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2-SUBSTITUTED HEXAHYDROPYRIMIDINES AND THEIR TAUTOMERISM

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2-SUBSTITUTED HEXAHYDROPYRIMIDINES AND THEIR TAUTOMERISM

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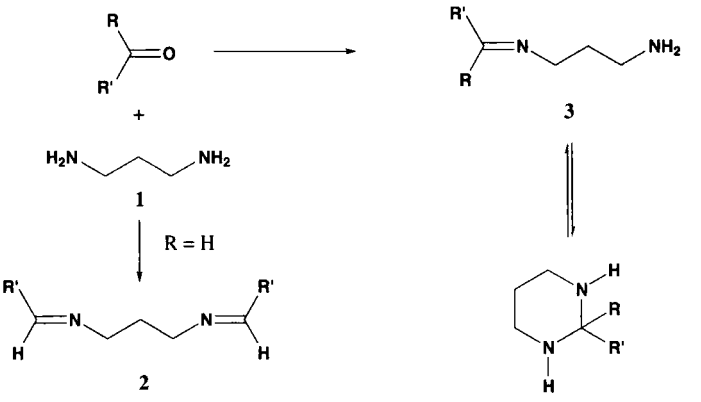
Information regarding the synthesis of hexahydropyrimidines is scarce. Several representatives have been obtained either by condensation of 1,3-diamines with carbonyl compounds[1-16] or by reduction of the corresponding pyrimidines.[17] A few N-unsubstituted hexahydropyrimidines have been reported only from 1,3-diaminopropane (**1**)[1-16] and 2,4-diamino-4-methylpentane,[17] *bis*-alkylidene derivatives are formed in some reactions with 1,3-diaminopropane.[6]

The structure of condensation products of 1,3-diamines with aldehydes and ketones has not been discussed in the literature. The hexahydropyrimidine structure is usually accepted and, in particular, has been proposed for the products of the interaction of 1,3-diaminopropane with formaldehyde,[1-7,9,10,12-14] acetaldehyde,[6,13,14] isobutyraldehyde,[16] phenylacetaldehyde,[14] 4-pyridinecarboxaldehyde,[8] pyridoxal-5-phosphate[8,11,15] and acetone.[6] In theory these substances can exist either as the monoimine (**3**), the hexahydropyrimidines (**4**) or even tautomeric mixtures, e.g. with formaldehyde,[1,2,5] pyridoxal-5-phosphate[8,11,15] and acetone[6] derivatives. Yet there is no clear evidence for such structures. Nevertheless, the structure of the reaction products of 1,2- and 1,3-aminoalcohols[18] and aminothiols[19] with aldehydes and ketones has been investigated during last decade and extensive information on the ring-chain equilibria for these compounds has been obtained. In addition, some recent data on the ring-chain tautomerism of the condensation products of carbonyl compounds with ethylenediamine[20] have been published. Therefore it was crucial to explore the reaction of carbonyl compounds with 1,3-diaminopropane (**1**) in equimolar ratio to establish the structure of the reaction products.

We studied the interaction of aliphatic and aromatic aldehydes and aliphatic ketones with 1,3-diaminopropane (**1**). Formation of corresponding *bis*-derivatives (**2a-c**, see the Experimental section) is observed only when the condensation is carried out with the excess of aromatic aldehydes. (3-Aminopropyl)imines (**3a-v**) have been obtained as the sole products in 50-95 % yields in the reaction of excess 1,3-diaminopropane (**1**) with aromatic aldehydes as well as in the cases of interaction with aliphatic carbonyl compounds.



