Efficient Synthesis of Benzimidazo[1,2-*a*]pyrimidinone Derivatives *via* Catalyst-Free Reactions of Baylis–Hillman Acetates, Alcohols, and Amines with 2-Aminobenzimidazole

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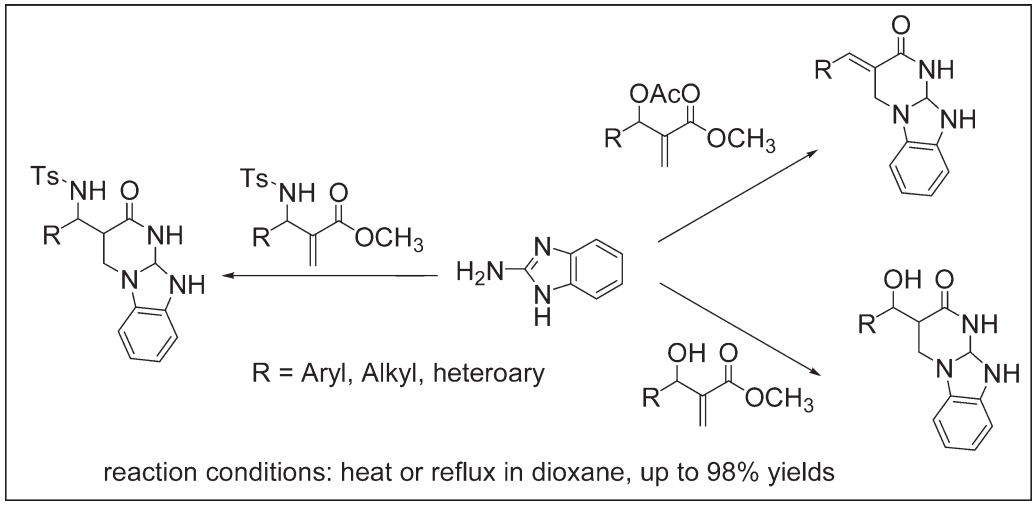

Benzimidazo[1,2-*a*]pyrimidinone and its derivatives were easily prepared in good to excellent yields *via* tandem reactions of 2-aminobenzimidazole with Baylis–Hillman acetates, alcohols, and amines without the use of catalyst and additive in one-pot process. The method provided an efficient and facile route to the title fused heterocyclic compounds with different functional groups.

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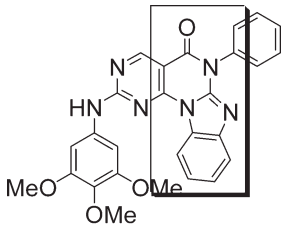
INTRODUCTION

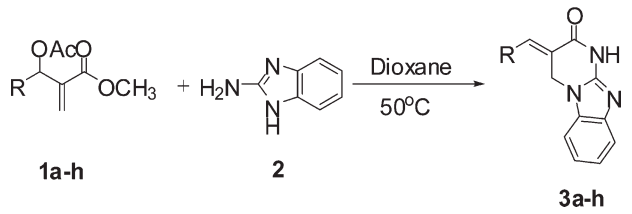
Imidazo[1,2-*a*]pyrimidines are very important intermediates and widely used in pharmaceutical chemistry [1]. Among them, benzimidazo[1,2-*a*]pyrimidinone and its derivatives have attracted considerable attention [2,3]. For example, the compound **A** is a kind of inhibitor of Lck kinase, which is a member of Src family of cytoplasmic tyrosine kinases. The inhibitor might be a useful immunosuppressive agent for the treatment of graft rejection and/or T-cell-mediated autoimmune diseases [4]. There were several approaches to develop the benzimidazo[1,2-*a*]pyrimidinones: the intramolecular substitution reaction of halide with amines [2], the reaction of 2-aminobenzimidazole with propiolic esters and α,β-unsaturated esters [3], and so on. To enhance the diversity of benzimidazo[1,2-*a*]pyrimidinone compounds, a new type of substrate is still required.



Compound **A**

Recently, it was noteworthy that the reactions of 2-aminobenzimidazole with several electrophiles, including nitrile, α,β-unsaturated carbonyl compounds, cyanoacetate, and acetylene-dicarboxylate, have been developed to construct heterocyclic structural unit [5]. The Baylis–Hillman adduct offers an excellent platform for several chemical transformations because of the presence of three functional groups including hydroxyl

Scheme 1



(or substituted amino), double bond, and electron-withdrawing group (alkoxycarbonyl or nitrile) in close proximity. The Baylis–Hillman adducts were illustrated as valuable precursor for the synthesis of heterocycles and many biologically active molecules [6]. It was envisaged that the reaction of 2-aminobenzimidazole with Baylis–Hillman adducts and their derivatives would provide an efficient route for the synthesis of annulated benzimidazole derivatives.

Herein, we wish to report the catalyst-free reactions of Baylis–Hillman acetates, alcohols, and amine for the synthesis of benzimidazo-[1,2-*a*]pyrimidinone and their derivatives bearing different functional groups with significant convenience [7].

RESULTS AND DISCUSSION

The reactions of Baylis–Hillman acetates (1) with 2-aminobenzoimidazole (2). Initially, the reaction of Baylis–Hillman acetate **1a** (R = Ph) and 2-aminobenzimidazole **2** was carried out in dioxane at room temperature without any catalyst, but no reaction was observed even after long period of time. However, on raising the temperature to 50°C, light yellow precipitates formed only after 30 min, affording (*E*)-6-benzylidene-5,6-dihydro-8*H*-benzo[4,5]imidazo[1,2-*a*]-pyrimidin-7-one **3a** in 93% yield (Scheme 1, Table 1, entry 1).

