

## **Pd (0) nanoparticles: A Novel and Reusable Catalyst for the Synthesis of bis(heterocyclyl)methanes in Water**

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### **SUPPORTING INFORMATION:**

#### **1. Compound 6a**

IR (KBr): 3443, 1672, 1613  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR ( $\text{CDCl}_3$ , 400 MHz):  $\delta$  = 11.46 (s, 1H), 11.23 (s, 1H), 7.16-7.99 (m, 13 H), 6.03 (s, 1H); ESI- MS:  $m/z$  413  $[\text{M} + \text{H}]^+$ . Anal. Calcd for  $\text{C}_{25}\text{H}_{16}\text{O}_6$ : C, 72.81; H, 3.91. Found: C, 72.92; H, 4.05.

#### **2. Compound 6b**

IR (KBr): 3441, 1659, 1613  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR ( $\text{CDCl}_3$ , 400 MHz):  $\delta$  = 11.50 (s, 1H), 11.46 (s, 1H), 7.33-7.62 (m, 8 H), 7.93-8.13 (m, 4H), 6.05 (s, 1H); ESI- MS:  $m/z$  458  $[\text{M} + \text{H}]^+$ . Anal. Calcd for  $\text{C}_{25}\text{H}_{15}\text{NO}_8$ : C, 65.65; H, 3.31; N, 3.06. Found: C, 65.60; H, 3.20; N, 3.16.

#### **3. Compound 6c**

IR (KBr): 3416, 1672, 1613  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR ( $\text{CDCl}_3$ , 400 MHz):  $\delta$  = 11.44 (s, 1H), 11.22 (s, 1H), 6.99-7.99 (m, 12H), 5.99 (s, 1H), 2.26 (s, 3H). ESI- MS:  $m/z$  427  $[\text{M} + \text{H}]^+$ . Anal. Calcd for  $\text{C}_{26}\text{H}_{18}\text{O}_6$ : C, 73.23; H, 4.25. Found: C, 73.03; H, 4.39.

#### **4. Compound 6d**

IR (KBr): 3469, 1666, 1613  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR ( $\text{CDCl}_3$ , 400 MHz):  $\delta$  = 11.44 (s, 1H), 11.22 (s, 22), 6.77-7.98 (m, 12H), 5.97 (s, 1H), 3.72 (s, 3H); ESI- MS:  $m/z$  443  $[\text{M} + \text{H}]^+$ . Anal. Calcd for  $\text{C}_{26}\text{H}_{18}\text{O}_7$ : C, 70.58; H, 4.10. Found: C, 70.39; H, 4.07.

#### **5. Compound 6e**

IR (KBr): 3465, 1666, 1619  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR ( $\text{CDCl}_3$ , 400 MHz):  $\delta$  = 11.47 (s, 1H), 11.25 (s, 1H), 7.02- 8.01 (m, 12H), 5.94 (s, 1H); ESI- MS:  $m/z$  491, 493  $[\text{M} + \text{H}]^+$ . Anal. Calcd for  $\text{C}_{25}\text{H}_{15}\text{BrO}_6$ : C, 61.12; H, 3.08. Found: C, 60.94; H, 3.20.

#### **6. Compound 7a**

IR (KBr): 3403, 2925, 1639  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  5.81 (s, 1H), 6.57 (s, 2H), 6.94 (t, 2H,  $J = 7.6$  Hz), 7.32-7.07 (m, 9H), 7.83 (br, s, 2H).  $^{13}\text{C}$  (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  40.2, 111.1, 119.2, 119.6, 119.9, 121.9, 123.7, 126.2, 127.0, 128.3, 128.7, 136.6, 144.0. ESI-MS:  $m/z$  323  $[\text{M} + \text{H}]^+$ . Anal calcd for  $\text{C}_{23}\text{H}_{18}\text{N}_2$ : C, 85.68, H, 5.63; N, 8.69. Found: C, 85.57; H, 5.51; N, 8.52.

