Synthesis and Reactivity of 2,3-Dihydro-1H-2,3-benzodiazepine-1,4(5H)-dione

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Abstract: Based on an orthogonal protective group strategy dealing with N-protected hydrazine, we established for the first time a highly efficient synthetic pathway leading to 2,3-benzodiazepine-1,4-dione. Moreover, the versatile reactivities exhibited by this 2,3-benzodiazepine-1,4-dione were evaluated towards both benzylation and amination reactions.

Key words: benzodiazepine, hydrazine, amides, aminations, bicyclic compounds

During the course of our investigations dealing with pyridazine-3,6-dione and phthalazine-1,4-dione scaffolds, extensive work has been done focusing on the regio- and chemoselective functionalization of the amide functions to provide either amidines through nucleophilic substitution or iminomethyl groups through palladium-catalyzed reactions.1 Most of the synthesized compounds, derived from the six-membered azine ring, were found pharmacologically active on various targets (receptors or enzymes) involved in pathologies such as Alzheimer’s disease or pain.2 In our quest of new bioactive compounds, we focused our research on design, synthesis, and functionalization of the 2,3-benzodiazepine (2,3-BZD) scaffold, as a seven-membered-ring homologue of the 2,3-phthalazine scaffold, and consequently report here a new convenient route to the 2,3-BZD-1,4-dione (I) (Figure 1). Moreover, the reactivity of this new scaffold toward both amination and benzylaion reactions was examined.

Figure 1 2,3-Dihydro-1H-benzodiazepine-1,4(5H)-dione (I)

A unique example of the 2,3-BZD-1,4-dione (I) synthesis was reported in 1944, when Whitmore and Cooney claimed that the reaction of homophthalic anhydride with hydrazine hydrate in boiling ethanol led to the 2,3-benzodiazepine-1,4-dione.3 However, this result was later disproved by several reports in which, using the same experimental conditions, only the N-aminoisoquinoline-1,3-dione (3) was isolated.4 It appeared that the amine function did not trigger the expected seven-membered-ring cyclization, which may be explained by the syn-position of the amine function toward the oxygen atom of the amide function. Consequently, it seemed critical to use a substituted hydrazine in order to modify the spatial position of the amine group toward the amide function. In agreement with this hypothesis, the synthesis of 2,3-dimethyl-2,3-BZD-1,4-dione was reported by Rosen et al., who used the 1,2-dimethylhydrazine to perform the cyclization.1 However, the main limitation of this procedure was the impossibility to remove the alkyl groups of the resulting 2,3-dimethyl-2,3-BZD-1,4-dione. So, we chose to develop an orthogonal protective group strategy in which the first amine function of hy-
drazine was protected by a Boc group, whereas the second amine function was protected either by a nosyl moiety (4) or by a benzyl group (6) (Scheme 2). Both benzyl and nosyl protections afford a satisfactory nucleophilic character of the protected amine allowing the coupling reaction with the carboxylic acid derivative 1,6 to obtain the compounds 7a and 7b in 63 and 85% yield, respectively (Scheme 3). A trifluoroacetic acid treatment led to the cleavage of the Boc group which was followed by a spontaneous cyclization step to provide the 2,3-BZD-1,4-diones 8a and 8b in 88% and 92% yield, respectively. The cleavage of the benzyl moiety was performed by hydrogenolysis using palladium chloride as catalyst. However, the deprotection remained incomplete after a reaction time of 24 hours and the expected 2,3-BZD-1,4-dione (I) was obtained in a poor 26% yield. On the contrary, the cleavage of the nosyl moiety was easily performed in mild conditions by treatment of 8b with thiophenol under basic conditions, leading to the unsubstituted 2,3-BZD-1,4-dione (I) in 76% yield.

![Scheme 2 Reagents and conditions: (i) NsCl, K₂CO₃, r.t., 1 h; (ii) PhCHO, THF, r.t., 1 h; (iii) H₂ (60 psi), Pd/C, MeOH, 2 h.](image)