In ^{1}H-NMR spectrum of **3a**, only one signal of N—H was observed, which showed the formation of cyclic product. The formation of lactam structure was further supported by the IR spectrum, in which an amide carbonyl vibration band appeared at 1657 cm^{-1}. The stereochemistry of the newly formed double bond in the products was established as (*E*)-configuration by X-ray diffraction analysis of the single crystal of the product **3d** (R = 2-$F_3CC_6H_4$) (Fig. 1). The structure of the single crystal was also an evidence for the formation of the three nitrogen-containing fused heterocycle.

As shown in Table 1, the substrate scope for the benzimidazo[1,2-*a*]pyrimidine forming process was quite broad, and the reaction demonstrated that various Baylis–Hillman acetates bearing aryl, heteroaryl, or alkyl groups can be used for this transformation. The reaction proceeded smoothly regardless of the electronic character of the substituents existed on the Baylis–Hillman acetates to afford the desired fused heterocycle, benzimidazo[1,2-*a*]pyrimidine derivatives in good to excellent yields (71–97%).

Table 1

Reaction of B-H acetates (**1**) with **2**.[a]

Entry	B-H acetate	Time (h)	Product (R)	Yield[b] (%)
1	**1a**, C_6H_5	0.5	**3a**, C_6H_5	85
2	**1b**, 4-ClC_6H_4	0.5	**3b**, 4-ClC_6H_4	93
3	**1c**, 2-furyl	1.5	**3c**, 2-furyl	76
4	**1d**, 2-$F_3CC_6H_4$	0.5	**3d**, 2-$F_3CC_6H_4$	90
5	**1e**, 3-BrC_6H_4	1.0	**3e**, 3-Br C_6H_4	97
6	**1f**, 3-$MeOC_6H_4$	1.0	**3f**, 3-$MeOC_6H_4$	90
7	**1g**, C_2H_5	1.0	**3g**, C_2H_5	71

[a] **1**:**2** = 1:1.2; in dioxane at 50°C.
[b] Isolated yield.

THE REACTIONS OF BAYLIS–HILLMAN ALCOHOLS (4) WITH 2

In contrast, when the Baylis–Hillman alcohols were used, the hydroxyl group remained in the product. However, as indicated by Batra and coworkers [8], the hydroxyl group was very sensitive to the reaction condition and ease to be removed out during the intramolecular cyclization by debenzylation. To our delight, under the same reaction conditions for Baylis–Hillman acetate, the fused heterocyclic compounds bearing hydroxyl group could be obtained in one-pot process (Scheme 2). As shown in Table 2, various Baylis–Hillman alcohols (**4a–i**) derived from aryl aldehydes reacted smoothly with **2** to give 6-[aryl(hydroxyl)methyl]-benzoimidazo[1,2-*a*]pyrimidines (**5a–i**) in good to excellent yields. The presence of substitute in the *ortho* position of the phenyl ring (**4f–g**) resulted in slow reactivity of the Baylis–Hillman adduct leading to increase in

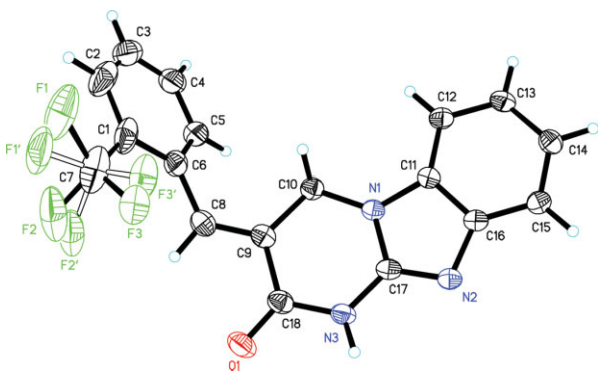
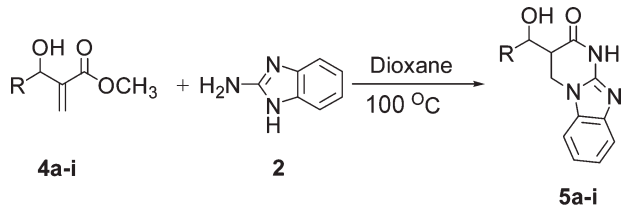


Figure 1. ORTEP drawing of **3d**. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

Scheme 2



reaction time (entries 6 and 7). Moreover, the substrate bearing aromatic heterocyclic (**4h**) and alkyl group (**4i**) also exhibited good ability for the reaction with **2**, affording the corresponding products (**5h** and **5i**) in 78 and 93% yields, respectively (entries 8 and 9).

The reactions of Baylis–Hillman amines (6) with 2. Recently, Lamaty and coworkers assimilated all applications of the aza-Baylis–Hillman adducts for the synthesis of nitrogen-containing compounds. It was demonstrated that when the aza-Baylis–Hillman adduct (Baylis–Hillman amine) was attacked by a nucleophile, the reaction could afford a Michael addition product or an allylic substitution product depending on the reaction conditions, which resulted in the amino group of aza-Baylis–Hillman adducts remaining either in the product or eliminating from the product [9]. When various Baylis–Hillman amines (**6a–g**) were used in the reaction with **2**, under the same condition for Baylis–Hillman acetate the reactions carried out smoothly to afford the Michael addition products **7** in high yields (Table 3). When the substituents in the phenyl ring were electron-withdrawing groups (**6b–f**), the reactions proceeded better than the substrate bearing electron-donating group in the phenyl ring (**6g**) (Entry 7) (Scheme 3).

