SYNTHESIS OF NEW 2-AMINOPYRROLO[2,1-*c*][1,4] BENZODIAZEPINE-5,11-DIONE DERIVATIVES

Alain-Claude Gillard, Mohamed Alkhader and Sylvain Rault*

Centre d'études et de Recherche sur le Médicament de Normandie, U.F.R. des Sciences Pharmaceutiques

1, rue Vaubenard 14032 Caen, France.

Abstract : 2-Aminopyrrolo[2,1-*c*][1,4]benzodiazepine-5,11-dione is prepared in 3 steps from the corresponding 2-hydroxy derivative; it exibits a good reactivity to give amides, Schiff bases, ureas, thioureas and guanidines.

Introduction

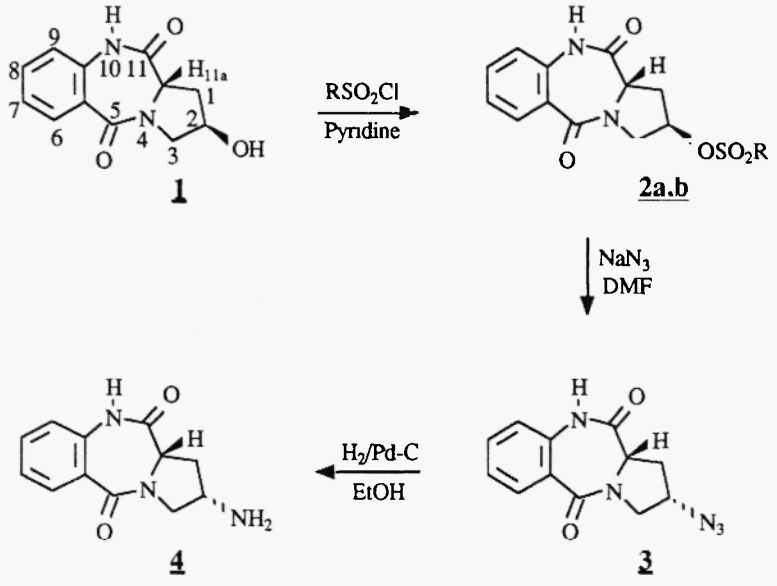
In continuation of our work concerning the chemical and biological studies of pyrrolo[2,1-*c*][1,4]benzodiazepines we describe herein the synthesis of new 2-substituted amino derivatives of this system. In previous papers we described the synthesis of N10 or C11 substituted derivatives (1,2), particularly amidine derivatives (3,4,5) which showed good DNA binding properties. The title compounds were prepared in order to study the influence of substitution in 2-position towards the DNA affinity. The biological study is under investigation.

Results and discussion

The reaction of 1.5 equivalent of methanesulfonyl chloride with (2*R*,11a*S*)-2-hydroxypyrrolo[2,1-*c*][1,4]benzodiazepine-5,11-dione **1** in pyridine (6) at room temperature led to the sulfonic ester **2a** (Scheme 1). In the same conditions 2-hydroxypyrrolo[2,1-*c*][1,4]benzodiazepine-5,11-dione **1** was converted to the tosylate **2b** by action of p-toluenesulfonyl chloride.

Treatment of **2a** and **2b** with sodium azide (7) in refluxing dimethylformamide gave in high yield (2*S*,11a*S*)-2-azidopyrrolo[2,1-*c*][1,4]benzodiazepine-5,11-dione **3**. Comparison of NMR spectra of **2** and **3** showed that C2 carbon had undergone an inversion of configuration during this nucleophilic substitution.

(2*S*,11a*S*)-2-Aminopyrrolo[2,1-*c*][1,4]benzodiazepine-5,11-dione **4** was obtained in good yield by catalytic hydrogenation of the azido compound using 10% palladium on carbon in ethanol at room temperature.



