Green Method for the Synthesis of Highly Substituted Cyclohexa-1,3-diene, Polyhydroindene, Polyhydronaphthalene, Isochromene, Isothiochromene, and Isoquinoline Derivatives in Ionic Liquids

Xiang-Shan Wang,* Jian-Rong Wu, Jie Zhou, and Shu-Jiang Tu

School of Chemistry and Chemical Engineering, The Key Laboratory of Biotechnology on Medical Plant, Xuzhou Normal University, Xuzhou Jiangsu 221116, P. R. China

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An efficient and green method for the synthesis of highly substituted cyclohexa-1,3-diene, polyhydroindene, polyhydronaphthalene, isochromene, isothiochromene, and isoquinoline derivatives has been developed. The synthesis was achieved by using a multicomponent procedure in ionic liquid media. The features of this procedure are characterized by the following: mild reaction conditions, high yields, one-pot procedures, operational simplicity, and environmentally benign conditions.

1. Introduction

In recent years, multicomponent reactions (MCRs) have become important tools in modern preparative synthetic chemistry because they increase the efficiency by combining several operational steps without isolation of intermediates or changing the reaction conditions.[1] MCRs have emerged as valuable tools for the preparation of structurally diverse chemical libraries of drug-like heterocyclic compounds.[2] Because of their convergence and productivity, the MCRs have attracted considerable attention from the combinatorial chemistry point of view.[3]

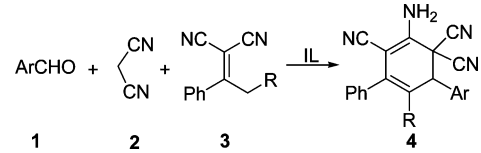
In the past decades, much research attention has been devoted to the investigation of the acceptor−donor−acceptor (A−D−A) triads to control the stoichiometry of both donor (D) and acceptor (A) partners, as well as the degree of charge transfer, which are crucial parameters in the design of metal centers in organometallics.[4] The basic unit in which electron transfer can be studied comprises a single-electron donor and two single-electron acceptors. This considerable research effort is justified by the potential applications of these molecular systems, which are the basis for artificial photosynthetic systems,[5] materials presenting semiconducting or nonlinear optical properties,[6] and molecular electronic devices.[7] 2,6-Dicyanoanilines are typical A−D−A systems, which have been reported to be prepared from arylidenemalonodinitriles and 1-arylethylidenemalonodinitriles in the presence of piperidine[8] or under microwave irradiation.[9] The reactions between propanedinitrile and α, β-unsaturated ketones can also give 2,6-dicyanoanilines, but the yields are very poor.[10] In addition, all above-mentioned reactions need to be performed in organic solvents. To obtain the A−D−A systems in high yields as well as in a green media, we have synthesized these potentive units in aqueous media successfully,[11] with some substituted cyclohexa-1,3-diene derivatives containing acceptor−donor−acceptor−acceptor (A−D−A−A) being obtained. As a continuation of our research devoted to multicomponent reactions in green media,[12] we would like to report the synthesis of the A−D−A−A type of compounds, including highly substituted cyclohexa-1,3-diene, polyhydroindene, polyhydronaphthalene, isochromene, isothiochromene, and isoquinoline derivatives via three-component reactions in ionic liquids.

2. Results and Discussion

Treatment of aromatic aldehyde **1** with malononitrile **2** and 2-(1,2-diphenylethylidene) malononitrile or 2-(1,3-diphenylpropan-2-ylidene) malononitrile **3** in [BMIm][BF_4] at 90 °C produced the corresponding 2-amino-4,6-diarylcyclohexa-1,5-diene-1,3,3-tricarbonitrile derivatives **4** in high yields (Scheme 1).

Using the conversion of 2-fluorobenzaldehyde, malononitrile and 2-(1,2-diphenylethylidene)malononitrile as a model reaction, different reaction temperatures were tested to optimize the conditions first. A summary of the optimization experiment is provided in Table 1. It was found that the reaction went smoothly at 90 °C to give a high yield of 96% (Table 1, entry 1), while no reaction was observed at room temperature. To further optimize condition, the reaction was carried out in ionic liquid [BMIm][BF_4] for 5, 9, and 12 h, respectively (Table 1, Entries 3, 4 and 5), resulting in

Scheme 1. Reaction of **1**, **2**, and 2-(1,2-Diphenylethylidene)malononitrile or 2-(1,3-Diphenylpropan-2-ylidene)malononitrile



* To whom correspondence should be addressed. E-mail: xswang1974@yahoo.com.

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Table 1. Synthetic Results of **4a** under Different Reaction Conditions[a]

entry	temp./°C	ionic liquid[b]	time/h	yield (%)[c]
1	r.t.	[BMIm][BF_4]	9	0
2	50	[BMIm][BF_4]	9	56
3	90	[BMIm][BF_4]	5	86
4	90	[BMIm][BF_4]	9	96
5	90	[BMIm][BF_4]	12	96
6	90	[EMIm]Br	9	89
7	90	[PMIm]Br	9	90
8	90	[BMIm]Br	9	92
9	90	[EMIm][BF_4]	9	90
10	90	[PMIm][BF_4]	9	92

[a] Reaction conditions: 2 mL solvent, 2-fluorobenzaldehyde (0.248 g, 2 mmol), malononitrile (0.139 g, 2.1 mmol), and 2-(1,2-diphenylethylidene)malononitrile (0.488 g, 2 mmol). [b] BMIm = 1-butyl-3-methylimidazolium; EMIm = 1-ethyl-3-methylimidazolium; PMIm = 1-methyl-3-propylimidazolium. [c] Isolated yields.

Table 2. Synthetic Results of **4** in Ionic Liquids[a]

entry	Ar	R	time (h)	products	yields (%)[b]
1	2-FC_6H_4	Ph	9	**4a**	96
2	3-FC_6H_4	Ph	10	**4b**	94
3	4-FC_6H_4	Ph	10	**4c**	98
4	2-ClC_6H_4	Ph	9	**4d**	92
5	3-ClC_6H_4	Ph	12	**4e**	90
6	3-BrC_6H_4	Ph	14	**4f**	92
7	3,4-$Me_2C_6H_3$	CH_2Ph	15	**4g**	87
8	2,4-$Cl_2C_6H_3$	CH_2Ph	12	**4h**	90
9	2-ClC_6H_4	CH_2Ph	12	**4i**	95
10	2,3-$Cl_2C_6H_3$	CH_2Ph	12	**4j**	93
11	3-BrC_6H_4	CH_2Ph	16	**4k**	85
12	3-ClC_6H_4	CH_2Ph	13	**4L**	88
13	3-$NO_2C_6H_4$	CH_2Ph	10	**4m**	89

[a] Reaction conditions: 2 mL of [BMIm][BF_4], **1** (2 mmol) and **2** (0.139 g, 2.1 mmol), and 2-(1,2-diphenylethylidene)malononitrile or 2-(1,3-diphenylpropan-2-ylidene)malononitrile (2 mmol), 90 °C. [b] Isolated yields.

the isolation of **4a** in 86%, 96%, and 96% yields, correspondingly. Therefore, reaction temperature of 90 °C and a period of 9 h were identified as the optimum condition. Moreover, different ionic liquids were further studied. As revealed in Table 1, it was found that different groups on the methylimidazolium, anions were chosen as media for this reaction, and [BMIm][BF_4] appeared to be the best media for this reaction.

After the reaction was completed as monitored by TLC, the reaction mixture was allowed to cool down to room temperature. A small amount of water was added to the mixture, and the solid was isolated by filtration. The water in the filtrate was removed by distillation under reduced pressure, and the [BMIm][BF_4] in the residue could be reused after being evaporated at 80 °C for 4 h in vacuum. Investigations by using 2-fluorobenzaldehyde, malononitrile and 2-(1,2-diphenylethylidene)malononitrile as model substrates showed the successive reuse of the recycled ionic liquid of [BMIm][BF_4]. Even in the fourth round the yield of the product **4a** is fairly high (92%).

Subsequently, these optimized conditions were applied for the conversion of various aromatic aldehydes **1** into the corresponding 2-amino-4,6-diarylcyclohexa-1,5-diene-1,3,3-tricarbonitrile analogues **4a**−**m** (Table 2). As shown in Table 2, for aldehydes **1**, the yields of **4** were not sensitive to the electronic properties of the aromatic rings in the presence of electron-withdrawing groups (such as halide, nitro) or electron-donating groups (such as alkyl group).

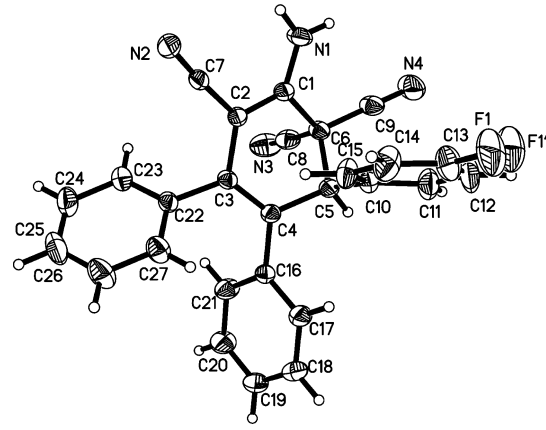
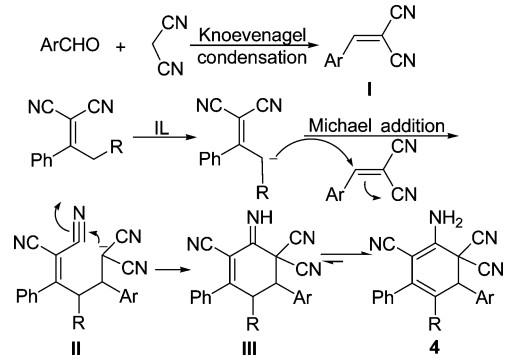


Figure 1. Crystal structure of product **4c**.

Scheme 2. Possible Mechanism for the Formation of Products **4**



The products **4** were fully characterized by IR, ^{1}H NMR, and HRMS. The data were in agreement with their structures. In order to further confirm the structure, the X-ray diffraction analysis of the product **4c** was carried out. As expected, the structure is 2-amino-4-(4-fluorophenyl)-5,6-diphenylcyclohexa-1,5-diene-1,3,3- tricarbonitrile **4c**, and the crystal structure of **4c** is shown in Figure 1.

Although the detailed mechanism of the above reaction has not been clarified, the formation of cyclohexa-1,5-diene-1,3,3-tricarbonitrile derivatives **4** can be tentatively explained by the pathway presented in Scheme 2. The product of Knoevenagel condensation **I** may be formed first from aromatic aldehyde and malononitrile. In the following step, the Michael addition reaction between **3** and **I** takes place to produce intermediate **II**, followed by intramolecular cyclization to form **III**. **III** isomerizes to give the final product **4**.

To our delight, one of intermediates **III** (Ar = 4-ClC_6H_4, R = Ph) was isolated in crystals but in a mixture of **III** and **4** in the solution of DMSO-d_6. Its structure is also confirmed by X-ray diffraction analysis, which indicates that C2−N2 (1.262(3) Å) and C1−C6 (1.349(4) Å) are double bonds. The crystal structure of **III** is shown in Figure 2.

As expected, the substrate of 2-(1,2-diphenylethylidene)-malononitrile could be extended to 2-cyclopentylidenemalononitrile or 2-cyclohexylidenemalononitrile, which were also chosen as reactants to react with aromatic aldehyde and malononitrile (Scheme 3). The desired reactions were found to generate the corresponding 7-arylindene-4,6,6-tricarbonitrile or 4-arylnaphthalene-1,3,3(4*H*)-tricarbonitrile deriva-

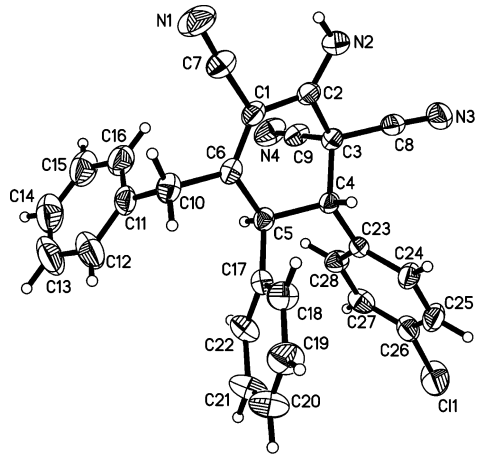


Figure 2. Crystal structure of product **III**.

