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Regioselective dehydrogenation of 3,4-dihydropyrimidin-2(1*H*)-ones mediated by ceric ammonium nitrate

P. Shanmugam and P. T. Perumal*

Organic Chemistry Division, Central Leather Research Institute, Chennai 600 020, Tamilnadu, India

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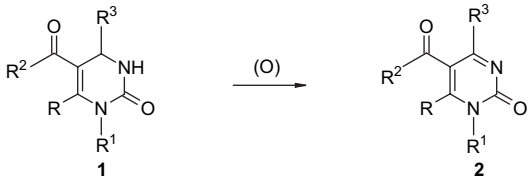
Abstract—Ceric ammonium nitrate (CAN) has been explored for the regioselective oxidation of 3,4-dihydropyrimidin-2(1*H*)-ones (DHPMs). Interestingly, we obtained ethyl 2,4-dioxo-6-phenyl-tetrahydropyrimidin-5-carboxylates as the major products during the oxidation of DHPMs by CAN/AcOH at 80 °C. The reaction afforded a mixture of products while employing CAN in organic solvents without additives. However, the regioselective dehydrogenated product, ethyl 6-methyl-4-aryl(alkyl)-pyrimidin-2(1*H*)-one-5-carboxylate was obtained by performing the reaction with $NaHCO_3$. The single crystal X-ray crystallography of ethyl 6-methyl-4-(2-phenyl)-pyrimidin-2(1*H*)-one-5-carboxylate revealed that the oxidized product existed in amidic form rather than aromatized enol form of pyrimidines. The efficiency of the present protocol enabled the synthesis of structurally diverse pyrimidines in moderate to good yields under milder reaction conditions.

1. Introduction

The pyrimidine core possesses potential biological applications.[1a,b] The pyrimidine derivative MKC-442 is already in clinical trials and similar compounds are expected to inhibit the HIV virus.[1c] A series of pyrazolo[1,5-*a*]pyrimidines derivatives were shown to be potent and orally active corticotropin-releasing factor receptor antagonists.[1d] Nucleosides containing the 5-substituted pyrimidine moiety have been demonstrated to inhibit growth of murine mammary carcinoma and HIV virus.[2] Pyrimidine based molecules with extended π-systems exhibited interesting fluorescent properties.[3a] Kang et al. employed readily accessible multifunctionalized pyrimidine templates for diversity-oriented synthesis.[3b]

Recently, various protocols have been utilized for the synthesis of pyrimidines.[4] The synthesis of pyrimidin-2(1*H*)-ones by oxidation of DHPMs (Scheme 1) has rarely been explored.[5a] Unlike a large number of oxidizing agents available for achieving nearly quantitative transformation of Hantzsch dihydropyridine (DHPs) to pyridine,[5b,c] the regioselective oxidation of DHPMs is not easy.[5a] A few available literature procedures required large volumes of highly acidic and corrosive reagents or multistep strategies.[6a,7a–c] $CuCl_2$/TBHP/K_2CO_3[7d] and Jone's reagent[7e] were employed for the above conversion, but they failed to yield the desired regioselective products for oxidatively sensitive functionalities. Consequently, it is of interest to synthesize structurally diverse pyrimidines by oxidizing DHPMs under mild conditions.



Scheme 1. Oxidation of DHPMs into pyrimidin-2(1*H*)-ones.

2. Results and discussion

2.1. Screening oxidants for the regioselective oxidation of DHPMs

It is well known that DHPMs are structurally similar to DHPs.[5a] Oxidants[8a–j] that efficiently convert the DHPs into pyridine were screened for the conversion of 3,4-dihydropyrimidin-2(1*H*)-ones to pyrimidin-2(1*H*)-ones. But DHPMs are highly stable toward powerful oxidants such as PCC, MnO_2, $KMnO_4$ adsorbed on clay, chloranil, DDQ, Pd/C, and sodium nitrate in acetic acid.[6a] In addition we found that MTO,[8c] $RuCl_3$ (5 mol %)/O_2 in AcOH (room temperature),[8d] Br_2,[8e] sulfur,[8g] $FeCl_3$ (in CH_3OH and CH_2Cl_2 under room temperature and reflux),[8i] $FeCl_3$/AcOH (room temperature), and $FeCl_3$/AcOH/H_2O (1:1, room temperature) were inefficient to dehydrogenate **1a**. Concd HNO_3,[8a] MnO_2,[8b]

Keywords: Oxidation; Pyrimidines; 3,4-Dihydropyrimidin-2(1*H*)-ones; Ceric ammonium nitrate.
* Corresponding author. Tel.: +91 44 24911386; fax: +91 44 24911589; e-mail: ptperumal@hotmail.com

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$Bi(NO_3)_3$, $FeCl_3$, IBX,[8j] and CAN[8h] afforded **2a** with moderate selectivity. Among them CAN was found to be selective and its application in organic synthesis is promising (Fig. 1).[9] $FeCl_3$ and CAN furnished reasonable amount of 2,4-dioxo-6-phenyl-tetrahydropyrimidin-5-carboxylates as well (Fig. 1).

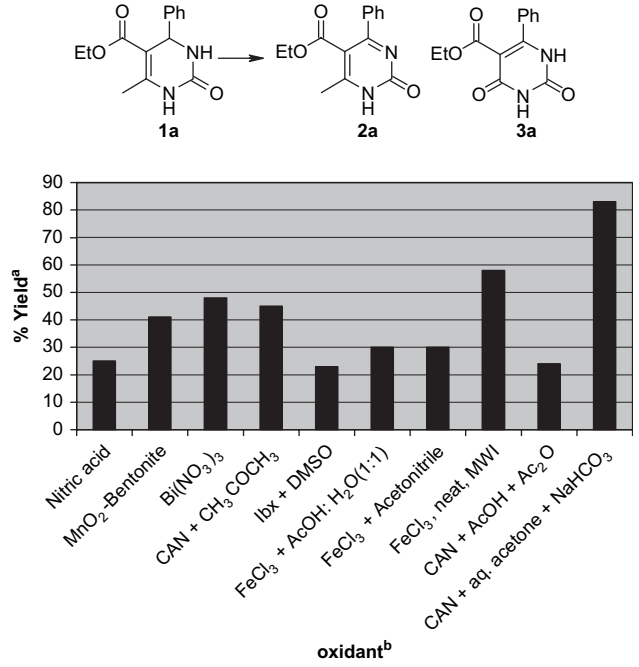
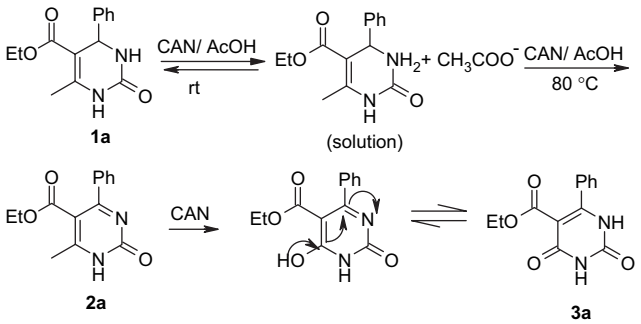


Figure 1. Screening of oxidants for the conversion of **1a** to **2a**. [a]Isolated yield. [b]The stoichiometry of oxidants was employed as used in literature for 1,4-dihydropyridine.[8a–j] And **3a** was formed in 21, 30, 10, and 33% yields, respectively, for the corresponding oxidants CAN+CH_3COCH_3, $FeCl_3$+acetonitrile, $FeCl_3$+heat+MWI, and CAN+AcOH+Ac_2O.