### 7. Compound 7b

IR (KBr): 3416, 2925, 1613  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  2.24 (s, 3H), 5.76 (s, 1H), 6.86 (s, 2H), 6.93 (t, 2H,  $J = 7.4$  Hz), 7.27-6.99 (m, 8H), 7.32 (br, s, 2H). ESI-MS:  $m/z$  337  $[\text{M} + \text{H}]^+$ . Anal calcd for  $\text{C}_{24}\text{H}_{20}\text{N}_2$ : C, 85.68, H, 5.99, N, 8.33. Found: 85.88; H, 5.85; N, 8.24.

### 8. Compound 7c

IR (KBr): 3443, 2925, 1593  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  5.92 (s, 1H), 6.61 (s, 2H), 6.97 (t, 2H,  $J = 7.4$  Hz), 8.08-7.11 (m, 9H), 8.34 (d, 2H,  $J = 8.4$  Hz). ESI-MS:  $m/z$  368  $[\text{M} + \text{H}]^+$ . Anal calcd for  $\text{C}_{23}\text{H}_{17}\text{N}_3\text{O}_2$ : C, 75.19; H, 4.66; N, 11.44. Found: C, 74.91; H, 4.61; N, 11.15.

### 9. Compound 7d

IR (KBr): 3409, 2925, 1600  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  5.79 (s, 1H), 6.95-6.86 (m, 2H), 7.12 (t, 2H,  $J = 7.8$  Hz), 7.30-7.18 (m, 8H), 7.85 (br, s, 2H). ESI-MS:  $m/z$  341  $[\text{M} + \text{H}]^+$ . Anal calcd for  $\text{C}_{23}\text{H}_{17}\text{FN}_2$ : C, 81.16; H, 5.03, N, 8.23. Found: C, 81.34; H, 4.91; N, 8.39.

### 10. Compound 7e

IR (KBr): 3429, 2925, 1633  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  5.74 (s, 1H), 6.44 (s, 2H), 6.85 (t, 2H,  $J = 7.4$  Hz), 7.65-6.98 (m, 8H), 7.79 (br, s, 2H). ESI-MS:  $m/z$  348  $[\text{M} + \text{H}]^+$ . Anal calcd for  $\text{C}_{24}\text{H}_{17}\text{N}_3$ : C, 82.97; H, 4.93; N, 12.10. Found: C, 82.71; H, 5.09; N, 12.19.

### 11. Compound 7f

IR (KBr):  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  5.72 (s, 1H), 6.45 (s, 2H), 6.90 (t, 2H,  $J = 7.4$  Hz), 7.05-7.27 (m, 8H), 7.80 (br, s, 2H). ESI-MS:  $m/z$  401, 403  $[\text{M} + \text{H}]^+$ . Anal calcd for  $\text{C}_{23}\text{H}_{17}\text{BrN}_2$ : C, 68.84; H, 4.27; N, 6.98. Found: 68.76; H, 4.33; N, 6.81.

### 12. Compound 7g

IR (KBr): 3476, 2866, 1600  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  5.78 (s, 1H), 6.56 (s, 1H), 6.93 (t, 2H,  $J = 7.6$  Hz), 7.87 (br, s, 2H). ESI-MS:  $m/z$  357, 359  $[\text{M} + \text{H}]^+$ . Anal calcd for  $\text{C}_{23}\text{H}_{17}\text{ClN}_2$ : C, 77.41; H, 4.80; N, 7.85. Found: C, 77.68; H, 4.96; N, 7.94.

### 13. Compound 7h

IR (KBr): 3409, 2932, 1739  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$  +  $\text{DMSO-d}_6$ ):  $\delta$  7.31-6.54 (m, 14H), 7.44 (s, 1H), 8.13 - 7.63 (m, 3H), 9.73 (s, 2H). ESI-MS:  $m/z$  373  $[\text{M} + \text{H}]^+$ . Anal calcd for  $\text{C}_{27}\text{H}_{20}\text{N}_2$ : C, 87.07; H, 5.41; N, 7.52. Found: C, 87.10; H, 5.52; N, 7.45.