2 a) R' = *p*-BrC_6H_4 **b)** R' = *p*-$MeOC_6H_4$ **c)** R' = *p*-$Me_2NC_6H_4$

3,4 **a)** R = H, R' = Me; **b)** R = H, R' = Et; **c)** R = H, R' = Pr; **d)** R = H, R' = *i*-Pr; **e)** R = R' = Me; **f)** R = Me, R' = Et; **g)** R = Me, R' = Pr; **h)** R = Me, R' = Bu; **i)** R = Me, R' = *i*-Bu; **j)** R = Me, R' = $PhCH_2$; **k)** R = R' = Et; **l)** R = H, R' = Ph; **m)** R = H, R' = *p*-FC_6H_4; **n)** R = H, R' = *p*-ClC_6H_4; **o)** R = H, R' = *p*-BrC_6H_4; **p)** R = H, R' = *p*-$MeOC_6H_4$; **q)** R = H, R' = *p*-$Me_2NC_6H_4$; **r)** R = H, R' = *p*-$Et_2NC_6H_4$; **s)** R = H, R' = *p*-$MeOCOC_6H_4$; **t)** R = H, R' = *o*-HOC_6H_4; **u)** R = H, R' = 3,4- $(MeO)_2C_6H_3$; **v)** R = H, R' = 2-Cl,6-$NO_2C_6H_3$

The linear structure of compounds **3a-v** in solution was established by NMR spectroscopy (Tables 1-4) which, in particular, showed the signal of H-C=N at δ 7.5-8.2 for aldehyde derivatives or the signal of the methyl (methylene) group at δ 1.6-2.2 in the ^1H NMR spectra of ketones and the signal of sp^2 carbon atom at δ 158.5-169.1 in the ^{13}C NMR spectra. The peak of the C-2 carbon atom δ 63.4-74.2 in ^{13}C NMR spectra and the signal of H-2 δ 3.2-4.7 for aldehyde derivatives or the signal of methyl (methylene) groups δ 1.1-1.5 in ^1H NMR spectra of ketone derivatives belong to the cyclic form **4**. Other peaks in the proton and carbon spectra of both tautomeric forms are consistent with the structure assigned for compounds **3a-v** (Tables 1-4).

On the basis of the data listed in these tables the following conclusions were drawn:

- Derivatives of unbranched aliphatic aldehydes exist solely as the hexahydropyrimidines (**4a-c**);
- The phenomenon of ring-chain tautomerism **3** ↔ **4** is observed for isobutyraldehyde and ketone derivatives (**3d-k**), the content of the linear tautomer increasing with increasing the size of substituents R and/or R'.
- The structure of derivatives of aromatic aldehydes (**l-v**) varies widely from the complete absence to overwhelming prevalence of the hexahydropyrimidines **4**, depending on the effect of the substituent at the aromatic ring. Electron-acceptor substituents stabilize the cyclic hexahydropyrimidine form **4**.

Since equilibrium **3** ↔ **4** at room temperature occurs slowly, within 3-5 days in solutions, it is possible to define the structure of compounds in the absence of solvent. In the neat state, these substances usually have the structure of the tautomer prevailing at equilibrium in solution.

TABLE 1. Products of Reaction 1,3-Diaminopropane with Aliphatic Aldehydes and Ketones

