Eur. J. Med. Chem. 33 (1998) 293–308

Synthesis of new pyrrolo[1,2-*a*]quinoxalines: potential non-peptide glucagon receptor antagonists

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(Received 30 September 1997; accepted 15 December 1997)

Abstract – Synthesis of new pyrrolo[1,2-*a*]quinoxaline derivatives was achieved starting from various nitroanilines or orthophenylenediamines. Their affinity towards glucagon receptors was evaluated. © Elsevier, Paris

pyrrolo[1,2-*a*]quinoxaline derivative / non-peptide antagonist / glucagon receptor / diabetes

1. Introduction

Glucagon is a 29 amino acid single-chain polypeptide hormone, synthesized from proglucagon in the α cells of the pancreatic islet of Langerhans [1]. Glucagon shares some sequence homology with the truncated glucagon-like peptide-1 (7-37) (tGLP-1) which is an other polypeptide hormone synthesized from the same precursor mainly in the L cells of the gastrointestinal tract [2].

The secretion of glucagon is regulated by dietary glucose, amino acids and fatty acids, but also by the autonomic innervation of the pancreatic cells [3, 4]. Glycemia is the primary regulator of glucagon secretion. Glucose, which is the most potent inhibitor of glucagon release by pancreatic α cells, acts both directly and through insulin secretion. Glucose is more effective when taken orally than when administered intravenously. Secretion of glucagon is stimulated by most amino acids and increased by stimulation of adrenergic and cholinergic pancreatic nerves ending. Glucagon plays a crucial role in the regulation of glucose homeostasis by adapting the glucose production to the glucose requirements. Glucagon stimulates hepatic gluconeogenesis and glycogenolysis leading to a release of glucose into the bloodstream [3, 4]. It also induces lipolysis in the liver and the fat cells [5].

The expression, cloning and signaling properties of the rat glucagon receptor have been published by Jelinek [6]. This receptor belongs to the family of G-protein coupled receptors with seven membrane spanning domains and is positively coupled to adenylcyclase via a Gs protein. Stimulation of cyclic AMP production triggers a succession of reactions leading to the metabolic effects of glucagon.

There are now clear evidences on the implication of glucagon in the pathogenesis of diabetes. In some diabetic states, insulin deficiency is exacerbated despite hyperglycemia by an inappropriate and persistent secretion of glucagon. According to the bihormonal hypothesis of Unger [7–9], overproduction of glucose and ketone bodies could be due to an excess of circulating glucagon whilst insulin deficiency or insensivity is responsible for the underutilisation of glucose. Considering these biological and physiological data, inhibition of the action of glucagon could be one way to restore normoglycemia. There are clear evidences that glucagon antagonists are able to lower hyperglycemia of diabetic animals without addition of

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exogeneous insulin [10]. If numerous peptidic antagonists of the glucagon receptor have been synthesized, CP-99,711 remains the sole antagonist of this receptor which have been yet described [11]. It was postulated that this compound, discovered by serendipity in a screening programm, exerts its activity through the presence of both an aminoalkyl chain and a styryl group linked to a quinoxaline squeleton, in such a manner they are able to mimic the amino terminal region of glucagon.

These structural prerequisites were used by us as the conceptual basis in designing new pyrroloquinoxalines in order to test and to enlarge this first structure–activity relationship.

Thus, taking into account our experience in the field of the synthesis of these type of compounds [12–14], we prepared substituted derivatives bearing aminoalkyl chains and aromatic substituents in various positions (*figure 1*).

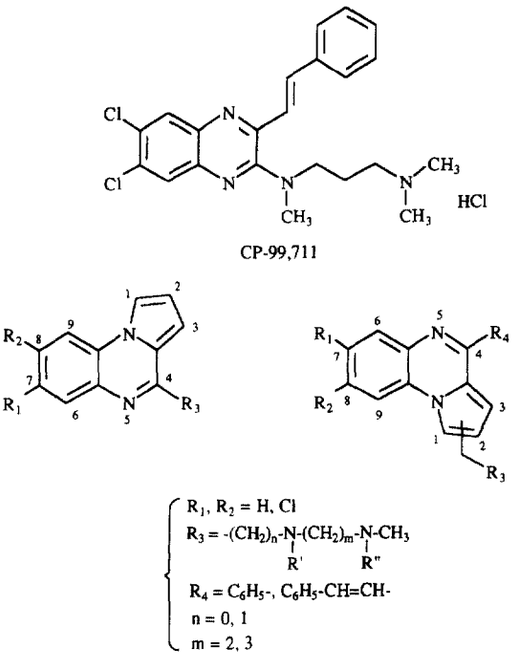

Figure 1. Structures of CP-99,711 and synthesized pyrrolo[1,2-*a*]quinoxalines.

2. Chemistry

Most of the reported structures were obtained from 1-(2-aminophenyl)pyrroles **1a–c**. Preparation of the latters was performed according to the Clauson-Kaas reaction [15, 16] runned under micro-waves irradiation starting from 2-nitroanilines **2a–c** and 2,5-dimethoxytetrahydrofuran in acetic acid. The resulting 1-(2-nitrophenyl)pyrroles **3a–c** intermediates were subsequently reduced using a $BiCl_3$-$NaBH_4$ treatment [17–19] into the attempted 1-(2-aminophenyl)pyrroles **1a–c** (*figure 2*).

The 5*H*-pyrrolo[1,2-*a*]quinoxalin-4-ones **4a–c** were prepared by reaction of phosgene in toluene solution with **1a–c** according to the previously reported Nagarajan method [20]. Chlorodeshydroxylation of lactames **4a–c** with phosphorus oxychloride according to Cheeseman method [21, 22] led to 4-chloropyrrolo[1,2-*a*]quinoxalines **5a–c**. Displacement of the chlorine atom of **5a–c** with *N,N,N'*-trimethyl-1,3-propanediamine or *N*-methylpiperazine was carried on in dimethylformamide in presence of potassium carbonate [23–26] leading to **6a–c** and **7c**, converted

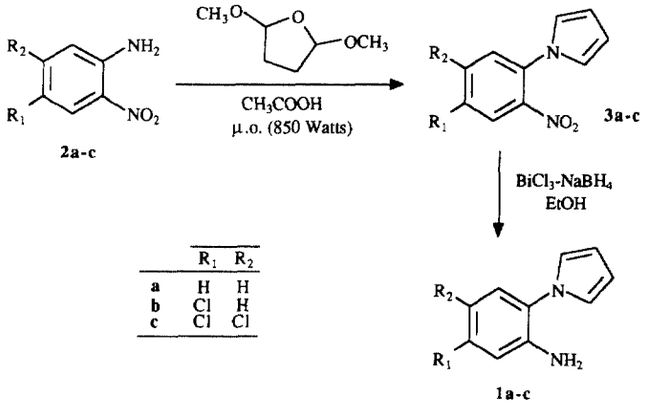

Figure 2. Synthesis of compounds **1a–c**.

into their oxalates **8a–c** and **9c** respectively by treatment with oxalic acid in refluxing isopropanol.

Treatment of **5c** with homopiperazine in a solid–solid fusion yielded the pyrrolo[1,2-*a*]quinoxaline **10c** whose the *N*-methyl derivative **11c** was obtained using dimethylsulfate in acetone [27] (*figure 3*).

Homologation of the amino side chain in C-4 position of the pyrrolo[1,2-*a*]quinoxaline system was realized by formation of the chloracetamides **12a–c** [28], cyclised into 4-chloromethylpyrrolo[1,2-*a*]-quinoxalines **13a–c** by refluxing in phosphorus oxychloride. Displacement of the chlorine atom of **13a–c** with *N,N,N'*-trimethyl-1,3-propanediamine took place in dimethylformamide solution as above to give **14a–c**. Conversion to the oxalates **15a–c** completes the reaction (*figure 4*).

The 4-phenylpyrrolo[1,2-*a*]quinoxalines **16a–c** and 4-styrylpyrrolo[1,2-*a*]quinoxalines **17a,c** were prepared by cyclisation of the amides **18a–c** and **19a,c** in refluxing phosphorus oxychloride. Under Vilsmeier–Haack reaction conditions [29–31], formylation of **16a–c** and **17a,c** occurs selectively using a $POCl_3$/DMF complex at 1 position to give the 4-arylpyrrolo[1,2-*a*]-quinoxaline-1-carbaldehydes **20a–c** and **21a,c**. Reaction of primary amines [32, 33] with the latters gave the imines **22a–c**, **23a–c** and **24a,c** reduced into the amines **25a–c**, **26a–c** and **27a,c** using sodium borohydride in methanol [34]. The salts **28a–c**, **29a–c** and **30a,c** were obtained as above (*figure 5*).

In order to obtain 4-phenylpyrrolo[1,2-*a*]quinoxaline-2-carbaldehyde **31a**, we tried to displace the formyl group of **20a** according to the method we

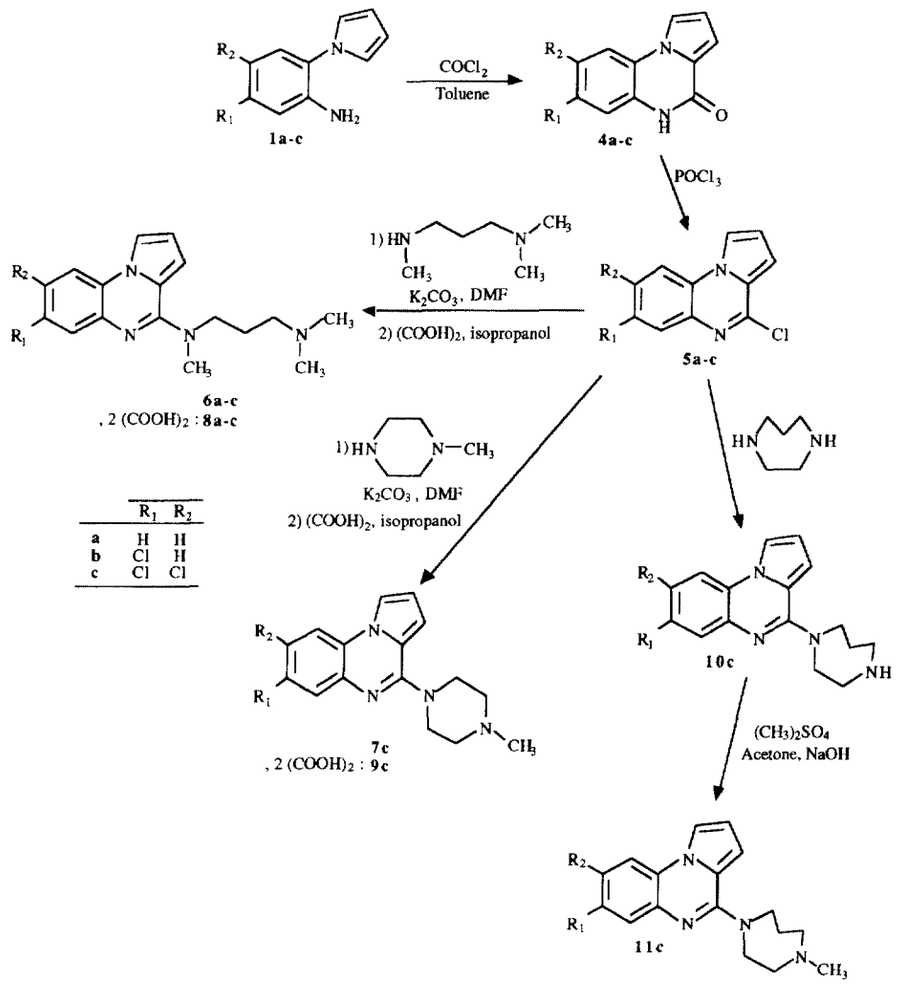

Figure 3. Synthesis of compounds **8a–c**, **9c** and **11c**.

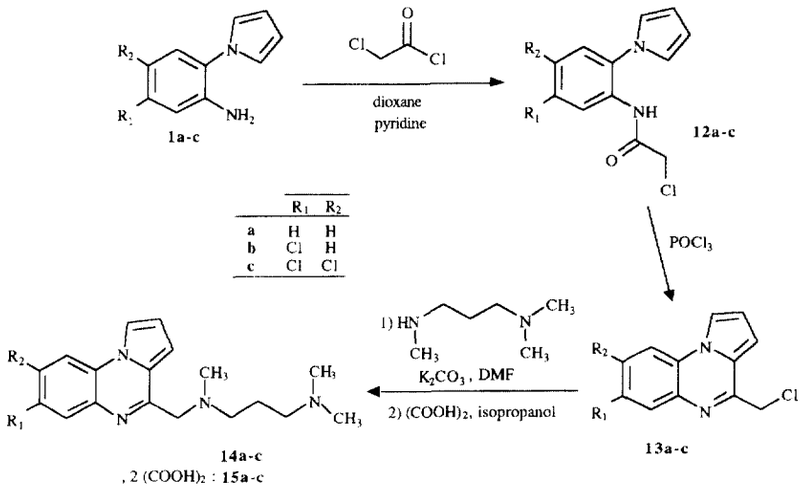

Figure 4. Synthesis of compounds **15a–c**.

previously described in 1-phenylpyrrole series [35]. However, all attempts using trifluoromethanesulfonic acid in various conditions of temperature failed and only furnished the deformylated product **16a** (*figure 6*).

The aldehydes **31a,b** were finally prepared according to the following sequence. Reaction of commercialy available phenylenediamines **32a,b** with 1-phenylpropan-1,2-dione in acetic acid gave the methylphenylquinoxalines **33a,b** according to the von Auwers method [36]. Treatment of **33a,b** with ethyl bromopyruvate in refluxing ethanol [37–39] led to ethyl 4-phenylpyrrolo[1,2-*a*]quinoxaline-2-carboxylates **34a,b**. Reduction of the ester group of **34a,b** with lithium aluminium hydride in anhydrous THF at 0 °C gave the alcohols **35a,b** [40] subsequently oxydized into the attempted aldehydes **31a,b** using manganese dioxide in chloroform [41, 42]. The imines **36a,b**, amines **37a,b** and oxalates **38a,b** were then prepared as above (*figure 7*).

3. In vitro pharmacology

The binding affinities of the described compounds and reference products (tGLP-1, glucagon, CP-99,711) have been measured at rat tGLP-1 and glucagon receptors [43].

4. Results and discussion

Twenty pyrrolo[1,2-*a*]quinoxaline derivatives were synthesized and evaluated for their affinity to the glucagon receptor. As glucagon share some sequence homology with tGLP-1 (7-37), all the compounds were also evaluated on the tGLP-1 receptor (*table I*).

Surprisingly CP-99,711 showed a better affinity for the tGLP-1 receptor than for the glucagon receptor with IC_{50} of respectively 0.3 μM and 1 μM.

With the exception of **30a** (IC_{50} = 5 μM and 2.5 μM on glucagon and tGLP-1 receptors respectively) and to a less extend **30c** (IC_{50} = 10 μM on both receptors) **8c** and **38b** (IC_{50} = 10 μM on glucagon receptor) none of the synthesized compounds showed any significant affinity for the glucagon receptor.

It is undoubtedly not a hazard if **30a** and **30c** are the only synthesized compounds having a styryl substituant as CP-99,711. Affinities of **30a** and **30c** remain lower than those of CP-99,711 probably because of a wrong relative orientation (too great angulation) between the styryl and the aminoalkylaminomethyl side chains. **38b** which present a lower angulation between the aromatic and amino substituents has a significant affinity for the glucagon receptor though been substituted by a phenyl instead of a styryl.

It would be interesting to enlarge the biological evaluation of these new pyrroloquinoxalines towards other receptors of the same type such as secretine or GRP receptors.

5. Experimental protocols

5.1. Chemistry

Melting points were determinated on a Kofler block and are uncorrected. IR spectra were recorded on a Philips PU-9716 spectrophotometer. NMR spectra (^1H, ^{13}C, ^1H-COSY) were

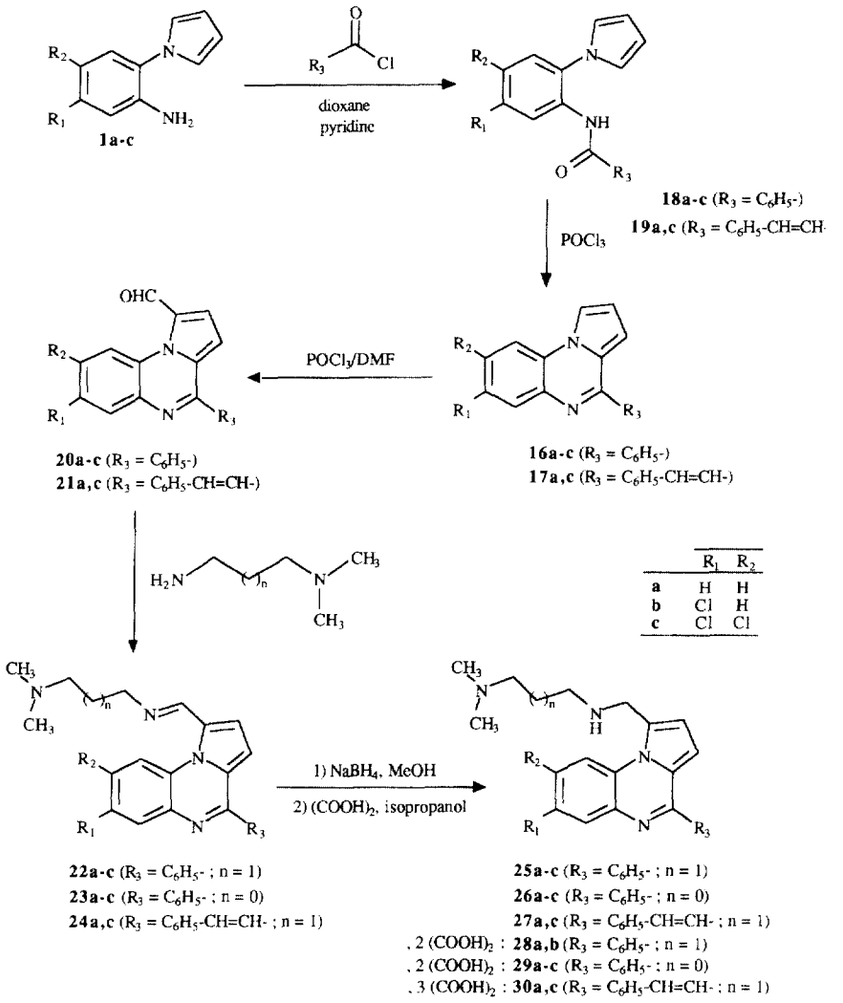

Figure 5. Synthesis of compounds **28a,b**, **29a–c** and **30a,c**.

recorded at 400 MHz or 100 MHz with tetramethylsilane as an internal standard using a JEOL JNM-LA 400 spectrometer. Splitting patterns have been designated as follows: s = singlet; bs = broad singlet; d = doublet; t = triplet; q = quartet; qt = quintuplet; dd = double doublet; m = multiplet. Mass spectra were recorded on a JEOL D 300 instrument using direct inlet system and electron impact ionisation. Analytical TLC was carried out on 0.25 precoated silica gel plates (POLYGRAM SIL G/UV$_{254}$) with visualisation by irradiation with a UV lamp. Silica gel 60 (70–230 mesh) was used for column chromatography. Analyses indicated by the symbols of the elements were within ± 0.4% of the theoretical values.

