_{18}N_2OF_3$ [M + H], 371.1365; found, 371.1363.

*5-(4′-Methoxyphenyl)methanoneyl-8-(trifluoromethyl)-2,3-dihydro-1H-pyrimido[1,2-a]-quinoline (**3bm**).* White

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solid, mp 192−193 °C; IR (KBr): 1662, 1641, 1593, 1319, 1264, 1157, 1029, 839 cm^{-1}; ^1H NMR (500 MHz, DMSO-d_6) (δ, ppm): 1.87−1.88 (m, 2H, CH_2), 3.26 (m, 2H, CH_2N), 3.84 (s, 3H, CH_3), 3.90−3.91 (m, 2H, NCH_2), 7.01−7.03 (m, 2H, Ar*H*), 7.36 (d, J = 8.8 Hz, 1H, Ar*H*), 7.41 (s, 1H, C*H*), 7.74 (d, J = 8.8 Hz, 1H, Ar*H*), 7.84−7.88 (m, 3H, Ar*H*); ^{13}C NMR (125 MHz, DMSO-d_6) (δ, ppm): 19.9, 43.4, 44.3, 55.9, 112.3, 114.3, 120.0, 121.3 (d, J = 32.5), 124.8 (d, J = 270.0 Hz), 125.9, 127.2, 127.2, 129.5, 129.7, 137.5, 143.7, 147.2, 163.8, 193.1; HRMS (TOF ES$^+$) m/z: calcd for $C_{21}H_{18}N_2O_2F_3$ [M + H], 387.1314; found, 387.1317.

*5-(Thiophen-2′-yl)methanoneyl-8-(trifluoromethyl)-2,3-dihydro-1H-pyrimido[1,2-a]quinoline (**3bn**).* Light red solid, mp 209−210 °C; IR (KBr): 1645, 1586, 1343, 1319, 1209, 1156, 1102, 821, 732 cm^{-1}; ^1H NMR (300 MHz, DMSO-d_6) (δ, ppm): 1.87−1.91 (m, 2H, CH_2), 3.29−3.32 (m, 2H, CH_2N), 3.88−3.92 (m, 2H, NCH_2), 7.19−7.22 (m, 1H, C*H*), 7.35 (d, J = 8.7 Hz, 1H, C*H*), 7.50 (s, 1H, C*H*), 7.72−7.76 (m, 2H, C*H*), 7.88 (d, J = 1.8 Hz, 1H, Ar*H*), 8.04 (dd, J_1 = 4.8 Hz, J_2 = 1.2 Hz, 1H, Ar*H*); ^{13}C NMR (75 MHz, DMSO-d_6) (δ, ppm): 19.5, 43.0, 43.9, 112.0, 119.4, 120.9 (q, J_2 = 32.3 Hz), 124.3 (d, J_1 = 269.3 Hz), 125.7, 126.1, 127.0, 128.7, 129.8, 135.2, 135.5, 136.2, 143.3 (d, J_3 = 9.8 Hz), 146.5, 186.3; HRMS (TOF ES$^+$) m/z: calcd for $C_{18}H_{14}N_2OF_3S$ [M + H], 363.0773; found, 363.0777.

*6,7,9-Trifluoro-4-(4′-fluorophenyl)methanoneyl-1,2-dihydroimidazo[1,2-a]quinoline (**3ca**).* Red solid, mp 177−178 °C; IR (KBr): 1668, 1636, 1598, 1496, 1393, 1267, 1157, 858, 603 cm^{-1}; ^1H NMR (500 MHz, DMSO-d_6) (δ, ppm): 3.84 (t, J = 10.3 Hz, 2H, CH_2N), 4.20−4.25 (m, 2H, NCH_2), 7.35 (t, J = 8.7 Hz, 2H, Ar*H*), 7.61 (s, 1H, C*H*), 7.70−7.76 (m, 1H, Ar*H*), 7.97−8.00 (m, 2H, Ar*H*); ^{13}C NMR (125 MHz, DMSO-d_6) (δ, ppm): 48.6, 54.1, 108.8 (t, J = 25.0 Hz), 111.5 (d, J = 15.0 Hz), 116.2 (d, J = 22.5 Hz), 126.4 (d, J = 13.8 Hz), 127.3, 131.2, 132.7, 132.9 (d, J = 10.0 Hz), 140.9 (t, J = 11.9 Hz), 141.9 (m), 142.7 (d, J = 12.5 Hz), 143.9 (t, J = 18.8 Hz), 153.7, 165.8 (d, J = 251.3 Hz), 191.1; ^{19}F NMR (565 MHz, DMSO-d_6) (δ, ppm): −148.4 (t, J = 16.9 Hz), −147.0 (d, J = 22.6 Hz), −132.8 (d, J = 11.3 Hz), −104.5; HRMS (TOF ES$^+$) m/z: calcd for $C_{18}H_{11}N_2OF_4$ [M + H], 347.0802; found, 347.0801.

