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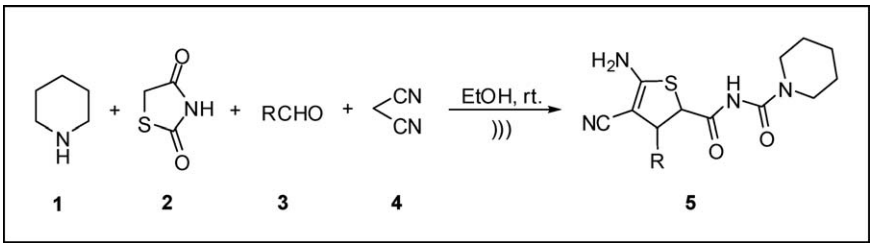

A series of dihydrothiphenes derivatives were synthesized via the four-component reaction of aldehyde, malononitrile, 1,3-thiazolidinedione, and piperidine at room temperature under ultrasound irradiation. Compared with the conventional methods, the remarkable advantages of this method are operational simplicity, higher yield, and shorter reaction time.

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INTRODUCTION

Currently, multicomponent reactions are being rapidly developed because using a ''one-pot'' methodology makes the synthesis simpler and more environmentally friendly [1]. They allow the creation of several bonds in a single operation and are attracting increasing attention as one of the most powerful emerging synthetic tools for the creation of molecular diversity and complexity [2].

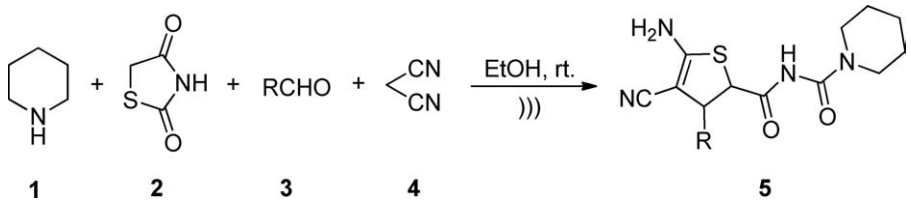
The efficient high-throughput synthesis of organic compounds is one of the most important objectives in modern drug discovery. Organic reactions should be rapid and facile, and the target products should be easily separated and purified in high yields. Therefore, there is much interest in the implementation of new synthetic strategies such as microwave assisted, ultrasonic irradiation, and supercritical fluids, which find application as methods to achieve these goals [3].

Recently published comprehensive books [4] and articles [5] indicate chemical applications of ultrasounds. Ultrasonic activation, based on cavitation effects leading to mass transfer improvement, is a green powerful synthetic approach in organic chemistry, offering a versatile and facile pathway for a large variety of syntheses [6]. After several decades of research, it is discovered that a large number of organic reactions can be carried out under ultrasonic irradiation in high yields, short reaction time, and mild conditions [7].

Sulfur-containing heterocyclic compounds are widespread in nature, and their applications to biologically active pharmaceuticals [8], agrochemicals [9], and functional materials are becoming more and more important. The development of new efficient methods to synthesize S-heterocycles with structural diversity is one major interest of modern synthetic organic chemists. Among a large variety of sulfur-containing heterocyclic compounds, the dihydrothiophene moiety has been found in various natural products, biologically active compounds, and synthetic intermediates [10,11], whose preparation often required lengthy steps and suffered from drawbacks, as well as lower yields [12,13].

Recently, Sun et al. [14] have reported the synthesis of dihydrothiophenes under stirring in the presence of acetonitrile. Nevertheless, this method possesses some weaknesses: (a) long reaction time of up to 48 h, (b) dramatically low yield and (c) utilization of toxic solvent-acetonitrile. Therefore, it is urgent to further develop an efficient and convenient method to construct such scaffold. As part of our current studies on the development of new routs to heterocyclic systems [15], we herein would like to report an ultrasound assisted one-pot procedure for the preparation of dihydrothiophene derivatives by four-component reaction (Scheme 1), which has the advantage of excellent yields and short reaction time.

Scheme 1. One-pot four-component reaction of aldehydes, malononitrile, 1,3-thiazolidinedione, and piperidine under ultrasonic irradiation.