5.1.1. General procedure for the preparation of 1-(2-aminophenyl)pyrroles ***1a–c***

To a solution of 1-(2-nitrophenyl)pyrrole **3** (0.02 mol) in ethanol (130 mL) was added bismuth trichloride (0.03 mol). Sodium borohydride (0.16 mol) was added portion-wise at 0 °C to the reaction mixture which was then stirred at room temperature for 2 h. The solution was then poured into an aqueous hydrochloric acid solution (1 N, 130 mL) and stirred for an other hour. Ethanol was evaporated under reduced pressure. The residue was made alkaline with concentrated aqueous ammonium hydroxide solution and then extracted with ethyl acetate. The organic layer was dried over magnesium sulfate and evaporated to dryness under reduced pressure. The residue was then recrystallized from hexane to give **1** as yellow crystals.

5.1.2. 1-(2-Aminophenyl)pyrrole ***1a***

Yellow crystals (70%): m.p. 96 °C (lit. [22] 98 °C); IR (KBr) 3480, 3310 (NH_2); ^{1}H-NMR (DMSO-d_6) δ: 7.08 (t, 1H, $J_{H\text{-}4\ H\text{-}3}$ = $J_{H\text{-}4\ H\text{-}5}$ = 7.32 Hz, H-4), 7.02 (dd, 1H, $J_{H\text{-}3\ H\text{-}4}$ = 7.32 Hz, $J_{H\text{-}3\ H\text{-}5}$ = 1.46 Hz, H-3), 6.88 (dd, 2H, $J_{H\text{-}\alpha\ H\text{-}\beta}$ =

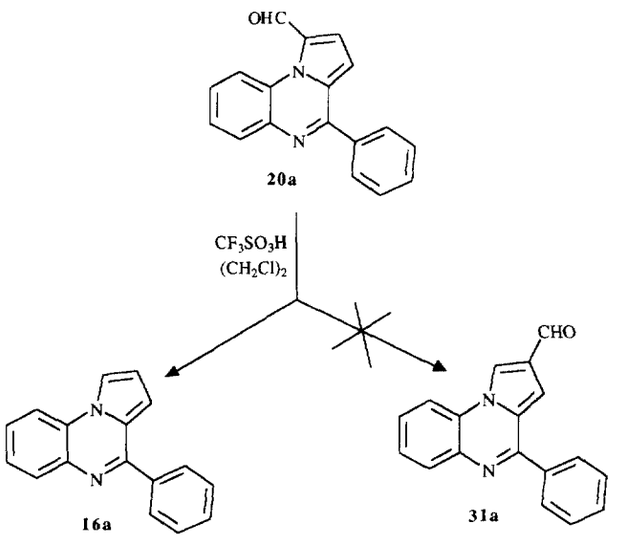

Figure 6. Attempt to rearrange compound **20a**.

1.96 Hz, 2H-α), 6.84 (dd, 1H, $J_{H\text{-}6\ H\text{-}5}$ = 7.32 Hz, $J_{H\text{-}6\ H\text{-}4}$ = 1.46 Hz, H-6), 6.63 (t, 1H, $J_{H\text{-}5\ H\text{-}6}$ = $J_{H\text{-}5\ H\text{-}4}$ = 7.32 Hz, H-5), 6.23 (dd, 2H, $J_{H\text{-}\beta\ H\text{-}\alpha}$ = 1.96 Hz, 2H-β); ^{13}C-NMR (DMSO-d_6) δ: 142.8 (C-1), 127.8 (C-2), 126.2 (C-4), 126.1 (C-6), 121.2 (2C-α), 116.3 (C-5), 115.6 (C-3), 108.7 (2C-β).

5.1.3. 1-(2-Amino-4-chlorophenyl)pyrrole ***1b***

Yellow crystals (74%): m.p. 89 °C (lit. [44] 89 °C); IR (KBr) 3380, 3210 (NH_2); ^{1}H-NMR (DMSO-d_6) δ: 7.01 (d, 1H, $J_{H\text{-}6\ H\text{-}5}$ = 8.30 Hz, H-6), 6.89 (d, 1H, $J_{H\text{-}3\ H\text{-}5}$ = 2.44 Hz, H-3), 6.87 (dd, 2H, $J_{H\text{-}\alpha\ H\text{-}\beta}$ = 1.95 Hz, 2H-α), 6.61 (dd, 1H, $J_{H\text{-}5\ H\text{-}6}$ = 8.30 Hz, $J_{H\text{-}5\ H\text{-}3}$ = 2.44 Hz, H-5), 6.24 (dd, 2H, $J_{H\text{-}\beta\ H\text{-}\alpha}$ = 1.95 Hz, 2H-β), 5.11 (s, 2H, NH_2); ^{13}C-NMR (DMSO-d_6) δ: 144.5 (C-2), 132.2 (C-4), 127.9 (C-1), 125.0 (C-6), 121.4 (2C-α), 115.8 (C-5), 114.8 (C-3), 109.2 (2C-β).

5.1.4. 1-(2-Amino-4,5-dichlorophenyl)pyrrole ***1c***

Yellow crystals (63%): m.p. 60 °C (lit. [44] 58 °C); IR (KBr) 3410, 3320 (NH_2); ^{1}H-NMR (DMSO-d_6) δ: 7.23 (s, 1H, H-3), 7.07 (s, 1H, H-6), 6.91 (dd, 2H, $J_{H\text{-}\alpha\ H\text{-}\beta}$ = 1.96 Hz, 2H-α), 6.29 (dd, 2H, $J_{H\text{-}\beta\ H\text{-}\alpha}$ = 1.96 Hz, 2H-β), 5.20 (s, 2H, NH_2), ^{13}C-NMR (DMSO-d_6) δ: 143.5 (C-2), 130.1 (C-4), 127.7 (C-1), 125.9 (C-5), 121.4 (2C-α), 116.8 (C-6), 116.2 (C-3), 109.4 (2C-β); MS (EI) *m/z*: 227 (M^+, 61), 226 (62), 225 (100), 224 (83), 198 (35), 156 (19), 78 (15).

5.1.5. General procedure for the preparation of 1-(2-nitrophenyl)pyrroles ***3a–c***

A mixture of nitroaniline **2** (0.07 mol) and 2,5-dimethoxytetrahydrofuran (0.07 mol) in acetic acid (100 mL) was refluxed for 8 min with vigorous stirring under microwaves (850 Watts) irradiations. After cooling, the reaction mixture was poured into water (300 mL). The precipitate was filtered, washed with water and dissolved in ethyl ether (150 mL). The organic layer was washed with water (100 mL), dried over magnesium sulfate and evaporated to dryness under reduced pressure to give red crystals which were recrystallized from petroleum ether.

5.1.6. 1-(2-Nitrophenyl)pyrrole ***3a***

Red crystals (82%): m.p. 56 °C (lit. [22] 55 °C); ^{1}H-NMR (DMSO-d_6) δ: 7.23 (dd, 1H, $J_{H\text{-}3\ H\text{-}4}$ = 7.32 Hz, $J_{H\text{-}3\ H\text{-}5}$ = 1.46 Hz, H-3), 6.98 (dd, 1H, $J_{H\text{-}6\ H\text{-}5}$ = 7.32 Hz, $J_{H\text{-}6\ H\text{-}4}$ = 1.46 Hz, H-6), 6.82 (m, 2H, H-4 et H-5), 6.12 (dd, 2H, $J_{H\text{-}\alpha\ H\text{-}\beta}$ = 1.96 Hz, 2H-α), 5.45 (dd, 2H, $J_{H\text{-}\beta\ H\text{-}\alpha}$ = 1.96 Hz, 2H-β).

5.1.7. 1-(4-Chloro-2-nitrophenyl)pyrrole ***3b***

Red crystals (84%): m.p. 57 °C (lit. [44] 56 °C); ^{1}H-NMR (DMSO-d_6) δ: 8.18 (d, 1H, $J_{H\text{-}3\ H\text{-}5}$ = 2.44 Hz, H-3), 7.83 (dd, 1H, $J_{H\text{-}5\ H\text{-}6}$ = 8.78 Hz, $J_{H\text{-}5\ H\text{-}3}$ = 2.44 Hz, H-5), 7.65 (d, 1H, $J_{H\text{-}6\ H\text{-}5}$ = 8.78 Hz, H-6), 6.93 (dd, 2H, $J_{H\text{-}\alpha\ H\text{-}\beta}$ = 1.96 Hz, 2H-α), 6.29 (dd, 2H, $J_{H\text{-}\beta\ H\text{-}\alpha}$ = 1.96 Hz, 2H-β).

5.1.8. 1-(4,5-Dichloro-2-nitrophenyl)pyrrole ***3c***

Red crystals (86%): m.p. 69 °C (lit. [44] 70 °C); ^{1}H-NMR (DMSO-d_6) δ: 8.43 (s, 1H, H-3), 8.01 (s, 1H, H-6), 6.97 (dd, 2H, $J_{H\text{-}\alpha\ H\text{-}\beta}$ = 1.95 Hz, 2H-α), 6.28 (dd, 2H, $J_{H\text{-}\beta\ H\text{-}\alpha}$ = 1.95 Hz, 2H-β); ^{13}C-NMR (DMSO-d_6) δ: 143.0 (C-5), 138.2 (C-2), 136.2 (C-1), 132.7 (C-4), 129.2 (C-3), 126.4 (C-6), 121.3 (2C-α), 111.0 (2C-β); MS (EI) *m/z*: 258 (M^+ + 1, 23), 256 (37), 241 (67), 239 (100), 211 (59), 186 (45), 140 (35).

5.1.9. General procedure for the preparation of 5H-pyrrolo[1,2-a]-quinoxalin-4-ones ***4a–c***

A solution of phosgene in toluene (20%, 0.0375 mol) was added to a solution of 1-(2-aminophenyl)pyrrole **1** (0.03 mol) in toluene (80 mL), then heated under reflux for 4 h. The solution was then allowed to come to room temperature. The crystalline precipitate was filtered off, washed with ethyl ether and recrystallized from ethyl acetate to give **4** as white crystals.

5.1.10. 7-Chloro-5H-pyrrolo[1,2-a]quinoxalin-4-one ***4b***

White crystals (84%): m.p. > 260 °C; IR (KBr) 3200-2700 (NH), 1650 (CO); ^{1}H-NMR (DMSO-d_6) δ: 11.25 (s, 1H, NH), 8.13 (dd, 1H, $J_{H\text{-}1\ H\text{-}2}$ = 2.60 Hz, $J_{H\text{-}1\ H\text{-}3}$ = 0.91 Hz, H-1), 8.03 (d, 1H, $J_{H\text{-}9\ H\text{-}8}$ = 8.75 Hz, H-9), 7.33 (d, 1H, $J_{H\text{-}6\ H\text{-}8}$ = 1.83 Hz, H-6), 7.21 (dd, 1H, $J_{H\text{-}8\ H\text{-}9}$ = 8.75 Hz, $J_{H\text{-}8\ H\text{-}6}$ = 1.83 Hz, H-8), 7.06 (dd, 1H, $J_{H\text{-}3\ H\text{-}2}$ = 3.70 Hz, $J_{H\text{-}3\ H\text{-}1}$ = 0.91 Hz, H-3), 6.69 (dd, 1H, $J_{H\text{-}2\ H\text{-}3}$ = 3.70 Hz, $J_{H\text{-}2\ H\text{-}1}$ = 2.60 Hz, 1H, H-2); ^{13}C-NMR (DMSO-d_6) δ: 154.8 (CO), 129.9 (C-5a), 129.3 (C-3a), 123.0 (C-7), 122.0 (C-9a), 121.6 (C-1), 118.3 (C-8), 116.6 (C-3), 115.7 (C-9), 112.9 (C-6), 111.7 (C-2). Anal. $C_{11}H_7ClN_2O$ (C, H, N).

5.1.11. 7,8-Dichloro-5H-pyrrolo[1,2-a]quinoxalin-4-one ***4c***

White crystals (91%): m.p. > 260 °C; IR (KBr) 3200-2700 (NH), 1645 (CO); ^{1}H-NMR (DMSO-d_6) δ: 11.09 (s, 1H, NH), 8.27 (s, 1H, H-9), 8.12 (dd, 1H, $J_{H\text{-}1\ H\text{-}2}$ = 2.70 Hz, $J_{H\text{-}1\ H\text{-}3}$ = 0.92 Hz, H-1), 7.45 (s, 1H, H-6), 7.05 (dd, 1H, $J_{H\text{-}3\ H\text{-}2}$ = 3.64 Hz, $J_{H\text{-}3\ H\text{-}1}$ = 0.92 Hz, H-3), 6.66 (dd, 1H, $J_{H\text{-}2\ H\text{-}3}$ = 3.64 Hz, $J_{H\text{-}2\ H\text{-}1}$ = 2.70 Hz, H-2); ^{13}C-NMR (DMSO-d_6) δ: 154.7 (CO), 128.9 (C-3a), 127.4 (C-5a), 124.4 (C-9a), 123.3 (C-7), 122.7 (C-8), 118.9 (C-1), 117.4 (C-3), 116.8 (C-6), 113.2 (C-9), 112.3 (C-2); MS (EI) *m/z*: 254 (M^+ + 1, 67), 253 (M^+, 15), 252 (100), 223 (10), 197 (13), 189 (23). Anal. $C_{11}H_6Cl_2N_2O$ (C, H, N).

5.1.12. General procedure for the preparation of 4-chloropyrrolo[1,2-a]quinoxalines ***5a–c***

A solution of 5*H*-pyrrolo[1,2-*a*]quinoxalin-4-one **4** (0.03 mol) in $POCl_3$ (60 mL) was refluxed for 4 h. After removing excess of reactive under vaccum, the residue was carrefully dissolved in water at 0 °C and the resulting solution was alkalinized with 30% aqueous ammonium hydroxide solution. The precipitate was filtered and recrystallized from ethyl acetate to give **5**.

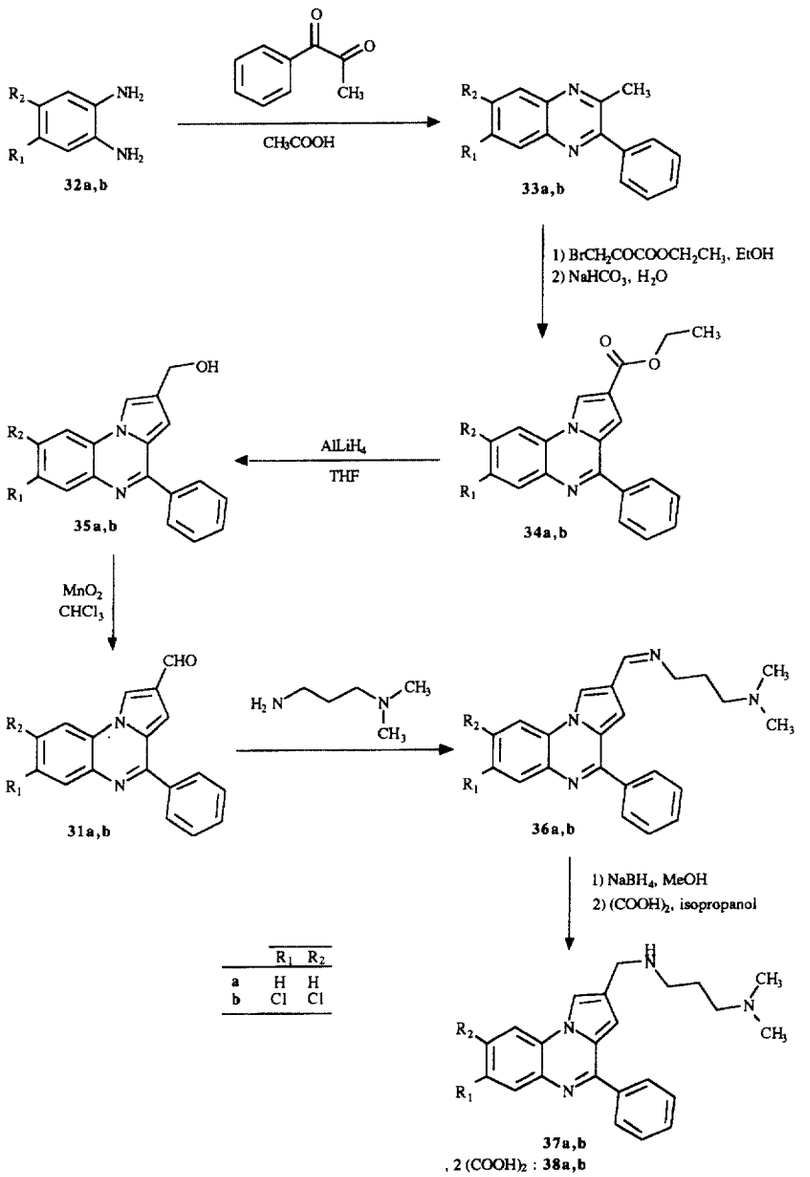

Figure 7. Synthesis of compounds **38a,b**.

5.1.13. 4,7-Dichloropyrrolo[1,2-a]quinoxaline ***5b***

White crystals (79%): m.p. 198 °C; ^{1}H-NMR (DMSO-d_6) δ: 8.52 (dd, 1H, $J_{H\text{-}1\,H\text{-}2}$ = 2.68 Hz, $J_{H\text{-}1\,H\text{-}3}$ = 0.98 Hz, H-1), 8.28 (d, 1H, $J_{H\text{-}9\,H\text{-}8}$ = 8.79 Hz, H-9), 7.83 (d, 1H, $J_{H\text{-}6\,H\text{-}8}$ = 2.44 Hz, H-6), 7.62 (dd, 1H, $J_{H\text{-}8\,H\text{-}9}$ = 8.79 Hz, $J_{H\text{-}8\,H\text{-}6}$ = 2.44 Hz, H-8), 7.06 (dd, 1H, $J_{H\text{-}3\,H\text{-}2}$ = 3.91 Hz, $J_{H\text{-}3\,H\text{-}1}$ = 0.98 Hz, H-3), 6.98 (dd, 1H, $J_{H\text{-}2\,H\text{-}3}$ = 3.91 Hz, $J_{H\text{-}2\,H\text{-}1}$ = 2.68 Hz, H-2). Anal. $C_{11}H_6Cl_2N_2$ (C, H, N).

Table I. Binding of new pyrrolo[1,2-*a*]quinoxalines to tGLP-1 and glucagon receptors.

