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Condensation of *N*-(2-Vinyloxyethyl)ethane-1,2-diamine with Carbonyl Compounds

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Abstract—Condensation of *N*-(2-vinyloxyethyl)ethane-1,2-diamine with aromatic aldehydes gave mixtures of 2-aryl-1-(2-vinyloxyethyl)imidazolidines and *N*-arylmethylidene-*N*′-(2-vinyloxyethyl)ethane-1,2-diamines in an overall yield of 79–84%, while analogous condensation with cyclic and acyclic ketones resulted in the formation of only the corresponding Schiff bases (yield 53–83%).

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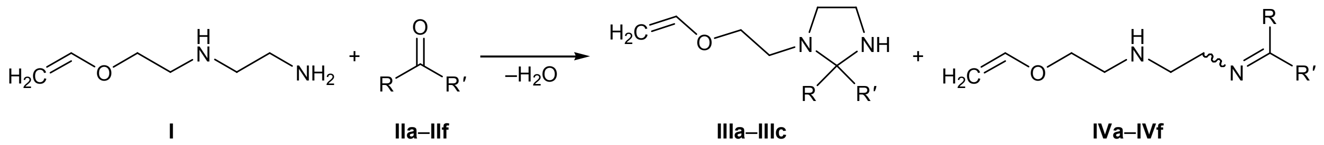
It is known that 2-vinyloxyethylamines possessing a primary amino group, as other typical primary amines, react with carbonyl compounds, yielding the corresponding Schiff bases [1]. However, the reaction of *N*-(2-vinyloxyethyl)ethane-1,2-diamine (**I**) with acetaldehyde, leading to 2-methyl-1-(2-vinyloxyethyl)-imidazolidine in 97% yield, is the only reported example of such condensation with participation of compound **I** [2]. On the other hand, only condensations of *N*,*N*′-disubstituted ethane-1,2-diamines with carbonyl compounds give individual imidazolidines [3], while monosubstituted ethylenediamines could give rise to mixtures of imidazolidines and Schiff bases.

In the present work we studied condensation of diamine **I** with various carbonyl compounds. The reactions were carried out by heating equimolar mixtures of the reactants in boiling benzene with simultaneous removal of water as azeotrope. Unlike acetaldehyde, the condensation of diamine **I** with aromatic aldehydes **IIa**–**IIc** led to the formation of 18–62% of Schiff bases **IVa**–**IVc** together with imidazolidines **IIIa**–**IIIc**. In the condensations of diamine **I** with ketones **IId**–**IIf**, Schiff bases **IVd**–**IVf** were obtained as the only products (Scheme 1).

Schiff bases **IV** were characterized by absorption bands in the region 1640–1665 cm^{-1} [ν(C=N)] in the IR spectra. The ^{1}H NMR spectra of compounds **IVa**–**IVc** contained a singlet from the N=CH proton at δ 8.30–8.36 ppm, indicating the presence of only one *E* isomer (cf. [4]). In the ^{13}C NMR spectra of **IVa**–**IVf**, the N=CH carbon signal was located at δ_C 158.88–163.68 ppm. The ^{1}H NMR spectra of the products obtained from diamine **I** and ketones **IId**–**IIf** lacked signals assignable to protons in the NCHN group, while protons in the vinyloxy group appeared as three doublets of doublets at δ 3.94–3.97 (*cis*-CH=), 4.13–4.17 (*trans*-CH=), and 6.42–6.44 ppm (OCH=); these data showed the absence of imidazolidines among the products.

