Chemical Reactions of Cycloalkanespirohydantoins. Part 2. Synthesis of New 4-Hydroxyimidazolidinone N_3-Substituted from Cycloalkanespirohydantoins

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N_3-Substituted hydantoins have been to undergo lithium aluminum hydride reduction (THF, room temperature, 5 hours) to give 4-hydroxy-2-imidazolidinones in good yields.

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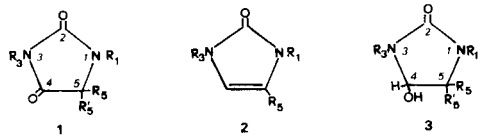
Lithium aluminum hydride ($LiAlH_4$) reductions of hydantoins **1** have been reported to yield a variety of products [1-3]. Studies have indicated that imidazolones **2** [4] and 4-hydroxy-2-imidazolidinones **3** [2] were formed from room-temperature reductions (Scheme I).

Scheme I



1 **2** **3**

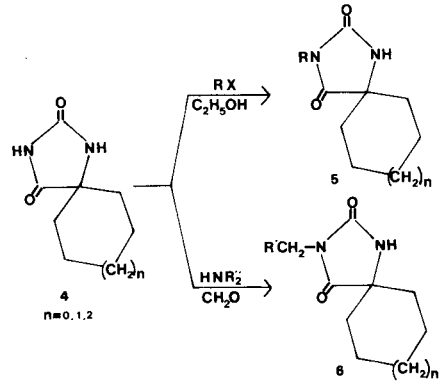
R_1: H
R_3: CH_3, n-C_4H_9, C_6H_5
R_5: H, CH_3, C_6H_5
R_5': H

Lithium aluminum hydride reduction of N_3-substituted hydantoins has been shown to afford 4-hydroxy-2-imidazolidinones in high yields *via* a simple experimental procedure. The latter compounds are of interest as valuable synthetic intermediates in the synthesis of heterocyclic compounds [5,6].

In this paper we describe the lithium aluminum hydride reduction of N_3-substituted spirohydantoins (THF, room temperature) and key spectral properties observed for all compounds examined (Tables I-IV).

The startin materials for this study were prepared from 5,5-spirohydantoins **4**. Alkylation of 5,5-spirohydantoins [6] with alkyl halides led to the corresponding 3-substituted hydantoins **5**, in moderate to good yields (60-80%). Reaction of **4** with formaldehyde (50% aqueous solution) and secondary amines [7] gave the corresponding Mannich bases **6** in good yields (80-90%) (Scheme II).

Scheme II



4 n=0,1,2 **5** **6**

5a; n = 0, R = CH_3
5b; n = 0, R = n-C_4H_9
5c; n = 0, R = $CH_2C_6H_5$
5d; n = 1, R = CH_3
5e; n = 1, R = n-C_4H_9
5f; n = 1, R = $CH_2C_6H_5$
5g; n = 1, R = $CH_2C_6H_4$(p)Cl
5h; n = 1, R = $(CH_2)_2C_6H_5$
5i; n = 1, R = $(CH_2)_3C_6H_5$
5j; n = 2, R = n-C_4H_9
5k; n = 2, R = $(CH_2)_3C_6H_5$

6a; n = 0, R' = $N(CH_3)CH_2C_6H_5$
6b; n = 0, R' = $N(C_2H_5)CH_2C_6H_5$
6c; n = 0, R' = $N(CH_2C_6H_5)_2$
6d; n = 0, R' = piperidino
6e; n = 0, R' = morpholino
6f; n = 1, R' = $N(CH_3)CH_2C_6H_5$
6g; n = 1, R' = $N(C_2H_5)CH_2C_6H_5$
6h; n = 1, R' = $N(CH_2C_6H_5)_2$
6i; n = 1, R' = piperidino
6j; n = 1, R' = morpholino

Treatment of the 3-substituted hydantoins listed in Tables I and II with lithium aluminum hydride in THF at room temperature (5 hours) gave good yields of **7** and **8** (Table III and IV) (Scheme III).