Cmpd	Yield (%)	bp. (°C, mm)	% form in equilibria	^{1}H NMR ($CDCl_3$, δ) R	R'	CH_2N	C-CH_2-C
4a	60	60 (30)	100	3.44 (q)	1.03 (d)	2.70 (m, H_a-4,6) 2.99 (m, H_e-4,6)	1.20-1.45 (m)
4b	59	62 (30)	100	3.24 (t)	0.88 (t)[a]	2.75 (m, H_a-4,6) 3.09 (m, H_e-4,6)	1.13-1.65 (m)
4c	63	64 (30)	100	3.36 (t)	0.85 (t)[a]	2.77 (m, H_a-4,6) 3.09 (m, H_e-4,6)	1.14-1.65 (m)
3d	55	61 (30)	5	7.50 (d)	0.91 (d)[a]	2.66 (t), 3.03 (t)	1.19-1.60 (m)
4d			95	3.15 (d)	1.06 (d)[a]	2.73 (m, H_a-4,6) 3.05 (m, H_e-4,6)	1.19-1.60 (m)
3e	51	65 (25)	10	1.79 (s)	1.94 (s)	2.69 (t), 3.25 (t)	1.30-1.54 (m)
4e			90	1.16 (s)	1.16 (s)	2.90 (t)	
3f	52	49 (2)	*E*, 9	0.95 (t), 2.22 (q)	1.78 (s)	2.73 (t),	1.12-1.45 (m)
			Z, 2	0.97 (t), 2.20 (q)	1.96 (s)	3.20 (t)	1.12-1.45 (m)
4f			89	0.87 (t), 1.51 (q)	1.11 (s)	2.98 (t)	1.12-1.45 (m)
3g	49	51 (2)	*E*, 26	0.88 (t), 2.13 (t)[a]	1.69 (s)	2.66 (t)	1.17-1.65 (m)
			Z, 9	0.94 (t), 2.11 (t)[a]	1.90 (s)	3.13 (t)	1.17-1.65 (m)
4g			65	0.83 (t)[a]	1.08 (s)	2.83 (t)	1.17-1.65 (m)
3h	60	57 (2)	*E*, 29	0.77 (t), 2.17 (t)[a]	1.69 (s)	2.71 (t)	1.13-1.65 (m)
			Z, 10	0.79 (t), 2.10 (t)[a]	1.90 (s)	3.24 (t)	1.13-1.65 (m)
4h			61	0.75 (t)[a]	1.11 (s)	2.87 (t)	1.13-1.65 (m)
3i	45	53 (2)	*E*, 6	0.86 (d)[a]	1.72 (s)	2.73 (t)	1.30-2.28 (m)
			Z, 16	0.88 (d)[a]	1.94 (s)	3.27 (t)	1.30-2.28 (m)
4i			20	0.83 (d)[a]	1.24 (s)	2.94 (t)	1.30-2.28 (m)
3j	83	–	*E*, 20	1.60 (s)	3.37 (s), 6.8-7.9 (m)	2.61 (t), 3.23 (t)	1.13-1.52 (m)
4j			80	1.10 (s)	2.77 (s), 6.8-7.9 (m)	2.87 (t)	1.13-1.52 (m)
3k	91	–	*E*, 22	0.83 (t), 2.21 (q)	0.85 (t), 2.17 (q)	2.79 (t), 3.31 (t)	1.07-1.94 (m)
4k			78	0.80 (t),1.55 (q)	0.80 (t), 1.55 (q)	2.89 (t)	1.07-1.94 (m)

a) The methylene and methine signals of the substituents R and/or R and of C-CH_2-C of imine fragment are superimposed on each other.

It should be noted that the ring-chain tautomeric equilibria are weakly affected by solvent. A good correlation between log K_T and the Hammet-Brown constant σ^+ of para-substituents (*X*) was

obtained for derivatives of para-substituted benzaldehydes (**l-s**):