RESULTS AND DISCUSSION

The choice of an appropriate reaction medium is of crucial importance for the successful organic synthesis. To achieve suitable conditions, we investigated the reaction of piperidine **1**, 1,3-thiazolidinedione **2**, 4-methylbenzaldehyde **3a** and malononitrile **4** in different conditions.

To study the effect of solvent on this synthesis, we first performed five experiments in water, acetonitrile, ethanol, methanol, and THF under stirring condition. However, they all afforded a lower yield at longer reaction time. Then, we have studied the sonochemical effect on model reaction by using different solvents. In all cases, the experimental results show that the reaction times are strikingly shorter and the yields of the products are higher under sonication and ethanol was the best choice of solvent and the use of ultrasound radiation in ethanol increased the yield of the reaction to 81% and decreased the reaction time to 1 h (Table 1, entry 3). Therefore, ultrasound irradiation exhibited several advantages over the classical methods by reducing the reaction time and improving the reaction yields. The reason may be the phenomenon of cavitation produced by ultrasound [16].

To further improve the yield of the reaction, we tried to perform the reaction in higher temperature under ultrasound irradiation. However, it showed no substantial improvement for this reaction. With our optimized the conditions, we performed the reaction at room temperature in ethanol under ultrasound irradiation. The results are summarized in Table 2. It was observed that the yields of the products decreased under conventional conditions (Table 2, entries 1–8). Thus, ultrasonic irradiation was found to have beneficial effect on the synthesis of dihydrothiophene derivatives which was superior to the traditional method with respect to yield, reaction time, simplicity, and safety.

To test the scope of the substrates, we used different aromatic aldehyde with either electron with-drawing groups or electron-donating groups (Table 2, entries 9–13), which was not used in the literature and heterocyclic aldehyde (Table 2, entries 14,15) can also be carried out smoothly. The results were excellent in terms of yields and product purity using ethanol as solvent (Table 2). According to the reported literature [14], in this reaction piperidine behaves both as a base catalyst and as a nucleophile. First, the arylidenemalononitrile **6** are likely formed via initial condensation of aromatic aldehyde with malononitrile, which is catalyzed by piperidine.

Table 1

Optimization for the synthesis of **5a**.

		With US[a]		Without US[b]	
Entry	Solvent	Time (h)	Yield[c] (%)	Time (h)	Yield[c] (%)
1	Water	3	54	33	33
2	Acetonitrile	2	50	48	31
3	Ethanol	1	81	27	38
4	Methanol	1	67	29	33
5	THF	1.5	72	30	40

[a] Reaction under ultrasonic waves at room temperature.
[b] Reaction under stirring condition at room temperature.
[c] Yields of isolated products.

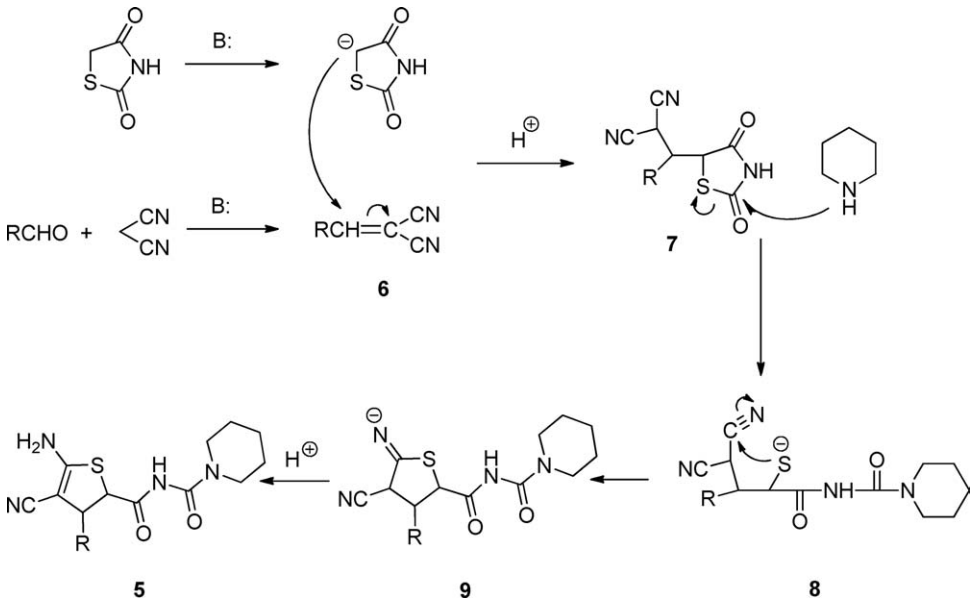
Table 2

Results of one-pot four-component reactions.[a]