*6,7,9-Trifluoro-4-(4′-chlorophenyl)methanoneyl-1,2-dihydroimidazo[1,2-a]quinoline (**3cb**).* Red solid, mp 186−187 °C; IR (KBr): 1664, 1638, 1595, 1499, 1393, 1269, 1090, 776 cm^{-1}; ^1H NMR (600 MHz, DMSO-d_6) (δ, ppm): 3.81−3.85 (m, 2H, CH_2N), 4.21−4.26 (m, 2H, NCH_2), 7.60 (d, J = 8.5 Hz, 2H, Ar*H*), 7.65 (s, 1H, C*H*), 7.73−7.78 (m, 1H, Ar*H*), 7.91 (d, J = 8.5 Hz, 2H, Ar*H*); ^{13}C NMR (150 MHz, DMSO-d_6) (δ, ppm): 48.7 (d, J = 9.0 Hz), 54.2, 109.0 (t, J = 25.5 Hz), 111.6 (d, J = 10.5 Hz), 126.6 (d, J = 10.0 Hz), 127.8, 129.3, 131.0, 131.8, 134.8, 139.4, 141.1, 142.5 (d, J = 60.0 Hz), 144.0 (d, J = 8.8 Hz), 153.8, 191.7; HRMS (TOF ES$^+$) m/z: calcd for $C_{18}H_{11}N_2OF_3Cl$ [M + H], 363.0506; found, 363.0503.

*6,7,9-Trifluoro-4-(4′-bromophenyl)methanoneyl-1,2-dihydroimidazo[1,2-a]quinoline (**3cc**).* Orange solid, mp 203−204 °C; IR (KBr): 1663, 1635, 1586, 1496, 1269, 1124, 774, 609 cm^{-1}; ^1H NMR (600 MHz, DMSO-d_6 + $DCCl_3$) (δ, ppm): 3.83 (t, J = 10.3 Hz, 2H, CH_2N), 4.21−4.26 (m, 2H, NCH_2), 7.64 (s, 1H, C*H*), 7.73−7.74 (m, 3H, Ar*H*), 7.82 (d, J = 8.4 Hz, 2H, Ar*H*); ^{13}C NMR (150 MHz, DMSO-d_6 + $DCCl_3$) (δ, ppm): 48.7 (d, J = 9.0 Hz), 54.2, 109.0 (t, J = 25.5 Hz), 111.6 (d, J = 10.5 Hz), 126.6, 127.9, 128.6, 131.0, 131.8, 132.3, 135.1, 141.1, 142.7, 143.9 (d, J = 51.0 Hz), 153.8, 191.8; HRMS (TOF ES$^+$) m/z: calcd for $C_{18}H_{11}N_2OF_3Br$ [M + H], 407.0001; found, 407.0000.

*6,7,9-Trifluoro-4-(phenyl)methanoneyl-1,2-dihydroimidazo[1,2-a]quinoline (**3cd**).* Orange solid, mp 195−196 °C; IR (KBr): 1667, 1636, 1498, 1392, 1270, 803, 609 cm^{-1}; ^1H NMR (500 MHz, DMSO-d_6) (δ, ppm): 3.84 (t, J = 10.3 Hz, 2H, CH_2N), 4.21−4.26 (m, 2H, NCH_2), 7.54 (d, J = 7.7 Hz, 2H, Ar*H*), 7.59 (s, 1H, C*H*), 7.67−7.76 (m, 2H, Ar*H*), 7.90 (d, J = 7.5 Hz, 2H, Ar*H*); ^{13}C NMR (125 MHz, DMSO-d_6) (δ, ppm): 48.6 (d, J = 8.8 Hz), 54.1, 108.7 (t, J = 24.4 Hz), 111.5 (d, J = 11.3 Hz), 126.4 (d, J = 12.5 Hz), 127.1, 129.1, 129.8, 131.4, 134.3, 135.9, 140.9, 141.9, 142.8, 143.9 (d, J = 33.8 Hz), 153.7, 192.6; HRMS (TOF ES$^+$) m/z: calcd for $C_{18}H_{12}N_2OF_3$ [M + H], 329.0896; found, 329.0894.