We next focused our study on the reactivity of this 2,3-BZD-1,4-dione (I) towards the benzylation of the amide function and its conversion into an amidine. A standard benzylation using benzyl bromide was performed in the presence of NaH in DMF, leading to a mixture of three compounds: monobenzylated derivatives (2-benzyl 8a and 3-benzyl 9) were both isolated in 22% yield, whereas the 2,3-dibenzylated compound 10 was isolated in 56% yield (Table 1). The same results were obtained with K₂CO₃ in DMF. However, no benzylation was detected under Mitsunobu conditions. Considering the fact that 8a and 9 were obtained in the same yield, we can assume that both amide groups of 2,3-BZD-1,4-dione (I) exhibit an equal nucleophilicity toward this benzylation reaction, despite the difference between benzamide and phenylacetamide moieties. Moreover, the dibenzyalted compound 10 was obtained in the highest yield (56%), highlighting the fact that as soon as one of the amide functions was benzyalted, the nucleophilicity of the second one was increased. Consequently, it appears very difficult to regioselectively alkylate a single amide group of compound I. Among the alternatives, an initial alkylation of Boc-hydrazine would lead to the corresponding 2-alkyl-2,3-BZD-1,4-dione, while the alkylation of the compound 8b, followed by nosyl deprotection, would provide the corresponding 3-alkyl-2,3-BZD-1,4-dione.

![Scheme 3 Reagents and conditions: (i) MeOH, H₂SO₄ (cat), Δ; (ii) 4 or 6, HBTU, DIPEA, DMF, r.t., 12 h; (iii) TFA, CH₂Cl₂, 1 h, r.t.; (iv) H₂ (60 psi), PdCl₂, AcOH, EnOAc, r.t., 12 h; (v) PhSH, Cs₂CO₃, DMF, r.t., 3 h.](image)

**Table 1** Benzylation of the 2,3-Benzodiazepine-1,4-dione (I)

<table>
<thead>
<tr>
<th>Benzylation reagent</th>
<th>Equiv</th>
<th>Conditions</th>
<th>T (°C)</th>
<th>Time (h)</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>BnBr</td>
<td>1</td>
<td>NaH, DMF</td>
<td>0</td>
<td>1</td>
<td>8a 22 22 56</td>
</tr>
<tr>
<td>BnBr</td>
<td>2</td>
<td>NaH, DMF</td>
<td>0</td>
<td>1</td>
<td>9 - - -</td>
</tr>
<tr>
<td>BnBr</td>
<td>1</td>
<td>K₂CO₃, DMF</td>
<td>r.t.</td>
<td>24</td>
<td>10 20 53</td>
</tr>
<tr>
<td>BnOH</td>
<td>1</td>
<td>DIAD, Ph₃P</td>
<td>r.t.</td>
<td>24</td>
<td>- - - - -</td>
</tr>
</tbody>
</table>

*a* Not detected.
The cyclic amidine represents an important functional group in medicinal chemistry and can be found in many FDA-approved drugs (i.e., clozapine). The most common and convergent strategies for amidine synthesis are based on substitution by an amine of an activated amide intermediate such as imidoyl chloride or O-triflated imidate. Unfortunately, our initial attempts to activate the amide functions of 2,3-BZD-1,4-dione (I) failed. Indeed, along with the fact there is a putative competition between both amides, the main problem was the lack of solubility of the compound I, especially in solvents such as THF, MeCN, or pyridine which are commonly used in this field. Several attempts under acidic conditions (POCl₃) failed, most of them led to degradation. Even the milder procedure using N,N-dimethyl-p-toluidine base in order to stabilize the imidoyl chloride, was performed without success. Under basic conditions, a multivariate screening analysis of the following variables was performed: solvent (THF, pyridine, MeCN, DMF), temperature, and nature of the electrophile (Tf₂O, TosCl, anhydride, etc.), but in most of the cases, the solubility was an issue. In order to bypass this parameter, we applied the multivariate screening analysis on the 2-benzyl-2,3-BZD-1,4-dione (8a), in which the amide at the 1-position is protected by a benzyl moiety. In most of the cases, no reaction was observed. However, under tosylation conditions (TsCl, NaH, DMF), the corresponding N-tosylated compound 11 was obtained in 67% yield, while no O-tosylation was detected (Scheme 4). This lack of reactivity of the carbonyl groups appeared to be the same as for the benzylation reactions, in which no O-benzylated compound was obtained.