2.2. Synthesis of 2,4-dioxo-6-phenyl-tetrahydropyrimidin-5-carboxylates

Initially, AcOH was chosen as solvent because it dissolved DHPMs completely and is widely employed during the oxidation of DHPs.[8d,f,i,10] The addition of CAN to a stirred solution of **1a** in acetic acid did not afford the expected dehydrogenated product at ambient temperature (Scheme 2). However, the reaction furnished an unstable salt of acetic acid and **1a** in solution and was decomposed to **1a** during the workup. The trifluoroacetate salt of 4-anisyl-DHPM was trapped and characterized by NMR in solution. Ce(IV)'s inability to dehydrogenate **1a** in AcOH at room temperature might be due to coordination of **1a** with acetic acid.



Scheme 2. CAN mediated oxidation of DHPMs in AcOH.

Serendipitously, an unusual oxidation–dealkylation product, **3a**, ethyl 2,4-dioxo-6-phenyl-tetrahydropyrimidin-5-carboxylate, formed at 80 °C (Scheme 2). The ^{1}H NMR spectrum of product (**3a**) showed two new peaks with an integration of one proton each between 10 and 12 ppm. The characteristic peaks corresponding to NH(3), CH(4), and 6-methyl protons of the starting material (**1a**) (δ 8.9, 5.2, and 2.3 ppm, respectively) were absent. The *m*/*z* value of products **3a–i** is the same as DHPMs.

Therefore, an X-ray structure of **3g** was further needed to confirm the structure of the product (Fig. 2).[11] Since **3a** exhibited structural resemblance with anti-HIV agents,[1c,2] **1b–i** have been subjected to typical oxidation and the reactions afforded **3b–i** in reasonable yields (Table 1).

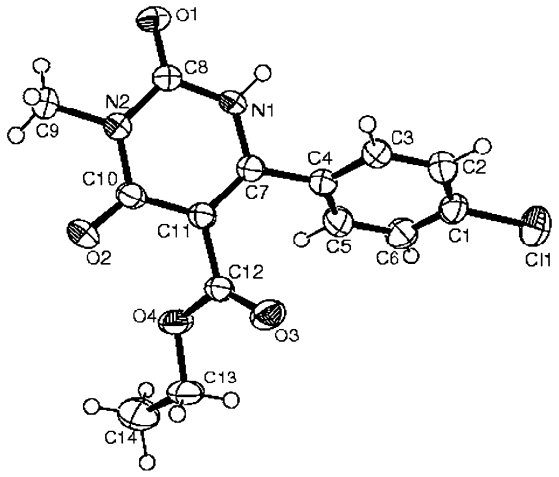
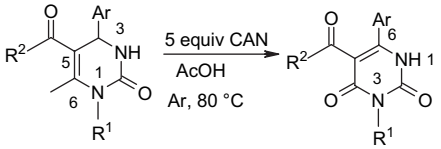


Figure 2. XRD structure of **3g**, ORTEP diagram.

Table 1. Oxidation of DHPM mediated by CAN in AcOH



Product	Ar	R^1	R^2	Time (h)	Yield (%)[a]
3a	C_6H_5	H	OEt	1.5	61
3b	3-NO_2-C_6H_4	Me	OEt	1.5	65
3c	2-NO_2-C_6H_4	H	OEt	1.0	55
3d	3-NO_2-C_6H_4	H	OEt	1.0	57
3e	4-Cl-C_6H_4	H	OEt	2.0	68
3f	1-Naphthyl	H	OEt	2.0	65
3g	4-Cl-C_6H_4	Me	OEt	1.0	62
3h	2,4-Cl_2-C_6H_3	H	Ph	2.5	63
3i	4-MeO-C_6H_4	H	OEt	1.5	68

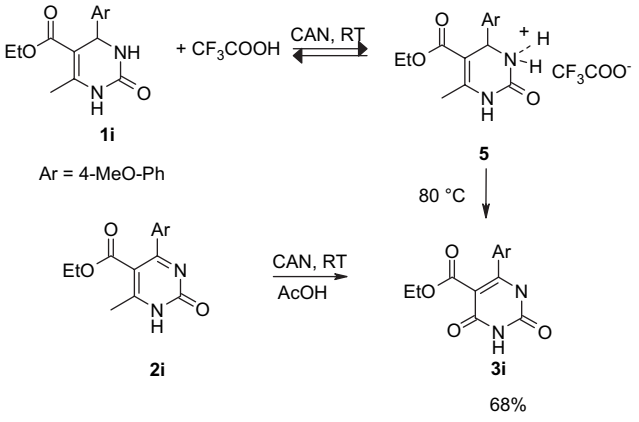
[a] The reaction was conducted using 1 mmol of DHPM and 5 mmol of CAN in 7 mL of acetic acid at 80 °C.

2.3. Trapping of 1i as trifluoroacetate salt

To confirm the formation of a salt in acetic acid, we have dissolved **1i** in trifluoroacetic acid and a small amount of TMS was added to the solution. The ^{1}H NMR spectrum of **5** in solution showed that the CH(4) of the product has been shifted 0.5 ppm to downfield. The quaternary N(3) of **5** has

no redox reaction with Ce^{4+} due to the unavailability of the N(3) lone pair electrons. This might be the reason that stirring with CAN in acetic acid at room temperature did not yield the expected product. The complex was labile at higher temperature and yielded **3i** at 80 °C.

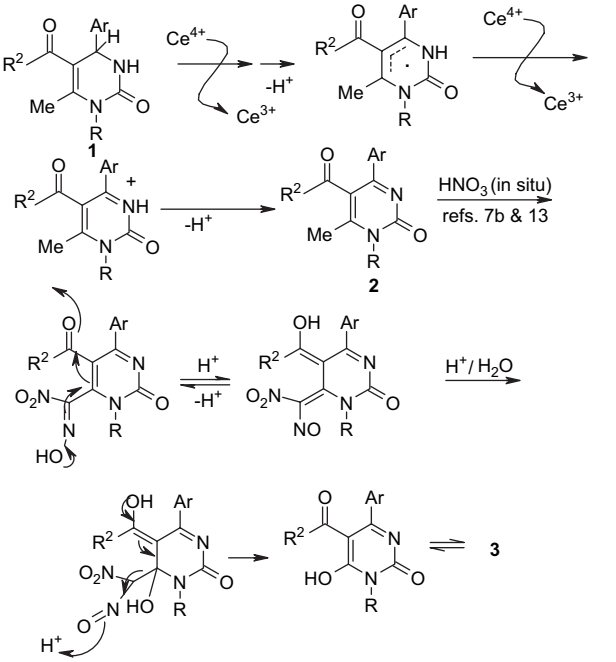
Independently prepared **2i** has been converted into the corresponding tetrahydropyrimidin-2,4(1*H*,3*H*)-dione **3i** at room temperature mediated by CAN/AcOH confirming the protonation of **1i** (Scheme 3).



Scheme 3. Trapping of **1i** as trifluoroacetate salt in solution.

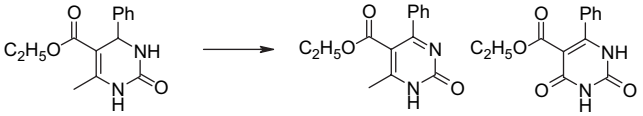
2.4. Mechanistic considerations

The mechanism of dehydrogenation mediated by Ce^{4+} expected to be the same as that of dihydropyridine.[12] But the dealkylation of 6-methyl pyrimidin-2(1*H*)-ones, **2** to **3** was uncertain; however, it was believed to proceed through nitrolic acid intermediate and hydrolysis of the same produced **3a–i**.[7b] We have proposed a tentative mechanism for the formation of products (Scheme 4).



Scheme 4. Mechanistic outlines for the formation of **3a–i**.

Despite the oxidation of **1a** to **3a** by CAN/AcOH, the regioselective oxidation to **2a** was not achieved. The following conditions (Scheme 5) were additionally screened to obtain **2a** exclusively but the formation of **3a** was inevitable. To our interest, the reaction mixture was acidic (pH=2) after addition of CAN in aqueous acetone. The decomposition of CAN during oxidation might generate nitric acid and a similar kind of observation has recently been reported in literature for high acidity of solution.[13] Presumably, as with CAN/AcOH, the acidic medium has facilitated the conversion of **2a** into **3a**.



