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Copper-Catalyzed Intramolecular C–C Bond Cleavage To Construct 2-Substituted Quinazolinones

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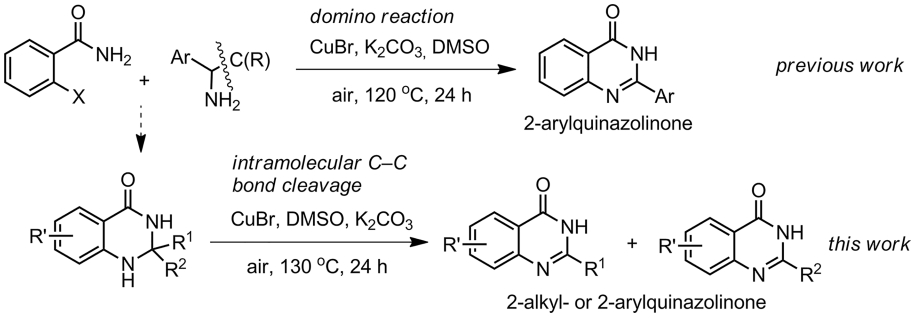
An efficient method for a copper-catalyzed intramolecular C–C bond cleavage to construct 2-substituted quinazolinones has been developed. The C–C bond at the 2-position of 2,2-disubstituted-1,2,3,4-tetrahydroquinazolinone was selectively cleaved by a Cu/air catalytic system. The trend for the cleavage was dependent on the leaving group in the order of: alkyl > methyl > phenyl > substituted aryl. The process described herein provides an explanation for the mechanism of the reaction between substituted 2-halobenzamides and α-substituted arylmethanamines to construct 2-substituted quinazolinones, which were previously reported and limited to the construction of 2-arylquinazolinones.

Introduction

Carbon–carbon and carbon–hydrogen bonds are the defining motifs of organic compounds. Selective C–C and C–H bond cleavages have always been an active area of research in organic chemistry, but they are mainly dependent on precious metal complexes.[1,2] C–C bond cleavage is more challenging than a C–H bond cleavage, in view of thermodynamic stability and uncontrollable selectivity.[1] Over the years, several approaches have been developed for the cleavage of a carbon–carbon single bond, including the employment of strained carbon skeletons[3] (three- and four-membered rings) or the use of chelation assistance strategies,[4] both of which are representative methods to promote a C–C bond cleavage. The cleavage of unstrained inert C–C bonds has traditionally required harsh conditions with stoichiometric amounts of oxidants such as peroxides and toxic metal salts. Thus, there is an urgent need for chemists to pursue milder and greener processes.

There is a growing interest in the use of inexpensive Cu[5] and Fe[6] metals for the development of new protocols for metal-catalyzed C–C bond cleavages. Molecular oxygen is considered an ideal oxidant because of its atom-economical and environmentally benign character.[7] To date, there are few reports of the use of a Cu/O_2 catalytic system for a C–C bond cleavage.[5e,8] Recently, we reported a copper-catalyzed domino reaction between substituted 2-halobenzamide and α-substituted arylmethanamine to construct 2-arylquinazolinones (Scheme 1).[9] 2,2-Disubstituted-1,2,3,4-tetrahydroquinazolinone might serve an important role as a key intermediate in the intramolecular C–C bond cleavage, but it could not be detected in the reaction system. Herein, we prepared 2,2-disubstituted-1,2,3,4-tetrahydroquinazolinone



Scheme 1. Copper-catalyzed C–C bond cleavage to construct 2-substituted quinazolinones (DMSO = dimethyl sulfoxide).

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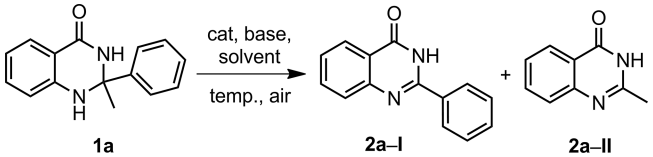
according to literature reports.[10,11] As part of our ongoing research, we pursued the copper-catalyzed intramolecular C–C bond cleavage of 2,2-disubstituted-1,2,3,4-tetrahydroquinazolinones to construct 2-substituted quinazolinones (Scheme 1).