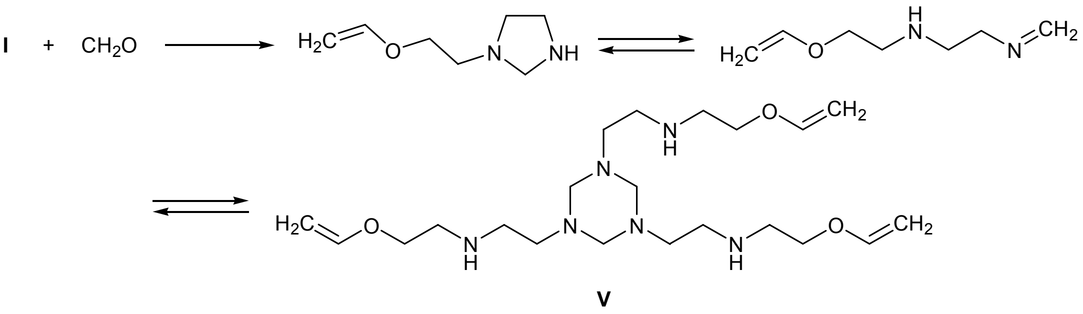
Imidazolidines **IIIa**–**IIIc** obtained by condensation of diamine **I** with aldehydes **IIa**–**IIc** displayed in the ^{1}H NMR spectra a singlet from the NCHN proton at

Scheme 1.



R = H, R′ = Ph (**a**), pyridin-4-yl (**b**), pyridin-3-yl (**c**); RR′ = $(CH_2)_4$ (**d**), $(CH_2)_5$ (**e**); R = Me, R′ = Me_2CHCH_2 (**f**).

Scheme 2.



δ 4.16–4.22 ppm. In addition, protons in the vinyloxy group resonated as three multiplets resulting from superposition of doublets of doublets belonging to vinyl protons in Schiff bases **IVa**–**IVc** and imidazolidines **IIIa**–**IIIc**. The ratios of compounds **IV** and **III**, determined from the intensities of the N=CH and NCHN signals, were 1 : 0.59 (**IVa** : **IIIa**), 1 : 4.52 (**IVb** : **IIIb**), and 1 : 1.99 (**IVc** : **IIIc**).

In the reaction of diamine **I** with methyl isobutyl ketone (**IId**) we obtained Schiff base **IVd** as a mixture of *E* and *Z* isomers, the latter prevailing. According to the intensities of signals from protons in methyl groups (singlets at δ 1.76 and 1.80 ppm), the ratio of the *Z* and *E* isomers was 1.0 : 0.12. Signals from all other groups were overlapped almost completely by each other, so that it was difficult to determine the corresponding coupling constants.

Our results do not conform completely to the existing views on electronic effects in heterolytic intramolecular cyclizations [5]. In keeping with these views, the addition of more nucleophilic NH group to C=N bond should occur more readily than the addition of OH group. Moreover, increased electrophilicity of the C=N carbon atom favors formation of the cyclic product. The condensations of 2-amino alcohols with carbonyl compounds follow the above rules: aromatic aldehydes give rise to imino alcohols, while cyclic products (oxazolidines) are obtained from aliphatic ketones [6]. Presumably, the observed deviation from general rules is related to elongation of the substituent on the nitrogen atom, which in some cases destabilizes cyclic structure [5].

The only product formed in the condensation of diamine **I** with formaldehyde was 1,3,5-tris[2-(2-vinyloxyethylamino)ethyl]hexahydro-1,3,5-triazine (**V**) which was isolated in 88% yield. The ^{1}H NMR spectrum of compound **V** contained a singlet from the NCH_2N proton at δ 3.44 ppm, and the corresponding carbon atom resonated in the ^{13}C NMR spectrum at δ_C 75.32 ppm, i.e., in a considerably stronger field than did C^2 in imidazolidine derivatives. In addition, no signals assignable to CH_2=N group were observed in the ^{1}H and ^{13}C NMR spectra of **V**.

EXPERIMENTAL

The ^{1}H and ^{13}C NMR spectra were recorded at 26°C on a Bruker DPX-400 spectrometer at 400 and 100 MHz, respectively, from solutions in $CDCl_3$ using hexamethyldisiloxane as internal reference. The IR spectra were measured from thin films on a Specord 75IR spectrophotometer. The purity of the initial reactants and products was checked by GLC on an LKhM-80 chromatograph equipped with a thermal conductivity detector and a steel column, 3 × 3000 mm, packed with 3% of OV-17 on Inerton Super (0.160–0.200 mm); oven temperature programming from 60 to 280°C at a rate of 4 deg/min; carrier gas helium.

Commercial carbonyl compounds and *N*-(2-vinyloxyethyl)ethane-1,2-diamine (**I**) prepared according to the procedure described in [2] (its purity was no less than 97% according to the GLC data) were distilled just before use.