Compound	tGLP-1 receptor IC_{50} (μM)	Glucagon receptor IC_{50} (μM)
tGLP-1	16×10^{-5}	> 10
Glucagon	> 10	5×10^{-4}
CP-99,711	0.3	0.1
8a	> 10	> 10
8b	> 10	> 10
8c	> 10	10
9c	> 10	> 10
11c	> 10	> 10
15a	> 10	> 10
15b	> 10	> 10
15c	> 10	> 10
22c	> 10	> 10
23a	> 10	> 10
25c	> 10	> 10
28a	> 10	> 10
28b	> 10	> 10
29a	> 10	> 10
29b	> 10	> 10
29c	> 10	> 10
30a	2.5	5
30c	10	10
38a	> 10	> 10
38b	> 10	10

5.1.14. 4,7,8-Trichloropyrrolo[1,2-a]quinoxaline ***5c***

White crystals (95%): m.p. 230 °C; ^{1}H-NMR (DMSO-d_6) δ: 8.57 (s, 1H, H-9), 8.54 (m, 1H, H-1), 7.95 (s, 1H, H-6), 7.06 (m, 1H, H-3), 6.97 (m, 1H, H-2); MS (EI) *m/z*: 272 (M^+ + 1, 94), 271 (M^+, 14), 270 (100), 235 (24), 208 (11), 200 (15), 135 (10). Anal. $C_{11}H_5Cl_3N_2$ (C, H, N).

5.1.15. General procedure for the preparation of N-(pyrrolo[1,2-a]quinoxalin-4-yl)-N,N',N'-trimethylpropane-1,3-diamines ***6a–c****, 7,8-Dichloro-4-(4-methylpiperazin-1-yl)pyrrolo[1,2-a]quinoxaline* ***7c*** *and N-(pyrrolo[1,2-a]quinoxalin-4-ylmethyl)-N,N',N'-trimethylpropane-1,3-diamines* ***14a–c***

To a solution of 4-chloropyrrolo[1,2-*a*]quinoxaline **5** or 4-chloromethylpyrrolo[1,2-*a*]quinoxaline **13** (0.01 mol) in dimethylformamide (35 mL) were added K_2CO_3 (0.012 mol) then *N,N,N'*-trimethyl-1,3-propanediamine or *N*-methylpiperazine (0.011 mol). The reaction mixture was heated at 120–130 °C for 4 h and, after cooling, was poured into water (100 mL). The suspension was extracted with ethyl ether (2 x 100 mL). The organic layers were collected, washed with water (150 mL), dried over magnesium sulfate and evaporated to dryness under reduced pressure to give **6a–c**, **7c** or **14a–c**. Oils were used without other purification; **7c** was recrystallized from hexane.

5.1.16. N-(pyrrolo[1,2-a]quinoxalin-4-yl)-N,N',N'-trimethylpropane-1,3-diamine ***6a***

Yellow oil (84%): ^{1}H-NMR (DMSO-d_6) δ: 8.26 (dd, 1H, $J_{H\text{-}1\,H\text{-}2}$ = 2.78 Hz, $J_{H\text{-}1\,H\text{-}3}$ = 1.20 Hz, H-1), 8.00 (d, 1H, $J_{H\text{-}9\,H\text{-}8}$ = 7.73 Hz, H-9), 7.45 (d, 1H, $J_{H\text{-}6\,H\text{-}7}$ = 7.73 Hz, H-6), 7.26 (t, 1H, $J_{H\text{-}8\,H\text{-}9} = J_{H\text{-}8\,H\text{-}7}$ = 7.73 Hz, H-8), 7.17 (t, 1H, $J_{H\text{-}7\,H\text{-}8} = J_{H\text{-}7\,H\text{-}6}$ = 7.73 Hz, H-7), 7.01 (dd, 1H, $J_{H\text{-}3\,H\text{-}2}$ = 4.03 Hz, $J_{H\text{-}3\,H\text{-}1}$ = 1.20 Hz, H-3), 6.76 (dd, 1H, $J_{H\text{-}2\,H\text{-}3}$ = 4.03 Hz, $J_{H\text{-}2\,H\text{-}1}$ = 2.78 Hz, H-2), 3.74 (t, 2H, $J_{CH2\,CH2}$ = 7.10 Hz, CH_2), 3.34 (s, 3H, CH_3), 2.26 (t, 2H, $J_{CH2\,CH2}$ = 7.10 Hz, CH_2), 2.14 (s, 6H, $2CH_3$), 1.81 (qt, 2H, $J_{CH2\,CH2}$ = 7.10 Hz, CH_2); ^{13}C-NMR (DMSO-d_6) δ: 150.6 (C-4), 136.3 (C-5a), 125.7 (C-6), 125.0 (C-7), 124.5 (C-9a), 122.2 (C-8), 118.7 (C-3a), 115.6 (C-9), 113.8 (C-1), 112.3 (C-3), 108.1 (C-2), 56.4 (CH_2), 49.3 (CH_2), 45.2 ($2CH_3$), 38.2 (CH_3), 25.4 (CH_2). Anal. $C_{17}H_{22}N_4$ (C, H, N).

5.1.17. N-(7-Chloropyrrolo[1,2-a]quinoxalin-4-yl)-N,N',N'-trimethylpropane-1,3-diamine ***6b***

Yellow oil (84%): ^{1}H-NMR (DMSO-d_6) δ: 8.19 (m, 1H, H-1), 7.95 (d, 1H, $J_{H\text{-}9\,H\text{-}8}$ = 8.79 Hz, H-9), 7.36 (d, 1H, $J_{H\text{-}6\,H\text{-}8}$ = 2.47 Hz, H-6), 7.11 (dd, 1H, $J_{H\text{-}8\,H\text{-}9}$ = 8.79 Hz, $J_{H\text{-}8\,H\text{-}6}$ = 2.47 Hz, H-8), 6.98 (m, 1H, H-3), 6.74 (m, 1H, H-2), 3.69 (t, 2H, $J_{CH2\,CH2}$ = 7.0 Hz, CH_2), 3.32 (s, 3H, CH_3), 2.27 (t, 2H, $J_{CH2\,CH2}$ = 7.0 Hz, CH_2), 2.14 (s, 6H, $2CH_3$), 1.77 (qt, 2H, $J_{CH2\,CH2}$ = 7.0 Hz, CH_2). Anal. $C_{17}H_{21}ClN_4$ (C, H, N).

5.1.18. N-(7,8-Dichloropyrrolo[1,2-a]quinoxalin-4-yl)-N,N',N'-trimethyl-propane-1,3-diamine ***6c***

Yellow oil (93%): ^{1}H-NMR (DMSO-d_6) δ: 8.30 (dd, 1H, $J_{H\text{-}1\,H\text{-}2}$ = 2.93 Hz, $J_{H\text{-}1\,H\text{-}3}$ = 0.98 Hz, H-1), 8.28 (s, 1H, H-9), 7.42 (s, 1H, H-6), 7.02 (dd, 1H, $J_{H\text{-}3\,H\text{-}2}$ = 3.91 Hz, $J_{H\text{-}3\,H\text{-}1}$ = 0.98 Hz, H-3), 6.76 (dd, 1H, $J_{H\text{-}2\,H\text{-}3}$ = 3.91 Hz, $J_{H\text{-}2\,H\text{-}1}$ = 2.93 Hz, H-2), 3.71 (t, 2H, $J_{CH2\,CH2}$ = 7.32 Hz, CH_2), 3.33 (s, 3H, CH_3), 2.26 (t, 2H, $J_{CH2\,CH2}$ = 7.32 Hz, CH_2), 2.15 (s, 6H, $2CH_3$), 1.80 (qt, 2H, $J_{CH2\,CH2}$ = 7.32 Hz, CH_2); ^{13}C-NMR (DMSO-d_6) δ: 150.8 (C-4), 136.5 (C-5a), 126.7 (C-9), 125.6 (C-9a), 124.0 (C-8), 122.9 (C-7), 118.0 (C-3a), 116.7 (C-1), 115.3 (C-6), 112.7 (C-2), 109.2 (C-3), 56.4 (CH_2), 49.3 (CH_2), 45.1 ($2CH_3$), 38.2 (CH_3), 25.3 (CH_2); MS (EI) *m/z*: 352 (M^+ + 1, 17), 351 (M^+, 32), 292 (36), 279 (80), 250 (73), 236 (20), 85 (63), 58 (100). Anal. $C_{17}H_{20}Cl_2N_4$ (C, H, N).

5.1.19. 7,8-Dichloro-4-(4-methylpiperazin-1-yl)pyrrolo[1,2-a]-quinoxaline ***7c***

Yellow crystals (80%): m.p. 144 °C; ^{1}H-NMR (DMSO-d_6) δ: 8.33 (s, 1H, H-9), 8.28 (dd, 1H, $J_{H\text{-}1\,H\text{-}2}$ = 3.11 Hz, $J_{H\text{-}1\,H\text{-}3}$ = 0.92 Hz, H-1), 7.59 (s, 1H, H-6), 6.96 (dd, 1H, $J_{H\text{-}3\,H\text{-}2}$ = 4.07 Hz, $J_{H\text{-}3\,H\text{-}1}$ = 0.92 Hz, H-3), 6.79 (dd, 1H, $J_{H\text{-}2\,H\text{-}3}$ = 4.07 Hz, $J_{H\text{-}2\,H\text{-}1}$ = 3.11 Hz, H-2), 3.79 (t, 4H, $J_{CH2\,CH2}$ = 4.76 Hz, $2CH_2$), 2.48 (t, 4H, $J_{CH2\,CH2}$ = 4.76 Hz, $2CH_2$), 2.24 (s, 3H, CH_3); ^{13}C-NMR (DMSO-d_6) δ: 152.1 (C-4), 135.9 (C-5a), 126.9 (C-9a), 126.7 (C-8), 124.7 (C-7), 124.6 (C-6), 118.6 (C-9), 117.0 (C-1), 115.6 (C-3a), 113.1 (C-3), 108.6 (C-2), 54.5 ($2CH_2$), 46.9 ($2CH_2$), 45.4 (CH_3). Anal. $C_{16}H_{16}Cl_2N_4$ (C, H, N).

5.1.20. N-(Pyrrolo[1,2-a]quinoxalin-4-ylmethyl)-N,N',N'-trimethylpropane-1,3-diamine ***14a***

Orange oil (66%): ^{1}H-NMR (DMSO-d_6) δ: 8.37 (m, 1H, H-1), 8.23 (d, 1H, $J_{H\text{-}9\,H\text{-}8}$ = 7.82 Hz, H-9), 7.86 (d, 1H, $J_{H\text{-}6\,H\text{-}7}$ = 7.82 Hz, H-6), 7.58 (m, 1H, H-8), 7.46 (m, 1H, H-7), 7.18 (m, 1H, H-3), 6.89 (m, 1H, H-2), 3.78 (s, 2H, CH_2), 2.46 (t, 2H,

$J_{CH2\ CH2}$ = 6.84 Hz, CH_2), 2.22 (s, 3H, CH_3), 2.16 (t, 2H, $J_{CH2\ CH2}$ = 6.84 Hz, CH_2), 2.05 (s, 6H, $2CH_3$), 1.54 (qt, 2H, $J_{CH2\ CH2}$ = 6.84 Hz, CH_2). Anal. $C_{18}H_{24}N_4$ (C, H, N).

5.1.21. N-(7-Chloropyrrolo[1,2-a]quinoxalin-4-ylmethyl)-N,N',N'-trimethylpropane-1,3-diamine ***14b***

Orange oil (78%): ^{1}H-NMR (DMSO-d_6) δ: 8.39 (m, 1H, H-1), 8.29 (d, 1H, $J_{H-9\ H-8}$ = 8.79 Hz, H-9), 7.84 (d, 1H, $J_{H-6\ H-8}$ = 2.44 Hz, H-6), 7.56 (dd, 1H, $J_{H-8\ H-9}$ = 8.79 Hz, $J_{H-8\ H-6}$ = 2.44 Hz, H-8), 7.19 (m, 1H, H-3), 6.89 (m, 1H, H-2), 3.75 (s, 2H, CH_2), 2.43 (t, 2H, $J_{CH2\ CH2}$ = 6.83 Hz, CH_2), 2.21 (s, 3H, CH_3), 2.16 (t, 2H, $J_{CH2\ CH2}$ = 6.83 Hz, CH_2), 2.05 (s, 6H, $2CH_3$), 1.59 (qt, 2H, $J_{CH2\ CH2}$ = 6.83 Hz, CH_2). Anal. $C_{18}H_{23}ClN_4$ (C, H, N).

5.1.22. N-(7,8-Dichloropyrrolo[1,2-a]quinoxalin-4-ylmethyl)-N,N',N'-trimethylpropane-1,3-diamine ***14c***

Orange oil (67%): ^{1}H-NMR (DMSO-d_6) δ: 8.55 (s, 1H, H-9), 8.43 (dd, 1H, $J_{H-1\ H-2}$ = 2.26 Hz, $J_{H-1\ H-3}$ = 0.96 Hz, H-1), 7.93 (s, 1H, H-6), 7.18 (dd, 1H, $J_{H-3\ H-2}$ = 3.50 Hz, $J_{H-3\ H-1}$ = 0.96 Hz, H-3), 6.89 (dd, 1H, $J_{H-2\ H-3}$ = 3.50 Hz, $J_{H-2\ H-1}$ = 2.26 Hz, H-2), 3.72 (s, 2H, CH_2), 2.47 (t, 2H, $J_{CH2\ CH2}$ = 6.92 Hz, CH_2), 2.25 (t, 2H, $J_{CH2\ CH2}$ = 6.92 Hz, CH_2), 2.21 (s, 3H, CH_3), 2.12 (s, 6H, $2CH_3$), 1.62 (qt, 2H, $J_{CH2\ CH2}$ = 6.92 Hz, CH_2); ^{13}C-NMR (DMSO-d_6) δ: 155.8 (C-4), 134.7 (C-5a), 129.7 (C-9a), 129.4 (C-8), 126.9 (C-7), 126.6 (C-6), 124.8 (C-9), 116.7 (C-3a), 116.4 (C-1), 114.0 (C-3), 108.5 (C-2), 62.2 (CH_2), 56.8 (CH_2), 55.4 (CH_2), 44.7 ($2CH_3$), 42.2 (CH_3), 24.6 (CH_2). Anal. $C_{18}H_{22}Cl_2N_4$ (C, H, N).

5.1.23. 7,8-Dichloro-4-([1,4]diazepan-1-yl)-pyrrolo[1,2-a]-quinoxaline ***10c***

To a solution of homopiperazine (0.026 mol) at 40-50 °C was added portion-wise 4,7,8-trichloropyrrolo[1,2-*a*]quinoxaline **5c** (0.0037 mol). The reaction mixture was heated at 140 °C for 3 h and then, after cooling, was poured into water (50 mL). The precipitate was collected, washed with water, dried and recrystallized from ethanol. Yellow crystals (70%): m.p. 110 °C; IR (KBr) 3420 (NH); ^{1}H-NMR (DMSO-d_6) δ: 8.25 (dd, 1H, $J_{H-1\ H-2}$ = 2.98 Hz, $J_{H-1\ H-3}$ = 0.97 Hz, H-1), 8.23 (s, 1H, H-9), 7.44 (s, 1H, H-6), 6.94 (dd, 1H, $J_{H-3\ H-2}$ = 4.08 Hz, $J_{H-3\ H-1}$ = 0.97 Hz, H-3), 6.74 (dd, 1H, $J_{H-2\ H-3}$ = 4.08 Hz, $J_{H-2\ H-1}$ = 2.98 Hz, H-2), 3.96 (t, 2H, $J_{CH2\ CH2}$ = 5.52 Hz, CH_2), 3.92 (t, 2H, $J_{CH2\ CH2}$ = 5.52 Hz, CH_2), 3.00 (t, 2H, $J_{CH2\ CH2}$ = 5.52 Hz, CH_2), 2.76 (m, 3H, NH and CH_2), 1.87 (qt, 2H, $J_{CH2\ CH2}$ = 5.52 Hz, CH_2). Anal. $C_{16}H_{16}Cl_2N_4$ (C, H, N).

5.1.24. 7,8-Dichloro-4-(4-methyl[1,4]diazepan-1-yl)-pyrrolo-[1,2-a]quinoxaline ***11c***

To a solution of 7,8-dichloro-4-([1,4]diazepan-1-yl)-pyrrolo[1,2-*a*]quinoxaline **10c** (0.002 mol) in acetone (35 mL) was added aqueous sodium hydroxide solution (5%, 5 mL) then dimethyl sulfate (0.003 mol). The mixture was refluxed for 3 h and evaporated to dryness. The residue was triturated in water to give **10c** as white crystals which were filtered, washed with water, dried and recrystallized from propan-2-ol. White crystals (91%): m.p. > 260 °C; ^{1}H-NMR (DMSO-d_6) δ: 8.39 (dd, 1H, $J_{H-1\ H-2}$ = 2.90 Hz, $J_{H-1\ H-3}$ = 0.80 Hz, H-1), 8.38 (s, 1H, H-9), 7.54 (s, 1H, H-6), 7.05 (dd, 1H, $J_{H-3\ H-2}$ = 3.40 Hz, $J_{H-3\ H-1}$ = 0.80 Hz, H-3), 6.84 (dd, 1H, $J_{H-2\ H-3}$ = 3.40 Hz, $J_{H-2\ H-1}$ = 2.90 Hz, H-2), 4.23 (t, 2H, $J_{CH2\ CH2}$ = 5.30 Hz, CH_2), 4.10 (t, 2H, $J_{CH2\ CH2}$ = 5.30 Hz, CH_2), 3.77 (t, 2H, $J_{CH2\ CH2}$ = 5.30 Hz, CH_2), 3.60 (t, 2H, $J_{CH2\ CH2}$ = 5.30 Hz, CH_2), 3,.41 (s, 3H, CH_3), 2.36 (qt, 2H, $J_{CH2\ CH2}$ = 5.30 Hz, CH_2); ^{13}C-NMR (DMSO-d_6) δ: 155.2 (C-4), 135.9 (C-5a), 126.9 (C-9a), 126.3 (C-7), 124.4 (C-8), 124.1 (C-6), 118.0 (C-9), 117.4 (C-1), 115.7 (C-3a), 113.2 (C-3), 109.9 (C-2), 64.9 (CH_2), 64.0 (CH_2), 52.7 (CH_2), 52.0 (CH_2), 40.8 (CH_3), 22.2 (CH_2). Anal. $C_{17}H_{18}Cl_2N_4$ (C, H, N).

5.1.25. General procedure for the preparation of N-(pyrrolo[1,2-a]quinoxalinyl)di- or -trimethylalkyldiamine oxalates ***8a–c, 9c, 15a–c, 28a,b, 29a–c, 30a,c and 38a,b***

To a solution of *N*-(pyrrolo[1,2-*a*]quinoxalinyl)di- or -trimethylalkyldiamines **6**, **7c**, **14**, **25**, **26**, **27** or **37** (0.006 mol) in isopropanol (35 mL) was added oxalic acid (0.018 mol). The reaction mixture was heated under reflux for 30 min. The precipitate was filtered, washed with ethyl ether and recrystallized from a mixture of propan-2-ol/water (60:40).

