Supporting Information

Metal-free site-selective C-H Cyanoalkylation of 8-Aminoquinoline and Aniline-derived Amides with Azobisisobutyronitrile

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1. **General information**

   All reagents, starting materials, and solvents were purchased from commercial sources and used without treatment unless otherwise indicated. All the solvents were dried and newly distilled. NMR spectra were obtained on a Bruker AMX 400 system using chloroform-d as deuterated solvents. The $^1$H-NMR spectra were recorded at 400 MHz in CDCl$_3$, and the $^{13}$C-NMR spectra were recorded at 100 MHz in CDCl$_3$. All shifts were given in ppm. All coupling constants ($J$ values) were reported in Hertz (Hz). High-Resolution Liquid Chromatography-Mass Spectrometry was recorded on the Bruker MicrOTOF QII. Column chromatography was performed on silica gel 100-200 mesh or 200-300 mesh. Ethyl acetate and petroleum ether were used for column chromatography.
2. Preparation of starting materials

Preparation of starting materials: Aromatic amine (5.0 mmol, 1.0 equiv) was dissolved in 10 mL of dichloromethane and cooled to 0 °C using an ice bath. NEt$_3$ (6.0 mmol, 1.2 equiv) was added to the aniline solution followed by the corresponding acid chloride (6.0 mmol, 1.2 equiv) dropwise. The mixture was stirred for 10 h at room temperature. Then, the mixture was washed with sat. NaHCO$_3$ (50 mL), and was extracted with dichloromethane for three times (3 x 40 mL). The organic layer was dried over Na$_2$SO$_4$. After filtration and evaporation, the amides were purified by column chromatography through silica gel.

*indolin-2-one 1q was purchased from Energy Chemical.*
3. Experimental section
3.1 Optimization of reaction conditions

Table S1 Optimization for selective cyanoalkylation reaction of aniline amides

![Reaction Diagram]

| Entry | Oxidant (eq)       | Solvent b | Temp(℃) | Yield c (%) |
|-------|--------------------|-----------|----------|-------------|
| 1     | K$_2$S$_2$O$_8$(2.0)| CH$_3$CN/H$_2$O | 120      | 87          |
| 2     | (NH$_4$)$_2$S$_2$O$_8$(2.0) | CH$_3$CN/H$_2$O | 120      | 81          |
| 3     | Ph$_2$(OAC)$_2$(2.0)  | CH$_3$CN/H$_2$O | 120      | 26          |
| 4     | TBHP(2.0)           | CH$_3$CN/H$_2$O | 120      | Trace       |
| 5     | K$_2$S$_2$O$_8$(2.0) | CH$_3$CN     | 120      | Trace       |
| 6     | K$_2$S$_2$O$_8$(2.0) | H$_2$O       | 120      | 13          |
| 7     | K$_2$S$_2$O$_8$(2.0) | DMF         | 120      | Trace       |
| 8     | K$_2$S$_2$O$_8$(2.0) | CH$_3$CN/DMSO | 120      | 9           |
| 9$^d$| K$_2$S$_2$O$_8$(2.0) | CH$_3$CN/H$_2$O | 120      | 15          |
| 10$^o$| K$_2$S$_2$O$_8$(2.0) | CH$_3$CN/H$_2$O | 120      | 46          |
| 11    | K$_2$S$_2$O$_8$(2.0) | CH$_3$CN/H$_2$O | 90       | 43          |
| 12    | K$_2$S$_2$O$_8$(2.0) | CH$_3$CN/H$_2$O | 100      | 55          |
| 13    | K$_2$S$_2$O$_8$(2.0) | CH$_3$CN/H$_2$O | 110      | 79          |
| 14    | K$_2$S$_2$O$_8$(2.0) | CH$_3$CN/H$_2$O | 130      | 85          |
| 15    | K$_2$S$_2$O$_8$(2.0) | CH$_3$CN/H$_2$O | 140      | 32          |
| 16    | K$_2$S$_2$O$_8$(2.0) | CH$_3$CN/H$_2$O | 150      | 11          |
| 17    | K$_2$S$_2$O$_8$(1.7) | CH$_3$CN/H$_2$O | 120      | 87          |
| 18    | K$_2$S$_2$O$_8$(1.5) | CH$_3$CN/H$_2$O | 120      | 84          |
| 19    | K$_2$S$_2$O$_8$(2.5) | CH$_3$CN/H$_2$O | 120      | 69          |
| 20$^o$| K$_2$S$_2$O$_8$(1.7) | CH$_3$CN/H$_2$O | 120      | 89          |
| 21$^d$| K$_2$S$_2$O$_8$(1.7) | CH$_3$CN/H$_2$O | 120      | 86          |
| 22$^b$| K$_2$S$_2$O$_8$(1.7) | CH$_3$CN/H$_2$O | 120      | 74          |
| 23$^i$| K$_2$S$_2$O$_8$(2.0) | CH$_3$CN/H$_2$O | 120      | 78          |
| 24$^j$| K$_2$S$_2$O$_8$(2.0) | CH$_3$CN/H$_2$O | 120      | 75          |

$^a$ Reaction conditions: 1a (0.2 mmol, 1.0 equiv), AIBN (0.3 mmol, 1.5 equiv), oxidant (0.4 mmol, 2.0 equiv), solvent (2.0 mL), in sealed tube for 1 h. $^b$ Solvents mentioned are mixed at a ratio of 1:1 unless otherwise specified. $^c$ Isolated yield. $^d$ CH$_3$CN/H$_2$O=0.5/1.5. $^e$ CH$_3$CN/H$_2$O=1.5/0.5. $^f$ AIBN (1.3 equiv). $^g$ AIBN (1.2 equiv). $^h$ AIBN (2.0 equiv). $^i$ AcOH (3.0 equiv). $^j$ Na$_2$CO$_3$ (3.0 equiv).
Table S2 Optimization for dimerization reaction of quinoline amides

![Diagram showing the reaction of quinoline amides](image)