$$\log K_X = (0.93 \pm 0.01) + (0.84 \pm 0.01)\sigma^+ \ (r = 0.99).$$

TABLE 2. Products of Reaction 1,3-Diaminopropane with Aromatic Aldehydes

Cmpd		^{1}H NMR ($CDCl_3$, δ)			
	% form in equilibria	H-C=N, H-2	H_{arom}	CH_2N	C-CH_2-C
3l	13	7.99 (s)	7.02-7.53 (m)	3.39 (t)[a]	1.20-1.60 (m)
4l	87	4.20 (s)	7.02-7.53 (m)	2.54 (m, H_a-4,6) 2.89 (m, H_e-4,6)	1.20-1.60 (m)
3m	11	8.09 (s)	7.0-8.1 (m)	3.25 (t), 3.60 (t)	1.13-1.78 (m)
4m	89	4.43 (s)	6.8-7.5 (m)	2.74 (m, H_a-4,6) 3.13 (m, H_e-4,6)	1.13-1.78 (m)
3n	10	8.17 (s)	7.5-7.7 (m)	3.21 (t), 3.59 (t)	1.19-1.87 (m)
4n	90	4.39 (s)	7.2-7.4 (m)	2.67 (m, H_a-4,6) 3.09 (m, H_e-4,6)	1.19-1.87 (m)
3o	8	7.84 (s)	7.4-7.6 (m)	3.33 (t), 3.68 (t)	1.15-1.87 (m)
4o	92	4.47 (s)	7.3-7.5 (m)	2.63 (m, H_a-4,6) 3.19 (m, H_e-4,6)	1.15-1.87 (m)
3p	35	8.08 (s)	3.54 (s), 7.3-7.6 (m)	3.08 (t), 3.46 (t)	1.16-1.77 (m)
4p	65	4.36 (s)	3.50 (s), 6.7-6.8 (m)	2.65 (m, H_a-4,6) 3.06 (m, H_e-4,6)	1.16-1.77 (m)
3q	76	8.15 (s)	2.95 (s), 6.65 (d), 7.63 (d)	3.09 (t), 3.65 (t)	1.58-2.27 (m)
4q	24	4.47 (s)	2.90 (s), 6.65 (d), 7.35 (d)	2.76 (m, H_a-4,6)[b]	1.58-2.27 (m)
3r	90	7.91 (s)	0.90 (t), 3.03 (q), 6.35 (d), 7.39 (d)	3.23 (t), 3.57(t)	1.31-2.19 (m)
4r	10	4.17 (s)	0.90 (t), 3.03 (q), 6.35 (d), 7.12 (d)	2.51 (m, H_a-4,6)[c]	1.31-2.19 (m)
4s	100	4.65 (s)	3.88 (s), 7.56 (d), 8.00 (d)	2.79 (m, H_a-4,6), 3.27 (m, H_e-4,6)	1.13-1.84 (m)
3t	95[d]	8.05 (s)	5.05 (m), 6.2-7.3 (m)	2.51 (t), 3.29 (t)	1.15-1.85 (m)
3u	72	8.11 (s)	3.80 (s), 3.84 (s), 6.7-7.4 (m)	3.61 (t), 4.11 (t)	1.13-1.70 (m)
4u	28	4.01 (s)	3.76 (s), 3.78 (s), 6.7-7.4 (m)	2.74 (m, H_a-4,6), 3.14 (m, H_e-4,6)	1.13-1.70 (m)
3v	16	8.20 (s)	7.3-7.7 (m)	3.32 (t), 3.74 (t)	1.21-2.24 (m)
4v	84	5.21 (s)	7.3-7.7 (m)	2.89 (m, H_a-4,6), 3.11 (m, H_e-4,6)	1.21-2.24 (m)

a) The signal is overlapped by H_a-4,6 multiplet. b) Multiplet H_a-4,6 is overlapped by CH_2-N signal of form **A**. c) Multiplet H_a-4,6 is overlapped by CH_2-N signal of diethylamino group. d) The ring tautomer (~5%) was identified by ^{13}C NMR spectra (see Table 4).

TABLE 3. ^{13}C NMR Spectra of Products of Reaction of 1,3-Diaminopropane with Aliphatic Aldehydes and Ketones ($CDCl_3$, δ)

Cmpd	C-2, C=N	N-CH_2	CH_2	R	R'
4a	66.1	44.4	25.9	-	21.7
4b	72.0	44.8	26.6	-	8.8, 29.1
4c	70.7	45.3	27.1	-	13.5, 17.9, 38.9
4d	75.8	45.3	26.9	-	17.2, 32.7
3e	168.4	39.3, 47.5	25.9	17.1	27.5
4e	63.4	38.8	25.9	25.6	25.6
3f[a](*E*)	168.5	39.6, 46.1	34.6	15.8	9.9, 33.8
4f	65.8	39.2	26.9	22.8	7.1, 31.5
3g(*E*)	168.6	41.2, 47.6	33.6	25.4	12.5, 18.6, 33.4
3g(*Z*)	169.1	39.2, 43.2	33.9	15.6	12.9, 18.6, 32.8
4g	65.4	38.8	26.5	22.9	13.4, 15.6, 41.3
3h(*E*)	168.1	41.0, 47.7	33.4	15.5	12.7, 21.1, 27.4, 30.5
3h(*Z*)	168.7	39.3, 47.1	33.6	22.2	12.7, 21.5, 25.5, 30.8
4h	65.2	38.8	26.6	22.6	12.6, 21.9, 24.5, 38.5
3i(*E*)	168.5	39.4, 47.9	33.6	25.0	21.4, 21.6, 50.6
3i(*Z*)	168.8	39.0, 47.6	33.9	16.3	21.6, 21.6, 51.6
4i	66.2	40.0	26.2	22.8	16.0, 23.5, 50.2
3j	167.8	39.3, 48.3	33.2	15.7	44.6, 125.6, 127.5, 128.1, 136.8
4j	66.0	39.4	26.6	23.7	45.4, 125.6, 127.3, 129.7, 136.3
3k	172.9	38.7, 46.9	33.8	9.5, 31.1	9.5, 21.8
4k	67.1	38.5	26.7	6.3, 26.5	6.3, 26.5

a) The minor *Z*-tautomer was not detected.