5.1.26. N-(pyrrolo[1,2-a]quinoxalin-4-yl)-N,N',N'-trimethylpropane-1,3-diamine (oxalate) ***8a***

White crystals (76%): m.p. 198 °C; IR (KBr) 2760-2630 (NH^+) 1690 (CO); ^{1}H-NMR (DMSO-d_6) δ: 8.57 (bs, 4H, NH^+ and OH), 8.31 (dd, 1H, $J_{H-1\ H-2}$ = 2.93 Hz, $J_{H-1\ H-3}$ = 0.97 Hz, H-1), 8.04 (d, 1H, $J_{H-9\ H-8}$ = 7.81 Hz, H-9), 7.46 (d, 1H, $J_{H-6\ H-7}$ = 7.81 Hz, H-6), 7.28 (t, 1H, $J_{H-8\ H-9}$ = $J_{H-8\ H-7}$ = 7.81 Hz, H-8), 7.19 (t, 1H, $J_{H-7\ H-8}$ = $J_{H-7\ H-6}$ = 7.81 Hz, H-7), 7.09 (dd, 1H, $J_{H-3\ H-2}$ = 4.15 Hz, $J_{H-3\ H-1}$ = 0.97 Hz, H-3), 6.80 (dd, 1H, $J_{H-2\ H-3}$ = 4.15 Hz, $J_{H-2\ H-1}$ = 2.93 Hz, H-2), 3.80 (t, 2H, $J_{CH2\ CH2}$ = 7.10 Hz, CH_2), 3.40 (s, 3H, CH_3), 3.13 (t, 2H, $J_{CH2\ CH2}$ = 7.10 Hz, CH_2), 2.79 (s, 6H, $2CH_3$), 2.09 (qt, 2H, $J_{CH2\ CH2}$ = 7.10 Hz, CH_2). Anal. $C_{21}H_{26}N_4O_8$ (C, H, N).

5.1.27. N-(7-Chloropyrrolo[1,2-a]quinoxalin-4-yl)-N,N',N'-trimethylpropane-1,3-diamine (oxalate) ***8b***

Yellow crystals (82%): m.p. 200 °C; IR (KBr) 3100-2400 (NH^+) 1710 (CO); ^{1}H-NMR (DMSO-d_6) δ: 9.94 (bs, 4H, NH^+ and OH), 8.22 (m, 1H, H-1), 7.99 (d, 1H, $J_{H-9\ H-8}$ = 8.78 Hz, H-9), 7.42 (d, 1H, $J_{H-6\ H-8}$ = 1.50 Hz, H-6), 7.15 (dd, 1H, $J_{H-8\ H-9}$ = 8.78 Hz, $J_{H-8\ H-6}$ = 1.50 Hz, H-8), 7.07 (m, 1H, H-3), 6.78 (m, 1H, H-2), 3.81 (t, 2H, $J_{CH2\ CH2}$ = 7.16 Hz, CH_2), 3.43 (s, 3H, CH_3), 3.14 (t, 2H, $J_{CH2\ CH2}$ = 7.16 Hz, CH_2), 2.79 (s, 6H, $2CH_3$), 2.09 (qt, 2H, $J_{CH2\ CH2}$ = 7.16 Hz, CH_2). Anal. $C_{21}H_{25}ClN_4O_8$ (C, H, N).

5.1.28. N-(7,8-Dichloropyrrolo[1,2-a]quinoxalin-4-yl)-N,N',N'-trimethylpropane-1,3-diamine (oxalate) ***8c***

White crystals (84%): m.p. 198 °C; IR (KBr) 3200-2300 (NH^+) 1710 (CO); ^{1}H-NMR (DMSO-d_6) δ: 9.83 (bs, 4H, NH^+ and OH), 8.27 (dd, 1H, $J_{H-1\ H-2}$ = 2.91 Hz, $J_{H-1\ H-3}$ = 1.03 Hz, H-1), 8.25 (s, 1H, H-9), 7.54 (s, 1H, H-6), 7.08 (dd, 1H, $J_{H-3\ H-2}$ = 4.05 Hz, $J_{H-3\ H-1}$ = 1.03 Hz, H-3), 6.78 (dd, 1H, $J_{H-2\ H-3}$ = 4.05 Hz, $J_{H-2\ H-1}$ = 2.91 Hz, H-2), 3.82 (t, 2H, $J_{CH2\ CH2}$ = 7.40 Hz, CH_2), 3.42 (s, 3H, CH_3), 3.15 (t, 2H, $J_{CH2\ CH2}$ = 7.40 Hz, CH_2), 2.79 (s, 6H, $2CH_3$), 2.10 (qt, $J_{CH2\ CH2}$ = 7.40 Hz, 2H, CH_2). Anal. $C_{21}H_{24}Cl_2N_4O_8$ (C, H, N).

5.1.29. 7,8-Dichloro-4-(4-methylpiperazin-1-yl)pyrrolo[1,2-a]quinoxaline (oxalate) ***9c***

White crystals (82%): m.p. > 260 °C; IR (KBr) 3100-2400 (NH^+) 1710 (CO); ^{1}H-NMR (DMSO-d_6) δ: 9.05 (bs, 4H, NH^+ and OH), 8.35 (s, 1H, H-9), 8.30 (dd, 1H, $J_{H-1\ H-2}$ = 3.28 Hz, $J_{H-1\ H-3}$ = 0.92 Hz, H-1), 7.64 (s, 1H, H-6), 7.02 (dd, 1H, $J_{H-3\ H-2}$ = 3.98 Hz, $J_{H-3\ H-1}$ = 0.92 Hz, H-3), 6.82 (dd, 1H, $J_{H-2\ H-3}$ = 3.98 Hz, $J_{H-2\ H-1}$ = 3.28 Hz, H-2), 3.96 (t, 4H, $J_{CH2\ CH2}$ = 4.83 Hz, $2CH_2$), 3.06 (t, 4H, $J_{CH2\ CH2}$ = 4.83 Hz, $2CH_2$), 2.64 (s, 3H, CH_3). Anal. $C_{20}H_{20}Cl_2N_4O_8$ (C, H, N).

5.1.30. N-(Pyrrolo[1,2-a]quinoxalin-4-ylmethyl)-N,N',N'-trimethylpropane-1,3-diamine (oxalate) ***15a***

Yellow crystals (66%): m.p. 228 °C; IR (KBr) 2850-2350 (NH^+) 1705 (CO); ^{1}H-NMR (DMSO-d_6) δ: 8.39 (dd, 1H,

$J_{H\text{-}1\ H\text{-}2}$ = 2.44 Hz, $J_{H\text{-}1\ H\text{-}3}$ = 1.46 Hz, H-1), 8.23 (d, 1H, $J_{H\text{-}9\ H\text{-}8}$ = 7.81 Hz, H-9), 7.88 (d, 1H, $J_{H\text{-}6\ H\text{-}7}$ = 7.81 Hz, H-6), 7.55 (t, 1H, $J_{H\text{-}8\ H\text{-}9}$ = $J_{H\text{-}8\ H\text{-}7}$ = 7.81 Hz, H-8), 7.48 (t, 1H, $J_{H\text{-}7\ H\text{-}8}$ = $J_{H\text{-}7\ H\text{-}6}$ = 7.81 Hz, H-7), 7.15 (dd, 1H, $J_{H\text{-}3\ H\text{-}2}$ = 3.90 Hz, $J_{H\text{-}3\ H\text{-}1}$ = 1.46 Hz, H-3), 7.03 (bs, 4H, NH^+ and OH), 6.92 (dd, 1H, $J_{H\text{-}2\ H\text{-}3}$ = 3.90 Hz, $J_{H\text{-}2\ H\text{-}1}$ = 2.44 Hz, H-2), 4.07 (s, 2H, CH_2), 3.09 (t, 2H, $J_{CH2\ CH2}$ = 7.33 Hz, CH_2), 2.80 (t, 2H, $J_{CH2\ CH2}$ = 7.33 Hz, CH_2), 2.75 (s, 6H, $2CH_3$), 2.46 (s, 3H, CH_3), 1.95 (qt, 2H, $J_{CH2\ CH2}$ = 7.33 Hz, CH_2). Anal. $C_{22}H_{28}N_4O_8$ (C, H, N).

5.1.31. N-(7-Chloropyrrolo[1,2-a]quinoxalin-4-ylmethyl)-N,N',N'-trimethylpropane-1,3-diamine (oxalate) ***15b***

Yellow crystals (72%): m.p. 254 °C; IR (KBr) 3150-2500 (NH^+) 1700 (CO); ^{1}H-NMR (DMSO-d_6) δ: 8.41 (m, 1H, H-1), 8.27 (d, 1H, $J_{H\text{-}9\ H\text{-}8}$ = 8.79 Hz, H-9), 7.87 (d, 1H, $J_{H\text{-}6\ H\text{-}8}$ = 1.95 Hz, H-6), 7.60 (dd, 1H, $J_{H\text{-}8\ H\text{-}9}$ = 8.79 Hz, $J_{H\text{-}8\ H\text{-}6}$ = 1.95 Hz, H-8), 7.19 (bs, 5H, H-3, NH^+ and OH), 6.94 (m, 1H, H-2), 4.06 (s, 2H, CH_2), 3.08 (t, 2H, $J_{CH2\ CH2}$ = 7.33 Hz, CH_2), 2.78 (t, 2H, $J_{CH2\ CH2}$ = 7.33 Hz, CH_2), 2.75 (s, 6H, $2CH_3$), 2.44 (s, 3H, CH_3), 1.94 (qt, 2H, $J_{CH2\ CH2}$ = 7.33 Hz, CH_2). Anal. $C_{22}H_{27}ClN_4O_8$ (C, H, N).

5.1.32. N-(7,8-Dichloropyrrolo[1,2-a]quinoxalin-4-ylmethyl)-N,N',N'-trimethylpropane-1,3-diamine (oxalate) ***15c***

Beige crystals (51%): m.p. 261 °C; IR (KBr) 2850-2300 (NH^+) 1710 (CO); ^{1}H-NMR (DMSO-d_6) δ: 8.61 (s, 1H, H-9), 8.49 (m, 1H, H-1), 8.03 (s, 1H, H-6), 7.21 (bs, 5H, H-3, NH^+ and OH), 6.95 (m, 1H, H-2), 4.04 (s, 2H, CH_2), 3.08 (t, 2H, $J_{CH2\ CH2}$ = 7.33 Hz, CH_2), 2.77 (t, 2H, $J_{CH2\ CH2}$ = 7.33 Hz, CH_2), 2.75 (s, 6H, $2CH_3$), 2.43 (s, 3H, CH_3), 1.94 (qt, 2H, $J_{CH2\ CH2}$ = 7.33 Hz, CH_2). Anal. $C_{22}H_{26}Cl_2N_4O_8$ (C, H, N).

5.1.33. N'-(4-Phenylpyrrolo[1,2-a]quinoxalin-1-ylmethyl)-N,N-dimethylpropane-1,3-diamine (oxalate) ***28a***

Orange crystals (68%): m.p. 218 °C; IR (KBr) 2900-2300 (NH_2^+ and NH^+) 1700 (CO); ^{1}H-NMR (DMSO-d_6) δ: 8.37 (d, 1H, $J_{H\text{-}9\ H\text{-}8}$ = 7.81 Hz, H-9), 7.93 (m, 3H, H-2', H-6' and H-6), 7.54 (m, 5H, H-3', H-4', H-5', H-7 and H-8), 7.01 (d, 1H, $J_{H\text{-}2\ H\text{-}3}$ = 3.91 Hz, H-2), 6.95 (d, 1H, $J_{H\text{-}3\ H\text{-}2}$ = 3.91 Hz, H-3), 6.89 (bs, 5H, NH_2^+, NH^+ and OH), 4.64 (s, 2H, CH_2), 3.10 (t, 2H, $J_{CH2\ CH2}$ = 6.84 Hz, CH_2), 3.00 (t, 2H, $J_{CH2\ CH2}$ = 6.84 Hz, CH_2), 2.71 (s, 6H, $2CH_3$), 2.00 (qt, 2H, $J_{CH2\ CH2}$ = 6.84 Hz, CH_2). Anal. $C_{27}H_{30}N_4O_8$ (C, H, N).

5.1.34. N'-(7-Chloro-4-phenylpyrrolo[1,2-a]quinoxalin-1-ylmethyl)-N,N-dimethylpropane-1,3-diamine (oxalate) ***28b***

Yellow crystals (67%): m.p. 239 °C; IR (KBr) 2900-2500 (NH_2^+ and NH^+) 1715 (CO); ^{1}H-NMR (DMSO-d_6) δ: 8.57 (bs, 5H, NH_2^+, NH^+ and OH), 8.44 (d, 1H, $J_{H\text{-}9\ H\text{-}8}$ = 8.80 Hz, H-9), 7.92 (m, 3H, H-2', H-6' and H-6), 7.55 (m, 4H, H-3', H-4', H-5' and H-8), 7.00 (2d, 2H, $J_{H\text{-}2\ H\text{-}3}$ = $J_{H\text{-}3\ H\text{-}2}$ = 4.39 Hz, H-2 and H-3), 4.50 (s, 2H, CH_2), 3.08 (t, 2H, $J_{CH2\ CH2}$ = 6.84 Hz, CH_2), 2.92 (t, 2H, $J_{CH2\ CH2}$ = 6.84 Hz, CH_2), 2.71 (s, 6H, $2CH_3$), 1.94 (qt, 2H, $J_{CH2\ CH2}$ = 6.84 Hz, CH_2). Anal. $C_{27}H_{29}ClN_4O_8$ (C, H, N).

5.1.35. N'-(4-Phenylpyrrolo[1,2-a]quinoxalin-1-ylmethyl)-N,N-dimethylethane-1,2-diamine (oxalate) ***29a***

Yellow crystals (72%): m.p. 236 °C; IR (KBr) 2900-2550 (NH_2^+ and NH^+) 1715 (CO); ^{1}H-NMR (DMSO-d_6) δ: 8.88 (bs, 5H, NH_2^+, NH^+ and OH), 8.39 (d, 1H, $J_{H\text{-}9\ H\text{-}8}$ = 7.82 Hz, H-9), 7.91 (m, 3H, H-2', H-6' and H-6), 7.54 (m, 5H, H-3', H-4', H-5', H-7 and H-8), 6.95 (d, 1H, $J_{H\text{-}2\ H\text{-}3}$ = 4.14 Hz, H-2), 6.91 (d, 1H, $J_{H\text{-}3\ H\text{-}2}$ = 4.14 Hz, H-3), 4.46 (s, 2H, CH_2), 3.17 (t, 2H, $J_{CH2\ CH2}$ = 6.84 Hz, CH_2), 3.13 (t, 2H, $J_{CH2\ CH2}$ = 6.84 Hz, CH_2), 2.73 (s, 6H, $2CH_3$). Anal. $C_{26}H_{28}N_4O_8$ (C, H, N).

5.1.36. N'-(7-Chloro-4-phenylpyrrolo[1,2-a]quinoxalin-1-ylmethyl)-N,N-dimethylethane-1,2-diamine (oxalate) ***29b***

Yellow crystals (66%): m.p. 232 °C; IR (KBr) 2880-2400 (NH_2^+ and NH^+) 1710 (CO); ^{1}H-NMR (DMSO-d_6) δ: 8.46 (d, 1H, $J_{H\text{-}9\ H\text{-}8}$ = 8.80 Hz, H-9), 7.93 (m, 3H, H-2', H-6' and H-6), 7.69 (bs, 5H, NH_2^+, NH^+ and OH), 7.57 (m, 4H, H-3', H-4', H-5' and H-8), 6.98 (2d, 2H, $J_{H\text{-}2\ H\text{-}3}$ = $J_{H\text{-}3\ H\text{-}2}$ = 4.40 Hz, H-2 and H-3), 4.42 (s, 2H, CH_2), 3.20 (t, 2H, $J_{CH2\ CH2}$ = 6.84 Hz, CH_2), 3.12 (t, 2H, $J_{CH2\ CH2}$ = 6.84 Hz, CH_2), 2.76 (s, 6H, $2CH_3$). Anal. $C_{26}H_{27}ClN_4O_8$ (C, H, N).

5.1.37. N'-(7,8-Dichloro-4-phenylpyrrolo[1,2-a]quinoxalin-1-ylmethyl)-N,N-dimethylethane-1,2-diamine (oxalate) ***29c***

Yellow crystals (71%): m.p. 236 °C; IR (KBr) 2930-2400 (NH_2^+ and NH^+) 1710 (CO); ^{1}H-NMR (DMSO-d_6) δ: 8.68 (s, 1H, H-9), 8.04 (s, 1H, H-6), 7.92 (m, 2H, H-2' and H-6'), 7.80 (bs, 5H, NH_2^+, NH^+ and OH), 7.60 (m, 3H, H-3', H-4' and H-5'), 6.99 (m, 2H, H-2 and H-3), 4.36 (s, 2H, CH_2), 3.22 (t, 2H, $J_{CH2\ CH2}$ = 5.70 Hz, CH_2), 3.09 (t, 2H, $J_{CH2\ CH2}$ = 5.70 Hz, CH_2), 2.79 (s, 6H, $2CH_3$). Anal. $C_{26}H_{26}Cl_2N_4O_8$ (C, H, N).

5.1.38. N'-(4-Styrylpyrrolo[1,2-a]quinoxalin-1-ylmethyl)-N,N-dimethylpropane-1,3-diamine (oxalate) ***30a***

Brown crystals (52%): m.p. 167 °C; IR (KBr) 2900-2600 (NH_2^+ and NH^+) 1710 (CO); ^{1}H-NMR (DMSO-d_6) δ: 8.28 (m, 1H, H-9), 8.02 (d, 1H, $J_{H\text{-}trans\ H\text{-}trans}$ = 15.70 Hz, CH=), 7.95 (m, 1H, H-6), 7.89 (d, 1H, $J_{H\text{-}trans\ H\text{-}trans}$ = 15.70 Hz, CH=), 7.69 (m, 11H, H-7, H-8, H-2', H-6', NH^+, NH_2^+ and OH), 7.55 (m, 3H, H-3', H-4' and H-5'), 7.08 (d, 1H, $J_{H\text{-}2\ H\text{-}3}$ = 4.10 Hz, H-2), 7.05 (d, 1H, $J_{H\text{-}3\ H\text{-}2}$ = 4.10 Hz, H-3), 4.28 (s, 2H, CH_2), 3.06 (m, 4H, $2CH_2$), 2.71 (s, 6H, $2CH_3$), 1.98 (m, 2H, CH_2). Anal. $C_{31}H_{34}N_4O_{12}$ (C, H, N).