Entry	R	Product	Yield[b] (%) (Lit.[14])	m.p. (°C) (Lit.[14])
1	4-$CH_3C_6H_4$	**5a**	81(31)	200–202(202–204)
2	C_6H_5	**5b**	70(41)	223–224(220–222)
3	4-HOC_6H_4	**5c**	67(32)	230–232(230–233)
4	4-$CH_3OC_6H_4$	**5d**	65(48)	211–213(210–212)
5	4-FC_6H_4	**5e**	94(43)	216–218(220–222)
6	4-ClC_6H_4	**5f**	73(35)	300–301(299–301)
7	4-BrC_6H_4	**5g**	69(49)	219–220(220–222)
8	4-$NO_2C_6H_4$	**5h**	87(27)	200–202(209–211)
9	3,4-$(CH_3O)_2C_6H_3$	**5i**	60	197–199
10	3-ClC_6H_4	**5j**	77	223–224
11	2-ClC_6H_4	**5k**	64	206–208
12	3,4-$Cl_2C_6H_3$	**5l**	94	219–220
13	3,4-$OCH_2OC_6H_3$	**5m**	70	215–217
14	thiophene-2-yl	**5n**	69	227–228
15	pyridine-3-yl	**5o**	53	209–210

[a] Reaction conditions: aldehyde (2 mmol), malononitrile (2 mmol), 1,3-thiazolidinedione (2 mmol), piperidine (2.5 mmol), ethanol (2 mL) at room temperature under ultrasound irradiation and the ultrasonic power 250 W, irradiation frequency 40 kHz.
[b] Yields of isolated products.

Scheme 2. Proposed reaction mechanism.



The second step is a Michael addition of the carbanion of 1,3-thiazolidinedione to arylidenemalononitrile **6** to yield adduct **7**. Then, piperidine attacks the carbonyl group of thiazolidinedione to open its ring and cause the formation of a sulfide anion **8**, which in turn intramolecularly attacks one of the two cyano group to form a sulfur-containing 5-membered ring intermediate **9**. Finally the dihydrothiophene **5** was produced through imine-enamine tautomerization (Scheme 2). When aniline and other piperidine derivatives were used as substrate instead of piperidine, unfortunately, we could not get the expected product.

In summary, we have found a facile and efficient method for the one-pot four-component synthesis of dihydrothiophene derivatives in ethanol under ultrasound irradiation. The present procedure avoided the use of poisonous organic solvent during the reaction, and showed a short reaction time and good yields.

EXPERIMENTAL

All reagents were purchased from commercial sources and used without further purification. Ultrasonication was performed in a KQ-250E medical ultrasound cleaner with a frequency of 40 KHz and an output power of 250 W (Builtin heating, 30–110°C thermostatically adjustable). Melting points are uncorrected. IR spectra were recorded on Varian F-1000 spectrometer in KBr with absorptions in cm^{-1}. ^1H NMR was determined on Varian Invoa-300/400 MHz spectrometer in DMSO-d_6 solution. J values are in Hz. Chemical shifts are expressed in ppm downfield from internal standard TMS. HRMS data were obtained using Bruker micrOTOF-Q instrument. The reaction flask was located at the maximum energy area in the cleaner; the surface of reactants is slightly lower than the level of the water.

General procedure for the synthesis of dihydrothiophene derivatives 5 is represented as follows. A 50 mL flask was charged with the aldehyde (2 mmol), malononitrile (0.132 g, 2 mmol), 1,3-thiazolidinedione (0.234 g, 2 mmol), and piperidine (0.213 g, 2.5 mmol) in ethanol (2 mL). The mixture was sonicated in the water bath of an ultrasonic cleaner under an air conditions at 25–30°C for 1 h (monitored by TLC). After the completion of the reaction, the resulting precipitate was filtered and washed with ethanol to afford the pure product as solid in good to excellent yields. The authenticity of the products was established by their IR, ^1H NMR, HRMS.