1 **2a,b** **3** **4**

a, R= methyl **b**, R= p-tolyl

Scheme 1

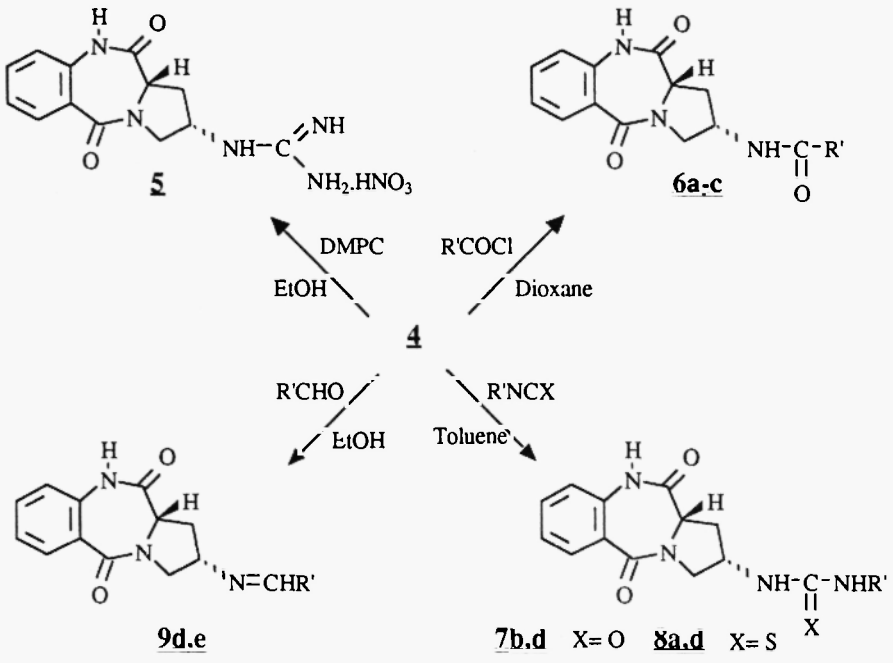
The action of 1 equivalent of 3,5-dimethylpyrazole-1-carboxamidine nitrate (8) on (2*S*,11a*S*)-2-aminopyrrolo[2,1-*c*][1,4]benzodiazepine-5,11-dione **4** in refluxing ethanol led to the guanidinium nitrate **5** (Scheme 2).

The amino compound 4 submitted to 1 equivalent of 4-toluoyl chloride in dioxane at 70°C led to the amide **6a**. This reaction was conducted in the presence of 1.1 equivalent of triethylamine. In the same conditions **6b** and **6c** were obtained by the action of p-anisoyl chloride and 3-nitrobenzoyl chloride respectively.

When the amine **4** was treated with 1.1 equivalent of 4-methoxyphenylisocyanate in refluxing toluene, it gave in high yield the urea **7b**. Application of this pathway to 3-bromophenylisocyanate afforded the corresponding urea **7d**.

In a similar manner, the thioureas **8a** and **8d** were obtained by reaction of the amine **4** with 4-tolylisothiocyanate and 3-bromophenylisothiocyanate respectively.

Treatment of the amine **4** with 1.2 equivalent of 3-bromobenzaldehyde or 3,4-dichlorobenzaldehyde in refluxing ethanol gave in good yield the Schiff bases **9d** or **9e**.



a, R'= 4-tolyl; **b**, R'= 4-methoxyphenyl; **c**, R'= 3-nitrophenyl; **d**, R'= 3-bromophenyl; **e**, R'= 3,4-dichlorophenyl

Scheme 2

Experimental section

Melting points were taken on a Kotier block and are uncorrected. Infrared spectra were recorded on a Philips PU 9716 spectrometer. ^{1}H NMR spectra were recorded on a Jeol FX 200 for samples in DMSO-d6, using TMS as internal standard.

(2*R*,11a*S*)-2-[(Methylsulfonyl)oxy]-1,2,3,10,11,11a-hexahydro-5*H*-pyrrolo[2,1-*c*][1,4]benzodiazepine-5,11-dione 2a. To an ice-cooled (0°C) solution of methanesulfonyl chloride (8 ml, 0.103 mol) in pyridine (80 ml) we added in small portions 15g (64.6 mmol) of the dilactam **1**. Stirring was continued for 20 minutes at 0°C and 14 hours at room temperature. The mixture was pourred into ice-water (200 ml) and the resulting solution was extracted with ethyl acetate (2 x 100 ml). The organic layer was washed with water (60 ml), dried over magnesium sulfate and evaporated. A solid residue was obtained. Recristallization from ether gave 16.4 g (82%) of **2a** as colourless crystals, mp 225-227°C; IR (KBr) 3320, 1680, 1615, 1470, 1445, 1350, 1160, 830 cm^{-1}; ^{1}H NMR (200 MHz) δ 10.73 (1H, s, NH), 7.82 (1H, d, *J*= 7.8 Hz, H_6), 7.55 (1H, t, *J*= 7.7 Hz, H_8), 7.26 (1H, t, *J*= 7.7 Hz, H_7), 7.15 (1H, d, *J*= 7.8 Hz, H_9), 5.35 (1H, m, H_{2b}), 4.20 (1H, d, *J*= 7.3 Hz, H_{11a}), 4.10 (1H, d, *J*= 12.2 Hz, H_{3a}), 3.70 (1H, dd, *J*= 12.3, 4.4 Hz, H_{3b}), 3.26 (3H, s, CH_3), 2.89 (1H, m, H_{1a}), 2.36 (1H, m, H_{1b}); Anal. Calcd. for $C_{13}H_{14}N_2O_5S$: C, 50.32, H, 4.55, N, 9.03. Found: C, 50.09, H, 4.63, N, 9.21.