Conditions	**2a** (%)	**3a** (%)
CAN/EtOH, 0 °C	20	32
CAN/MeOH, 0 °C	26	30
CAN/CH_3CN, 0 °C	45	25
CAN/CH_3CN, -78 °C	51	12
CAN/CH_3COCH_3	40	10
CAN/CH_3COCH_3/$NaHCO_3$	83	0

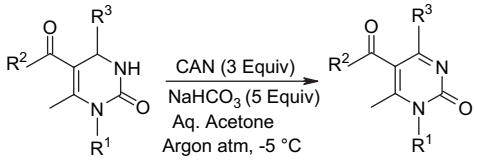
Scheme 5. CAN mediated oxidation of DHPMs.

2.5. Regioselective oxidation of DHPMs

To oxidize DHPMs regioselectively, we have demonstrated a new procedure herein using $NaHCO_3$ as buffering agent at −5 to 0 °C under Ar atmosphere. In a typical example, addition of CAN (3 equiv) to a mixture of **1a** and $NaHCO_3$ (5 equiv) suspended in acetone under inert atmosphere at ice-cold conditions followed by stirring the reaction mixture at ambient temperature for 1 h afforded **2a**.[6]

This methodology has been successfully employed to electron rich and deficient substrates (**2c**, **2k**, **2m**, **2o**, and **2i**) with satisfactory yields (Table 2). In addition, this methodology was found to be successful for higher homologues of aryl groups of DHPM to form **2j** and **2l**. The ^1H NMR spectrum of the product showed the absence of CH(4) and NH(3) peaks. The identity of C-4, C-6, and substituted aromatic

Table 2. Regioselective oxidation of DHPM mediated by CAN



Product	R^3	R^2	R^1	Time (h)	Yield (%)[a,b]
2a	C_6H_5	OEt	H	1	83[6]
2j	4-Biphenyl	OEt	H	1.5	79
2k	2-Cl-C_6H_4	OEt	H	1	85
2c	2-NO_2-C_6H_4	OEt	H	1	80
2l	3-HO-C_6H_4	OEt	H	1	81
2m	4-MeO-C_6H_4	OMe	H	1.5	83
2n	C_6H_5	OEt	Me	0.5	85[7b]
2o	4-MeO-C_6H_4	OEt	Me	3	69
2i	4-MeO-C_6H_4	OEt	H	1	81

[a] The reaction was conducted using 1 mmol of DHPM, 3 mmol of CAN, and 5 mmol of $NaHCO_3$ in 10 mL of acetone at −5 to 0 °C.
[b] Isolated yield.

carbons (asterisks) of **2a**, **2c**, **2i** and **2j–2m** was difficult to locate in the ^{13}C NMR spectrum due to tautomerization of NH(1) to N(3) in solution (Fig. 3a and b).[7b] *N*(1)-Alkyl substituted pyrimidin-2(1*H*)-ones, **2n** and **2o**, have no tautomerization in solution (Fig. 3c) and the ^{13}C NMR spectrum contained all peaks. The X-ray structure of **2k**[14] has confirmed that CONH group existed as amide form in solid state unlike reported as enol form (Fig. 4).[7d]

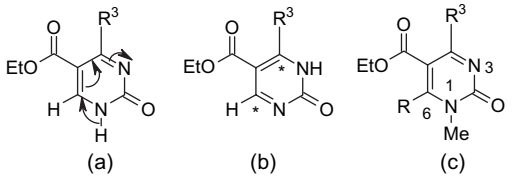


Figure 3. Tautomerism of pyrimidines in solution.

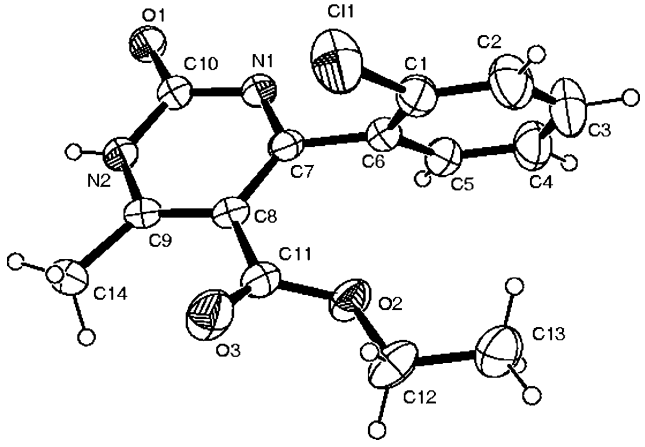


Figure 4. XRD structure of **2k**, ORTEP diagram.

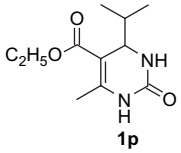
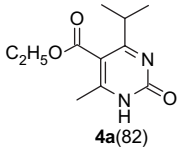
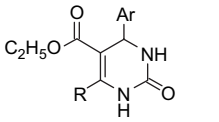
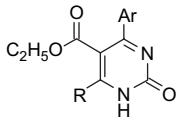
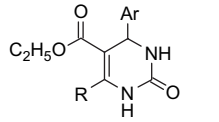
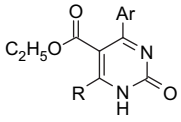
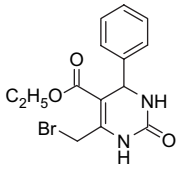
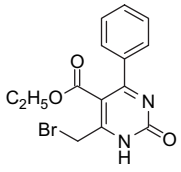
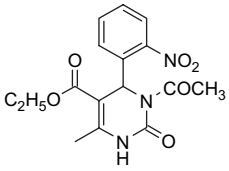
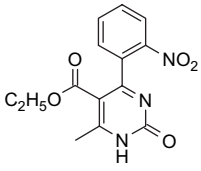
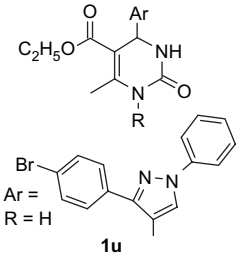
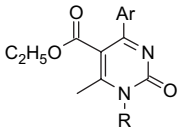
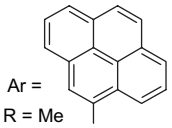
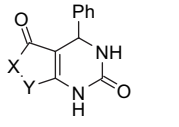
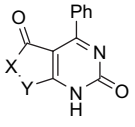
2.6. Synthesis of structurally diverse pyrimidines

To prove the mildness and efficacy of the procedure, we have subjected 4-alkyl DHPM (Table 3, entry 1) to the typical reaction conditions and the corresponding pyrimidin-2(1*H*)-one **4a** was obtained in good yield. It is noteworthy to mention here that other method furnished a lower yield or the dealkylated product.[5c,7d,e] The current procedure did not affect the Ph- and CF_3-groups at C-6 of DHPM (entries 2 and 3).[7d] Furthermore, highly regioselective dehydrogenation was achieved by subjecting 6-bromomethylene DHPM to the typical oxidation procedure (entry 4).

Notably, N(3)-acylated DHPM afforded the typical 3,4-dehydrogenated product **2c** (entry 5). DHPMs bearing bulky aryl groups furnished the corresponding oxidized products in reasonable yields (entries 6 and 7). Cyclohexane-fused and indenone-fused DHPMs yielded **4g** and **4h** (entries 8 and 9) in a short span of time. Oxidation of bisaryl DHPM (**1y**) under CAN in AcOH medium resulted in **4i**.