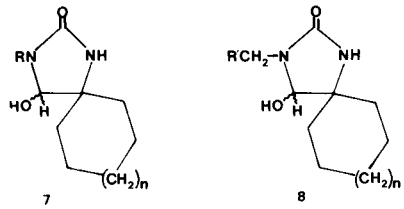
Table I

Analytical and Spectral Data of N_3-Alkylcycloalkanespirohydantoins **5**

Compound	Yield (%)	Mp °C [a]	Molecular Formula	Analysis % Calcd./(Found) C	H	N	IR, cm^{-1} N-H	C=O	[e]	NMR (δ ppm) [f]
5a	80	130-132 [b]	$C_8H_{12}N_2O_2$	57.12 (57.05)	7.19 (7.21)	16.65 (16.59)	3290	1770	1715	8.3 (s, 1H, NH), 3.0 (s, 3H, NCH_3), 1.95 (m, 8H, CH_2)
5b	60	73-75 [c]	$C_{11}H_{18}N_2O_2$	62.83 (62.87)	8.62 (8.65)	13.32 (13.40)	3240	1770	1710	8.4 (s, 1H, NH), 3.25 (t, 2H, NCH_2), 1.75 (m, 8H, CH_2 of ring), 1.5 (m, 4H, $NCCH_2CH_2$), 0.9 (t, 3H, CH_3)
5c	87	103-105 [c]	$C_{14}H_{16}N_2O_2$	68.83 (68.85)	6.60 (6.55)	11.46 (11.10)	3280	1770	1710	8.0 (s, 2H, NH), 7.3 (m, 5H, aromatic), 4.6 (s, 2H, NCH_2), 1.8 (m, 8H, CH_2 of ring)
5d	76 [10]	208-209 [c]	$C_9H_{14}N_2O_2$	59.32 (59.39)	7.74 (7.68)	15.38 (15.45)	3300	1775	1710	8.55 (s, 1H, NH), 2.8 (s, 3H, NCH_3), 1.55 (m, 10H, CH_2 of ring)
5e	73 [11]	141-143 [c]	$C_{12}H_{20}N_2O_2$	64.25 (64.20)	8.99 (8.75)	12.49 (12.54)	3220	1775	1710	8.55 (s, 1H, NH), 3.45 (t, 2H, NCH_2), 1.7 (m, 10H, CH_2 of ring), 1.6 (m,4H, $NCCH_2CH_2$), 1.0 (t, 3H, CH_3)
5f	81 [10]	155-156 [c]	$C_{13}H_{16}N_2O_2$	69.74 (69.70)	7.02 (7.06)	12.38 (12.35)	3320	1775	1710	8.5 (s, 1H, NH), 7.25 (m, 5H, aromatic), 4.5 (s, 2H, NCH_2), 1.6 (m, 10H, CH_2 of ring)
5g	73	182-183 [c]	$C_{15}H_{17}N_2O_2$	61.54 (61.57)	5.85 (5.80)	9.56 (9.53)	3220	1775	1710	8.75 (s, 1H, NH), 7.3 (m, 4H, aromatic), 4.5 (s, 2H, NCH_2), 1.6 (m, 10H, CH_2 of ring)
5h	70	195-197 [d]	$C_{16}H_{20}N_2O_2$	70.56 (70.53)	7.40 (7.43)	10.28 (10.35)	3290	1775	1710	8.55 (s, 1H, NH), 7.2 (m, 5H, aromatic), 3.6 (t, 2H, NCH_2), 2.9 (t, 2H, $NCCH_2$), 1.5 (m, 10H, CH_2 of ring)
5i	84	155-157 [c]	$C_{17}H_{22}N_2O_2$	71.30 (71.37)	7.43 (7.50)	9.78 (9.48)	3280	1770	1705	7.5 (s, 1H, NH), 7.2 (m, 5H, aromatic), 3.6 (t, 2H, NCH_2), 2.7 (t, 2H, $NCCCH_2$), 2.5 (m, 2H, $NCCH_2$), 1.7 (m, 10H, CH_2 of ring)
5j	72	135-137 [c]	$C_{13}H_{22}N_2O_2$	65.51 (65.46)	9.30 (9.55)	11.73 (11.74)	3210	1775	1715	8.4 (s, 1H, NH), 3.25 (t, 2H, NCH_2), 1.6 (m, 12H, CH_2 of ring), 1.4 (m, 4H, $NCCH_2CH_2$), 0.95 (t, 3H, CH_3)
5k	60	151-153 [c]	$C_{18}H_{24}N_2O_2$	71.96 (71.92)	8.05 (8.18)	9.35 (9.35)	3300	1775	1710	7.2 (s, 1H, NH), 7.1 (m, 5H, aromatic), 3.5 (t, 2H, NCH_2), 2.7 (t, 2H, $NCCCH_2$), 1.9 (t, 2H, $NCCH_2$), 1.6 (m, 12H, CH_2 of ring)

