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Received August 7, 1992

A synthetic route to the title compounds is described, which involves as the key step an intramolecular cycloaddition of properly functionalized nitrilimines.

J. Heterocyclic Chem., **30**, 559 (1993).

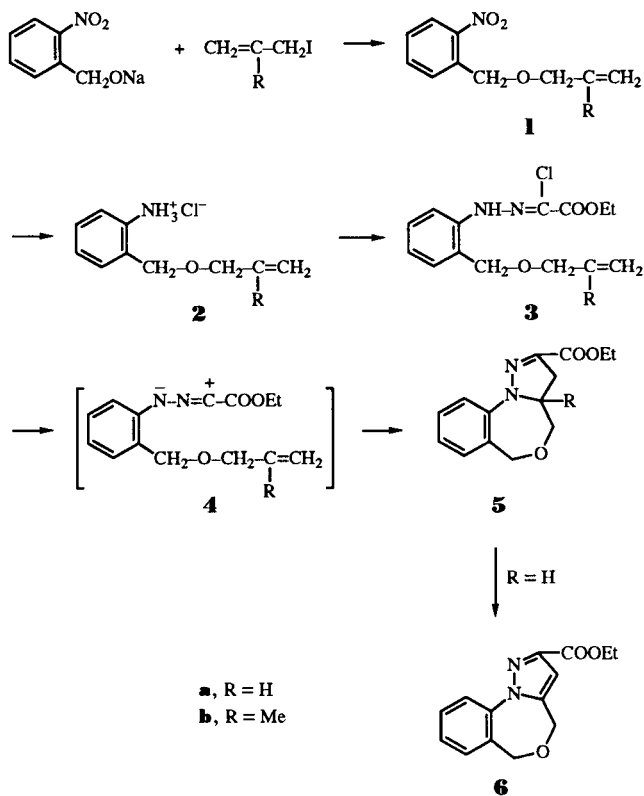
Previous works by us [1-4] as well as by other research groups [5-8] have shown that the intramolecular nitrilimine cycloadditions represent an efficient and versatile strategy for the construction of nitrogen-containing heterocycles. We now wish to report the application of this strategy to the synthesis of the hitherto unknown pyrazolo[1,5-*a*][4,1]benzoxazepine system.

As suitable precursors of the target compounds, we devised the functionalized nitrilimines **4**, which were generated *in situ* from the corresponding hydrazonyl chlorides **3**. The latter intermediates were in turn accessible through the reaction sequence outlined in the Scheme 1.

Treatment of **3** with an excess of triethylamine in boiling toluene led to the tricyclic compounds **5** in fairly good yields. The product structures rely upon analytical and spectral data as well as upon the DDQ oxidation of **5a** to the corresponding pyrazole derivative **6**.

No improvement in the formation of **5** was achieved by using either stronger bases (DABCO and NaH) or a more polar solvent (acetonitrile). These new conditions accelerated the disappearance of the starting hydrazonyl chlorides, but gave sizable amounts of tarry material. Such a result is explicable if one thinks that only the slow generation of the labile intermediates **4** can mimic the high-dilution conditions, so favouring intramolecular over intermolecular processes.

Scheme 1



EXPERIMENTAL

Melting points were taken on a Büchi apparatus and are uncorrected. The ir spectra were run with a Perkin-Elmer 298 spectrophotometer. The nmr spectra were recorded on a Varian EM-390 instrument by using tetramethylsilane as an internal standard. Mass spectra were measured on a V6-70EQ apparatus. Compound **1a** was prepared as described in the literature [9].

2-Methyl-3-(2-nitrobenzyloxy)propene (**1b**).

2-Nitrobenzyl alcohol (5.0 g) was added to 1.8M sodium ethoxide solution in ethanol (20 ml). After 1 hour refluxing, the solvent was evaporated and the residue was dissolved in anhydrous DMF (40 ml). Methallyl iodide (13 g) was added dropwise and the solution was refluxed for 30 minutes. The resulting mixture was poured into water and extracted with ether. The organic layer was dried over sodium sulfate and evaporated. The residue was chromatographed on a silica gel column with diethyl ether-light petroleum 1:1 as the eluent to give the title compound (4.3 g) as an undistillable oil; ¹H nmr (deuteriochloroform): δ 1.8 (s, 3H), 4.0 (s, 2H), 4.8 (s, 2H), 4.8-5.0 (m, 2H), 7.2-8.1 (m, 4H); ms: m/z 207 (M⁺).