In conclusion, we have developed an efficient method for the synthesis of benzimidazo[1,2-*a*]pyrimidine derivatives in good to excellent yields. The developed protocol was simple, and no additives or catalysts were required to promote the reaction. The reaction underwent the Michael addition or allylic substitution reaction, followed by intramolecular cyclization. The produced compounds possessed different functions, double bond, hydroxyl and amino groups, which provided an opportunity to do derivatization further for enhancing the diversity of benzimidazo[1,2-*a*]pyrimidine compounds.

Table 2

Reaction of B-H alcohols (**4**) with **2**.[a]

Entry	B-H alcohol	Time (h)	Product (R)	Yield[b] (%)
1	**4a**, C_6H_5	2.0	**5a**, C_6H_5	89
2	**4b**, 4-FC_6H_4	2.0	**5b**, 4-FC_6H_4	93
3	**4c**, 4-ClC_6H_4	2.0	**5c**, 4-ClC_6H_4	94
4	**4d**, 4-$NO_2C_6H_4$	1.5	**5d**, 4-$NO_2C_6H_4$	97
5	**4e**, 3-$NO_2C_6H_4$	2.0	**5e**, 3-$NO_2C_6H_4$	98
6	**4f**, 2-$NO_2C_6H_4$	3.0	**5f**, 2-$NO_2C_6H_4$	93
7	**4g**, 2-$F_3CC_6H_4$	3.0	**5g**, 2-$F_3CC_6H_4$	93
8	**4h**, 2-furyl	1.5	**5h**, 2-furyl	78
9	**4i**, H	3.0	**5i**, H	95

[a] **4**:**2** = 1:1.2; in dioxane at 100°C.
[b] Isolated yield.

Table 3

Reaction of B-H amines (**6**) with **2**.[a]

Entry	B-H amine	Time (h)	Product (R)	Yield[b] (%)
1	**6a**, C_6H_5	2.5	**7a**, C_6H_5	86
2	**6b**, 4-FC_6H_4	5.0	**7b**, 4-FC_6H_4	91
3	**6c**, 4-ClC_6H_4	1.0	**7c**, 4-ClC_6H_4	94
4	**6d**, 4-$NO_2C_6H_4$	0.5	**7d**, 4-$NO_2C_6H_4$	81
5	**6e**, 3-$NO_2C_6H_4$	1.5	**7e**, 3-$NO_2C_6H_4$	97
6	**6f**, 2-$NO_2C_6H_4$	2.0	**7f**, 2-$NO_2C_6H_4$	96
7	**6g**, 4-MeC_6H_4	3.0	**7g**, 4-MeC_6H_4	75

[a] **6**:**2** = 1:1.2; in dioxane at 100°C.
[b] Isolated yield.

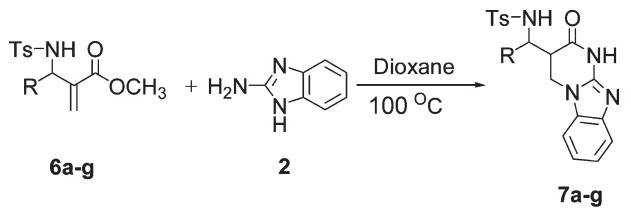
EXPERIMENTAL

IR spectra were recorded with a Perkin–Elmer 782 IR spectrometer. ^{1}H-NMR and ^{13}C-NMR spectra were obtained with a Bruker DMX-300 (300 MHz) spectrometer. Chemical shifts are given in ppm relative to tetramethylsilane (TMS), and the center of the multiplet of the DMSO was also defined as 39.53 ppm for ^{13}C-NMR spectra. HRMS (EI) spectra were measured on a JEOL JMS-DX303. Melting points were measured with a Beijing-Taike X-4 apparatus and are uncorrected. Unless otherwise noted, all reagents were obtained from commercial suppliers and were used without further purification.

According to reference's method [10], starting from α,β-unsaturated ester, with aryl or alkyl aldehydes the B-H alcohols (**4a–i**), and with imines the B-H amines (**6a–g**) were synthesized, respectively. B-H acetates (**1a–h**) were derived from B-H alcohols by acetyl chloride.

General procedure for the reaction of Baylis–Hillman acetates (1a–h) with 2-aminobenzimidazole (2). To a solution of B-H acetate **1a–h** (1 mmol) in dioxane was added 2-aminobenimidazole **2** (1.2 mmol), and the resultant reaction mixture was heated at 50°C. Upon completion as judged by TLC or the reaction time given in Table 1, precipitates were formed, which were filtered and washed with ether. The crude product was recrystallized from dichloromethane/

Scheme 3



petroleum ether to give corresponding products, benzimidazo[1,2-*a*]pyrimidinone derivatives (**3a–g**).

(*E*)-6-Benzylidene-5,6-dihydro-8*H*-benzo[4,5]imidazo[1,2-*a*]pyrimidin-7-one (3a). A light brown solid, m.p. > 300°C (decom.); FTIR (KBr): 3271, 2923, 1668, 1589, 1338 cm^{-1}; ^{1}H-NMR (300 MHz, DMSO-d_6): δ 5.33 (s, 2H, CH_2), 7.13 (s, 2H, ArH), 7.28–7.65 (m, 7H, ArH), 7.90 (s, 1H, CH), 11.80 (brs, 1H, NH); ^{13}C-NMR (75 MHz, DMSO-d_6): δ = 42.3, 109.2, 117.1, 120.6, 121.6, 121.8, 128.9, 129.7, 130.6, 133.1, 133.8, 138.1, 141.5, 146.4, 161.8; HR MS(EI): *m/z* calcd. for $C_{17}H_{13}N_3O$ (M^+): 275.1059, found 275.1057.