The coefficient ρ which characterizes the sensitivity of the tautomeric systems towards electronic effects of substituents is in accord with previous investigations on the effects of *para*-substituents on the ring-chain tautomerism of the oxygen analogues of **3**, namely, N-hydroxyalkylimines of *para*-substituted benzaldehydes.[19] The greater tendency for 1,3-diaminopropane derivatives to form the cyclic tautomer in comparison with the compounds derived from ethylenediamine[20] is in accordance with the Baldwin rules since the hexahydropyrimidine formation represents the favored 6-*endo-trig*-process.[21] Mono-derivatives of 1,3-diaminopropane are of interest as synthons for the preparation of N-substituted 1,3-diaminopropanes, 1,5-diazabicyclo[3.1.0]hexanes,[13,22] as a promising new group of ligands. Several piperimidines display biological activity.[23,24]

EXPERIMENTAL SECTION

The ^1H (200 MHz) and ^{13}C NMR (50.33 MHz) spectra were recorded with Brucker-AC-200 spectro-

meter using HMDS as internal standard. The tautomer ratios were determined by integrating the signals of suitable well separated protons, mainly of H-2 methine or C-CH_3 methyl protons.

TABLE 4. ^{13}C NMR Spectra of Products of Reaction of 1,3-Diaminopropane with Aromatic Aldehydes ($CDCl_3$, δ)

Cmpd	C-2, C=N	C_{arom}	N-CH_2	CH_2
3l	159.4	126.8, 127.3, 129.2, 135.2	38.7, 58.2	33.7
4l	73.2	125.2, 126.5, 127.0, 141.7	45.0	26.0
3m	158.6	114.7, 129.0, 131.8, 163.3	39.3, 58.3	33.9
4m	73.0	114.2, 127.3, 137.9, 161.4	45.4	26.2
3n	158.5	127.9, 128.3, 133.9, 135.9	39.3, 58.3	33.8
4n	72.8	127.0, 127.5, 132.4, 140.5	45.3	26.3
3o	158.6	123.8, 128.4, 130.8, 134.2	39.2, 58.2	33.7
4o	72.7	120.6, 127.4, 130.3, 141.0	45.2	26.2
3p	158.7	53.9, 112.3, 126.4, 128.2, 157.9	39.0, 58.0	33.7
4p	72.8	53.8, 112.7, 128.3, 134.3, 160.3	45.1	26.2
3q	160.8	40.0, 114.4, 124.3, 129.2, 151.7	40.4, 59.0	34.9
4q	74.1	40.0, 112.2, 124.2, 126.7, 150.2	46.1	26.9
3r	160.0	11.8, 43.5, 110.2, 123.0, 128.9, 148.6	39.5, 58.4	34.9
4r	73.4	11.8, 43.5, 110.6, 123.0, 126.5, 146.5	45.6	26.4
4s	73.4	52.0, 120.5, 126.8, 128.6, 129.5, 146.4, 166.2	45.7	27.0
3t	164.7	116.2, 117.7, 117.8, 130.6, 131.4, 160.4	39.2, 56.0	33.9
4t	71.7	115.5, 118.8, 124.7, 126.2, 128.6, 156.6	44.0	26.2
3u	160.5	55.6, 108.3, 110.1, 122.6, 129.1, 149.0, 150.9	39.9, 58.9	31.6
4u	74.2	55.6, 109.3, 110.5, 118.0, 135.2, 148.2, 148.5	46.1	26.8
3v	161.2	121.5, 123.5, 130.3, 133.4, 134.5, 154.6	39.6, 59.2	33.8
4v	71.3	122.4, 129.1, 131.7, 132.9, 134.9, 151.8	46.3	26.4

General Procedure for the Synthesis of 1,2-*bis*-Arylideneaminopropanes (2).- Anhydrous 1,3-diaminopropane (3.7 g, 0.05 mol) in 50 mL of chloroform was added to the appropriate aldehyde (0.1 mol). The reaction mixture was kept overnight at room temperature. The white crystals obtained after the removal of the solvent under reduced pressure at 60° were recrystallized from appropriate solvents.