Results and Discussion

Our initial studies focused on determining the optimal reaction conditions. 2-Methyl-2-phenyl-1,2,3,4-tetrahydroquinazolinone (**1a**) was chosen as the model substrate, which was smoothly converted into 2-phenylquinazolinone **2a-I** in 90% yield by using 10 mol-% CuBr as the catalyst, 2 equiv. of K_2CO_3 as the base, and DMSO as the solvent under air at 130 °C for 24 h (Table 1, Entry 1). Carrying out the reaction under argon led to a decreased yield of 64% (Table 1, Entry 2), which indicates that the absence of air could inhibit the transformation. Thus, we screened other catalysts as the reaction was performed under air (Table 1, Entries 3–7) and determined that CuBr provided the highest yield, whereas both of the examined Fe salts were inefficient in the process. The base had a significant influence on the yield. For example, Na_2CO_3 afforded **2a-I** in only 33% yield (Table 1, Entry 9), whereas Cs_2CO_3 provided **2a-I** in an equivalent amount as that from K_2CO_3 (Table 1, compare Entries 1 and 8). When *N*,*N*-dimethylformamide (DMF, Table 1, Entry 10) was used instead of DMSO, the reaction gave **2a-I** in a lower yield. The effect of temperature was also investigated, and we found that performing the reaction at 130 °C was optimal (Table 1, compare Entries 1, 11, and 12). Under these reaction conditions, the cleavage of C–C_{aryl} bond to give **2a-II** did not occur, indicating that the intramolecular C–C bond cleavage at the 2-position of 2-methyl-2-phenyl-1,2,3,4-tetrahydroquinazolinone (**1a**) was selective. In addition to the participation of air, CuBr or K_2CO_3 alone did not show any catalytic activity, indicating that the copper catalyst and base must function concertedly (Table 1, Entries 13 and 14).

Table 1. Optimization of conditions for copper-catalyzed transformation of 2-methyl-2-phenyl-1,2,3,4-tetrahydroquinazolinone under air.[a,b]



1a **2a–I** **2a–II**

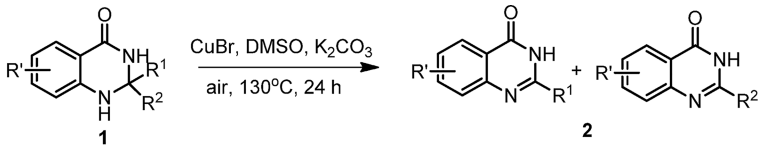
Entry	Catalyst	Base	Solvent	Temp.[°C]	% Yield **2a**[c]
1	CuBr	K_2CO_3	DMSO	130	90
2	CuBr	K_2CO_3	DMSO	130	64[d]
3	$CuBr_2$	K_2CO_3	DMSO	130	63
4	$CuCl_2$	K_2CO_3	DMSO	130	76
5	CuI	K_2CO_3	DMSO	130	74
6	$FeCl_3$	K_2CO_3	DMSO	130	21
7	$Fe(acac)_2$[e]	K_2CO_3	DMSO	130	trace
8	CuBr	Cs_2CO_3	DMSO	130	86
9	CuBr	Na_2CO_3	DMSO	130	33
10	CuBr	K_2CO_3	DMF	130	69
11	CuBr	K_2CO_3	DMSO	150	81
12	CuBr	K_2CO_3	DMSO	110	31
13	–	K_2CO_3	DMSO	130	–
14	CuBr	–	DMSO	130	–

[a] Reagents and conditions: **1a** (0.2 mmol), catalyst (0.02 mmol), base (0.4 mmol), and solvent (2 mL) under air for 24 h. [b] Product **2a-II** was not detected. [c] Isolated yield. [d] Under argon. [e] acac = acetylacetonate.