(2*R*,11a*S*)-2-[(4-Tolylsulfonyl)oxy]-1,2,3,10,11,11a-hexahydro-5*H*-pyrrolo[2,1-c][1,4]benzodiazepine-5,11-dione 2b. To an ice-cooled (0°C) solution of the hydroxydilactam **1** (12g, 51.7 mmol) in pyridine (70 ml) we added in small portions 15.8g (82.7 mmol) of p-toluenesulfonyl chloride. Stirring was continued for 20 minutes at 0°C and 15 hours at room temperature. The mixture was pourred into ice-water (150 ml) and the resulting precipitate collected, dried and recrystallized from ether to give 15.5g (78%) of **2b** which was obtained as colourless crystals, mp 230-232°C; IR (KBr) 3310, 1680, 1610, 1480, 1370, 1250, 1190, 760 cm^{-1}; ^{1}H NMR (200 MHz) δ 10.69 (1H, s, NH), 7.85-7.78 (3H, m), 7.52-

7.46 (3H, m), 7.10 (2H, m), 5.23 (1H, m, H_{2b}), 4.12 (1H, d, *J*= 7.6 Hz, H_{11a}), 3.82 (1H, d, *J*= 12.2 Hz, H_{3a}), 3.59 (1H, dd, *J*= 12.2; 4.3 Hz, H_{3b}), 3.27 (3H, s, CH_3), 2.64 (1H, m, H_{1a}), 2.49 (1H, m, H_{1b}); Anal. Calcd. for $C_{19}H_{18}N_2O_5S$: C, 59.06, H, 4.69, N, 7.25. Found: C, 58.90, H, 4.56, N, 7.02.

(2*S*,11a*S*)-2-Azido-1,2,3,10,11,11a-hexahydro-5*H*-pyrrolo[2,1-*c*][1,4]benzodiazepine-5,11-dione 3.

A solution of 15g (39 mmol) of the tosylate **2b** and 11.35g (0.174 mol) of sodium azide was stirred for 5 hours at 100°C in dimethylformamide (60 ml). The cooled mixture was diluted with water (120 ml) and the resulting precipitate filtered, dried and recrystallized from water to give 8.70g (87%) of the title compound as colourless crystals, mp 220-222°C; IR (KBr) 3220, 2120, 1690, 1620, 1580, 1450, 1380, 1310, 1270, 1220, 780 cm^{-1}; ^1H NMR (200 MHz) δ 10.59 (1H, s, NH), 7.86 (1H, d, *J*= 7.8 Hz, H_6), 7.59 (1H, t, *J*= 7.4 Hz, H_8), 7.28-7.20 (2H, m, H_7 and H_9), 4.56 (1H, m, H_{2a}), 4.30 (1H, d, *J*= 8.3 Hz, H_{11a}), 3.72 (1H, dd, *J*= 12.1, 4.2 Hz, H_{3a}), 3.48 (1H, d, *J*= 12.1 Hz, H_{3b}), 2.83 (1H, m, H_{1a}), 2.42 (1H, m, H_{1b}); Anal. Calcd. for $C_{12}H_{11}N_5O_2$: C, 55.98, H, 4.28, N, 27.21. Found: C, 56.04, H, 4.10, N, 27.08.

(2*S*,11a*S*)-2-Amino-1,2,3,10,11,11a-hexahydro-5*H*-pyrrolo[2,1-*c*][1,4]benzodiazepine-5,11-dione 4.