(*E*)-6-(4-Chlorobenzylidene)-5,6-dihydro-8*H*-benzo[4,5]imidazo[1,2-*a*]pyrimidine-7-one (3b). A light brown solid, m.p. > 300°C (decom.); FTIR (KBr): 3271, 2923, 1668, 1589, 1338 cm^{-1}; ^{1}H-NMR (300 MHz, DMSO-d_6): δ 5.31 (s, 2H, CH_2), 6.88 (s, 2H, ArH), 7.42–7.67 (m, 7H, ArH), 7.88 (s, 1H, CH), 11.83 (brs, 1H, NH); ^{13}C-NMR (75 MHz, DMSO-d_6): δ 42.2, 109.2, 117.1, 120.6, 121.6, 122.7, 128.9, 132.4, 132.8, 133.1, 134.3, 136.7, 141.5, 146.4, 161.6; HR MS(EI): *m/z* calcd. for $C_{17}H_{13}N_3O$ (M^+): 309.0669, found 309.0672.

(*E*)-6-(Furan-2-ylmethylene)-5,6-dihydro-8*H*-benzo[4,5]imidazo[1,2-*a*]pyrimidin-7-one (3c). A light yellow solid, m.p. > 300°C (decom.); FTIR (KBr): 3430, 3118, 1684, 1532, 1348 cm^{-1}; ^{1}H-NMR (300 MHz, DMSO-d_6): δ 5.30 (s, 2H, CH_2), 6.80 (d, 1H, *J* = 1.4 Hz, ArH), 7.14–7.20 (m, 3H, ArH), 7.42–7.54 (m, 2H, ArH), 7.69 (s, 1H, ArH), 8.01 (s, 1H, CH), 11.8 (brs, 1H, NH); ^{13}C-NMR (75 MHz, DMSO-d_6): δ 42.6, 109.0, 113.2, 117.1, 117.9, 120.6, 121.6, 123.9, 133.1, 141.5, 146.6, 146.7, 150.4, 161.2; HRMS(EI): *m/z* calcd. for $C_{15}H_{11}N_3O_2$ (M^+): 265.0851, found 265.0849.

(*E*)-6-(*o*-Trifluoromethylbenzylidene)-5,6-dihydro-8*H*-benzo[4,5]imidazo[1,2-*a*]pyrimidin-7-one (3d). A white solid, m.p. > 300°C (decom.); FTIR (KBr): 3157, 1692, 1531, 1457, 1351 cm^{-1}; ^{1}H-NMR (300 MHz, DMSO-d_6): δ 5.14 (s, 2H, CH_2), 7.05–7.14 (m, 3H, ArH), 7.36–7.44 (dd, 2H, *J* = 7.2, 7.6 Hz, ArH), 7.70 (t, 1H, *J* = 6.7 Hz, ArH), 7.83–7.92 (dd, 2H, *J*= 7.9, 7.5 Hz, ArH), 8.01 (s, 1H, CH), 11.9 (brs, 1H, NH); ^{13}C-NMR (75 MHz, DMSO-d_6): δ 41.5, 109.2, 117.1, 120.8, 121.7, 125.6, 126.3, 126.3, 127.5, 129.6, 130.4, 132.1, 132.9, 133.0, 134.0, 141.4, 146.5, 161.4; HRMS(EI): *m/z* calcd. for $C_{18}H_{12}N_3OF_3$ (M^+): 343.0932, found 343.0929. The crystal used for the X-ray study had the dimensions 0.41 mm × 0.38 mm × 0.06 mm. Crystal data: $C_{18}H_{12}F_3N_3O$, *M* = 343.31, monoclinic, space group *P*2(1)/*c*, *a* = 6.5560(13), *b* = 33.361(7), *c* = 7.1651(14) Å, β = 99.55(3)°, *V* = 1545.4(5) Å^3, *Z* = 4, D_{calcd} = 1.476 g/cm^3, F_0 = 704, reflections collected: 8887, λ = 0.71073 Å. CCDC: 738372.

(*E*)-6-(3-Bromobenzylidene)-5,6-dihydro-8*H*-benzo[4,5]imidazo[1,2-*a*]pyrimidine-7-one (3e). A light yellow solid, m.p. > 300°C (decom.); FTIR (KBr): 3271, 2923, 1668, 1589, 1338 cm^{-1}; ^{1}H-NMR (300 MHz, DMSO-d_6): δ 5.31 (s, 2H, CH_2), 7.12 (t, 2H, *J* = 2.1 Hz, ArH), 7.41 (m, 1H, CH), 7.50 (m, 2H, ArH), 7.67 (t, 2H, *J* = 8.0 Hz, ArH), 7.84–7.86 (m, 2H, ArH); 11.9 (brs, 1H, NH); ^{13}C-NMR (75 MHz, DMSO-d_6): δ 42.1, 109.2, 117.1, 120.7, 121.7, 122.1, 123.5, 129.0, 130.9, 132.2, 132.9, 133.0, 136.2, 136.5, 141.5, 146.5, 161.5; HRMS(EI): *m/z* calcd. for $C_{17}H_{13}N_3O$ (M^+): 355.0143, found 355.0148.