1,2-*bis*(*p*-Bromobenzylideneamino)propane (2a), yield 89%, mp. 45° (hexane). ^1H NMR ($CDCl_3$): δ 2.09 (t, 2H); 3.65 (t, 4H); 6.80 (d, 4H); 7.63 (d, 4H); 8.15 (s, 2H).

1,2-*bis*(*p*-Methoxybenzylideneamino)propane (2b), yield 90%, mp. 81° (hexane). ^1H NMR ($CDCl_3$): δ 2.14 (t, 2H); 3.69 (t, 4H); 3.81 (s, 6H); 6.92 (d, 4H); 7.69 (d, 4H); 8.23 (s, 2H).

1,2-*bis*(*p*-Dimethylaminobenzylideneamino)propane (2c), yield 85%, mp. 135° (benzene). ^1H NMR ($CDCl_3$): δ 2.06 (t, 2H); 3.09 (s, 12H); 3.68 (t, 4H); 6.67 (d, 4H); 7.60 (d, 4H); 8.11 (s, 2H).

General Procedures for the Synthesis of Compounds 3 and 4 (Tables 1 and 2). Procedure A (Compounds a-k).- A solution of the carbonyl compound (0.1 mol) in 50 mL ether was added slowly to anhydrous 1,3-diaminopropane (7.77 g, 0.105 mol) at 0°; was kept for 24 hours over K_2CO_3. The solvent was removed under reduced pressure at room temperature, the residue was distilled *in vacuo* (except for **3j** and **3k**). **3a**: lit.[6] bp. 143-145°, **3d**: lit.[16] $bp._{50}$ 65°, **3e**: lit.[6] $bp._{17}$ 57-61°.

TABLE 5. Elemental Analyses for New Compounds

Cmpd	Formula	Calcd			Found		
		C	H	N	C	H	N
2a	$C_{17}H_{16}Br_2N_2$	50.03	3.95	6.86	49.85	4.21	6.93
2b	$C_{19}H_{22}N_2O_2$	73.52	7.14	9.03	73.61	7.25	8.91
2c	$C_{21}H_{28}N_4$	74.96	8.39	16.65	75.08	8.45	16.43
3b	$C_6H_{14}N_2$	63.11	12.36	24.53	62.94	12.61	24.43
3c	$C_7H_{16}N_2$	65.56	12.58	21.26	65.30	12.51	21.40
3f	$C_7H_{16}N_2$	65.56	12.58	21.26	65.68	12.40	21.50
3g	$C_8H_{18}N_2$	67.54	12.76	19.70	67.63	12.62	19.83
3h	$C_9H_{20}N_2$	69.16	12.91	17.93	69.01	13.16	17.91
3i	$C_9H_{20}N_2$	69.16	12.91	17.93	69.05	12.75	18.13
3j	$C_{12}H_{18}N_2$	75.73	9.54	14.73	75.51	9.43	14.98
3k	$C_8H_{18}N_2$	67.54	12.76	19.70	67.43	13.01	19.45
3l	$C_{10}H_{14}N_2$	74.02	8.70	17.28	74.23	8.58	17.13
3m	$C_{10}H_{13}FN_2$	66.63	7.27	15.55	66.54	7.43	15.48
3n	$C_{10}H_{13}ClN_2$	61.20	6.68	14.28	61.37	6.63	14.35
3o	$C_{10}H_{13}BrN_2$	49.99	5.46	11.67	50.15	5.43	11.58
3p	$C_{11}H_{16}N_2O$	68.72	8.39	14.57	68.93	8.15	14.60
3q	$C_{12}H_{19}N_3$	70.20	9.33	20.47	70.28	9.08	20.22
3r	$C_{14}H_{23}N_3$	72.06	9.93	18.01	72.22	9.72	18.03
3s	$C_{12}H_{16}N_2O_2$	65.43	7.32	12.72	65.57	7.09	12.85
3t	$C_{10}H_{14}N_2O$	67.39	7.92	15.72	67.52	7.71	15.63
3u	$C_{12}H_{18}N_2O_2$	64.84	8.16	12.60	65.01	7.93	12.74
3v	$C_{10}H_{12}ClN_3O_2$	49.70	5.00	17.39	49.83	4.80	17.35