![Scheme 4](image)

We recently published an efficient microwave-assisted cyclic amidine synthesis using TiCl₄. This conversion of an amide into the corresponding amidine involves a two-step one-pot reaction. At first, the amide function interacts with the activated titanium complex to form an imidotitanium adduct, which can be displaced by an amine moiety to yield the corresponding amidine. The microwave-assisted amination of I was performed in the presence of 1.2 equivalents of TiCl₄ along with 10 equivalents of a primary amine (2-piperidin-1-ylethylamine, cyclohexylamine) or 30 equivalents of a secondary amine (N-methylpiperazine, piperidine, morpholine) at 100 °C for 30 minutes (Table 2). A regioselective amination was observed leading to the amidines 12a-e. The amination site at the 4-position was fully characterized by nuclear Overhauser effect (NOE) contact between the methylene group at the 5-position and the protons assignable to methylenes at the α-position of the amine moiety. 

<table>
<thead>
<tr>
<th>Amine (RH)</th>
<th>Equiv</th>
<th>Product</th>
<th>Yield (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NHNHO₂H₂</td>
<td>30</td>
<td>12a</td>
<td>53</td>
</tr>
<tr>
<td>NHNHO₂H₂</td>
<td>30</td>
<td>12b</td>
<td>49</td>
</tr>
<tr>
<td>NH</td>
<td>30</td>
<td>12c</td>
<td>50</td>
</tr>
<tr>
<td>NH</td>
<td>10</td>
<td>12d</td>
<td>53</td>
</tr>
<tr>
<td>MeO-NHNH₂</td>
<td>10</td>
<td>12e</td>
<td>51</td>
</tr>
</tbody>
</table>

All anhydrous reactions were carried avoiding moisture by standard procedures under argon. Commercially available reagents were used as received. The solvents were dried by distillation over the appropriate drying agents. Reactions were monitored by TLC inspection on silica gel GF₂₅₄ plates. Column chromatography was generally performed on silica gel (200–300 mesh). All solvent ratios are given as v/v. ¹H, ¹³C NMR spectra, and NOE experiments were recorded on a Bruker DPX 200 MHz or a Bruker Avance 300 spectrometer. The chemical shifts (δ) are reported in ppm and coupling constants (J) in Hz. High-resolution mass spectra (HRMS) and mass spectra (MS) were obtained from a MALDI-TOF and an Agilent 1200XL mass spectrometer, respectively. Melting Points were measured on a Büchi Melting-Point B-540 apparatus. All the microwave reactions were performed with a self-tunable microwave synthesizer (Biotage Initiator EXP microwave apparatus).
The instrument continuously adjusted the wattage automatically to maintain the desired temperature.

3-Methoxyisocoumarine (2)\(^1\)

To a solution of 2-(2-methoxy-2-oxoethyl)benzoic acid (1; 200 mg, 1.03 mmol) in degassed anhyd CH\(_2\)Cl\(_2\) (5 mL) at 0 °C was added HBTU (2.15 g, 5.67 mmol) and Et\(_3\)N (1.40 mL, 10.31 mmol). The mixture was stirred for 1 h at r.t. and concentrated in vacuo. The residue was partitioned between EtOAc (20 mL) and aq sat. NaHCO\(_3\), and evaporated in vacuo to yield 2 as a colorless solid (75 mg, 96%).

\(^{1}\)H NMR (CDCl\(_3\), 300 MHz): \(\delta = 8.16 \) (d, \( J = 7.8\) Hz, 1 H, Ar), 7.59 (ddd, \( J = 7.6, 7.6, 7.8\) Hz, 1 H, Ar), 7.48 (dd, \( J = 7.6, 7.6\) Hz, 1 H, Ar), 7.39 (d, \( J = 7.6\) Hz, 1 H, Ar), 5.53 (s, 2 H, NH\(_2\)), 4.21 (s, 2 H, CH\(_2\)).

\(^{13}\)C NMR (CDCl\(_3\), 75 MHz): \(\delta = 161.5, 160.1, 140.2, 135.4, 134.0, 125.8, 125.0, 117.7, 79.2, 56.4\).

MS (ES\(^+\)): \(m/z = 277 + [M + H]^+\).

2-Aminoisoquinoline-1,3(2H,4H)-dione (3)\(^4\)

To a solution of hydrazine hydrate (153 mg, 149 mL, 1.08 mmol) in anhyd DMF (20 mL) were added HBTU (2.15 g, 5.67 mmol) and Et\(_3\)N (1.40 mL, 10.31 mmol). The mixture was stirred for 10 min at r.t. and concentrated in vacuo. The resulting crude 3 was filtered and dried at reduced pressure to yield 3 as a yellow oil (2.12 g, 85%).