Condensation of *N*-(2-vinyloxyethyl)ethane-1,2-diamine (I) with carbonyl compounds IIa–IIf (*general procedure*). A mixture of 6.51 g (0.05 mol) of *N*-(2-vinyloxyethyl)ethane-1,2-diamine (**I**), 0.05 mol of carbonyl compound **IIa**–**IIf**, and 100 ml of benzene was heated under reflux in a flask equipped with a Dean–Stark trap until water no longer separated. The products were isolated from the reaction mixture by vacuum distillation.

2-Phenyl-1-(2-vinyloxyethyl)imidazolidine (IIIa) and *N*-benzylidene-*N′*-(2-vinyloxyethyl)ethane-1,2-diamine (IVa). Yield of mixture **IIIa**/**IVa** 79%, bp 151–155°C (3 mm), n_D^{20} = 1.5398. IR spectrum, ν, cm^{-1}: 3290, 3116, 3062, 2932, 2881, 2832, 1.645, 1618, 1600, 1581, 1493, 1454, 1430, 1370, 1320, 1294, 1205, 1130, 1076, 1026, 998, 964, 817, 756, 697, 633. ^{1}H NMR spectrum, δ, ppm: **IIIa**: 2.05 br.s (1H, NH), 2.48 m (2H, $NC\mathbf{H}_2CH_2O$), 2.8, 3.1–3.4 m (4H, NCH_2CH_2NH), 3.79 t (2H, OCH_2, ^3J = 5.7 Hz), 3.96 d.d (1H, *cis*-CH=C, ^2J = 2.2 Hz), 4.15 d.d (1H, *trans*-CH=C, ^2J = 2.2 Hz), 4.16 s (1H, NCHN), 6.43 d.d (1H, OCH=, $^3J_{cis}$ = 6.7, $^3J_{trans}$ = 14.3 Hz), 7.38 m (3H, *m*-H, *p*-H), 7.70 m (2H, *o*-H); **IVa**: 2.05 br.s (1H, NH), 2.69 t (2H, $NC\mathbf{H}_2CH_2O$, ^3J = 5.5 Hz), 2.95 t (2H, $NC\mathbf{H}_2CH_2N$=C, ^3J = 5.6 Hz), 3.75 t (2H, OCH_2, ^3J = 5.5 Hz), 3.77 t (2H, CH_2N=C, ^3J = 5.6 Hz), 3.94 d.d (1H, *cis*-CH=C, ^2J = 2.1, $^3J_{cis}$ = 6.6 Hz), 4.10 d.d (1H, *trans*-CH=, ^2J = 2.1, $^3J_{trans}$ = 14.3 Hz), 6.43 d.d (1H, OCH=, $^3J_{cis}$ = 6.6, $^3J_{trans}$ = 14.3 Hz), 7.40 m (3H, *m*-H, *p*-H), 7.72 m (2H, *o*-H), 8.31 s (1H, N=CH). ^{13}C NMR spectrum, δ_C, ppm: **IIIa**: 46.29 ($NCH_2\mathbf{C}H_2NH$), 51.33 ($OCH_2\mathbf{C}H_2N$), 54.82 ($N\mathbf{C}H_2CH_2NH$), 68.49 (OCH_2), 85.10 (NCHN), 87.90 (=CH_2), 128.96 (C^o), 129.09 (C^m), 131.99 (C^p), 141.21 (C^i), 151.91 (OCH=); **IVa**: 49.85 ($OCH_2\mathbf{C}H_2NH$), 49.91 ($NH\mathbf{C}H_2CH_2N$), 62.60 (CH_2N=), 68.70 (OCH_2), 88.02 (=CH_2), 129.54 (C^o), 129.98 (C^m), 132.07 (C^p), 141.65 (C^i), 153.11 (OCH=), 163.68 (CH=N). Found, %: C 71.41; H 8.49; N 12.19. $C_{13}H_{18}N_2O$. Calculated, %: C 71.53; H 8.31; N 12.83.