5.1.39. N'-(7,8-Dichloro-4-styrylpyrrolo[1,2-a]quinoxalin-1-ylmethyl)-N,N-dimethylpropane-1,3-diamine (oxalate) ***30c***

Orange crystals (57%): m.p. 203 °C; IR (KBr) 3100-2300 (NH_2^+ and NH^+) 1700 (CO); ^{1}H-NMR (DMSO-d_6) δ: 8.73 (s, 1H, H-9), 7.99 (s, 1H, H-6), 7.98 (d, 1H, $J_{H\text{-}trans\ H\text{-}trans}$ = 15.75 Hz, CH=), 7.77 (m, 2H, H-2' and H-6'), 7.63 (d, 1H, $J_{H\text{-}trans\ H\text{-}trans}$ = 15.75 Hz, CH=), 7.42 (m, 4H, H-2, H-3', H-4' and H-5'), 6.98 (d, 1H, $J_{H\text{-}3\ H\text{-}2}$ = 3.60 Hz, H-3), 6.56 (bs, 7H, NH_2^+, NH^+ and OH), 4.34 (s, 2H, CH_2), 3.08 (t, 2H, $J_{CH2\ CH2}$ = 7.0 Hz, CH_2), 2.84 (t, 2H, $J_{CH2\ CH2}$ = 7.0 Hz, CH_2), 2.71 (s, 6H, $2CH_3$), 1.93 (qt, 2H, $J_{CH2\ CH2}$ = 7.0 Hz, 2H, CH_2). Anal. $C_{31}H_{32}N_4Cl_2O_{12}$ (C, H, N).

5.4.40. N'-(4-Phenylpyrrolo[1,2-a]quinoxalin-2-ylmethyl)-N,N-dimethylpropane-1,3-diamine (oxalate) ***38a***

Yellow crystals (76%): m.p. 234 °C; IR (KBr) 3100-2400 (NH_2^+ and NH^+) 1710 (CO); ^{1}H-NMR (DMSO-d_6) δ: 8.59 (d, 1H, $J_{H\text{-}1\ H\text{-}3}$ = 0.90 Hz, H-1), 8.19 (dd, 1H, $J_{H\text{-}9\ H\text{-}8}$ = 8.20 Hz, $J_{H\text{-}9\ H\text{-}7}$ = 1.20 Hz, H-9), 8.01 (m, 2H, H-2' and H-6'), 7.95 (dd, 1H, $J_{H\text{-}6\ H\text{-}7}$ = 8.20 Hz, $J_{H\text{-}6\ H\text{-}8}$ = 1.20 Hz, H-6), 7.63 (t, 1H, $J_{H\text{-}8\ H\text{-}7}$ = $J_{H\text{-}8\ H\text{-}9}$ = 8.20 Hz, H-8), 7.59 (m, 3H, H-3', H-4' and H-5'), 7.53 (t, 1H, $J_{H\text{-}7\ H\text{-}8}$ = $J_{H\text{-}7\ H\text{-}6}$ = 8.20 Hz, H-7), 7.45 (bs, 5H, NH_2^+, NH^+ and OH), 7.20 (d, 1H, $J_{H\text{-}3\ H\text{-}1}$ = 0.90 Hz, H-3), 4.29 (s, 2H, CH_2), 3.01 (t, 2H, $J_{CH2\ CH2}$ = 7.30 Hz, CH_2), 3.01 (t, 2H, $J_{CH2\ CH2}$ = 7.30 Hz, CH_2), 2.64 (s, 6H, $2CH_3$), 2.04 (qt, 2H, $J_{CH2\ CH2}$ = 7.30 Hz, CH_2). Anal. $C_{27}H_{30}N_4O_8$ (C, H, N).

5.1.41. N'-(7,8-Dichloro-4-phenylpyrrolo[1,2-a]quinoxalin-2-ylmethyl)-N,N-dimethylpropane-1,3-diamine (oxalate) ***38b***

Yellow crystals (64%): m.p. 245 °C; IR (KBr) 3070-2740 (NH_2^+ and NH^+) 1720 (CO); ^{1}H-NMR (DMSO-d_6) δ: 8.64 (s, 1H, H-1), 8.44 (s, 1H, H-9), 8.26 (bs, 5H, NH_2^+, $NH^+$and OH), 8.04 (s, 1H, H-6), 7.98 (m, 2H, H-2' and H-6'), 7.57 (m, 3H, H-3', H-4' and H-5'), 7.26 (s, 1H, H-3), 4.26 (s, 2H, CH_2), 3.04

(t, 2H, $J_{CH2\ CH2}$ = 6.93 Hz, CH_2), 3.01 (t, 2H, $J_{CH2\ CH2}$ = 6.93 Hz, CH_2), 2.64 (s, 6H, $2CH_3$), 2.06 (qt, 2H, $J_{CH2\ CH2}$ = 6.93 Hz, CH_2). Anal. $C_{27}H_{28}Cl_2N_4O_8$ (C, H, N).

5.1.42. General procedure for the preparation of 2-chloro-N-(2-pyrrol-1-yl-phenyl)acetamides ***12a–c***

To a solution of 1-(2-aminophenyl)pyrrole **1** (0.02 mol) in dioxane (80 mL) was added pyridine (0.022 mol) then chloroacetyl chloride (0.02 mol). The reaction mixture was refluxed for 4 h and the solvent then removed under reduced pressure. The residue was triturated with water and extracted with ethyl ether (2 x 80 mL). The organic layers were collected, washed with an aqueous sodium hydrogen carbonate solution (100 mL) then with water (100 mL), dried over magnesium sulfate and evaporated to dryness. The precipitate was recrystallized from ethanol.

5.1.43. 2-Chloro-N-(4-chloro-2-pyrrol-1-yl-phenyl)acetamide ***12b***

Beige crystals (84%): m.p. 103 °C; IR (KBr) 3340 (NH), 1700 (CO); ^{1}H-NMR (DMSO-d_6) δ: 9.75 (s, 1H, NH), 7.80 (s, 1H, H-3), 7.38 (m, 2H, H-5 and H-6), 6.98 (dd, 2H, $J_{H\text{-}\alpha\ H\text{-}\beta}$ = 1.95 Hz, 2H-α), 6.27 (dd, 2H, $J_{H\text{-}\beta\ H\text{-}\alpha}$ = 1.95 Hz, 2H-β), 4.24 (s, 2H, CH_2). Anal. $C_{12}H_{10}N_2Cl_2$ (C, H, N).

5.1.44. 2-Chloro-N-(4,5-dichloro-2-pyrrol-1-yl-phenyl)acetamide ***12c***

Yellow crystals (71%): m.p. 149 °C; IR (KBr) 3290 (NH), 1665 (CO); ^{1}H-NMR (DMSO-d_6) δ: 9.87 (s, 1H, NH), 7.96 (s, 1H, H-3), 7.68 (s, 1H, H-6), 7.04 (dd, 2H, $J_{H\text{-}\alpha\ H\text{-}\beta}$ = 1.95 Hz, 2H-α), 6.28 (dd, 2H, $J_{H\text{-}\beta\ H\text{-}\alpha}$ = 1.95 Hz, 2H-β), 4.24 (s, 2H, CH_2). Anal. $C_{12}H_9N_2Cl_3$ (C, H, N).

5.1.45. General procedure for the preparation of 4-chloromethylpyrrolo[1,2-a]quinoxalines ***13a–c***

A solution of chloroacetyl derivative **12** (0.02 mol) and $POCl_3$ (0.1 mol) in toluene (100 mL) was heated under reflux for 4 h. After cooling, the precipitate was filtered and dissolved in water (100 mL). The solution was then made alkaline with sodium hydrogen carbonate and extracted with ethyl acetate (150 mL). The organic layer was washed with water (120 mL), dried over magnesium sulfate and evaporated to dryness under reduced pressure. The precipitate was collected and recrystallized from hexane.

5.1.46. 7-Chloro-4-chloromethylpyrrolo[1,2-a]quinoxaline ***13b***

Yellow crystals (52%): m.p. 152 °C; ^{1}H-NMR (DMSO-d_6) δ: 8.55 (dd, 1H, $J_{H\text{-}1\ H\text{-}2}$ = 2.93 Hz, $J_{H\text{-}1\ H\text{-}3}$ = 1.46 Hz, H-1), 8.35 (d, 1H, $J_{H\text{-}9\ H\text{-}8}$ = 8.79 Hz, H-9), 7.92 (d, 1H, $J_{H\text{-}6\ H\text{-}8}$ = 2.44 Hz, H-6), 7.68 (dd, 1H, $J_{H\text{-}8\ H\text{-}9}$ = 8.79 Hz, $J_{H\text{-}8\ H\text{-}6}$ = 2.44 Hz, H-8), 7.24 (dd, 1H, $J_{H\text{-}3\ H\text{-}2}$ = 3.91 Hz, $J_{H\text{-}3\ H\text{-}1}$ = 1.46 Hz, H-3), 7.01 (dd, 1H, $J_{H\text{-}2\ H\text{-}3}$ = 3.91 Hz, $J_{H\text{-}2\ H\text{-}1}$ = 2.93 Hz, H-2), 5.02 (s, 2H, CH_2). Anal. $C_{12}H_8N_2Cl_2$ (C, H, N).

5.1.47. 7,8-Dichloro-4-chloromethylpyrrolo[1,2-a]quinoxaline ^{13}C

Yellow crystals (67%): m.p. 180 °C; ^{1}H-NMR (DMSO-d_6) δ: 8.56 (s, 1H, H-9), 8.48 (dd, 1H, $J_{H\text{-}1\ H\text{-}2}$ = 3.10 Hz, $J_{H\text{-}1\ H\text{-}3}$ = 1.20 Hz, H-1), 7.99 (s, 1H, H-6), 7.19 (dd, 1H, $J_{H\text{-}3\ H\text{-}2}$ = 4.30 Hz, $J_{H\text{-}3\ H\text{-}1}$ = 1.20 Hz, H-3), 6.96 (dd, 1H, $J_{H\text{-}2\ H\text{-}3}$ = 4.30 Hz, $J_{H\text{-}2\ H\text{-}1}$ = 3.10 Hz, H-2), 4.94 (s, 2H, CH_2). Anal. $C_{12}H_7N_2Cl_3$ (C, H, N).

5.1.48. General procedure for the preparation of 4-phenylpyrrolo[1,2-a]quinoxalines ***16a–c*** *and 4-styrylpyrrolo[1,2-a]-quinoxalines* ***17a,c***

A solution of derivative **18** or **19** (0.03 mol) and pyridine (0.03 mol) in phosphorus oxychloride (70 mL) was heated under reflux for 4 h then evaporated to dryness. After cooling, the precipitate was filtered and slowly dissolved in water (100 mL). The solution was then made alkaline with sodium carbonate and extracted with methylene chloride (150 mL). The organic layer was washed with water (120 mL), dried over calcium chloride and evaporated to dryness under reduced pressure. The precipitate was collected, washed with hexane and recrystallized from toluene.

5.1.49. 4,5-Dichloro-4-phenylpyrrolo[1,2-a]quinoxaline ***16c***

White crystals (93%): m.p. 180 °C; ^{1}H-NMR (DMSO-d_6) δ: 8.55 (s, 1H, H-9), 8.49 (dd, 1H, $J_{H\text{-}1\ H\text{-}2}$ = 2.48 Hz, $J_{H\text{-}1\ H\text{-}3}$ = 1.28 Hz, H-1), 8.02 (s, 1H, H-6), 7.96 (m, 2H, H-2' and H-6'), 7.56 (m, 3H, H-3', H-4' and H-5'), 7.02 (dd, 1H, $J_{H\text{-}3\ H\text{-}2}$ = 3.84 Hz, $J_{H\text{-}3\ H\text{-}1}$ = 1.28 Hz, H-3), 6.95 (dd, 1H, $J_{H\text{-}2\ H\text{-}3}$ = 3.84 Hz, $J_{H\text{-}2\ H\text{-}1}$ = 2.48 Hz, H-2); ^{13}C-NMR (DMSO-d_6) δ: 154.0 (C-4), 136.9 (C-5a), 134.9 (C-1'), 129.6 (C-9a), 129.5 (C-8), 129.2 (C-7), 128.0 (C-4'), 127.6 (C-2' and C-6'), 126.9 (C-3' and C-5'), 125.8 (C-6), 123.7 (C-9), 117.0 (C-1), 116.0 (C-3a), 114.1 (C-3), 108.9 (C-2); MS (EI) *m/z*: 314 (M^+ + 1, 19); 313 (M^+, 64); 311 (100); 285 (21); 250 (6); 156 (14); 105 (21); 80 (22). Anal. $C_{17}H_{10}N_2Cl_2$ (C, H, N).

5.1.50. 4-Styrylpyrrolo[1,2-a]quinoxaline ***17a***

Yellow crystals (74%): m.p. 118 °C; ^{1}H-NMR (DMSO-d_6) δ: 8.40 (m, 1H, H-1), 8.20 (d, 1H, $J_{H\text{-}9\ H\text{-}8}$ = 7.83 Hz, H-9), 8.05 (d, 1H, $J_{H\text{-}trans\ H\text{-}trans}$ = 15.80 Hz, CH=), 7.93 (d, 1H, $J_{H\text{-}6\ H\text{-}7}$ = 7.83 Hz, H-6), 7.84 (m, 2H, H-2' and H-6'), 7.73 (d, 1H, $J_{H\text{-}trans\ H\text{-}trans}$ = 15.80 Hz, CH=), 7.49 (m, 6H, H-3', H-4', H-5', H-7, H-8 and H-3), 6.97 (dd, 1H, $J_{H\text{-}2\ H\text{-}3}$ = 3.65 Hz, $J_{H\text{-}2\ H\text{-}1}$ = 2.80 Hz, H-2); ^{13}C-NMR (DMSO-d_6) δ: 149.0 (C-4), 136.0 (CH=), 135.7 (C-9a), 135.6 (CH=), 129.1 (C-5a), 129.0 (C-4'), 128.7 (C-3' and C-5'), 127.7 (C-2' and C-6'), 127.1 (C-6), 126.9 (C-8), 125.5 (C-3a), 125.3 (C-7), 123.3 (C-1'), 116.0 (C-1), 114.5 (C-9), 113.8 (C-3), 106.5 (C-2). Anal. $C_{19}H_{14}N_2$ (C, H, N).

5.1.51. 7,8-Dichloro-4-styrylpyrrolo[1,2-a]quinoxaline ***17c***

Yellow crystals (84%): m.p. 182 °C; ^{1}H-NMR (DMSO-d_6) δ: 8.51 (s, 1H, H-9), 8.45 (dd, 1H, $J_{H\text{-}1\ H\text{-}2}$ = 2.74 Hz, $J_{H\text{-}1\ H\text{-}3}$ = 0.91 Hz, H-1), 8.00 (d, 1H, $J_{H\text{-}trans\ H\text{-}trans}$ = 15.83 Hz, CH=), 7.99 (s, 1H, H-6), 7.79 (m, 2H, H-2' and H-6'), 7.63 (d, 1H, $J_{H\text{-}trans\ H\text{-}trans}$ = 15.83 Hz, CH=), 7.42 (m, 4H, H-3', H-4', H-5' and H-3), 6.97 (dd, 1H, $J_{H\text{-}2\ H\text{-}3}$ = 3.70 Hz, $J_{H\text{-}2\ H\text{-}1}$ = 2.74 Hz, H-2); ^{13}C-NMR (DMSO-d_6) δ: 150.3 (C-4), 136.7 (CH=), 135.7 (C-5a), 135.4 (C-1'), 129.5 (C-9a), 129.3 (C-8), 128.8 (C-3' and C-5'), 128.4 (C-7), 127.9 (C-2' and C-6'), 127.2 (CH=), 126.4 (C-4'), 125.3 (C-6), 122.4 (C-9), 117.5 (C-1), 116.5 (C-3a), 114.5 (C-3), 107.8 (C-2). Anal. $C_{19}H_{12}N_2Cl_2$ (C, H, N).

5.1.52. General procedure for the preparation of N-(2-pyrrol-1-yl-phenyl)benzamides ***18a–c*** *and N-(2-pyrrol-1-yl-phenyl)-3-phenylacrylamides* ***19a,c***

To a solution of 1-(2-aminophenyl)pyrrole **1** (0.02 mol) in dioxane (80 mL) was added pyridine (0.022 mol) then benzoyl chloride or cinnamoyl chloride (0.022 mol). The reaction mixture was refluxed for 4 h and the solvent then removed under reduced pressure. The residue was triturated with water and extracted with ethyl ether (2 x 80 mL). The organic layers were collected, washed with an aqueous sodium hydrogen carbonate solution (100 mL) then with water (100 mL), dried over magnesium sulfate and evaporated to dryness. The precipitate was recrystallized from ethanol.

5.1.53. N-(4,5-Dichloro-2-pyrrol-1-yl-phenyl)benzamide ***18c***

White crystals (89%): m.p. 135 °C; IR (KBr) 3390 (NH), 1670 (CO); ^{1}H-NMR (DMSO-d_6) δ: 9.97 (s, 1H, NH), 7.95 (s,

1H, H-3), 7.84 (d, 2H, $J_{H\text{-}2'\,H\text{-}3'} = J_{H\text{-}6'\,H\text{-}5'} = 7.51$ Hz, H-2' and H-6'), 7.73 (s, 1H, H-6), 7.58 (t, 1H, $J_{H\text{-}4'\,H\text{-}3'} = J_{H\text{-}4'\,H\text{-}5'} = 7.51$ Hz, H-4'), 7.49 (t, 2H, $J_{H\text{-}3'\,H\text{-}4'} = J_{H\text{-}3'\,H\text{-}2'} = J_{H\text{-}5'\,H\text{-}4'} = J_{H\text{-}5'\,H\text{-}6'} = 7.51$ Hz, H-3' and H-5'), 7.08 (dd, 2H, $J_{H\text{-}\alpha\,H\text{-}\beta} = 1.95$ Hz, 2H-α), 6.22 (dd, 2H, $J_{H\text{-}\beta\,H\text{-}\alpha} = 1.95$ Hz, 2H-β); ^{13}C-NMR (DMSO-d_6) δ: 165.7 (CO), 135.9 (C-1'), 133.5 (C-2), 131.7 (C-4'), 131.4 (C-1), 129.5 (C-4), 128.8 (C-5), 128.6 (C-3), 128.3 (C-3' and C-5'), 127.5 (C-2' and C-6'), 127.0 (C-6), 121.3 (2C-α), 109.8 (2C-β); MS (EI) *m/z*: 332 (M^+ + 1, 13), 330 (20), 315 (9), 123 (42), 122 (100), 106 (64). Anal. $C_{17}H_{12}N_2Cl_2O$ (C, H, N).