*6,7,9-Trifluoro-4-(p-tolyl)methanoneyl-1,2-dihydroimidazo[1,2-a]quinoline (**3ce**).* Red-orange solid, mp 185−186 °C; IR (KBr): 1662, 1635, 1496, 1392, 1272, 1193, 603 cm^{-1}; ^1H NMR (500 MHz, DMSO-d_6) (δ, ppm): 2.39 (s, 3H, CH_3), 3.83 (t, J = 10.3 Hz, 2H, CH_2N), 4.19−4.25 (m, 2H, NCH_2), 7.33 (d, J = 8.0 Hz, 2H, Ar*H*), 7.53 (s, 1H, C*H*), 7.69−7.75 (m, 1H, Ar*H*), 7.79 (d, J = 8.1 Hz, 2H, Ar*H*); ^{13}C NMR (125 MHz, DMSO-d_6) (δ, ppm): 21.6, 48.6 (d, J = 8.8 Hz), 54.1, 108.6 (t, J = 25.0 Hz), 111.6, 126.4, 126.7, 129.7, 130.0, 131.7, 133.5, 140.9, 141.9 (d, J = 30.0 Hz), 142.8, 143.9, 145.0, 153.7, 192.0; HRMS (TOF ES$^+$) m/z: calcd for $C_{19}H_{14}N_2OF_3$ [M + H], 343.1052; found, 343.1050.

*6,7,9-Trifluoro-4-(4′-methoxyphenyl)methanoneyl-1,2-dihydroimidazo[1,2-a]quinoline (**3cf**).* Orange solid, mp 191−192 °C; IR (KBr): 1633, 1598, 1497, 1260, 1162, 1026, 603 cm^{-1}; ^1H NMR (300 MHz, DMSO-d_6 + $DCCl_3$) (δ, ppm): 3.82−3.89 (m, 2H, CH_2N), 3.85 (s, 3H, CH_3), 4.19−4.27 (m, 2H, NCH_2), 7.02 (d, J = 9.0 Hz, 2H, Ar*H*), 7.46 (d, J = 1.5 Hz, 1H, C*H*), 7.57−7.67 (m, 1H, Ar*H*), 7.83−7.88 (m, 2H, Ar*H*); ^{13}C NMR (75 MHz, DMSO-d_6) (δ, ppm): 48.2 (d, J = 8.3 Hz), 5.71, 55.5, 108.0 (t, J = 24.8 Hz), 111.1 (d, J = 10.5 Hz), 113.9, 126.0, 128.3, 131.3, 131.9, 139.8, 140.8, 143.1 (d, J = 18.8 Hz), 144.0, 153.4, 163.8, 190.3; HRMS (TOF ES$^+$) m/z: calcd for $C_{19}H_{14}N_2O_2F_3$ [M + H], 359.1001; found, 359.0999.

*6,7,9-Trifluoro-4-(thiophen-2-yl)methanoneyl-1,2-dihydroimidazo[1,2-a]quinoline (**3cg**).* Orange solid, mp 170−171 °C; IR (KBr): 1640, 1496, 1413, 1280, 1127, 733 cm^{-1}; ^1H NMR (600 MHz, DMSO-d_6) (δ, ppm): 3.86−3.89 (m, 2H, CH_2N), 4.22−4.25 (m, 2H, NCH_2), 7.25−7.26 (m, 1H, C*H*), 7.63 (s, 1H, C*H*), 7.66−7.72 (m, 1H, Ar*H*), 7.86−7.87 (m, 1H, C*H*), 8.13−8.14 (m, 1H, C*H*); ^{13}C NMR (150 MHz, DMSO-d_6) (δ, ppm): 48.8, 54.2, 108.9 (m), 111.5 (m), 126.5 (d, J = 12.0 Hz), 127.1, 129.4, 130.8, 136.9, 137.2, 141.1−142.7 (m), 142.0−142.4 (m), 142.9, 143.6−144.0 (m), 153.5, 184.4; HRMS (TOF ES$^+$) m/z: calcd for $C_{16}H_{10}N_2OF_3S$ [M + H], 335.0460; found, 335.0464.

