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

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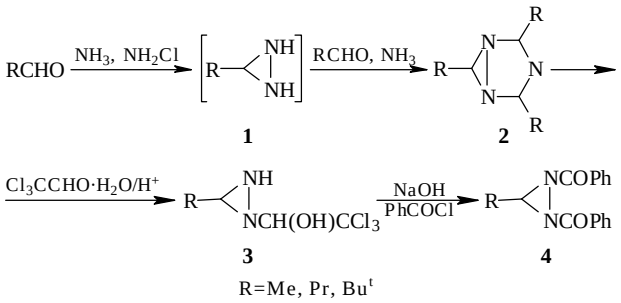
It was shown for the first time that aliphatic aldoxime-*O*-sulfonic acids can be stabilised as ammonium or alkylammonium salts and can be used in diaziridinium synthesis with primary aliphatic amines or ammonia to give 1,3-dialkyldiaziridines and 3-alkyldiaziridines, respectively; the latter compounds 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**.[1] 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^t).[2a–c] Upon alkaline decomposition of **3** (R = Me, Pr, Bu^t) in the presence of benzoyl chloride, corresponding 1,2-dibenzoyl derivatives **4** were isolated.[2a,c] The only reported synthesis of 3-alkyldiaziridines, *viz.* 3-propyldiaziridine, was described in a German patent.[2d] 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.

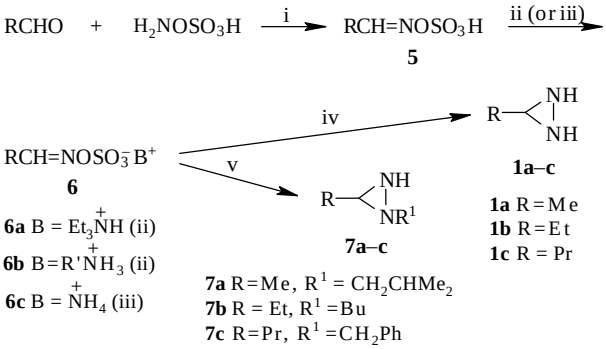


Scheme 1

Other known methods for the synthesis of 1,2-unsubstituted diaziridines [treatment of oxime-*O*-sulfonic acids[3] or their esters[4–6] with ammonia or treatment of carbonyl compounds with ammonia and hydroxylamine-*O*-sulfonic acid[7] (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,[8] which decreases in the base sequence: $Et_3N > Py > NH_3 > NH_2NH_2 > KOH$. 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_3 (>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_3) 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_2O [or H_2O–MeOH (4 : 1)], –10 to –5 °C, 15–20 min; ii, Et_3N (R^1NH_2), H_2O, –20 to –15°C; iii, 47% NH_3, H_2O, –20 to –18°C; iv, *ca.* 40% NH_3, H_2O (or H_2O–MeOH), 0–2°C, 8–10 h, then 18–20°C, 10 h; v, R^1NH_2, H_2O (or H_2O–MeOH), 15–20°C, 7 h.

To obtain **6c**, an aqueous solution of NH_3 was saturated with gaseous NH_3 with cooling, and then a freshly prepared cooled solution of **5** was added to it dropwise with stirring. 3-Alkyldiaziridines **1**[†,‡] (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

† *Preparation of* 3-*alkyldiaziridines* **1** (*general procedure*): HASA (0.5mol) was added at –10 to –5 °C to a solution of aldehyde (0.5 mol) in water (60ml) (in the case of butyric aldehyde, in 45 ml of water + 15ml of MeOH), and the mixture was stirred for 15–20min 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 (300g, 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 10h 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 7h at 15–20°C and then the product extracted with CH_2Cl_2. The extract was dried with K_2CO_3, the solvent evaporated and the residue distilled *in vacuo*.

‡ *Selected spectroscopic data for* 3-*alkyldiaziridines*. For **1a**: ^{1}H NMR (δ, ppm, $CDCl_3$): 1.26 (d, 3H, CH_3), 2.19 (br. s, 2H, NH), 3.03 (q, 1H, CH); (CH_2Cl_2): 1.26 (d, 3H, CH_3), 1.83 (br. s, 1H, NH), 2.51 (br.s, 1H, NH), 3.02 (q, 1H, CH). For **1b**: ^{1}H NMR (δ, ppm, $CDCl_3$): 0.94 (t, 3H, CH_3), 1.37 (dq, 2H, CH_2), 2.17 (br. s, 2H, NH), 2.91 (t, 1H, CH). For **1c**: ^{1}H NMR (δ, ppm, $CDCl_3$): 0.94 (t, 3H, CH_3), 1.43 (m, 4H, CH_2CH_2), 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.[a]

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

[a] The IR spectra of all compounds **1** and **7** contained ν_{NH} = 3220 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[9–11] (Table 1).

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