| Entry | Oxidant (eq) | Solvent | Temp (°C) | Time (h) | Yield b (%) |
|-------|--------------|---------|-----------|----------|-------------|
| 1 c   | K₂S₂O₈(1.7)  | MeCN/H₂O(1/1) | 100       | 12       | 6           |
| 2     | K₂S₂O₈(1.7)  | MeCN/H₂O(1/1) | 100       | 12       | 6           |
| 3     | (NH₄)₂S₂O₈(1.7) | MeCN/H₂O(1/1) | 100       | 12       | trace       |
| 4     | TBHP(1.7)    | MeCN/H₂O(1/1) | 100       | 12       | n.r         |
| 5     | Phl(OAc)₂(1.7) | MeCN/H₂O(1/1) | 100       | 12       | trace       |
| 6     | K₂S₂O₈(1.7)  | MeCN/H₂O(1/1) | 100       | 4        | 8           |
| 7     | K₂S₂O₈(1.7)  | MeCN/H₂O(1.5/0.5) | 100   | 4       | 27          |
| 8     | K₂S₂O₈(1.7)  | MeCN/H₂O(0.5/1.5) | 100   | 4       | <5          |
| 9     | K₂S₂O₈(1.7)  | MeCN/DMSO(1/1) | 100       | 4        | 11          |
| 10    | K₂S₂O₈(1.7)  | DMSO     | 100       | 4        | 39          |
| 11    | K₂S₂O₈(1.7)  | DCE      | 100       | 4        | n.r         |
| 12    | K₂S₂O₈(1.7)  | DMF      | 100       | 4        | n.r         |
| 13    | K₂S₂O₈(1.7)  | DMSO/H₂O (1/1) | 100   | 4       | 15          |
| 14    | K₂S₂O₈(1.7)  | DMSO     | 120       | 4        | 28          |
| 15    | K₂S₂O₈(1.7)  | DMSO     | 80        | 4        | 22          |
| 16    | K₂S₂O₈(1.2)  | DMSO     | 100       | 4        | 24          |
| 17    | K₂S₂O₈(2.0)  | DMSO     | 100       | 4        | 52          |
| 18    | K₂S₂O₈(3.0)  | DMSO     | 100       | 4        | 49          |
| 19 d  | K₂S₂O₈(2.0)  | DMSO     | 100       | 4        | 25          |
| 20 e  | K₂S₂O₈(2.0)  | DMSO     | 100       | 4        | 12          |

*Reaction conditions: 3b (0.2 mmol, 1.0 equiv), solvent (2.0 mL), in sealed tube. Isolated yield. CF₃SO₃Na (0.4 mmol, 2.0 equiv), Na₂CO₃ (3.0 equiv). PivOH (3.0 eq)

3.2 General procedure for cyanoalkylation of aniline and 8-aminoquinoline amides²

![Diagram showing the cyanoalkylation reaction](image)
1 or 3 (0.20 mmol, 1.0 equiv), AIBN (0.26 mmol, 1.3 equiv), K$_2$S$_2$O$_8$ (0.34 mmol, 1.7 equiv) were mixed in CH$_3$CN/H$_2$O=1:1 (2.0 mL) and stirred in a dried sealed tube under air atmosphere at 120 °C for 1 h. After completion of the reaction (TLC monitored), it was cooled to room temperature and washed with sat. NaCl (10 mL), and was extracted with ethyl acetate for three times (3 x 5 mL). The organic layer was then transferred to a round bottom flask after dried over anhydrous Na$_2$SO$_4$. The solvent was concentrated under reduced pressure and further purified by flash chromatography (SiO$_2$, petroleum ether/ethyl acetate gradient), yielding the target products 2 or 4.

3.3 General procedure for bromination of 3b

\[
\begin{align*}
\text{3b} & \quad + \quad \text{K}_2\text{S}_2\text{O}_8 \quad (2.0 \text{ eq}) \quad \text{CH}_3\text{CN/H}_2\text{O}=1:1 \\
& \quad \quad 120 ^\circ\text{C, 1h} \\
\text{8b} & \quad , \quad 93\%
\end{align*}
\]

3b (0.20 mmol, 1.0 equiv), NaBr (0.4 mmol, 2.0 equiv), K$_2$S$_2$O$_8$ (0.4 mmol, 2.0 equiv) were mixed in CH$_3$CN/H$_2$O=1:1 (2.0 mL) and stirred in a dried sealed tube under air atmosphere at 120 °C for 1 h. After completion of the reaction (TLC monitored), it was cooled to room temperature and washed with sat. NaCl (10 mL), and was extracted with ethyl acetate for three times (3 x 5 mL). The organic layer was then transferred to a round bottom flask after dried over anhydrous Na$_2$SO$_4$. The solvent was concentrated under reduced pressure and further purified by flash chromatography (SiO$_2$, petroleum ether/ethyl acetate gradient), yielding the target products 8b.

3.4 General procedure for dimerization of 3a and 3b

\[
\begin{align*}
\text{3a; 3b} & \quad \text{K}_2\text{S}_2\text{O}_8 \quad (2.0 \text{ eq}) \\
& \quad \text{DMSO} \\
& \quad 100 ^\circ\text{C, 4h} \\
\text{9a, 48%}; \quad \text{9b, 52%}
\end{align*}
\]

3a or 3b (0.20 mmol, 1.0 equiv), K$_2$S$_2$O$_8$ (0.40 mmol, 2.0 equiv) were mixed in DMSO (2.0 mL) and stirred in a dried sealed tube under air atmosphere at 100 °C for 4 h. After completion of the reaction (TLC monitored), it was cooled to room temperature and washed with sat. NaCl (10 mL), and was extracted with dichloromethane for three times (3 x 5 mL). The organic layer was then transferred to a round bottom flask after dried over anhydrous Na$_2$SO$_4$. The solvent was concentrated under reduced pressure and further purified by flash chromatography (SiO$_2$, petroleum ether/ethyl acetate gradient), yielding the target products 9.

3.5 General procedure for para-C4-amidation of 1a
1a (0.20 mmol, 1.0 equiv), K$_2$S$_2$O$_8$ (0.40 mmol, 2.0 equiv) were mixed in DMSO (2.0 mL) and stirred in a dried sealed tube under air atmosphere at 100 °C for 4 h. After completion of the reaction (TLC monitored), it was cooled to room temperature and washed with sat. NaCl (10 mL), and was extracted with dichloromethane for three times (3 x 5 mL). The organic layer was then transferred to a round bottom flask after dried over anhydrous Na$_2$SO$_4$. The solvent was concentrated under reduced pressure and further purified by flash chromatography (SiO$_2$, petroleum ether/ethyl acetate gradient), yielding the target products 10.

4. The single crystal X-ray diffraction studies of N-(5-(2-cyanopropan-2-yl)quinolin-8-yl)-2-methylbenzamide 4d

Table S3 Crystal data and structure refinement for 4d

| Bond precision:  | C-C = 0.0025 Å  | Wavelength = 0.71073 |
|------------------|-----------------|----------------------|
| Cell:            | a = 13.4703(3)  | b = 14.2884(3)       |
|                  | c = 9.0192(2)   |                      |
|                  | alpha = 90      | beta = 97.198 (1)    |
|                  |                  | gamma = 90           |
| Temperature:     | 180 K           |                      |
| Calculated       |                | Reported             |
| Volume           | 1722.24(7)      | 1722.24(7)           |
| Space group      | P 21/c          | P 1 21/c             |
Hall group\n\-P 2ybc

Moiety formula\n$C_{20}H_{16}BrN_3O$ $C_{20}H_{16}BrN_3O$

Sum formula\n$C_{20}H_{16}BrN_3O$ $C_{20}H_{16}BrN_3O$

Mr\n394.26 394.27

$D_x$ (g · cm$^{-3}$)\n1.520 1.521

$Z$\n4 4

$\mu$ (mm$^{-1}$)\n2.399 2.400

$F_{000}$\n800.0 800.0

$F_{000}'$\n799.12

$h, k, l_{\text{max}}$\n16,17,10 16,17,10

$N_{\text{ref}}$\n3050 3013

$T_{\text{min}}, T_{\text{max}}$\n0.787, 0.825 0.616, 0.745

$T_{\text{min}}'$\n0.787

Correction method = # Reported T Limits: $T_{\text{min}} = 0.616$, $T_{\text{max}} = 0.745$,