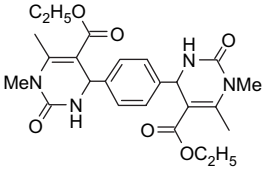
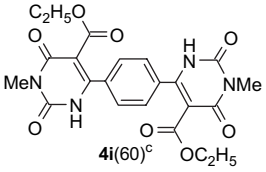
In conclusion, the highly regioselective oxidation did not affect sensitive or bulky aryl or alkyl pendant groups of pyrimidin-2(1*H*)-ones. Pyrimidines with extensive π-conjugation, **2j**, **4b**, **4e**, **4f**, **4h**, and **4i**, may be used for the preparation of photonic materials.[3a] The unexpected formation of **3a–i** deserves further investigation.

Table 3. Synthesis of structurally diverse pyrimidines, **4a–i** and **2c** via CAN mediated oxidation of DHPMs at different conditions

Entry	Reactant	Time (h)	Product (yield)[a,b]
1	 **1p**	2	 **4a**(82)
2	 Ar = $MeOC_6H_4$, R = Ph **1q**	4	 **4b**(80)
3	 Ar = $MeOC_6H_4$, R = CF_3 **1r**	4	 **4c**(76)
4	 **1s**	2	 **4d**(80)
5	 **1t**	3	 **2c**(85)
6	 **1u**	6	 **4e**(71)
7	 **1v**	6	**4f**(65)
8	 -X-Y-CH_2-(CMe_2)-CH_2 **1w**	1	 **4g**(61)

(*continued*)

Table 3. (*continued*)

Entry	Reactant	Time (h)	Product (yield)[a,b]
9	-X-Y- =  **1x**	1	**4h**(71)
10	 **1y**	4	 **4i**(60)[c]

[a] Isolated yield.
[b] The reaction was conducted using 1 mmol of DHPM, 3 mmol of CAN, and 5 mmol of $NaHCO_3$ in 10 mL of acetone at −5 to 0 °C.
[c] The reaction was conducted using 1 mmol of DHPM and 10 mmol of CAN in 15 mL of acetic acid at 80 °C.

3. Experimental

3.1. General introduction

Melting points were determined in open capillary tubes and were uncorrected. IR measurements were carried out using KBr pellets in FTIR. The ^{1}H NMR and ^{13}C NMR spectra were recorded in 500, 400, and 300 MHz high-resolution NMR spectrometers with TMS as an internal standard. All NMR spectra of pyrimidin-2(1*H*)-ones were recorded in $CDCl_3$. ^{1}H NMR of 4-anisylpyrimidinonium acetate (**5**) was recorded by dissolving ethyl 4-anisylpyrimidin-2(1*H*)-one-5-carboxylate in trifluoroacetic acid using TMS as an internal standard. Mass spectra were obtained in EI ionization mode at 70 eV. TLC was performed on precoated Polygram sheets. Column chromatography was carried out using 100–200 mesh silica gel or flash-column with 200–400 mesh silica gel.

3.2. Experimental procedure for the synthesis of 3,4-dihydropyrimidin-2(1*H*)-ones

All the DHPMs needed for oxidation were prepared by using reported procedure and purified through column chromatography before subjecting to dehydrogenation. The column purified samples furnished better yields over re-crystallized DHPMs. Ethyl 6-bromomethylene-4-phenyl-pyrimidin-2(1*H*)-one-5-carboxylate (**1s**) was prepared by the addition of Br_2 in $CHCl_3$ to the stirred solution of ethyl 6-methyl-4-phenylpyrimidin-2(1*H*)-one-5-carboxylate at 0 °C. The DHPMs (**1q**, **1r**, **1w**, and **1x**) were prepared by reported procedures.[15] 4-Pyrazolyl 3,4-dihydropyrimidin-2(1*H*)-ones (**1u**)[15c] were prepared by pyrazole aldehyde (1 mmol), ethyl acetoacetate (1.2 mmol), urea (1.2 mmol), and phosphotungstic acid (0.1 mmol) in methanol at reflux conditions. *N*(3)-Acetyl-4-(2-nitrophenyl)-3,4-dihydropyrimidin-2(1*H*)-one-5-carboxylate ester (**1t**) was prepared by stirring the reaction of corresponding DHPM in acetic anhydride in an oil bath for 2 h at 120 °C and re-crystallized in ethanol. Bis-DHPM (**1y**) was prepared using classical Biginelli conditions involving 1 mmol of terephthalaldehyde, 3 mmol of urea, and 5 mmol of ethyl acetoacetate at reflux in acidified ethanol.[15a–d]

3.3. Experimental procedure for oxidation of 3,4-dihydropyrimidin-2(1*H*)-ones

3.3.1. Optimization of oxidation of DHPMs by various oxidants. The regioselective oxidation of ethyl 6-methyl-4-phenyl-3,4-dihydropyrimidin-2(1*H*)-one-5-carboxylate, **1a** was optimized by employing various oxidants and experimental procedure was strictly followed as described for the oxidation of dihydropyridine.[8a–j]

3.3.2. Oxidation of DHPM by CAN in acetic acid (3a–i). Ethyl 2,4-dioxo-6-phenyl-tetrahydropyrimidin-5-carboxylate (**3a**): a 50 mL round bottom flask containing magnetic bar was charged with **1a** (1 mmol, 0.260 g) and acetic acid (7 mL). To this solution, ceric ammonium nitrate (5 mmol, 2.740 g) was added in one portion. The solution was stirred at 80 °C for appropriate time (Table 2) until TLC showed the complete disappearance of **1a**. Then the reaction mixture was poured into crushed ice, neutralized with $NaHCO_3$, and extracted with $CHCl_3$ (3×20 mL). The organic extracts were pooled up, washed with brine solution, dried over anhydrous Na_2SO_4, and concentrated in vacuum to afford 0.230 g of **3a** as crude product. The column purification of crude product using 1:1 petroleum ether and ethyl acetate yielded 0.160 g of **3a** as colorless crystalline solid. The same procedure was followed for preparation of **4i** except 10 mmol of CAN was employed.

3.3.2.1. Ethyl 2,4-dioxo-6-phenyl-1,2,3,4-tetrahydropyrimidin-5-carboxylate (3a). Mp: 224–226 °C. IR (KBr): 1236, 1420, 1600, 1630, 1675, 1705, 3257, 3340 cm^{-1}. ^{1}H NMR: δ 0.83 (t, J=6.9 Hz, 3H), 3.87 (q, J=6.9 Hz, 2H), 7.40 (d, J=6.9 Hz, 2H), 7.45 (doublet of triplet, J=1.6 and 6.9 Hz, 2H), 7.50 (doublet of triplet, J=7.6 and 2.2 Hz, 1H), 11.42 (s, 1H, D_2O-exchangeable), 11.46 (s, 1H, D_2O-exchangeable). ^{13}C NMR: δ 13.4, 60.5, 106.5, 127.6, 128.4, 130.6, 131.5, 150.2, 153.5, 161.1, 163.9. EIMS (*m*/*z*): 260 (M^+). Anal. calcd for $C_{13}H_{12}N_2O_4$: C, 60.00; H, 4.65; N, 10.76. Found: C, 59.93; H, 4.61; N, 10.82.

3.3.2.2. Ethyl 2,4-dioxo-3-methyl-6-(3-nitrophenyl)-1,2,3,4-tetrahydropyrimidin-5-carboxylate (3b). Mp: 234–237 °C. IR (KBr): 1232, 1415, 1607, 1635, 1670, 1702, 3255 cm^{-1}. ^{1}H NMR: δ 0.86 (t, J=6.9 Hz, 3H), 3.16 (s, 3H), 3.89 (q, J=6.9 Hz, 2H, CH_3CH_2), 7.40 (d, J=8.6 Hz, 1H), 7.51 (doublet of triplet, J=1.7 and 6.9 Hz, 2H), 7.9 (d, J=8.6 Hz, 1H), 11.77 (s, 1H, D_2O-exchangeable). ^{13}C NMR: δ 14.0, 27.4, 61.4, 106.6, 129.1, 129.3, 130.3, 131.7, 136.1, 138.3, 151.2, 160.8, 164.4, 167.0. EIMS (*m*/*z*): 319 (M^+). Anal. calcd for $C_{14}H_{13}N_3O_6$: C, 52.67; H, 4.10; N, 13.16. Found: C, 52.58; H, 4.03; N, 13.21.