***N*-(5-Amino-4-cyano-3-(*p*-tolyl)-2,3-dihydrothiophene-2-carbonyl)piperidine-1-carboxamide (5a).** White powder; m.p. 200–202°C (lit.[14] m.p. 202–204°C); IR (KBr, cm^{-1}): 3412, 3324, 3217, 3081, 2926, 2175, 1675, 1626, 1474, 1346, 1242, 1021, 810, 739, 651; ^1H NMR (300 MHz, DMSO-d_6): δ (ppm) 1.42 (d, J = 3.6 Hz, 4H, 2 × CH_2), 1.51 (d, J = 4.2 Hz, 2H, CH_2), 2.27 (s, 3H, CH_3), 3.28–3.30 (m, 4H, 2 × CH_2), 4.36 (d, J = 2.1 Hz, 1H, CH), 4.54 (d, J = 3.0 Hz, 1H, CH), 7.07 (s, 2H, NH_2), 7.15 (s, 4H, ArH), 9.98 (s, 1H, NH); HRMS calculated for $C_{19}H_{23}N_4O_2S$ [M + H]: 371.1536, found: 371.1554.

***N*-(5-Amino-4-cyano-3-phenyl-2,3-dihydrothiophene-2-carbonyl)piperidine-1-carboxamide (5b).** White powder; m.p. 223–224°C (lit.[14] m.p. 220–222°C); IR (KBr, cm^{-1}): 3400, 3307, 3193, 2941, 2855, 2195, 1690, 1654, 1585, 1492, 1379, 1246, 1025, 749, 696; ^1H NMR (300 MHz, DMSO-d_6): δ (ppm) 1.43 (d, J = 3.3 Hz, 4H, 2 × CH_2), 1.51 (d, J = 3.6 Hz, 2H, CH_2), 3.29–3.31 (m, 4H, 2 × CH_2), 4.39 (s, 1H, CH), 4.58 (d, J = 2.7 Hz, 1H, CH), 7.11 (s, 2H, NH_2), 7.26–7.38 (m, 5H, ArH), 10.00 (s, 1H, NH); HRMS calculated for $C_{18}H_{20}N_4O_2SNa$ [M + Na]: 379.1199, found: 379.1198.

***N*-(5-Amino-4-cyano-3-(4-hydroxyphenyl)-2,3-dihydrothiophene-2-carbonyl)piperidine-1-carboxamide (5c).** White powder; m.p. 230–232°C (lit.[14] m.p. 230–233°C); IR (KBr,

cm^{-1}): 3402, 3301, 3196, 2941, 2857, 2192, 1657, 1651, 1511, 1374, 1252, 1032, 819, 729; ^1H NMR (300 MHz, DMSO-d_6): δ (ppm) 1.42 (s, 4H, 2 × CH_2), 1.51 (s, 2H, CH_2), 3.29 (s, 4H, 2 × CH_2), 4.31 (s, 1H, CH), 4.48 (s, 1H, CH), 6.72 (d, J = 7.8 Hz, 2H, ArH and NH_2), 7.04 (s, 4H, ArH), 9.39 (s, 1H, OH), 9.98 (s, 1H, NH); HRMS calculated for $C_{18}H_{20}N_4O_3SNa$ [M + Na]: 395.1148, found: 395.1157.

N-(5-Amino-4-cyano-3-(4-methoxyphenyl)-2,3-dihydrothiophene-2-carbonyl)piperidine-1-carboxamide (5d). White powder; m.p. 211–213°C (lit.[14] m.p. 210–212°C); IR (KBr, cm^{-1}): 3404, 3312, 3201, 2930, 2858, 2175, 1676, 1626, 1472, 1345, 1244, 1031, 825, 653; ^1H NMR (300 MHz, DMSO-d_6): δ (ppm) 1.42 (s, 4H, 2 × CH_2), 1.50 (s, 2H, CH_2), 3.28 (s, 4H, 2 × CH_2), 3.72 (s, 3H, OCH_3), 4.34 (s, 1H, CH), 4.54 (d, J = 2.7 Hz, 1H, CH), 6.91 (d, J = 8.4 Hz, 2H, ArH), 7.07 (s, 2H, NH_2), 7.18 (d, J = 8.4 Hz, 2H, ArH), 9.98 (s, 1H, NH); HRMS calculated for $C_{19}H_{22}N_4O_3SNa$ [M + Na]: 409.1305, found: 409.1316.