To investigate the selectivity of the C–C bond cleavage at the 2-position, the transformations of various 2,2-disubstituted-1,2,3,4-tetrahydroquinazolinones were performed under the established conditions (10 mol-% of CuBr as the catalyst and 2 equiv. of K_2CO_3 as the base in DMSO under air at 130 °C for 24 h). As shown in Table 2, the substrates with R^2 as a (substituted) phenyl or heteroaromatic group and R^1 as methyl group provided 2-arylquinazolinone as the only product in good yields of 46–91% (Table 2, Entries 1–6) by proceeding through a C–C_{alkyl} bond cleavage. Compound **1g**, which contained the same alkyl group for R^1 and R^2, afforded 2-methylquinazolinone **2g** as the major product (Table 2, Entry 7). Other substrates that contained different alkyl groups for R^1 and R^2 afforded products in low to moderate yields through the cleavage of C–C_{alkyl} bond of the longer alkyl chain (Table 2, Entries 8 and 9). Substrates in which R^1 and R^2 are the same aryl groups (Table 2, Entries 10–12) or the different aryl groups (Table 2, Entries 13–15) led to the C–C_{aryl} bond cleavage products in good yields, with the exception of 2,2-di(2-pyridyl)-1,2,3,4-tetrahydroquinazolinone (**1l**), which chelated to the copper ion. Mixtures of 2-R^1-substituted quinazolinone and 2-R^2-substituted quinazolinones as the products in varying ratios resulted from substrates **1m**–**1o** (Table 2, Entries 13–15). In addition, 1,2,3,4-tetrahydroquinazolinones with varying electronic properties led to better yields than those with an unsubstituted phenyl group. 6-Methoxy- and 7-nitro-substituted substrates with R^1 = methyl and R^2 = phenyl gave products **2p** and **2q** in yields 85 and 75%, respectively, by cleavage of C–C_{alkyl} bond (Table 2, Entries 16 and 17). Cleavage of C–H bond was shown to be easier than that of the C–C_{aryl} or C–C_{alkyl} bond (Table 2, Entries 18 and 19), and 2-phenylquinazolinone (**2a**) and 2-(phenylethyl)quinazolinone (**2s**) were isolated in 100 and 44% yield, respectively. We failed to isolate the products of spiro compounds **1t** and **1u**, as neither reaction could provide any clear or distinguishable products by TLC analysis. The results in Table 2 indicate that the cleavage of the C–C bond occurs in the following order: H > alkyl > methyl > phenyl > substituted aryl, which may be explained by the properties of the target C–C bond, such as the bond energy and steric hindrance.

On the basis of these experimental results, we proposed a reasonable mechanistic pathway (Scheme 2). The 2,2-disubstituted-1,2,3,4-tetrahydroquinazolinone is first oxidized to give radical cation **I**. A base-assisted deprotonation then takes place, and radical cation **I** is converted into **II**. Finally, product **2** is produced by a C–C bond cleavage. This radical process was indirectly confirmed in two ways. In a radical trapping experiment, the addition of 2,2,6,6-tetramethyl-1-piperidinyloxy (TEMPO) to the reaction of **1a** under the

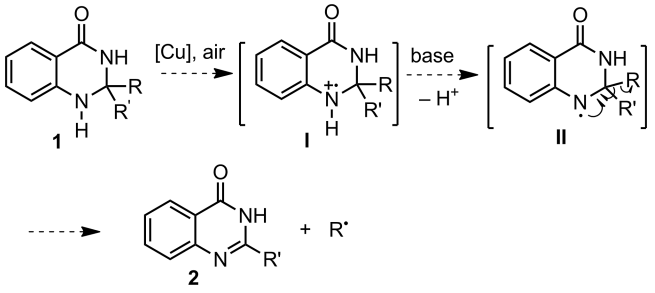
Table 2. Substrate scope of CuBr-catalyzed transformations of 2,2-disubstituted-1,2,3,4-tetrahydroquinazolinones.[a]