Anal. Calcd. for C₁₁H₁₃NO₃: C, 63.7; H, 6.3; N, 6.8. Found: C, 63.6; H, 6.4; N, 6.7.

2-(Prop-2-enyloxymethyl)benzenamine Hydrochloride (**2a**).

A solution of stannous chloride dihydrate (3.9 g) in concentrated hydrochloric acid (40 ml) was added dropwise into a solution of **1a** (3.6 g) in acetic acid (40 ml) under vigorous stirring and cooling at 15-20°. Zinc powder (10 g) was then added portionwise

(1 hour) with stirring and cooling. The undissolved material was filtered, the solution was adjusted to pH 5 with ammonia, and the solvent was partly removed under reduced pressure. The residue was alkalized and extracted with chloroform. The organic solution was dried over sodium sulfate and evaporated. The residue was dissolved in anhydrous diethyl ether and treated with gaseous hydrogen chloride for 1 hour. The solid material was filtered and washed with anhydrous ether to give the title hydrochloride (2.4 g); ^1H nmr (deuterium oxide): δ 4.1 (dt, $J = 6$ and 1 Hz, 2H), 4.9 (s, 2H), 5.1-5.5 (m, 2H), 5.7-6.3 (m, 1H), 7.4-7.6 (m, 4H).

Anal. Calcd. for $\text{C}_{10}\text{H}_{14}\text{NOCl}$: C, 60.1; H, 7.1; N, 7.0. Found: C, 60.2; H, 7.0; N, 6.9.

2-[(2-Methyl-2-propenyloxy)methyl]benzenamine Hydrochloride (2b).

Following the preceding procedure, compound **1b** (3.6 g) was converted into the title hydrochloride (2.0 g); ^1H nmr (deuterium oxide): δ 1.3 (s, 3H), 3.5 (t, $J = 2$ Hz, 2H), 4.7 (s, 2H), 4.8-5.0 (m, 2H), 7.4-7.6 (m, 4H).

Anal. Calcd. for $\text{C}_{11}\text{H}_{16}\text{NOCl}$: C, 61.8; H, 7.6; N, 6.5. Found: C, 62.0; H, 7.5; N, 6.7.

Ethyl 2-Chloro-2-[2-(prop-2-enyloxy-methyl)phenylhydrazono]acetate (3a).

Sodium nitrite (1.1 g) in water (25 ml) was added dropwise to a suspension of **2a** (2.4 g) in 1N hydrochloric acid (50 ml) with stirring and ice-cooling. After 30 minutes, the solution was adjusted to pH 4 with sodium acetate and ethyl 2-chloroacetate (2.5 g) in methanol (20 ml) was added with vigorous stirring and cooling. The resulting mixture was left at room temperature for 1 hour and extracted with ether. The organic solution was washed with water, dried over sodium sulfate, and evaporated. The residue was chromatographed on a silica gel column with light petroleum-diethyl ether 4:1 as the eluent to give **3a** (2.3 g) as an undistillable oil; ir (neat): 3310 and 1730 cm^{-1} ; ^1H nmr (deuteriochloroform): δ 1.4 (t, $J = 7$ Hz, 3H), 3.9-4.1 (m, 2H), 4.3 (q, $J = 7$ Hz, 2H), 4.6 (s, 2H), 5.0-5.4 (m, 2H), 5.6-6.1 (m, 1H), 6.8-7.6 (m, 4H), 9.3 (br s, 1H); ms: m/z 296 (M^+).

Anal. Calcd. for $\text{C}_{14}\text{H}_{17}\text{N}_2\text{O}_3\text{Cl}$: C, 56.6; H, 5.8; N, 9.4. Found: C, 56.5; H, 5.9; N, 9.3.

Ethyl 2-Chloro-2-[2-[(2-methyl-2-propenyloxy)methyl]phenylhydrazono]acetate (3b).