AbsCorr = MULTI-SCAN

Data completeness = 0.988  Theta(max) = 25.040

$R(\text{reflections}) = 0.0221$ (2770)  $wR^2(\text{reflections}) = 0.0574$ (3013)

$S = 1.046$  $N_{\text{par}} = 228$

5. Mechanism investigation

To gain insight into the reaction mechanism, some control experiments were carried out (Scheme S1). Only a trace of the desired products 2a was obtained in the presence of radical scavenger TEMPO (1). In addition, the TEMPO adduct 6 was detected by HRLC-MS, which implied the involvement of free radical in the reaction pathway (2). Furthermore, we tried to capture cyanopropyl radical by using 3.0 equiv. of 1, 1-diphenylethylene, and radical coupling product 7 was detected via HRLC-MS. (3).
Several aniline substrates were undertaken under the standard conditions (Figure S1). The aniline substrates \(1m-1o\) with C2-H and C3-H substituted on the same side are not effective for the reaction, suggesting that a smooth hydrogen atom transfer path from C4 to N is important to the reaction. Besides, the naphthylamide substrate \(1p\) and indolin-2-one \(1q\) were also inactive in the reaction. Sulfonamide derivative \(3n\) failed to get the expected product, which probably due to the acid intolerance of the sulfonyl group, but C5-H was replaced by cyanoalkyl group Unexpectedly, N-methylpivalanilide \(1r\) obtained the para-C-functionalized product \(2a\) in a moderate 45% yield. This may be because the N-C bond is fragile (with bond energy 305 kJ/mol vs. 389 kJ/mol of N-H bond), which makes the methyl group easy to leave in the presence of the strong oxidant \(K_2S_2O_8\).

**Scheme S1** Investigation of the radical pathway

**Figure S1** Screening substrates

### 6. Exploration of further application
6.1 Scaled-up experiment
The scaled-up experiment was carried out by using 1a as substrate, and 65% yield could be obtained, which indicated its potential applications.

![Scheme S2 Gram-scaled experiment](image)

* Reaction conditions: 1a (0.71 g, 4.0 mmol), AIBN (0.85 g, 5.2 mmol), K$_2$S$_2$O$_8$ (1.84 g, 6.8 mmol), H$_2$O (5.0 mL), MeCN (5.0 mL), 120 °C, in sealed tube for 1 h.

6.2 Exploration of compatibility with other free radicals
The synthetic utility of this direct C-H activation procedure was implemented with 3b as the substrate. Delightly, the para-bromo-substituted product 8b was obtained with 93% yield readily when an inexpensive inorganic salts NaBr as bromine source reagent (Scheme S3, eq 3). Interestingly, a dimerization product 9b was found when the experiment was carried out without any radical reagents (eq 5, proved by NMR and HRLC-MS (SI)).
\[ \text{N\textsubscript{3}b} \xrightarrow{\text{selectfluor, standard conditions}} \text{X} \quad (eq 4) \]

\[ \text{N\textsubscript{3}b} \xrightarrow{2.0 \text{ eq}, \text{CF}_{3}\text{SO}_{3}\text{Na, standard conditions}} \text{9b, 9\%} \quad (eq 5) \]

\(^a\) standard conditions: 3b (0.2 mmol), K\textsubscript{2}S\textsubscript{2}O\textsubscript{8} (0.34 mmol), CH\textsubscript{3}CN (1 mL), H\textsubscript{2}O (1 mL), 120 °C, 1 h.

**Scheme S3** Exploration of compatibility with other free radicals

### 6.3 Synthetic transformations of 4b and 2a\(^{1c}\)

\[ \text{HCl, EtOH, 100 °C} \quad \text{11, 85\%} \]

\[ \text{NaOH, EtOH, 90 °C} \quad \text{12, 82\%} \]

\[ \text{HCl, EtOH, 100 °C} \quad \text{13, 90\%} \]

**Scheme S4** Functional groups transformation.

To demonstrate the potential application, the transformations of the products were also investigated (Scheme S4). Upon treatment of 4b with HCl or NaOH in EtOH for 12 h, the corresponding amide derivatives 11 and 12 were obtained in 85% yield and 82% yield, respectively. In addition, the acyl group is easily removed from 2a by simple acid hydrolysis, giving the corresponding product 13 in 90% yield.
To a solution of 4b (0.2 mmol, 1.0 equiv) in 4.0 mL of EtOH, concentrated HCl (2.0 mL) was added. The mixture was stirred at 100 °C for 12 h. Upon completion of room temperature and evaporation of the solvent under reduced pressure, the residue was purified by column chromatography (petroleum ether/EtOAc=5:1) to afford pure 11 as a pale yellow solid in 85% yield.

To a solution of 4b (0.2 mmol, 1.0 equiv) in 2.0 mL of EtOH, NaOH (0.8 mmol, 4.0 equiv) was added. The mixture was stirred at 90 °C for 12 h. Upon completion of room temperature and evaporation of the solvent under reduced pressure, the residue was purified by column chromatography (petroleum ether/EtOAc=2:1) to afford pure 12 as a white solid in 82% yield.

To a solution of 2a (0.20 mmol, 1.0 equiv) in 2.0 mL of EtOH, HCl (0.8 mmol, 4.0 equiv) was added. The mixture was stirred at 100 °C for 12 h. Upon completion of room temperature and evaporation of the solvent under reduced pressure, the residue was purified by column chromatography (petroleum ether/EtOAc=2:1) to afford pure 13 in 90% yield.

7. Characterization data of products
2a:

White solid, isolated yield: 89%; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.55 (d, $J = 8.7$ Hz, 2H), 7.42 (d, $J = 8.8$ Hz, 2H), 7.35 (s, 1H), 1.71 (s, 6H), 1.32 (s, 9H). $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 176.74 (s), 137.63 (s), 137.05 (s), 125.68 (s), 124.56 (s), 120.32 (s), 39.65 (s), 36.73 (s), 29.16 (s), 27.60 (s). HRMS (ESI): m/z: calcd for [M+H]$^+$ C$_{15}$H$_{21}$N$_2$O: 245.1648, found: 245.1645.

2b:

White solid, isolated yield: 73%; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.91 (d, $J = 8.5$ Hz, 1H), 7.31 (d, $J = 2.2$ Hz, 1H), 7.28 (d, $J = 2.4$ Hz, 1H), 7.24 (s, 1H), 2.28 (s, 3H), 1.70 (s, 6H), 1.34 (s, 9H). $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 176.63 (s), 137.68 (s), 135.40 (s), 129.81 (s), 127.15 (s), 124.53 (s), 123.50 (s), 123.06 (s), 39.58 (s), 36.61 (s), 29.04 (s), 27.55 (s), 17.75 (s). HRMS (ESI): m/z: calcd for [M+H]$^+$ C$_{16}$H$_{23}$N$_2$O: 259.1805, found: 259.1814.