[a] Recrystallization solvents; [b] Diethyl ether. [c] Ethanol. [d] Ethanol/acetone (1:1) [e] In Potassium bromide. [f] In DMSO-d_6.

Scheme III



7 8

7a; n = 0, R = CH_3
7b; n = 0, R = n-C_4H_9
7c; n = 0, R = $CH_2C_6H_5$
7d; n = 1, R = CH_3
7e; n = 1; R = n-C_4H_9
7f; n = 1; R = $CH_2C_6H_5$
7g; n = 1; R = $CH_2C_6H_4$(p)Cl
7h; n = 1; R = $(CH_2)_2C_6H_5$
7i; n = 1; R = $(CH_2)_3C_6H_5$
7j; n = 2; R = n-C_4H_9
7k; n = 2; R = $(CH_2)_3C_6H_5$

8a; n = 0, R′ = $N(CH_3)CH_2C_6H_5$
8b; n = 0, R′ = $N(C_2H_5)CH_2C_6H_5$
8c; n = 0, R′ = $N(CH_2C_6H_5)_2$
8d; n = 0, R′ = piperidino
8e; n = 0, R′ = morpholino
8f; n = 1, R′ = $N(CH_3)CH_2C_6H_5$
8g; n = 1, R′ = $N(C_2H_5)CH_2C_6H_5$
8h; n = 1, R′ = $N(CH_2C_6H_5)_2$
8i; n = 1, R′ = piperidino
8j; n = 1, R′ = morpholino

The infrared spectra of compounds **7** and **8** in the solid state showed absorptions at 3140 and 3270 cm^{-1} approximately. The band at 3140 cm^{-1} is due to the stretching of the N_1-H bond belonging to the intermoleculer bonding system N_1-H----O=C_2 formed between pairs of molecules related by a center of symmetry. Similar intramolecular carbonyl couplings have been described [8]. This structural fact is in good agreement with the results obtained by X-ray diffraction for the compound **8a** [9]. The band at 3260 cm^{-1} is due to the O-H stretching vibration which originates from intermolecular vibrational coupling between the O-H and H-O bonding from methanol. Vibration H-O from methanol appeared at about 3350 cm^{-1}. The ir spectrum of all the compounds in solid state shows a very strong band 1695 cm^{-1} in the carbonyl region which indicated that partial reduction of one carbonyl group had taken place (Table III and IV).