A solution of 8g (31.1 mmol) of the azide **3** in ethanol (200 ml) was hydrogenated at 70 atm for 14 hours over 10% palladium-charcoal (1.2g). The resulting mixture was filtered and the solvant removed under reduced pressure. The solid residue was recrystallized from ether to give 6.2g (86%) of **4** as colourless crystals, mp 140-142°C; IR (KBr) 3430, 3370, 1690, 1630, 1570, 1480, 1420, 1380, 1285, 1170, 760 cm^{-1}; ^1H NMR (200 MHz) δ 10.48 (1H, s, NH), 7.78 (1H, d, *J*= 7.8 Hz, H_6), 7.52 (1H, t, *J*= 7.7 Hz, H_8), 7.24-7.16 (2H, m, H_7 and H_9), 4.15 (1H, m, H_{2a}), 3.92 (1H, m, H_{11a}), 3.68 (1H, dd, *J*= 12.2, 4.3 Hz, H_{3a}), 3.47 (1H, m, H_{3b}), 3.36 (2H, br s, NH_2), 2.45 (1H, m, H_{1a}), 2.29 (1H, m, H_{1b}); Anal. Calcd. for $C_{12}H_{13}N_3O_2$: C, 62.29, H, 5.62, N, 18.17. Found: C, 62.18, H, 5.65, N, 18.29.

(2*S*,11a*S*)-2-Guanidino-1,2,3,10,11,11a-hexahydro-5*H*-pyrrolo[2,1-*c*][1,4]benzodiazepine-5,11-dione nitrate 5.

A solution of 1.5g (6.49 mmol) of amino compound **4** and 1.3g (6.49 mmol) of 3,5-dimethylpyrazole-1-carboxamidine nitrate in ethanol (30 ml) was refluxed for 3 hours and cooled. The resulting precipitate was collected, dried and recrystallized from isopropanol to give 1.55g (71%) of **5** as colourless crystals, mp> 260°C; IR (KBr) 3380, 3290, 3180, 1680, 1630, 1480, 1420, 1380, 1290, 1200, 870, 660 cm^{-1}; ^1H NMR (200 MHz) δ 10.69 (1H, s, NH), 7.82 (1H, d, *J*= 7.7 Hz, H_6), 7.51 (1H, t, *J*= 7.8 Hz, H_8), 7.22 (2H, m, H_7 and H_9), 7.28-6.46 (5H, br s, H_{guan}), 4.25 (1H, m, H_{2a}), 3.98 (1H, m, H_{11a}), 3.90 (1H, dd, *J*= 12.0, 4.7 Hz, H_{3a}), 3.46 (1H, dd, *J*= 12.0, 2.2 Hz, H_{3b}), 2.56 (1H, m, H_{1a}), 2.31 (1H, m, H_{1b}); Anal. Calcd. for $C_{13}H_{16}N_6O_5$: C, 46.43, H, 4.80, N, 24.99. Found: C, 46.45, H, 4.68, N, 24.83.

General procedure for synthesis of amides 6 :

To a solution of the amine **4** (1g, 4.32 mmol) and triethylamine (0.65 ml, 4.76 mmol) in dioxane (40 ml), we added at room temperature 1.1 equivalent of acid chloride. The stirring was continued for 15 minutes at room temperature and for 1 hour at 70°C. The solvant was removed and the solid residue was taken up in water (70 ml) and extracted with ethyl acetate (2 x 80 ml). The organic layer was washed with a saturated sodium hydrogen carbonate solution (2 x 50 ml), dried (magnesium sulfate) and evaporated. The solid was recrystallized from a convenient solvant to give the amide.

(2*S*,11a*S*)-2-(4-Toluoylamino)-1,2,3,10,11,11a-hexahydro-5*H*-pyrrolo[2,1-*c*][1,4]benzodiazepine-5,11-dione 6a.