*7,8,10-Trifluoro-5-(4′-fluorophenyl)methanoneyl-2,3-dihydro-1H-pyrimido[1,2-a]quinoline (**3ch**).* Yellow solid, mp 179−180 °C; IR (KBr): 2845, 1665, 1639, 1599, 1492, 1265, 1151, 992, 844 cm^{-1}; ^1H NMR (500 MHz, DMSO-d_6) (δ, ppm): 1.75 (m, 2H, CH_2), 3.22 (m, 2H, CH_2N), 4.14 (m, 2H, NCH_2), 7.32 (t, J = 8.7 Hz, 2H, Ar*H*), 7.43 (s, 1H, C*H*), 7.66−7.72 (m, 1H, Ar*H*), 7.94−7.97 (m, 2H, Ar*H*); ^{13}C NMR (125 MHz, DMSO-d_6) (δ, ppm): 20.1, 43.5, 48.5 (d, J = 17.5 Hz), 108.2 (m), 112.4 (d, J = 18.8 Hz), 116.0 (t, J = 25.6 Hz), 121.3, 127.4, 132.4 (d, J = 10.0 Hz), 133.2 (d, J = 10.0 Hz), 138.5, 141.5 (d, J = 21.3 Hz), 143.5 (d, J = 6.3 Hz), 145.6, 146.8, 165.5 (d, J = 251.3 Hz), 192.5; ^{19}F NMR (470 MHz, DMSO-d_6) (δ, ppm): −149.6, −145.5 (t, J = 9.4 Hz), −123.2, −105.3;

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HRMS (TOF ES$^+$) m/z: calcd for $C_{19}H_{13}N_2OF_4$ [M + H], 361.0958; found, 361.0959.

*7,8,10-Trifluoro-5-(4′-chlorophenyl)methanoneyl-2,3-dihydro-1H-pyrimido[1,2-a]quinoline (**3ci**).* Yellow solid, mp 199−200 °C; IR (KBr): 2924, 1663, 1638, 1600, 1492, 1264, 1088, 991, 842 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6 + $HClO_4$) (δ, ppm): 2.16 (m, 2H, CH_2), 3.54 (m, 2H, CH_2N), 4.67 (m, 2H, NCH_2), 7.71 (d, J = 8.2 Hz, 2H, ArH), 7.99 (d, J = 8.3 Hz, 2H, ArH), 8.26−8.31 (m, 1H, ArH), 8.48 (s, 1H, CH); ^{13}C NMR (150 MHz, DMSO-d_6 + $HClO_4$) (δ, ppm): 18.3, 39.1, 50.8 (d, J = 19.5 Hz), 112.7 (m), 113.6 (d, J = 16.5 Hz), 124.8, 125.1, 129.6, 132.7, 134.9, 135.1, 140.3, 143.5 (d, J = 6.3 Hz), 145.6, 146.8, 150.7, 190.9; ^{19}F NMR (565 MHz, DMSO-d_6 + $HClO_4$) (δ, ppm): −145.3 (m), −138.3 (m), −115.8; HRMS (TOF ES$^+$) m/z: calcd for $C_{19}H_{13}N_2OF_3Cl$ [M + H], 377.0663; found, 377.0665.

*7,8,10-Trifluoro-5-(4′-bromophenyl)methanoneyl-2,3-dihydro-1H-pyrimido[1,2-a]quinoline (**3cj**).* Yellow solid, mp 193−194 °C; IR (KBr): 2948, 1669, 1638, 1587, 1493, 1263, 1163, 1070, 906, 844 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) (δ, ppm): 1.74 (m, 2H, CH_2), 3.21 (m, 2H, CH_2N), 4.14 (m, 2H, NCH_2), 7.47 (s, 1H, ArH), 7.71−7.72 (m, 3H, ArH), 7.79−7.81 (m, 2H, ArH); ^{13}C NMR (150 MHz, DMSO-d_6 + $HClO_4$) (δ, ppm): 20.2, 43.6, 48.6 (d, J = 16.5 Hz), 108.4 (m), 112.5 (d, J = 18.0 Hz), 121.8, 127.5, 128.0, 131.5, 132.2, 135.6, 138.3, 141.9 (d, J = 12.0 Hz), 143.5, 144.0, 147.0, 193.3; HRMS (TOF ES$^+$) m/z: calcd for $C_{19}H_{13}N_2OF_3Br$ [M + H], 421.0158; found, 421.0159.