The chemical shift values observed in the nmr for **7** and **8** are in agreement with the proposed structure. The most distinguishing feature in the nmr is a pair of doublets (J = 7 Hz) between 5.8 and 4.8 ppm and a singlet at 6.8. The signal at 5.8 disappeared after deuterium oxide exchange and the signal at 4.8 is resolved into a singlet after deuterium oxide exchange. These signals have been assigned to the coupling OH, H of hydroxyl group. The singlet observed at 6.8 ppm corresponding to the hydrogen of N-H group. The nmr spectrum of **7c**, **7f**, **7g**, **8a**, **8b** and **8c** ex-

Table II

Analytical and Spectral Data of N_1-Dialkylaminomethylcycloalkanespirohydantoins **6**

Compound	Yield (%)	Mp °C [a]	Molecular Formula	Analysis % Calcd./(Found) C	H	N	IR, cm^{-1} N-H	C=O	[g]	NMR (δ ppm)
6a	71	97-99 [b]	$C_{16}H_{21}N_3O_2$	66.87 (66.92)	7.36 (7.40)	14.62 (14.35)	3210	1175	1720	8.4 (s, 1H, NH), 7.2 (m, 5H, aromatic), 4.3 (s, 2H, NCH_2N), 3.6 (s, 2H, NCH_2Ar), 2.1 (s, 3H, CH_3), 1.8 (m, 8H, CH_2 of ring) [h]
6b [h]	70	96-98 [c]	$C_{17}H_{23}N_3O_2$	67.74 (67.90)	7.69 (7.73)	13.94 (13.82)	3215	1775	1725	8.4 (s, 1H, NH), 7.3 (m, 5H, aromatic), 4.5 (s, 2H, NCH_2N), 3.7 (s, 2H, NCH_2Ar), 2.5 (m, 2H, NCH_2C), 1.8 (m, 8H, CH_2 of ring), 1 (t, 3H, CH_3)
6c	66 [12]	167-169 [d]	$C_{22}H_{25}N_3O_2$	72.70 (72.56)	6.93 (6.95)	11.56 (11.60)	3215	1775	1725	8.4 (s, 1H, NH), 7.4 (m, 10H, aromatic), 4.6 (s, 2H, NCH_2N), 3.8 (s, 4H, NCH_2Ar), 1.9 (m, 8H, CH_2 of ring) [i]
6d	67 [12]	112-114 [c]	$C_{13}H_{21}N_3O_2$	62.12 (62.48)	8.42 (8.46)	16.71 (16.54)	3240	1775	1725	8.4 (s, 1H, NH), 4.3 (s, 2H, NCH_2N), 2.5 (s, 2H, NCH_2C), 1.8 (m, 8H, CH_2 of ring), 1.4 (m, 6H, $NCCH_2CH_2CH_2C$) [h]
6e	86	90-92 [c]	$C_{12}H_{19}N_3O_3$	56.92 (57.13)	7.51 (7.73)	16.60 (16.54)	3270	1770	1720	7.7 (s, 1H, NH), 4.4 (s, 2H, NCH_2N), 3.7 (t, 4H, OCH_2C), 2.6 (t, 4H, NCH_2C), 1.9 (m, 8H, CH_2 of ring) [i]
6f	87	166-168 [c]	$C_{17}H_{23}N_3O_2$	67.75 (67.96)	7.69 (7.62)	13.94 (13.86)	3210	1770	1710	7.9 (s, 1H, NH), 7.3 (m, 5H, aromatic), 4.5 (s, 2H, NCH_2N), 3.7 (s, 2H, NCH_2Ar), 2.3 (s, 3H, CH_3), 1.7 (m, 10H, CH_2 of ring) [i]
6g [h]	88	136-138 [e]	$C_{18}H_{25}N_3O_2$	68.54 (68.73)	7.98 (7.89)	13.32 (13.46)	3210	1770	1710	8.7 (s, 1H, NH), 7.3 (m, 5H, aromatic), 4.4 (s, 2H, NCH_2N), 3.7 (s, 2H, NCH_2Ar), 2.6 (m, 2H, NCH_2), 1.6 (m, 10H, CH_2 of ring), 1 (t, 3H, CH)
6h	85 [12]	163-165 [f]	$C_{23}H_{27}N_3O_2$	73.18 (73.20)	7.20 (7.16)	11.13 (11.02)	3220	1775	1715	8.3 (s, 1H, NH), 7.3 (m, 10H, aromatic), 4.5 (s, 2H, NCH_2N), 3.7 (s, 4H, NCH_2Ar)), 1.7 (m, 10H, CH_2 of ring) [i]
6i [h]	96 [12]	183-185 [f]	$C_{14}H_{23}N_3O_2$	63.37 (63.39)	8.73 (8.67)	15.83 (15.80)	3210	1780	1710	7.9 (s, 1H, NH), 4.4 (s, 2H, NCH_2N), 2.6 (m, 4H, NCH_2C), 1.7 (m, 10H, CH_2 of ring), 1.5 (m, 6H, $NCCH_2CH_2CH_2C$) [i]
6j	80 [12]	179-181 [e]	$C_{13}H_{21}N_3O_3$	58.40 (58.35)	7.91 (7.85)	15.71 (15.63)	3210	1780	1710	8.7 (s, 1H, NH), 4.3 (s, 2H, NCH_2N), 3.6 (t, 4H, OCH_2), 2.6 (t, 4H, NCH_2), 1.6 (m, 10H, CH_2 of ring)