4-[1-(2-Vinyloxyethyl)imidazolidin-2-yl]pyridine (IIIb) and *N*-[(*E*)-pyridin-4-ylmethylidene]-*N*′-(2-vinyloxyethyl)ethane-1,2-diamine (IVb). Yield of mixture **IIIb**/**IVb** 84%, bp 138–142°C (2 mm), d_4^{20} = 1.0609, n_D^{20} = 1.5400. IR spectrum, ν, cm^{-1}: 3260, 3105, 3060, 3015, 2920, 2870, 2805, 1640, 1615, 1600, 1555, 1445, 1420, 1395, 1355, 1300, 1180, 1115, 1040, 1005, 975, 950, 930, 895, 795, 725, 680, 610, 530, 470. ^{1}H NMR spectrum, δ, ppm: **IIIb**: 1.92 br.s (1H, NH), 2.57 m (2H, $NC\mathbf{H}_2CH_2O$), 2.8–2.95 m (2H, $NC\mathbf{H}_2CH_2NH$), 3.15–3.25 m (2H, $NCH_2C\mathbf{H}_2NH$), 3.74 t (2H, OCH_2, ^3J = 5.6 Hz), 3.97 d.d (1H, *cis*-CH=C, ^2J = 1.8, $^3J_{cis}$ = 6.7 Hz), 4.12 d.d (1H, *trans*-CH=C, ^2J = 1.8, $^3J_{trans}$ = 14.3 Hz), 4.22 s (1H, NCHN), 6.41 d.d (1H, OCH=, $^3J_{cis}$ = 6.7, $^3J_{trans}$ = 14.3 Hz), 7.43 d.d (2H, 3-H, 5-H, ^3J = 4.4, ^4J = 1.1 Hz), 8.58 d.d (2H, 2-H, 6-H, ^3J = 4.4, ^4J = 1.4 Hz); **IVb**: 1.92 br.s (1H, NH), 2.69 t (2H, $N\mathbf{C}H_2CH_2O$, ^3J = 5.3 Hz), 2.88 t (2H, $NC\mathbf{H}_2CH_2N$=C, ^3J = 5.4 Hz), 3.78 t (2H, OCH_2, ^3J = 5.3 Hz), 3.79 t (2H, CH_2N=C, ^3J = 5.5 Hz), 3.97 d.d (1H, *cis*-CH=C), 4.16 d.d (1H, *trans*-CH=C, ^2J = 1.8 Hz), 6.47 d.d (1H, OCH=, $^3J_{cis}$ = 6.8 Hz), 7.58 d.d (2H, 3-H, 5-H, ^3J = 4.4, ^4J = 1.1 Hz), 8.30 s (1H, N=CH), 8.67 d.d (2H, 2-H, 6-H, ^3J = 4.4, ^4J = 1.3 Hz). ^{13}C NMR spectrum, δ_C, ppm: **IIIb**: 44.17 ($NCH_2\mathbf{C}H_2NH$), 51.30 ($OCH_2\mathbf{C}H_2N$), 53.04 ($N\mathbf{C}H_2CH_2NH$), 66.46 (OCH_2), 81.61 (NCHN), 86.21 (=CH_2), 122.19 (C^3, C^5), 142.29 (C^4), 149.57 (C^2, C^6), 151.05 (OCH=); **IVb**: 48.02 ($OCH_2\mathbf{C}H_2NH$), 49.17 ($NH\mathbf{C}H_2CH_2N$), 60.91 (CH_2N=), 66.80 (OCH_2), 86.21 (=CH_2), 121.45 (C^3, C^5), 142.25 (C^4), 149.88 (C^2, C^6), 151.21 (OCH=), 159.77 (CH=N). Found, %: C 65.60; H 7.90; N 19.38. $C_{12}H_{17}N_3O$. Calculated, %: C 65.73; H 7.81; N 19.16.