N-(5-Amino-4-cyano-3-(4-fluorophenyl)-2,3-dihydrothiophene-2-carbonyl)piperidine-1-carboxamide (5e). Yellow powder; m.p. 216–218°C (lit.[14] m.p. 220–222°C); IR (KBr, cm^{-1}): 3397, 3302, 3195, 2936, 2852, 2193, 1653, 1581, 1504, 1378, 1237, 1019, 823, 726; ^1H NMR (400 MHz, DMSO-d_6): δ (ppm) 1.44 (s, 4H, 2 × CH_2), 1.52 (s, 2H, CH_2), 3.31 (s, 4H, 2 × CH_2), 4.37 (s, 1H, CH), 4.60 (s, 1H, CH), 7.17 (s, 2H, NH_2), 7.22 (d, J = 8.4 Hz, 2H, ArH), 7.32–7.35 (m, 2H, ArH), 10.03 (s, 1H, NH); HRMS calculated for $C_{18}H_{19}N_4O_2SFNa$ [M+Na]: 397.1105, found: 397.1127.

N-(5-Amino-3-(4-chlorophenyl)-4-cyano-2,3-dihydrothiophene-2-carbonyl)piperidine-1-carboxamide (5f). Yellow powder; m.p. 300–301°C (lit.[14] m.p. 299–301°C); IR (KBr, cm^{-1}): 3406, 3310, 3219, 2930, 2858, 2175, 1676, 1577, 1478, 1345, 1242, 1017, 817, 652; ^1H NMR (300 MHz, DMSO-d_6): δ (ppm) 1.42 (s, 4H, 2 × CH_2), 1.51 (s, 2H, CH_2), 3.28 (s, 4H, 2 × CH_2), 4.37 (s, 1H, CH), 4.59 (d, J = 2.1 Hz, 1H, CH), 7.16 (s, 2H, NH_2), 7.31 (d, J = 8.1 Hz, 2H, ArH), 7.43 (d, J = 8.4 Hz, 2H, ArH), 10.00 (s, 1H, NH); HRMS calculated for $C_{18}H_{20}N_4O_2S^{35}Cl$ [M+H]: 391.0990, found: 391.0989.

N-(5-Amino-3-(4-bromophenyl)-4-cyano-2,3-dihydrothiophene-2-carbonyl)piperidine-1-carboxamide (5g). White powder; m.p. 219–220°C (lit.[14] m.p. 220–222°C); IR (KBr, cm^{-1}): 3406, 3313, 3218, 2933, 2857, 2174, 1675, 1578, 1480, 1347, 1242, 1011, 815, 652; ^1H NMR (300 MHz, DMSO-d_6): δ (ppm) 1.44 (s, 4H, 2 × CH_2), 1.53 (s, 2H, CH_2), 3.31 (s, 4H, 2 × CH_2), 4.39 (s, 1H, CH), 4.58 (s, 1H, CH), 7.18 (s, 2H, NH_2), 7.26 (d, J = 7.6 Hz, 2H, ArH), 7.57 (d, J = 7.2 Hz, 2H, ArH), 10.02 (s, 1H, NH); HRMS calculated for $C_{18}H_{19}N_4O_2S^{79}BrNa$ [M+Na]: 457.0304, found: 457.0303.