(*E*)-6-(3-Methoxybenzylidene)-5,6-dihydro-8*H*-benzo[4,5]imidazo[1,2-*a*]pyrimidine-7-one (3f). A white solid; m.p. > 300°C (decom.); FTIR (KBr): 3271, 2923, 1668, 1589, 1338 cm^{-1}; ^{1}H-NMR (300 MHz, DMSO-d_6): δ 3.85 (s, 3H, CH_3), 5.33 (s, 2H,CH_2), 7.06–7.44 (m, 5H, ArH), 7.44–7.47 (m, 3H, ArH), 7.89 (s, 1H, CH); 11.84 (brs, 1H, NH); ^{13}C-NMR (75 MHz, DMSO-d_6): δ 42.2, 55.2, 109.2, 115.6, 115.8, 117.1, 120.6, 121.6, 122.1, 122.6, 129.9, 133.1, 135.2, 138.2, 141.5, 146.4, 159.4, 161.8; HRMS(EI): *m/z* calcd. for $C_{17}H_{13}N_3O$ (M^+): 305.1164, found 305.1167.

(*E*)-6-Propylidene-5,6-dihydro-8*H*-benzo[4,5]imidazo[1,2-*a*]pyrimidin-7-one (3g). A white solid; m.p. = 267–268°C (decom.); FTIR (KBr): 3422, 2888, 1685, 1535, 1349 cm^{-1}; ^{1}H-NMR (300 MHz, DMSO-d_6): δ 1.06 (t, 3H, *J* = 7.5 Hz, CH_3CH_2), 2.29 (p, 2H, *J* = 7.6, 7.4 Hz, CH_3CH_2), 4.99 (s, 2H, CH_2), 6.93 (t, 1H, *J* = 7.4 Hz, $CHCH_2$), 7.11 (dd, 2H, *J* = 7.3, 0.7 Hz, ArH), 7.38–7.44 (m, 2H, ArH), 11.5 (brs, 1H, NH); ^{13}C-NMR (75 MHz, DMSO-d_6): δ 13.1, 21.6, 41.1, 109.6, 117.7, 121.1, 121.9, 122.1, 133.7, 142.2, 144.9, 147.4, 161.9; HRMS(EI): *m/z* calcd. for $C_{13}H_{13}N_3O$ (M^+): 227.1059, found 227.1057.

According to the same procedure, starting from Baylis–Hillman alcohols (**4**) and amines (**6**) with 2-aminobenzimidazole (**2**), **5a–i** and **7a–g** were synthesized and the diastereoselectivities were around 1:1 determined by NMR.

6-(Phenylhydroxymethyl)-5,6-dihydro-8*H*-benzo[4,5]imidazo[1,2-*a*]pyrimidin-7-one (5a). A white solid, m.p. = 233–235°C (decom.); FTIR (KBr): 3390, 3064, 1665, 1515, 1458, 1334 cm^{-1}; ^{1}H-NMR (300 MHz, DMSO-d_6): δ 3.26 (m, 1H, CHCO), 3.97 (m, 1H, CH_2), 4.19 (m, 1H, CH_2), 5.08 (5.28) (m, 1H, OH), (the data in parentheses are for diastereomeric peaks, the same below), 5.80 (m, 1H, $CHOH$), 7.01–7.16 (m, 2H, ArH), 7.19–7.33 (m, 2H, ArH), 7.33–7.52 (m, 5H, ArH), 11.53 (s, 1H, NH); ^{13}C-NMR (75 MHz, DMSO-d_6): δ 36.9, 46.6, 69.8, 108.6, 117.1, 120.6, 121.2, 125.9, 127.1, 128.1, 133.0, 141.7, 142.8, 147.6, 168.6; HRMS(EI): *m/z* calcd. for $C_{17}H_{16}N_3O_2$ (M^++1): 294.1234, found 294.1237.

6-[(4-Fluorophenyl)hydroxymethyl]-5,6-dihydro-8*H*-benzo[4,5]imidazo[1,2-*a*]pyrimidin-7-one (5b). A white solid, m.p. = 225–227°C (decom.); FTIR (KBr): 3382, 3056, 1678, 1510, 1457, 1223 cm^{-1}; ^{1}H-NMR (300 MHz, DMSO-d_6): δ 3.27 (m, 1H, CHCO), 3.96–4.25 (m, 2H, CH_2), 5.07 (5.25) (m, 1H, OH), 5.87–5.90 (m, 1H, $CHOH$), 6.91–6.97 (m, 1H, ArH), 7.06–7.12 (m, 2H, ArH), 7.15–7.24 (m, 1H, ArH), 7.24–7.34 (m, 2H, ArH), 7.38–7.45 (m, 2H, ArH), 11.50 (s, 1H, NH); ^{13}C-NMR (75 MHz, DMSO-d_6): δ 37.0, 46.7, 69.2, 108.7, 114.7, 115.0, 117.1, 120.6, 121.2, 127.9, 128.0, 133.0, 141.7, 147.6, 168.5; HRMS(EI): *m/z* calcd. for $C_{17}H_{15}N_3O_2F$ (M^+ + 1): 312.1141, found 312.1143.

6-[(4-Chlorophenyl)hydroxymethyl]-5,6-dihydro-8*H*-benzo[4,5]imidazo[1,2-*a*]pyrimidin-7-one (5c). A white solid, m.p. = 206–208°C (decom.); FTIR (KBr): 3414, 3054, 1689, 1526, 1458, 1238 cm^{-1}; ^{1}H-NMR (300 MHz, DMSO-d_6): δ 3.28 (m, 1H, CHCO), 3.97–4.27 (m, 2H, CH_2), 5.09 (2.27) (m, 1H, OH), 5.76–5.93 (m, 1H, $CHOH$), 6.85–7.50 (m, 8H, ArH), 11.53 (s, 1H, NH); ^{13}C-NMR (75 MHz, DMSO-d_6): δ 36.9, 46.6, 69.8, 108.6, 117.1, 120.6, 121.2, 125.9, 127.1, 127.9, 128.1, 133.0, 142.8, 147.6, 168.6; HRMS (EI): *m/z* calcd. for $C_{17}H_{15}N_3O_2Cl$ (M^+ + 1): 328.0845, found 328.0847.