According to the preceding procedure, compound **2b** (1.3 g) gave **3b** (0.4 g) as an undistillable oil; ir (neat): 3310 and 1725 cm^{-1} ; ^1H nmr (deuteriochloroform): δ 1.3 (t, $J = 7$ Hz, 3H), 1.5 (s, 3H), 3.5 (s, 2H), 4.4 (q, $J = 7$ Hz, 2H), 4.7 (s, 2H), 4.7-5.1 (m, 2H), 6.9-7.7 (m, 4H), 9.4 (br s, 1H); ms: m/z 310 (M^+).

Anal. Calcd. for $\text{C}_{15}\text{H}_{19}\text{N}_2\text{O}_3\text{Cl}$: C, 58.0; H, 6.2; N, 9.0. Found: C, 58.1; H, 6.1; N, 9.1.

2-Ethoxycarbonyl-3,3a-dihydro-4H,6H-pyrazolo[1,5-a][4,1]benzoxazepine (5a).

A solution of **3a** (2 mmoles) in toluene (20 ml) was treated with

triethylamine (10 mmoles) and refluxed for 7 hours. The solvent was evaporated and the residue was chromatographed on a silica gel column with light petroleum-diethyl ether 4:1 as the eluent to afford **5a** in 41% yield, mp 82-83° (from diisopropyl ether); ir (Nujol): 1720 cm^{-1} ; ^1H nmr (deuteriochloroform): δ 1.4 (t, $J = 7$ Hz, 3H), 2.6 (dd, $J = 18$ and 13 Hz, 1H), 3.1-4.2 (overlapping, 4H), 4.3 (q, $J = 7$ Hz, 2H), 4.5, 4.7 (AB, $J = 13$ Hz, 2H), 6.9-7.5 (m, 4H); ms: m/z 260 (M^+).

Anal. Calcd. for $\text{C}_{14}\text{H}_{16}\text{N}_2\text{O}_3$: C, 64.6; H, 6.2; N, 10.8. Found: C, 64.7; H, 6.2; N, 10.7.

2-Ethoxycarbonyl-3a-methyl-3,3a-dihydro-4H,6H-pyrazolo[1,5-a][4,1]benzoxazepine (5b).

A solution of **3b** (1 mmole) in toluene (10 ml) was treated with triethylamine (5 mmoles) and refluxed for 6 hours. After removal of the solvent, the residue was chromatographed on a silica gel column with light petroleum-diethyl ether 4:1 as the eluent to afford **5b** in 33% yield, mp 66-67° (from diisopropyl ether); ir (Nujol): 1710 cm^{-1} ; ^1H nmr (deuteriochloroform): δ 1.05 (s, 3H), 1.4 (t, $J = 7$ Hz, 3H), 2.9, 3.0 (AB, $J = 18$ Hz, 2H), 3.7, 4.1 (AB, $J = 12$ Hz, 2H), 4.3 (q, $J = 7$ Hz, 2H), 4.5, 4.8 (AB, $J = 13$ Hz, 2H), 6.9-7.6 (m, 4H); ms: m/z 274 (M^+).

Anal. Calcd. for $\text{C}_{15}\text{H}_{18}\text{N}_2\text{O}_3$: C, 65.7; H, 6.6; N, 10.2. Found: C, 65.6; H, 6.2; N, 10.1.

2-Ethoxycarbonyl-4H,6H-pyrazolo[1,5-a][4,1]benzoxazepine (6).

A solution of **5a** (0.5 mmole) in toluene (40 ml) was treated with DDQ (2 mmoles) and refluxed for 18 hours. The undissolved material was filtered off, the solvent was removed, and the residue was chromatographed on a silica gel column with diethyl ether-light petroleum 4:1 as the eluent to give **6** (0.08 g), mp 74-75° (from diisopropyl ether); ir (Nujol): 1720 cm^{-1} ; ^1H nmr (deuteriochloroform): δ 1.4 (t, $J = 7$ Hz, 3H), 4.4 (q, $J = 7$ Hz, 2H), 4.5 (s, 2H), 4.6 (s, 2H), 6.9 (s, 1H), 7.2-8.0 (m, 4H); ms: m/z 258 (M^+).

Anal. Calcd. for $\text{C}_{14}\text{H}_{14}\text{N}_2\text{O}_3$: C, 65.1; H, 5.5; N, 10.8. Found: C, 65.0; H, 5.5; N, 10.8.

Acknowledgements.

The authors are indebted to CNR and MURST for financial support.

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