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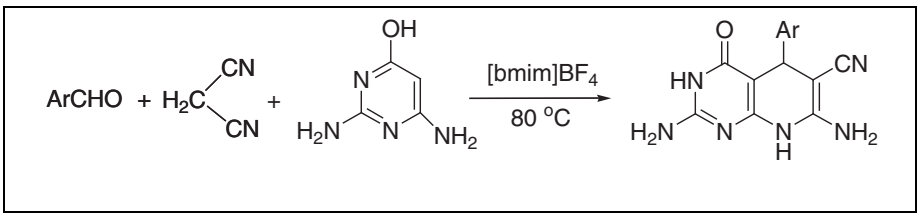

Ionic liquid [bmim]BF_4 was found to be an efficient and recyclable reaction medium for the one-pot synthesis of pyrido[2,3-*d*] pyrimidines. The structures of the products were characterized by IR, ^{1}H NMR, and HRMS spectra. This method had the advantages of easier work-up, milder reaction conditions, high yields, and environmentally benign procedure.

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INTRODUCTION

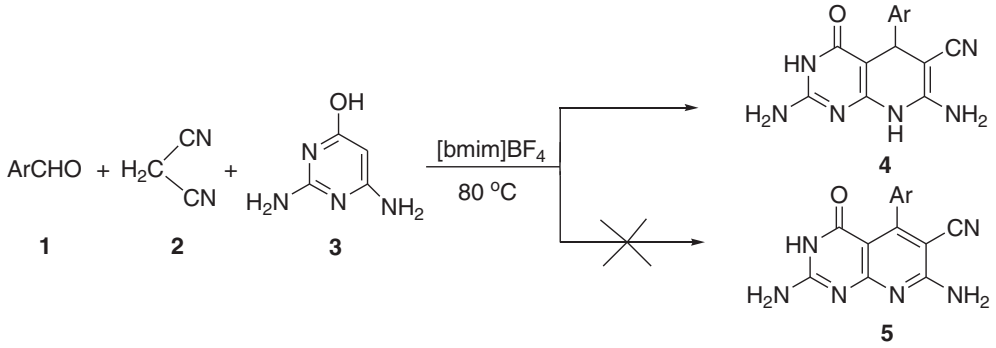
Heterocyclic compounds containing nitrogen atoms are of great value in the design and discovery of new biologically active compounds. For example, uracil and its derivatives have received considerable attention because of their wide range of biological activities [1]. Among them, pyrido[2,3-*d*]pyrimidines are annulated uracils that have diverse pharmacological activity such as antitumour, antibacterial, anti-inflammatory antiviral, antihypertensive, antibronchitic, and antimicrobial activity [2–6].

Therefore, it is not surprising that research on the synthesis of pyrido[2,3-*d*]pyrimidines has received significant attention. Stanley synthesized pyrido[2,3-*d*]pyrimidine-2, 4-diones by the acid-catalyzed and base-catalyzed condensation of 6-amino-1,3-dimethyluracil with α, β-unsaturated carbonyl compounds [7]. Quiroga *et al*. reported the synthesis of pyrido[2,3-*d*]pyrimidines by the reaction of 6-amino-2,3-dihydro-2-thioxo-4(1*H*)-pyrimidinone and α, β-unsaturated ketones in boiling DMF [8]. Sharma reported synthesis of 5,7-disubstituted 3-phenyl- pyrido[2,3-*d*] pyrimidine-2,4(1*H*,3*H*)-diones starting from chalcone and malononitrile in a two-step reaction performed in ethanol or dioxane during 22–24 h [9]. Recently, Wang reported the synthesis of pyrido[2,3-*d*]pyrimidines by the reaction of aldehydes, malononitrile or cyanoacetate, and 4-amino-2, 6-dihydroxylpyrimidine in ethyl alcohol at 80 °C using KF–Al_2O_3 as catalyst [10]. Agarwal synthesized a library of pyrido[2,3-*d*]pyrimidines in high yields on solid support using microwave irradiation via the resin-bound aldehydes, 6-amino-1,3-dimethyluracil, and compounds having an active methylene group in acetic acid [11]. Tu reported a simple and efficient synthesis of pyrido[2,3-*d*]pyrimidine derivatives via a three-component reaction under microwave irradiation at 120 °C [12]. Shaabani *et al*. reported on the synthesis of pyrido[2,3-*d*]pyrimidines via a one-pot four-component condensation of amines, diketene, aldehydes, and 6-amino-1,3-dimethyluracil in the presence of *p*-toluenesulfonic acid as a catalyst in high yields in CH_2Cl_2 at ambient temperature [13]. Shi synthesized pyrido[2,3-*d*]pyrimidine derivatives via the three-component reaction in water in the presence of triethylbenzylammonium chloride [14]. These methods usually require forcing conditions, long reaction times, and complex synthetic pathways and often react in organic solvents or catalyzed by catalyst. Thus, the development of new and simple synthetic methods for the efficient preparation of these molecules is therefore an interesting challenge.