6-[(4-Nitrophenyl)hydroxymethyl]-5,6-dihydro-8*H*-benzo[4,5]imidazo[1,2-*a*]-pyrimidin-7-one (5d). A white solid, m.p. = 231–233°C (decom.); FTIR (KBr): 3373, 3052, 1667, 1521, 1456, 1348 cm^{-1}; ^{1}H-NMR (300 MHz, DMSO-d_6): δ 3.40 (m, 1H, CHCO), 3.98–4.34 (m, 2H, CH_2), 5.15 (5.05) (m,

1H, OH), 6.17–6.18 (m, 1H, C*H*OH), 7.06–7.09 (m, 2H, ArH), 7.28–7.38 (m, 2H, ArH), 7.52–7.72 (m, 2H, ArH), 7.97–8.26 (m, 2H, ArH), 11.60 (s, 1H, NH); ^{13}C-NMR (75 MHz, DMSO-d_6): δ 36.9, 46.3, 69.0, 108.8, 117.1, 120.6, 121.3, 123.3, 127.4, 133.0, 141.6, 146.7, 147.5, 150.8, 168.1; HRMS(EI): *m/z* calcd. for $C_{17}H_{13}N_4O_4$ (M^+ + 1): 339.1086, found 339.1087.

6-[(3-Nitrophenyl)hydroxymethyl]-5,6-dihydro-8*H*-benzo[4,5]imidazo[1,2-*a*]-pyrimidin-7-one (5e). A white solid, m.p. = 211–213°C (decom.); FTIR (KBr): 3378, 3051, 1671, 1523, 1456, 1351 cm^{-1}; ^{1}H-NMR (300 MHz, DMSO-d_6): δ 3.42 (m, 1H, CHCO), 4.01–4.29 (m, 2H, CH_2), 5.25 (5.50) (m, 1H, OH), 5.75–6.19 (m, 1H, C*H*OH), 7.04–7.11 (m, 2H, ArH), 7.26–7.45 (m, 2H, ArH), 7.64–7.69 (m, 1H, ArH), 7.85–7.92 (m, 1H, ArH), 8.11–8.17 (m, 1H, ArH), 8.27 (m, 1H, ArH), 11.60 (s, 1H, NH); ^{13}C-NMR (75 MHz, DMSO-d_6): δ 36.9, 46.3, 68.7, 108.9, 117.1, 120.6, 120.8, 121.3, 122.1, 129.6, 132.8, 133.0, 141.6, 145.3, 147.5, 147.8, 168.2; HRMS(EI): *m/z* calcd. for $C_{17}H_{13}N_4O_4$ (M^+ + 1): 339.1086, found 339.1087.

6-(2-Nitrophenylhydroxymethzyl)-5,6-dihydro-8*H*-benzo[4,5]imidazo[1,2-*a*]-pyrimidin-7-one (5f). A white solid, m.p. = 204–206°C (decom.); FTIR (KBr) 3360, 3055, 1671, 1523, 1456, 1340 cm^{-1}; ^{1}H-NMR (300 MHz, DMSO-d_6) δ 3.34 (m, 1H, CHCO), 4.11 (m, 1H, CH_2), 4.28 (m, 1H, CH_2), 5.53 (5.86) (m, 1H, OH), 6.14 (m, 1H, C*H*OH), 7.10 (m, 2H, ArH), 7.30 (m, 1H, ArH), 7.41 (m, 1H, ArH), 7.59 (m 1H, ArH), 7.82 (m, 1H, ArH), 7.91 (m, 1H, ArH), 8.03 (m, 1H, ArH), 11.60 (s, 1H, NH); ^{13}C-NMR (75 MHz, DMSO-d_6) δ 37.3, 45.4, 65.1, 108.8, 117.1, 120.6, 121.2, 124.3, 128.6, 129.3, 133.0, 133.5, 138.1, 141.7, 147.2, 147.6, 168.0; HRMS(EI): *m/z* calcd. for $C_{17}H_{13}N_4O_4$ (M^+ + 1): 339.1086, found 339.1087.

6-[(2-Trifluoromethylphenyl)hydroxymethyl]-5,6-dihydro-8*H*-benzo[4,5]imidazo[1,2-*a*]pyrimidin-7-one (5g). A white solid, m.p. = 175–177°C (decom.); FTIR (KBr): 3393, 3054, 1674, 1525, 1456, 1312 cm^{-1}; ^{1}H-NMR (300 MHz, DMSO-d_6): δ 3.15 (m, 1H, CHCO), 4.16 (m, 1H, CH_2), 4.35 (m, 1H, CH_2), 5.20 (5.62) (m, 1H, OH), 5.93–6.11 (m, 1H, C*H*OH), 6.75–7.95 (m, 8H, ArH), 11.58 (s, 1H, NH); ^{13}C-NMR (75 MHz, DMSO-d_6): δ 36.9, 46.2, 65.1, 108.8, 117.1, 120.6, 121.2, 125.4, 125.5, 127.9, 129.2, 132.4, 133.0, 141.6, 141.8, 147.5, 167.9; HRMS(EI): *m/z* calcd. for $C_{18}H_{13}N_3O_2F$ (M^+ + 1): 362.1106, found 362.1101.