*7,8,10-Trifluoro-5-(phenyl)methanoneyl-2,3-dihydro-1H-pyrimido[1,2-a]quinoline (**3ck**).* Yellow solid, mp 191−192 °C; IR (KBr): 2958, 1669, 1638, 1597, 1492, 1267, 1198, 1165, 990, 665 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) (δ, ppm): 1.72−1.76 (m, 2H, CH_2), 3.21 (m, 2H, CH_2N), 4.13−4.16 (m, 2H, NCH_2), 7.42 (s, 1H, CH), 7.48−7.52 (m, 2H, ArH), 7.64 (t, J = 7.4 Hz, 1H, ArH), 7.67−7.72 (m, 1H, ArH), 7.85−7.88 (m, 2H, ArH); ^{13}C NMR (150 MHz, DMSO-d_6) (δ, ppm): 20.2, 43.6, 48.6, 108.2 (m), 112.5 (t, J = 10.5 Hz), 121.2, 127.4, 129.1, 129.5, 134.0, 136.4, 138.9, 141.8 (m), 143.4 (m), 145.6 (m), 147.0, 194.0; HRMS (TOF ES$^+$) m/z: calcd for $C_{19}H_{14}N_2OF_3$ [M + H], 343.1052; found, 343.1054.

*7,8,10-Trifluoro-5-(p-tolyl)methanoneyl-2,3-dihydro-1H-pyrimido[1,2-a]quinoline (**3cl**).* Yellow solid, mp 196−197 °C; IR (KBr): 1663, 1602, 1492, 1268, 1163, 990, 836 cm^{-1}; ^{1}H NMR (300 MHz, DMSO-d_6) (δ, ppm): 1.69−1.76 (m, 2H, CH_2), 2.37 (s, 3H, CH_3), 3.19−3.22 (m, 2H, CH_2N), 4.10−4.16 (m, 2H, NCH_2), 7.30 (d, J = 7.8 Hz, 2H, ArH), 7.35 (s, 1H, CH), 7.62−7.73 (m, 1H, ArH), 7.75 (d, J = 8.4 Hz, 2H, ArH); ^{13}C NMR (75 MHz, DMSO-d_6) (δ, ppm): 19.7, 21.2, 43.0, 48.2, 107.6 (m), 112.0 (d, J = 20.3 Hz), 120.4, 127.0, 129.2, 129.2, 133.5, 138.6, 140.6 (m), 143.7 (m), 142.6−145.8 (m), 144.0, 146.4, 193.1; HRMS (TOF ES$^+$) m/z: calcd for $C_{20}H_{16}N_2OF_3$ [M + H], 357.1209; found, 357.1208.

*7,8,10-Trifluoro-5-(4′-methoxyphenyl)methanoneyl-2,3-dihydro-1H-pyrimido[1,2-a]quinoline (**3cm**).* Yellow solid, mp 174−175 °C; IR (KBr): 1659, 1597, 1493, 1257, 1162, 1019, 849 cm^{-1}; ^{1}H NMR (500 MHz, DMSO-d_6) (δ, ppm): 1.74−1.76 (m, 2H, CH_2), 3.23−3.24 (m, 2H, CH_2N), 3.85 (s, 3H, CH_3), 4.14−4.15 (m, 2H, NCH_2), 7.03 (d, J = 8.8 Hz, 2H, ArH), 7.34 (s, 1H, CH), 7.63−7.73 (m, 1H, ArH), 7.84 (d, J = 8.7 Hz, 2H, ArH); ^{13}C NMR (125 MHz, DMSO-d_6) (δ, ppm): 20.1, 43.4, 48.5, 56.0, 108.0 (m), 112.4, 114.3, 120.7, 127.3, 129.3, 131.9, 139.0, 141.6 (m), 143.3 (m), 143.7−145.5 (m), 146.8, 163.9, 192.3; HRMS (TOF ES$^+$) m/z: calcd for $C_{20}H_{16}N_2O_2F_3$ [M + H], 373.1158; found, 373.1158.