2c:

White solid, isolated yield: 67%; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 8.40 (d, $J = 8.4$ Hz, 1H), 8.09 (s, 1H), 7.01 (d, $J = 2.0$ Hz, 1H), 6.98 (dd, $J = 8.5, 2.1$ Hz, 1H), 3.94 (s, 3H), 1.71 (s, 6H), 1.31 (s, 9H). $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 176.60 (s), 148.12 (s), 136.55 (s), 127.37 (s), 124.59 (s), 119.61 (s), 117.13 (s), 107.18 (s), 55.98 (s), 39.99 (s), 37.02 (s), 29.17 (s), 27.58 (s). HRMS (ESI): m/z: calcd for [M+H]$^+$ C$_{16}$H$_{23}$N$_2$O$_2$: 275.1754, found: 275.1742.

2d:

White solid, isolated yield: 58%; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 8.46 (d, $J = 8.6$ Hz, 1H), 7.92 (s, 1H), 7.40 – 7.33 (m, 2H), 7.24 (dd, $J = 8.7, 2.3$ Hz, 1H), 7.14 (t, $J = 7.4$ Hz, 1H), 7.05 (d, $J = 2.2$ Hz, 1H), 6.97 (dd, $J = 8.6, 0.9$ Hz, 2H), 1.66 (s, 6H), 1.19 (s, 9H). $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 176.58 (s), 156.39 (s), 145.18 (s), 137.37 (s), 130.14 (s), 129.90 (s), 124.15 (s), 123.87 (s), 121.47 (s), 121.15 (s), 117.32 (s), 116.00 (s), 39.85 (s), 36.66 (s), 29.01 (s), 27.37 (s). HRMS (ESI): m/z: calcd for [M+H]$^+$ C$_{21}$H$_{25}$N$_2$O$_2$: 337.1911, found: 337.1909.

2e:
White solid, isolated yield: 54%; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 8.42 (d, $J = 8.7$ Hz, 1H), 8.01 (s, 1H), 7.39 (dd, $J = 8.7, 2.3$ Hz, 1H), 1.70 (s, 6H), 1.35 (s, 9H). $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 176.69 (s), 138.13 (s), 135.46 (s), 128.91 (s), 125.05 (s), 123.88 (s), 121.89 (s), 121.43 (s), 39.28 (s), 28.97 (s), 27.49 (s), 23.27 (s). HRMS (ESI): m/z: calcd for [M+H]$^+$ C$_{15}$H$_{20}$BrN$_2$O: 323.0754, 325.0733, found: 323.0761, 325.0739.

2f:

White solid, isolated yield: 37%; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 8.31 (d, $J = 8.6$ Hz, 1H), 7.82 (s, 1H), 7.68 (s, 1H), 7.64 (d, $J = 8.8$ Hz, 1H), 1.73 (s, 6H), 1.32 (s, 9H). $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 176.74 (s), 137.48 (s), 137.37 (s), 129.62 (s), 127.94, 125.22, 122.51, 119.79 (q, $J = 274$ Hz, 1H), 124.81, 123.70 (q apparent d, $J = 37.4$ Hz, 1H), 122.75 (q, $J = 5.4$ Hz), 121.41 (s), 119.07 (s), 28.96 (s), 27.28 (s), 25.12 (s), 23.36 (s). HRMS (ESI): m/z: calcd for [M+H]$^+$ C$_{16}$H$_{20}$F$_3$N$_2$O: 313.1522, found: 313.1543.

2g:

White solid, isolated yield: 84%; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.42 (dd, $J = 8.5, 2.3$ Hz, 1H), 7.39 (d, $J = 2.0$ Hz, 1H), 7.32 (s, 1H), 7.23 (d, $J = 8.5$ Hz, 1H), 2.61 (s, 3H), 1.76 (s, 6H), 1.31 (s, 9H). $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 176.88 (s), 137.71 (s), 137.12 (s), 133.66 (s), 125.41 (s), 124.59 (s), 123.78 (s), 117.75 (s), 39.65 (s), 34.57 (s), 28.26 (s), 27.58 (s), 21.13 (s). HRMS (ESI): m/z: calcd for [M+H]$^+$ C$_{16}$H$_{23}$N$_2$O: 259.1805, found: 259.1814.

2h:

White solid, isolated yield: 61%; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.89 (d, $J = 2.2$ Hz, 1H), 7.55 (dd, $J = 8.7, 2.2$ Hz, 1H), 7.44 (s, 1H), 7.37 (d, $J = 8.7$ Hz, 1H), 1.86 (s, 6H), 1.30 (s, 9H). $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 176.93 (s), 138.86 (s), 133.49 (s), 127.36 (s), 123.78 (s), 118.97 (s), 39.76 (s), 36.93 (s), 27.60 (s), 27.52 (s). HRMS (ESI): m/z: calcd for [M+H]$^+$ C$_{15}$H$_{20}$BrN$_2$O: 323.0754, 325.0733, found: 323.0761, 325.0743.

2i:
White solid, isolated yield: 90%; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 8.35 (s, 1H), 8.12 – 8.04 (m, 2H), 7.70 (d, $J$ = 7.9 Hz, 1H), 7.60 – 7.51 (m, 3H), 7.47 – 7.42 (m, 1H), 7.40 – 7.30 (m, 2H), 1.76 (s, 6H). $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 166.10 (s), 132.28 (s), 129.83 (s), 129.17 (s), 128.88 (d, $J$ = 17.2 Hz), 127.29 (t, $J$ = 16.2 Hz), 125.82 (s), 124.95 (s), 120.62 (s), 29.17 (s), 27.29 (s). HRMS (ESI): m/z: calcd for [M+H]$^+$ C$_{17}$H$_{17}$N$_2$O: 265.1335, found: 265.1331.

White solid, isolated yield: 68%; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.55 (d, $J$ = 8.6 Hz, 2H), 7.40 (d, $J$ = 8.6 Hz, 2H), 2.23 (dd, $J$ = 13.3, 10.0 Hz, 1H), 1.94 (d, $J$ = 13.1 Hz, 2H), 1.83 (d, $J$ = 9.5 Hz, 2H), 1.70 (s, 6H), 1.53 (d, $J$ = 11.9 Hz, 2H), 1.38 – 1.22 (m, 4H). $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 174.54 (s), 129.82 (s), 129.02 (s), 125.70 (s), 124.82 (s), 120.07 (s), 29.63 (s), 29.57 (s), 29.15 (s), 27.32 (s), 25.71 (s), 25.65 (s). HRMS (ESI): m/z: calcd for [M+H]$^+$ C$_{17}$H$_{23}$N$_2$O: 271.1805, found: 271.1803.