Recently, the use of ionic liquids as environmentally benign solvents for a broad range of chemical processes has been advocated [15]. This is due to a number of intriguing properties of ionic liquids: high thermal and chemical stability, negligible vapor pressure, nonflammability, and high capacity. Ionic liquids, especially those based on the 1,3-dialkylimidazolium cations, have been shown to be good "solvents" for a wide range of inorganic and organic reactions. A nice feature of ionic liquid is that yields can be optimized by changing the anions or properties of the cation. In addition, several ionic liquids show enhancement in reaction rates and selectivity, compared with organic solvents with the added benefit of the ease of recovery and reuse of these ionic liquids.

In view of the emerging importance of ionic liquids as reaction media, we report in this paper a novel three-component one-pot synthesis of well-functionalized pyrido [2,3-*d*]pyrimidine in ionic liquid medium (Scheme 1). When

Scheme 1. The reaction of **1**, **2**, and **3** in ionic liquid [bmim]BF_4.



three components of aromatic aldehyde **1**, malononitrile **2**, and 2,6-diaminopyrimidin-4-one **3** were treated in ionic liquids [bmim]BF_4 at 80 °C for a few hours (Scheme 1), the unaromatized pyrido[2,3-*d*]pyrimidine derivatives **4** were obtained in high yields (78–88%) (Table. 1), which is different from the reaction reported by Shi [14] and Tu [12]. The desired aromatized product **5** was not obtained (Scheme 1). To the best of our knowledge, this is the first report on such a synthesis of unaromatized pyrido[2,3-*d*] pyrimidine derivatives.

RESULTS AND DISCUSSION

We began our study on the reaction showed in Scheme 1 by optimizing the reaction conditions for the preparation of **4a**. A summary of the optimization experiments was provided in Table 1. It was found that no conversion to product occurred even after 24 h at room temperature (Table 1, entry 1). To optimize the reaction temperature, we carried out the reactions at different temperatures ranging from 40 to 90 °C. We found that the yield of product **4a** was improved and the reaction time was shortened as the temperature increased to 80 °C. The yield plateau when temperature was further increased to 90 °C (Table 1, entries 2–5). So, the most suitable reaction temperature is 80 °C. The effect of reaction time on yields of product **4a** was also investigated. The reactions were performed in ionic liquid [bmim]BF_4 for 4, 6, or 8 h at 80 °C (Table 1, entries 4, 6–7), leading to **4a** in 58%, 88%, and 87% yield, respectively. Thus, the optimal reaction time is 6 h. Moreover, different ionic liquids were also studied as shown in Table 1. On the basis of results in Table 1, we could conclude that [bmim]BF_4 was the best ionic liquid for this reaction.

Table 1

Optimization of the reaction conditions for synthesis of **4a**.