*7,8,10-Trifluoro-5-(thiophen-2′-yl)methanoneyl-2,3-dihydro-1H-pyrimido[1,2-a]quinoline (**3cn**).* Yellow solid, mp 178−179 °C; IR (KBr): 2959, 1641, 1599, 1492, 1409, 1256, 1197, 983, 857 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) (δ, ppm): 1.75−1.78 (m, 2H, CH_2), 3.26−3.28 (m, 2H, CH_2N), 4.12−4.15 (m, 2H, NCH_2), 7.20−7.22 (m, 1H, CH), 7.42 (s, 1H, CH), 7.66−7.72 (m, 1H, ArH), 7.75−7.76 (m, 1H, CH), 8.04−8.05 (m, 1H, CH); ^{13}C NMR (150 MHz, DMSO-d_6) (δ, ppm): 20.2, 43.5, 48.6, 108.4 (m), 112.3 (t, J = 7.5 Hz), 121.2, 127.5 (d, J = 7.5 Hz), 129.2, 135.8, 136.0, 138.3, 141.7−142.0 (m), 143.4−143.5 (m), 143.5, 143.8−145.5 (m), 146.6, 186.2; HRMS (TOF ES$^+$) m/z: calcd for $C_{17}H_{12}N_2OF_3S$ [M + H], 349.0616; found, 349.0618.

*6,7,9-Trifluoro-4-(4′-fluorophenyl)methanoneyl-8-(piperidin-1-yl)-1,2-dihydroimidazo-[1,2-a]quinoline (**4da**).* Red solid, mp 170−171 °C; IR (KBr): 2935, 2851, 1653, 1628, 1482, 1271, 1232, 1156, 1119, 1001, 848, 768, 602 cm^{-1}; ^{1}H NMR (500 MHz, DMSO-d_6 + $CDCl_3$) (δ, ppm): 1.62−1.68 (m, 6H, CH_2), 3.23 (m, 4H, CH_2), 3.84 (t, J = 10.2 Hz, 2H, CH_2N), 4.21−4.26 (m, 2H, NCH_2), 7.28 (t, J = 8.7 Hz, 2H, ArH), 7.48 (s, 1H, CH), 7.90−7.93 (m, 2H, ArH); ^{13}C NMR (125 MHz, DMSO-d_6 + $CDCl_3$) (δ, ppm): 24.0, 26.5, 48.8, 52.2, 53.9, 115.9 (d, J_2 = 22.5 Hz), 127.3, 128.7, 132.7 (d, J_3 = 10.0 Hz), 133.1, 133.6, 154.0, 165.7 (d, J_1 = 252.5 Hz), 191.1; ^{19}F NMR (471 MHz, DMSO-d_6 + $DCCl_3$) (δ, ppm): −105.0, −145.9, −148.5, −156.9 (d, J = 18.8 Hz); HRMS (TOF ES$^+$) m/z: calcd for $C_{23}H_{20}N_3OF_4$ [M + H], 430.1537; found, 430.1533.

*6,7,9-Trifluoro-4-(4′-chlorophenyl)methanoneyl-8-(piperidin-1-yl)-1,2-dihydroimidazo-[1,2-a]quinoline (**4db**).* Red solid, mp 160−161 °C; IR (KBr): 2932, 2854, 1628, 1483, 1269, 1120, 1090, 1000, 844, 766 cm^{-1}; ^{1}H NMR (300 MHz, DMSO-d_6 + $CDCl_3$) (δ, ppm): 1.61 (m, 6H, CH_2), 3.22 (m, 4H, CH_2), 3.84 (t, J = 10.2 Hz, 2H, CH_2N), 4.17−4.26 (m, 2H, NCH_2), 7.47 (s, 1H, CH), 7.49 (d, J = 8.7 Hz, 2H, ArH), 7.82 (d, J = 8.4 Hz, 2H, ArH); ^{13}C NMR (75 MHz, DMSO-d_6 + $CDCl_3$) (δ, ppm): 23.6, 26.1, 48.3, 51.8, 53.6, 103.2, 126.0, 126.5, 128.5, 128.8, 131.0, 134.7, 138.6, 153.6, 191.0; HRMS (TOF ES$^+$) m/z: calcd for $C_{23}H_{20}ClN_3OF_3$ [M + H], 446.1242; found, 446.1239.