White solid, isolated yield: 81%; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.59 (s, 1H), 7.52 (d, $J$ = 8.6 Hz, 2H), 7.39 (d, $J$ = 8.5 Hz, 2H), 2.17 (s, 3H), 1.70 (s, 6H). $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 169.61 (s), 137.98 (s), 136.65 (s), 125.49 (s), 124.67 (s), 120.40 (s), 36.62 (s), 28.99 (s), 24.18 (s). HRMS (ESI): m/z: calcd for [M+H]$^+$ C$_{12}$H$_{15}$N$_2$O: 203.1179, found: 203.1193.

White solid, isolated yield: 52%; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 10.07 (s, 1H), 8.62 (d, $J$ = 4.6 Hz, 1H), 8.29 (d, $J$ = 7.8 Hz, 1H), 7.91 (td, $J$ = 7.6, 0.8 Hz, 1H), 7.81 (d, $J$ = 8.6 Hz, 2H), 7.49 (m, 3H), 1.73 (s, 6H). $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 162.10 (s), 149.56 (s), 148.01 (s), 137.76 (s), 137.24 (d, $J$ = 13.0 Hz), 126.62 (s), 125.87 (s), 124.56 (s), 122.46 (s), 120.02 (s), 36.79 (s), 29.19 (s). HRMS (ESI): m/z: calcd for [M+H]$^+$ C$_{16}$H$_{16}$N$_3$O: 266.1288, found: 266.1295.

White solid, isolated yield: 92%; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 10.89 (s, 1H), 8.96 (dd, $J$ = 8.8, 1.1 Hz, 1H), 8.94 – 8.87 (m, 2H), 8.09 (d, $J$ = 6.7 Hz, 2H), 7.66 – 7.62 (m, 1H), 7.62 – 7.56 (m, 4H), 1.97 (s,
6H). $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 165.53 (s), 147.92 (s), 139.57 (s), 135.26 (s), 134.90 (s), 133.24 (s), 132.03 (s), 129.74 (s), 128.86 (s), 127.32 (s), 125.32 (s), 124.84 (s), 124.22 (s), 121.59 (s), 115.37 (s), 33.93 (s), 28.89 (s). HRMS (ESI): m/z: calcd for [M+H]$^+$ C$_{20}$H$_{18}$N$_3$O: 316.1444, found: 316.1453.

4b:

White solid, isolated yield: 90%; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 10.34 (s, 1H), 8.94 (d, $J$ = 8.1 Hz, 1H), 8.89 (d, $J$ = 8.3 Hz, 1H), 8.84 (d, $J$ = 3.9 Hz, 1H), 7.68 (d, $J$ = 7.6 Hz, 1H), 7.63 – 7.55 (m, 2H), 7.42 (s, 1H). $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 168.28 (s), 147.89 (s), 139.43 (s), 136.76 (s), 136.40 (s), 135.42 (s), 133.19 (s), 131.45 (s), 130.49 (s), 129.84 (s), 127.29 (s), 126.07 (s), 125.32 (s), 124.82 (s), 124.15 (s), 115.33 (s), 33.93 (s), 20.25 (s). HRMS (ESI): m/z: calcd for [M+H]$^+$ C$_{21}$H$_{20}$N$_3$O: 330.1601, found: 330.1600.

4c:

White solid, isolated yield: 94%; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 12.46 (s, 1H), 8.98 (d, $J$ = 8.3 Hz, 1H), 8.93 (d, $J$ = 1.7 Hz, 1H), 8.92 (s, 1H), 8.34 (dd, $J$ = 7.8, 1.5 Hz, 1H), 7.62 – 7.57 (m, 1H), 7.57 – 7.50 (m, 2H), 7.15 (t, $J$ = 7.5 Hz, 1H), 7.08 (d, $J$ = 8.3 Hz, 1H), 4.20 (s, 3H), 1.95 (s, 6H). $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 163.78 (s), 157.78 (s), 147.82 (s), 140.06 (s), 136.47 (s), 133.33 (s), 130.49 (s), 129.84 (s), 129.33 (s), 125.37 (s), 124.96 (s), 124.37 (s), 122.16 (s), 121.31 (s), 116.12 (s), 56.15 (s), 33.88 (s), 28.91 (s). HRMS (ESI): m/z: calcd for [M+H]$^+$ C$_{21}$H$_{20}$N$_3$O: 346.1550, found: 346.1561.

4d:

Brown solid, isolated yield: 53%; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 10.44 (s, 1H), 8.94 (dd, $J$ = 8.8, 1.4 Hz, 1H), 8.90 (d, $J$ = 8.3 Hz, 1H), 8.84 (dd, $J$ = 4.1, 1.4 Hz, 1H), 7.71 (dd, $J$ = 7.6, 1.6 Hz, 1H), 7.68 (dd, $J$ = 8.0, 0.8 Hz, 1H), 7.59-7.57 (m, 1H), 7.58(t, $J$=4.4 Hz, 1H), 7.44 (td, $J$ = 7.5, 1.0 Hz, 1H), 7.35 (td, $J$ = 7.8, 1.7 Hz, 1H), 1.95 (s, 6H). $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 166.05 (s), 148.01 (s), 139.37 (s), 138.07
(s), 134.97 (s), 133.73 (s), 133.19 (s), 131.66 (s), 129.60 (s), 127.72 (s), 125.31 (s), 124.78 (s), 124.14 (s), 121.65 (s), 119.67 (s), 115.74 (s), 33.95 (s), 28.89 (s).

HRMS (ESI): m/z: calcd for [M+H]+ C20H17BrN3O: 394.0550, 396.0529, found: 394.0564, 396.0545.

4e:

![Image](attachment:image.png)

White solid, isolated yield: 82%; 1H NMR (400 MHz, CDCl3) δ 10.85 (s, 1H), 8.93 (d, J = 8.8 Hz, 1H), 8.89 (d, J = 3.9 Hz, 1H), 8.87 (d, J = 8.4 Hz, 1H), 7.61 (dd, J = 12.7, 5.3 Hz, 3H), 7.56 (d, J = 8.3 Hz, 1H), 7.45 (t, J = 8.1 Hz, 1H), 7.15 – 7.09 (m, 1H), 3.90 (s, 3H), 1.95 (s, 6H). 13C NMR (101 MHz, CDCl3) δ 165.36 (s), 160.01 (s), 147.96 (s), 139.52 (s), 136.33 (s), 135.21 (s), 129.81 (d, J = 8.7 Hz), 125.29 (s), 124.84 (s), 124.20 (s), 121.61 (s), 119.08 (s), 118.15 (s), 115.37 (s), 112.73 (s), 55.53 (s), 33.92 (s), 28.87 (s). HRMS (ESI): m/z: calcd for [M+H]+ C21H20N3O2: 346.1550, found: 346.1566.