[a] Recrystallization solvents; [b] Hexane. [c]Petroleum ether/diethyl ether (1:1). [d] Methanol. [e] Methanol/ethanol (1:1). [f] Ethanol. [g] In Potassium bromide. [h] In DMSO-d_6. [i] In deuteriochloroform.

hibits an AB pattern (J = 15 Hz), for the distereotopic benzylic protons.

EXPERIMENTAL

Melting points were determined with a Thomas-Hoover capillary melting apparatus and are uncorrected. The ir spectra were recorded on a Perkin Elmer 577 spectrometer. Infrared peak positions recorded in cm^{-1} *vs.* the 1601 cm^{-1} band of polystyrene. The nmr spectra were recorded on a Hitachi R-24 spectrometer operating at 60 MHz as an internal standard.

General Procedure for the Preparation of N_3-Alkylcycloalkanespirohydantoins **5**.

A solution of the suitable spirohydantoins **4** (0.005 mole) in 3 ml of ethanol was added to 5 ml of 1*N* aqueous sodium hydroxide, the mixture was refluxed about 15 minutes. To this solution was added a solution of 0.005 mole of the corresponding alkylating agent. The mixture was refluxed about 24 hours and allowed to cool with ice-water. The resulting precipitate was washed with water and recrystallized. Physical properties of these compounds are given in Table I.

General Procedure for the Preparation of N_3-Dialkylaminomethylcycloalkanespirohydantoins **6**.

A solution of **4** (0.001 mole), 40% aqueous formaldehyde (1 ml) and the suitable amine (0.01 mole) in ethanol (40 ml) was refluxed with magnetic stirring for 2 hours, and then the solution was concentrated under reduced pressure to dryness and the residue was recrystallized. Physical properties of these compounds are given in Table II.

General Procedure for the Preparation of N_3-Substituted-4-hydroxycycloalkane-5-spiro-2-imidazolidinones **7** and **8**.

A solution of **5** (5.08 mmoles) in THF was added dropwise to a slurry of lithium aluminum hydride (15.2 mmoles) in THF (15 ml). The reaction was stirred for 5 hours at room temperature and the excess of hydride was destroyed by the careful addition of methanol and a saturated solution of sodium sulphate in water. After the solid was discarded, the organic layer of the filtrate was separated. Following the addition of an equal volume of chloroform to the organic layer, it was washed with water and saturated sodium chloride solution and dried (sodium sulphate). After removal of the solvent, the only residue was triturated with ether and then recrystallized. Physical properties of these compounds are given in Table III and IV.