5.1.54. N-(2-pyrrol-1-yl-phenyl)-3-phenylacrylamide ***19a***

White crystals (30%): m.p. 128 °C; IR (KBr) 3200 (NH), 1650 (CO); ^{1}H-NMR (DMSO-d_6) δ: 9.58 (s, 1H, NH), 7.71 (d, 1H, $J_{H\text{-}trans\,H\text{-}trans} = 15.60$ Hz, CH=), 7.61 (m, 3H, H-arom), 7.40 (m, 6H, H-arom), 6,99 (dd, 2H, $J_{H\text{-}\alpha\,H\text{-}\beta} = 1.96$ Hz, 2H-α), 6.83 (d, 1H, $J_{H\text{-}trans\,H\text{-}trans} = 15.60$ Hz, CH=), 6.25 (dd, 2H, $J_{H\text{-}\beta\,H\text{-}\alpha} = 1.96$ Hz, 2H-β). Anal. $C_{19}H_{16}N_2O$ (C, H, N).

5.1.55. N-(4,5-Dichloro-2-pyrrol-1-yl-phenyl)-3-phenylacrylamide ***19c***

White crystals (41%): m.p. 158 °C; IR (KBr) 3240 (NH), 1650 (CO); ^{1}H-NMR (DMSO-d_6) δ: 9.65 (s, 1H, NH), 8.10 (s, 1H, H-3), 7.62 (s, 1H, H-6), 7.59 (m, 2H, H-2' and H-6'), 7.58 (d, 1H, $J_{H\text{-}trans\,H\text{-}trans} = 15.60$ Hz, CH=), 7.42 (m, 3H, H-3', H-4' and H-5'), 7.04 (dd, 2H, $J_{H\text{-}\alpha\,H\text{-}\beta} = 1.85$ Hz, 2H-α), 6.85 (d, 1H, $J_{H\text{-}trans\,H\text{-}trans} = 15.60$ Hz, CH=), 6.27 (dd, 2H, $J_{H\text{-}\beta\,H\text{-}\alpha} = 1.85$ Hz, 2H-β); ^{13}C-NMR (DMSO-d_6) δ: 164.4 (CO), 141.0 (CH=), 134.5 (C-1'), 134.0 (C-2), 131.5 (C-1), 129.9 (C-4), 128.9 (C-5), 127.8 (C-3' and C-5'), 127.7 (C-4'), 127.5 (C-2' and C-6'), 127.4 (C-3), 121.6 (C-6), 121.5 (CH=), 121.2 (2C-α), 110.2 (2C-β). Anal. $C_{19}H_{14}N_2OCl_2$ (C, H, N).

5.1.56. General procedure for the preparation of 4-arylpyrrolo[1,2-a]quinoxaline-1-carbaldehydes ***20a–c*** *and* ***21a,c***

To cold (0 °C) *N,N*-dimethylformamide (0.09 mol) was added dropwise phosphorus oxychloride (0.09 mol). The mixture was allowed to stir at 0–5 °C for 10 min, then a solution of 4-arylpyrrolo[1,2-*a*]quinoxaline **16** or **17** in *N,N*-dimethylformamide (70 mL) was slowly added. The reaction mixture was then stirred at 130 °C for 3 h, colded, poured into ice water (100 mL) and treated with an aqueous sodium hydroxide solution (6 N) until pH = 8–9. The solid product was isolated by filtration and dissolved in methylene chloride (100 mL). The organic layer was washed with water (80 mL), dried over calcium chloride and evaporated to dryness. The precipitate was collected, washed with hexane, dried and recrystallized from ethanol (A silica-gel column was used to purify the product **21c** with methylene chloride. The desired fractions were combined and evaporated to dryness).

5.1.57. 4-Phenylpyrrolo[1,2-a]quinoxaline-1-carbaldehyde ***20a***

Beige crystals (71%): m.p. 153 °C; IR (KBr) 1665 (CO); ^{1}H-NMR (DMSO-d_6) δ: 10.03 (s, 1H, CHO), 9.16 (dd, 1H, $J_{H\text{-}9\,H\text{-}8} = 7.80$ Hz, $J_{H\text{-}9\,H\text{-}7} = 1.28$ Hz, H-9), 8.03 (dd, 1H, $J_{H\text{-}6\,H\text{-}7} = 7.80$ Hz, $J_{H\text{-}6\,H\text{-}8} = 1.28$ Hz, H-6), 7.92 (m, 2H, H-2' and H-6'), 7.80 (d, 1H, $J_{H\text{-}2\,H\text{-}3} = 4.44$ Hz, H-2), 7.62 (m, 5H, H-3', H-4', H-5', H-7 and H-8), 7.07 (d, 1H, $J_{H\text{-}3\,H\text{-}2} = 4.44$ Hz, H-3); ^{13}C-NMR (DMSO-d_6) δ: 179.0 (CO), 153.6 (C-4), 137.2 (C-5a), 131.8 (C-1'), 131.1 (C-9a), 130.0 (C-1), 129.8 (C-4'), 129.7 (C-3a), 128.6 (C-2' and C-6'), 128.5 (C-3' and C-5'), 128.0 (C-8), 127.4 (C-7), 126.7 (C-2), 119.3 (C-6), 119.2 (C-9), 109.2 (C-3). Anal. $C_{18}H_{12}N_2O$ (C, H, N).

5.1.58. 7-Chloro-4-phenylpyrrolo[1,2-a]quinoxaline-1-carbaldehyde ***20b***

Beige crystals (54%): m.p. 197 °C; IR (KBr) 1675 (CO); ^{1}H-NMR (DMSO-d_6) δ: 10.02 (s, 1H, CHO), 9.20 (d, 1H, $J_{H\text{-}9\,H\text{-}8} = 8.80$ Hz, H-9), 7.98 (d, 1H, $J_{H\text{-}6\,H\text{-}8} = 2.20$ Hz, H-6), 7.92 (m, 2H, H-2' and H-6'), 7.84 (d, 1H, $J_{H\text{-}2\,H\text{-}3} = 4.40$ Hz, H-2), 7.61 (m, 4H, H-3', H-4', H-5' and H-8), 7.11 (d, $J_{H\text{-}3\,H\text{-}2} = 4.40$ Hz, H-3). Anal. $C_{18}H_{11}N_2ClO$ (C, H, N).

5.1.59. 7,8-Dichloro-4-phenylpyrrolo[1,2-a]quinoxaline-1-carbaldehyde ***20c***

Orange crystals (41%): m.p. 229 °C; IR (KBr) 1660 (CO); ^{1}H-NMR (DMSO-d_6) δ: 9.93 (s, 1H, CHO), 9.60 (s, 1H, H-9), 8.10 (s, 1H, H-6), 7.90 (m, 2H, H-2' and H-6'), 7.86 (d, 1H, $J_{H\text{-}2\,H\text{-}3} = 4.35$ Hz, H-2), 7.57 (m, 3H, H-3', H-4' and H-5'), 7.12 (d, 1H, $J_{H\text{-}3\,H\text{-}2} = 4.35$ Hz, H-3); ^{13}C-NMR (DMSO-d_6) δ: 179.3 (CO), 155.2 (C-4), 136.9 (C-5a), 136.6 (C-1'), 132.0 (C-9a), 131.4 (C-1), 131.1 (C-8), 130.4 (C-7), 129.8 (C-4'), 129.1 (C-3a), 128.6 (C-2' and C-6'), 128.5 (C-3' and C-5'), 126.8 (C-6), 121.2 (C-2), 120.9 (C-9), 110.3 (C-3); MS (EI) *m/z*: 342 (M^+ + 1, 70), 340 (100), 316 (52), 286 (77), 276 (26), 241 (30), 152 (43). Anal. $C_{18}H_{10}N_2Cl_2O$ (C, H, N).

5.1.60. 4-Styrylpyrrolo[1,2-a]quinoxaline-1-carbaldehyde ***21a***

Brown crystals (35%): m.p. 80 °C; IR (KBr) 1675 (CO); ^{1}H-NMR (DMSO-d_6) δ: 9.96 (s, 1H, CHO), 9.21 (m, 1H, H-9), 8.04 (d, 1H, $J_{H\text{-}trans\,H\text{-}trans} = 16.60$ Hz, CH=), 7.96 (m, 1H, H-6), 7.88 (m, 2H, CH= and H-2), 7.69 (d, 1H, $J_{H\text{-}3\,H\text{-}2} = 4.20$ Hz, H-3), 7.58 (m, 2H, H-2' and H-6'), 7.46 (m, 5H, H-7, H-8, H-3', H-4' and H-5'). Anal. $C_{20}H_{14}N_2O$ (C, H, N).

5.1.61. 7,8-Dichloro-4-styrylpyrrolo[1,2-a]quinoxaline-1-carbaldehyde ***21c***

Yellow crystals (9%): m.p. 228 °C; IR (KBr) 1660 (CO); ^{1}H-NMR (DMSO-d_6) δ: 9.88 (s, 1H, CHO), 9.55 (s, 1H, H-9), 7.99 (s, 1H, H-6), 7.96 (d, 1H, $J_{H\text{-}trans\,H\text{-}trans} = 16.0$ Hz, CH=), 7.85 (d, 1H, $J_{H\text{-}2\,H\text{-}3} = 4.30$ Hz, H-2), 7.75 (d, 2H, $J_{H\text{-}2'\,H\text{-}3'} = J_{H\text{-}6'\,H\text{-}5'} = 7.40$ Hz, H-2' and H-6'), 7.63 (d, 1H, $J_{H\text{-}trans\,H\text{-}trans} = 16.0$ Hz, CH=), 7.55 (d, 1H, $J_{H\text{-}3\,H\text{-}2} = 4.30$ Hz, H-2), 7.41 (m, 3H, H-3', H-4' and H-5'); ^{13}C-NMR (DMSO-d_6) δ: 179.1 (CO), 151.0 (C-4), 138.1 (CH=), 137.1 (C-5a), 135.7 (C-1'), 132.0 (C-9a), 131.9 (C-1), 131.4 (C-8), 129.7 (C-7), 129.4 (CH=), 129.1 (C-3a), 129.0 (C-4'), 128.7 (C-3' and C-5'), 128.0 (C-2' and C-6'), 126.9 (C-6), 121.9 (C-2), 121.1 (C-9), 108.5 (C-3). Anal. $C_{20}H_{12}N_2Cl_2O$ (C, H, N).

5.1.62. General procedure for the preparation of N'-(4-arylpyrrolo[1,2-a]quinoxalin-1- or -2-ylmethylene)-N,N-dimethylalkyldiamines ***22a–c***, ***23a–c***, ***24a,c*** *and* ***36a,b***

A solution of 4-arylpyrrolo[1,2-*a*]quinoxaline-1- or -2-carbaldehyde **20**, **21** or **31** (0.008 mol) in 3-dimethylaminopropylamine or 2-dimethylaminoethylamine (20 mL) was refluxed for 4 h. The excess of diamine was evaporated to dryness under reduced pressure. After cooling, the residue was extracted with methylene chloride (100 mL). The organic layer was washed with water (90 mL), dried over calcium chloride and evaporated to dryness. Solids were recrystallized from methanol; oils were used without further purification.

5.1.63. N'-(4-Phenylpyrrolo[1,2-a]quinoxalin-1-ylmethylene)-N,N-dimethylpropane-1,3-diamine ***22a***

Orange oil (96%): IR (KBr) 1620 (C=N); ^{1}H-NMR (DMSO-d_6) δ: 8.92 (s, 1H, CH=N), 8.57 (dd, 1H, $J_{H\text{-}9\,H\text{-}8} = 7.81$ Hz, $J_{H\text{-}9\,H\text{-}7} = 1.95$ Hz, H-9), 7.95 (m, 3H, H-2', H-6' and H-6), 7.57 (m, 5H, H-3', H-4', H-5', H-7 and H-8), 7.31 (d, 1H, $J_{H\text{-}2\,H\text{-}3} = 4.40$ Hz, H-2), 7.00 (d, 1H, $J_{H\text{-}3\,H\text{-}2} = 4.40$ Hz, H-3), 3.72 (t, 2H, $J_{CH2\,CH2} = 6.84$ Hz, CH_2), 2.33 (t, 2H, $J_{CH2\,CH2} = 6.84$ Hz, CH_2), 2.16 (s, 6H, $2CH_3$), 1.83 (qt, 2H, $J_{CH2\,CH2} = 6.84$ Hz, CH_2). Anal. $C_{23}H_{24}N_4$ (C, H, N).

5.1.64. N'-(7-Chloro-4-phenylpyrrolo[1,2-a]quinoxalin-1-ylmethylene)-N,N-dimethylpropane-1,3-diamine ***22b***

Orange crystals (98%): m.p. 90 °C; IR (KBr) 1620 (C=N); ^{1}H-NMR (DMSO-d_6) δ: 8.80 (d, 1H, $J_{H\text{-}9\ H\text{-}8}$ = 8.80 Hz, H-9), 8.78 (s, 1H, CH=N), 7.89 (m, 3H, H-2', H-6' and H-6), 7.56 (m, 3H, H-3', H-4' and H-5'), 7.47 (dd, 1H, $J_{H\text{-}8\ H\text{-}9}$ = 8.80 Hz, $J_{H\text{-}8\ H\text{-}6}$ = 2.44 Hz, H-8), 7.28 (d, 1H, $J_{H\text{-}2\ H\text{-}3}$ = 4.30 Hz, H-2), 6.98 (d, 1H, $J_{H\text{-}3\ H\text{-}2}$ = 4.30 Hz, H-3), 3.70 (t, 2H, $J_{CH2\ CH2}$ = 6.84 Hz, CH_2), 2.36 (t, 2H, $J_{CH2\ CH2}$ = 6.84 Hz, CH_2), 2.17 (s, 6H, $2CH_3$), 1.83 (qt, 2H, $J_{CH2\ CH2}$ = 6.84 Hz, CH_2). Anal. $C_{23}H_{23}N_4Cl$ (C, H, N).

5.1.65. N'-(7,8-Dichloro-4-phenylpyrrolo[1,2-a]quinoxalin-1-ylmethylene)-N,N-dimethyl-propane-1,3-diamine ***22c***

Beige crystals (93%): m.p. 119 °C; IR (KBr) 1615 (C=N); ^{1}H-NMR (DMSO-d_6) δ: 9.92 (s, 1H, H-9), 8.65 (s, 1H, CH=N), 8.00 (s, 1H, H-6), 7.87 (m, 2H, H-2' and H-6'), 7.56 (m, 3H, H-3', H-4' and H-5'), 7.32 (d, 1H, $J_{H\text{-}2\ H\text{-}3}$ = 4.40 Hz, H-2), 7.02 (d, 1H, $J_{H\text{-}3\ H\text{-}2}$ = 4.40 Hz, H-3), 3.71 (t, 2H, $J_{CH2\ CH2}$ = 6.84 Hz, CH_2), 2.40 (t, 2H, $J_{CH2\ CH2}$ = 6.84 Hz, CH_2), 2.18 (s, 6H, $2CH_3$), 1.87 (qt, 2H, $J_{CH2\ CH2}$ = 6.84 Hz, CH_2); MS (EI) *m/z*: 426 (M^+ + 1, 20), 356 (60), 312 (100), 207 (51), 149 (65). Anal. $C_{23}H_{22}N_4Cl_2$ (C, H, N).

5.1.66. N'-(4-Phenylpyrrolo[1,2-a]quinoxalin-1-ylmethylene)-N,N-dimethylethane-1,2-diamine ***23a***

Beige crystals (88%): m.p. 74 °C; IR (KBr) 1635 (C=N); ^{1}H-NMR (DMSO-d_6) δ: 8.88 (s, 1H, CH=N), 8.57 (dd, 1H, $J_{H\text{-}9\ H\text{-}8}$ = 7.80 Hz, $J_{H\text{-}9\ H\text{-}7}$ = 1.96 Hz, H-9), 7.94 (m, 3H, H-2', H-6' and H-6), 7.54 (m, 5H, H-3', H-4', H-5', H-7 and H-8), 7.26 (d, 1H, $J_{H\text{-}2\ H\text{-}3}$ = 4.40 Hz, H-2), 6.99 (d, 1H, $J_{H\text{-}3\ H\text{-}2}$ = 4.40 Hz, H-3), 3.78 (t, 2H, $J_{CH2\ CH2}$ = 6.84 Hz, CH_2), 2.61 (t, 2H, $J_{CH2\ CH2}$ = 6.84 Hz, CH_2), 2.28 (s, 6H, $2CH_3$). Anal. $C_{22}H_{22}N_4$ (C, H, N).

5.1.67. N'-(7-Chloro-4-phenylpyrrolo[1,2-a]quinoxalin-1-ylmethylene)-N,N-dimethylethane-1,2-diamine ***23b***

Orange crystals (98%): m.p. 93 °C; IR (KBr) 1615 (C=N); ^{1}H-NMR (DMSO-d_6) δ: 8.79 (s, 1H, CH=N), 8.77 (d, 1H, $J_{H\text{-}9\ H\text{-}8}$ = 8.80 Hz, H-9), 7.89 (m, 3H, H-2', H-6' and H-6), 7.57 (m, 3H, H-3', H-4' and H-5'), 7.50 (dd, 1H, $J_{H\text{-}8\ H\text{-}9}$ = 8.80 Hz, $J_{H\text{-}8\ H\text{-}6}$ = 2.44 Hz, H-8), 7.27 (d, 1H, $J_{H\text{-}2\ H\text{-}3}$ = 4.40 Hz, H-2), 7.00 (d, 1H, $J_{H\text{-}3\ H\text{-}2}$ = 4.40 Hz, H-3), 3.77 (t, 2H, $J_{CH2\ CH2}$ = 6.35 Hz, CH_2), 2.60 (t, 2H, $J_{CH2\ CH2}$ = 6.35 Hz, CH_2), 2.26 (s, 6H, $2CH_3$). Anal. $C_{22}H_{21}ClN_4$ (C, H, N).

5.1.68. N'-(7,8-Dichloro-4-phenylpyrrolo[1,2-a]quinoxalin-1-ylmethylene)-N,N-dimethyl-ethane-1,2-diamine ***23c***

Orange crystals (94%): m.p. 95 °C; IR (KBr) 1635 (C=N); ^{1}H-NMR (DMSO-d_6) δ: 9.79 (s, 1H, CH=N), 8.73 (s, 1H, H-9), 8.07 (s, 1H, H-6), 7.90 (m, 2H, H-2' and H-6'), 7.58 (m, 3H, H-3', H-4' and H-5'), 7.36 (d, 1H, $J_{H\text{-}2\ H\text{-}3}$ = 4.0 Hz, H-2), 7.07 (d, 1H, $J_{H\text{-}3\ H\text{-}2}$ = 4.0 Hz, H-3), 3.80 (t, 2H, $J_{CH2\ CH2}$ = 6.1 Hz, CH_2), 2.68 (t, 2H, $J_{CH2\ CH2}$ = 6.1 Hz, CH_2), 2.27 (s, 6H, $2CH_3$). Anal. $C_{22}H_{20}Cl_2N_4$ (C, H, N).