When 4-toluoyl chloride (0.63 ml, 4.75 mmol) was used, 1.20g (79%) of the title compound was obtained as colourless crystals, mp 253-254°C (ether); IR (KBr) 3305, 3190, 1665, 1630, 1610, 1560, 1520, 1470, 1405, 1300, 1170, 790 cm^{-1}; ^1H NMR (200 MHz) δ 10.76 (1H, s, NH_{lact}), 8.30 (1H, d, *J*= 6.5 Hz, NH_{amide}), 7.80 (1H, d, *J*= 7.7 Hz, H_6), 7.55-7.48 (3H, m), 7.37-7.28 (3H, m), 7.12 (1H, d, *J*= 7.8 Hz, H_9), 4.26 (1H, m, H_{2a}), 4.08 (1H, m, H_{11a}), 3.89 (1H, dd, *J*= 12.1, 4.6 Hz, H_{3a}), 3.50 (1H, dd, *J*= 11.9, 3.2 Hz, H_{3b}), 2.54 (1H, m, H_{1a}), 2.33 (3H, s, CH_3), 2.30 (1H, m, H_{1b}); Anal. Calcd. for $C_{20}H_{19}N_3O_3$: C, 68.75, H, 5.48, N, 12.03. Found: C, 68.63, H, 5.34, N, 11.90.

(2*S*,11a*S*)-2-(4-Methoxybenzoylamino)-1,2,3,10,11,11a-hexahydro-5*H*-pyrrolo[2,1-*c*][1,4]benzodiazepine-5,11-dione 6b.

When p-anisoyl chloride (0.81g, 4.75 mmol) was used, 1.15g (74%) of the title compound was obtained as yellow crystals, mp 244-246°C (isopropanol); IR (KBr) 3400, 3250, 1680, 1645, 1610, 1520, 1475, 1335, 1300, 1210, 1060, 910 cm^{-1}; ^1H NMR (200 MHz) δ 10.81 (1H, s, NH_{lact}), 8.44 (1H, d, *J*= 6.2 Hz, NH_{amide}), 7.82-7.71 (3H, m), 7.53 (1H, d, *J*= 7.8 Hz, H_8), 7.38-7.30 (3H, m), 7.15 (1H, d, *J*= 7.8 Hz, H_9), 4.16 (2H, m, H_{2a} and H_{11a}), 3.95 (1H, dd, *J*= 12.3, 4.6 Hz, H_{3a}), 3.68 (3H, s, CH_3), 3.52 (1H, dd, *J*= 12.0, 3.2 Hz, H_{3b}), 2.48 (1H, m, H_{1a}), 2.27 (1H, m, H_{1b}); Anal. Calcd. for $C_{20}H_{19}N_3O_4$: C, 65.74, H, 5.24, N, 11.50. Found: C, 65.53, H, 5.16, N, 11.45.

(2*S*,11a*S*)-2-(3-Nitrobenzoylamino)-1,2,3,10,11,11a-hexahydro-5*H*-pyrrolo[2,1-*c*][1,4]benzodiazepine-5,11-dione 6c.

When 3-nitrobenzoyl chloride (0.90g, 4.75 mmol) was used, 1.30g (79%) of the title compound was obtained as yellow cristals, mp 238-240°C (ether); IR (KBr) 3330, 3225, 1680, 1670, 1615, 1435, 1320, 1255, 810 cm^{-1}; ^1H NMR (200 MHz) δ 10.69 (1H, s, NH_{lact}), 8.74 (1H, d, *J*= 6.5 Hz, NH_{amide}), 8.06-7.70 (4H, m), 7.58-7.40 (2H, m), 7.29-7.17 (2H, m), 4.46 (1H, m, H_{2a}), 4.25 (1H, m, H_{11a}), 3.92 (1H, dd, *J*= 12.1, 4.5 Hz, H_{3a}), 3.54 (1H, dd, *J*= 12.2, 3.2 Hz, H_{3b}), 2.61 (1H, m, H_{1a}), 2.29 (1H, m, H_{1b}); Anal. Calcd. for $C_{19}H_{16}N_4O_5$: C, 60.02, H, 4.24, N, 14.73. Found: C, 59.93, H, 4.09, N, 14.65.

General procedure for synthesis of ureas 7 and thioureas 8 :

A solution of the amine 4 (1g, 4.32 mmol) and isocyanate or isothiocyanate (1.1 equivalent) in toluene (50 ml) was refluxed for 1 hour. The solvant was removed under reduced pressure and the oily residue taken up in ether (40 ml). The resulting precipitate was collected, dried and recrystallized.

(2*S*,11a*S*)-2-(N,N'-4-Methoxyphenylureido)-1,2,3,10,11,11a-hexahydro-5*H*-pyrrolo[2,1-*c*][1,4]benzodiazepine-5,11-dione 7b.