3.3.2.3. Ethyl 2,4-dioxo-6-(2-nitrophenyl)-1,2,3,4-tetrahydropyrimidin-5-carboxylate (3c). Mp: 230–233 °C. IR (KBr): 1234, 1425, 1605, 1634, 1670, 1705, 3257, 3340 cm^{-1}. ^{1}H NMR: δ 0.71 (t, J=7.5 Hz, 3H, CH_3CH_2), 3.71 (q, J=7.5 Hz, 2H, CH_3CH_2), 7.59 (doublet of doublet, J=1.2 and 7.5 Hz, 1H), 7.75 (doublet of triplet, J=8.6 and 1.2 Hz, 1H), 7.83 (doublet of triplet, J=1.2 and 7.8 Hz, 1H), 7.85 (doublet of doublet, J=1.1 and 8.0 Hz, 1H), 11.55 (s, 1H, D_2O-exchangeable), 11.71 (s, 1H, D_2O-exchangeable). ^{13}C NMR: δ 13.9, 60.7, 105.4, 125.0, 128.2, 130.9, 132.1, 135.2, 146.9, 150.5, 155.0, 161.2, 163.2.

EIMS (*m/z*): 305 (M^+). Anal. calcd for $C_{13}H_{11}N_3O_6$: C, 51.15; H, 3.63; N, 13.77. Found: C, 51.19; H, 3.61; N, 13.69.

3.3.2.4. Ethyl 2,4-dioxo-6-(3-nitrophenyl)-1,2,3,4-tetrahydropyrimidin-5-carboxylate (3d). Mp: 243–245 °C. IR (KBr): 1237, 1421, 1603, 1633, 1674, 1705, 3259, 3340 cm^{-1}. ^1H NMR: δ 0.85 (t, J=6.8 Hz, 3H), 3.90 (q, J=6.8 Hz, 2H), 7.44 (t, J=7.4 and 8.0 Hz, 1H), 7.89 (d, J=7.4 Hz, 1H), 8.3 (m, 1H), 8.38 (doublet of doublet, J=2.3 and 8.0 Hz, 1H), 11.58 (s, 1H, D_2O-exchangeable), 11.66 (s, 1H, D_2O-exchangeable). ^{13}C NMR: δ 14.0, 61.3, 107.5, 123.5, 125.8, 130.8, 133.7, 135.1, 147.9, 150.7, 152.6, 161.6, 164.1. EIMS (*m/z*): 305 (M^+). Anal. calcd for $C_{13}H_{11}N_3O_6$: C, 51.15; H, 3.63; N, 13.77. Found: C, 51.09; H, 3.64; N, 13.81.

3.3.2.5. Ethyl 2,4-dioxo-6-(4-chlorophenyl)-1,2,3,4-tetrahydropyrimidin-5-carboxylate (3e). Mp: 240–242 °C. IR (KBr): 1231, 1418, 1603, 1621, 1673, 3251, 3342 cm^{-1}. ^1H NMR: δ 0.86 (t, J=6.8 Hz, 3H), 3.89 (q, J=6.8 Hz, 2H), 7.43 (d, J=8.3 Hz, 2H), 7.58 (d, J=8.3 Hz, 2H), 11.51 (s, 2H). EIMS (*m/z*): 294 (M^+). Anal. calcd for $C_{13}H_{11}ClN_2O_4$: C, 52.98; H, 3.76; N, 9.51. Found: C, 52.85; H, 3.69; N, 9.55.

3.3.2.6. Ethyl 2,4-dioxo-6-(1-naphthyl)-1,2,3,4-tetrahydropyrimidin-5-carboxylate (3f). Mp: 224–226 °C. IR (KBr): 1235, 1421, 1604, 1631, 1673, 1706, 3258, 3342 cm^{-1}. ^1H NMR: δ 0.32 (t, J=6.9 Hz, 3H, CH_3CH_2), 3.48–3.60 (quartet of quartet, J=6.9 Hz, 2H, CH_3CH_2), 7.5 (d, J=6.9 Hz, 1H), 7.52 (s, J=8.0 Hz, 1H), 7.54 (quintet, J=2.9, 3.5, and 1.7 Hz, 2H), 7.81 (sextet, J=2.9, 3.5, and 6.9 Hz, 1H), 7.95 (sextet, J=3.5, 2.9, and 6.9 Hz, 1H), 8.02 (d, J=7.9 Hz, 1H), 11.50 (s, 1H, D_2O-exchangeable), 11.54 (s, 1H, D_2O-exchangeable). ^{13}C NMR: δ 13.5, 60.4, 108.5, 125.4, 125.6, 126.1, 126.8, 127.1, 127.6, 128.7, 129.2, 140.2, 148.3, 150.7, 154.3, 161.7, 163.8. EIMS (*m/z*): 310 (M^+). Anal. calcd for $C_{17}H_{14}N_2O_4$: C, 65.80; H, 4.55; N, 9.03. Found: C, 65.81; H, 4.56; N, 9.02.

3.3.2.7. Ethyl 2,4-dioxo-3-methyl-6-(4-chlorophenyl)-1,2,3,4-tetrahydropyrimidin-5-carboxylate (3g). Mp: 230–232 °C. IR (KBr): 1236, 1419, 1600, 1630, 1673, 1704, 3257 cm^{-1}. ^1H NMR: δ 1.06 (t, J=7.5 Hz, 3H), 3.65 (s, 3H), 4.08 (q, J=7.5 Hz, 2H), 7.43 (s, 4H), 10.42 (s, 1H, D_2O-exchangeable). ^{13}C NMR: δ 13.8, 27.5, 62.0, 107.7, 129.0, 129.1, 129.3, 138.0, 149.9, 151.9, 160.5, 164.0. EIMS (*m/z*): 308 (M^+). Anal. calcd for $C_{14}H_{13}ClN_2O_4$: C, 54.47; H, 4.24; N, 9.07. Found: C, 54.43; H, 4.23; N, 9.06.

3.3.2.8. 5-Benzoyl-2,4-dioxo-6-(2,4-dichlorophenyl)-pyrimidin-2(1*H*)-one (3h). Mp: >300 °C. IR (KBr): 1235, 1419, 1605, 1628, 1676, 3255, 3341 cm^{-1}. ^1H NMR: δ 7.38 (t, J=7.4 and 8.0 Hz, 2H), 7.42 (m, 2H), 7.57 (d, J=7.4 Hz, 1H), 7.82 (d, J=7.7 Hz, 1H), 8.2 (d, J=10.2 Hz, 1H), 8.27 (s, 1H). ^{13}C NMR: δ 117.6, 128.5, 130.04, 133.5, 134.0, 134.8, 137.7, 138.5, 139.5, 142.3, 152.4, 154.8, 160.0, 167.5, 174.3. EIMS (*m/z*): 361 (M^+). Anal. calcd for $C_{17}H_{10}Cl_2N_2O_3$: C, 56.53; H, 2.79; N, 7.76. Found: C, 56.57; H, 2.79; N, 7.76.

3.3.2.9. Ethyl 2,4-dioxo-6-(4-anisyl)-1,2,3,4-tetrahydropyrimidin-5-carboxylate (3i). Mp: 228–230 °C. IR (KBr): 1241, 1421, 1603, 1629, 1675, 1701, 3261 cm^{-1}. ^1H NMR: δ 1.05 (t, J=7.5 Hz, 3H), 3.84 (s, 3H), 4.13 (q, J=7.5 Hz, 2H), 6.95 (d, J=9.2 Hz, 2H), 7.41 (d, J=7.2 Hz, 2H). ^{13}C NMR: δ 13.8, 56.1, 62.1, 101.0, 108.1, 114.5, 124.5, 130.3, 147.1, 147.9, 156.2, 162.2, 164.4. EIMS (*m/z*): 290 (M^+). Anal. calcd for $C_{14}H_{14}N_2O_5$: C, 57.93; H, 4.86; N, 9.65. Found: C, 57.86; H, 4.78; N, 9.69.