N-(5-Amino-4-cyano-3-(4-nitrophenyl)-2,3-dihydrothiophene-2-carbonyl)piperidine-1-carboxamide (5h). Deep yellow powder; m.p. 208–210°C (lit.[14] m.p. 209–211°C); IR (KBr, cm^{-1}): 3422, 3314, 3211, 2938, 2857, 2180, 1697, 1569, 1518, 1348, 1247, 1016, 855, 741, 697; ^1H NMR (400 MHz, DMSO-d_6): δ (ppm) 1.44 (s, 4H, 2 × CH_2), 1.51 (s, 2H, CH_2), 3.21 (s, 4H, 2 × CH_2), 4.45 (s, 1H, CH), 4.74 (d, J = 2.1 Hz, 1H, CH), 7.28 (s, 2H, NH_2), 7.59 (d, J = 8.7 Hz, 2H, ArH), 8.25 (d, J = 8.7 Hz, 2H, ArH), 10.06 (s, 1H, NH); HRMS calculated for $C_{18}H_{19}N_5O_4SNa$ [M+Na]: 424.1050, found: 424.1048.

N-(5-Amino-4-cyano-3-(3,4-dimethoxyphenyl)-2,3-dihydrothiophene-2-carbonyl)piperidine-1-carboxamide (5i). Light yellow powder; m.p. 197–199°C; IR (KBr, cm^{-1}): 3383, 3314, 3214, 2940, 2856, 2177, 1667, 1577, 1514, 1463, 1351, 1238, 1141, 1025, 741, 654; ^1H NMR (300 MHz, DMSO-d_6): δ (ppm) 1.43 (d, J = 3.3 Hz, 4H, 2 × CH_2), 1.52 (d, J = 3.3 Hz, 2H, CH_2), 3.29 (s, 4H, 2 × CH_2), 3.72 (s, 6H, 2 × OCH_3), 4.36 (s, 1H, CH), 4.54 (d, J = 3.0 Hz, 1H, CH), 6.77 (d, J = 8.4 Hz, 1H, ArH), 6.86 (d, J = 1.5 Hz, 1H, ArH), 6.92 (d, J = 8.4 Hz, 1H, ArH), 7.06 (s, 2H, NH_2), 9.96 (s, 1H, NH); HRMS calculated for $C_{20}H_{24}N_4O_4SNa$ [M+Na]: 439.1410, found: 439.1422.

N-(5-Amino-3-(3-chlorophenyl)-4-cyano-2,3-dihydrothiophene-2-carbonyl)piperidine-1-carboxamide (5j). White powder; m.p. 223–224°C; IR (KBr, cm^{-1}): 3412, 3326, 3231, 2940, 2856, 2177, 1699, 1577, 1471, 1362, 1241, 1025, 896, 790, 652; ^1H NMR (300 MHz, DMSO-d_6): δ (ppm) 1.44 (s, 4H, 2 × CH_2), 1.51–1.52 (m, 2H, CH_2), 3.30 (s, 4H, 2 × CH_2), 4.40 (s, 1H, CH), 4.59 (d, J = 2.1 Hz, 1H, CH), 7.19 (s, 2H, NH_2), 7.25–7.42 (m, 4H, ArH), 10.00 (s, 1H, NH); HRMS calculated for $C_{18}H_{20}N_4O_2S^{35}Cl$ [M+H]: 391.0990, found: 391.0989.

N-(5-Amino-3-(2-chlorophenyl)-4-cyano-2,3-dihydrothiophene-2-carbonyl)piperidine-1-carboxamide (5k). White powder; m.p. 206–208°C; IR (KBr, cm^{-1}): 3412, 3316, 3211, 2942, 2855, 2188, 1656, 1583, 1496, 1368, 1241, 1031, 897, 755, 650; ^1H NMR (300 MHz, DMSO-d_6): δ (ppm) 1.44 (s, 4H, 2 × CH_2), 1.52 (d, J = 3.9 Hz, 2H, CH_2), 3.31 (s, 4H, 2 × CH_2), 4.28 (s, 1H, CH), 4.97 (s, 1H, CH), 7.28 (s, 2H, NH_2), 7.31–7.52 (m, 4H, ArH), 10.08 (s, 1H, NH); HRMS calculated for $C_{18}H_{19}N_4O_2S^{35}ClNa$ [M+Na]: 413.0809, found: 413.0804.