6-(Furan-2-ylmethyl)-5,6-dihydro-8*H*-benzo[4,5]-imidazo[1,2-*a*]pyrimidin-7-one (5h). A yellow solid, m.p. = 206–208°C (decom.); FTIR (KBr) 3434, 3054, 1685, 1522, 1456, 1384 cm^{-1}; ^{1}H-NMR (300 MHz, DMSO-d_6) δ 3.39 (m, 1H, CHCO), 4.04–4.34 (m, 2H, CH_2), 5.09 (5.25) (m, 1H, OH), 5.98–5.99 (m, 1H, C*H*OH), 6.23–7.64 (m, 7H, ArH), 11.55 (s, 1H, NH); ^{13}C-NMR (75 MHz, DMSO-d_6) δ 37.4, 44.2, 64.6, 106.8, 108.8, 110.3, 117.1, 120.6, 121.3, 133.0, 141.7, 142.2, 147.5, 155.2, 169.1; HRMS(EI): *m/z* calcd. for $C_{15}H_{14}N_3O_2$ (M^+ + 1): 284.1026, found 284.1029.

6-(Methylhydroxymethyl)-5.6-dihydro-8*H*-benzo-[4,5]imidazo[1,2-*a*]pyrimidin-7-one (5i). A white solid, m.p. = 260–262°C (decom.); FTIR (KBr) cm^{-1}; ^{1}H-NMR (300 MHz, DMSO-d_6) δ 3.05 (m, 1H, CHCO), 3.76 (m, 2H, CH_2OH), 4.13 (m, 1H, CH_2CH), 4.42 (m, 1H, CH_2CH), 5.00 (5.02) (m, 1H, OH), 7.11 (m, 2H, ArH), 7.41 (m, 2H, ArH), 11.47 (s, 1H, NH); ^{13}C-NMR (75 MHz, DMSO-d_6) δ 38.7, 42.0, 59.1, 108.8, 117.1, 120.6, 121.3, 133.0, 141.7, 147.7, 168.9; HRMS(EI): *m/z* calcd. for $C_{15}H_{14}N_3O_2$ (M^++1): 218.0924, found 218.0924.

6-[(Phenyl)tosylaminomethyl]-5,6-dihydro-8*H*-benzo[4,5]imidazo[1,2-*a*]pyrimidin-7-one (7a). A white solid, m.p. = 239–241°C (decom.); FTIR (KBr): 3343, 3059, 1680, 1457, 1328, 1239 cm^{-1}; ^{1}H-NMR (300 MHz, DMSO-d_6): δ 2.24 (s, 3H, CH_3), 3.17–3.32 (m, 1H, CHCO), 3.70–4.50 (m, 2H, CH_2CH), 4.60–4.80 (m, 1H, C*H*NH), 6.90–7.50 (m, 13H, ArH), 8.40 (8.70) (m, 1H, $NHSO_2$) (the data in parentheses are for diastereomeric peaks, the same below), 11.53 (s, 1H, NHCO); ^{13}C-NMR (75 MHz, DMSO-d_6): δ 20.8, 46.2, 56.3, 66.0, 108.8, 120.8, 121.3, 126.3, 127.0, 127.3, 127.8, 129.0, 129.1, 132.6, 133.0, 137.1, 138.6, 142.2, 147.1, 167.6; HRMS(EI): *m/z* calcd. for $C_{24}H_{23}N_4O_3S$ (M^+ + 1): 447.1480, found 447.1485.

6-[(4-Fluorophenyl)tosylaminomethyl]-5,6-dihydro-8*H*-benzo[4,5]imidazo[1,2-*a*]pyrimidin-7-one (7b). A white solid, m.p. > 300°C (decom.); FTIR (KBr): 3415, 3050, 1680, 1510, 1456, 1160 cm^{-1}; ^{1}H-NMR (300 MHz, DMSO-d_6): δ 2.26 (s, 3H, CH_3), 3.15–3.31 (m, 1H, CHCO), 3.70–4.50 (m, 2H, CH_2CH), 4.55–4.85 (m, 1H, C*H*NH), 6.81–7.43 (m, 12H, ArH), 8.38 (8.80) (m, 1H, $NHSO_2$), 11.56 (s, 1H, NHCO); ^{13}C-NMR (75 MHz, DMSO-d_6): δ 20.8, 46.1, 55.5, 55.7, 108.9, 114.3, 114.6, 117.2, 120.8, 121.4, 126.4, 129.0, 129.1, 132.6, 133.0, 137.8, 137.9, 142.2, 147.1, 167.5; HRMS(EI): *m/z* calcd. for $C_{24}H_{22}N_4O_3SF$ (M^+ + 1): 465.1389, found 465.1391.

6-[(4-Chlorophenyl)tosylmethyl]-5,6-dihydro-8*H*-benzo[4,5]imidazo[1,2-*a*]pyrimidin-7-one (7c). A white solid, m.p. = 260–262°C (decom.); FTIR (KBr) 3263, 3053, 1689, 1456, 1331, 1159 cm^{-1}; ^{1}H-NMR (300 MHz, DMSO-d_6) δ 2.27 (s, 3H, CH_3), 3.20–3.32 (m, 1H, CHCO), 3.57–4.32 (m, 2H, CH_2CH), 4.55–4.71 (m, 1H, C*H*NH), 7.00–7.42 (m, 12H, ArH), 8.40 (8.70) (m, 1H, $NHSO_2$), 11.54 (s, 1H, NHCO); ^{13}C-NMR (75 MHz, DMSO-d_6) δ 20.8, 30.6, 46.0, 55.7, 108.9, 117.3, 120.9, 121.4, 126.4, 127.7, 129.0, 129.1, 131.8, 132.0, 136.1, 137.6, 137.8, 142.4, 147.1, 167.4; HRMS(EI): *m/z* calcd. for $C_{24}H_{22}N_4O_3SCl$ (M^+ + 1): 481.1092, found 481.1095.