Entry	*T* (°C)	Medium	Time (h)	Yield[a] (%)
1	rt	[bmim]BF_4	24	0
2	40	[bmim]BF_4	9	30
3	60	[bmim]BF_4	7	35
4	80	[bmim]BF_4	4	58
5	90	[bmim]BF_4	6	85
6	80	[bmim]BF_4	6	88
7	80	[bmim]BF_4	8	87
9	80	[emim]Br	6	35
9	80	[pmim]Br	6	40
10	80	[bmim]Br	6	30
11	80	[emim]BF_4	6	60
12	80	[pmim]BF_4	6	62
13	80	[bmim]PF_6	6	65

Reaction condition: 5 mL of ionic liquid, 1 mmol aromatic aldehyde, 1 mmol malononitrile, 1 mmol 2,6-diaminopyrimidin-4-one.
[a]Isolated yields.

To explore the scope and limitations of this reaction further, we applied this ionic liquid to the reaction of a range of aromatic aldehydes with 2,6-diaminopyrimidin-4-one and malononitrile, furnishing the respective 2,7-diamino-5-aryl-3,4,5,8-tetrahydro-4-oxopyrido[2,3-*d*]pyrimidine-6-carbonitrile **4b–p** in good to high yields. The results were summarized in Table 2. All the products were characterized by melting points, ^{1}H NMR, IR, and HRMS.

The electronic effect of aryl group on this reaction was also investigated. Under the optimized reaction conditions, the aldehydes bearing both electron-withdrawing and electron-donating substituents readily provided pyrido [2,3-*d*]pyrimidine derivatives in high yields (Table 2). Therefore, the electronic nature of the substrate had no significant effect on this reaction.

On the basis of the experimental results, we proposed a plausible mechanism for the formation of derivatives **4** as shown in Scheme 2. Initially, Knoevenagel condensation of aromatic aldehyde **1** with malononitrile **2** could lead to the formation of intermediate **6**. Then, Michael addition between **6** and **3** would give intermediate **7**, which would undergo a rapid imine–enamine tautomerization to give **8**. Finally, the product would be produced by an intramolecular cyclization of the amino group attacking carbon atom of the CN of the intermediate **8** and tautomerization between imine–enamine.

Table 2

Synthesis of **4** in ionic liquid [bmim]BF_4.

Entry	Ar	Time (h)	Products	Yields (%)[a]
1	4-ClC_6H_4	6	**4a**	88
2	4-$CH_3C_6H_4$	7	**4b**	81
3	4-$NO_2C_6H_4$	4	**4c**	79
4	2,4-$Cl_2C_6H_3$	5	**4d**	83
5	3-$NO_2C_6H_4$	5	**4e**	82
6	3,4-$(CH_3)_2C_6H_3$	8	**4f**	84
7	4-FC_6H_4	4	**4g**	85
8	3,4-$OCH_2OC_6H_3$	8	**4h**	80
9	2-$NO_2C_6H_4$	7	**4i**	81
10	2-ClC_6H_4	6	**4j**	78
11	3-$CH_3OC_6H_4$	4	**4k**	80
12	3,4-$Cl_2C_6H_3$	8	**4l**	83
13	3-HOC_6H_4	6	**4m**	85
14	3-ClC_6H_4	5	**4n**	84
15	4-BrC_6H_4	6	**4o**	86
16	3-FC_6H_4	5	**4p**	88

Reaction condition: 5 mL ionic liquid, 1 mmol aromatic aldehyde, 1 mmol malononitrile, 1 mmol 2,6-diaminopyrimidin-4-one, 80 °C.
[a]Isolated yields.

These products were unaromatized pyrido[2,3-*d*]pyrimidine derivatives, almost insoluble in ionic liquid and rapidly precipitated from the reaction system once formed. Shi and Tu synthesized aromatized pyrido[2,3-*d*]pyrimidines under different conditions we had mentioned in the Introduction, and under these reaction conditions, unaromatized pyrido [2,3-*d*]pyrimidines were just intermediates, and they would experience a dehydrogenation process to obtain aromatized pyrido[2,3-*d*]pyrimidine derivatives.

