

### 3-Alkyldiaziridines and 1,3-dialkyldiaziridines from aliphatic aldoxime-*O*-sulfonic acid salts

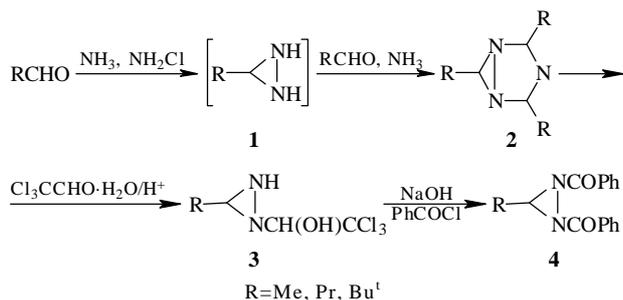
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It was shown for the first time that aliphatic aldoxime-*O*-sulfonic acids can be stabilised as ammonium or alkylammonium salts and can be used in diaziridinium synthesis with primary aliphatic amines or ammonia to give 1,3-dialkyldiaziridines and 3-alkyldiaziridines, respectively; the latter compounds have not been previously easily accessible.

Among the alkyl derivatives of diaziridine, 3-alkyldiaziridines **1** are the least accessible. This is mainly due to their clear-cut tendency to undergo condensation with the starting aldehydes and with ammonia under the conditions used in their synthesis (from aliphatic aldehydes, ammonia and *N*-chloramine) to give 2,4,6-trialkyl-1,3,5-triazabicyclo[3.1.0]hexane **2**.<sup>1</sup> Mild selective acid hydrolysis of the triazolidine ring in **2** in the presence of chloral hydrate yields the chloral hydrate derivatives **3** (R = Pr, Bu<sup>t</sup>).<sup>2a-c</sup> Upon alkaline decomposition of **3** (R = Me, Pr, Bu<sup>t</sup>) in the presence of benzoyl chloride, corresponding 1,2-dibenzoyl derivatives **4** were isolated.<sup>2a,c</sup> The only reported synthesis of 3-alkyldiaziridines, *viz.* 3-propyldiaziridine, was described in a German patent.<sup>2d</sup> This compound was prepared in 6% yield by the reaction of butyric aldehyde with ammonia and chloramine in aqueous methanol at 60 °C. However, the only characteristic reported for this compound was its boiling point. These literature data are presented in Scheme 1.



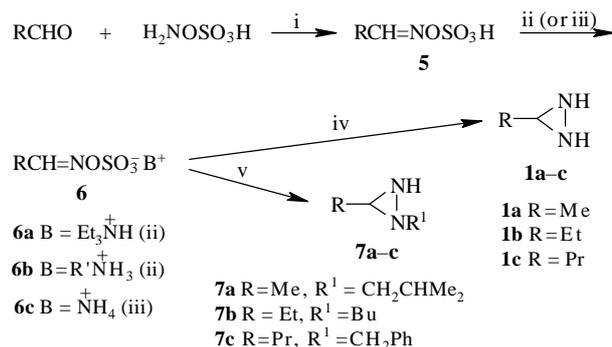
Scheme 1

Other known methods for the synthesis of 1,2-unsubstituted diaziridines [treatment of oxime-*O*-sulfonic acids<sup>3</sup> or their esters<sup>4-6</sup> with ammonia or treatment of carbonyl compounds with ammonia and hydroxylamine-*O*-sulfonic acid<sup>7</sup> (HASA)] are considered to be unsuitable for the preparation of 3-alkyldiaziridines, because aldoxime-*O*-sulfonic acids **5** and aldoxime esters decompose immediately after formation giving nitriles and the corresponding acids. The formation and decomposition of aldoxime-*O*-sulfonic acids **5** were also observed in the reaction described in ref. 7.

In the present study, we have found conditions for the stabilisation of aldoxime-*O*-sulfonic acids **5**. This allowed us to propose a new method for the synthesis of 3-alkyldiaziridines **1**, which makes these compounds fairly accessible.

Our search for the stabilisation conditions for **5** was based on the known data on the stability of HASA salts,<sup>8</sup> which decreases in the base sequence: Et<sub>3</sub>N > Py > NH<sub>3</sub> > NH<sub>2</sub>NH<sub>2</sub> > KOH. We found that triethylammonium salts of aliphatic aldoxime-*O*-sulfonic acids **6a** can be stored at 20 °C in a vacuum desiccator over alkali. Salts derived from primary aliphatic amines **6b** are also fairly stable. However, the ammonium salts **6c** proved to be stable only in a saturated aqueous solution of NH<sub>3</sub> (>40%) at a reduced temperature. In 25% aqueous ammonia compounds **5** decomposed. Salts **6** were synthesised by the reaction of the corresponding amines (or

NH<sub>3</sub>) with **5** in the cold. The latter, in turn, were prepared from aliphatic aldehydes and HASA in water (or in aqueous methanol) at a reduced temperature.



**Scheme 2** Reagents and conditions: i, H<sub>2</sub>O [or H<sub>2</sub>O–MeOH (4 : 1)], –10 to –5 °C, 15–20 min; ii, Et<sub>3</sub>N (R<sup>1</sup>NH<sub>2</sub>), H<sub>2</sub>O, –20 to –15 °C; iii, 47% NH<sub>3</sub>, H<sub>2</sub>O, –20 to –18 °C; iv, *ca.* 40% NH<sub>3</sub>, H<sub>2</sub>O (or H<sub>2</sub>O–MeOH), 0–2 °C, 8–10 h, then 18–20 °C, 10 h; v, R<sup>1</sup>NH<sub>2</sub>, H<sub>2</sub>O (or H<sub>2</sub>O–MeOH), 15–20 °C, 7 h.