5.1.69. N'-(4-Styrylpyrrolo[1,2-a]quinoxalin-1-ylmethylene)-N,N-dimethylpropane-1,3-diamine ***24a***

Brown oil (85%): IR (KBr) 1625 (C=N); ^{1}H-NMR (DMSO-d_6) δ: 8.91 (s, 1H, CH=N), 8.62 (m, 1H, H-9), 8.07 (d, 1H, $J_{H\text{-}trans\ H\text{-}trans}$ = 15.70 Hz, CH=), 7.91 (m, 1H, H-6), 7.84 (d, 1H, $J_{H\text{-}trans\ H\text{-}trans}$ = 15.70 Hz, CH=), 7.45 (m, 4H, H-7, H-8, H-2' and H-6'), 7.27 (m, 4H, H-2, H-3', H-4' and H-5'), 7.11 (d, 1H, $J_{H\text{-}3\ H\text{-}2}$ = 4.15 Hz, H-3), 3.25 (t, 2H, $J_{CH2\ CH2}$ = 6.85 Hz, CH_2), 2.31 (t, 2H, $J_{CH2\ CH2}$ = 6.85 Hz, CH_2), 2.15 (s, 6H, $2CH_3$), 1.81 (qt, 2H, $J_{CH2\ CH2}$ = 6.85 Hz, CH_2). Anal. $C_{25}H_{26}N_4$ (C, H, N).

5.1.70. N'-(7,8-Dichloro-4-styrylpyrrolo[1,2-a]quinoxalin-1-ylmethylene)-N,N-dimethyl-propane-1,3-diamine ***24c***

Orange oil (85%): IR (KBr) 1630 (C=N); ^{1}H-NMR (DMSO-d_6) δ: 9.05 (s, 1H, CH=N), 8.52 (s, 1H, H-9), 7.90 (d, 1H, $J_{H\text{-}trans\ H\text{-}trans}$ = 15.65 Hz, CH=), 7.86 (s, 1H, H-6), 7.78 (m, 2H, H-2' and H-6'), 7.61 (d, 1H, $J_{H\text{-}trans\ H\text{-}trans}$ = 15.65 Hz, CH=), 7.43 (m, 3H, H-3', H-4' and H-5'), 7.17 (d, 1H, $J_{H\text{-}2\ H\text{-}3}$ = 4.0 Hz, H-2), 7.06 (d, 1H, $J_{H\text{-}3\ H\text{-}2}$ = 4.0 Hz, H-3), 3.66 (t, 2H, $J_{CH2\ CH2}$ = 6.90 Hz, CH_2), 2.43 (t, 2H, $J_{CH2\ CH2}$ = 6.90 Hz, CH_2), 2.20 (s, 6H, $2CH_3$), 1.86 (qt, 2H, $J_{CH2\ CH2}$ = 6.90 Hz, CH_2). Anal. $C_{25}H_{24}Cl_2N_4$ (C, H, N).

5.1.71. N'-(4-Phenylpyrrolo[1,2-a]quinoxalin-2-ylmethylene)-N,N-dimethylpropane-1,3-diamine ***36a***

Orange oil (95%): IR (KBr) 1640 (C=N); ^{1}H-NMR (DMSO-d_6) δ: 8.80 (s, 1H, H-1), 8.39 (s, 1H, CH=N), 8.30 (d, 1H, $J_{H\text{-}9\ H\text{-}8}$ = 7.86 Hz, H-9), 7.95 (m, 2H, H-2' and H-6'), 7.89 (d, 1H, $J_{H\text{-}6\ H\text{-}7}$ = 7.86 Hz, H-6), 7.56 (m, 4H, H-3', H-4', H-5' and H-8), 7.48 (m, 1H, H-7), 7.18 (s, 1H, H-3), 3.52 (t, 2H, $J_{CH2\ CH2}$ = 7.03 Hz, CH_2), 2.20 (t, 2H, $J_{CH2\ CH2}$ = 7.03 Hz, CH_2), 2.08 (s, 6H, $3CH_3$), 1.69 (qt, 2H, $J_{CH2\ CH2}$ = 7.03 Hz, CH_2); ^{13}C-NMR (DMSO-d_6) δ: 154.7 (C-4), 153.3 (CH=N), 137.4 (C-5a), 135.5 (C-1'), 130.0 (C-9a), 129.5 (C-4'), 128.4 (C-2' and C-6'), 128.2 (C-3' and C-5'), 128.1 (C-8), 127.0 (C-7), 126.3 (C-6), 125.9 (C-9), 124.7 (C-1), 117.0 (C-3a), 114.8 (C-2), 106.5 (C-3), 58.8 (CH_2), 56.8 (CH_2), 45.1 ($2CH_3$), 28.5 (CH_2). Anal. $C_{23}H_{24}N_4$ (C, H, N).

5.1.72. N'-(7,8-Dichloro-4-phenylpyrrolo[1,2-a]quinoxalin-2-ylmethylene)-N,N-dimethyl-propane-1,3-diamine ***36b***

Orange oil (96%): IR (KBr) 1630 (C=N); ^{1}H-NMR (DMSO-d_6) δ: 8.77 (d, 1H, $J_{H\text{-}1\ H\text{-}3}$ = 1.0 Hz, H-1), 8.59 (s, 1H, H-9), 8.30 (s, 1H, CH=N), 7.95 (s, 1H, H-6), 7.91 (dd, 2H, $J_{H\text{-}2'\ H\text{-}3'}$ = $J_{H\text{-}6'\ H\text{-}5'}$ = 7.70 Hz, $J_{H\text{-}2'\ H\text{-}4'}$ = $J_{H\text{-}5'\ H\text{-}4'}$ = 1.40 Hz, H-2' and H-6'), 7.58 (m, 3H, H-3', H-4' and H-5'), 7.13 (d, 1H, $J_{H\text{-}3\ H\text{-}1}$ = 1.0 Hz, H-3), 3.53 (t, 2H, $J_{CH2\ CH2}$ = 7.0 Hz, CH_2), 2.26 (t, 2H, $J_{CH2\ CH2}$ = 7.0 Hz, CH_2), 2.14 (s, 6H, $2CH_3$), 1.73 (qt, 2H, $J_{CH2\ CH2}$ = 7.0 Hz, CH_2); ^{13}C-NMR (DMSO-d_6) δ: 154.6 (C-4), 154.2 (CH=N), 136.8 (C-5a), 135.1 (C-1'), 130.3 (C-9a), 130.0 (C-8), 129.8 (C-7), 128.5 (C-2' and C-6'), 128.4 (C-3' and C-5'), 127.8 (C-4'), 127.4 (C-6), 125.8 (C-9), 124.3 (C-1), 118.1 (C-3a), 116.7 (C-2), 107.5 (C-3), 58.8 (CH_2), 56.9 (CH_2), 45.1 ($2CH_3$), 28.4 (CH_2). Anal. $C_{23}H_{22}N_4Cl_2$ (C, H, N).

5.1.73. General procedure for the preparation of N'-(4-arylpyrrolo[1,2-a]quinoxalin-1- or -2-ylmethyl)-N,N-dimethylalkyldiamines ***25a–c, 26a–c, 27a,c and 37a,b***

To a solution of *N'*-(4-arylpyrrolo[1,2-*a*]quinoxalin-1- or -2-ylmethylene)-*N,N*-dimethylalkyldiamines **22**, **23**, **24** or **36** (0.008 mol) in methanol (50 mL) was added portion-wise at 0 °C sodium borohydride (0.016 mol). The reaction mixture was then heated under reflux for 4 h and then evaporated to dryness under reduced pressure. After cooling, the residue was triturated in water and extracted with methylene chloride (100 mL). The organic layer was washed with water (80 mL), dried over calcium chloride and evaporated to dryness. Solids were recrystallized from hexane; oils were used without further purification.

5.1.74. N'-(4-Phenylpyrrolo[1,2-a]quinoxalin-1-ylmethyl)-N,N-dimethylpropane-1,3-diamine ***25a***

Orange oil (81%): IR (KBr) 3230 (NH); ^{1}H-NMR (DMSO-d_6) δ: 8.60 (m, 1H, H-9), 7.93 (m, 3H, H-2', H-6' and H-6), 7.54 (m, 5H, H-3', H-4', H-5', H-7 and H-8), 6.89 (d, 1H, $J_{H\text{-}2\ H\text{-}3}$ = 4.40 Hz, H-2), 6.83 (d, 1H, $J_{H\text{-}3\ H\text{-}2}$ = 4.40 Hz, H-3), 4.20 (s, 2H, CH_2), 2.82 (bs, 1H, NH), 2.68 (t, 2H, $J_{CH2\ CH2}$ =

6.84 Hz, CH_2), 2.25 (t, 2H, $J_{CH2\ CH2}$ = 6.84 Hz, CH_2), 2.09 (s, 6H, $2CH_3$), 1.59 (qt, 2H, $J_{CH2\ CH2}$ = 6.84 Hz, CH_2). Anal. $C_{23}H_{26}N_4$ (C, H, N).

5.1.75. N'-(7-Chloro-4-phenylpyrrolo[1,2-a]quinoxalin-1-ylmethyl)-N,N-dimethylpropane-1,3-diamine ***25b***

Yellow oil (97%): IR (KBr) 3285 (NH); ^{1}H-NMR (DMSO-d_6) δ: 8.56 (d, 1H, $J_{H-9\ H-8}$ = 8.79 Hz, H-9), 7.90 (m, 2H, H-2' and H-6'), 7.84 (d, 1H, $J_{H-6\ H-8}$ = 2.44 Hz, H-6), 7.56 (m, 3H, H-3', H-4' and H-5'), 7.47 (dd, 1H, $J_{H-8\ H-9}$ = 8.79 Hz, $J_{H-8\ H-6}$ = 2.44 Hz, H-8), 6.90 (d, 1H, $J_{H-2\ H-3}$ = 3.91 Hz, H-2), 6.83 (d, 1H, $J_{H-3\ H-2}$ = 3.91 Hz, H-3), 4.12 (s, 2H, CH_2), 3.06 (s, 1H, NH), 2.64 (t, 2H, $J_{CH2\ CH2}$ = 6.84 Hz, CH_2), 2.23 (t, 2H, $J_{CH2\ CH2}$ = 6.84 Hz, CH_2), 2.08 (s, 6H, $2CH_3$), 1.57 (qt, 2H, $J_{CH2\ CH2}$ = 6.84 Hz, CH_2); ^{13}C-NMR (DMSO-d_6) δ: 154.3 (C-4), 137.8 (C-5a), 137.5 (C-1'), 132.7 (C-9a), 129.9 (C-7), 128.8 (C-1), 128.4 (C-3' and C-5'), 128.0 (C-2' and C-6'), 127.1 (C-4'), 126.6 (C-8), 126.2 (C-6), 125.7 (C-9), 119.7 (C-3a), 116.5 (C-2), 108.2 (C-3), 57.3 (CH_2), 54.8 (CH_2), 47.0 (CH_2), 45.1 ($2CH_3$), 27.2 (CH_2). Anal. $C_{23}H_{25}ClN_4$ (C, H, N).

5.1.76. N'-(7,8-Dichloro-4-phenylpyrrolo[1,2-a]quinoxalin-1-ylmethyl)-N,N-dimethylpropane-1,3-diamine ***25c***

Yellow crystals (89%): m.p. 120 °C; IR (KBr) 3240 (NH); ^{1}H-NMR (DMSO-d_6) δ: 8.89 (s, 1H, H-9), 7.95 (s, 1H, H-6), 7.87 (m, 2H, H-2' and H-6'), 7.54 (m, 3H, H-3', H-4' and H-5'), 6.91 (d, 1H, $J_{H-2\ H-3}$ = 4.05 Hz, H-2), 6.85 (d, 1H, $J_{H-3\ H-2}$ = 4.05 Hz, H-3), 4.03 (s, 2H, CH_2), 3.32 (s, 1H, NH), 2.62 (t, 2H, $J_{CH2\ CH2}$ = 7.01 Hz, CH_2), 2.32 (t, 2H, $J_{CH2\ CH2}$ = 7.01 Hz, CH_2), 2.11 (s, 6H, $2CH_3$), 1.59 (qt, 2H, $J_{CH2\ CH2}$ = 7.01 Hz, CH_2); ^{13}C-NMR (DMSO-d_6) δ: 154.5 (C-4), 137.1 (C-5a), 136.3 (C-1'), 132.6 (C-9a), 129.8 (C-8), 129.1 (C-7), 128.4 (C-2' and C-6'), 128.2 (C-3' and C-5'), 126.9 (C-1), 126.8 (C-4'), 125.5 (C-9), 120.1 (C-6), 119.8 (C-3a), 117.1 (C-2), 108.6 (C-3), 56.9 (CH_2), 46.7 (CH_2), 46.6 (CH_2), 44.4 ($2CH_3$), 26.5 (CH_2); MS (EI) *m/z*: 427 (M^+, 12), 326 (23), 281 (15), 207 (31), 149 (16), 85 (35), 58 (100). Anal. $C_{23}H_{24}Cl_2N_4$ (C, H, N).

5.1.77. N'-(4-Phenylpyrrolo[1,2-a]quinoxalin-1-ylmethyl)-N,N-dimethylethane-1,2-diamine ***26a***

Orange oil (95%): IR (KBr) 3290 (NH); ^{1}H-NMR (DMSO-d_6) δ: 8.59 (d, 1H, $J_{H-9\ H-8}$ = 7.81 Hz, H-9), 7.93 (m, 3H, H-2', H-6' and H-6), 7.51 (m, 5H, H-3', H-4', H-5', H-7 and H-8), 6.89 (d, 1H, $J_{H-2\ H-3}$ = 4.20 Hz, H-2), 6.85 (d, 1H, $J_{H-3\ H-2}$ = 4.20 Hz, H-3), 4.26 (s, 2H, CH_2), 2.88 (bs, 1H, NH), 2.75 (t, 2H, $J_{CH2\ CH2}$ = 6.35 Hz, CH_2), 2.39 (t, 2H, $J_{CH2\ CH2}$ = 6.35 Hz, CH_2), 2.16 (s, 6H, $2CH_3$). Anal. $C_{22}H_{24}N_4$ (C, H, N).

5.1.78. N'-(7-Chloro-4-phenylpyrrolo[1,2-a]quinoxalin-1-ylmethyl)-N,N-dimethylethane-1,2-diamine ***26b***

Orange oil (95%): IR (KBr) 3290 (NH); ^{1}H-NMR (DMSO-d_6) δ: 8.58 (d, 1H, $J_{H-9\ H-8}$ = 8.79 Hz, H-9), 7.90 (m, 2H, H-2' and H-6'), 7.85 (d, 1H, $J_{H-6\ H-8}$ = 2.44 Hz, H-6), 7.56 (m, 3H, H-3', H-4' and H-5'), 7.47 (dd, 1H, $J_{H-8\ H-9}$ = 8.79 Hz, $J_{H-8\ H-6}$ = 2.44 Hz, H-8), 6.90 (d, 1H, $J_{H-2\ H-3}$ = 4.40 Hz, H-2), 6.83 (d, 1H, $J_{H-3\ H-2}$ = 4.40 Hz, H-3), 4.18 (s, 2H, CH_2), 2.71 (t, 2H, $J_{CH2\ CH2}$ = 6.34 Hz, CH_2), 2.35 (t, 2H, $J_{CH2\ CH2}$ = 6.34 Hz, CH_2), 2.20 (bs, 1H, NH), 2.14 (s, 6H, $2CH_3$). Anal. $C_{22}H_{23}ClN_4$ (C, H, N).

5.1.79. N'-(7,8-Dichloro-4-phenylpyrrolo[1,2-a]quinoxalin-1-ylmethyl)-N,N-dimethylethane-1,2-diamine ***26c***

Yellow crystals (97%): m.p. 81 °C; IR (KBr) 3280 (NH); ^{1}H-NMR (DMSO-d_6) δ: 8.88 (s, 1H, H-9), 7.94 (s, 1H, H-6), 7.88 (m, 2H, H-2' and H-6'), 7.54 (m, 3H, H-3', H-4' and H-5'), 6.90 (d, 1H, $J_{H-2\ H-3}$ = 3.98 Hz, H-2), 6.83 (d, 1H, $J_{H-3\ H-2}$ = 3.98 Hz, H-3), 4.13 (s, 2H, CH_2), 3.15 (s, 1H, NH), 2.75 (t, 2H, $J_{CH2\ CH2}$ = 6.40 Hz, CH_2), 2.41 (t, 2H, $J_{CH2\ CH2}$ = 6.40 Hz, CH_2), 2.16 (s, 6H, $2CH_3$); ^{13}C-NMR (DMSO-d_6) δ: 154.8 (C-4), 137.4 (C-5a), 136.7 (C-1'), 132.9 (C-9a), 130.0 (C-8), 129.4 (C-7), 128.7 (C-4'), 128.5 (C-2' and C-6'), 128.3 (C-3' and C-5'), 127.2 (C-6), 127.1 (C-9), 125.9 (C-1), 120.0 (C-3a), 117.2 (C-3), 108.8 (C-2), 58.8 (CH_2), 46.9 (CH_2), 46.5 (CH_2), 45.2 ($2CH_3$). Anal. $C_{22}H_{22}Cl_2N_4$ (C, H, N).

5.1.80. N'-(4-Styrylpyrrolo[1,2-a]quinoxalin-1-ylmethyl)-N,N-dimethylpropane-1,3-diamine ***27a***

Brown oil (87%): IR (KBr) 3280 (NH); ^{1}H-NMR (DMSO-d_6) δ: 8.49 (m, 1H, H-9), 7.93 (d, 1H, $J_{H\text{-}trans\ H\text{-}trans}$ = 15.75 Hz, CH=), 7.84 (m, 1H, H-6), 7.77 (d, 1H, $J_{H\text{-}trans\ H\text{-}trans}$ = 15.75 Hz, CH=), 7.43 (m, 4H, H-7, H-8, H-2' and H-6'), 7.28 (m, 3H, H-3', H-4' and H-5'), 6.95 (d, 1H, $J_{H-2\ H-3}$ = 4.10 Hz, H-2), 6.77 (d, 1H, $J_{H-3\ H-2}$ = 4.10 Hz, H-3), 4.23 (s, 2H, CH_2), 3.16 (bs, 1H, NH), 2.60 (t, 2H, $J_{CH2\ CH2}$ = 6.85 Hz, CH_2), 2.24 (t, 2H, $J_{CH2\ CH2}$ = 6.85 Hz, CH_2), 2.06 (s, 6H, $2CH_3$), 1.90 (qt, 2H, $J_{CH2\ CH2}$ = 6.85 Hz, 2H, CH_2). Anal. $C_{25}H_{28}N_4$ (C, H, N).