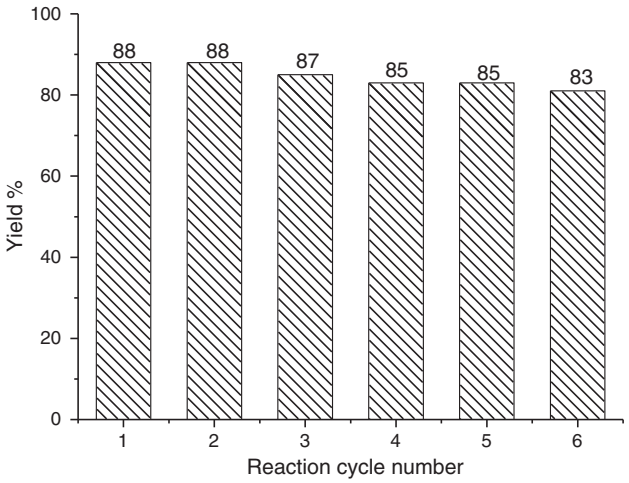


Figure 1. Reusability of ionic liquid [bmim]BF_4.

Finally, the recovery and reuse of the ionic liquid [bmim]BF_4 were studied by using the preparation of **4a** as a model. As the poor solubility of products in ionic liquids, they were easily separated by simple filtration and the filtrate could be recovered easily by drying at 80 °C in vacuum for several hours. As shown in Figure 1, the reaction medium could be recycled at least six times without significant decrease of the yields, which ranged from 88% to 83%.

The electronic absorption spectra of 5×10^{-5} M solutions of **4a–p** in DMSO was measured (Table 3). The longest wavelength maximum absorption (λ_{max}) of all the compounds was located between 268 and 301 nm. Studies on the fluorescent properties of these compounds were also carried out in DMSO (Table 3).

Scheme 2. Reaction mechanism of **1**, **2**, and **3** in ionic liquid [bmim]BF_4.

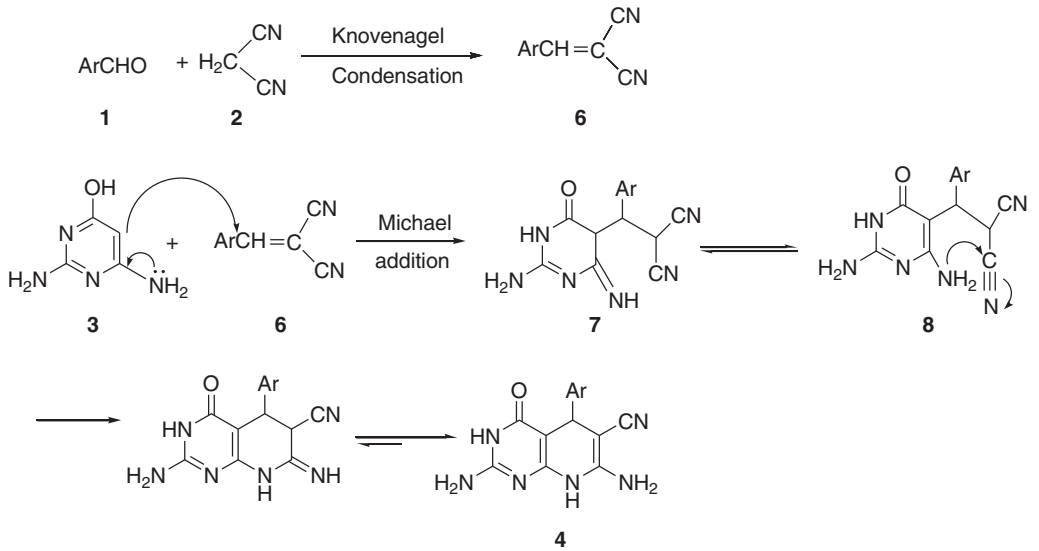


Table 3

UV/visible data and fluorescence properties for compounds **4** in DMSO.