### 14. Compound 8a

IR (KBr): 3432, 2962, 1592  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  = 11.91 (s, 1H), 7.28-7.08 (m, 5H), 5.54 (s, 1H), 2.48-2.29 (m, 8H), 1.23 (s, 6H), 1.10 (s, 6H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  = 190.5, 189.4, 138.0, 128.2, 126.7, 125.8, 115.5, 47.0, 46.4, 32.7, 31.4, 29.6, 27.3; ESI- MS:  $m/z$  369  $[\text{M} + \text{H}]^+$ . Anal. Calcd for  $\text{C}_{23}\text{H}_{28}\text{O}_4$ : C, 74.97; H, 7.66. Found: C, 74.92; H, 7.73.

### 15. Compound 8b

IR (KBr): 3447, 2959, 1604  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  = 11.93 (s, 1H), 7.01 (d,  $J$  = 8.4 Hz, 2H), 6.82 (d,  $J$  = 8.8 Hz, 2H), 5.49 (s, 1H), 3.78 (s, 3H), 2.48-2.29 (m, 8H), 1.23 (s, 6H), 1.10 (s, 6H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  = 190.4, 189.3, 157.5, 129.8, 127.7, 115.7, 113.6, 55.2, 47.0, 46.4, 32.0, 31.3, 29.6, 27.3; ESI- MS:  $m/z$  399  $[\text{M} + \text{H}]^+$ . Anal. Calcd for  $\text{C}_{24}\text{H}_{30}\text{O}_5$ : C, 72.34; H, 7.59. Found: C, 72.13; H, 7.65.

### 16. Compound 8c

IR (KBr): 3410, 2960, 1593  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  = 11.87 (s, 1H), 8.05-8.00 (m, 2H), 7.46-7.40 (m, 2H), 5.54 (s, 1H) 2.52-2.31 (m, 8H), 1.27 (s, 6H), 1.12 (s, 6H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  = 191.1, 189.6, 148.3, 140.6, 132.8, 129.0, 122.2, 121.0, 114.7, 46.9, 46.4, 32.8, 31.4, 29.6, 27.2; ESI-MS:  $m/z$  414  $[\text{M} + \text{H}]^+$ . Anal. Calcd for  $\text{C}_{23}\text{H}_{27}\text{NO}_6$ : C, 66.81; H, 6.58; N, 3.39 Found: C, 66.97; H, 6.37; N, 3.62.

### 17. Compound 8d

IR (KBr): 3432, 2962, 1592  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  = 11.92 (s, 1H), 7.08-6.96 (m, 4H), 5.51 (s, 1H), 2.51-2.32 (m, 8H), 1.25 (s, 6H), 1.13 (s, 6H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  = 190.5, 189.4, 162.2, 159.8, 133.6, 128.2, 115.5, 115.1, 114.9, 47.0, 46.4, 32.2, 31.4, 29.6, 27.3; ESI- MS:  $m/z$  387  $[\text{M} + \text{H}]^+$ . Anal. Calcd for  $\text{C}_{23}\text{H}_{27}\text{FO}_4$ : C, 71.48; H, 7.04. Found: C, 71.56; H, 7.16.

### 18. Compound 8e

IR (KBr): 3435, 2957, 1596  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  = 11.88 (s, 1H), 7.38 (d,  $J$  = 8.0 Hz, 2H), 6.96 (d,  $J$  = 8.4 Hz, 2H), 5.44 (s, 1H), 2.48-2.28 (m, 8H), 1.21 (s, 6H), 1.10 (s, 6H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  = 190.6, 189.4, 137.2, 131.2, 128.6, 119.6, 115.2, 47.0, 46.4,

32.4, 31.4, 29.6, 27.4; ESI-MS:  $m/z$  447, 449  $[M + H]^+$ . Anal. Calcd for  $C_{23}H_{27}BrO_4$ : C, 61.75; H, 6.08. Found: C, 61.65; H, 6.34.