Scheme 3. Reaction of **1**, **2**, and 2-Cyclopentylidenemalononitrile or 2-Cyclohexylidenemalononitrile

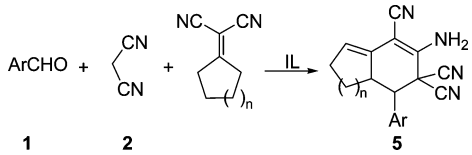


Table 3. Synthetic Results of **5** in Ionic Liquids[a]

entry	Ar	*n*	products	time (h)	yields (%)[b]
1	2-ClC_6H_4	1	**5a**	8	93
2	2,4-$Cl_2C_6H_3$	1	**5b**	8	92
3	2,3-$Cl_2C_6H_3$	1	**5c**	8	87
4	4-$NO_2C_6H_4$	1	**5d**	6	87
5	4-FC_6H_4	1	**5e**	7	90
6	4-$MeOC_6H_4$	1	**5f**	9	93
7	4-ClC_6H_4	1	**5g**	8	98
8	2,4-$Cl_2C_6H_3$	2	**5h**	8	88
9	3-$NO_2C_6H_4$	2	**5i**	7	89
10	3-BrC_6H_4	2	**5j**	10	93
11	4-$MeOC_6H_4$	2	**5k**	10	93
12	3-ClC_6H_4	2	**5l**	8	92
13	4-ClC_6H_4	2	**5m**	8	87
14	4-FC_6H_4	2	**5n**	6	88
15	4-BrC_6H_4	2	**5o**	9	88
16	4-CNC_6H_4	2	**5p**	8	90
17	2-ClC_6H_4	2	**5q**	7	93
18	2,3-$(MeO)_2C_6H_3$	2	**5r**	10	89
19	3,4-$Cl_2C_6H_3$	2	**5s**	8	90
20	3,4-$(MeO)_2C_6H_3$	2	**5t**	10	96

[a] Reaction conditions: 2 mL of [BMIm][BF_4], **1** (2 mmol), **2** (0.139 g, 2.1 mmol), and 2-cyclopentylidenemalononitrile or 2-cyclohexylidenemalononitrile (2 mmol), 90 °C. [b] Isolated yields.

tives (**5a**−**t**) in high yields. The results are summarized in Table 3. The structure of **5k** is also confirmed by X-ray diffraction analysis, and its crystal structure is shown in Figure 3.

Iso(thio)chromene derivatives are important and useful skeletons in organic synthesis. For example, it was reported that many isochromene derivatives displayed a wide range of biological activities, such as antiinflammatory activity,[13] antitumor activity,[14] antiviral activity,[15] and antiapoptotic activity.[16] For this purpose, a number of elegant approaches to iso(thio)chromene derivatives have thus been developed.[17] However, these methods exhibit many drawbacks such as multiple reaction steps, low yields, or unavailable reactants. To overcome the lack of efficient synthetic methods and

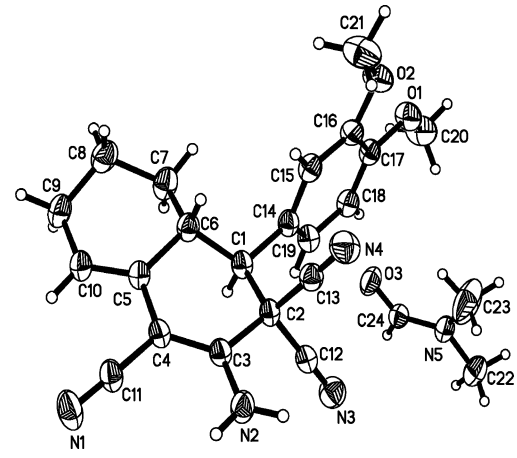


Figure 3. Crystal structure of product **5t** with DMF solvate.

Scheme 4. Reaction of **1**, **2**, and 2-(Tetrahydro(thio)pyran-4-ylidene)malononitrile

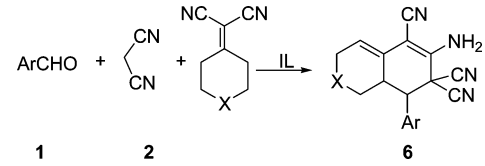


Table 4. Synthetic Results of **6** in Ionic Liquids[a]

entry	Ar	X	products	time (h)	yields (%)[b]
1	4-FC_6H_4	O	**6a**	8	90
2	2-FC_6H_4	O	**6b**	6	89
3	2,3-$Cl_2C_6H_3$	O	**6c**	7	97
4	3,4-$Cl_2C_6H_3$	O	**6d**	10	85
5	2-$MeOC_6H_4$	O	**6e**	9	89
6	3,5-$(CH_3O)_2C_6H_3$	O	**6f**	10	90
7	2,4,5-$(CH_3O)_3C_6H_2$	O	**6g**	10	90
8	4-BrC_6H_4	O	**6h**	9	91
9	2-BrC_6H_4	O	**6i**	8	87
10	2-ClC_6H_4	O	**6j**	7	88
11	2,3-$(CH_3O)_2C_6H_3$	O	**6k**	8	88
12	2-FC_6H_4	S	**6l**	9	90
13	4-FC_6H_4	S	**6m**	6	95
14	2-ClC_6H_4	S	**6n**	6	98
15	2-BrC_6H_4	S	**6o**	7	98
16	4-BrC_6H_4	S	**6p**	9	89
17	2-$MeOC_6H_4$	S	**6q**	12	90
18	3,4-$(CH_3O)_2C_6H_3$	S	**6r**	12	94
19	3,5-$(CH_3O)_2C_6H_3$	S	**6s**	12	95
20	2,3-$(CH_3O)_2C_6H_3$	S	**6t**	12	95
21	2,3-$Cl_2C_6H_3$	S	**6u**	8	94
22	3,4-$Cl_2C_6H_3$	S	**6v**	8	90

[a] Reaction conditions: 2 mL of [BMIm][BF_4], **1** (2 mmol), **2** (0.139 g, 2.1 mmol), and 2-(tetrahydro(thio)pyran-4-ylidene)malononitrile (2 mmol), 90 °C. [b] Isolated yields.

knowledge, in the continued study, the 2-(tetrahydro(thio)-pyran-4-ylidene) malononitrile was selected as reagent to react with aromatic aldehyde and malononitrile. It was found that 8-aryl-1*H*-iso(thio)chromene-5,7,7(3*H*)-tricarbonitrile derivatives were obtained in high yields via one step in [BMIm][BF_4] (Scheme 4). The results are summarized in Table 4. The structure of **6d** is further confirmed by X-ray diffraction analysis, and its crystal structure is shown in Figure 4.

Molecules with isoquinoline substructures are attractive targets for synthesis because they often exhibit diverse and important biological properties. Indeed, many total syntheses of natural alkaloids have been achieved using 1,2-dihydroisoquinolines as synthetic intermediates.[18] Accordingly,

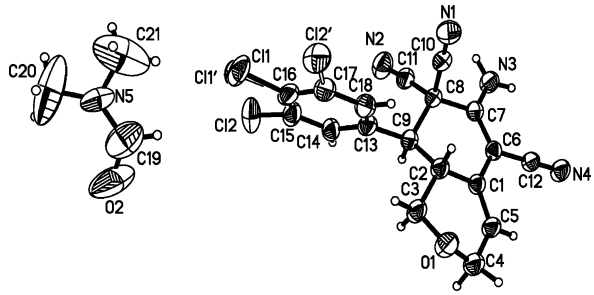


Figure 4. Crystal structure of product **6d** with DMF solvate.

Scheme 5. Reaction of **1**, **2**, and *tert*-Butyl 4-(dicyanomethylene)piperidine-1-carboxylate

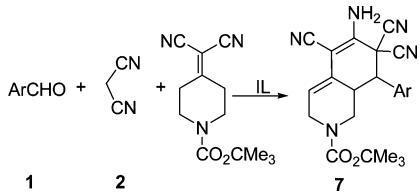


Table 5. Synthetic Results of **7** in Ionic Liquids[a]

entry	Ar	products	time (h)	yields (%)[b]
1	2-FC_6H_4	**7a**	9	96
2	2-ClC_6H_4	**7b**	9	90
3	4-ClC_6H_4	**7c**	12	95
4	2-BrC_6H_4	**7d**	8	94
5	4-BrC_6H_4	**7e**	11	90
6	2-$MeOC_6H_4$	**7f**	9	89
7	2,4-$Cl_2C_6H_3$	**7g**	10	90
8	3,5-$(CH_3O)_2C_6H_3$	**7h**	12	93
9	3,4-$(CH_3O)_2C_6H_3$	**7i**	12	91
10	2,3-$(CH_3O)_2C_6H_3$	**7j**	12	93

[a] Reaction conditions: 2 mL of [BMIm][BF_4], **1** (2 mmol), **2** (0.139 g, 2.1 mmol), and *tert*-butyl 4-(dicyanomethylene)piperidine-1-carboxylate (0.494 g, 2 mmol), 90 °C. [b] Isolated yields.

novel strategies for the synthesis of isoquinolines continue to receive considerable attention in the field of synthetic organic chemistry,[19] except for the known classical isoquinoline synthetic methods, for example, Bischler−Napieralski reaction, Pictet−Gams isoquinoline synthesis, Pomeranz−Fritsch reaction, Gabriel−Colman rearrangement, and Pictet−Spengler isoquinoline synthesis. In general, amines containing benzene ring were used as reactants to construct the pyridine nucleus to gain the isoquinolines. On the contrary, inspired by the reaction outlined in Scheme 4, another series of isoquinoline derivatives could be easily synthesized by a three-component reaction in the same reaction conditions, using *tert*-butyl 4-(dicyanomethylene) piperidine-1-carboxylate as a fragment-containing pyridine ring to form the benzene moiety (Scheme 5). The results are summarized in Table 5.

3. Conclusion

In conclusion, an efficient and green method is found for the synthesis of highly substituted cyclohexa-1,3-diene, polyhydroindene, polyhydronaphthalene, isochromene, isothiochromene, and isoquinoline derivatives via three-component reactions in [BMIm][BF_4]. The features of this procedure include mild reaction conditions, high yields, one-pot, operational simplicity and environmentally benign.

Experimental Section

Melting points were determined in open capillaries and are uncorrected. IR spectra were recorded on a Tensor 27 spectrometer in KBr pellet. ^{1}H NMR and ^{13}C NMR spectra were obtained from a solution in DMSO-d_6 or $CDCl_3$ with Me_4Si as internal standard using a Bruker-400 spectrometer. HRMS analyses were carried out using a Bruker-micro-TOF-Q-MS analyzer.

General Procedure for the Synthesis of 2-Amino-4-aryl-5,6-diphenyl cyclohexa-1,5-diene-1,3,3-tricarbonitrile derivatives 4. A dry 50 mL flask was charged with aromatic aldehyde (2.0 mmol), malononitrile (0.139 g, 2.1 mmol), 2-(1,2-diphenylethylidene)malononitrile or 2-(1,3-diphenyl propan-2-ylidene) malononitrile (2.0 mmol), and ionic liquid of [BMIm][BF_4] (2 mL). The reaction mixture was stirred at 90 °C for 9−16 h and then cooled down to room temperature. A small amount of water (5 mL) was added to the mixture, and the generated yellow solid was filtered off. The water in the filtrate was removed by distillation under reduced pressure, and the ionic liquid in the residue could be reusable by being evaporated at 80 °C for 4 h at vacuum. The crude yellow products were washed with water, purified by recrystallization from DMF and water, then dried at 80 °C for 2 h under *vacuum* to give **4**.

2-Amino-4-(2-fluorophenyl)-5,6-diphenylcyclohexa-1,5-diene-1,3,3-tricarbonitrile 4a: mp 226−228 °C; ^{1}H NMR (DMSO-d_6, 400 MHz) δ_H 5.12 (s, 1H, CH), 6.79−6.92 (m, 2H, ArH), 7.04−7.07(m, 3H, ArH), 7.14−7.16 (m, 2H, ArH), 7.24−7.37 (m, 5H, ArH), 7.48−7.5 (m, 1H, ArH), 7.62−7.66 (m, 1H, ArH), 7.93 (s, 2H, NH_2); IR (KBr) 3525, 3452, 3347, 3271, 3083, 2969, 2210, 1644, 1587, 1485, 1444, 1388, 1252, 1224, 1193, 1153, 1094, 1073, 1034, 842, 760, 718, 700 cm^{-1}; HRMS (ESI, *m*/*z*) calcd for $C_{27}H_{17}FN_4Na$ ($M + Na^+$) 439.1335, found 439.1352.

2-Amino-4-(3-fluorophenyl)-5,6-diphenylcyclohexa-1,5-diene-1,3,3-tricarbonitrile 4b: mp 183−184 °C; ^{1}H NMR (DMSO-d_6, 400 MHz) δ_H 5.18 (s, 1H, CH), 6.78−6.8 (m, 2H, ArH), 7.04−7.07 (m, 3H, ArH), 7.14−7.16 (m, 2H, ArH), 7.27−7.31 (m, 4H, ArH), 7.36 (d, J = 10.0 Hz, 1H, ArH), 7.44 (d, J = 8.0 Hz, 1H, ArH), 7.51−7.54 (m, 1H, ArH), 7.85 (s, 2H, NH_2); IR (KBr): 3387, 3325, 3084, 3061, 3031, 2219, 1653, 1588, 1488, 1445, 1388, 1236, 1194, 1163, 1136, 1073, 945, 913, 886, 793, 769, 758, 711, 699 cm^{-1}; HRMS (ESI, *m*/*z*) calcd for $C_{27}H_{17}FN_4Na$ ($M + Na^+$) 439.1335, found 439.1344.

2-Amino-4-(4-fluorophenyl)-5,6-diphenylcyclohexa-1,5-diene-1,3,3-tricarbonitrile 4c: mp 232−234 °C; ^{1}H NMR (DMSO-d_6, 400 MHz) δ_H 5.13 (s, 1H, CH), 6.77−6.79 (m, 2H, ArH), 7.03 (b, 2H, ArH), 7.26−7.31 (m, 5H, ArH), 7.60−7.62 (m, 2H, ArH), 7.79 (b, 2H, ArH); IR (KBr) 3458, 3326, 3239, 3065, 3022, 2206, 1652, 1601, 1505, 1444, 1274, 1225, 1158, 1101, 1070, 1029, 854, 838, 789, 774, 762, 714, 702 cm^{-1}; HRMS (ESI, *m*/*z*) calcd for $C_{27}H_{17}FN_4Na$ ($M + Na^+$) 439.1335, found 439.1350.