3.3.3. Trapping of 1i as trifluoroacetate salt in solution. Compound **1i** (30 mg) was dissolved in trifluoroacetic acid (1.5 mL) and a drop of TMS was added to the solution as internal reference. ^1H NMR of the solution was recorded in JEOL 500 MHz instrument with 16 scans. TLC of the solution showed disappearance of **1i** and a new spot above the starting material. The dissolution of **1i** in DMSO-d_6 or $CDCl_3$ and (trifluoro)acetic acid did not form salt in solution.

Compound **5**: ^1H NMR (CF_3COOH, TMS): 1.17 (t, J=6.9 Hz, 3H), 2.42 (s, 3H), 3.87 (s, 3H), 4.07 (q, J=6.9 Hz, 2H), 5.49 (s, 1H), 6.97 (d, J=8.6 Hz, 2H), 7.32 (d, J=8.6 Hz, 2H), 8.32 (s, 1H).

Compound **1j**: ^1H NMR (DMSO-d_6): 1.08 (t, J=6.9 Hz, 3H), 2.24 (s, 3H), 3.71 (s, 3H), 3.98 (q, J=6.9 Hz, 2H), 5.10 (s, 1H), 6.86 (d, J=8.6 Hz, 2H), 7.13 (d, J=8.6 Hz, 2H), 7.65 (s, 1H), 9.15 (d, 1H).

3.3.4. Highly regioselective oxidation of DHPMs mediated by CAN. Ethyl 6-methyl-4-phenyl-pyrimidin-2(1*H*)-one-5-carboxylate: a 50 mL round bottom flask containing magnetic bar was charged with **1a** (1 mmol, 0.260 g), $NaHCO_3$ (5 mmol, 0.420 g), and 10 mL of acetone. To this suspension was added CAN (3 mmol, 1.65 g) in water for 1 h stirred at −5 °C under argon atmosphere. The stirring continued overnight at room temperature and the reaction mixture was diluted with $CHCl_3$ (20 mL) and decanted. The residue was washed with $CHCl_3$ (2×30 mL). The combined $CHCl_3$ layer was neutralized, washed with NaCl solution, dried over anhydrous Na_2SO_4, and column chromatographed using 1:1 mixture of ethyl acetate/petroleum ether to afford 0.214 g of **2a**. The same reaction when conducted without using $NaHCO_3$ yielded a mixture of **2a** and **3a**.

3.3.4.1. Ethyl 6-methyl-4-phenyl-pyrimidin-2(1*H*)-one-5-carboxylate (2a). Mp: 216–218 °C. IR (KBr): 1410, 1625, 1655, 1705, 3420 cm^{-1}. ^1H NMR: δ 0.68 (t, J=7.5 Hz, 3H), 2.45 (s, 3H, 6-Me), 3.80 (q, J=7.5 Hz, 2H), 7.31 (d, J=7.5 Hz, 1H), 7.36 (t, J=6.9 Hz, 1H), 7.45 (d, J=6.9 Hz, 2H), 7.47 (t, J=6.3 Hz, 1H), 11.71 (s, 1H, D_2O-exchangeable). ^{13}C NMR: δ 13.6, 19.1, 60.9, 109.2, 127.5, 129.4, 129.7, 130.7, 139.7, 156.6, 162.5, 164.7. EIMS (*m/z*): 258 (M^+). Anal. calcd for $C_{14}H_{14}N_2O_3$: C, 65.11; H, 5.46; N, 10.85. Found: C, 65.09; H, 5.54; N, 10.24.

3.3.4.2. Ethyl 6-methyl-4-biphenyl-pyrimidin-2(1*H*)-one-5-carboxylate (2j). Mp: 178–179 °C. IR (KBr): 1412, 1624, 1655, 1703, 3423 cm^{-1}. ^1H NMR: δ 0.98 (t, J=6.9 Hz, 3H), 2.45 (s, 3H), 3.12 (q, J=6.9 Hz, 2H), 7.32 (t, J=7.6 Hz, 2H), 7.41 (t, J=7.6 Hz, 2H), 7.53 (d, J=8.5 Hz, 2H), 7.66 (d, J=7.6 Hz, 2H), 7.68 (d, J=8.4 Hz, 1H), 11.35 (s, 1H, D_2O-exchangeable). ^{13}C NMR: δ 14.3, 61.5, 108.3, 126.2, 127.8, 128.3, 129.6, 129.7, 130.1, 139.6, 142.7, 146.7, 156.7, 158.0, 164.3, 174.6. EIMS (*m/z*): 334 (M^+).

Anal. calcd for $C_{20}H_{18}N_2O_3$: C, 71.84; H, 5.43; N, 8.38. Found: C, 71.76; H, 5.21; N, 8.73.

3.3.4.3. Ethyl 6-methyl-4-(2-chlorophenyl)-pyrimidin-2(1*H*)-one-5-carboxylate (2k). Mp: 164–166 °C. IR (KBr): 1106, 1422, 1505, 1658, 1713, 1732, 2827, 3147, 3345 cm^{-1}. ^1H NMR: δ 0.69 (t, J=6.8 Hz, 3H), 2.49 (s, 3H), 3.80 (q, J=6.8 Hz, 2H), 7.37–7.45 (m, 4H), 11.53 (s, 1H, NH). ^{13}C NMR: δ 13.6, 19.1, 60.9, 109.5, 127.5, 129.4, 129.7, 130.0, 130.7, 140.1, 155.3, 162.5, 164.7, 172.1. EIMS (*m*/*z*): 292 (M^+). Anal. calcd for $C_{14}H_{13}ClN_2O_3$: C, 57.44; H, 4.48; N, 9.57. Found: C, 57.32; H, 4.42; N, 9.55.

3.3.4.4. Ethyl 6-methyl-4-(2-nitrophenyl)-pyrimidin-2(1*H*)-one-5-carboxylate (2c). Mp: 180–182 °C. IR (KBr): 1208, 1421, 1543, 1641, 1693, 1715, 2827, 3345 cm^{-1}. ^1H NMR: δ 0.67 (t, J=7.5 Hz, 3H), 2.49 (s, 3H), 3.78 (q, J=7.5 Hz, 2H), 7.40 (d, J=7.5 Hz, 1H), 7.67 (t, J=7.5 Hz, 1H), 7.77 (t, J=7.5 Hz, 1H), 8.17 (d, J= 8.1 Hz, 1H), 11.50 (s, 1H, NH). ^{13}C NMR: δ 13.7, 20.5, 61.0, 107.5, 124.6, 129.7, 130.5, 134.05, 134.7, 146.6, 152.3, 162.2, 164.3, 173.3. EIMS (*m*/*z*): 303 (M^+). Anal. calcd for $C_{14}H_{13}N_3O_5$: C, 55.45; H, 4.32; N, 13.86. Found: C, 55.32; H, 4.27; N, 13.74.

3.3.4.5. Ethyl 6-methyl-4-(3-hydroxyphenyl)-pyrimidin-2(1*H*)-one-5-carboxylate (2l). Mp: 180–182 °C. IR (KBr): 1132, 1463, 1643, 1693, 3204, 3421 cm^{-1}. ^1H NMR: δ 0.82 (t, J=6.5 Hz, 3H), 2.4 (s, 3H), 3.9 (q, J=6.5 Hz, 2H), 6.8 (m, 3H), 7.2 (t, 7.5 Hz, 1H), 9.7 (s, 1H), 11.32 (s, 1H). ^{13}C NMR: δ 13.8, 21.1, 61.4, 102.6, 114.8, 117.7, 118.7, 128.5, 129.9, 146.5, 157.7, 160.1, 163.2, 172.4. EIMS (*m*/*z*): 274 (M^+). Anal. calcd for $C_{14}H_{14}N_2O_4$: C, 61.31; H, 5.14; N, 10.21. Found: C, 61.28; H, 5.16; N, 10.20.

