Russian Journal of Organic Chemistry, Vol. 37, No. 11, 2001, pp. 1659–1661. Translated from Zhurnal Organicheskoi Khimii, Vol. 37, No. 11, 2001, pp. 1729–1731.

SHORT COMMUNICATIONS

Epoxidation of Stereoisomeric Sulfonylureas of the Norbornene Series

A. O. Kas'yan, I. N. Tarabara, E. A. Golodaeva, and L. I. Kas'yan

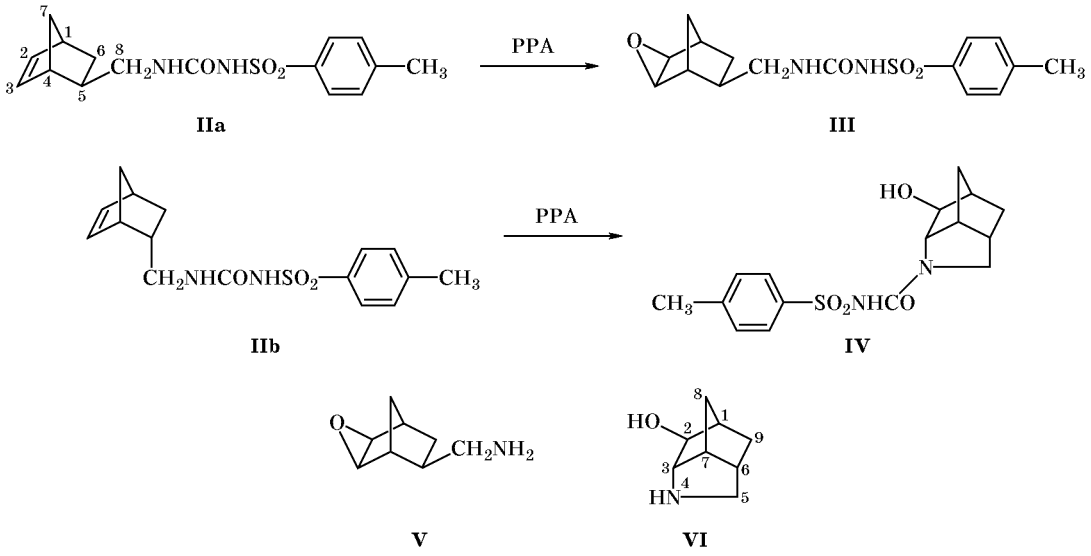
Dnepropetrovsk National University, per. Nauchnyi 13, Dnepropetrovsk, 49005 Ukraine

Received August 8, 2001

In the recent years extensive studies were performed on stereochemical aspects of epoxidation of *exo*- (**Ia**) and *endo*-5-aminomethylbicyclo[2.2.1]hept-2-ene (**Ib**) derivatives, such as sulfonamides, carboxamides, and ureas [1]. Substituted norbornenes with the *exo*-oriented substituent are converted into epoxy derivatives by the action of peroxy acids. The corresponding *endo* isomers behave differently. Carboxamides react like their *exo* isomers [2], arylureas undergo heterocyclization to form substituted 3-azatricyclo[4.2.1.$0^{3,7}$]nonanes, and sulfonamides are capable of reacting along both these pathways, depending on the substituent on the nitrogen [1, 3]. We performed reactions of amines **Ia** and **Ib** with *p*-tolylsulfonyl isocyanate and subsequent oxidation of stereoisomeric sulfonylureas **IIa** and **IIb** with peroxyphthalic acid (PPA) generated *in situ* from phthalic anhydride and 40% hydrogen peroxide. We found that the oxidation products are epoxy derivative **III** and substituted azabrendane **IV** from *exo* and *endo* isomers **IIa** and **IIb**, respectively (Scheme 1). Compounds **III** and **IV** were also synthesized by the action of *p*-tolylsulfonyl isocyanate on epoxyamine **V** (which was prepared by the procedure reported in [4]) and tricyclic amine **VI** (which was described previously [5]).

The structure of compounds **II**–**IV** was confirmed by the IR and ^{1}H and ^{13}C NMR spectra; the latter were recorded using the Rubenstein–Nakashima technique. In the IR spectrum of **III** a strong band was observed at 850–845 cm^{-1}, which belongs to vibrations of the C–O bond in the oxirane moiety. The 2-H and 3-H signals in the ^{1}H NMR spectrum of **III** were located at δ 3.02 and 2.95 ppm; the corresponding carbon nuclei (C^2 and C^3) had chemical shifts δ_C 51.1 and 50.8 ppm. Azabrendane **IV** showed in the ^{1}H NMR spectra recorded in $CDCl_3$, DMSO-d_6, and acetic acid characteristic signals from 2-H and 3-H as a doublet and singlet in the region δ 3.4–4.0 ppm.