\(^{1}\)H NMR (CDCl\(_3\), 300 MHz): \(\delta = 8.39 \) (d, \( J = 9.1\) Hz, 2 H, Ar), 8.40 (d, \( J = 9.1\) Hz, 2 H, Ar), 7.75 (s, 1 H, NH), 7.38–7.32 (m, 3 H, CH\(_2\)), 3.92 (s, 2 H, CH\(_2\)), 1.42 (s, 9 H, t-C\(_4\)H\(_9\)).

\(^{13}\)C NMR (CDCl\(_3\), 75 MHz): \(\delta = 172.5, 170.7, 153.4, 150.6, 143.2, 133.5, 130.9, 130.7, 126.5, 124.7, 124.3, 82.6, 52.3, 37.4, 27.7\).

ESI-HRMS: \(m/z\) calc for C\(_{11}\)H\(_{14}\)N\(_3\)O\(_6\)S: [M – H]–: 316.0538; found: 316.0537.

Cleavage of Boc Protected 7a,b and Cyclization to 8a,b; General Procedure

To a solution of 7a or 7b (3.26 mmol) in anhyd CH\(_2\)Cl\(_2\) (10 mL) was added trifluoroacetic acid (10 mL). The mixture was stirred for 1 h at r.t. and concentrated in vacuo. Et\(_2\)O (5 mL) was added and sonication of the resulting solution for 60 s afforded a white solid which was filtered and dried at reduced pressure to yield 8a or 8b as white powders.

2-Benzyl-2,3-dihydro-5H-2,3-benzodiazepine-1,4-dione (8a)
Yield: 764 mg (88%); mp 143 °C.

2-(4-Nitrobenzenesulfonyl)-2,3-dihydro-5H-2,3-benzodiazepine-1,4-dione (8b)
Yield: 1.08 g (92%); mp 241 °C.

2-(4-Nitrobenzenesulfonyl)-2,3-dihydro-5H-2,3-benzodiazepine-1,4-dione (8b) By Cleavage of the Nosyl Group

ESI-HRMS: \(m/z\) calc for C\(_{16}\)H\(_{12}\)N\(_2\)O\(_3\)S\(_2\)Na [M + Na\(^+\)]: 492.0892; found: 492.0890.

2-(4-Nitrobenzenesulfonyl)-2,3-dihydro-5H-2,3-benzodiazepine-1,4-dione (8b) By Cleavage of the Nosyl Group: To a solution of 8b (1.00 g, 2.77 mmol) in anhyd DMF (5 mL) were added Cs\(_2\)CO\(_3\) (2.70 g, 8.31 mmol) and thiophenol (311 mL, 3.05 mmol). The mixture was stirred for 3 h at r.t., and concentrated in vacuo. The resulting crude product was dissolved in a solution of 5% MeOH in CH\(_2\)Cl\(_2\), filtered

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and purified by chromatography on silica gel (5% MeOH in CH₂Cl₂ + 1% AcOEt) to yield I as a white powder (370 mg, 76%).

**By Cleavage of the Benzyl Group:** To a solution of 8a (40 mg, 0.15 mmol) in EtOAc (4 mL) and AcOH (1 mL) was added PdCl₂ (3.00 mg, 10% mol). The mixture was stirred for 1 h and concentrated in vacuo. The residue was partitioned between EtOAc (20 mL) and H₂O (20 mL). The organic layer was washed with brine (2 × 5 mL), dried (Na₂SO₄), and evaporated in vacuo. Purification was performed by chromatography on silica gel (5% MeOH in CH₂Cl₂ + 1% AcOEt) to yield I as a white powder (7 mg, 26%); mp 185 °C.

1H NMR (CDCl₃, 300 MHz): δ = 7.79–7.25 (m, 6 H, Ar), 7.19–7.13 (m, 3 H, Ar), 7.10–6.94 (m, 3 H, Ar), 6.71 (d, J = 7.2 Hz, 2 H, Ar), 4.87 (dd, J = 14.0, 392 Hz, 2 Ph-H₂, 4.65 (dd, J = 14.0, 374 Hz, 2 H, CH₂Ph₂), 3.30 (dd, J = 13.0, 156 Hz, 2 H, CH₂CO).

1C NMR (CDCl₃, 125 MHz): δ = 173.5, 169.1, 136.6, 132.1, 131.8, 129.4, 128.4, 127.6, 40.8.

ESI-HRMS: m/z calcd for C₁₆H₁₄N₂O₂Na [M + Na⁺]: 289.0943; found: 289.0945.