Entry	Compound	λ_{max} (nm)	ε (10^4/L mol^{-1} cm^{-1})	λ_{em} (nm)
1	**4a**	270	1.32	360
2	**4b**	270	1.82	360
3	**4c**	274	2.50	360
4	**4d**	270	1.60	360
5	**4e**	268	2.36	360
6	**4f**	269	2.50	359
7	**4g**	271	1.58	353
8	**4h**	271	2.36	367
9	**4i**	268	1.64	355
10	**4j**	269	1.50	354
11	**4k**	269	1.75	371
12	**4l**	274	1.60	360
13	**4m**	301	0.79	361
14	**4n**	269	1.20	365
15	**4o**	269	1.26	370
16	**4p**	270	1.55	363

EXPERIMENTAL

Melting points were determined in open capillaries without further correction. IR spectra were recorded on a Tensor 27 spectrometer (Bruker, Ettlingen, Germany) in KBr. We obtained ^{1}H NMR spectra from a solution in DMSO-d_6 with Me_4Si as an internal standard by using a Bruker-400 spectrometer (Bruker, Zurich, Switzerland). Using a MicroTOF-QII instrument (Bruker, Bremen, Germany), we obtained HRMS data.

General procedure for preparation of 4. A dry 50-mL flask was charged with aromatic aldehyde **1** (1 mmol), malononitrile **2** (1 mmol), 2,6-diaminopyrimidin-4-one **3** (1 mmol), and ionic liquid [bmim]BF_4 (5 mL). The mixture was stirred at 80 °C for 4–8 h to complete the reaction (monitored by TLC), then cooled to room temperature. The solid was filtered off and washed with water. The filtrate of ionic liquid [bmim]BF_4 was then recovered for reuse by drying at 80 °C several hours *in vacuo*. The crude product was purified by recrystallization from DMF to give **4**.

2,7-Diamino-5-(4-chlorophenyl)-3,4,5,8-tetrahydro-4-oxopyrido [2,3-d]pyrimidine-6-carbonitrile 4a. mp >300 °C. IR (KBr, *v*, cm^{-1}): 3465, 3428, 3327, 3195, 2180, 1671, 1553, 1460, 1383, 1306, 1208, 1047, 855, 799. ^{1}H NMR (DMSO-d_6, δ, ppm): 7.49 (d, 2H, J = 8.4 Hz, ArH), 7.15 (d, 2H, J = 8.4 Hz, ArH), 6.97 (s, 2H, 2× NH), 6.21 (s, br, 2H, NH_2), 6.13 (s, 2H, NH_2), 4.42 (s, 1H, CH). HRMS Calcd for $C_{14}H_{12}ClN_6O$ (M + H$^+$): requires 315.0761, found: 315.0770.

2,7-Diamino-5-(4-methylphenyl)-3,4,5,8-tetrahydro-4-oxopyrido [2,3-d]pyrimidine-6-carbonitrile 4b. mp >300 °C. IR (KBr, *v*, cm^{-1}): 3487, 3437, 3369, 3146, 2190, 1674, 1553, 1454, 1389, 1294, 1145, 1095, 1041, 793. ^{1}H NMR (DMSO-d_6, δ, ppm): 7.06–7.11 (m, 4H, ArH), 6.88 (s, 2H, 2× NH), 6.13 (s, br, 4H, 2× NH_2), 4.36 (s, 1H, CH), 2.25 (s, 3H, CH_3). HRMS Calcd for $C_{15}H_{15}N_6O$ (M + H$^+$): requires 295.1307, found: 295.1327.

2,7-Diamino-5-(4-nitrophenyl)-3,4,5,8-tetrahydro-4-oxopyrido [2,3-d]pyrimidine-6-carbonitrile 4c. mp >300 °C. IR (KBr, *v*, cm^{-1}): 3356, 3160, 2192, 1667, 1626, 1557, 1521, 1462, 1397, 1347,1304, 1205, 1140, 1043. ^{1}H NMR (DMSO-d_6, δ, ppm): 8.20 (d, 2H, J = 8.8 Hz, ArH), 7.46 (d, 2H, J = 8.4 Hz, ArH), 7.09 (s, 2H, 2× NH), 6.29 (s, br, 2H, NH_2), 6.19 (s, 2H, NH_2), 4.62 (s, 1H, CH). HRMS Calcd for $C_{14}H_{12}N_7O_3$ (M + H$^+$): requires 326.1002, found: 326.1011.