4f:

![Image](attachment:image.png)

White solid, isolated yield: 78%; 1H NMR (400 MHz, CDCl3) δ 10.85 (s, 1H), 8.94 (d, J = 8.7, 1.5 Hz, 1H), 8.91 (dd, J = 4.2, 1.4 Hz, 1H), 8.89 (d, J = 8.3 Hz, 1H), 7.98 (d, J = 8.2 Hz, 2H), 7.62 (dd, J = 8.7, 4.2 Hz, 1H), 7.56 (d, J = 8.3 Hz, 1H), 7.36 (d, J = 7.9 Hz, 2H), 2.46 (s, 3H), 1.96 (s, 6H). 13C NMR (101 MHz, CDCl3) δ 147.88 (s), 142.59 (s), 139.58 (s), 136.36 (s), 133.22 (s), 132.09 (s), 130.09 (s), 129.81 (d, J = 2.6 Hz), 127.34 (s), 124.24 (s), 121.56 (s), 115.30 (s), 33.91 (s), 28.90 (s), 21.60 (s). HRMS (ESI): m/z: calcd for [M+H]+ C21H20N3O2: 330.1601, found: 330.1593.

4g:

![Image](attachment:image.png)

White solid, isolated yield: 75%; 1H NMR (400 MHz, CDCl3) δ 10.85 (s, 1H), 8.94 (d, J = 8.8 Hz, 1H), 8.91 (d, J = 8.5 Hz, 1H), 8.01 (d, J = 8.1 Hz, 2H), 7.61 (dd, J = 8.7, 4.1 Hz, 1H), 7.56 (d, J = 8.3 Hz, 1H), 7.38 (d, J = 8.0 Hz, 2H), 2.75 (q, J = 7.6 Hz, 2H), 1.95 (s, 6H), 1.30 (t, J = 7.6 Hz, 3H). 13C NMR (101 MHz, CDCl3) δ 176.81 (s), 137.47 (s), 135.34 (s), 129.63 (s), 125.22 (s), 124.79 (s),
123.72 (s), 122.76 (d, J = 5.5 Hz), 121.43 (s), 119.10 (s), 28.98 (s), 27.29 (s), 25.14 (s), 23.39 (s). HRMS (ESI): m/z: calcd for [M+H]+ C_{22}H_{22}N_{3}O: 344.1757, found: 344.1749.

4h:

![Image of compound 4h]

White solid, isolated yield: 43%; $^1$H NMR (400 MHz, CDCl$_3$) δ 10.83 (s, 1H), 8.96 (dd, J = 8.8, 1.4 Hz, 1H), 8.92 (dd, J = 4.1, 1.4 Hz, 1H), 8.86 (d, J = 8.3 Hz, 1H), 8.13 – 8.07 (m, 2H), 7.64 (dd, J = 8.7, 4.2 Hz, 1H), 7.58 (d, J = 8.3 Hz, 1H), 7.22 (dd, J = 6.7, 4.8 Hz, 2H), 1.96 (s, 6H). $^{13}$C NMR (101 MHz, CDCl$_3$) δ 164.47 (s), 147.95 (s), 139.53 (s), 135.10 (s), 133.31 (s), 132.86 (d, J = 9.7 Hz, 1H), 131.09 (d, J = 3.2 Hz, 1H), 129.90 (s), 129.73 (d, J = 9.0 Hz, 1H), 125.34 (s), 124.80 (s), 124.21 (s), 121.64 (s), 115.94 (d, J = 21.8 Hz, 1H), 115.83 – 115.74 (m), 115.62 (s), 115.41 (s), 33.94 (s), 28.89 (s). HRMS (ESI): m/z: calcd for [M+H]+ C_{20}H_{17}FNO: 334.1350, found: 334.1375.

4i:

![Image of compound 4i]

White solid, isolated yield: 71%; $^1$H NMR (400 MHz, CDCl$_3$) δ 9.91 (s, 1H), 8.91 (d, J = 8.8 Hz, 1H), 8.85 – 8.81 (m, 1H), 8.74 (d, J = 8.3 Hz, 1H), 7.58 (dd, J = 8.7, 4.1 Hz, 1H), 7.51 (d, J = 8.3 Hz, 1H), 7.30 (d, J = 4.3 Hz, 4H), 7.21 (dd, J = 8.4, 4.2 Hz, 1H), 3.15 (t, J = 7.8 Hz, 2H), 2.90 (t, J = 7.8 Hz, 2H), 1.93 (s, 6H). $^{13}$C NMR (101 MHz, CDCl$_3$) δ 170.96 (s), 147.71 (s), 140.64 (s), 139.09 (s), 135.07 (s), 133.15 (s), 129.51 (s), 128.49 (d, J = 19.2 Hz), 126.30 (s), 125.21 (s), 124.15 (s), 121.48 (s), 115.31 (s), 39.74 (s), 33.87 (s), 31.42 (s), 28.87 (s). HRMS (ESI): m/z: calcd for [M+H]+ C_{22}H_{22}NO: 344.1757, found: 344.1767.

4j:

![Image of compound 4j]

White solid, isolated yield: 78%; $^1$H NMR (400 MHz, CDCl$_3$) δ 10.03 (s, 1H), 8.87 (d, J = 8.8 Hz, 1H), 8.74 (d, J = 4.1 Hz, 1H), 8.71 (d, J = 8.3 Hz, 1H), 7.54 (dd, J = 8.8, 4.1 Hz, 1H), 7.48 (d, J = 8.3 Hz, 1H), 7.46 – 7.38 (m, 4H), 7.37 – 7.31 (m, 1H), 3.90 (s, 2H), 1.91 (s, 6H). $^{13}$C NMR (101 MHz, CDCl$_3$)
δ 169.68 (s), 147.76 (s), 139.22 (s), 135.04 (s), 134.52 (s), 133.07 (s), 129.65 (s), 129.54 (s), 129.02 (s), 127.41 (s), 125.15 (s), 124.80 (s), 124.06 (s), 121.42 (s), 115.14 (s), 45.38 (s), 33.86 (s), 28.85 (s).

**HRMS (ESI):** m/z: calcd for [M+H]+ C21H20N3O: 330.1601, found: 330.1608.

**4k:**

![Chemical Structure](image)

White solid, isolated yield: 84%; 1H NMR (400 MHz, CDCl3) δ 9.94 (s, 1H), 8.91 (d, J = 8.7 Hz, 1H), 8.85 (d, J = 3.6 Hz, 1H), 8.73 (d, J = 8.3 Hz, 1H), 7.58 (dd, J = 8.7, 4.1 Hz, 1H), 7.50 (d, J = 8.3 Hz, 1H), 2.60 (q, J = 7.5 Hz, 2H), 1.93 (s, 6H), 1.33 (t, J = 7.6 Hz, 3H). 13C NMR (101 MHz, CDCl3) δ 172.64 (s), 147.70 (s), 139.14 (s), 135.22 (s), 133.16 (s), 129.32 (s), 125.22 (s), 124.85 (s), 124.18 (s), 121.45 (s), 115.17 (s), 77.37 (s), 77.06 (s), 76.74 (s), 33.86 (s), 31.26 (s), 28.87 (s), 9.69 (s). HRMS (ESI): m/z: calcd for [M+H]+ C16H18N3O: 268.1444, found: 268.1452.