2,3-Dihydro-2,3-benzodiazepine-1,4-dione (10)

**Method C**

To a solution of 2,3-dihydro-2,3-benzodiazepine-1,4-dione (19.0 mg, 0.11 mmol) in anhyd DMF (2 mL) at 0 °C was added K₂CO₃ (55.00 mg, 0.28 mmol) and the mixture was stirred for 30 min at 0 °C. Then, tosyl chloride (342 mg, 1.80 mmol) was quickly added and the mixture was stirred for 1 h and concentrated in vacuo. The residue was partitioned between EtOAc (20 mL) and H₂O (20 mL). The organic layer was washed with brine (2 × 20 mL), dried (Na₂SO₄), and evaporated in vacuo. Purification by chromatography on silica gel (10% to 50% EtOAc in heptane) afforded 8 as a colorless oil, which was dissolved in Et₂O and sonicated to yield 11 as a white powder (420 mg, 67%); mp 155 °C.

1H NMR (CDCl₃, 300 MHz): δ = 7.79 (dd, J = 1.5, 7.3 Hz, 1 H), 7.35 (m, 9 H), 7.00 (d, J = 8.3 Hz, 2 H), 6.84 (d, J = 7.3 Hz, 1 H), 5.16 (dd, J = 14.0, 305 Hz, 2 H), 3.20 (dd, J = 13.0, 122 Hz, 2 H), 2.30 (s, 3 H).

1C NMR (CDCl₃, 75 MHz): δ = 171.4, 169.1, 146.2, 135.3, 132.2, 132.9, 132.5, 131.3, 130.7, 130.5, 130.2, 130.1, 129.8, 129.6, 129.5, 129.2, 129.1, 128.9, 54.1, 42.3, 22.0.

ESI-HRMS: m/z calcd for C₁₆H₁₄N₂O₂Na [M + Na⁺]: 443.1041; found: 443.1039.

**Amination of 2,3-Dihydro-2,3-benzodiazepine-1,4-dione (11)**

To a 1 M solution of TiCl₄ in CH₂Cl₂ (250 mL, 0.25 mmol) was added anisole (700 μL) under argon and the mixture was stirred for 15 min. Then, amine (10 equiv for a primary amine, 30 equiv for a secondary amine) and I (38.2 mg, 0.21 mmol) were added and the mixture was irradiated under microwave at 100 °C for 30 min and was partitioned between EtOAc (20 mL) and aq NaHCO₃ (20 mL). The organic layer was washed with aq NaHCO₃ (20 mL), dried (Na₂SO₄), and evaporated in vacuo. Purification by chromatography on silica gel (5% MeOH in CH₂Cl₂ + 1% AcOH) afforded the expected amidine.

1H NMR (CDCl₃, 300 MHz): δ = 8.39 (s, 1 H, NH), 8.00 (dd, J = 1.5, 7.6 Hz, 1 H, Ar), 7.48–7.41 (m, 2 H, Ar), 7.33 (d, J = 7.5 Hz, 1 H, Ar), 7.31–7.24 (m, 3 H, Ar), 7.10 (dd, J = 1.6, 7.5 Hz, 2 H, Ar), 4.72 (dd, J = 14.0, 372 Hz, 2 H, CH₂Ph₂), 3.90 (dd, J = 13.0, 209 Hz, 2 H, CH₂CO).

1C NMR (CDCl₃, 75 MHz): δ = 175.0, 173.4, 139.2, 137.2, 136.6, 133.7, 133.2, 132.4, 132.2, 131.9, 131.5, 55.6, 45.3.

ESI-HRMS: m/z calcd for C₁₉H₁₄N₄O₃Na [M + Na⁺]: 379.1422; found: 379.1408.

2-Benzyl-3-((p-toluenesulfonyl)-2,3-dihydro-5H-benzodiazepine-1,4-dione (11)

To a solution of 8a (400 mg, 1.5 mmol) in anhyd THF (20 mL) was added NaN₃ (60% suspension in mineral oil; 78 mg, 1.95 mmol) at 0 °C and the mixture was stirred for 30 min at 0 °C. Then, tosyl chloride (342 mg, 1.80 mmol) was quickly added and the mixture was stirred for 1 h and concentrated in vacuo. The residue was partitioned between EtOAc (20 mL) and H₂O (20 mL). The organic layer was washed with brine (2 × 20 mL), dried (Na₂SO₄), and evaporated in vacuo. Purification by chromatography on silica gel (5% to 50% EtOAc in heptane) afforded 8 as a colorless oil, which was dissolved in Et₂O and sonicated to yield 11 as a white powder (420 mg, 67%); mp 155 °C.