2-Amino-4-(2-chlorophenyl)-5,6-diphenylcyclohexa-1,5-diene-1,3,3-tricarbonitrile 4d: mp 200−202 °C; ^{1}H NMR

(DMSO-d_6, 400 MHz) δ_H 5.18 (s, 1H, ArH), 6.73−6.75 (m, 2H, ArH), 7.04 ((b, 3H, ArH), 7.15 (d, J = 6.8 Hz, 2H, ArH), 7.25−7.27 (m, 3H, ArH), 7.47−7.52 (m, 2H, ArH), 7.59 (d, J = 7.2 Hz, 1H, ArH), 7.73 (d, J = 7.6 Hz, 1H, ArH), 7.99 (s, 2H, NH_2); IR (KBr) 3443, 3344, 3243, 3201, 3058, 3028, 2205, 1644, 1577, 1491, 1469, 1385, 1270, 1242, 1181, 1071, 1051, 1035, 785, 755, 729, 697 cm^{-1}; HRMS (ESI, *m/z*) calcd for $C_{27}H_{17}ClN_4Na$ (M + Na^+) 455.1039, found 455.1047.

2-Amino-4-(3-chlorophenyl)-5,6-diphenylcyclohexa-1,5-diene-1,3,3-tricarbonitrile 4e: mp 225−227 °C;^{1}H NMR (DMSO-d_6, 400 MHz) δ_H 5.18 (s, 1H, CH), 6.78−6.80 (m, 2H, ArH), 7.05−7.08 (m, 3H, ArH), 7.14−7.16 (m, 2H, ArH), 7.25−7.30 (m, 3H, ArH), 7.51−7.56 (m, 3H, ArH), 7.61 (s, 1H, ArH), 7.85 (s, 2H, ArH); IR (KBr) 3386, 3312, 3206, 3082, 3027, 2222, 1648, 1620, 1585, 1491, 1477, 1428, 1389, 1310, 1267, 1237, 1175, 1103, 1071, 1029, 898, 869, 772, 736, 715, 698 cm^{-1}; HRMS (ESI, *m/z*) calcd for $C_{27}H_{17}ClN_4Na$ (M + Na^+) 455.1039, found 455.1046.

2-Amino-4-(3-bromophenyl)-5,6-diphenylcyclohexa-1,5-diene-1,3,3-tricarbonitrile 4f: mp 239−240 °C; IR (KBr) 3388, 3309, 3204, 3081, 3050, 3027, 2221, 1642, 1584, 1491, 1475, 1444, 1424, 1411, 1389, 1267, 1174, 1099, 1075, 1029, 935, 852, 770, 725, 714, 697 cm^{-1}; ^{1}H NMR ($CDCl_3$, 400 MHz) δ_H 5.17 (s, 1H, CH), 6.77−6.80 (m, 2H, ArH), 7.04−7.07 (m, 3H, ArH), 7.14 (d, J = 8.0 Hz, 2H, ArH), 7.25−7.29 (m, 3H, ArH), 7.45 (t, J = 8.0 Hz, 1H, ArH), 7.60 (d, J = 7.6 Hz, 1H, ArH), 7.64 (d, J = 8.0 Hz, 1H, ArH), 7.75 (s, 1H, ArH), 7.86 (s, 2H, NH_2); HRMS (ESI, *m/z*) calcd for $C_{27}H_{18}BrN_4$ (M + H^+) 477.0715, found 477.0700.

2-Amino-6-benzyl-4-(3,4-dimethylphenyl)-5-phenylcyclohexa-1,5-diene-1,3,3-tricarbonitrile 4g: mp 220−222 °C; IR (KBr) 3439, 3325, 3061, 3031, 2947, 2210, 1656, 1626, 1583, 1495, 1453, 1387, 1273, 1158, 1113, 1028, 829, 790, 767, 727, 708 cm^{-1}; ^{1}H NMR ($CDCl_3$, 400 MHz) δ_H 2.24 (s, 3H, CH_3), 2.25 (s, 3H, CH_3), 3.64 (d, J = 5.6 Hz, 1H, CH), 3.88 (d, J = 15.6 Hz, 1H, CH), 4.23 (s, 1H, CH), 5.15 (s, 1H, ArH), 7.05 (s, 1H, ArH), 7.06 (d, J = 7.6 Hz, 1H, ArH), 7.10−7.14 (m, 3H, ArH), 7.22−7.32 (m, 8H, ArH); HRMS (ESI, *m/z*) calcd for $C_{30}H_{24}N_4Na$ (M + Na^+) 463.1899, found 463.1913.

2-Amino-6-benzyl-4-(2,4-dichlorophenyl)-5-phenylcyclohexa-1,5-diene-1,3,3-tricarbonitrile 4h: mp 178−179 °C; IR (KBr) 3411, 3333, 3029, 2955, 2208, 1666, 1644, 1585, 1494, 1470, 1454, 1386, 1085, 1028, 865, 786, 731, 701 cm^{-1}; ^{1}H NMR (DMSO-d_6, 400 MHz) δ_H 3.57 (d, J = 16.0 Hz, 1H, CH), 3.75 (d, J = 16.0 Hz, 1H, CH), 5.12 (s, 1H, CH), 7.10−7.21 (m, 5H, ArH), 7.25−7.35 (m, 5H, ArH), 7.55−7.61 (m, 2H, ArH), 7.71 (s, 1H, ArH), 7.82 (s, 2H, NH_2); HRMS (ESI, *m/z*) calcd for $C_{28}H_{18}N_4Na$ (M + Na^+) 503.0806, found 503.0828.

2-Amino-6-benzyl-4-(2-chlorophenyl)-5-phenylcyclohexa-1,5-diene-1,3,3-tricarbonitrile 4i: mp 218−220 °C; IR (KBr) 3439, 3324, 3063, 3031, 2206, 1648, 1581, 1494, 1469, 1453, 1441, 1391, 1238, 1160, 1086, 1051, 1041, 1029, 937, 764, 731, 709 cm^{-1}; ^{1}H NMR (DMSO-d_6, 400 MHz) δ_H 3.58 (d, J = 15.6 Hz, 1H, CH), 3.76 (d, J = 15.6 Hz, 1H, CH), 5.14 (s, 1H, CH), 7.10 (d, J = 7.6 Hz, 2H, ArH), 7.15−7.21 (m, 3H, ArH), 7.25−7.34 (m, 5H, ArH), 7.42−7.51 (m, 3H, ArH), 7.59 (dd, J = 7.6 Hz, J' = 7.6 Hz, 1H, ArH), 7.78 (s, 2H, NH_2); HRMS (ESI, *m/z*) calcd for $C_{28}H_{19}ClN_4Na$ (M + Na^+) 469.1196, found 469.1215.

2-Amino-6-benzyl-4-(2,3-dichlorophenyl)-5-phenylcyclohexa-1,5-diene-1,3,3-tricarbonitrile 4j: mp 225−226 °C; IR (KBr) 3424, 3317, 3061, 3030, 2219, 1655, 1586, 1495, 1447, 1420, 1393, 1271, 1159, 1046, 788, 767, 730, 699 cm^{-1}; ^{1}H NMR (DMSO-d_6, 400 MHz) δ_H 3.57 (d, J = 16.0 Hz, 1H, CH), 3.76 (d, J = 16.0 Hz, 1H, CH), 5.25 (s, 1H, CH), 7.12−7.16 (m, 4H, ArH), 7.19 (d, J = 7.2 Hz, 1H, ArH), 7.24−7.28 (m, 3H, ArH), 7.31−7.34 (m, 2H, ArH), 7.48 (t, J = 8.0 Hz, 1H, ArH), 7.59 (d, J = 7.2 Hz, 1H, ArH), 7.70 (d, J = 8.0 Hz, 1H, ArH), 7.83 (s, 2H, NH_2); HRMS (ESI, *m/z*) calcd for $C_{28}H_{18}Cl_2N_4Na$ (M + Na^+) 503.0806, found 503.0826.

2-Amino-6-benzyl-4-(3-bromophenyl)-5-phenylcyclohexa-1,5-diene-1,3,3-tricarbonitrile 4k: mp 207−209 °C; IR (KBr) 3413, 3316, 3060, 3031, 2897, 2219, 1656, 1584, 1495, 1473, 1453, 1439, 1397, 1270, 1240, 1170, 1097, 1076, 1028, 866, 787, 769, 725, 706 cm^{-1}; ^{1}H NMR (DMSO-d_6, 400 MHz) δ_H 3.60 (d, J = 16.0 Hz, 1H, CH), 3.80 (d, J = 16.0 Hz, 1H, CH), 5.11 (s, 1H, CH), 7.14−7.20 (m, 5H, ArH), 7.24−7.28 (m, 3H, ArH), 7.31−7.39 (m, 3H, ArH), 7.45 (d, J = 7.6 Hz, 1H, ArH), 7.57−7.62 (m, 2H, ArH), 7.65 (s, 2H, NH_2); HRMS (ESI, *m/z*) calcd for $C_{28}H_{19}BrN_4Na$ (M + Na^+) 513.0691, found 513.0723.

2-Amino-6-benzyl-4-(3-chlorophenyl)-5-phenylcyclohexa-1,5-diene-1,3,3-tricarbonitrile 4l: mp 214−216 °C; IR (KBr) 3412, 3322, 3062, 3031, 2214, 1654, 1583, 1497, 1475, 1453, 1441, 1394, 1270, 1237, 1184, 1167, 1102, 1084, 1029, 1000, 880, 786, 770, 725, 703 cm^{-1}; ^{1}H NMR (DMSO-d_6, 400 MHz) δ_H 3.61 (d, J = 16.0 Hz, 1H, CH), 3.80 (d, J = 16.0 Hz, 1H, CH), 5.12 (s, 1H, CH), 7.14−7.18 (m, 5H, ArH), 7.20−7.28 (m, 3H, ArH), 7.31−7.35 (m, 2H, ArH), 7.41−7.46 (m, 3H, ArH), 7.48 (d, J = 1.2 Hz, 1H, ArH), 7.65 (s, 2H, NH_2); HRMS (ESI, *m/z*) calcd for $C_{28}H_{19}ClN_4Na$ (M + Na^+) 469.1196, found 469.1227.

2-Amino-6-benzyl-4-(3-nitrophenyl)-5-phenylcyclohexa-1,5-diene-1,3,3-tricarbonitrile 4m: mp 215−216 °C; IR (KBr) 3459, 3364, 3082, 3030, 2210, 1643, 1628, 1582, 1531, 1494, 1454, 1443, 1379, 1353, 1303, 1241, 1158, 1100, 1030, 904, 827, 803, 767, 721, 701 cm^{-1}; ^{1}H NMR (DMSO-d_6, 400 MHz) δ_H 3.63 (d, J = 16.0 Hz, 1H, CH), 3.83 (d, J = 16.0 Hz, 1H, CH), 5.38 (s, 1H, CH), 7.16−7.27 (m, 5H, ArH), 7.28−7.35 (m, 5H, ArH), 7.68 (s, 2H, NH_2), 7.73 (t, J = 8.0 Hz, 1H, ArH), 7.90 (d, J = 8.0 Hz, 1H, ArH), 7.24 (dd, J = 8.0 Hz, J' = 2.0 Hz, 1H, ArH), 8.34−8.35 (m, 1H, ArH); HRMS (ESI, *m/z*) calcd for $C_{28}H_{19}N_5O_2Na$ (M + Na^+) 480.1436, found 480.1466.

General Procedure for the Synthesis of 7-Arylindene-4,6,6-tricarbonitrile and 4-arylnaphthalene-1,3,3(4H)-tricarbonitrile Derivatives 5. A dry 50 mL flask was charged with aromatic aldehyde (2.0 mmol), malononitrile (0.139 g, 2.1 mmol), 2-cyclopentylidenemalononitrile or 2-cyclohexylidenemalononitrile (2.0 mmol), and ionic liquid of [BMIm][BF_4] (2 mL). The reaction mixture was stirred at 90 °C for 6−10 h and then cooled down to room temperature. A small amount of water (5 mL) was added to the mixture,

and the generated yellow solid was filtered off. The water in the filtrate was removed by distillation under reduced pressure, and the ionic liquid in the residue could be reusable by being evaporated at 80 °C for 4 h at vacuum. The crude yellow products were washed with water and purified by recrystallization from DMF and water, then dried at 80 °C for 2 h under vacuum to give **5**.