3-[1-(2-Vinyloxyethyl)imidazolidin-2-yl]pyridine (IIIc) and *N*-[(*E*)-pyridin-3-yl-3-methylidene]-*N*′-(2-vinyloxyethyl)ethane-1,2-diamine (IVc). Yield of mixture **IIIc**/**IVc** 81%, bp 163–166°C (4 mm), d_4^{20} = 1.0570, n_D^{20} = 1.5354. IR spectrum, ν, cm^{-1}: 3260, 3100, 3065, 3015, 2910, 2860, 2800, 1645, 1620, 1610, 1590, 1570, 1555, 1445, 1400, 1345, 1290, 1275, 1170, 1105, 1050, 1000, 970, 940, 920, 885, 780, 685, 635, 590, 520, 460. ^{1}H NMR spectrum, δ, ppm: **IIIc**: 1.79 br.s (1H, NH), 2.57 m (2H, $NC\mathbf{H}_2CH_2O$), 2.81 m and 2.93–2.99 m (2H, $NC\mathbf{H}_2CH_2NH$), 3.15–3.35 m (2H, $NCH_2C\mathbf{H}_2NH$), 3.73 t (2H, OCH_2, ^3J = 5.7 Hz), 3.96 d.d (1H, *cis*-CH=C, ^2J = 2.0 Hz), 4.11 d.d (1H, *trans*-CH=C, ^2J = 2.0, $^3J_{trans}$ = 14.3 Hz), 4.22 s (1H, NCHN), 6.42 d.d (1H, OCH=, $^3J_{cis}$ = 6.6, $^3J_{trans}$ = 14.2 Hz), 7.28 m (1H, 5-H), 7.83 d.t (1H, 4-H, ^3J = 7.9, ^4J = 0.8 Hz), 8.56 d.d (1H, 6-H, ^3J = 4.7, ^4J = 0.8 Hz), 8.71 d (1H, 2-H, ^4J = 1.8 Hz); **IVc**: 1.79 br.s (1H, NH), 2.69 t (2H, $NC\mathbf{H}_2CH_2O$, ^3J = 5.3 Hz), 2.89 t (2H, $NC\mathbf{H}_2CH_2N$=C, ^3J = 5.4 Hz), 3.78 t (2H, OCH_2, ^3J = 5.3 Hz), 3.79 t (2H, CH_2N=C, ^3J = 5.4 Hz), 3.98 d.d (1H, *cis*-CH=C, ^2J = 1.8 Hz), 4.16 d.d (1H, *trans*-CH=C, ^2J = 1.8, $^3J_{trans}$ = 14.3 Hz), 6.46 d.d (1H, OCH=, $^3J_{cis}$ = 6.6 Hz), 7.34 m (1H, 5-H), 8.09 d.t (1H, 4-H, ^3J = 7.9, ^4J = 0.8 Hz), 8.63 d.d (1H, 6-H, ^3J = 4.7, ^4J = 0.8 Hz), 8.36 s (1H, N=CH), 8.70 d (1H, 2-H, ^4J = 1.8 Hz). ^{13}C NMR spectrum, δ_C, ppm: **IIIc**: 44.65 ($NCH_2\mathbf{C}H_2NH$), 51.04 ($OCH_2\mathbf{C}H_2N$), 53.01 ($N\mathbf{C}H_2CH_2NH$), 66.49 (OCH_2), 80.85 (NCHN), 86.22 (=CH_2), 123.13 (C^5), 134.85 (C^4), 135.74 (C^3), 149.33 (C^2), 149.43 (C^6), 151.13 (OCH=); **IVc**: 48.10 ($OCH_2\mathbf{C}H_2NH$), 49.38 ($NH\mathbf{C}H_2CH_2N$), 61.03 (CH_2N=), 66.87 (OCH_2), 86.22 (=CH_2), 123.19 (C^5), 131.18 (C^3), 134.16 (C^4), 149.79 (C^2), 151.06 (C^6), 151.28 (OCH=), 158.88 (CH=N). Found, %: C 65.70; H 7.60; N 19.19. $C_{12}H_{17}N_3O$. Calculated, %: C 65.73; H 7.81; N 19.16.