Scheme 1.



IIa **III** **IIb** **IV** **V** **VI**

1070-4280/01/3711-1659 $25.00 © 2001 MAIK "Nauka / Interperiodica"

Samples of **IV** prepared by different methods had different melting points and ^{13}C NMR spectra. Unlike the product of stereoselective transformation of amine **VI**, that obtained by epoxidation of **IIb** showed in the spectrum two sets of signals with fairly similar chemical shifts. Presumably, the second set of signals arises from the appearance of a new chiral center, the nitrogen atom incorporated into the rigid polycyclic system. No such pattern was observed for the other substituted azabrendanes [2, 3].

Amines **Ia** and **Ib** were synthesized by the procedure reported in [4], and amines **V** and **VI** were prepared as described in [4, 5]. Their properties were consistent with published data.

Sulfonylureas IIa, IIb, III, and IV (*general procedure***).** To a solution of 2 g (0.01 mol) of *p*-tolylsulfonyl isocyanate in 5 ml of benzene we added 0.01 mol of amine **Ia**, **Ib**, **V**, or **VI** in 5 ml of benzene. The progress of the reaction was monitored by TLC. When the reaction was complete, the precipitate was filtered off, washed with benzene, dried, and recrystallized from aqueous ethanol.

***N*-(Bicyclo[2.2.1]hept-5-en-*exo*-2-ylmethyl)-*N'*-(*p*-tolylsulfonyl)urea (IIa).** Yield 86%, mp 167–168°C. IR spectrum, ν, cm^{-1}: 3324, 3068, 1657, 1561, 1468, 1348, 1325, 1240, 1162. ^1H NMR spectrum, δ, ppm: 6.06 d.d (2-H), 6.02 d.d (3-H), 3.28 d.d (8-H_A), 3.17 d.d (8-H_B), 2.82 m (1-H), 2.49 m (4-H), 1.51 m (5-H), 1.33 d (7-H_{anti}), 1.29 d (7-H_{syn}), 1.23 d.d.d (6-H_{exo}), 1.09 d.t (6-H_{endo}), 2.44 (CH_3), 7.76 d and 7.31 d (H_{arom}). ^{13}C NMR spectrum, δ_C, ppm: 137.2, 136.3 (C^2, C^3); 45.8 (C^8); 45.2 (C^7); 44.3, 41.9, 39.4 (C^4, C^1, C^5); 30.9 (C^6); 21.9 (CH_3); 130.2–127.1 (C_{arom}). Found, %: C 60.13; H 6.37; N 8.66. $C_{16}H_{20}N_2O_3S$. Calculated, %: C 60.00; H 6.25; N 8.75.

***N*-(Bicyclo[2.2.1]hept-5-en-*endo*-2-ylmethyl)-*N'*-(*p*-tolylsulfonyl)urea (IIb).** Yield 89%, mp 147–148°C. IR spectrum, ν, cm^{-1}: 3370, 3073, 1680, 1555, 1460, 1346, 1170, 730. ^1H NMR spectrum, δ, ppm: 6.12 d.d (2-H), 5.87 d.d (3-H), 2.95 d.d (8-H_A), 2.84 d.d (8-H_B), 2.77 m (1-H), 2.69 m (4-H), 2.18 m (5-H), 1.77 d.d.d (6-H_{exo}), 1.41 d (7-H_{syn}), 1.19 d (7-H_{anti}), 0.49 d.t (6-H_{endo}), 2.42 (CH_3), 7.79 d and 7.27 d (H_{arom}). ^{13}C NMR spectrum, δ_C, ppm: 137.8, 132.0 (C^2, C^3); 49.5 (C^8); 44.4 (C^7); 44.2, 42.5, 38.9 (C^4, C^1, C^5); 30.0 (C^6); 21.7 (CH_3); 129.8–127.0 (C_{arom}). Found, %: C 60.09; H 6.27; N 8.62. $C_{16}H_{20}N_2O_3S$. Calculated, %: C 60.00; H 6.25; N 8.75.