Entry	1	2 yield [b]	Entry	1	2 yield [b]
1	**1a** R′ = H, R^1 = CH_3, R^2 = C_6H_5	**2a** 90%	12	**1l** R′ = H, R^1 = R^2 = 2-C_6H_4N	**2l** 18%
2	**1b** R′ = H, R^1 = CH_3, R^2 = 4-$CH_3C_6H_4$	**2b** 91%	13	**1m** R′ = H, R^1 = C_6H_5, R^2 = 4-CNC_6H_4	**2a** + 21%, **2m** 67%
3	**1c** R′ = H, R^1 = CH_3, R^2 = 4-$CH_3OC_6H_4$	**2c** 65%	14[c]	**1n** R′ = H, R^1 = C_6H_5, R^2 = 4-$CH_3OC_6H_4$	**2a** 11% + **2c** 45%
4	**1d** R′ = H, R^1 = CH_3, R^2 = 3-ClC_6H_4	**2d** 86%	15	**1o** R′ = H, R^1 = C_6H_5, R^2 = 4-ClC_6H_4	**2a** + 22%, **2o** 68%
5	**1e** R′ = H, R^1 = CH_3, R^2 = 4-C_6H_4N	**2e** 46%	16	**1p** R′ = 6-CH_3O, R^1 = CH_3, R^2 = C_6H_5	**2p** 85%
6	**1f** R′ = H, R^1 = CH_3, R^2 = 2-C_4H_3O	**2f** 86%	17	**1q** R′ = 7-NO_2, R^1 = CH_3, R^2 = C_6H_5	**2q** 75%
7	**1g** R′ = H, R^1 = R^2 = CH_3	**2g** 35%	18	**1r** R′ = H, R^1 = H, R^2 = C_6H_5	**2a** 100%
8	**1h** R′ = H, R^1 = CH_3, R^2 = n-C_6H_{13}	**2g** 62%	19	**1s** R′ = H, R^1 = H, R^2 = $C_6H_5CH_2CH_2$	**2s** 44%
9	**1i** R′ = H, R^1 = CH_3, R^2 = $C_6H_5CH_2CH_2$	**2g** 68%	20	**1t** R′ = H, R^1 R^2= $(CH_2)_5$	–[d]
10[c]	**1j** R′ = H, R^1 = R^2 = C_6H_5	**2a** 58%	21	**1u** R′ = H, R^1 R^2= $C_6H_4(CH_2)_3$	–[d]
11	**1k** R′ = H, R^1 = R^2 = 4-BrC_6H_4	**2k** 80%			

[a] Reagents and conditions: **1** (0.2 mmol), catalyst (0.02 mmol), base (0.4 mmol), and DMSO (2 mL) under air for 24 h. [b] Isolated yield. [c] Starting materials **1j** and **1n** were recovered. [d] A mixture of products were found, and no major products could be isolated.

optimized conditions led to a decreased yield of 47%. Then, in the transformation of **1k**, byproducts 4,4′-dibromobiphenyl and *p*-bromo(methylthio)benzene were detected by GC–MS (Figure 1). Multiple pathways may be involved in this transformation, and a thorough mechanistic study is needed to unravel the intricacies of this process.



Scheme 2. Possible reaction pathway for copper-catalyzed intramolecular C–C bond cleavage of 2,2-disubstituted-1,2,3,4-tetrahydroquinazolinones.

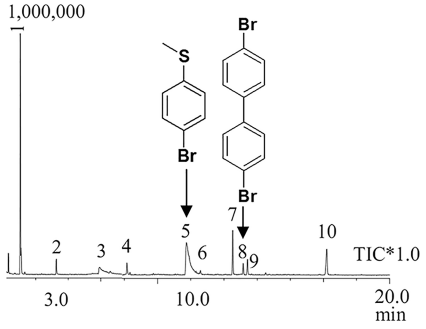


Figure 1. GC–MS analysis of reaction mixture of the transformation of **1k**.

Conclusions

In summary, we have demonstrated a copper-catalyzed approach for the synthesis of 2-substituted quinazolinones through an intramolecular C–C bond cleavage with air as the oxidant under basic conditions. This reaction not only provides an efficient method to construct medically important quinazolinones but also offers a new strategy for C–C bond cleavage.

Experimental Section

General Methods: Reactions were monitored by analytical thin-layer chromatography, and the developed plates were visualized by ultraviolet light. Purification of products was accomplished by flash chromatography on silica gel (100–200 mesh), and analytical TLC showed a single spot for the purified compounds. Chemical shifts (δ) were reported in ppm downfield from tetramethylsilane, and either tetramethylsilane or the residual solvent resonance was used as the internal standard.

General Procedure: To a vial that contained a stir bar were added **1** (0.2 mmol), K_2CO_3 (0.4 mmol), and CuBr (0.02 mmol) in DMSO (2 mL). The resulting mixture was stirred and heated at 130 °C for 24 h under air. Upon completion of the reaction, the mixture was cooled to room temperature and filtered, and the filtrate was concentrated with the aid of a rotary evaporator. The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate) to provide the desired product **2**.