3.3.4.6. Methyl 6-methyl-4-(4-methoxyphenyl)-pyrimidin-2(1*H*)-one-5-carboxylate (2m). Mp: 180–181 °C. IR (KBr): 1228, 1456, 1547, 1660, 1681, 1715, 2827, 3348 cm^{-1}. ^1H NMR: δ 2.32 (s, 3H), 3.57 (s, 3H), 3.77 (s, 3H), 6.97 (d, J=8.4 Hz, 2H), 7.40 (d, J=8.4 Hz, 2H), 12.23 (s, 1H, D_2O-exchangeable). ^{13}C NMR: δ 19.2, 52.6, 55.9, 102.3, 114.3, 116.4, 130.0, 136.1, 156.3, 161.7, 167.4, 174.2. EIMS (*m*/*z*): 274 (M^+). Anal. calcd for $C_{14}H_{14}N_2O_4$: C, 61.31; H, 5.14; N, 10.21. Found: C, 61.28; H, 5.08; N, 10.13.

3.3.4.7. Ethyl 1,6-dimethyl-4-phenyl-pyrimidin-2(1*H*)-one-5-carboxylate (2n). Mp: 212–213 °C. IR (KBr): 1103, 1197, 1286, 1439, 1494, 1616, 1679, 1722, 2990 cm^{-1}. ^1H NMR: δ 1.14 (t, J=7.6 Hz, 3H, CH_3CH_2), 2.41 (s, 3H), 3.35 (s, 3H, N-Me), 3.97 (q, J=7.6 Hz, 2H, CH_3CH_2), 7.38 (t, J=6.8 Hz, 2H), 7.41 (t, J=7.6 and 2.3 Hz, 1H), 7.54 (t, J=6.9 Hz, 2H). ^{13}C NMR: δ 13.8, 20.2, 39.3, 61.0, 108.8, 127.9, 128.6, 130.5, 137.1, 153.1, 155.3, 163.5, 173.5. EIMS (*m*/*z*): 272 (M^+). Anal. calcd for $C_{15}H_{16}N_2O_3$: C, 66.16; H, 5.92; N, 10.29. Found: C, 66.08; H, 5.83; N, 10.17.

3.3.4.8. Ethyl 1,6-dimethyl-4-(4-methoxyphenyl)-pyrimidin-2(1*H*)-one-5-carboxylate (2o). Mp: 140–142 °C. IR (KBr): 1231, 1453, 1549, 1662, 1683, 1720, 3351 cm^{-1}. ^1H NMR: δ 0.85 (t, J=6.7 Hz, 3H), 2.38 (s, 3H), 3.46 (s, 3H), 3.73 (s, 3H), 3.92 (q, J=6.8 Hz, 2H), 6.77 (d, J=9.2 Hz, 2H), 7.4 (d, J=9.2 Hz, 2H). ^{13}C NMR: δ 13.6, 18.1, 33.1, 55.4, 61.8, 111.5, 113.7, 129.8, 130.3, 155.9, 158.4, 161.7, 167.3, 169.8. EIMS (*m*/*z*): 302 (M^+). Anal. calcd for $C_{16}H_{18}N_2O_4$: C, 63.56; H, 6.00; N, 9.27. Found: C, 63.44; H, 5.92; N, 9.31.

3.3.4.9. Ethyl 6-methyl-4-(4-methoxyphenyl)-pyrimidin-2(1*H*)-one-5-carboxylate (2i). Mp: 172–173 °C. IR (KBr): 1132, 1463, 1643, 1693, 3220 cm^{-1}. ^1H NMR: δ 0.9 (t, J=6.5 Hz, 3H), 2.3 (s, 3H), 3.81 (s, 3H), 3.93 (q, J=6.8 Hz, 2H), 6.8 (m, 2H), 7.2 (t, J=8.4 Hz, 2H), 9.7 (s, 1H). ^{13}C NMR: δ 13.8, 21.1, 55.2, 61.4, 102.6, 114.8, 118.7, 128.5, 129.9, 146.5, 157.7, 160.1, 172.1. EIMS (*m*/*z*): 288 (M^+). Anal. calcd for $C_{15}H_{16}N_2O_4$: C, 62.49; H, 5.59; N, 9.72. Found: C, 62.35; H, 5.52; N, 9.70.

3.3.4.10. Ethyl 6-methyl-4-(2-propyl)-pyrimidin-2(1*H*)-one-5-carboxylate (4a). Mp: 232–234 °C. IR (KBr): 1131, 1455, 1642, 1688, 3205, 3433 cm^{-1}. ^1H NMR: δ 1.34 (t, J=7.5 Hz, 3H), 1.39 (d, J=6.8 Hz, 6H), 2.45 (s, 3H), 3.15 (m, J=6.8 Hz, 1H), 4.32 (q, J=7.5 Hz, 2H), 13.65 (s, 1H). ^{13}C NMR: δ 14.2, 21.1, 29.7, 61.9, 112.5, 145.6, 159.6, 163.1, 173.6. EIMS (*m*/*z*): 224 (M^+). Anal. calcd for $C_{11}H_{16}N_2O_3$: C, 58.91; H, 7.19; N, 12.49. Found: C, 58.68; H, 7.12; N, 12.42.

3.3.4.11. Ethyl 4-(4-methoxyphenyl)-6-phenyl-pyrimidin-2(1*H*)-one-5-carboxylate (4b). Mp: 153–154 °C. IR (KBr): 1163, 1238, 1328, 1446, 1517, 1599, 1668, 1709, 2280, 2808, 2984, 3213 cm^{-1}. ^1H NMR: δ 0.85 (t, J=6.8 Hz, 3H), 3.82 (s, 3H), 3.90 (q, J=6.8 Hz, 2H), 6.94 (d, J=9.2 Hz, 1H), 7.00 (d, J=8.5 Hz, 1H), 7.40 (m, J=6.9 and 7.6 Hz, 2H), 7.49 (d, J=3.8 Hz, 1H), 7.58 (t, J=8.5 Hz, 2H), 8.01 (q, J=8.5 and 9.2 Hz, 2H), 13.32 (s, 1H, D_2O-exchangeable). ^{13}C NMR: δ 13.5, 55.4, 61.9, 106.5, 114.2, 128.6, 129.2, 129.6, 130.2, 138.5, 139.7, 150.2, 158.2, 162.2, 162.9, 174.1. EIMS (*m*/*z*): 350 (M^+). Anal. calcd for $C_{20}H_{18}N_2O_4$: C, 68.56; H, 5.18; N, 8.00. Found: C, 68.49; H, 5.12; N, 8.02.

3.3.4.12. Ethyl 4-(4-methoxyphenyl)-6-trifluoromethyl-pyrimidin-2(1*H*)-one-5-carboxylate (4c). Mp: 136–138 °C. IR (KBr): 1017, 1127, 1162, 1210, 1299, 1509, 1605, 1699, 1739, 3188 cm^{-1}. ^1H NMR: δ 1.15 (t, J=6.8 Hz, 3H), 3.85 (s, 3H), 4.17 (q, J=6.8 Hz, 2H), 7.05 (d, J=8.4 Hz, 2H), 7.54 (d, J=8.4 Hz, 2H), 11.50 (s, 1H). ^{13}C NMR: δ 13.7, 55.6, 62.8, 109.5, 114.9, 122.0 (q, J=275 Hz), 130.2, 138.6, 155.6 (q, J=34 Hz), 161.2, 163.2, 164.1, 174.2. EIMS (*m*/*z*): 342 (M^+). Anal. calcd for $C_{15}H_{13}F_3N_2O_4$: C, 52.64; H, 3.83; N, 8.18. Found: C, 52.59; H, 3.77; N, 8.19.