To obtain **6c**, an aqueous solution of NH<sub>3</sub> was saturated with gaseous NH<sub>3</sub> with cooling, and then a freshly prepared cooled solution of **5** was added to it dropwise with stirring. 3-Alkyldiaziridines **1**<sup>†,‡</sup> (Table 1) were synthesised at a reduced temperature by passing a flow of gaseous ammonia through the reaction mixture throughout the reaction. 1,3-Dialkyldiaziridines **7** were prepared by the interaction of

<sup>†</sup> Preparation of 3-alkyldiaziridines **1** (general procedure): HASA (0.5 mol) was added at –10 to –5 °C to a solution of aldehyde (0.5 mol) in water (60 ml) (in the case of butyric aldehyde, in 45 ml of water + 15 ml of MeOH), and the mixture was stirred for 15–20 min until it no longer reacted with an acidified solution of KI. Then the solution of aldoxime-*O*-sulfonic acid **5** thus obtained was added dropwise at –20 to –18 °C to an aqueous solution of ammonia (300 g, 47%). The reaction mixture was stirred for 8–10 h at 0–2 °C with a moderate flow of ammonia being passed through. The mixture was then allowed to stand overnight at 0 °C and stirred for 10 h at 18–20 °C under a flow of ammonia. The aqueous diaziridine solution was distilled off using a rotary evaporator into a vessel cooled with dry ice, and the product was distilled three times from solid alkali. For all the compounds **1** synthesised, satisfactory elemental analysis data were obtained.

Preparation of 1,3-dialkyldiaziridines **7** (general procedure): A 50% aqueous solution containing a two-fold molar excess of the corresponding primary aliphatic amine was added dropwise to a solution of aldoxime-*O*-sulfonic acid **5** obtained by the above procedure. The mixture was stirred for 7 h at 15–20 °C and then the product extracted with CH<sub>2</sub>Cl<sub>2</sub>. The extract was dried with K<sub>2</sub>CO<sub>3</sub>, the solvent evaporated and the residue distilled *in vacuo*.

<sup>‡</sup> Selected spectroscopic data for 3-alkyldiaziridines. For **1a**: <sup>1</sup>H NMR (δ, ppm, CDCl<sub>3</sub>): 1.26 (d, 3H, CH<sub>3</sub>), 2.19 (br. s, 2H, NH), 3.03 (q, 1H, CH); (CH<sub>2</sub>Cl<sub>2</sub>): 1.26 (d, 3H, CH<sub>3</sub>), 1.83 (br. s, 1H, NH), 2.51 (br. s, 1H, NH), 3.02 (q, 1H, CH). For **1b**: <sup>1</sup>H NMR (δ, ppm, CDCl<sub>3</sub>): 0.94 (t, 3H, CH<sub>3</sub>), 1.37 (dq, 2H, CH<sub>2</sub>), 2.17 (br. s, 2H, NH), 2.91 (t, 1H, CH). For **1c**: <sup>1</sup>H NMR (δ, ppm, CDCl<sub>3</sub>): 0.94 (t, 3H, CH<sub>3</sub>), 1.43 (m, 4H, CH<sub>2</sub>CH<sub>2</sub>), 1.72 (br. s, 1H, NH), 2.34 (br. s, 1H, NH), 2.92 (t, 1H, CH).

**Table 1** Yields and some physicochemical characteristics of 3-alkyldiaziridines **1** and 1,3-dialkyldiaziridines **7** and their derivatives.<sup>a</sup>

Compound	Yield (%)	Bp/°C(Torr) (Mp/°C)	$n_D^{20}$	Derivative
<b>1a</b>	22	105–107(760) (24.5–25.5)	–	1,2-Dibenzoyl <b>4a</b> , mp 106–108 °C (lit., <sup>2c</sup> 108–109 °C)
<b>1b</b>	32	60–61(55)	1.4445	–
<b>1c</b>	22.1	47–49(30) (12.5–14) [lit., <sup>2d</sup> 45–48(30)]	1.4478	Chloralhydrate <b>3c</b> , mp 116–118 °C (MeOH) (lit., <sup>2c</sup> 116–118 °C)
<b>7a</b>	44.0	42–45(20) [lit., <sup>9</sup> 43–45(20)]	1.4260	–
<b>7b</b>	34.0	50–51(31)	–	Oxalate, mp 108 °C (decomp.) (lit., <sup>10</sup> 108 °C, decomp.)
<b>7c</b>	32.2	106–112(1) (11–13) [lit., <sup>11</sup> 100–103(0.6) (12–13)]	–	–

<sup>a</sup> The IR spectra of all compounds **1** and **7** contained  $\nu_{NH} = 3220 \text{ cm}^{-1}$ .

primary aliphatic amines with either triethylammonium salts **6a**, obtained beforehand, or with salts **6b**, prepared by the reaction of **5** with an excess of the same amine, which was used in this reaction (Scheme 2). The yields of 3-alkyldiaziridines **1** were 22–32%. The yields of **7** were somewhat higher and comparable with those previously reported in the literature<sup>9–11</sup> (Table 1).

This work was supported by the INTAS grant no. 94-2839.

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Received: Moscow, 12th November 1996

Cambridge, 12th December 1996; Com. 6/07747A