2a:[9] White solid (40 mg, 90%); m.p. 235–236 °C. IR (KBr): $\tilde{\nu}$ = 3428, 1672, 1605, 1481, 769 cm^{-1}. ^1H NMR (400 MHz, [D_6]-DMSO): δ = 12.53 (br. s, 1 H), 8.20–8.15 (m, 3 H), 7.84 (t, J = 7.2 Hz, 1 H), 7.74 (d, J = 8.0 Hz, 1 H), 7.57–7.51 (m, 4 H) ppm. ^{13}C NMR (75 MHz, [D_6]DMSO): δ = 162.7, 152.8, 149.2, 135.1, 133.2, 131.9, 129.1, 128.2, 128.0, 127.1, 126.3, 121.4 ppm.

2b:[9] White solid (43 mg, 91%); m.p. 256–257 °C. IR (KBr): $\tilde{\nu}$ = 3432, 1668, 1606, 1295, 942 cm^{-1}. ^1H NMR (400 MHz, [D_6]-DMSO): δ = 12.46 (br. s, 1 H), 8.15 (d, J = 7.2 Hz, 1 H), 8.10 (d, J = 8.0 Hz, 2 H), 7.83 (t, J = 7.2 Hz, 1 H), 7.73 (d, J = 8.0 Hz, 1 H), 7.51 (t, J = 7.2 Hz, 1 H), 7.36 (d, J = 8.0 Hz, 2 H), 2.40 (s, 3 H) ppm. ^{13}C NMR (75 MHz, [D_6]DMSO): δ = 162.7, 152.7, 149.3, 141.9, 135.1, 130.4, 129.7, 128.2, 127.9, 126.9, 126.3, 121.4, 21.5 ppm.

2c:[9] White solid (33 mg, 65%); m.p. 250–251 °C. IR (KBr): $\tilde{\nu}$ = 3437, 1679, 1606, 1258, 1031 cm^{-1}. ^1H NMR (400 MHz, [D_6]-DMSO): δ = 12.40 (br. s, 1 H), 8.19 (d, J = 8.8 Hz, 2 H), 8.13 (d, J = 6.8 Hz, 1 H), 7.82 (t, J = 6.8 Hz, 1 H), 7.70 (d, J = 7.6 Hz, 1 H), 7.49 (t, J = 6.8 Hz, 1 H), 7.09 (d, J = 8.8 Hz, 2 H), 3.85 (s, 3 H) ppm. ^{13}C NMR (75 MHz, [D_6]DMSO): δ = 162.8, 162.3, 152.3, 149.4, 135.1, 129.9, 127.8, 126.6, 126.3, 125.3, 121.1, 114.5, 55.9 ppm.

2d: White solid (44 mg, 86%); m.p. 253–254 °C. IR (KBr): $\tilde{\nu}$ = 3430, 1680, 1608, 1310, 1112 cm^{-1}. ^1H NMR (300 MHz, [D_6]-DMSO): δ = 8.34 (s, 1 H), 8.26 (d, J = 6.6 Hz, 1 H), 8.04 (d, J = 7.8 Hz, 1 H), 7.64–7.56 (m, 2 H), 7.52–7.45 (m, 2 H), 7.30 (t, J = 7.2 Hz, 1 H) ppm. ^{13}C NMR (75 MHz, [D_6]DMSO): δ = 168.2, 157.0, 151.0, 140.4, 133.4, 132.6, 130.4, 129.9, 127.9, 127.1, 126.8, 126.3, 124.7, 122.3 ppm. HRMS: calcd. for $C_{14}H_{10}ClN_2O$ [M + H]$^+$ 257.04762; found 257.04760.

2e:[9] Light yellow solid (21 mg, 46%); m.p. 278–279 °C. IR (KBr): $\tilde{\nu}$ = 3080, 1672, 1607, 1005 cm^{-1}. ^1H NMR (400 MHz, [D_6]DMSO): δ = 12.77 (br. s, 1 H), 8.79 (d, J = 4.8 Hz, 2 H), 8.19 (d, J = 8.0 Hz, 1 H), 8.12 (d, J = 5.6 Hz, 2 H), 7.89 (t, J = 7.2 Hz, 1 H), 7.80 (d, J = 8.0 Hz, 1 H), 7.59 (t, J = 7.6 Hz, 1 H) ppm.