When 4-methoxyphenylisocyanate (0.60 ml, 4.75 mmol) was used, 1.20g (73%) of the title compound was obtained as colourless crystals, mp> 260°C (ether); IR (KBr) 3380, 3305, 3200, 1700, 1680, 1615, 1565, 1485, 1430, 1280, 1220, 760 cm^{-1}; ^1H NMR (200 MHz) δ 10.66 (1H, s, NH_{lact}), 9,67 (1H, s, PhNH), 7.80 (1H, d, *J*= 7.8 Hz, H_6), 7.51 (2H, m), 7.43-7.28 (5H, m), 7.14 (1H, d, *J*= 7.8 Hz, C^2NH), 4.10 (1H, m, H_{2a}), 3.78 (1H, m, H_{11a}), 3.67 (3H, s, CH_3), 3.62 (1H, dd, *J*= 12.0, 4.6 Hz, H_{3a}), 3.41 (1H, dd, *J*= 11.9, 2.5 Hz, H_{3b}), 2.48 (1H, m, H_{1a}), 2.25 (1H, m, H_{1b}); Anal. Calcd. for $C_{20}H_{20}N_4O_4$: C, 63.15, H, 5.30, N, 14.73. Found: C, 62.94, H, 5.21, N, 14.52.

(2*S*,11a*S*)-2-(N,N'-3-Bromophenylureido)-1,2,3,10,11,11a-hexahydro-5*H*-pyrrolo[2,1-*c*][1,4]benzodiazepine-5,11-dione 7d.

When 3-bromophenylisocyanate (0.60 ml, 4.75 mmol) was used, 1.55g (85%) of the title compound was obtained as yellow crystals, mp> 260°C (acetonitrile); IR (KBr) 3340, 3295, 3200, 1685, 1670, 1610, 1520, 1440, 1405, 1380, 1235, 850 cm^{-1}; ^1H NMR (200 MHz) δ 10.61 (1H, s, NH_{lact}), 8,57 (1H, s, PhNH), 7.82 (1H, d, *J*= 7.8 Hz, H_6), 7.54 (1H, t, *J*= 7.7 Hz, H_8), 7.45-7.13 (6H, m), 6.37 (1H, d, *J*= 6.0 Hz, C^2NH), 4.21 (2H, m, H_{2a} and H_{11a}), 3.76 (1H, dd, *J*= 12.1, 4.5 Hz, H_{3a}), 3.40 (1H, dd, *J*= 12.0, 2.9 Hz, H_{3b}), 2.52 (1H, m, H_{1a}), 2.36 (1H, m, H_{1b}); Anal. Calcd. for $C_{19}H_{17}N_4O_3Br$: C, 53.16, H, 3.99, N, 13.05. Found: C, 53.08, H, 3.88, N, 12.92.

(2*S*,11a*S*)-2-(N,N'-4-Tolylthioureido)-1,2,3,10,11,11a-hexahydro-5*H*-pyrrolo[2,1-*c*][1,4]benzodiazepine-5,11-dione 8a.

When p-tolylisothiocyanate (0.70g, 4.75 mmol) was used, 1.30g (79%) of 8a was obtained as yellow crystals, mp 230-232°C (ethyl acetate); IR (KBr) 3310, 3280, 3230, 1690, 1620, 1530, 1205, 810 cm^{-1}; ^1H NMR (200 MHz) δ 10.69 (1H, s, NH_{lact}), 9,74 (1H, s, PhNH), 7.72 (1H, d, *J*= 7.8 Hz, H_6), 7.61 (1H, d, *J*= 6.3 Hz, C^2NH), 7.53-7.40 (3H, m), 7.36-7.19

(4H, m), 4.23 (1H, m, H_{2a}), 4.04 (1H, m, H_{11a}), 3.83 (1H, dd, *J*= 12.1, 4.6 Hz, H_{3a}), 3.52 (1H, dd, *J*= 12.0, 3.1 Hz, H_{3b}), 2.60 (1H, m, H_{1a}), 2.39 (1H, m, H_{1b}), 2.30 (3H, s, CH_3); Anal. Calcd. for $C_{20}H_{20}N_4O_2S$: C, 63.14, H, 5.30, N, 14.73. Found: C, 63.30, H, 5.46, N, 14.87.