N-(5-Amino-4-cyano-3-(3,4-dichlorophenyl)-2,3-dihydrothiophene-2-carbonyl)piperidine-1-carboxamide (5l). White powder; m.p. 219–220°C; IR (KBr, cm^{-1}): 3417, 3334, 3229, 2941, 2182, 1667, 1581, 1468, 1352, 1241, 1023, 893, 821, 739, 649; ^1H NMR (400 MHz, DMSO-d_6): δ (ppm) 1.44 (s, 4H, 2 × CH_2), 1.52 (s, 2H, CH_2), 3.32 (s, 4H, 2 × CH_2), 4.41 (s, 1H, CH), 4.62 (s, 1H, CH), 7.26 (s, 2H, NH_2), 7.32 (d, J = 8.4 Hz, 1H, ArH), 7.51–7.67 (m, 2H, ArH), 10.03 (s, 1H, NH); HRMS calculated for $C_{18}H_{18}N_4O_2S^{35}Cl_2Na$ [M+Na]: 447.0420, found: 447.0407.

N-(5-Amino-3-(benzo[d][1,3]dioxol-5-yl)-4-cyano-2,3-dihydrothiophene-2-carbonyl)piperidine-1-carboxamide (5m). Light yellow powder; m.p. 215–217°C; IR (KBr, cm^{-1}): 3434, 3337, 3223, 2927, 2176, 1699, 1572, 1495, 1355, 1235, 1035, 924, 815, 742, 655; ^1H NMR (300 MHz, DMSO-d_6): δ (ppm) 1.42 (s, 4H, 2 × CH_2), 1.51 (s, 2H, CH_2), 3.30 (s, 4H, 2 × CH_2), 4.34 (s, 1H, CH), 4,52 (d, J = 2.7 Hz, 1H, CH), 6.00 (s, 2H, CH_2), 6.74 (dd, J_1 = 7.8 Hz, J_2 = 1.2 Hz, 1H, ArH), 6.82–6.89 (m, 2H, ArH), 7.11 (s, 2H, NH_2), 10.00 (s, 1H, NH); HRMS calculated for $C_{19}H_{20}N_4O_4SNa$ [M+Na]: 423.1097, found: 423.1094.

N-(5'-Amino-4'-cyano-2',3'-dihydro-[2,3'-bithiophene]-2'-carbonyl)piperidine-1-carboxamide (5n). White powder; m.p. 227–228°C; IR (KBr, cm^{-1}): 3404, 3298, 3225, 2937, 2857, 2180, 1670, 1572, 1472, 1351, 1232, 1026, 849, 710; ^1H NMR (300 MHz, DMSO-d_6): δ (ppm) 1.45 (d, J = 3.3 Hz, 4H, 2 × CH_2), 1.52 (s, 2H, CH_2), 3.32 (s, 4H, 2 × CH_2), 4.46 (s, 1H, CH), 4.89 (s, 1H, CH), 6.96–7.00 (m, 2H, ArH), 7.17 (s, 2H, NH_2), 7.42 (d, J = 4.8 Hz, 1H, ArH), 10.06 (s, 1H, NH); HRMS calculated for $C_{16}H_{18}N_4O_2S_2Na$ [M+Na]: 385.0763, found: 385.0744.

N-(5-Amino-4-cyano-3-(pyridin-3-yl)-2,3-dihydrothiophene-2-carbonyl)piperidine-1-carboxamide (5o). White powder; m.p. 209–210°C; IR (KBr, cm^{-1}): 3350, 3301, 3241, 2940,

2857, 2179, 1661, 1573, 1497, 1357, 1245, 1025, 814, 742, 654; ^{1}H NMR (400 MHz, DMSO-d_6): δ (ppm) 1.38 (s, 4H, 2 × CH_2), 1.47 (s, 2H, CH_2), 3.26 (s, 4H, 2 × CH_2), 4.38 (s, 1H, CH), 4.58 (s, 1H, CH), 7.17 (s, 2H, NH_2), 7.34–7.37 (m, 1H, ArH), 7.65–7.67 (m, 1H, ArH), 8.46 (d, J = 2.4 Hz, 2H, ArH), 9.98 (s, 1H, NH); HRMS calculated for $C_{17}H_{19}N_5O_2SNa$ [M+Na]: 380.1152 found: 380.1132.

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