Table III

Analytical and Spectral Data of N_3-Alkyl-4-hydroxy-5-cycloalkanespiro-2-imidazolidinones **7**

Compound	Yield (%)	Mp °C [a]	Molecular Formula	Analysis % Calcd./(Found) C	H	N	IR, cm^{-1} [g] O-H	N-H	C=O	NMR (δ ppm)
7a	45	118-120 [b]	$C_8H_{14}N_2O_2$	56.45 (56.43)	8.29 (8.25)	16.45 (16.41)	3270	3150	1695	6.5 (s, 1H, NH), 5.8 (d, 1H, OH), 4.5 (d, 1H, CH), 2.6 (s, 3H, CH_3), 1.5 (m, 8H, CH_2 of ring) [h]
7b	47	123-124 [c]	$C_{11}H_{20}N_2O_2$	62.23 (62.20)	9.49 (9.47)	15.07 (15.02)	3300	3180	1700	6.5 (s, 1H, NH), 5.7 (d, 1H, OH), 4.6 (d, 1H, CH), 3.1 (t, 2H, NCH_2), 1.5 (m, 8H, CH_2 of ring), 1.4 (m, 4H, $NCCH_2CH_2$), 0.9 (t, 3H, CH_3) [h]
7c	50	194-196 [d]	$C_{14}H_{16}N_2O_2$	68.26 (68.21)	7.36 (7.39)	11.37 (11.33)	3255	3160	1690	7.3 (m, 5H, aromatic), 6.9 (s, 1H, NH), 6.1 (d, 1H, OH), 4.5 (d, 2H, NCH_2), 4.1 (d, 1H, CH), 1.6 (m, 8H, CH_2 of ring) [h]
7d	70	142-144 [b]	$C_9H_{16}N_2O_2$	58.67 (58.60)	8.75 (8.80)	15.20 (15.25)	3300	3170	1680	6.6 (s, 1H, NH), 5.9 (d, 1H, OH), 4.5 (d, 1H, CH), 2.6 (t, 3H, CH_3), 1.4 (m, 10H, CH_2 of ring) [h]
7e	64	110-112 [c]	$C_{12}H_{12}N_2O_2$	63.68 (63.62)	9.79 (9.83)	12.37 (12.34)	3300	3180	1700	6.6 (s, 1H, NH), 5.7 (d, 1H, OH), 4.5 (d, 1H, CH), 3.1 (t, 2H, NCH_2), 1.4 (m, 10H, CH_2 of ring), 1.3 (m, 4H, $NCCH_2$-CH_2), 0.9 (t, 3H, CH_2) [h]
7f	59	182-183 [e]	$C_{15}H_{20}N_2O_2$	69.20 (69.15)	7.74 (7.80)	10.76 (10.71)	3280	3160	1690	7.3 (m, 5H, aromatic), 6.9 (s, 1H, NH), 5.9 (d, 1H, OH), 4.5 (s, 2H, NCH_2), 4.2 (d, 1H, CH), 1.8 (m, 10H, CH_2 of ring) [h]
7g	48	196-197 [e]	$C_{15}H_{19}N_2O_2Cl$	61.11 (61.18)	6.49 (6.43)	9.50 (9.42)	3275	3170	1690	7.3 (m, 4H, aromatic), 6.9 (s, 1H, NH), 5.9 (d, 1H, OH), 4.3 (s, 2H, NCH_2), 4.1 (d, 1H, CH), 1.4 (m, 10H, CH_2 of ring) [h]
7h	60	178-180 [f]	$C_{16}H_{22}N_2O_2$	70.04 (70.17)	8.08 (8.06)	10.21 (10.12)	3280	3180	1680	7.3 (m, 5H, aromatic), 6.5 (s, 1H, NH), 6.1 (d, 1H, OH), 4.1 (d, 1H, CH), 3.6 (t, 2H, NCH_2), 2.9 (t, 2H, $NCCH_2$), 1.5 (m, 10H, CH_2 of ring) [h]
7i	65	140-142 [e]	$C_{17}H_{24}N_2O_2$	70.82 (70.67)	8.38 (8.42)	9.71 (9.74)	3280	3180	1680	7.2 (m, 5H, aromatic), 6.9 (s, 1H, NH), 6.7 (d, 1H, OH), 4.6 (d, 1H, CH), 3.1 (t, 2H, NCH_2), 2.5 (t, 2H, $NCCCH_2$), 1.9 (m, 2H, $NCCH_2$), 1.5 (m, 10H, CH_2 of ring) [h]
7j	68	137-138 [d]	$C_{13}H_{24}N_2O_2$	64.96 (64.89)	10.06 (10.03)	11.65 (11.67)	3280	3150	1680	6.7 (s, 1H, NH), 4.8 (s, 1H, CH), 4.5 (s, 1H, CH), 3.5 (t, 2H, NCH_2), 1.5 (m, 4H, $NCCH_2CH_2$), 1.5 (m, 12H, CH_2 of ring), 0.9 (t, 3H, CH_3) [i]
7k	70	151-153 [d]	$C_{15}H_{26}N_2O_2$	71.49 (71.53)	8.66 (8.67)	9.26 (9.30)	3270	3150	1690	7.2 (m, 5H, aromatic), 6.7 (s, 1H, NH), 5.9 (d, 1H, OH), 4.6 (d, 1H, CH), 3.1 (t, 2H, NCH_2), 2.6 (t, 2H, $NCCCH_2$), 1.9 (m, 2H, $NCCH_2$), 1.6 (m, 8H, CH_2 of ring) [h]