2f:[12] White solid (37 mg, 86%). IR (KBr): $\tilde{\nu}$ = 3428, 1682, 1604, 1460, 770 cm^{-1}. ^1H NMR (400 MHz, [D_6]DMSO): δ = 12.49 (s, 1 H), 8.11 (d, J = 7.6 Hz, 1 H), 7.99 (s, 1 H), 7.80 (dt, J = 1.2 Hz, J = 7.2 Hz, 1 H), 7.68 (d, J = 8 Hz, 1 H), 7.62 (d, J = 3.6 Hz, 1 H), 7.48 (t, J = 8 Hz, 1 H), 6.74 (d, J = 3.6 Hz, 1 H) ppm. ^{13}C NMR (100 MHz, [D_6]DMSO): δ = 162.0, 149.1, 147.1, 146.6, 144.5, 135.1, 127.7, 127.0, 126.4, 121.6, 114.9, 112.9 ppm.

2g:[13] White solid (20 mg, 62%); m.p. 234–235 °C. IR (KBr): $\tilde{\nu}$ = 3079, 1672, 1606, 1481, 784 cm^{-1}. ^1H NMR (300 MHz, [D_6]-DMSO): δ = 12.18 (br. s, 1 H), 8.07 (dd, J = 8.1, 1.5 Hz, 1 H), 7.76 (t, J = 8.1 Hz, 1 H), 7.56 (d, J = 8.1 Hz, 1 H), 7.44 (t, J = 7.4 Hz, 1 H), 2.34 (s, 3 H) ppm. ^{13}C NMR (75 MHz, [D_6]DMSO): δ = 162.2, 154.7, 149.4, 134.7, 127.0, 126.3, 126.1, 121.1, 21.9 ppm.

2k: White solid (50 mg, 80%); m.p. 294–295 °C. IR (KBr): $\tilde{\nu}$ = 3343, 1672, 1606, 1481, 1306 cm^{-1}. ^1H NMR (300 MHz, [D_6]-DMSO): δ = 12.61 (br. s, 1 H), 8.16–8.10 (m, 3 H), 7.84 (t, J = 8.1 Hz, 1 H), 7.77–7.72 (m, 3 H), 7.53 (t, J = 7.5 Hz, 1 H) ppm. ^{13}C NMR (75 MHz, [D_6]DMSO): δ = 162.6, 151.9, 149.1, 135.1, 132.4, 132.1, 130.3, 128.0, 127.3, 126.4, 125.7, 121.5 ppm. HRMS: calcd. for $C_{14}H_8{}^{79}BrN_2O$ [M + H]$^+$ 298.98200; found 298.98224; calcd. for $C_{14}H_8{}^{81}BrN_2O$ [M + H]$^+$ 300.97995; found 300.98019.

2l:[14] Light yellow solid (8 mg, 18%); m.p. 269–270 °C. IR (KBr): $\tilde{\nu}$ = 3081, 1672, 1611, 1012 cm^{-1}. ^1H NMR (300 MHz, [D_6]DMSO): δ = 10.97 (br. s, 1 H), 8.68 (d, J = 4.2 Hz, 1 H), 8.61 (d, J = 8.1 Hz, 1 H), 8.36 (dd, J = 8.1, 0.9 Hz, 1 H), 7.93 (ddd, J = 7.8, 1.8 Hz, 1 H), 7.86–7.77 (m, 2 H), 7.56–7.47 (m, 2 H) ppm. ^{13}C NMR (75 MHz, [D_6]DMSO): δ = 161.4, 149.2, 148.9, 148.7, 148.5, 137.5, 134.6, 128.0, 127.3, 126.8, 126.2, 122.5, 122.0 ppm.