5-Amino-1,2,7,7a-tetrahydro-7-(2-chlorophenyl)indene-4,6,6-tricarbonitrile 5a: mp 231−233 °C; ^{1}H NMR (DMSO-d_6, 400 MHz) δ_H 1.07−1.15 (m, 1H, CH), 1.77−1.83 (m, 1H, CH), 2.31−2.35 (m, 2H, CH_2), 3.32−3.40 (m, 1H, CH), 3.99 (d, J = 12.4 Hz, 1H, CH), 5.54 (d, J = 2.0 Hz, 1H, CH), 7.45−7.55 (m, 2H, ArH), 7.63 (d, J = 8.0 Hz, 1H, ArH), 7.74 (s, 2H, NH_2), 7.79 (d, J = 7.2 Hz, 1H, ArH); IR (KBr) 3422, 3333, 3233, 2961, 2919, 2852, 2217, 1656, 1593, 1478, 1454, 1438, 1395, 1309, 1282, 1203, 1164, 1107, 1049, 986, 806, 777, 749, 707 cm^{-1}; HRMS (ESI, *m*/*z*) calcd for $C_{18}H_{13}ClN_4Na$ (M + Na^+) 343.0726, found 343.0706.

5-Amino-1,2,7,7a-tetrahydro-7-(2,4-dichlorophenyl)indene-4,6,6-tricarbonitrile 5b: mp 240−242 °C; ^{1}H NMR ($CDCl_3$, 400 MHz): δ_H 1.23−1.34 (m, 1H, CH), 1.89−1.96 (m, 1H, CH), 2.44−2.48 (m, 2H, CH_2), 3.30−3.38 (m, 1H, CH), 4.03 (d, J = 12.4 Hz, 1H, CH), 5.12 (s, 2H, NH_2), 5.87 (d, J = 2.4 Hz, 1H, CH), 7.43 (dd, J = 8.4 Hz, J' = 2.0 Hz, 1H, ArH), 7.56 (d, J = 2.0 Hz, 1H, ArH), 7.62 (d, J = 8.4 Hz, 1H, ArH); IR (KBr) 3423, 3319, 3216, 3006, 2940, 2846, 2214, 1705, 1648, 1589, 1559, 1474, 1389, 1364, 1281, 1232, 1164, 1104, 1051, 857, 829, 805, 775 cm^{-1}; HRMS (ESI, *m*/*z*) calcd for $C_{18}H_{12}Cl_2N_4Na$ (M + Na^+) 377.0337, found 377.0348.

5-Amino-1,2,7,7a-tetrahydro-7-(2,3-dichlorophenyl)indene-4,6,6-tricarbonitrile 5c: mp 243−245 °C; ^{1}H NMR ($CDCl_3$, 400 MHz) δ_H 1.25−1.35 (m, 1H, CH), 1.89−1.96 (m, 1H, CH), 2.43−2.48 (m, 2H, CH_2), 3.31−3.39 (m, 1H, CH), 4.17 (d, J = 12.4 Hz, 1H, CH), 5.14 (s, 2H, NH_2), 5.87 (dd, J = 4.8 Hz, J' = 2.4 Hz, 1H, CH), 7.37−7.41 (m, 1H, ArH), 7.57−7.63 (m, 2H, ArH); IR (KBr) 3429, 3320, 3217, 3069, 2847, 2218, 1652, 1590, 1507, 1454, 1423, 1395, 1309, 1281, 1188, 1155, 1109, 1046, 812, 795, 749, 738 cm^{-1}; HRMS (ESI, *m*/*z*) calcd for $C_{18}H_{12}Cl_2N_4Na$ (M + Na^+) 377.0337, found 377.0335.

5-Amino-1,2,7,7a-tetrahydro-7-(4-nitrophenyl)indene-4,6,6-tricarbonitrile 5d: mp 230−232 °C; ^{1}H NMR ($CDCl_3$, 400 MHz): δ_H 1.26−1.36 (m, 1H, CH), 2.02−2.08 (m, 1H, CH), 2.47−2.54 (m, 2H, CH_2), 3.33 (d, J = 12.4 Hz, 1H, CH), 3.43−3.48 (m, 1H, CH), 5.18 (s, 2H, NH_2), 5.89 (dd, J = 4.8 Hz, J' = 2.4 Hz, 1H, CH), 7.70 (d, J = 8.8 Hz, 2H, ArH), 8.36 (d, J = 8.8 Hz, 2H, ArH); IR (KBr) 3426, 3332, 3245, 2958, 2921, 2846, 2222, 1656, 1591, 1519, 1497, 1439, 1394, 1317, 1279, 1202, 1159, 1111, 1082, 1016, 980, 862, 841, 818, 805, 766, 721 cm^{-1}; HRMS (ESI, *m*/*z*) calcd for $C_{18}H_{13}N_5O_2Na$ (M + Na^+) 354.0967, found 354.0948.

5-Amino-1,2,7,7a-tetrahydro-7-(4-fluorophenyl)indene-4,6,6-tricarbonitrile 5e: mp 219−221 °C; ^{1}H NMR ($CDCl_3$, 400 MHz) δ_H 1.23−1.36 (m, 1H, CH), 2.01−2.08 (m, 1H, CH), 2.40−2.49 (m, 2H, CH_2), 3.18 (d, J = 12.4 Hz, 1H, CH), 3.36−3.43 (m, 1H, CH), 5.09 (s, 2H, NH_2), 5.85 (d, J = 2.0 Hz, 1H, CH), 7.05−7.20 (m, 2H, ArH), 7.46−7.49 (m, 2H, ArH); IR (KBr) 3417, 3337, 3246, 2945, 2850, 2211, 1647, 1606, 1590, 1512, 1394, 1307, 1281, 1232, 1165, 844, 807, 791, 768, 749 cm^{-1}; HRMS (ESI, *m*/*z*) calcd for $C_{18}H_{13}FN_4Na$ (M + Na^+) 327.1022, found 327.1030.

5-Amino-1,2,7,7a-tetrahydro-7-(4-methoxyphenyl)indene-4,6,6-tricarbonitrile 5f: mp 215−217 °C; ^{1}H NMR ($CDCl_3$, 400 MHz) δ_H 1.26−1.34 (m, 1H, CH), 2.02−2.09 (m, 1H, CH), 2.43−2.48 (m, 2H, CH_2), 3.14 (d, J = 12.4 Hz, 1H, CH), 3.35−3.43 (m, 1H, CH), 5.07 (s, 2H, NH_2), 5.83 (d, J = 2.4 Hz, 1H, CH), 6.89 (d, J = 8.8 Hz, 2H, ArH), 7.40 (d, J = 8.8 Hz, 2H, ArH); IR (KBr) 3412, 3335, 3246, 3046, 3009, 2960, 2936, 2846, 2217, 1652, 1613, 1589, 1515, 1458, 1394, 1309, 1279, 1257, 1181, 1030, 841, 803, 780, 766 cm^{-1}; HRMS (ESI, *m*/*z*) calcd for $C_{19}H_{16}N_4ONa$ (M + Na^+) 339.1222, found 339.1232.

5-Amino-1,2,7,7a-tetrahydro-7-(4-chlorophenyl)indene-4,6,6-tricarbonitrile 5g: mp 229−231 °C; ^{1}H NMR ($CDCl_3$, 400 MHz) δ_H 1.27−1.35 (m, 1H, CH), 2.01−2.08 (m, 1H, CH), 2.42−2.50 (m, 2H, CH_2), 3.17 (d, J = 12.4 Hz, 1H, CH), 3.35−3.43 (m, 1H, CH), 5.08 (s, 2H, NH_2), 5.86 (d, J = 2.4 Hz, 1H, CH), 7.42 (d, J = 8.4 Hz, 2H, ArH), 7.46 (d, J = 8.4 Hz, 2H, ArH); IR (KBr) 3414, 3334, 3247, 3047, 2957, 2939, 2852, 2217, 1649, 1591, 1494, 1456, 1414, 1393, 1308, 1281, 1160, 1094, 1016, 838, 803, 770, 748 cm^{-1}; HRMS (ESI, *m*/*z*) calcd for $C_{18}H_{13}ClN_4Na$ (M + Na^+) 343.0726, found 343.0723.

2-Amino-4a,5,6,7-tetrahydro-4-(2,4-dichlorophenyl)naphthalene-1,3,3(4*H*)-tricarbonitrile 5h: mp 236−238 °C; ^{1}H NMR (DMSO-d_6, 400 MHz) δ_H 0.77−0.86 (m, 1H, CH), 1.36−1.49 (m, 2H, CH_2), 1.67 (d, J = 9.2 Hz, 1H, CH), 2.03−2.21 (m, 2H, CH_2), 2.87 (d, J = 9.2 Hz, 1H, CH), 3.88 (d, J = 12.4 Hz, 1H, CH), 5.77 (s, 1H, CH), 7.43 (s, 2H, NH_2), 7.66 (dd, J = 8.8 Hz, J' = 2.4 Hz, 1H, ArH), 7.80 (d, J = 8.8 Hz, 1H, ArH), 7.82 (d, J = 2.4 Hz, 1H, ArH); IR (KBr) 3446, 3358, 3074, 2944, 2920, 2860, 2837, 2214, 1642, 1619, 1477, 1450, 1432, 1389, 1268, 1111, 1050, 885, 847, 823, 811, 794, 752 cm^{-1}; HRMS (ESI, *m*/*z*) calcd for $C_{19}H_{14}Cl_2N_4Na$ (M + Na^+) 391.0493, found 391.0493.

2-Amino-4a,5,6,7-tetrahydro-4-(3-nitrophenyl)naphthalene-1,3,3(4*H*)-tricarbonitrile 5i: mp 127−129 °C; ^{1}H NMR (DMSO-d_6, 400 MHz) δ_H 0.86−0.91 (m, 1H, CH), 1.45−1.50 (m, 2H, CH_2), 1.67 (b, 1H, CH), 2.03−2.22 (m, 2H, CH_2), 2.89−2.94 (m, 1H, CH), 3.93 (dd, J = 2.0 Hz, J' = 12.8 Hz, 1H, CH), 5.76 (s, 1H, CH), 7.44 (s, 2H, NH_2), 7.76−8.12 (m, 2H, ArH), 8.32 (d, J = 7.6 Hz, 1H, ArH), 8.42 (s, 1H, ArH); IR (KBr) 3343, 3188, 2946, 2877, 2208, 1658, 1605, 1434, 1414, 1390, 1351, 1273, 1104, 912, 830, 738, 723, 693 cm^{-1}; HRMS (ESI, *m*/*z*) calcd for $C_{19}H_{15}N_5O_2Na$ (M + Na^+) 368.1123, found 368.1112.

2-Amino-4a,5,6,7-tetrahydro-4-(3-bromophenyl)naphthalene-1,3,3(4*H*)-tricarbonitrile 5j: mp 129−131 °C; ^{1}H NMR (DMSO-d_6, 400 MHz) δ_H 0.83−0.92 (m, 1H, CH), 1.45−1.47 (m, 2H, CH_2), 1.66−1.69 (m, 1H, CH), 2.01−2.21 (m, 2H, CH_2), 2.81−2.84 (m, 1H, CH), 3.64 (d, J = 12.8 Hz, 1H, CH), 5.73 (s, 1H, CH), 7.40 (s, 2H, NH_2), 7.43−7.50 (m, 1H, ArH), 7.62−7.78 (m, 3H, ArH); IR (KBr) 3340, 3186, 2953, 2876, 2202, 1656, 1604, 1570, 1478, 1433, 1414, 1389, 1279, 1103, 1077, 892, 798, 748 cm^{-1}; HRMS (ESI, *m*/*z*) calcd for $C_{19}H_{15}BrN_4Na$ (M + Na^+) 401.0378, found 401.0372.

2-Amino-4a,5,6,7-tetrahydro-4-(4-methoxyphenyl)naphthalene-1,3,3(4*H*)-tricarbonitrile 5k: mp 258−259 °C (Lit.[20] 253−254 °C); ^{1}H NMR (DMSO-d_6, 400 MHz) δ_H 0.80−0.86 (m, 1H, CH), 1.45−1.51 (m, 2H, CH_2), 1.67−1.71 (m, 1H, CH), 2.06−2.21 (m, 2H, CH_2), 2.73−2.76 (m, 1H, CH), 3.47 (d, J = 12.4 Hz, 1H, CH), 3.80 (s, 3H, CH_3O), 5.72 (d, J = 2.0 Hz, 1H, CH), 6.97−7.07 (m, 2H, ArH), 7.35 (b, 3H, ArH + NH_2), 7.50 (d, J = 7.6 Hz, 1H, ArH); IR (KBr) 3421, 3341, 3252, 2948, 2869, 2833, 2213, 1649, 1614, 1599, 1516, 1474, 1443, 1391, 1288, 1256, 1182, 1029, 839, 806 cm^{-1}; HRMS (ESI, *m*/*z*) calcd for $C_{20}H_{18}N_4ONa$ (M + Na^+) 353.1378, found 353.1375.

2-Amino-4a,5,6,7-tetrahydro-4-(3-chlorophenyl)naphthalene-1,3,3(4*H*)-tricarbonitrile 5l: mp 122−123 °C; ^{1}H NMR (DMSO-d_6, 400 MHz) δ_H 0.83−0.92 (m, 1H, CH), 1.45−1.47 (m, 2H, CH_2), 1.67−1.70 (m, 1H, CH), 2.02−2.22 (m, 2H, CH_2), 2.82−2.85 (m, 1H, CH), 3.66 (d, J = 12.8 Hz, 1H, CH), 5.74 (s, 1H, CH), 7.38 (s, 2H, NH_2), 7.43−7.66 (m, 4H, ArH); IR (KBr) 3344, 3197, 2939, 2872, 2838, 2206, 1657, 1605, 1573, 1480, 1435, 1414, 1388, 1277, 1103, 901, 804, 750, 708 cm^{-1}; HRMS (ESI, *m*/*z*) calcd for $C_{19}H_{15}ClN_4Na$ (M + Na^+) 357.0883, found 357.0885.