[a] Recrystallization solvents. [b] Chloroform. [c] Diethyl ether/acetone (1:1). [d] Acetone. [e] Methanol/ethanol. [f] Ethanol. [g] In Potassium bromide. [h] In DMSO-d_6. [i] In deuteriochloroform.

Table IV

Analytical and Spectral Data of N_3-Dialkylaminomethyl-4-hydroxy-5-cycloalkanespiro-2-imidazolidinones **8**

Compound	Yield (%)	Mp °C [a]	Molecular Formula	Analysis % Calcd./(Found) C	H	N	IR, cm^{-1} [h] O-H	N-H	C=O	NMR (δ ppm)
8a	85	125-127 [b]	$C_{16}H_{23}N_3O_2$	66.41 (66.55)	8.01 (8.12)	14.52 (14.53)	3260	3180	1680	7.3 (m, 5H, aromatic), 6.8 (s, 1H, NH), 5.9 (d, 1H, OH), 4.8 (d, 1H, CH), 4.0 (q, 2H, NCH_2N), 3.6 (q, 2H, NCH_2Ar), 2.1 (s, 3H, CH_3), 1.6 (m, 8H, CH_2 of ring) [i]
8b	53	107-109 [c]	$C_{17}H_{25}N_3O_2$	67.29 (67.68)	8.30 (8.27)	13.84 (13.92)	3260	3180	1680	7.3 (m, 5H, aromatic), 6.8 (s, 1H, NH), 5.9 (d, 1H, OH), 4.8 (d, 1H, CH), 4.0 (q, 2H, NCH_2N), 3.7 (q, 2H, NCH_2Ar), 2.6 (m, 2H, NCH_2C), 1.6 (m, 8H, CH_2 of ring), 1.0 (t, 3H, CH_3) [i]
8c	52	150-152 [d]	$C_{22}H_{27}N_3O_2$	72.30 (71.98)	7.44 (7.42)	11.49 (11.22)	3240	3180	1700	7.2 (m, 10H, aromatic), 6.8 (s, 1H, NH), 5.8 (d, 1H, OH), 4.8 (d, 1H, CH), 4.0 (q, 2H, NCH_2N), 3.6 (q, 4H, NCH_2Ar), 1.6 (m, 8H, CH_2 of ring) [i]
8d	85	162-164 [b]	$C_{13}H_{23}N_3O_2$	61.63 (61.42)	9.15 (9.22)	16.58 (16.37)	3260	3180	1700	6.7 (s, 1H, NH), 5.9 (d, 1H, OH), 4.7 (d, 1H, CH), 3.8 (d, 2H, NCH_2N), 2.5 (m, 4H, NCH_2C), 1.6 (m, 8H, CH_2 of ring), 1.4 (m, 6H, $NCCH_2CH_2CH_2$) [i]
8e	56	175-177 [e]	$C_{12}H_{21}N_3O_3$	56.45 (56.84)	8.29 (8.16)	16.45 (16.75)	3260	3180	1690	6.7 (s, 1H, NH), 5.9 (d, 1H, OH), 4.6 (d, 1H, CH), 3.9 (d, 2H, NCH_2N), 3.5 (m, 4H, OCH_2C), 2.5 (m, 4H, NCH_2C), 1.6 (m, 8H, CH_2 of ring) [i]