***N*-(5,6-Epoxybicyclo[2.2.1]hept-*exo*-2-ylmethyl)-*N'*-(*p*-tolylsulfonyl)urea (III).** Yield 78%, mp 189–190°C. IR spectrum, ν, cm^{-1}: 3390, 3050, 1668, 1640, 1525, 1420, 1310, 1224, 1130, 845. ^1H NMR spectrum, δ, ppm: 3.02 d (2-H), 2.95 d (3-H), 2.67 m (2H, 8-H), 2.25 m (1-H), 2.16 m (4-H), 1.45 m (5-H), 1.22 d.d.d (6-H_{exo}), 0.95 d (7-H_{syn}), 0.90 d.t (6-H_{endo}), 0.67 d (7-H_{anti}), 2.25 (CH_3), 7.76 d and 7.08 d (H_{arom}). ^{13}C NMR spectrum, δ_C, ppm: 160.8 (CO); 145.1–126.3 (C_{arom}); 51.1 (C^2); 50.8 (C^3); 38.9, 38.7, 36.4 (C^1, C^5, C^4); 30.7 (C^7); 22.8 (C^6); 20.8 (CH_3). Found, %: C 57.23; H 5.84; N 8.26. $C_{16}H_{20}N_2O_4S$. Calculated, %: C 57.14; H 5.95; N 8.33.

***exo*-2-Hydroxy-4-(*p*-tolylsulfonylcarbamoyl)-4-azatricyclo[4.2.1.0^{3,7}]nonane (IV).** Yield 88%, mp 200–202°C. IR spectrum, ν, cm^{-1}: 3440, 1625, 1475, 1385, 1340, 1280, 1170, 1080. ^1H NMR spectrum, δ, ppm: 3.88 s (2-H), 3.63 d (3-H), 3.33 d.d (5-H_A), 3.12 d (5-H_B), 2.59 m (7-H), 2.25 m (6-H), 2.15 m (1-H), 1.85 m (9-H_{exo}), 1.74 d (8-H_{syn}), 1.45 d (8-H_{anti}), 0.80 d (9-H_{endo}), 2.42 (CH_3), 7.92 d and 7.29 d (H_{arom}). ^{13}C NMR spectrum, δ_C, ppm: 174.1 (CO); 144.1–128.5 (C_{arom}); 84.9, 64.6 (C^2, C^3); 53.4 (C^5); 46.3, 39.8, 35.6 (C^7, C^1, C^6); 35.0 (C^9); 32.3 (C^8); 21.9 (CH_3). Found, %: C 57.21; H 5.83; N 8.37. $C_{16}H_{20}N_2O_4S$. Calculated, %: C 57.14; H 5.95; N 8.33.

Epoxidation of sulfonylureas IIa and IIb (*general procedure***).** To a suspension of 0.002 mol of sulfonylurea **IIa** or **IIb**, 0.001 mol of urea, and 0.004 mol of 40% hydrogen peroxide in 10 ml of ethyl acetate we added with stirring at 20–25°C 0.004 mol of phthalic anhydride, and the mixture was stirred until the reaction was complete (TLC). The mixture was treated with a saturated solution of sodium hydrogen carbonate until it became alkaline, the organic layer was separated, dried over calcined magnesium sulfate, and evaporated, and the product was recrystallized from aqueous ethanol. Compound **III** was thus obtained in 91% yield; it was identical to a sample prepared as described above from amine **V**. Compound **IV** was obtained in 73% yield. mp 144–146°C. IR spectrum, ν, cm^{-1}: 3415, 1612, 1563, 1440, 1370, 1247, 1180, 1126, 1080.

The IR spectra were recorded on a Specord 75IR spectrometer from samples pelleted with KBr. The ^1H NMR spectra were obtained on Varian VXR-300 and Inova 400 instruments operating at 300 and 400 MHz, respectively, using $CDCl_3$ and DMSO-d_6 as solvents and HMDS as internal reference. The ^{13}C NMR

spectra were measured on the same instruments at 75.4 and 100.6 MHz, respectively. The progress of reactions was monitored, and the purity of products was checked, by TLC on Silufol UV-254 plates using ether as eluent. Chromatograms were developed with iodine vapor. The elemental compositions were determined on a Karlo Erba analyzer.

REFERENCES

1. Kas'yan, L.I., *Usp. Khim.*, 1998, vol. 67, no. 4, pp. 299–316.
2. Kas'yan, L.I., Tarabara, I.N., Savel'eva, O.A., and Kas'yan, A.O., *Russ. J. Org. Chem.*, 1997, vol. 33, no. 9, pp. 1353–1354.
3. Kasyan, L.I., Sereda, S.V., Potekhin, K.A., and Kasyan, A.O., *Heteroatom Chem.*, 1997, vol. 8, no. 2, pp. 177–184.
4. Kas'yan, A.O., Krasnovskaya, O.Yu., Okovityi, S.I., and Kas'yan, L.I., *Russ. J. Org. Chem.*, 1995, vol. 31, no. 3, pp. 311–319.
5. Kasyan, L.I., Okovity, S.I., and Kasyan, A.O., *Heteroatom Chem.*, 1997, vol. 8, no. 2, pp. 185–190.