Procedure B (Compounds l-v).- A solution of the carbonyl compound (0.1 mol) in 50 mL chloroform was added slowly to anhydrous 1,3-diaminopropane (37 g, 0.5 mol) in 100 mL chloroform at 0° and was kept for 24 hours over K_2CO_3. Solvent and excess diamine were removed under reduced pressure (2 mm) at room temperature. The residual oily materials (except for **3q**, mp. 129° and **3t**, mp. 116°) were washed with hexane (2 (100 mL) and dried *in vacuo*. According to ^1H NMR spectra, the oily products were of more than 97% purity.

REFERENCES

1. G. E. K. Branch, A. W. Titherley, *J. Chem. Soc.*, **103**, 330 (1913).
2. G. E. K. Branch, *J. Am. Chem. Soc.*, **38**, 2466 (1916)
3. E. Bergmann, D. Herman and E. Zimkin, *J. Org. Chem.*, **13**, 353 (1948).
4. J. L. Reebsomer and G. H. Morey *ibid.*, **15**, 245 (1950).
5. H. Krässig, *Makrom. Chem.*, **17**, 77 (1956).
6. R. F. Evans, *Australian J. Chem.*, **20**, 1643 (1967).
7. H. Booth and R. U. Lemieux, *Can. J. Chem.*, **49**, 777 (1971).
8. M. H. O'Leary, *Biochim. Biophys. Acta,* **242**, 484 (1971).
9. M. J. Cook, R. A. Y. Jones, A. R. Katritzky, M. M. Man_s, A. C. Richard and A. J. Spardu, *J. Chem. Soc. Perkin Trans. II*, 325 (**1973**).
10. M. K. Dewar, R. B. Jones, D. P. Kelly and J. F. Jates, *Australian J. Chem.*, **28**, 917 (1975).
11. P. S. Tobias and R. G. Kallen, *J. Am. Chem. Soc.*, **97**, 6530 (1975).
12. A. T. Nielsen, D. W. Moore, M. D. Ogan and R. L. Atkins, *J. Org. Chem.*, **44**, 1678 (1979).
13. G. V. Shustov, S. N. Denisenko, I. I. Chervin, N. L. Asfandiarov and R. G. Kostyanovsky, *Tetrahedron*, **41**, 5719 (1985).
14. B. T. Golding and I. K. Nassereddin, *J. Chem. Soc. Perkin Trans. I*, 2011 (**1985**).
15. P.-M. Robitaille, R. D. Scott, J. Wang and D. E. Metzler, *J. Am. Chem. Soc.*, **111**, 3034 (1989).
16. G. Parinello and R. Mulhaupt, *J. Org. Chem.*, **55**, 1772 (1990).
17. C. Kashima, M. Shimizu, A. Katoh and Y. Omote, *J. Heterocycl. Chem.*, **21**, 441 (1984).
18. F. Fülöp, G. Bernath, J. Mattinen and K. Pihlaja, *Tetrahedron*, **45**, 4317 (1989).
19. F. Fülöp, J. Mattinen and K. Pihlaja, *ibid.*, **46**, 6545 (1990).
20. K. N. Zelenin and I. V. Ukraintsev, *Org. Prep. Proc. Int.*, **30**, 109 (1998).
21. J. E. Baldwin, *Chem. Commun.*, 734 (**1976**).
22. K. Bronstert, Ger. Offen. DE3, 607,993 (Cl. C07D487/04); *Chem. Abstr.*, **107**, 236687h (1985).

23. A. A. Bilgin and H. Akgun, *Eczacilic Bul.*, **25**, 42 (1983); *Chem. Abstr.*, **100**, 120993f (1984).

24. H. Brown, B. Bertman and M. Wiessler, *J. Labelled Compd. Radiopharm.*, **13**, 375 (1977).

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