2,7-Diamino-5-(2,4-dichlorophenyl)-3,4,5,8-tetrahydro-4-oxopyrido[2,3-d]pyrimidine-6-carbonitrile 4d. mp >300 °C. IR (KBr, *v*, cm^{-1}): 3465, 3362, 3167, 2189, 1666, 1555, 1462, 1398, 1302, 1207, 1136, 1049, 794. ^{1}H NMR (DMSO-d_6, δ, ppm): 7.55 (s, 1H, ArH), 7.40–7.45 (m, 2H, ArH), 7.03 (s, 2H, 2× NH), 6.18 (s, 2H, NH_2), 5.81 (s, br, 2H, NH_2), 4.78 (s, 1H, CH). HRMS Calcd for $C_{14}H_{11}Cl_2N_6O$ (M + H$^+$): requires 349.0371, found: 349.0378.

2,7-Diamino-5-(3-nitrophenyl)-3,4,5,8-tetrahydro-4-oxopyrido [2,3-d]pyrimidine-6-carbonitrile 4e. mp >300 °C. IR (KBr, *v*, cm^{-1}): 3469, 3390, 3167, 2188, 1668, 1553, 1533, 1465, 1395, 1349, 1300, 1203, 1139, 1067, 786. ^{1}H NMR (DMSO- d_6, δ, ppm): 8.06–8.14 (m, 2H, ArH), 7.62–7.65 (m, 2H, ArH), 7.09 (s, 2H, 2× NH), 6.32 (s, br, 2H, NH_2), 6.19 (s, 2H, NH_2), 4.63 (s, 1H, CH). HRMS Calcd for $C_{14}H_{12}N_7O_3$ (M + H$^+$): requires 326.1002, found: 326.1016.

2,7-Diamino-5-(3,4-dimethylphenyl)-3,4,5,8-tetrahydro-4-oxopyrido[2,3-d]pyrimidine-6-carbonitrile 4f. mp >300 °C. IR (KBr, *v*, cm^{-1}): 3480, 3438, 3370, 3153, 2190, 1672, 1555, 1453, 1389, 1298, 1207, 1147, 1093,797. ^{1}H NMR (DMSO-d_6, δ, ppm): 7.04 (d, 2H, J = 7.6 Hz, ArH), 6.94 (s, 1H, ArH), 6.93 (d, 1H, J = 8.4 Hz, ArH), 6.68 (s, 2H, 2× NH), 6.13 (s, br, 4H, 2× NH_2), 2.17 (s, 6H, 2× CH_3). HRMS Calcd for $C_{16}H_{17}N_6O$ (M + H$^+$): requires 309.1464, found: 309.1467.

2,7-Diamino-5-(4-fluorophenyl)-3,4,5,8-tetrahydro-4-oxopyrido [2,3-d]pyrimidine-6-carbonitrile 4g. mp >300 °C. IR (KBr, *v*, cm^{-1}): 3326, 3159, 2189, 1669, 1556, 1463, 1431, 1302, 1203, 1138, 1062, 797. ^{1}H NMR (DMSO-d_6, δ, ppm): 7.20–7.24 (m, 2H, ArH), 7.10–7.15 (m, 2H, ArH), 6.95 (s, 2H, 2× NH), 6.20 (s, br, 2H, NH_2), 6.12 (s, 2H, NH_2), 4.44 (s, 1H, CH). HRMS Calcd for $C_{14}H_{12}FN_6O$ (M + H$^+$): requires 299.1057, found: 299.1076.

2,7-Diamino-5-(3,4-methylelnedioxyphenyl)-3,4,5,8-tetrahydro-4-oxopyrido[2,3-d]pyrimidine-6-carbonitrile 4h. mp >300 °C. IR (KBr, *v*, cm^{-1}): 3470, 3395, 3315, 2194, 2146, 1654, 1557, 1457, 1393, 1248, 1137, 1036, 923, 797. ^{1}H NMR (DMSO-d_6, δ, ppm): 6.92 (s, 2H, 2× NH), 6.83 (d, 2H, J = 8.0 Hz, ArH), 6.68 (d, 1H, J = 7.2 Hz, ArH), 6.11 (s, br, 4H, 2× NH_2), 5.98 (s, 2H, CH_2), 4.33 (s, 1H, CH). HRMS Calcd for $C_{15}H_{13}N_6O_3$ (M + H$^+$): requires 325.1049, found: 325.1058.