**4l:**

![Chemical Structure](image)

White solid, isolated yield: 87%; 1H NMR (400 MHz, CDCl3) δ 10.39 (s, 1H), 8.91 (d, J = 8.8 Hz, 1H), 8.87 (dd, J = 4.0, 1.0 Hz, 1H), 8.74 (d, J = 8.3 Hz, 1H), 7.59 (dd, J = 8.7, 4.2 Hz, 1H), 7.50 (d, J = 8.3 Hz, 1H), 1.93 (s, 6H), 1.42 (s, 9H). 13C NMR (101 MHz, CDCl3) δ 177.44 (s), 147.83 (s), 135.37 (s), 133.14 (s), 129.26 (s), 125.24 (s), 124.87 (s), 124.17 (s), 115.02 (s), 40.41 (s), 33.86 (s), 28.89 (s), 27.71 (s). HRMS (ESI): m/z: calcd for [M+H]+ C16H18N3O: 296.1757, found: 296.1764.

**4m**

![Chemical Structure](image)

White solid, isolated yield: 56%; 1H NMR (400 MHz, CDCl3) δ 10.95 (s, 1H), 8.93 (d, J = 8.5 Hz, 1H), 8.71 (d, J = 4.6 Hz, 1H), 8.06 (dd, J = 8.0, 1.3 Hz, 2H), 7.81 (d, J = 8.6 Hz, 1H), 7.71 (d, J = 4.6 Hz, 1H), 7.62 – 7.56 (m, 3H), 2.06 (s, 6H). 13C NMR (101 MHz, CDCl3) δ: 165.37 (s), 148.83 (s), 144.68 (s), 139.35 (s), 131.86 (s), 131.36 (s), 130.51 (s), 129.70 (s), 128.82 (s), 127.26 (s), 123.58 (s), 123.40
(s), 121.56 (s), 116.19 (s), 116.06 (s), 72.69 (s), 27.53 (s). HRMS (ESI): m/z: calcd for [M+H]+ C_{20}H_{16}ClN_{3}O_{2}: 366.1004, found: 366.1003.

\textbf{2aa}

White solid, isolated yield: 57\%; \textsuperscript{1}H NMR (400 MHz, CDCl\textsubscript{3}) δ 7.56 (d, \(J = 8.6\) Hz, 2H), 7.39 (s, 1H), 7.36 (d, \(J = 8.6\) Hz, 2H), 1.99 – 1.86 (m, 2H), 1.68 (s, 3H), 1.31 (s, 9H), 0.94 (t, \(J = 7.4\) Hz, 3H). \textsuperscript{13}C NMR (101 MHz, CDCl\textsubscript{3}) δ 176.87 (s), 137.66 (s), 135.56 (s), 126.05 (s), 123.50 (s), 120.39 (s), 42.77 (s), 39.63 (s), 35.19 (s), 27.57 (s), 27.27 (s), 9.82 (s). HRMS (ESI): m/z: calcd for [M+H]+ C_{16}H_{23}N_{2}O: 259.1805, found: 259.1810.

\textbf{2ab}

White solid, isolated yield: 46\%; \textsuperscript{1}H NMR (400 MHz, CDCl\textsubscript{3}) δ 7.48 (d, \(J = 8.7\) Hz, 2H), 7.29 (d, \(J = 8.7\) Hz, 3H), 3.63 (s, 3H), 1.56 (s, 6H), 1.31 (s, 9H). \textsuperscript{13}C NMR (101 MHz, CDCl\textsubscript{3}) δ 177.22 (s), 176.59 (s), 140.42 (s), 136.63 (s), 126.22 (s), 119.96 (s), 52.21 (s), 46.04 (s), 39.57 (s), 27.62 (s), 26.49 (s). HRMS (ESI): m/z: calcd for [M+H]+ C_{16}H_{24}NO_{3}: 278.1751, found: 258.1759.

\textbf{4ba}

White solid, isolated yield: 53\%; \textsuperscript{1}H NMR (400 MHz, CDCl\textsubscript{3}) δ 10.35 (s, 1H), 8.92 (t, \(J = 8.9\) Hz, 2H), 8.82 (d, \(J = 4.0\) Hz, 1H), 7.68 (d, \(J = 7.4\) Hz, 1H), 7.61 – 7.55 (m, 2H), 7.41 (t, \(J = 7.4\) Hz, 1H), 7.33 (t, \(J = 7.7\) Hz, 2H), 2.61 (s, 3H), 2.38 (dq, \(J = 14.5, 7.3\) Hz, 1H), 2.10 (dq, \(J = 14.6, 7.4\) Hz, 1H), 1.94 (s, 3H), 1.10 (t, \(J = 7.4\) Hz, 3H). \textsuperscript{13}C NMR (101 MHz, CDCl\textsubscript{3}) δ 168.27 (s), 147.85 (s), 139.44 (s), 136.76 (s), 136.40 (s), 135.30 (s), 133.11 (s), 131.45 (s), 130.49 (s), 128.91 (s), 127.29 (s), 126.07 (s), 125.31 (d, \(J = 18.0\) Hz), 124.10 (s), 121.45 (s), 115.31 (s), 39.55 (s), 33.74 (s), 25.74 (s), 20.26 (s), 9.53 (s). HRMS (ESI): m/z: calcd for [M+H]+ C_{22}H_{24}N_{3}O: 344.1757, found: 344.1760.

\textbf{4bb}
White solid, isolated yield: 61%; $^1$H NMR (400 MHz, CDCl$_3$) δ 10.29 (s, 1H), 8.90 (d, $J = 8.2$ Hz, 1H), 8.75 (d, $J = 4.0$ Hz, 1H), 8.22 (d, $J = 8.7$ Hz, 1H), 7.67 (d, $J = 7.4$ Hz, 1H), 7.63 (d, $J = 8.2$ Hz, 1H), 7.45 – 7.38 (m, 2H), 7.32 (t, $J = 7.4$ Hz, 2H), 3.59 (s, 3H), 2.60 (s, 3H), 1.76 (s, 6H). $^{13}$C NMR (101 MHz, CDCl$_3$) δ 178.99 (s), 168.16 (s), 147.42 (s), 139.34 (s), 136.68 (s), 136.66 (s), 134.97 (s), 134.14 (s), 132.75 (s), 131.37 (s), 130.33 (s), 127.26 (s), 126.12 (s), 126.03 (s), 124.01 (s), 121.31 (s), 115.79 (s), 52.51 (s), 45.85 (s), 27.55 (s), 20.22 (s). HRMS (ESI): m/z: calcd for [M+H]$^+$ C$_{22}$H$_{23}$N$_2$O$_3$: 363.1703, found: 363.1710.