5.1.81. N'-(7,8-Dichloro-4-styrylpyrrolo[1,2-a]quinoxalin-1-ylmethyl)-N,N-dimethylpropane-1,3-diamine ***27c***

Orange oil (76%): IR (KBr) 3290 (NH); ^{1}H-NMR ($CDCl_3$) δ: 8.78 (s, 1H, H-9), 7.95 (s, 1H, H-6), 7.93 (d, 1H, $J_{H\text{-}trans\ H\text{-}trans}$ = 15.80 Hz, CH=), 7.46 (m, 2H, H-2' and H-6'), 7.40 (d, 1H, $J_{H\text{-}trans\ H\text{-}trans}$ = 15.80 Hz, CH=), 7.32 (m, 3H, H-3', H-4' and H-5'), 6.78 (d, 1H, $J_{H-2\ H-3}$ = 3.90 Hz, H-2), 6.67 (d, 1H, $J_{H-3\ H-2}$ = 3.90 Hz, 1H, H-3), 4.14 (s, 2H,CH_2), 2.85 (t, 2H, $J_{CH2\ CH2}$ = 6.60 Hz, CH_2), 2.45 (t, 2H, $J_{CH2\ CH2}$ = 6.60 Hz, CH_2), 2.21 (s, 6H, $2CH_3$), 1.76 (qt, 2H, $J_{CH2\ CH2}$ = 6.60 Hz, CH_2). MS (EI) *m/z*: 454 (M^+ + 1, 22), 453 (M^+, 35), 352 (55), 265 (24), 202 (54), 140 (35), 91 (51), 85 (100), 59 (93). Anal. $C_{25}H_{26}Cl_2N_4$ (C, H, N).

5.1.82. N'-(4-Phenylpyrrolo[1,2-a]quinoxalin-2-ylmethyl)-N,N-dimethylpropane-1,3-diamine ***37a***

Yellow oil (92%): IR (KBr) 3260 (NH); ^{1}H-NMR (DMSO-d_6) δ: 8.45 (s, 1H, H-1), 8.21 (d, 1H, $J_{H-9\ H-8}$ = 7.76 Hz, H-9), 7.98 (m, 2H, H-2' and H-6'), 7.91 (d, 1H, $J_{H-6\ H-7}$ = 7.76 Hz, H-6), 7.58 (m, 4H, H-3', H-4', H-5' and H-8), 7.47 (t, 1H, $J_{H-7\ H-8}$ = $J_{H-7\ H-6}$ = 7.76 Hz, H-7), 7.02 (s, 1H, H-3), 3.88 (s, 2H, CH_2), 3.70 (bs, 1H, NH), 2.62 (t, 2H, $J_{CH2\ CH2}$ = 6.96 Hz, CH_2), 2.25 (t, 2H, $J_{CH2\ CH2}$ = 6.96 Hz, CH_2), 2.09 (s, 6H, $2CH_3$), 1.59 (qt, 2H, $J_{CH2\ CH2}$ = 6.96 Hz, CH_2); ^{13}C-NMR (DMSO-d_6) δ: 152.7 (C-4), 137.9 (C-5a), 135.4 (C-1'), 129.9 (C-9a), 129.5 (C-4'), 128.5 (C-2' and C-6'), 128.3 (C-3' and C-5'), 128.2 (C-8), 127.8 (C-7), 126.5 (C-6), 125.2 (C-9), 124.1 (C-2), 115.0 (C-3a), 114.4 (C-1), 108.2 (C-3), 57.2 (CH_2), 46.8 (CH_2), 45.5 (CH_2), 45.0 ($2CH_3$), 26.7 (CH_2). Anal. $C_{23}H_{26}N_4$ (C, H, N).

5.1.83. N'-(7,8-Dichloro-4-phenylpyrrolo[1,2-a]quinoxalin-2-ylmethyl)-N,N-dimethylpropane-1,3-diamine ***37b***

Yellow crystals (81%): m.p. 56 °C; IR (KBr) 3440 (NH); ^{1}H-NMR (DMSO-d_6) δ: 8.52 (s, 1H, H-9), 8.48 (s, 1H, H-1), 8.03 (s, 1H, H-6), 7.97 (m, 2H, H-2' and H-6'), 7.57 (m, 3H, H-3', H-4' and H-5'), 7.07 (s, 1H, H-3), 3.89 (s, 2H, CH_2), 3.21 (s, 1H, NH), 2.67 (t, 2H, $J_{CH2\ CH2}$ = 7.10 Hz, CH_2), 2.32 (t, 2H, $J_{CH2\ CH2}$ = 7.10 Hz, CH_2), 2.15 (s, 6H, $2CH_3$), 1.64 (qt, 2H, $J_{CH2\ CH2}$ = 7.10 Hz, CH_2); ^{13}C-NMR (DMSO-d_6) δ: 154.0 (C-4), 137.1 (C-5a), 135.0 (C-1'), 130;2 (C-9a), 129.9 (C-8), 129.5 (C-7), 128.5 (C-2' and C-6'), 128.4 (C-3' and C-5'), 127.1 (C-4'), 126.7 (C-6), 125.8 (C-9), 123.8 (C-2), 116.7 (C-3a), 116.2 (C-1), 109.6 (C-3), 56.7 (CH_2), 46.2 (CH_2), 44.7 ($2CH_3$), 44.6 (CH_2), 25.5 (CH_2); MS (EI) *m/z*: 429 (M^+ + 2, 16), 428 (M^+ + 1, 27), 427 (M^+, 73), 380 (22), 354 (30), 325 (100), 285 (66), 250 (24), 101 (58). Anal. $C_{23}H_{24}Cl_2N_4$ (C, H, N).

*5.1.84. General procedure for the preparation of 4-phenylpyrrolo[1,2-a]quinoxaline-2-carbaldehydes **31a,b***

To a solution of (4-phenylpyrrolo[1,2-*a*]quinoxalin-2-yl)-methanol **35** (0.008 mol) in chloroform (180 mL), was added manganese dioxide (0.08 mol). The reaction mixture was then refluxed for 12 h. The black solid was removed and washed with chloroform (2 x 50 mL). The filtrate and washings were combined, dried and evaporated to dryness under reduced pressure. The residue was chromatographed on a silica-gel column eluting with ethyl acetate/petroleum ether (50:50).

*5.1.85. 4-Phenylpyrrolo[1,2-a]quinoxaline-2-carbaldehyde **31a***

White crystals (38%): m.p. 181 °C; IR (KBr) 1670 (CO); ^{1}H-NMR (DMSO-d_6) δ: 10.08 (s, 1H, CHO), 9.16 (d, 1H, $J_{H\text{-}1\ H\text{-}3}$ = 1.20 Hz, H-1), 8.38 (dd, 1H, $J_{H\text{-}9\ H\text{-}8}$ = 8.17 Hz, $J_{H\text{-}9\ H\text{-}7}$ = 1.37 Hz, H-9), 7.97 (m, 2H, H-2' and H-6'), 7.93 (dd, 1H, $J_{H\text{-}6\ H\text{-}7}$ = 8.17 Hz, $J_{H\text{-}6\ H\text{-}8}$ = 1.37 Hz, H-6), 7.63 (m, 1H, H-8), 7.59 (m, 3H, H-3', H-4' and H-5'), 7.56 (m, 1H, H-7), 7.33 (d, 1H, $J_{H\text{-}3\ H\text{-}1}$ = 1.20 Hz, H-3); ^{13}C-NMR (DMSO-d_6) δ: 187.1 (CO), 154.2 (C-4), 137.1 (C-5a), 135.9 (C-1'), 130.3 (C-9a), 129.8 (C-4'), 128.6 (C-2' and C-6'), 128.5 (C-8), 128.4 (C-3' and C-5'), 128.3 (C-7), 126.9 (C-6), 126.2 (C-9), 125.3 (C-1), 120.9 (C-3a), 115.2 (C-2), 107.4 (C-3). Anal. $C_{18}H_{12}N_2O$ (C, H, N).

*5.1.86. 7,8-Dichloro-4-phenylpyrrolo[1,2-a]quinoxaline-2-carbaldehyde **31b***

White crystals (62%): m.p. > 260 °C; IR (KBr) 1690 (CO); ^{1}H-NMR (DMSO-d_6) δ: 10.10 (s, 1H, CHO), 9.09 (d, 1H, $J_{H\text{-}1\ H\text{-}3}$ = 1.40 Hz, H-1), 8.65 (s, 1H, H-9), 8.04 (s, 1H, H-6), 7.96 (m, 2H, H-2' and H-6'), 7.57 (m, 3H, H-3', H-4' and H-5'), 7.34 (d, 1H, $J_{H\text{-}3\ H\text{-}1}$ = 1.40 Hz, H-3); MS (EI) *m/z*: 343 (M^+ + 2, 14), 342 (M^+ + 1, 50), 341 (M^+, 31), 340 (75), 311 (55), 213 (52), 207 (60), 133 (100), 96 (18). Anal. $C_{18}H_{10}Cl_2N_2O$ (C, H, N).

*5.1.87. General procedure for the preparation of 2-methyl-3-phenylquinoxalines **33a,b***

To a solution of 1-phenyl-1,2-propanedione (0.08 mol) in acetic acid (80 mL) cooled at 0 °C, was added 1,2-phenylenediamine **32** (0.08 mol). The reaction mixture was then refluxed for 1 h, then cooled and poured into water (150 mL). The precipitate was filtered, washed with water and dissolved in methylene chloride (100 mL). The organic layer was washed with water (85 mL), dried over calcium chloride and evaporated to dryness under reduced pressure. The precipitate was then recrystallized from ethanol.

*5.1.88. 6,7-Dichloro-2-methyl-3-phenylquinoxaline **33b***

Beige crystals (75%): m.p. 161 °C; ^{1}H-NMR (DMSO-d_6) δ: 8.19 (s, 1H, H-8), 8.16 (s, 1H, H-5), 7.68 (m, 2H, H-2' and H-6'), 7.52 (m, 3H, H-3', H-4' and H-5'), 2.67 (s, 3H, CH_3); ^{13}C-NMR (DMSO-d_6) δ: 155.7 (C-3), 154.2 (C-2), 139.5 (C-4a), 139.3 (C-8a), 138.1 (C-1'), 132.5 (C-7), 132.1 (C-6), 129.6 (C-5), 129.5 (C-8), 129.1 (C-4'), 128.9 (C-3' and C-5'), 128.2 (C-2' and C-6'), 24.0 (CH_3); MS (EI) *m/z*: 291 (M^+ + 2, 8), 290 (M^+ + 1, 18), 289 (M^+, 43), 288 (75), 286 (100), 185 (16), 144 (29), 109 (13). Anal. $C_{15}H_{10}Cl_2N_2$ (C, H, N).

*5.1.89. General procedure for the preparation of ethyl 4-phenylpyrrolo[1,2-a]quinoxaline-2-carboxylates **34a,b***

To a solution of 2-methyl-3-phenylquinoxaline **33** (0.03 mol) in dry ethanol (100 mL), was added ethyl bromopyruvate (0.0405 mol). The mixture was refluxed for 20 h. After filtration the solid was suspended in water, made alkaline with sodium hydrogen carbonate and extracted with methylene chloride. After drying, the organic layers were evaporated to give **34a,b** which were recrystallized from ethyl acetate.

*5.1.90. Ethyl 4-phenylpyrrolo[1,2-a]quinoxaline-2-carboxylate **34a***

White crystals (36%): m.p. 210 °C; IR (KBr) 1700 (CO); ^{1}H-NMR (DMSO-d_6) δ: 8.91 (d, 1H, $J_{H\text{-}1\ H\text{-}3}$ = 1.50 Hz, H-1), 8.38 (dd, 1H, $J_{H\text{-}9\ H\text{-}8}$ = 7.74 Hz, $J_{H\text{-}9\ H\text{-}7}$ = 1.47 Hz, H-9), 7.96 (m, 2H, H-2' and H-6'), 7.93 (dd, 1H, $J_{H\text{-}6\ H\text{-}7}$ = 7.74 Hz, $J_{H\text{-}6\ H\text{-}8}$ = 1.47 Hz, H-6), 7.57 (m, 5H, H-3', H-4', H-5', H-7 and H-8), 7.22 (d, 1H, $J_{H\text{-}3\ H\text{-}1}$ = 1.50 Hz, H-3), 4.34 (q, 2H, $J_{CH2\ CH3}$ = 7.04 Hz, CH_2), 1.35 (t, 3H, $J_{CH3\ CH2}$ = 7.04 Hz, CH_3); ^{13}C-NMR (DMSO-d_6) δ: 162.8 (CO), 153.3 (C-4), 136.9 (C-5a), 135.5 (C-1'), 129.5 (C-9a), 129.2 (C-4'), 128.0 (C-2' and C-6'), 127.8 (C-3' and C-5'), 127.7 (C-8), 126.0 (C-7), 125.7 (C-6), 124.3 (C-9), 119.7 (C-1), 118.6 (C-3a), 114.6 (C-2), 108.0 (C-3), 59.5 (CH_2), 13.7 (CH_3). Anal. $C_{20}H_{16}N_2O_2$ (C, H, N).

*5.1.91. Ethyl 7,8-dichloro-4-phenylpyrrolo[1,2-a]quinoxaline-2-carboxylate **34b***

White crystals (19%): m.p. 232 °C; IR (KBr) 1710 (CO); ^{1}H-NMR (DMSO-d_6) δ: 9.04 (d, 1H, $J_{H\text{-}1\ H\text{-}3}$ = 1.30 Hz, H-1), 8.79 (s, 1H, H-9), 8.06 (s, 1H, H-6), 7.95 (m, 2H, H-2' and H-6'), 7.58 (m, 3H, H-3', H-4' and H-5'), 7.23 (d, 1H, $J_{H\text{-}3\ H\text{-}1}$ = 1.30 Hz, H-3), 4.33 (q, 2H, $J_{CH2\ CH3}$ = 7.10 Hz, CH_2), 1.34 (t, 3H, $J_{CH3\ CH2}$ = 7.10 Hz, CH_3); MS (EI) *m/z*: 387 (M^+ + 2, 15), 386 (M^+ + 1, 21), 385 (M^+, 71), 383 (100), 354 (34), 310 (45), 286 (31), 213 (50), 133 (71). Anal. $C_{20}H_{14}Cl_2N_2O_2$ (C, H, N).

*5.1.92. General procedure for the preparation of (4-phenylpyrrolo[1,2-a]quinoxalin-2-yl)-methanols **35a,b***

To a suspension of lithium aluminium hydride (0.018 mol) in tetrahydrofuran (130 mL) cooled at 0 °C, was added under nitrogen ethyl 4-phenylpyrrolo[1,2-*a*]quinoxaline-2-carboxylate **34** (0.006 mol). The reaction mixture was then stirred at 0–5 °C during 2 h, then water was added dropwise and caustiously for decomposition of excess hydride. The precipitate was filtered and washed with tetrahydrofuran. The filtrate was then dried over calcium chloride and evaporated to dryness. The residue was triturated in ethyl acetate and the precipitate was filtered and recrystallized from chloroform.

*5.1.93. (4-Phenylpyrrolo[1,2-a]quinoxalin-2-yl)methanol **35a***

Yellow crystals (43%): m.p. 146 °C; IR (KBr) 3260 (OH); ^{1}H-NMR (DMSO-d_6) δ: 8.43 (s, 1H, H-1), 8.25 (d, 1H, $J_{H\text{-}9\ H\text{-}8}$ = 7.72 Hz, H-9), 7.97 (m, 2H, H-2' and H-6'), 7.91 (d, 1H, $J_{H\text{-}6\ H\text{-}7}$ = 7.72 Hz, H-6), 7.57 (m, 4H, H-3', H-4', H-5' and H-8), 7.47 (t, 1H, $J_{H\text{-}7\ H\text{-}8}$ = $J_{H\text{-}7\ H\text{-}6}$ = 7.72 Hz, H-7), 6.96 (s, 1H, H-3), 5.13 (t, 1H, $J_{OH\ CH2}$ = 5.53 Hz, OH), 4.65 (d, 2H, $J_{CH2\ OH}$ = 5.53 Hz, CH_2); ^{13}C-NMR (DMSO-d_6) δ: 152.9 (C-4), 137.9 (C-5a), 135.4 (C-1'), 131.3 (C-9a), 129.9 (C-4'), 129.5 (C-8), 128.5 (C-2' and C-6'), 128.3 (C-3' and C-5'), 127.8 (C-7), 126.6 (C-6), 125.2 (C-9), 124.1 (C-2), 114.5 (C-3a), 114.1 (C-1), 107.2 (C-3), 56.8 (CH_2). Anal. $C_{18}H_{14}N_2O$ (C, H, N).

*5.1.94. (7,8-Dichloro-4-phenylpyrrolo[1,2-a]quinoxalin-2-yl)-methanol **35b***

Yellow crystals (70%): m.p. 188 °C; IR (KBr) 3390 (OH); ^{1}H-NMR (DMSO-d_6) δ: 8.64 (s, 1H, H-9), 8.50 (d, 1H, $J_{H\text{-}1\ H\text{-}3}$ = 1.0 Hz, H-1), 8.05 (s, 1H, H-6), 7.93 (m, 2H, H-2' and H-6'), 7.56 (m, 3H, H-3', H-4' and H-5'), 6.98 (d, 1H, $J_{H\text{-}3\ H\text{-}1}$ = 1.0 Hz, H-3), 5.19 (t, 1H, $J_{OH\ CH2}$ = 5.50 Hz, OH), 4.61 (d, 2H, $J_{CH2\ OH}$ = 5.50 Hz, CH_2); ^{13}C-NMR (DMSO-d_6) δ: 154.2 (C-4), 137.2 (C-5a), 135.2 (C-1'), 132.1 (C-9a), 130.3 (C-8), 130.0 (C-7), 129.6 (C-4'), 128.6 (C-2' and C-6'), 128.4 (C-3' and C-5'), 127.1 (C-6), 126.2 (C-9), 123.9 (C-2), 116.5 (C-3a), 115.6

(C-1), 108.4 (C-3), 56.7 (CH_2); MS (EI) *m/z*: 345 (M^+ + 2, 12), 344 (M^+ + 1, 18), 343 (M^+, 65), 341 (100), 324 (30), 310 (57), 287 (17), 144 (25). Anal. $C_{18}H_{12}Cl_2N_2O$ (C, H, N).

5.2. In vitro pharmacology

5.2.1. Cell cultures

The rat beta cell line subcloned RIN T3 was cultured in DMEM-glucose 1 g/l medium with 10% foetal calf serum, 100 U/mL penicillin and 100 µg/mL streptomycin [45].

5.2.2. Membrane preparations

The RIN T3 cells membranes were prepared on sucrose gradient according to the method previously described [43].

The membranes of rat liver were prepared on sucrose gradient according to the method of Neville Jr up to step eleven [46].

5.2.3. Radioligand preparations

tGLP-1 (Peninsula, USA) and glucagon (Novo Nordisk, Denmark) were labelled with 125 iodine according to the method using the chloramine T and purified on HPLC column (µBondapak C 18).

5.2.4. Binding studies

Competition experiments with labelled tGLP-1 or glucagon were performed according to the method previously described [43].

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