3.3.4.13. Ethyl 6-bromomethyl-4-phenyl-pyrimidin-2(1*H*)-one-5-carboxylate (4d). Mp: 181–182 °C. IR (KBr): 1125, 1468, 1651, 1689, 3253, 3455 cm^{-1}. ^1H NMR: δ 0.86 (t, J=7.5 Hz, 3H), 3.84 (s, 2H, CH_2Br), 3.93 (q, J=7.5 Hz, 2H), 7.42 (m, 2H), 7.59 (t, J=6.8 Hz, 3H), 13.52 (s, 1H, D_2O-exchangeable, NH). ^{13}C NMR: δ 13.5, 25.9, 55.5, 105.3, 128.1, 128.7, 130.2, 140.5, 158.1, 162.3, 166.8, 173.1. EIMS (*m*/*z*): 337 (M^+). Anal. calcd for $C_{14}H_{13}BrN_2O_3$: C, 49.87; H, 3.89; N, 8.31. Found: C, 49.78; H, 3.92; N, 8.27.

3.3.4.14. Ethyl 6-methyl-4-(4-(4-bromophenyl)-1-phenyl-1*H*-pyrazolyl)-pyrimidin-2(1*H*)-one-5-carboxylate (4e). Mp: 221–223 °C. IR (KBr): 1058, 1464, 1645, 1693, 3258 cm^{-1}. ^1H NMR: δ 0.78 (t, J=6.8 Hz, 3H), 2.34 (s, 3H), 3.67 (q, J=6.8 Hz, 2H), 7.32 (t, J=7.6 Hz, 1H), 7.43 (d, J=8.4 Hz, 2H), 7.49 (t, J=7.6 Hz, 2H), 7.56 (d, J=7.6 Hz, 2H), 7.89 (d, J=7.6 Hz, 2H), 8.77 (s, 1H), 12.39 (s, 1H, NH(3)). ^{13}C NMR: δ 13.7, 20.2, 61.2, 105.7, 119.0, 124.2, 126.5, 128.5, 130.1, 130.3, 131.2, 132.1, 132.6, 148.3, 149.8, 156.5, 162.3, 163.9, 174.9. EIMS (*m*/*z*): 479 (M^+). Anal. calcd for $C_{23}H_{19}BrN_4O_3$: C, 57.63; H, 4.00; N, 11.69. Found: C, 57.58; H, 3.92; N, 11.67.

3.3.4.15. Ethyl 1,6-dimethyl-4-(1-pyrenyl)-pyrimidin-2(1*H*)-one-5-carboxylate (4f). Mp: 231–232 °C. IR (KBr): 1109, 1463, 1649, 1703 cm^{-1}. ^1H NMR: δ 1.24 (t, J=6.7 Hz, 3H), 2.61 (s, 3H), 3.71 (s, 3H), 4.11 (q, J=7.5 Hz, 2H), 7.93 (t, J=7.5 and 6.8 Hz, 1H), 7.99 (t, J=7.5 Hz, 1H), 8.03 (t, J=8.6 and 8 Hz, 2H), 8.09 (s, 1H), 8.15 (m, 4H). ^{13}C NMR: δ 12.8, 18.5, 33.4, 61.4, 114.0, 124.3, 124.4, 124.5, 125.6, 125.7, 125.8, 126.3, 127.3, 128.1, 128.5, 130.8, 131.3, 132.1, 133.3, 155.8, 159.4, 166.2, 172.7. EIMS (*m*/*z*): 398 (M^+). Anal. calcd for $C_{25}H_{22}N_2O_3$: C, 75.36; H, 5.57; N, 7.03. Found: C, 75.31; H, 5.31; N, 7.12.

3.3.4.16. 7,7-Dimethyl-4-phenyl-7,8-dihydroquinazoline-2,5(1*H*,6*H*)-dione (4g). Mp: 196–198 °C. IR (KBr): 1092, 1323, 1640, 1722, 2956, 3208 cm^{-1}. ^1H NMR: δ 1.35 (s, 6H), 2.58 (s, 2H), 2.88 (s, 2H), 7.01 (q, J=1.7, 5.2, and 7.5 Hz, 2H), 7.40 (q, J=1.7 and 5.2 Hz, 3H), 11.83 (s, 1H). ^{13}C NMR: δ 25.4, 28.3, 32.1, 48.1, 54.1, 108.5, 126.6, 127.8, 128.0, 138.8, 152.3, 167.7, 172.2, 194.8. EIMS (*m*/*z*): 268 (M^+). Anal. calcd for $C_{16}H_{16}N_2O_2$: C, 71.62; H, 6.01; N, 10.44. Found: C, 71.58; H, 5.96; N, 10.46.

3.3.4.17. 4-Phenyl-1*H*-indeno[1,2-*d*]pyrimidin-2,5-dione (4h). Mp: 210–212 °C. IR (KBr): 1276, 1378, 1459, 1576, 1617, 1659, 1723, 2854, 2923, 3484 cm^{-1}. ^1H NMR: δ 7.60 (t, J=6.8 Hz, 2H), 7.65 (q, J=7.5 and 6.3 Hz, 2H), 7.71 (t, J=7.5 and 6.3 Hz, 1H), 7.82 (d, J=7.5 Hz, 1H), 7.89 (d, J=7.5 Hz, 2H), 8.11 (d, J=6.8 Hz, 1H). ^{13}C NMR: δ 106.2, 120.8, 121.5, 126.7, 128.3, 128.9, 130.1, 132.1, 133.7, 135.2, 143.5, 151.2, 157.4, 173.9, 187.5. EIMS (*m*/*z*): 274 (M^+). Anal. calcd for $C_{17}H_{10}N_2O_2$: C, 74.44; H, 3.67; N, 10.21. Found: C, 74.38; H, 3.61; N, 10.20.

3.3.4.18. Ethyl 3-methyl-6-{4-[1-methyl-5-(ethoxycarbonyl)-2,6-dioxo-1,2,3,6-tetrahydro-pyrimidin-4-yl]-phenyl}-2,4-dioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (4i). Mp: >260 °C. IR (KBr): 1050, 1510, 1620, 1690, 3248 cm^{-1}. ^1H NMR: δ 0.97 (t, J=7.5 Hz, 6H), 3.17 (s, 6H), 3.93 (q, J=7.5 Hz, 4H), 7.54 (s, 4H), 11.90 (s, 2H). ^{13}C NMR: δ 14.2, 27.4, 61.5, 112.5, 122.3, 128.5, 131.7, 152.9, 153.0, 161.5, 164.1. EIMS (*m*/*z*): 470 (M^+). Anal. calcd for $C_{22}H_{22}N_4O_8$: C, 56.17; H, 4.71; N, 11.91. Found: C, 56.03; H, 4.59; N, 11.95.

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11. Crystal analysis for **3g**: MF: $C_{14}H_{13}ClN_2O_4$, formula weight: 308.71, crystal system: monoclinic, space group: *P*21/*n*, cell length: *a* 9.5074, *b* 15.158, *c* 9.882, cell angle: α 90°, β 94.149°, γ 90°. Volume (cubic angstroms): 1420.4(5), *Z*: 4, temperature: 293(2) K, absorption coefficient: 0.28. Calculated

density: 1.444, reflections collected/unique 2653/2497 [R(int)=0.0169] R indices (all data) $R1$=0.0672, $wR2$=0.0979. Final R indices [$I>2\sigma(I)$] $R1$=0.0377, $wR2$=0.0861. Crystallographic data was submitted in Cambridge Crystallographic Centre and CCDC no. is 26952.

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