8b

White solid, isolated yield: 93%; $^1$H NMR (400 MHz, CDCl$_3$) δ 10.19 (s, 1H), 8.84 (d, $J = 8.4$ Hz, 1H), 8.79 (d, $J = 3.9$ Hz, 1H), 8.53 (d, $J = 8.5$ Hz, 1H), 7.85 (d, $J = 8.4$ Hz, 1H), 7.68 (d, $J = 7.4$ Hz, 1H), 7.56 (dd, $J = 8.5$, 4.2 Hz, 1H), 7.41 (t, $J = 7.4$ Hz, 1H), 7.33 (t, $J = 7.7$ Hz, 2H), 2.60 (s, 3H). $^{13}$C NMR (101 MHz, CDCl$_3$) δ 168.13 (s), 148.76 (s), 139.29 (s), 136.81 (s), 136.30 (s), 136.00 (s), 134.65 (s), 131.48 (s), 130.93 (s), 130.52 (s), 127.25 (s), 126.07 (s), 126.73 (s), 116.99 (s), 114.50 (s), 20.27 (s). HRMS (ESI): m/z: calcd for [M+H]$^+$ C$_{17}$H$_{14}$BrN$_2$O: 341.0284, found: 341.0274, 343.0248.

9a

White solid, isolated yield: 48%; $^1$H NMR (400 MHz, CDCl$_3$) δ 10.91 (s, 1H), 9.07 (d, $J = 7.9$ Hz, 1H), 8.89 (dd, $J = 4.1$, 1.4 Hz, 1H), 8.15 (dd, $J = 7.8$, 1.5 Hz, 2H), 7.85 (dd, $J = 8.5$, 1.4 Hz, 1H), 7.67 – 7.57 (m, 4H), 7.37 (dd, $J = 8.5$, 4.2 Hz, 1H). $^{13}$C NMR (101 MHz, CDCl$_3$) δ 165.60 (s), 148.34 (s), 138.71 (s), 135.00 (d, $J = 18.4$ Hz), 134.60 (s), 131.99 (s), 130.77 (s), 129.64 (s), 128.88 (s), 127.38 (s), 121.89 (s), 116.09 (s). HRMS (ESI): m/z: calcd for [M+H]$^+$ C$_{32}$H$_{23}$N$_4$O$_2$: 495.1816, found: 495.1828.

9b

White solid, isolated yield: 52%; $^1$H NMR (400 MHz, CDCl$_3$) δ 10.36 (s, 1H), 9.06 (d, $J = 7.9$ Hz, 1H), 8.80 (dd, $J = 4.0$, 1.3 Hz, 1H), 7.83 (dd, $J = 8.5$, 1.3 Hz, 1H), 7.75 (d, $J = 7.5$ Hz, 1H), 7.64 (d, $J = 7.9$ Hz, 1H), 7.44 (t, $J = 7.2$ Hz, 1H), 7.35 (dt, $J = 8.7$, 6.2 Hz, 3H), 2.66 (s, 3H). $^{13}$C NMR (101 MHz, CDCl$_3$) δ 168.33 (s), 148.33 (s), 138.54 (s), 136.79 (s), 136.55 (s), 134.79 (d, $J = 9.4$ Hz), 131.47 (s), 130.85 (s), 20.27 (s).
130.47 (s), 129.57 (s), 127.76 (s), 127.33 (s), 126.10 (s), 121.87 (s), 116.03 (s), 20.31 (s). HRMS (ESI): m/z: caleed for [M+H]+ C34H27N4O2: 523.2129, found: 523.2117.

White solid, isolated yield: 42%; 1H NMR (400 MHz, CDCl3) δ 7.51 (d, J = 8.7 Hz, 2H), 7.32 (t, J = 7.6 Hz, 3H), 7.23 – 7.17 (m, 5H), 1.30 (s, 9H), 1.14 (s, 9H). 13C NMR (101 MHz, CDCl3) δ 179.53 (s), 176.65 (s), 144.54 (s), 140.18 (s), 136.82 (s), 129.02 (d, J = 10.6 Hz), 128.16 (s), 126.78 (s), 120.51 (s), 41.65 (s), 39.63 (s), 29.67 (s), 27.61 (d, J = 6.1 Hz). HRMS (ESI): m/z: caleed for [M+H]+ C22H29N2O2: 353.2224, found: 353.2226.

Pale yellow solid, isolated yield: 85%; 1H NMR (400 MHz, CDCl3) δ 8.80 (dd, J = 10.2, 1.8 Hz, 2H), 7.51 (dd, J = 8.7, 4.2 Hz, 1H), 7.30 (d, J = 8.1 Hz, 1H), 6.85 (d, J = 8.1 Hz, 1H), 5.20 (s, 2H), 1.90 (s, 6H). 13C NMR (101 MHz, CDCl3) δ 148.58 (s), 145.52 (s), 139.28 (s), 136.57 (s), 130.20 (s), 127.24 (s), 125.97 (s), 122.84 (s), 121.14 (s), 113.11 (s), 73.33 (s), 25.70 (s). HRMS (ESI): m/z: caleed for [M+H]+ C13H14N3O: 228.1131, found: 228.1128.

White solid, isolated yield: 82%; 1H NMR (400 MHz, CDCl3) δ 10.03 (s, 1H), 8.84 (d, J = 8.6 Hz, 1H), 8.80 (dd, J = 4.1, 1.4 Hz, 1H), 8.53 (dd, J = 8.5, 1.4 Hz, 1H), 7.66 (d, J = 7.3 Hz, 1H), 7.49 (dd, J = 8.5, 4.2 Hz, 1H), 7.40 (t, J = 7.3 Hz, 1H), 7.32 (t, J = 7.2 Hz, 2H), 7.10 (d, J = 8.5 Hz, 1H), 6.70 (s, 1H), 5.56 (s, 1H), 2.60 (s, 3H), 1.64 (s, 6H). 13C NMR (101 MHz, CDCl3) δ: 180.48 (s), 168.27 (s), 147.85 (s), 139.50 (s), 136.70 (s), 136.46 (s), 134.81 (s), 134.70 (s), 134.04 (s), 131.43 (s), 130.45 (s), 127.27 (s), 126.24 (s), 126.06 (s), 124.70 (s), 121.51 (s), 115.56 (s), 46.45 (s), 27.88 (s), 20.24 (s). HRMS (ESI): m/z: caleed for [M+H]+ C21H22N3O2: 348.1707, found: 348.1705. 13
Pale yellow solid, isolated yield: 90%; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.27 (d, $J = 8.6$ Hz, 2H), 6.71 (d, $J = 8.6$ Hz, 2H), 3.78 (s, 2H), 1.71 (s, 6H). $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$: 146.98 (s), 144.62 (s), 139.17 (s), 132.70 (s), 125.99 (s), 125.29 (s), 124.21 (s), 123.53 (s), 121.23 (s), 108.18 (s), 33.63 (s), 28.92 (s). HRMS (ESI): m/z: calcd for [M+H]$^+$ C$_{13}$H$_{14}$N$_3$: 212.1182, found: 212.1180.
8. $^1$H and $^{13}$C NMR Spectra

2a
2c
4c
4k
9. References

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