2,7-Diamino-5-(2-nitrophenyl)-3,4,5,8-tetrahydro-4-oxopyrido [2,3-d]pyrimidine-6-carbonitrile 4i. mp >300 °C. IR (KBr, *v*, cm^{-1}): 3476, 3395, 3154, 2191, 1667, 1631, 1556, 1520, 1461, 1395, 1338, 1302, 1209, 1139, 1035, 812, 786, 741. ^{1}H NMR (DMSO-d_6, δ, ppm): 7.87 (d, 1H, J = 8.4 Hz, ArH), 7.68 (t, 1H, J = 7.6 Hz, ArH), 7.5 (t, 1H, J = 7.6 Hz, ArH), 7.31 (d, 1H, J = 8.0 Hz, ArH), 7.06 (s, 2H, 2× NH), 6.26 (s, 2H, NH_2), 6.01 (s, 2H, NH_2), 4.94 (s, 1H, CH). HRMS Calcd for $C_{14}H_{12}N_7O_3$ (M + H$^+$): requires 326.1002, found: 326.1011.

2,7-Diamino-5-(2-chlorophenyl)-3,4,5,8-tetrahydro-4-oxopyrido [2,3-d]pyrimidine-6-carbonitrile 4j. mp >300 °C. IR (KBr, *v*, cm^{-1}): 3463, 3387, 3819, 3169, 2189, 1661, 1556, 1457, 1394, 1301, 1206, 1137, 1036, 788, 756, 684. ^{1}H NMR (DMSO-d_6, δ, ppm): 7.40–7.52 (m, 4H, ArH), 6.98 (s, 2H, 2× NH), 6.14 (s, 2H, NH_2), 5.74 (s, br, 2H, NH_2), 4.76 (s, 1H, CH). HRMS Calcd for $C_{14}H_{12}ClN_6O$ (M + H$^+$): requires 315.0761, found: 315.0776.

2,7-Diamino-5-(3-methoxyphenyl)-3,4,5,8-tetrahydro-4-oxopyrido [2,3-d]pyrimidine-6-carbonitrile 4k. mp >300 °C. IR (KBr, *v*, cm^{-1}): 3486, 3426, 3369, 3163, 2191, 1682, 1636, 1551, 1457, 1387, 1279, 1144, 1100, 1045, 919, 880, 794, 712, 662. ^{1}H NMR

(DMSO-d_6, δ, ppm): 7.20–7.24 (m, 1H, ArH), 6.90 (s, 2H, 2× NH), 6.71–6.80 (m, 3H, ArH), 6.15 (s, 2H, NH_2), 6.08 (s, 2H, NH_2), 4.37 (s, 1H, CH), 3.72 (s, 3H, OCH_3). HRMS Calcd for $C_{15}H_{15}N_6O_2$ ($M+H^+$): requires 311.1256, found: 311.1270.

2,7-Diamino-5-(3,4-dichlorophenyl)-3,4,5,8-tetrahydro-4-oxopyrido[2,3-d]pyrimidine-6-carbonitrile 4l. mp >300 °C. IR (KBr, ν, cm^{-1}): 3480, 3389, 3168, 2190, 1666, 1623, 1555, 1468, 1398, 1205, 1064, 702. ^{1}H NMR (DMSO-d_6, δ, ppm): 7.55 (d, 1H, ArH), 7.40–7.46 (m, 2H, ArH), 7.04 (s, 2H, 2× NH), 6.20 (s, 2H, NH_2), 5.83 (s, br, 2H, NH_2), 4.77 (s, 1H, CH). HRMS Calcd for $C_{14}H_{11}Cl_2N_6O$ ($M+H^+$): requires 349.0371, found: 349.0368.