6-[(4-Nitrophenyl)tosylaminomethyl]-5,6-dihydro-8*H*-benzo[4,5]imidazo[1,2-*a*]pyrimidin-2-one (7d). A white solid, m.p. = 268–270°C (decom.); FTIR (KBr): 3306, 3056, 1684, 1519, 1348, 1157 cm^{-1}; ^{1}H-NMR (300 MHz, DMSO-d_6): δ 2.24 (s, 3H, CH_3), 3.34–3.45 (m, 1H, CHCO), 3.70–4.40 (m, 2H, CH_2CH), 4.70–4.95 (m, 1H, C*H*NH), 7.00–8.00 (m, 12H, ArH), 8.50 (8.83) (m, 1H, $NHSO_2$), 11.56 (s, 1H, NHCO); ^{13}C-NMR (75 MHz, DMSO-d_6): δ 20.8, 38.7, 45.3, 51.0, 108.8, 117.1, 120.7, 121.3, 124.1, 126.2, 128.7, 129.1, 130.3, 132.8, 133.0, 133.1, 137.2, 141.3, 142.4, 147.2, 148.1, 167.0; HRMS(EI): *m/z* calcd. for $C_{24}H_{22}N_5O_5S$ (M^+ + 1): 492.1339, found 492.1336.

6-[(3-Nitrophenyl)tosylaminomethyl]-5,6-dihydro-8*H*-benzo[4,5]imidazo[1,2-*a*]pyrimidin-7-one (7e). A white solid, m.p. = 281–283°C (decom.); FTIR (KBr): 3300, 3065, 1692, 1530, 1329, 1157 cm^{-1}; ^{1}H-NMR (300 MHz, DMSO-d_6): δ 2.21 (s, 3H, CH_3), 3.32–3.45 (m, 1H, CHCO), 3.80–4.40 (m, 2H, CH_2CH), 4.72–4.95 (m, 1H, C*H*NH), 6.80–8.00 (m, 12H, ArH), 8.50 (8.85) (m, 1H, $NHSO_2$), 11.56 (s, 1H, NHCO); ^{13}C-NMR (75 MHz, DMSO-d_6): δ 20.7, 30.6, 45.6, 55.5, 108.9, 117.1, 120.8, 121.4, 121.9, 122.1, 126.4, 129.0, 129.3, 132.9, 134.1, 137.7, 140.8, 141.6, 142.3, 147.2, 147.3, 166.7;

HRMS(EI): *m*/*z* calcd. for $C_{24}H_{22}N_5O_5S$ ($M^+ + 1$): 492.1339, found 492.1336.

6-[(2-Nitrophenyl)tosylaminomethyl)-5,6-dihydro-8*H*-benzo[4,5]imidazo[1,2-*a*]pyrimidin-7-one (7f). A white solid, m.p. = 178–180°C (decom.); FTIR (KBr): 3381, 3051, 1697, 1525, 1346, 1160 cm^{-1}; ^{1}H-NMR (300 MHz, DMSO-d_6): δ 2.25 (s, 3H, CH_3), 3.35–3.50 (m, 1H, CHCO), 3.80–4.45 (m, 2H, C*H*$_2$CH), 5.30–5.48 (m, 1H, C*H*NH), 7.05–7.85 (m, 12H, ArH), 8.65 (8.75) (m, 1H, $NHSO_2$), 11.58 (s, 1H, NHCO); ^{13}C-NMR (75 MHz, DMSO-d_6): δ 20.8, 38.7, 45.3, 51.0, 108.8, 117.1, 120.7, 121.3, 124.1, 126.2, 128.7, 129.1, 130.3, 132.8, 133.0, 133.1, 137.2, 141.3, 142.4, 147.2, 148.1, 167.0; HRMS(EI): *m*/*z* calcd. for $C_{24}H_{22}N_5O_5S$ ($M^+ + 1$): 492.1339, found 492.1336.

6-[(4-Methylphenyl)tosylaminomethyl)-5,6-dihydro-8*H*-benzo[4,5]imidazo[1,2-*a*]pyrimidin-7-one (7g). A white solid, m.p. = 251–253°C (decom.); FTIR (KBr): 3274, 3052, 1692, 1456, 1323, 1159 cm^{-1}; ^{1}H-NMR (300 MHz, DMSO-d_6): δ 2.26 (s, 3H, CH_3), 3.14–3.24 (m, 1H, CHCO), 3.57–4.40 (m, 2H, C*H*$_2$CH), 4.57–4.64 (m, 1H, C*H*NH), 6.79–7.39 (m, 12H, ArH), 8.30 (8.85) (m, 1H, $NHSO_2$), 11.49 (s, 1H, NHCO); ^{13}C-NMR (75 MHz, DMSO-d_6): δ 20.5, 20.8, 46.2, 56.1, 108.8, 117.2, 119.1, 120.8, 121.3, 127.0, 128.4, 129.0, 132.6, 134.0, 135.6, 136.5, 138.0, 141.1, 147.4, 167.6; HRMS(EI): *m*/*z* calcd. for $C_{25}H_{25}N_4O_3S$ ($M^+ + 1$): 461.1637, found 481.1642.

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