2-Amino-4a,5,6,7-tetrahydro-4-(4-chlorophenyl)naphthalene-1,3,3(4*H*)-tricarbonitrile 5m: mp 283−285 °C; ^{1}H NMR (DMSO-d_6, 400 MHz) δ_H 0.81−0.90 (m, 1H, CH), 1.44−1.46 (m, 2H, CH_2), 1.66−1.68 (m, 1H, CH), 2.02−2.21 (m, 2H, CH_2), 2.77−2.82 (m, 1H, CH), 3.64 (d, J = 12.4 Hz, 1H, CH), 5.73 (s, 1H, CH), 7.40 (s, 2H, NH_2), 7.46 (d, J = 7.6 Hz, 1H, ArH), 7.53 (d, J = 7.6 Hz, 1H, ArH), 7.58 (d, J = 7.6 Hz, 1H, ArH), 7.63 (d, J = 7.6 Hz, 1H, ArH); IR (KBr) 3421, 3343, 3252, 3227, 2947, 2907, 2865, 2832, 2212, 1646, 1602, 1493, 1414, 1391, 1278, 1095, 1016, 838, 805, 753 cm^{-1}; HRMS (ESI, *m*/*z*) calcd for $C_{19}H_{15}ClN_4Na$ (M + Na^+) 357.0883, found 357.0870.

2-Amino-4a,5,6,7-tetrahydro-4-(4-fulorophenyl)naphthalene-1,3,3(4*H*)-tricarbonitrile 5n: mp 270−272 °C (Lit.[20] 263−264 °C); ^{1}H NMR (DMSO-d_6, 400 MHz) δ_H 0.82−0.89 (m, 1H, CH), 1.45−1.48 (m, 2H, CH_2), 1.67−1.69 (m, 1H, CH), 2.03−2.21 (m, 2H, CH_2), 2.77−2.83 (m, 1H, CH), 3.63 (d, J = 12.4 Hz, 1H, CH), 5.74 (s, 1H, CH), 7.27−7.36 (m, 2H, ArH), 7.38 (s, 2H, NH_2), 7.50 (b, 1H, ArH), 7.65 (b, 1H, ArH); IR (KBr) 3420, 3342, 3255, 2950, 2910, 2873, 2832, 2212, 1649, 1603, 1511, 1429, 1391, 1272, 1230, 1213, 1165, 844, 807, 754 cm^{-1}; HRMS (ESI, *m*/*z*) calcd for $C_{19}H_{16}FN_4$ (M + H^+) 319.1378, found 319.1359.

2-Amino-4a,5,6,7-tetrahydro-4-(4-bromophenyl)naphthalene-1,3,3(4*H*)-tricarbonitrile 5o: mp 264−265 °C (Lit.[20] 273−274 °C); ^{1}H NMR (DMSO-d_6, 400 MHz): δ_H 0.81−0.90 (m, 1H, CH), 1.44−1.48 (m, 2H, CH_2), 1.67−1.69 (m, 1H, CH), 2.02−2.21 (m, 2H, CH_2), 2.77−2.82 (m, 1H, CH), 3.63 (d, J = 12.4 Hz, 1H, CH), 5.74 (s, 1H, CH), 7.37 (s, 2H, NH_2), 7.40 (d, J = 7.2 Hz, 1H, ArH), 7.56 (d, J = 7.2 Hz, 1H, ArH), 7.67 (d, J = 7.2 Hz, 1H, ArH), 7.71 (d, J = 7.2 Hz, 1H, ArH); IR (KBr) 3423, 3345, 3252, 2926, 2864, 2834, 2211, 1646, 1601, 1490, 1391, 1279, 1077, 1011, 835, 805, 752 cm^{-1}; HRMS (ESI, *m*/*z*) calcd for $C_{19}H_{15}BrN_4Na$ (M + Na^+) 401.0378, found 401.0362.

2-Amino-4a,5,6,7-tetrahydro-4-(4-cyanophenyl)naphthalene-1,3,3(4*H*)-tricarbonitrile. 5p: mp 270−272 °C; ^{1}H NMR (DMSO-d_6, 400 MHz) δ_H 0.82−0.90 (m, 1H, CH), 1.40−1.49 (m, 2H, CH_2), 1.66−1.69 (m, 1H, CH), 2.06−2.22 (m, 2H, CH_2), 2.84−2.90 (m, 1H, CH), 3.79 (d, J = 12.4 Hz, 1H, CH), 5.75 (s, 1H, CH), 7.41 (s, 2H, NH_2), 7.66 (d, J = 7.2 Hz, 1H, ArH), 7.83 (d, J = 7.2 Hz, 1H, ArH), 7.96 (d, J = 7.2 Hz, 1H, ArH), 8.00 (d, J = 7.2 Hz, 1H, ArH); IR (KBr) 3428, 3343, 3230, 3071, 2945, 2909, 2871, 2841, 2232, 2209, 1635, 1604, 1506, 1454, 1430, 1421, 1336, 1305, 1281, 1216, 1039, 855, 842, 809, 788, 762, 731 cm^{-1}; HRMS (ESI, *m*/*z*) calcd for $C_{20}H_{15}N_5Na$ (M + Na^+) 348.1225, found 348.1220.

2-Amino-4a,5,6,7-tetrahydro-4-(2-chlorophenyl)naphthalene-1,3,3(4*H*)-tricarbonitrile 5q: mp 279−280 °C; ^{1}H NMR (DMSO-d_6, 400 MHz) δ_H 0.76−0.86 (m, 1H, CH), 1.36−1.49 (m, 2H, CH_2), 1.65−1.69 (m, 1H, CH), 2.08−2.22 (m, 2H, CH_2), 2.83−2.85 (m, 1H, CH), 3.89 (d, J = 12.4 Hz, 1H, CH), 5.76 (t, J = 2.4 Hz, 1H, CH), 7.43 (s, 2H, NH_2), 7.46−7.56 (m, 2H, ArH), 7.63 (dd, J = 8.0 Hz, J' = 1.6 Hz, 1H, ArH), 7.77 (dd, J = 7.6 Hz, J' = 1.6 Hz, 1H, ArH); IR (KBr) 3447, 3351, 3204, 2949, 2921, 2878, 2855, 2839, 2217, 1633, 1596, 1478, 1434, 1391, 1341, 1271, 1213, 1165, 1100, 1056, 1042, 972, 951, 841, 814, 777, 749, 702 cm^{-1}; HRMS (ESI, *m*/*z*) calcd for $C_{19}H_{15}ClN_4Na$ (M + Na^+) 357.0883, found 357.0868.

2-Amino-4a,5,6,7-tetrahydro-4-(2,3-dimethoxyphenyl)-naphthalene-1,3,3(4*H*)-tricarbonitrile 5r: mp 220−221 °C; ^{1}H NMR (DMSO-d_6, 400 MHz) δ_H 0.78−0.87 (m, 1H, CH), 1.37−1.40 (m, 2H, CH_2), 1.65−1.68 (m, 1H, CH), 2.08−2.15 (m, 2H, CH_2), 2.68−2.71 (m, 1H, CH), 3.74 (d, J = 12.4 Hz, 1H, CH), 3.75 (s, 3H, CH_3O), 3.85 (s, 3H, CH_3O), 5.73 (d, J = 2.0 Hz, 1H, CH), 7.12−7.21 (m, 3H, ArH), 7.37 (s, 2H, NH_2); IR (KBr): 3327, 3222, 2944, 2920, 2857, 2838, 2216, 1651, 1601, 1480, 1432, 1393, 1339, 1327, 1295, 1273, 1240, 1220, 1167, 1097, 1061, 1022, 991, 850, 808, 791, 764, 726, 716 cm^{-1}; HRMS (ESI, *m*/*z*) calcd for $C_{21}H_{20}N_4O_2Na$ (M + Na^+) 383.1484, found 383.1481.

2-Amino-4a,5,6,7-tetrahydro-4-(3,4-dichlorophenyl)naphthalene-1,3,3(4H)-tricarbonitrile 5s: mp 294−295 °C; ^{1}H NMR (DMSO-d_6, 400 MHz) δ_H 0.84−0.87 (m, 1H, CH), 1.45−1.46 (m, 2H, CH_2), 1.66−1.69 (m, 1H, CH), 2.03−2.21 (m, 2H, CH_2), 2.82−2.85 (m, 1H, CH), 3.71 (dd, J = 12.4 Hz, J' = 4.8 Hz, 1H, CH), 5.74 (d, J = 2.0 Hz, 1H, CH), 7.42 (s, 2H, NH_2), 7.47−7.63 (m, 1H, ArH), 7.74−7.88 (m, 2H, ArH); IR (KBr): 3420, 3332, 3258, 3183, 2947, 2874, 2832, 2212, 1638, 1604, 1476, 1430, 1393, 1340, 1302, 1279, 1165, 1137, 1103, 1032, 922, 883, 849, 824, 808, 756, 721 cm^{-1}; HRMS (ESI, *m*/*z*) calcd for $C_{19}H_{14}Cl_2N_4Na$ (M + Na^+) 391.0493, found 391.0470.

2-Amino-4a,5,6,7-tetrahydro-4-(3,4-dimethoxyphenyl)-naphthalene-1,3,3(4*H*)-tricarbonitrile 5t: mp 265−268 °C; ^{1}H NMR (DMSO-d_6, 400 MHz) δ_H 0.82−0.92 (m, 1H, CH), 1.42−1.57 (m, 2H, CH_2), 1.63−1.69 (m, 1H, CH), 2.03−2.21 (m, 2H, CH_2), 2.80−2.85 (m, 1H, CH), 3.73−3.78 (m, 7H, 2CH_3O+CH), 5.72 (d, J = 2.0 Hz, 1H, CH), 6.97 (s, 1H, ArH), 7.08−7.14 (m, 2H, ArH), 7.35 (s, 2H, NH_2); IR (KBr) 3433, 3335, 3253, 3228, 3000, 2938, 2834, 2211, 1651, 1603, 1519, 1445, 1422, 1393, 1335, 1265, 1146, 1101, 1022, 865, 853, 823, 767, 746, 730 cm^{-1}; HRMS (ESI, *m*/*z*) calcd for $C_{21}H_{20}N_4O_2Na$ (M + Na^+) 383.1484, found 383.1470.

2-Amino-4a,5,6,7-tetrahydro-4-(2,3-dichlorophenyl)naphthalene-1,3,3(4*H*)-tricarbonitrile 5u: mp 252−254 °C; ^{1}H NMR (DMSO-d_6, 400 MHz) δ_H 0.79−0.88 (m, 1H, CH), 1.36−1.47 (m, 2H, CH_2), 1.65−1.69 (m, 1H, CH), 2.09−2.22 (m, 2H, CH_2), 2.85−2.90 (m, 1H, CH), 4.01 (d, J = 12.4 Hz, 1H, CH), 5.77 (m, 1H, CH), 7.45 (s, 2H, NH_2), 7.56−7.60 (m, 2H, ArH), 7.78 (d, J = 8.0 Hz, 2H, ArH); ^{13}C NMR ($CDCl_3$, 100 MHz) δ_C 21.4, 25.4, 26.7, 35.8, 41.8, 46.8, 88.3, 111.0, 111.8, 114.9, 126.0, 126.6, 127.1, 128.1, 131.5, 134.0, 134.4, 134.6, 140.2; IR (KBr) 3461, 3368, 3225, 2973, 2948, 2859, 2835, 2210, 1636, 1607, 1566, 1454, 1423, 1393, 1337, 1277, 1248, 1186, 1161, 1104, 1045, 923, 848, 812, 796, 755, 739 cm^{-1}; HRMS (ESI, *m*/*z*) calcd for $C_{19}H_{14}Cl_2N_4Na$ (M + Na^+) 391.0493, found 391.0483.

General Procedure for the Synthesis of 8-Aryl-1*H*-iso(thio)chromene-5,7,7(3*H*)-tricarbonitrile 6. A dry 50 mL flask was charged with aromatic aldehyde (2.0 mmol), malononitrile (0.139 g, 2.1 mmol), 2-(tetrahydropyran-4-ylidene)malononitrile or 2-(tetrahydrothiopyran-4-ylidene)-malononitrile (2.0 mmol), and ionic liquid of [BMIm][BF_4] (2 mL). The reaction mixture was stirred at 90 °C for 6−12 h and then cooled down to room temperature. A small amount of water (5 mL) was added to the mixture, and the generated yellow solid was filtered off. The water in the filtrate was removed by distillation under reduced pressure, and the ionic liquid in the residue could be reusable by being evaporated at 80 °C for 4 h at vacuum. The crude yellow products were washed with water, purified by recrystallization from DMF and water, and then dried at 80 °C for 2 h under vacuum to give **6**.