***N*-Cyclopentylidene-*N*′-(2-vinyloxyethyl)ethane-1,2-diamine (IVd).** Yield 64%, bp 112–117°C (3 mm), n_D^{20} = 1.4930. IR spectrum, ν, cm^{-1}: 3295, 3090, 3020, 2925, 2850, 2800, 1665, 1620, 1605, 1420, 1390, 1285, 1240, 1160, 1100, 1035, 985, 960, 925, 880, 775, 665, 590, 460. ^{1}H NMR spectrum, δ, ppm: 1.57–2.25 m (9H, CH_2, NH), 2.83 m (4H, CH_2NCH_2), 3.21 t

(2H, =NCH$_2$, ^3J = 6.1 Hz), 3.79 t (2H, OCH$_2$, ^3J = 5.3 Hz), 3.97 d.d (1H, *cis*-CH=C, ^2J = 1.8, $^3J_{cis}$ = 6.7 Hz), 4.17 d.d (1H, *trans*-CH=C, ^2J = 1.8, $^3J_{trans}$ = 14.3 Hz), 6.47 d.d (1H, OCH=, $^3J_{cis}$ = 6.8, $^3J_{trans}$ = 14.3 Hz). ^{13}C NMR spectrum, δ$_C$, ppm: 24.28 (*syn*-CN=CCH$_2$**C**H$_2$), 24.84 (*anti*-CN=CCH$_2$**C**H$_2$), 29.28 (*syn*-CN=C**C**H$_2$), 36.36 (*anti*-CN=C**C**H$_2$), 48.72 (OCH$_2$**C**H$_2$NH), 50.43 (NH**C**H$_2$CH$_2$N=), 53.31 (CH$_2$N=), 67.37 (OCH$_2$), 86.37 (=CH$_2$), 151.72 (OCH=), 181.73 (N=C). Found, %: C 67.17; H 10.14; N 14.21. $C_{11}H_{20}N_2O$. Calculated, %: C 67.31; H 10.27; N 14.27.

***N*-Cyclohexylidene-*N′*-(2-vinyloxyethyl)ethane-1,2-diamine (IVe).** Yield 83%, bp 111–116°C (2 mm), n_D^{20} = 1.4998. IR spectrum, ν, cm^{-1}: 3300, 3100, 3065, 3040, 2915, 2865, 2830, 2795, 1660, 1615, 1605, 1420, 1335, 1295, 1270, 1230, 1175, 1125, 1105, 1045, 1030, 975, 935, 880, 840, 780, 745, 680, 600, 585, 520, 460, 430. ^{1}H NMR spectrum, δ, ppm: 1.30–1.80 m (10H, CH$_2$), 2.75 t (2H, OCH$_2$C**H**$_2$N, ^3J = 6.1 Hz), 2.86 t (2H, =NCH$_2$C**H**$_2$, ^3J = 6.9 Hz), 3.01 t (2H, =NCH$_2$, ^3J = 6.9 Hz), 3.25 br.s (1H, NH), 3.73 t (2H, OCH$_2$, ^3J = 6.1 Hz), 3.95 d.d (1H, *cis*-CH=C, ^2J = 1.8, $^3J_{cis}$ = 6.7 Hz), 4.13 d.d (1H, *trans*-CH=C, ^2J = 1.8, $^3J_{trans}$ = 14.3 Hz), 6.44 d.d (1H, OCH=, $^3J_{cis}$ = 6.7, $^3J_{trans}$ = 14.3 Hz). ^{13}C NMR spectrum, δ$_C$, ppm: 25.11 (=CCH$_2$CH$_2$**C**H$_2$), 27.45 (*anti*-CN=CCH$_2$**C**H$_2$), 28.35 (*syn*-CN=CCH$_2$**C**H$_2$), 32.81 (=C**C**H$_2$), 49.39 (OCH$_2$-**C**H$_2$NH), 49.88 (NH**C**H$_2$CH$_2$N=), 52.69 (CH$_2$N=), 69.01 (OCH$_2$), 87.80 (=CH$_2$), 153.13 (OCH=), 172.92 (N=C). Found, %: C 68.47; H 10.30; N 13.20. $C_{12}H_{22}N_2O$. Calculated, %: C 68.53; H 10.54; N 13.32.