1H NMR (CDCl₃, 300 MHz): δ = 7.48–7.25 (m, 6 H, Ar), 7.19–7.13 (m, 3 H, Ar), 7.02–6.94 (m, 3 H, Ar), 6.71 (d, J = 7.2 Hz, 2 H, Ar), 4.87 (dd, J = 14.0, 392 Hz, 2 Ph-H₂, 4.65 (dd, J = 14.0, 374 Hz, 2 H, CH₂Ph₂), 3.30 (dd, J = 13.0, 156 Hz, 2 H, CH₂CO).

1C NMR (CDCl₃, 75 MHz): δ = 173.4, 170.0, 136.0, 14.9, 134.2, 132.5, 131.7, 129.9, 129.7, 129.5, 128.9, 128.6, 128.4, 128.2, 128.1, 94.9, 48.8, 41.3.

ESI-HRMS: m/z calcd for C₁₆H₁₄N₂O₂Na [M + Na⁺]: 443.1041; found: 443.1039.
4-(Piperidin-1-yl)-2,5-dihydro-1H-2,3-benzodiazepin-1-one (12b)
Yield: 27.0 mg (49%).

1H NMR (CDCl3, 300 MHz): δ = 8.30 (br s, 1 H, NH), 8.07 (dd, J = 1.2, 7.6 Hz, 1 H), 7.53 (dd, J = 1.7, 7.3 Hz, 1 H, Ar), 7.42 (dd, J = 1.2, 7.3 Hz, 1 H, Ar), 7.22 (d, J = 7.6 Hz, 1 H, Ar), 3.42–3.19 (m, 6 H, 3 × CH2), 2.53–2.39 (m, 4 H, 2 × CH2), 1.61–1.54 (m, 2 H, CH2).

13C NMR (CDCl3, 75 MHz): δ = 161.8, 163.2, 140.5, 133.3, 131.6, 129.0, 128.4, 58.6, 55.2, 48.6, 30.1, 26.1.


4-(Morpholin-1-yl)-2,5-dihydro-1H-2,3-benzodiazepin-1-one (12c)
Yield: 28.0 mg (51%).

1H NMR (DMSO-d6, 300 MHz): δ = 8.52 (br s, 1 H, NH), 8.01 (dd, J = 7.5 Hz, 1 H, Ar), 7.50 (dd, J = 1.6, 7.5 Hz, 1 H, Ar), 7.37 (dd, J = 7.5, 7.5 Hz, 1 H, Ar), 7.23 (d, J = 7.5 Hz, 1 H, Ar), 6.93 (br s, 1 H, NCH3), 3.55 (s, 2 H, CH2N), 3.21 (m, 2 H, CH2), 2.67 (m, 4 H, 2 × CH2N), 1.43 (m, 8 H, 4 × CH2).

13C NMR (CDCl3, 75 MHz): δ = 169.3, 161.2, 137.4, 132.9, 132.2, 130.6, 128.0, 127.9, 56.5, 54.4, 38.0, 37.5, 24.5, 23.5.


4-Cyclohexylamino-2,5-dihydro-1H-2,3-benzodiazepin-1-one (12d)
Yield: 25.0 mg (50%).

1H NMR (CDCl3, 300 MHz): δ = 8.52 (br s, 1 H, NH), 8.01 (dd, J = 1.6, 7.6 Hz, 1 H, Ar), 7.50 (dd, J = 1.6, 7.5 Hz, 1 H, Ar), 7.41 (dd, J = 1.2, 7.8 Hz, 1 H, Ar), 7.16 (d, J = 7.5 Hz, 1 H, Ar), 3.72 (s, 2 H, CH2), 3.55 (s, 2 H, CH2C=N), 3.21 (m, 2 H, CH2), 2.67 (m, 4 H, 2 × CH2), 1.27–1.04 (m, 4 H, CH2).

13C NMR (CDCl3, 75 MHz): δ = 168.1, 163.2, 140.5, 133.3, 131.6, 129.0, 128.4, 58.6, 55.2, 48.6, 30.1, 26.1.

ESI-HRMS: m/z calec for C14H18N3O [M + H]+: 244.1444; found: 244.1444.

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References

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