6-Amino-8,8a-dihydro-8-(4-fluorophenyl)-1*H*-isochromene-5,7,7(3*H*)-tricarbonitrile 6a: mp 247−248 °C; ^{1}H NMR (DMSO-d_6, 400 MHz) δ_H 2.95−3.00 (m, 1H, CH), 3.05−3.08 (m, 1H, CH), 3.47−3.51 (m, 1H, CH), 3.76 (d, J = 12.4 Hz, 1H, CH), 4.14 (d, J = 15.2 Hz, 1H, CH), 4.28 (d, J = 15.2 Hz, 1H, CH), 5.71 (s, 1H, CH), 7.29−7.39 (m, 2H, ArH), 7.47 (s, 1H, ArH), 7.65 (s, 2H, NH_2), 7.76 (s, 1H, ArH); IR (KBr) 3319, 3134, 2981, 2849, 2214, 1665, 1605, 1512, 1454, 1388, 1231, 1165, 1129, 1102, 988, 911, 852, 826, 810, 789, 758 cm^{-1}; HRMS (ESI, *m*/*z*) calcd for $C_{18}H_{13}FN_4ONa$ (M + Na^+) 343.0971, found 343.0974.

6-Amino-8,8a-dihydro-8-(2-fluorophenyl)-1*H*-isochromene-5,7,7(3*H*)-tricarbonitrile 6b: mp 256−258 °C; ^{1}H NMR ($CDCl_3$, 400 MHz) δ_H 3.05−3.10 (m, 1H, CH), 3.17−3.21 (m, 1H, CH), 3.58 (dd, J = 10.8 Hz, 1H, CH), 4.03 (d, J = 12.4 Hz, 1H, CH), 4.28−4.31 (m, 1H, CH), 4.37−4.43 (m, 1H, CH), 5.05 (s, 2H, NH_2), 5.99 (dd, J = 2.0 Hz, J' = 1.2 Hz, 1H, CH), 7.31−7.36 (m, 1H, ArH), 7.49−7.53 (m, 1H, ArH), 7.72−7.75 (m, 2H, ArH); IR (KBr) 3414, 3337, 3213, 3062, 2991, 2925, 2894, 2842, 2215, 1659, 1601, 1474, 1433, 1395, 1277, 1221, 1122, 1024, 985, 908, 779, 753 cm^{-1}; HRMS (ESI, *m*/*z*) calcd for $C_{18}H_{13}FN_4ONa$ (M + Na^+) 343.0971, found 343.0971.

6-Amino-8,8a-dihydro-8-(2,3-dichlorophenyl)-1*H*-isochromene-5,7,7(3*H*)-tricarbonitrile 6c: mp 281−283 °C; ^{1}H NMR (DMSO-d_6, 400 MHz) δ_H 2.96−3.01 (m, 1H, CH), 3.14−3.19 (m, 1H, CH), 3.39−3.43 (m, 1H, CH), 4.08 (d, J = 12.4 Hz, 1H, CH), 4.16 (d, J = 17.6 Hz, 1H, CH), 4.28 (d, J = 17.6 Hz, 1H, CH), 5.75 (s, 1H, CH), 7.59 (t, J = 8.0 Hz, 1H, ArH), 7.70 (s, 2H, NH_2), 7.80 (d, J = 7.6 Hz, 1H, ArH), 7.89 (d, J = 7.6 Hz, 1H, ArH); IR (KBr) 3363, 3338, 3228, 3087, 2974, 2818, 2228, 2212, 1656, 1637, 1602, 1456, 1425, 1394, 1278, 1168, 1129, 1106, 1046, 988, 913, 826, 798, 755, 739 cm^{-1}; HRMS (ESI, *m*/*z*) calcd for $C_{18}H_{12}Cl_2N_4ONa$ (M + Na^+) 393.0286, found 393.0287.

6-Amino-8,8a-dihydro-8-(3,4-dichlorophenyl)-1*H*-isochromene-5,7,7(3*H*)-tricarbonitrile 6d: mp 273−275 °C; ^{1}H NMR (DMSO-d_6, 400 MHz) δ_H 2.96−3.01 (m, 1H, CH), 3.06−3.17 (m, 1H, CH), 3.50−3.54 (m, 1H, CH), 3.81−3.86 (m, 1H, CH), 4.14 (d, J = 17.6 Hz, 1H, CH), 4.29 (d, J = 17.6 Hz, 1H, CH), 5.72 (s, 1H, CH), 7.41−8.02 (m, 5H, ArH + NH_2); IR (KBr) 3355, 3178, 2977, 2833, 2209, 1671, 1602, 1560, 1475, 1455, 1388, 1280, 1259, 1131, 1100, 1033, 988, 911, 824, 757, 729 cm^{-1}; HRMS (ESI, *m*/*z*) calcd for $C_{18}H_{12}Cl_2N_4ONa$ (M + Na^+) 393.0286, found 393.0280.

6-Amino-8,8a-dihydro-8-(2-methoxyphenyl)-1*H*-isochromene-5,7,7(3*H*)-tricarbonitrile 6e: mp 235−236 °C; ^{1}H NMR ($CDCl_3$, 400 MHz) δ_H 3.00−3.05 (m, 1H, CH), 3.17−3.20 (m, 1H, CH), 3.77 (dd, J = 11.2 Hz, J' = 4.8 Hz, 1H, CH), 3.84 (s, 3H, CH_3O), 4.02 (d, J = 12.8 Hz, 1H, CH), 4.22−4.28 (m, 1H, CH), 4.36−4.42 (m, 1H, CH), 5.04 (s, 2H, NH_2), 5.94−5.96 (m, 1H, CH), 6.99 (d, J = 8.4 Hz, 1H, ArH), 7.08−7.12 (m, 1H, ArH), 7.39−7.44 (m, 1H, ArH), 7.57 (dd, J = 8.0 Hz, J' = 1.6 Hz, 1H, ArH); IR (KBr) 3409, 3337, 3212, 2933, 2828, 2214, 1661, 1601, 1496, 1463, 1437, 1395, 1361, 1275, 1254, 1173, 1119, 1057, 1034, 984, 909, 820, 783, 763, 709 cm^{-1}; HRMS (ESI, *m*/*z*) calcd for $C_{19}H_{16}N_4O_2Na$ (M + Na^+) 355.1171, found 355.1181.

6-Amino-8,8a-dihydro-8-(3,5-dimethoxyphenyl)-1*H*-isochromene-5,7,7(3*H*)-tricarbonitrile 6f: mp 273−275 °C; ^{1}H NMR (DMSO-d_6, 400 MHz) δ_H 2.99−3.04 (m, 2H, CH_2), 3.55−3.59 (m, 2H, CH_2), 3.75 (s, 3H, CH_3O), 3.79 (s, 3H, CH_3O), 4.14 (d, J = 17.2 Hz, 1H, CH), 4.26−4.31 (m, 1H, CH), 5.70 (s, 1H, CH), 6.59−6.61 (m, 2H, ArH), 6.80 (s, 1H, ArH), 7.62 (s, 2H, NH_2); ^{13}C NMR ($CDCl_3$, 100 MHz) δ_C 32.7, 42.1, 55.2, 55.3, 65.3, 65.8, 79.6, 100.4, 104.1, 110.7, 111.9, 112.3, 115.7, 117.2, 127.0, 135.5, 144.5; IR (KBr) 3315, 3177, 2943, 2847, 2209, 1651, 1596, 1477, 1458, 1390, 1326, 1301, 1208, 1156, 1127, 1058, 990, 937, 830, 776, 759 cm^{-1}; HRMS (ESI, *m*/*z*) calcd for $C_{20}H_{18}N_4O_3Na$ (M + Na^+) 385.1277, found 385.1285.

6-Amino-8,8a-dihydro-8-(2,4,5-trimethoxyphenyl)-1*H*-isochromene-5,7,7(3*H*)-tricarbonitrile 6g: mp 204−205 °C; ^{1}H NMR ($CDCl_3$, 400 MHz) δ_H 2.34−2.39 (m, 1H, CH), 2.56−2.63 (m, 1H, CH), 3.77 (s, 3H, CH_3O), 3.82−3.86 (m, 2H, CH_2), 3.87 (s, 3H, CH_3O), 3.91 (s, 3H, CH_3O), 3.97−4.02 (m, 1H, CH), 4.09 (d, J = 16.4 Hz, 1H, CH), 4.53 (s, 1H, CH), 5.20 (s, 2H, NH_2), 6.54 (s, 1H, ArH), 6.63 (s, 1H, ArH); IR (KBr) 3397, 3316, 3240, 3207, 3016, 2985, 2884, 2841, 2199, 1641, 1614, 1588, 1470, 1443, 1403, 1386, 1326, 1262, 1216, 1108, 1032, 984, 866, 825, 759 cm^{-1}; HRMS (ESI, *m*/*z*) calcd for $C_{21}H_{20}N_4O_4Na$ (M + Na^+) 415.1382, found 415.1397.

6-Amino-8,8a-dihydro-8-(4-bromophenyl)-1*H*-isochromene-5,7,7(3*H*)-tricarbonitrile 6h: mp 261−263 °C; ^{1}H NMR ($CDCl_3$, 400 MHz) δ_H 3.04−3.08 (m, 2H, CH_2), 3.19−3.23 (m, 1H, CH), 3.74 (dd, J = 6.8 Hz, J' = 0.8 Hz, 1H, CH), 4.23−4.28 (m, 1H, CH), 4.37−4.43 (m, 1H, CH),

5.02 (s, 2H, NH_2), 5.99−6.00 (m, 1H, CH), 7.14−7.18 (m, 1H, ArH), 7.52−7.69 (m, 3H, ArH); IR (KBr) 3422, 3342, 3250, 3218, 2975, 2933, 2886, 2868, 2833, 2215, 1642, 1600, 1491, 1459, 1411, 1390, 1274, 1222, 1128, 1077, 1011, 992, 903, 836, 816, 792, 767, 750 cm^{-1}; HRMS (ESI, *m/z*) calcd for $C_{18}H_{13}BrN_4ONa$ ($M + Na^+$) 403.0170, found 403.0177.

6-Amino-8,8a-dihydro-8-(2-bromophenyl)-1*H*-isochromene-5,7,7(3*H*)-tricarbonitrile 6i: mp 248−249 °C; ^1H NMR ($CDCl_3$, 400 MHz) δ_H 3.05−3.10 (m, 1H, CH), 3.18−3.24 (m, 1H, CH), 3.70−3.71 (m, 2H, CH_2), 4.24−4.30 (m, 1H, CH), 4.38−4.43 (m, 1H, CH), 5.09 (s, 2H, NH_2), 5.99−6.00 (m, 1H, CH), 7.19−7.24 (m, 1H, ArH), 7.32−7.36 (m, 1H, ArH), 7.45−7.52 (m, 1H, ArH), 7.66−7.74 (m, 1H, ArH); IR (KBr): 3467, 3331, 3255, 3225, 2982, 2939, 2840, 2220, 1650, 1605, 1455, 1393, 1276, 1235, 1180, 1133, 990, 910, 826, 790, 772, 761 cm^{-1}; HRMS (ESI, *m/z*) calcd for $C_{18}H_{13}BrN_4ONa$ ($M + Na^+$) 403.0170, found 403.0177.

6-Amino-8,8a-dihydro-8-(2-chlorophenyl)-1*H*-isochromene-5,7,7(3*H*)-tricarbonitrile 6j: mp 220−222 °C; ^1H NMR ($CDCl_3$, 400 MHz) δ_H 3.05−3.09 (m, 1H, CH), 3.17−3.23 (m, 1H, CH), 3.61 (dd, $J = 6.8$ Hz, J' = 0.8 Hz, 1H, CH), 4.02 (d, $J = 12.8$ Hz, 1H, CH), 4.25−4.30 (m, 1H, CH), 4.37−4.43 (m, 1H, CH), 5.06 (s, 2H, NH_2), 5.99−6.00 (m, 1H, CH), 7.42−7.47 (m, 2H, ArH), 7.54 (dd, $J = 7.6$ Hz, $J' = 1.2$ Hz, 1H, ArH), 7.74 (dd, $J = 8.0$ Hz, $J' = 1.2$ Hz, 1H, ArH); IR (KBr) 3414, 3335, 3211, 2843, 2216, 1660, 1602, 1508, 1479, 1437, 1388, 1278, 1222, 1123, 1054, 985, 909, 779, 756, 709 cm^{-1}; HRMS (ESI, *m/z*) calcd for $C_{18}H_{13}ClN_4ONa$ ($M + Na^+$) 359.0676, found 359.0663.

6-Amino-8,8a-dihydro-8-(2,3-dimethoxyphenyl)-1*H*-isochromene-5,7,7(3*H*)-tricarbonitrile 6k: mp 210−212 °C; ^1H NMR ($CDCl_3$, 400 MHz) δ_H 3.02 (t, $J = 6.4$ Hz, 1H, CH), 3.09−3.12 (m, 1H, CH), 3.62 (dd, $J = 6.8$ Hz, $J' = 0.8$ Hz, 1H, CH), 3.70 (s, 3H, CH_3O), 3.91 (s, 3H, CH_3O), 3.94 (d, $J = 12.6$ Hz, 1H, CH), 4.22−4.28 (m, 1H, CH), 4.36−4.41 (m, 1H, CH), 5.12 (s, 2H, NH_2), 5.94−5.95 (m, 1H, CH), 6.99−7.01 (m, 1H, ArH), 7.19−7.24 (m, 2H, ArH); IR (KBr) 3319, 3213, 2970, 2938, 2831, 2210, 1651, 1588, 1483, 1431, 1387, 1283, 1219, 1167, 1108, 1075, 998, 936, 794, 754 cm^{-1}; HRMS (ESI, *m/z*) calcd for $C_{20}H_{18}N_4O_3Na$ ($M + Na^+$) 385.1277, found 385.1276.