8f	83	149-151 [f]	$C_{17}H_{25}N_3O_2$	67.29 (67.23)	8.30 (8.13)	13.84 (13.70)	3320	3200	1690	7.3 (m, 5H, aromatic), 6.9 (s, 1H, NH), 5.8 (d, 1H, OH), 4.8 (d, 1H, CH), 4.1 (q, 2H, NCH_2N), 3.7 (q, 2H, NCH_2Ar), 2.1 (s, 3H, CH_3), 1.5 (m, 10H, CH_2 of ring) [i]
8g	68	131-133 [b]	$C_{18}H_{27}N_3O_2$	68.11 (67.77)	8.57 (8.66)	13.23 (13.07)	3280	3160	1700	7.3 (m, 5H, aromatic), 6.9 (s, 1H, NH), 5.8 (d, 1H, OH), 4.8 (s, 1H, CH), 4.1 (q, 2H, NCH_2N), 3.7 (q, 2H, NCH_2Ar), 2.5 (m, 2H, NCH_2C), 1.5(m, 10H, CH_2 of ring), 1.0 (t, 3H, CH_3) [j]
8h	90	160-162 [g]	$C_{23}H_{29}N_3O_2$	72.79 (72.52)	7.70 (7.82)	11.07 (11.13)	3370	3220	1690	7.3 (m, 10H, aromatic), 6.9 (s, 1H, NH), 5.6 (d, 1H, OH), 4.8 (d, 1H, CH), 4.1 (q, 2H, NCH_2N), 3.6 (q, 4H, NCH_2Ar), 1.5 (m, 10H, CH_2 of ring) [j]
8i	88	187-189 [g]	$C_{14}H_{25}N_3O_2$	62.89 (62.79)	9.42 (9.64)	15.71 (15.67)	3300	3190	1700	6.9 (s, 1H, NH), 5.8 (d, 1H, OH), 4.8 (d, 1H, CH), 3.9 (d, 2H, NCH_2N), 3.5 (m, 4H, NCH_2C), 2.6 (m, 6H, $NCCH_2CH_2$-CH_2), 1.5 (m, 10H, CH_2 of ring) [i]
8j	91	176-178 [g]	$C_{13}H_{23}N_3O_2$	57.97 (57.90)	8.60 (8.60)	15.60 (15.48)	3280	3180	1690	6.9 (s, 1H, NH), 5.8 (d, 1H, OH), 4.7 (d, 1H, CH), 3.9 (d, 2H, NCH_2N), 3.6 (m, 4H, OCH_2C), 2.5 (m, 4H, NCH_2C), 1.5 (m, 10H, CH_2 of ring) [i]

[a] Recrystallization solvents. [b] Acetonitrile. [c] Acetone. [d]Chloroform. [e] Ethanol. [f] Benzene. [g] Methanol. [h] In Potassium bromide. [i] In DMSO-d_6. [j] In deuteriochloroform.

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