2,7-Diamino-5-(3-hydroxyphenyl)-3,4,5,8-tetrahydro-4-oxopyrido[2,3-d]pyrimidine-6-carbonitrile 4m. mp >300 °C. IR (KBr, ν, cm^{-1}): 3463, 3372, 3277, 3168, 2167, 1669, 1525, 1474, 1387, 1304, 1212, 1137, 1036, 788, 756, 684. ^{1}H NMR (DMSO-d_6, δ, ppm): 10.42 (s, 1H, OH), 9.25 (s, 1H, NH), 8.68 (s, 1H, NH), 7.00–7.03 (m, 1H, ArH), 6.52–6.60 (m, 3H, ArH), 6.43 (s, br, 2H, NH_2), 5.72 (s, 2H, NH_2), 4.24 (s, 1H, CH). HRMS Calcd for $C_{14}H_{13}N_6O_2$ ($M+H^+$): requires 297.1100, found: 297.1105.

2,7-Diamino-5-(3-chlorophenyl)-3,4,5,8-tetrahydro-4-oxopyrido[2,3-d]pyrimidine-6-carbonitrile 4n. mp >300 °C. IR (KBr, ν, cm^{-1}): 3475, 3396, 3176, 1658, 1556, 1463, 1393, 1301, 1296, 1130, 1080, 790. ^{1}H NMR (DMSO-d_6, δ, ppm): 7.23–7.36 (m, 3H, ArH), 7.10–7.13 (m, 1H, ArH), 6.99 (s, 2H, 2× NH), 6.23 (s, br, 2H, NH_2), 6.13 (s, 2H, NH_2), 4.44 (s, 1H, CH). HRMS Calcd for $C_{14}H_{12}ClN_6O$ ($M+H^+$): requires 315.0761, found: 315.0770.

2,7-Diamino-5-(4-bromophenyl)-3,4,5,8-tetrahydro-4-oxopyrido[2,3-d]pyrimidine-6-carbonitrile 4o. mp >300 °C. IR (KBr, ν, cm^{-1}): 3380, 3162, 2193, 1669, 1557, 1464, 1396, 1304, 1205, 1141, 1040, 825, 793. ^{1}H NMR (DMSO-d_6, δ, ppm): 7.49 (d, 2H, J = 8.8 Hz, ArH), 7.14 (d, 2H, J = 8.4 Hz, ArH), 6.94 (s, 2H, 2× NH), 6.17 (s, br, 2H, NH_2), 6.09 (s, 2H, NH_2), 4.41 (s, 1H, CH). HRMS Calcd for $C_{14}H_{12}BrN_6O$ ($M+H^+$): requires 359.0256, found: 359.0278.

2,7-Diamino-5-(3-fluorophenyl)-3,4,5,8-tetrahydro-4-oxopyrido[2,3-d]pyrimidine-6-carbonitrile 4p. mp >300 °C. IR (KBr, ν, cm^{-1}): 3524, 3481, 3399, 3158, 2189, 1661, 1557, 1459, 1394, 1298, 1201, 1135, 1042, 798. ^{1}H NMR (DMSO-d_6, δ, ppm): 7.32–7.38 (m, 1H, ArH), 6.96–7.06 (m, 5H, ArH + 2× NH), 6.21 (s, br, 2H, NH_2), 6.11 (s, 2H, NH_2), 4.45 (s, 1H, CH). HRMS Calcd for $C_{14}H_{12}FN_6O$ ($M+H^+$): requires 299.1057, found: 299.1073.

CONCLUSION

In conclusion, we have developed a simple and clean method for the preparation of 2,7-diamino-5-aryl-3,4,5,8-tetrahydro-4-oxopyrido[2,3-*d*]pyrimidine-6-carbonitrile derivatives in ionic liquid [bmim]BF_4. The operational simplicity, green reaction media, and good to high yields make this procedure an interesting approach. Meanwhile, ionic liquid [bmim]BF_4 could be reused for several rounds without apparent loss of activity. More significantly, this work clearly demonstrates the potential of a room temperature ionic liquid to act as an efficient and recyclable reaction medium and shows much promise for further applications.

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