### 19. Compound 8f

IR (KBr): 3384, 2956, 1608  $cm^{-1}$ .  $^1H$  NMR (400 MHz,  $CDCl_3$ ):  $\delta$  = 11.62 (s, 1H), 7.56-7.24 (m, 4H), 6.04 (s, 1H), 2.52-2.02 (m, 8H), 2.18 (s, 3H), 1.16 (s, 6H), 1.02 (s, 6H).  $^{13}C$  NMR (100 MHz,  $CDCl_3$ ):  $\delta$  = 190.6, 189.4, 136.7, 131.5, 128.3, 128.2, 115.3, 47.0, 46.4, 32.3, 31.4, 29.6, 27.4; ESI- MS:  $m/z$  383  $[M + H]^+$ . Anal. Calcd for  $C_{24}H_{30}O_4$ : C, 75.36; H, 7.91. Found: C, 75.61; H, 8.13.

### 20. Compound 8g

IR (KBr): 3439, 2963, 1594  $cm^{-1}$ .  $^1H$  NMR (400 MHz,  $CDCl_3$ ):  $\delta$  = 11.80 (s, 1H), 7.57 (d,  $J$  = 8.4 Hz, 2H), 7.20 (d,  $J$  = 8.4 Hz, 2H), 5.52 (s, 1H), 2.50-2.30 (m, 8H), 1.22 (s, 6H), 1.11 (s, 6H).  $^{13}C$  NMR (100 MHz,  $CDCl_3$ ):  $\delta$  190.9, 190.6, 189.5, 144.3, 132.9, 132.0, 129.8, 127.6, 118.9, 114.8, 109.6, 46.9, 46.4, 33.2, 31.4, 29.5, 27.4; ESI- MS:  $m/z$  394  $[M + H]^+$ . Anal. Calcd for  $C_{24}H_{27}NO_4$ : C, 73.26; H, 6.92; N, 3.56. Found: C, 73.14; H, 6.95; N, 3.69.

### 21. Compound 8h

IR (KBr): 3431, 2952, 1596  $cm^{-1}$ .  $^1H$  NMR (400 MHz,  $CDCl_3$ ):  $\delta$  = 11.92 (s, 1H), 7.22-6.96 (m, 4H), 5.49 (s, 1H), 2.50-2.30 (m, 8H), 1.23 (s, 6H), 1.10 (s, 6H).  $^{13}C$  NMR (100 MHz,  $CDCl_3$ ):  $\delta$  = 190.6, 189.4, 140.4, 134.1, 129.4, 127.1, 126.0, 124.9, 115.1, 47.0, 46.3, 32.6, 31.4, 29.5, 27.3; ESI- MS:  $m/z$  403, 405  $[M + H]^+$ . Anal. Calcd for  $C_{23}H_{27}ClO_4$ : C, 68.56; H, 6.75. Found: C, 68.43; H, 6.66.

### 22. Compound 8i

IR (KBr): 3434, 2959, 1601  $cm^{-1}$ .  $^1H$  NMR (400 MHz,  $CDCl_3$ ):  $\delta$  = 11.95 (s, 1H), 6.95 (d,  $J$  = 8.4 Hz, 2H), 6.67 (d,  $J$  = 8.4 Hz, 2H), 5.47 (s, 1H), 2.89 (s, 6H), 2.46-2.28 (m, 8H), 1.22 (s, 6H), 1.09 (s, 6H).  $^{13}C$  NMR (100 MHz,  $CDCl_3$ ):  $\delta$  = 190.2, 189.3, 148.7, 127.4, 125.5, 115.9, 112.6, 47.0, 46.4, 40.7, 31.8, 31.3, 29.7, 27.3; ESI- MS:  $m/z$  412  $[M + H]^+$ . Anal. Calcd for  $C_{25}H_{33}NO_4$ : C, 72.96; H, 8.08; N, 3.40. Found: C, 73.20; H, 8.36; N, 3.36.