6-Amino-8,8a-dihydro-8-(2-fluorophenyl)-1*H*-isothiochromene-5,7,7(3*H*)-tricarbonitrile 6l: mp 265−267 °C; ^1H NMR (DMSO-d_6, 400 MHz) δ_H 2.29−2.39 (m, 2H, CH_2), 3.03−3.09 (m, 1H, CH), 3.17 (dd, $J = 22.4$ Hz, $J' = 5.6$ Hz, 1H, CH), 3.43−3.49 (m, 1H, CH), 3.87 (d, $J = 12.4$ Hz, 1H, CH), 5.97−5.98 (m, 1H, CH), 7.36−7.42 (m, 2H, ArH), 7.54−7.60 (m, 3H, ArH+NH_2), 7.74−7.78 (m, 1H, ArH); IR (KBr) 3483, 3327, 3224, 3161, 2931, 2901, 2870, 2212, 1668, 1606, 1492, 1453, 1417, 1388, 1345, 1284, 1260, 1231, 1177, 1103, 1051, 887, 800, 769 cm^{-1}; HRMS (ESI, *m/z*) calcd for $C_{18}H_{13}FN_4SNa$ ($M + Na^+$) 359.0743, found 359.0745.

6-Amino-8,8a-dihydro-8-(4-fluorophenyl)-1*H*-isothiochromene-5,7,7(3*H*)-tricarbonitrile 6m: mp 263−265 °C; ^1H NMR (DMSO-d_6, 400 MHz) δ_H 2.21−2.29 (m, 2H, CH_2), 2.97−3.03 (m, 1H, CH), 3.17 (dd, $J = 22.4$ Hz, $J' = 5.6$ Hz, 1H, CH), 3.41−3.46 (m, 1H, CH), 3.76 (d, $J = 12.8$ Hz, 1H, CH), 5.95−5.96 (m, 1H, CH), 7.34−7.36 (m, 2H, ArH), 7.49−7.70 (m, 4H, ArH + NH_2); IR (KBr) 3336, 3144, 2917, 2208, 1662, 1604, 1512, 1416, 1388, 1284, 1232, 1165, 1102, 886, 855, 808, 743 cm^{-1}; HRMS (ESI, *m/z*) calcd for $C_{18}H_{14}FN_4S$ ($M + H^+$) 337.0923, found 337.0940.

6-Amino-8,8a-dihydro-8-(2-chlorophenyl)-1*H*-isothiochromene-5,7,7(3*H*)-tricarbonitrile 6n: mp 253−255 °C; ^1H NMR (DMSO-d_6, 400 MHz) δ_H 2.17−2.28 (m, 2H, CH_2), 3.04−3.10 (m, 1H, CH), 3.17 (dd, $J = 22.4$ Hz, J' = 5.6 Hz, 1H, CH), 3.46−3.51 (m, 1H, CH), 3.99 (d, $J = 12.4$ Hz, 1H, CH), 5.99 (t, $J = 2.8$ Hz, 1H, CH), 7.51−7.58 (m, 2H, ArH), 7.60 (s, 2H, NH_2), 7.66 (dd, $J = 8.0$ Hz, $J' = 1.6$ Hz, 1H, CH), 7.83 (dd, $J = 7.6$ Hz, $J' = 1.6$ Hz, 1H, ArH); IR (KBr) 3352, 3173, 2934, 2209, 1669, 1605, 1478, 1439, 1416, 1388, 1350, 1283, 1257, 1153, 1101, 1055, 886, 769, 748 cm^{-1}; HRMS (ESI, *m/z*) calcd for $C_{18}H_{13}ClN_4SNa$ ($M + Na^+$) 375.0447, found 375.0454.

6-Amino-8,8a-dihydro-8-(2-bromophenyl)-1*H*-isothiochromene-5,7,7(3*H*)-tricarbonitrile 6o: mp 264−266 °C; ^1H NMR (DMSO-d_6, 400 MHz) δ_H 2.17−2.27 (m, 2H, CH_2), 3.06−3.12 (m, 1H, CH), 3.18 (dd, $J = 22.4$ Hz, $J' = 5.6$ Hz, 1H, CH), 3.47−3.53 (m, 1H, CH), 3.94 (d, $J = 12.4$ Hz, 1H, CH), 5.98−5.60 (m, 1H, CH), 7.42−7.46 (m, 1H, ArH), 7.60 (d, $J = 8.0$ Hz, 1H, ArH), 7.63 (s, 2H, NH_2), 7.82 (d, $J = 8.0$ Hz, 2H, ArH); IR (KBr) 3437, 3348, 3070, 2974, 2935, 2885, 2220, 1667, 1633, 1619, 1597, 1474, 1428, 1391, 1346, 1284, 1255, 1103, 1054, 1023, 893, 761, 740 cm^{-1}; HRMS (ESI, *m/z*) calcd for $C_{18}H_{13}BrN_4SNa$ ($M + Na^+$) 418.9942, found 418.9950.

6-Amino-8,8a-dihydro-8-(4-bromophenyl)-1*H*-isothiochromene-5,7,7(3*H*)-tricarbonitrile 6p: mp 284−286 °C; ^1H NMR (DMSO-d_6, 400 MHz) δ_H 2.21−2.30 (m, 2H, CH_2), 2.97−3.03 (m, 1H, CH), 3.17 (dd, $J = 22.4$ Hz, $J' = 5.6$ Hz, 1H, CH), 3.42−3.47 (m, 1H, CH), 3.78 (d, $J = 12.8$ Hz, 1H, CH), 5.95−5.96 (m, 1H, CH), 7.40−7.62 (m, 4H, NH_2 + ArH), 7.72 (d, $J = 7.6$ Hz, 2H, ArH); IR (KBr) 3437, 3347, 3213, 2880, 2210, 1642, 1600, 1491, 1413, 1389, 1347, 1280, 1257, 1103, 1076, 1012, 887, 839, 799, 777, 739 cm^{-1}; HRMS (ESI, *m/z*) calcd for $C_{18}H_{13}BrN_4SNa$ ($M + Na^+$) 418.9942, found 418.9932.

6-Amino-8,8a-dihydro-8-(2-methoxyphenyl)-1*H*-isothiochromene-5,7,7(3H)-tricarbonitrile 6q: mp 257−259 °C; ^1H NMR (DMSO-d_6, 400 MHz) δ_H 2.17−2.35 (m, 2H, CH_2), 2.95−3.01(m, 1H, CH), 3.15 (dd, $J = 22.4$ Hz, $J' = 5.6$ Hz, 1H, CH), 3.44−3.49 (m, 1H, CH), 3.79 (s, 3H, CH_3O), 3.94 (d, $J = 12.8$ Hz, 1H, CH), 5.95−5.97 (m, 1H, CH), 7.10−7.18 (m, 2H, ArH), 7.43−7.47 (m, 1H, ArH), 7.52−7.58 (m, 3H, NH_2 + ArH); IR (KBr) 3439, 3380, 2969, 2944, 2905, 2885, 2842, 2220, 1631, 1618, 1597, 1494, 1465, 1441, 1392, 1359, 1285, 1252, 1222, 1117, 1052, 1027, 892, 804, 753 cm^{-1}; HRMS (ESI, *m/z*) calcd for $C_{19}H_{16}N_4OSNa$ ($M + Na^+$) 371.0943, found 371.0949.

6-Amino-8,8a-dihydro-8-(3,4-dimethoxyphenyl)-1*H*-isothiochromene-5,7,7(3*H*)-tricarbonitrile 6r: mp 259−260 °C; ^1H NMR (DMSO-d_6, 400 MHz) δ_H 2.23−2.39 (m, 2H, CH_2), 2.97−3.04 (m, 1H, CH), 3.13−3.19 (m, 1H, CH), 3.41−3.46 (m, 1H, CH), 3.57 (d, $J = 12.0$ Hz, 1H, CH), 3.80 (s, 6H, $2CH_3O$), 5.94−5.95 (m, 1H, CH), 6.96−7.16 (m, 3H, ArH), 7.53 (s, 2H, NH_2); IR (KBr) 3358, 3140, 3012, 2961, 2937, 2839, 2208, 1660, 1609, 1518, 1464, 1423, 1394,

1354, 1268, 1184, 1148, 1101, 1028, 866, 770, 743 cm^{-1}; HRMS (ESI, *m/z*) calcd for $C_{20}H_{18}N_4O_2SNa$ (M + Na^+) 401.1048, found 401.1049.

6-Amino-8,8a-dihydro-8-(3,5-dimethoxyphenyl)-1*H*-isothiochromene-5,7,7(3*H*)-tricarbonitrile 6s: mp 258−260 °C; ^1H NMR (DMSO-d_6, 400 MHz) δ_H 2.09−2.39 (m, 2H, CH_2), 2.94−2.99 (m, 1H, CH), 3.17 (dd, J = 22.4 Hz, J' = 5.6 Hz, 1H, CH), 3.41−3.47 (m, 1H, CH), 3.59 (d, J = 12.4 Hz, 1H, CH), 3.78 (s, 6H, $2CH_3O$), 5.94−5.95 (m, 1H, CH), 6.60−6.74 (m, 3H, ArH), 7.53 (s, 2H, NH_2); IR (KBr) 3395, 3344, 3234, 3004, 2958, 2899, 2837, 2209, 1657, 1608, 1460, 1431, 1392, 1354, 1324, 1299, 1204, 1159, 1292, 1068, 1048, 1021, 925, 856, 826, 742, 708 cm^{-1}; HRMS (ESI, *m/z*) calcd for $C_{20}H_{18}N_4O_2SNa$ (M + Na^+) 401.1048, found 401.1055.

6-Amino-8,8a-dihydro-8-(2,3-dimethoxyphenyl)-1*H*-isothiochromene-5,7,7(3*H*)-tricarbonitrile 6t: mp 261−264 °C; ^1H NMR (DMSO-d_6, 400 MHz) δ_H 2.18−2.29 (m, 2H, CH_2), 2.89−2.96 (m, 1H, CH), 3.17 (dd, J = 22.4 Hz, J' = 5.6 Hz, 1H, CH), 3.45−3.51 (m, 1H, CH), 3.78 (s, 3H, CH_3O), 3.83−3.87 (m, 4H, CH_3O+CH), 5.94−5.96 (m, 1H, CH), 7.16−7.26 (m, 3H, ArH), 7.54 (s, 2H, NH_2); IR (KBr) 3444, 3322, 3204, 3022, 2940, 2882, 2840, 2209, 1639, 1587, 1480, 1435, 1393, 1301, 1273, 1222, 1163, 1088, 1065, 991, 891, 801, 750 cm^{-1}; HRMS (ESI, *m/z*) calcd for $C_{20}H_{18}N_4O_2SNa$ (M + Na^+) 401.1048, found 401.1049.

6-Amino-8,8a-dihydro-8-(2,3-dichlorophenyl)-1*H*-isothiochromene-5,7,7(3*H*)-tricarbonitrile 6u: mp 248−250 °C; ^1H NMR (DMSO-d_6, 400 MHz) δ_H 2.19−2.31 (m, 2H, CH_2), 3.06−3.11 (m, 1H, CH), 3.18 (dd, J = 22.4 Hz, J' = 5.6 Hz, 1H, CH), 3.46−3.51 (m, 1H, CH), 4.10 (d, J = 12.4 Hz, 1H, CH), 5.98−6.00 (m, 1H, CH), 7.58 (d, J = 8.0 Hz, 1H, ArH), 7.62 (s, 2H, NH_2), 7.80−7.85 (m, 2H, ArH); ^{13}C NMR ($CDCl_3$, 100 MHz) δ_C 24.9, 27.2, 39.4, 41.6, 46.3, 81.6, 111.2, 111.8, 115.8, 118.3, 127.9, 129.0, 131.6, 132.9, 133.3, 133.6, 143.8; IR (KBr) 3378, 3306, 3135, 2934, 2864, 2207, 1662, 1602, 1453, 1425, 1389, 1349, 1276, 1249, 1161, 1102, 1055, 881, 798, 780, 743 cm^{-1}; HRMS (ESI, *m/z*) calcd for $C_{18}H_{12}Cl_2N_4SNa$ (M + Na^+) 409.0057, found 409.0061.

6-Amino-8,8a-dihydro-8-(3,4-dichlorophenyl)-1*H*-isothiochromene-5,7,7(3*H*)-tricarbonitrile 6v: mp 278−280 °C; ^1H NMR (DMSO-d_6, 400 MHz) δ_H 2.20−2.35 (m, 2H, CH_2), 3.02−3.06 (m, 1H, CH), 3.17 (dd, J = 22.4 Hz, J' = 5.6 Hz, 1H, CH), 3.44 (d, J = 22.4 Hz, 1H, CH), 3.84 (d, J = 12.4 Hz, 1H, CH), 5.96−5.97 (m, 1H, CH), 7.42−8.00 (m, 5H, ArH + NH_2); IR (KBr) 3356, 3164, 2926, 2874, 2204, 1670, 1601, 1477, 1412, 1388, 1347, 1314, 1256, 1138, 1101, 1060, 1034, 880, 724 cm^{-1}; HRMS (ESI, *m/z*) calcd for $C_{18}H_{12}Cl_2N_4SNa$ (M + Na^+) 409.0057, found 409.0069.