*6,7,9-Trifluoro-4-(4′-bromophenyl)methanoneyl-8-(piperidin-1-yl)-1,2-dihydroimidazo-[1,2-a]quinoline (**4dc**).* Orange solid, mp 181−181 °C; IR (KBr): 2933, 2855, 1654, 1633, 1478, 1386, 1270, 1156, 1121, 997, 832, 761 cm^{-1}; ^{1}H NMR (500 MHz, DMSO-d_6 + $CDCl_3$) (δ, ppm): 1.62 (m, 6H, CH_2), 3.24 (m, 4H, CH_2), 3.83 (t, J = 10.2 Hz, 2H, CH_2N), 4.21−4.26 (m, 2H, NCH_2), 7.52 (s, 1H, CH), 7.69 (d, J = 8.4 Hz, 2H, ArH), 7.76 (d, J = 8.4 Hz, 2H, ArH); ^{13}C NMR (150 MHz, DMSO-d_6 + $CDCl_3$) (δ, ppm): 23.80, 26.6, 44.7, 50.8, 52.4, 104.9, 114.7, 124.0, 126.6, 127.0, 128.1, 131.9, 132.4, 135.6, 137.4, 138.1, 139.7, 140.2, 140.5, 141.6, 146.7, 155.2, 190.9; ^{19}F NMR (565 MHz, DMSO-d_6 + $DCCl_3$) (δ, ppm): −143.9, −144.0, −148.7 (d, J = 16.9 Hz); HRMS (TOF ES$^+$) m/z: calcd for $C_{23}H_{20}N_3OF_3Br$ [M + H], 490.0735; found, 490.0737.

*6,7,9-Trifluoro-4-(phenyl)methanoneyl-8-(piperidin-1-yl)-1,2-dihydroimidazo[1,2-a]quinoline (**4dd**).* Orange-red solid, mp 186−187 °C; IR (KBr): 2938, 2853, 1633, 1480, 1456, 1268, 1119, 1000, 656 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) (δ, ppm): 1.62 (m, 6H, CH_2), 3.23 (m, 4H, CH_2), 3.86 (t, J = 10.3 Hz, 2H, CH_2N), 4.21−4.26 (m, 2H, NCH_2), 7.43 (s, 1H, CH), 7.46−7.49 (m, 2H, ArH), 7.60−7.62 (m, 1H, ArH), 7.83

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(d, J = 7.5 Hz, 2H, ArH); ^{13}C NMR (150 MHz, DMSO-d_6) (δ, ppm): 23.7, 26.5, 44.7, 50.7, 52.3, 104.8 (d, J_3 = 19.5 Hz), 114.8, 124.0, 129.3, 129.9, 133.9, 136.5, 137.2, 137.9, 139.8, 140.4, 155.2, 191.7; ^{19}F NMR (471 MHz, DMSO-d_6 + $DCCl_3$) (δ, ppm): −143.9, −144.6, −149.0 (d, J = 22.6 Hz); HRMS (TOF ES$^+$) m/z: calcd for $C_{23}H_{21}N_3OF_3$ [M + H], 412.1631; found, 412.1633.

■ ASSOCIATED CONTENT

Supporting Information

The Supporting Information is available free of charge on the ACS Publications website at DOI: 10.1021/acsomega.7b01856.

Spectroscopic and analytical data as well as the original copy of ^{1}H and ^{13}C NMR spectra of all new compounds and X-ray crystallographic data (CIF file) of compound **3bf** (CCDC 1587141) (PDF)

■ AUTHOR INFORMATION

Corresponding Authors

*E-mail: linjun@ynu.edu.cn. Phone and Fax: +86 87165031633 (J.L).

*E-mail: yansj@ynu.edu.cn. Phone and Fax: +86 87165031633 (S.-J.Y).

ORCID

Jun Lin: 0000-0002-2087-6013

Sheng-Jiao Yan: 0000-0002-7430-4096

Notes

The authors declare no competing financial interest.

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