### 23. Compound 8j

IR (KBr): 3430, 2960, 1602  $cm^{-1}$ .  $^1H$  NMR (400 MHz,  $CDCl_3$ ):  $\delta$  = 11.91 (s, 1H), 7.08 (d,  $J$  = 8.0 Hz, 2H), 6.98 (d,  $J$  = 8.0 Hz, 2H), 5.49 (s, 1H), 2.47-2.32 (m, 8H), 2.29 (s, 3H), 1.22 (s, 6H), 1.09 (s, 6H).  $^{13}C$  NMR (100 MHz,  $CDCl_3$ ):  $\delta$  = 190.4, 189.3, 135.2, 134.9, 128.9, 126.6, 115.7, 47.0, 46.4, 32.4, 31.4, 29.6, 27.3, 20.9; ESI- MS:  $m/z$  383  $[M + H]^+$ . Anal. Calcd for  $C_{24}H_{30}O_4$ : C, 75.36; H, 7.91. Found: C, 75.41; H, 7.95.

#### 24. Compound 8k

IR (KBr): 3447, 2959, 1593  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  11.85 (s, 1H), 8.18 (d,  $J = 8.8$  Hz, 2H), 7.28 (d,  $J = 8.0$  Hz, 2H), 5.57 (s, 1H), 2.54-2.34 (m, 8H), 1.26 (s, 6H), 1.14 (s, 6H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  190.9, 189.5, 146.5, 146.0, 127.6, 123.5, 114.9, 46.9, 46.4, 33.2, 31.4, 29.5, 27.4; ESI- MS:  $m/z$  414  $[\text{M} + \text{H}]^+$ . Anal. Calcd for  $\text{C}_{23}\text{H}_{27}\text{NO}_6$ : C, 66.81; H, 6.58; N, 3.39. Found: C, 66.58; H, 6.44; N, 3.60.

#### 25. Compound 8l

IR (KBr): 3446, 2957, 1594  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  = 11.87 (s, 1H), 7.23 (d,  $J = 8.4$  Hz, 2H), 7.02 (d,  $J = 8.0$  Hz, 2H), 5.47 (s, 1H), 2.48-2.28 (m, 8H), 1.21 (s, 6H), 1.09 (s, 6H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  = 190.6, 189.4, 136.7, 131.5, 128.3, 128.2, 115.3, 47.0, 46.4, 32.3, 31.4, 29.6, 27.4; ESI- MS:  $m/z$  403, 405  $[\text{M} + \text{H}]^+$ . Anal. Calcd for  $\text{C}_{23}\text{H}_{27}\text{ClO}_4$ : C, 68.56; H, 6.75. Found: C, 68.81; H, 6.97.

#### 26. Compound 9a

IR (KBr): 3450, 2925, 1600  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR ( $\text{CDCl}_3 + \text{DMSO-d}_6$ , 400 MHz):  $\delta$  = 2.26 (s, 6H), 4.84 (s, 1H), 7.09-7.39 (m, 11H), 7.66 (d,  $J = 8.0$  Hz, 4H), 13.38 (brs, 2H). ESI-MS  $m/z$  437  $[\text{M} + \text{H}]^+$ . Anal calcd for  $\text{C}_{27}\text{H}_{24}\text{N}_4\text{O}_2$ : C, 74.29; H, 5.54; N, 12.84. Found: C, 74.18; H, 5.42; N, 12.67.

#### 27. Compound 9b

IR (KBr): 3489, 2925, 1593  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR ( $\text{CDCl}_3 + \text{DMSO-d}_6$ , 400 MHz):  $\delta$  = 2.30 (s, 6H), 5.16 (s, 1H), 7.03-7.17 (m, 7H), 7.66 (d,  $J = 8.0$  Hz, 5H), 7.89 (d,  $J = 7.6$  Hz, 2H), 13.56 (brs, 2H). ESI-MS  $m/z$  471, 473  $[\text{M} + \text{H}]^+$ . Anal calcd for  $\text{C}_{27}\text{H}_{23}\text{ClN}_4\text{O}_2$ : C, 68.86; H, 4.92; N, 11.90. Found: C, 69.09; H, 4.82; N, 11.72.