General Procedure for the Synthesis of *tert*-Butyl 8-phenylisoquinoline-2(1*H*,3*H*,7*H*)-carboxylate 7. A dry 50 mL flask was charged with aromatic aldehyde (2.0 mmol), malononitrile (0.139 g, 2.1 mmol), *tert*-butyl 4-(dicyanomethylene)piperidine-1-carboxylate (2.0 mmol), and ionic liquid of [BMIm][BF_4] (2 mL). The reaction mixture was stirred at 90 °C for 9−12 h and then cooled down to room temperature. A small amount of water (5 mL) was added to the mixture, and the generated yellow solid was filtered off. The water in the filtrate was removed by distillation under reduced pressure, and the ionic liquid in the residue could be reusable by being evaporated at 80 °C for 4 h at vacuum. The crude yellow products were washed with water, purified by recrystallization from DMF and water, and then dried at 80 °C for 2 h under vacuum to give **7**.

***tert*-Butyl 6-Amino-5,7,7-tricyano-8,8a-dihydro-8-(2-fluorophenyl)isoquinoline-2(1*H*,3*H*,7*H*)-carboxylate 7a:** mp 229−230 °C; ^1H NMR (DMSO-d_6, 400 MHz) δ_H 1.37 (s, 9H, $3CH_3$), 2.34−2.38 (m, 1H, CH), 2.96−3.16 (m, 1H, CH), 3.58−3.73 (m, 2H, CH_2), 3.88−3.95 (m, 1H, CH), 4.23−4.40 (m, 1H, CH), 5.66−5.69 (m, 1H, CH), 7.32−7.44 (m, 2H, ArH), 7.56−7.66 (m, 3H, ArH+NH_2), 7.72−7.75 (m, 1H, ArH); IR (KBr) 3402, 3227, 3000, 2967, 2930, 2846, 2214, 1686, 1639, 1612, 1493, 1458, 1419, 1394, 1368, 1341, 1300, 1285, 1239, 1169, 1127, 878, 756 cm^{-1}; HRMS (ESI, *m/z*) calcd for $C_{23}H_{22}FN_5O_2Na$ (M + Na^+) 442.1665, found 442.1657.

***tert*-Butyl 6-Amino-5,7,7-tricyano-8,8a-dihydro-8-(2-chlorophenyl)isoquinoline-2(1*H*,3*H*,7*H*)-carboxylate 7b.** mp 216−218 °C; ^1H NMR ($CDCl_3$, 400 MHz) δ_H 1.43 (s, 9H, $3CH_3$), 2.31−2.42 (m, 1H, CH), 3.01−3.09 (m, 2H, CH_2), 4.06 (d, J = 12.4 Hz, 1H, CH), 4.37−4.59 (m, 1H, CH), 5.08 (s, 2H, NH_2), 5.96 (s, 1H, CH), 7.42−7.56 (m, 3H, ArH), 7.74−7.80 (m, 1H, ArH); ^{13}C NMR ($CDCl_3$, 100 MHz) δ_C 18.5, 27.88, 27.93, 30.7, 41.3, 43.3, 56.0, 79.9, 111.2, 111.8, 112.7, 115.6, 128.6, 129.5, 130.4, 130.8, 131.1, 135.0, 144.4, 163.8. IR (KBr): 3415, 3339, 3225, 2971, 2928, 2852, 2214, 1688, 1639, 1606, 1479, 1422, 1393, 1366, 1301, 1285, 1241, 1170, 1126, 1034, 876, 821, 770, 749, 703 cm^{-1}; HRMS (ESI, *m/z*) calcd for $C_{23}H_{22}ClN_5O_2Na$ (M + Na^+) 458.1360, found 458.1362.

***tert*-Butyl 6-Amino-5,7,7-tricyano-8,8a-dihydro-8-(4-chlorophenyl)isoquinoline-2(1*H*,3*H*,7*H*)-carboxylate 7c:** mp 238−239 °C; ^1H NMR ($CDCl_3$, 400 MHz) δ_H 1.44 (s, 9H, $3CH_3$), 2.27−2.42 (m, 1H, CH), 3.04−3.14 (m, 2H, CH_2), 3.66−4.01 (m, 2H, CH_2), 4.37−4.60 (m, 1H, CH), 5.14 (s, 2H, NH_2), 5.96 (s, 1H, CH), 7.42−7.67 (m, 4H, ArH); IR (KBr) 3407, 3225, 2968, 2931, 2842, 2211, 1722, 1682, 1651, 1604, 1494, 1456, 1416, 1394, 1368, 1297, 1279, 1242, 1164, 1127, 1096, 1016, 878, 838, 776, 757 cm^{-1}; HRMS (ESI, *m/z*) calcd for $C_{23}H_{22}ClN_5O_2Na$ (M + Na^+) 458.1360, found 458.1364.

***tert*-Butyl 6-Amino-5,7,7-tricyano-8,8a-dihydro-8-(2-bromophenyl)isoquinoline-2(1*H*,3*H*,7*H*)-carboxylate 7d:** mp 225−226 °C; ^1H NMR (DMSO-d_6, 400 MHz) δ_H 1.31−1.36 (m, 9H, $3CH_3$), 2.27−2.44 (m, 1H, CH), 2.98−3.01 (m, 1H, CH), 3.48−3.78 (m, 2H, CH_2), 3.96 (d, J = 12.8 Hz, 1H, CH), 4.21−4.32 (m, 1H, CH), 5.72 (s, 1H, CH), 7.42−7.44 (m, 2H, ArH), 7.64−7.69 (m, 3H, ArH + NH_2), 7.79−7.86 (m, 2H, ArH); IR (KBr) 3555, 3416, 3340, 3225, 2970, 2928, 2886, 2849, 2215, 1683, 1640, 1605, 1475, 1459, 1422, 1393, 1367, 1300, 1284, 1240, 1169, 1126, 1024, 876, 820, 770, 748 cm^{-1}; HRMS (ESI, *m/z*) calcd for $C_{23}H_{22}BrN_5O_2Na$ (M + Na^+) 502.0855, found 502.0854.

***tert*-Butyl 6-Amino-5,7,7-tricyano-8,8a-dihydro-8-(4-bromophenyl)isoquinoline-2(1*H*,3*H*,7*H*)-carboxylate 7e:** mp 228−229 °C; ^1H NMR ($CDCl_3$, 400 MHz) δ_H 1.44 (s, 9H, $3CH_3$), 2.29−2.39 (m, 1H, CH), 3.04−3.12 (m, 2H, CH_2), 3.66−4.10 (m, 2H, CH_2), 4.38−4.59 (m, 1H, CH), 5.18 (s,

2H, NH_2), 5.94 (s, 1H, CH), 7.58−7.74 (m, 4H, ArH); IR (KBr): 3407, 3336, 3226, 2976, 2933, 2212, 1681, 1608, 1490, 1461, 1418, 1393, 1369, 1299, 1281, 1242, 1164, 1127, 1074, 1010, 878, 822, 755 cm^{-1}; HRMS (ESI, *m/z*) calcd for $C_{23}H_{22}BrN_5O_2Na$ ($M + Na^+$) 502.0855, found 502.0871.

***tert*-Butyl 6-Amino-5,7,7-tricyano-8,8a-dihydro-8-(2-methoxyphenyl)isoquinoline-2(1*H*,3*H*,7*H*)-carboxylate 7f:** mp 231−232 °C; ^1H NMR (DMSO-d_6, 400 MHz) δ_H 1.35 (s, 9H, $3CH_3$), 2.23−2.38 (m, 1H, CH), 2.88−2.89 (m, 1H, CH), 3.56−3.80 (m, 5H, $CH_3O + CH_2$), 3.96 (d, $J = 12.8$ Hz, 1H, CH), 4.22−4.37 (m, 1H, CH), 5.68 (s, 1H, CH), 7.14−7.20 (m, 2H, ArH), 7.46−7.50 (m, 1H, ArH), 7.55−7.61 (m, 3H, ArH + NH_2); IR (KBr) 3453, 3404, 3363, 3226, 2971, 2933, 2847, 2212, 1688, 1641, 1605, 1494, 1463, 1425, 1392, 1367, 1296, 1258, 1242, 1167, 1126, 1052, 1027, 879, 770, 748 cm^{-1}; HRMS (ESI, *m/z*) calcd for $C_{24}H_{25}N_5O_3Na$ ($M + Na^+$) 454.1855, found 454.1859.

***tert*-Butyl 6-Amino-5,7,7-tricyano-8,8a-dihydro-8-(2,4-dichlorophenyl)isoquinoline-2(1*H*,3*H*,7*H*)-carboxylate 7g:** mp 228−229 °C; ^1H NMR ($CDCl_3$, 400 MHz) δ_H 1.43 (s, 9H, $3CH_3$), 2.27−2.44 (m, 1H, CH), 2.99−3.06 (m, 1H, CH), 3.71−3.95 (m, 2H, CH_2), 4.00 (d, $J = 12.8$ Hz, 1H, CH), 4.35−4.60 (m, 1H, CH), 5.07 (s, 2H, NH_2), 5.76−5.97 (m, 1H, CH), 7.48−7.72 (m, 3H, ArH); IR (KBr) 3445, 3354, 3225, 2973, 2932, 2849, 2211, 1686, 1640, 1600, 1477, 1421, 1392, 1365, 1299, 1281, 1256, 1238, 1170, 1125, 876, 824, 765 cm^{-1}; HRMS (ESI, *m/z*) calcd for $C_{23}H_{21}Cl_2N_5O_2Na$ ($M + Na^+$) 492.0970, found 492.0993.

***tert*-Butyl 6-Amino-5,7,7-tricyano-8,8a-dihydro-8-(3,5-dimethoxyphenyl)isoquinoline-2(1*H*,3*H*,7*H*)-carboxylate 7h:** mp 221−222 °C; ^1H NMR ($CDCl_3$, 400 MHz) δ_H 1.43 (s, 9H, $3CH_3$), 2.32−2.44 (m, 1H, CH), 3.02 (s, 2H, CH_2), 3.66−3.83 (m, 7H, $2CH_3O$ + CH), 4.00−4.18 (m, 1H, CH), 4.36−4.58 (m, 1H, CH), 5.05 (s, 2H, NH_2), 5.93−5.94 (m, 1H, CH), 6.41−6.42 (m, 1H, ArH), 6.53 (s, 1H, ArH), 6.80 (s, 1H, ArH); IR (KBr) 3409, 3335, 3228, 2942, 2843, 2211, 1686, 1642, 1607, 1462, 1416, 1368, 1343, 1297, 1235, 1206, 1164, 1125, 1060, 873, 849 cm^{-1}; HRMS (ESI, *m/z*) calcd for $C_{27}H_{27}N_5O_4Na$ ($M + Na^+$) 484.1961, found 484.1971.

***tert*-Butyl 6-amino-5,7,7-tricyano-8,8a-dihydro-8-(3,4-dimethoxyphenyl)isoquinoline-2(1*H*,3*H*,7*H*)-carboxylate 7i:** mp 208−210 °C; ^1H NMR ($CDCl_3$, 400 MHz) δ_H 1.44 (s, 9H, $3CH_3$), 2.28−2.42 (m, 1H, CH), 3.07 (s, 2H, CH_2), 3.68−3.75 (m, 1H, CH), 3.92−4.02 (m, 7H, $2CH_3O$ + CH), 4.38−4.59 (m, 1H, CH), 5.12 (s, 2H, NH_2), 5.92−5.93 (m, 1H, CH), 6.77−7.06 (m, 3H, ArH); IR (KBr) 3635, 3520, 3468, 3359, 2970, 2844, 2211, 1678, 1597, 1518, 1457, 1424, 1369, 1341, 1295, 1260, 1164, 1021, 874, 820, 773, 743 cm^{-1}; HRMS (ESI, *m/z*) calcd for $C_{25}H_{27}N_5O_4Na$ ($M + Na^+$) 484.1961, found 484.1972.

***tert*-Butyl 6-Amino-5,7,7-tricyano-8,8a-dihydro-8-(2,3-dimethoxyphenyl)isoquino line-2(1*H*,3*H*,7*H*)-carboxylate 7j:** mp 230−233 °C; ^1H NMR ($CDCl_3$, 400 MHz) δ_H 1.43 (s, 9H, $3CH_3$), 2.27−2.36 (m, 1H, CH), 2.92−3.01 (m, 1H, CH), 3.64−4.02 (m, 9H, $2CH_3O$+3CH), 4.36−4.56 (m, 1H, CH), 5.04 (s, 2H, NH_2), 5.92−5.94 (m, 1H, CH), 6.99−7.01 (m, 1H, ArH), 7.18−7.24 (m, 2H, ArH); IR (KBr) 3405, 3325, 3227, 2977, 2945, 2843, 2209, 1699, 1651, 1599, 1481, 1421, 1395, 1367, 1294, 1266, 1169, 1119, 1070, 1004, 876, 815, 748 cm^{-1}; HRMS (ESI, *m/z*) calcd for $C_{25}H_{27}N_5O_4Na$ ($M + Na^+$) 484.1961, found 484.1973.

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Supporting Information Available. Spectral data of compounds **4a−m**, **5a−t**, **6a−v**, and **7a−j** and crystallographic information files (CIF) of **4c**, **III**, **5t**, and **6d**. This material is available free charge via the Internet at http://pubs.acs.org.

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