***N*-(1,3-Dimethylbutylidene)-*N′*-(2-vinyloxyethyl)-ethane-1,2-diamine (IVf).** Yield 53%, bp 131–133°C (8 mm), d_4^{20} = 0.8743, n_D^{20} = 1.4635. IR spectrum, ν, cm^{-1}: 3210, 3110, 3070, 3035, 2945, 2915, 2860, 2820, 1645, 1605, 1445, 1350, 1305, 1270, 1230, 1180, 1125, 1060, 1005, 980, 945, 795, 740, 585, 515. ^{1}H NMR spectrum, δ, ppm: major isomer: 0.86 (6H, CH**Me**$_2$, ^3J = 6.6 Hz), 1.76 s (3H, Me), 1.95 m (2H, C**H**Me$_2$, NH), 1.95 m (1H, C**H**Me$_2$), 2.09 m (3H, C**H**$_2$CHMe$_2$, NH), 2.88 m (4H, C**H**$_2$NHC**H**$_2$), 3.31 t (2H, CH$_2$N=C, ^3J = 5.9 Hz), 3.75 t (2H, OCH$_2$, ^3J = 5.3 Hz), 3.94 d.d (1H, *cis*-CH=C, ^2J = 2.0, $^3J_{cis}$ = 6.8 Hz), 4.14 d.d (1H, *trans*-HC=C, ^2J = 2.0, $^3J_{trans}$ = 14.3 Hz), 6.42 d.d (1H, OCH=, $^3J_{cis}$ = 6.8, $^3J_{trans}$ = 14.3 Hz); minor isomer: 0.88 (6H, CH**Me**$_2$, ^3J = 6.7 Hz), 1.80 s (3H, Me), 1.95 m (1H, C**H**Me$_2$), 2.09 m (3H, C**H**$_2$CHMe$_2$, NH), 2.88 m (4H, C**H**$_2$NHC**H**$_2$), 3.36 t (1H, CH$_2$N=C, ^3J = 6.0 Hz), 3.75 t (2H, OCH$_2$), 3.94 d.d (1H, *cis*-CH=C), 4.14 d.d (1H, *trans*-HC=C), 6.44 d.d (1H, OCH=). Found, %: C 67.64; H 11.82; N 13.15. $C_{12}H_{24}N_2O$. Calculated, %: C 67.88; H 11.39; N 13.19.

1,3,5-Tris[2-(2-vinyloxyethylamino)ethyl]hexahydro-1,3,5-triazine (V). Yield 88%, bp 164–169°C (2 mm), d_4^{20} = 1.0226, n_D^{20} = 1.4953. IR spectrum, ν, cm^{-1}: 3280, 3110, 3075, 3025, 2915, 2870, 2805, 1625, 1605, 1480, 1460, 1425, 1395, 1345, 1310, 1280, 1185, 1060, 1010, 985, 950, 910, 870, 800, 685, 630, 580, 525. ^{1}H NMR spectrum, δ, ppm: 1.83 br.s (1H, NH), 2.62 t (2H, NHC**H**$_2$CH$_2$N, ^3J = 7.1 Hz), 2.73 t (2H, NHC**H**$_2$CH$_2$O, ^3J = 5.6 Hz Hz), 3.01 t (2H, NHCH$_2$C**H**$_2$N, ^3J = 7.1 Hz), 3.44 s (2H, NCH$_2$N), 3.73 t (2H, OCH$_2$, ^3J = 5.6 Hz), 3.93 d.d (1H, *cis*-CH=C, ^2J = 1.8, $^3J_{cis}$ = 6.9 Hz), 4.10 d.d (1H, *trans*-CH=C, ^2J = 1.8, $^3J_{trans}$ = 14.3 Hz), 6.43 d.d (1H, OCH=, $^3J_{cis}$ = 6.9, $^3J_{trans}$ = 14.3 Hz). ^{13}C NMR spectrum, δ$_C$, ppm: 50.39 (NH**C**H$_2$CH$_2$O), 52.69 (NCH$_2$-**C**H$_2$NH), 53.54 (N**C**H$_2$CH$_2$NH), 66.66 (OCH$_2$), 75.32 (NCH$_2$N), 86.34 (=CH$_2$), 151.60 (OCH=). Found, %: C 59.44; H 9.72; N 19.82. $C_{21}H_{42}N_6O_3$. Calculated, %: C 59.12; H 9.92; N 19.70.

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