(2*S*,11a*S*)-2-(N,N'-3-Bromophenylthioureido)-1,2,3,10,11,11a-hexahydro-5*H*-pyrrolo[2,1-*c*][1,4]benzodiazepine-5,11-dione 8d.

When 3-bromophenylisothiocyanate (1g, 4.75 mmol) was used, 1.50g (78%) of the title compound was obtained as orange crystals, mp 215-216°C (ether); IR (KBr) 3315, 3280, 3210, 1700, 1610, 1555, 1430, 1080, 830 cm^{-1}; ^1H NMR (200 MHz) δ 10.73 (1H, s, NH_{lact}), 9,69 (1H, s, PhNH), 7.76-7.51 (4H, m), 7.39-7.23 (3H, m), 7.17-7.09 (2H, m), 4.26 (1H, m, H_{2a}), 4.10 (1H, m, H_{11a}), 3.80 (1H, dd, *J*= 12.2, 4.6 Hz, H_{3a}), 3.50 (1H, d, *J*= 12.1 Hz, H_{3b}), 2.67 (1H, m, H_{1a}), 2.43 (1H, m, H_{1b}); Anal. Calcd. for $C_{19}H_{17}N_4O_2SBr$: C, 51.24, H, 3.85, N, 12.58. Found: C, 51.10, H, 3.73, N, 12.39.

General procedure for synthesis of Schiff bases 9 :

A solution of the amine 4 (1g, 4.32 mmol) and aldehyde (1.2 equivalent) in ethanol (40 ml) was refluxed for 2 hours. The resulting precipitate was collected, dried and recrystallized to give the Schiff base.

(2*S*,11a*S*)-2-(3-Bromophenylidenimino)-1,2,3,10,11,11a-hexahydro-5*H*-pyrrolo[2,1-*c*][1,4]benzodiazepine-5,11-dione 9d.

When 3-bromobenzaldehyde (0.60 ml, 5.19 mmol) was used, 1.35g (78%) of the title compound was obtained as yellow crystals, mp> 260°C (ether); IR (KBr) 3200, 1675, 1615, 1540, 1470, 1415, 1370, 1260, 1200, 1090, 850 cm^{-1}; ^1H NMR (200 MHz) δ 10.56 (1H, s, NH), 8,40 (1H, s, CH_{imine}), 7.80 (2H, m), 7.55-7.44 (3H, m), 7.38-7.08 (3H, m), 4.22 (1H, m, H_{2a}), 3.94 (1H, m, H_{11a}), 3.72 (1H, dd, *J*= 12.0, 4.2 Hz, H_{3a}), 3.48 (1H, m, H_{3b}), 2.62 (1H, m, H_{1a}), 2.37 (1H, m, H_{1b}); Anal. Calcd. for $C_{19}H_{16}N_3O_2Br$: C, 57.30, H, 4.05, N, 10.55. Found: C, 57.19, H, 4.20, N, 10.43.

(2*S*,11a*S*)-2-(3,4-Dichlorophenylidenimino)-1,2,3,10,11,11a-hexahydro-5*H*-pyrrolo[2,1-*c*][1,4]benzodiazepine-5,11-dione 9e.

When 3,4-dichlorobenzaldehyde (0.90g, 5.2 mmol) was used, 1.20g (71%) of 9e was obtained as colourless crystals, mp 236-238°C (ethanol); IR (KBr) 3310, 1690, 1620, 1520, 1450, 1380, 1080, 740 cm^{-1}; ^1H NMR (200 MHz) δ 10.47 (1H, s, NH), 8,33 (1H, s, CH_{imine}), 7.75 (2H, m), 7.58-7.43 (3H, m), 7.21 (1H, t, *J*= 7.6 Hz, H_7), 7.15 (1H, d, *J*= 7.8 Hz, H_9), 4.16 (1H, m, H_{2a}), 4.04 (1H, m, H_{11a}), 3.69 (1H, dd, *J*= 11.9, 4.5 Hz, H_{3a}), 3.53 (1H, d, *J*= 11.9 Hz, H_{3b}), 2.61 (1H, m, H_{1a}), 2.46 (1H, m, H_{1b}); Anal. Calcd. for $C_{19}H_{15}N_3O_2Cl_2$: C, 58.78, H, 3.89, N, 10.82. Found: C, 58.65, H, 3.74, N, 10.93.

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