#### 28. Compound 9c

IR (KBr): 3476, 2919, 1600  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR ( $\text{CDCl}_3 + \text{DMSO-d}_6$ , 400 MHz):  $\delta$  = 2.29 (s, 6H), 4.82 (s, 1H), 6.87 (t,  $J = 8.6$  Hz, 2H), 7.11-7.40 (m, 12H), 13.45 (brs, 2H). ESI-MS  $m/z$  455  $[\text{M} + \text{H}]^+$ . Anal calcd for  $\text{C}_{27}\text{H}_{23}\text{FN}_4\text{O}_2$ : C, 71.35; H, 5.10; N, 12.33. Found: C, 71.14; H, 5.27; N, 12.39.

#### 29. Compound 9d

IR (KBr): 3416, 2925, 1600  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR ( $\text{CDCl}_3 + \text{DMSO-d}_6$ , 400 MHz):  $\delta = 2.29$  (s, 6H), 4.88 (s, 1H), 7.12-7.12 (m, 2H), 7.31 (t,  $J = 7.8$  Hz, 4H), 7.42 (d,  $J = 8.4$  Hz, 2H), 7.66 (d,  $J = 7.6$  Hz, 4H), 8.05 (d,  $J = 8.4$  Hz, 2H) 13.26 (brs, 2H). ESI-MS  $m/z$  482  $[\text{M} + \text{H}]^+$ . Anal calcd for  $\text{C}_{27}\text{H}_{23}\text{N}_5\text{O}_4$ : C, 67.35; H, 4.81; N, 14.54. Found: C, 67.07; H, 4.76; N, 14.14.

### 30. Compound 9e

IR (KBr): 3390, 2925, 1600  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR ( $\text{CDCl}_3 + \text{DMSO-d}_6$ , 400 MHz):  $\delta = 2.30$  (s, 6H), 4.92 (s, 1H), 7.17-7.25 (m, 4H), 7.40-7.46 (m, 6H), 7.69 (d,  $J = 8.0$  Hz, 4H) 13.89 (brs, 2H). ESI-MS  $m/z$  515, 517  $[\text{M} + \text{H}]^+$ . Anal calcd for  $\text{C}_{27}\text{H}_{23}\text{BrN}_4\text{O}_2$ : C, 62.92; H, 4.50; N, 10.87. Found: C, 63.10; H, 4.38; N, 11.03.

### 31. Compound 9f

IR (KBr): 3400, 2932, 1593  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR ( $\text{CDCl}_3 + \text{DMSO-d}_6$ , 400 MHz):  $\delta = 2.27$  (s, 6H), 4.80 (s, 1H), 7.10-7.18 (m, 6H), 7.28-7.32 (m, 4H), 7.66 (d,  $J = 7.6$  Hz, 2H), 13.35 (brs, 2H). ESI-MS  $m/z$  471, 473  $[\text{M} + \text{H}]^+$ . Anal calcd for  $\text{C}_{27}\text{H}_{23}\text{ClN}_4\text{O}_2$ : C, 68.86; H, 4.92; N, 11.90. Found: C, 68.94; H, 4.95; N, 11.92.

### 32. Compound 9g

IR (KBr): 3396, 2932, 1593  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR ( $\text{CDCl}_3 + \text{DMSO-d}_6$ , 400 MHz):  $\delta = 1.95$  (s, 6H), 2.17 (s, 3H), 4.61 (s, 1H), 6.93-7.00 (m, 6H), 7.12-7.18 (m, 4H), 7.45 (d,  $J = 7.6$  Hz, 2H). ESI-MS  $m/z$  451  $[\text{M} + \text{H}]^+$ . Anal calcd for  $\text{C}_{28}\text{H}_{26}\text{N}_4\text{O}_2$ : C, 74.65; H, 5.82; N, 12.44. Found: C, 74.60; H, 5.93; N, 12.32.