2m: White solid (39 mg, 67%); m.p. >300 °C. IR (KBr): $\tilde{\nu}$ = 3429, 1681, 1605, 1311, 772 cm^{-1}. ^1H NMR (300 MHz, [D_6]DMSO): δ = 12.74 (br. s, 1 H), 8.33 (d, J = 8.4 Hz, 2 H), 8.17 (d, J = 7.8 Hz, 1 H), 8.02 (d, J = 8.1 Hz, 2 H), 7.86 (t, J = 7.7 Hz, 1 H), 7.77 (d, J = 8.1 Hz, 1 H), 7.56 (t, J = 7.4 Hz, 1 H) ppm. ^{13}C NMR (75 MHz, [D_6]DMSO): δ = 162.6, 151.4, 148.8, 137.3, 135.2, 132.9, 129.1, 128.2, 127.7, 126.4, 121.7, 118.8, 114.1 ppm. HRMS: calcd. for $C_{15}H_8N_3O$ [M + H]$^+$ 246.06729; found 246.06720.

2o: White solid (35 mg, 68%); m.p. 295–296 °C. IR (KBr): $\tilde{\nu}$ = 3428, 1678, 1605, 1094, 766 cm^{-1}. ^1H NMR (400 MHz, [D_6]-DMSO): δ = 12.73 (br. s, 1 H), 9.30 (s, 1 H), 8.76 (d, J = 3.2 Hz, 1 H), 8.50 (d, J = 7.6 Hz, 1 H), 8.18 (d, J = 7.6 Hz, 1 H), 7.87 (t, J = 7.6 Hz, 1 H), 7.78 (d, J = 8.0 Hz, 1 H), 7.61–7.54 (m, 2 H) ppm. ^{13}C NMR (75 MHz, [D_6]DMSO): δ = 162.6, 151.8, 149.1, 136.8, 135.2, 132.0, 130.1, 129.2, 128.0, 127.3, 126.3, 121.5 ppm.

2p:[9] White solid (42.6 mg, 85%); m.p. 247–248 °C. IR (KBr): $\tilde{\nu}$ = 3428, 1675, 1493, 1262, 1036 cm^{-1}. ^1H NMR (300 MHz, [D_6]-DMSO): δ = 12.51 (br. s, 1 H), 8.16 (d, J = 8.1 Hz, 2 H), 7.71 (d, J = 8.7 Hz, 1 H), 7.56–7.53 (m, 4 H), 7.45 (dd, J = 8.7, 3.0 Hz, 1 H), 3.90 (s, 3 H) ppm. ^{13}C NMR (75 MHz, [D_6]DMSO): δ = 162.5, 158.2, 150.6, 143.7, 133.3, 131.5, 129.7, 129.1, 128.0, 124.6, 122.3, 106.3, 56.1 ppm.

2q:[9] Yellow solid (38 mg, 75%); m.p. >300 °C. IR (KBr): $\tilde{\nu}$ = 3080, 1672, 1606, 1451, 1351, 943 cm^{-1}. ^1H NMR (300 MHz, [D_6]-DMSO): δ = 12.93 (br. s, 1 H), 8.44 (d, J = 1.8 Hz, 1 H), 8.37 (d, J = 8.7 Hz, 1 H), 8.22 (d, J = 6.6 Hz, 3 H), 7.67–7.56 (m, 3 H) ppm. ^{13}C NMR (75 MHz, [D_6]DMSO): δ = 161.8, 155.0, 151.8, 132.6, 132.5, 130.1, 129.2, 128.7, 128.5, 125.8, 122.9, 120.5 ppm.

2s:[15] White solid (22 mg, 44%); m.p. 208–209 °C. IR (KBr): $\tilde{\nu}$ = 3438, 1682, 1618, 1462, 901 cm^{-1}. ^1H NMR (300 MHz, [D_6]-DMSO): δ = 12.26 (br. s, 1 H), 8.08 (d, J = 7.8 Hz, 2 H), 7.79 (d, J = 7.8 Hz, 1 H), 7.81 (d, J = 7.5 Hz, 1 H), 7.69 (d, J = 7.8 Hz, 1 H), 7.48 (t, J = 7.4 Hz, 1 H), 7.08 (d, J = 9.0 Hz, 2 H), 3.84 (s, 3 H) ppm. ^{13}C NMR (75 MHz, [D_6]DMSO): δ = 162.2, 157.1, 149.3, 141.2, 134.8, 128.83, 128.81, 127.3, 126.6, 126.5, 126.2, 121.3, 36.8, 32.9 ppm.

Supporting Information (see footnote on the first page of this article): Detailed description of the experimental procedures and analytical data for all compounds.

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