

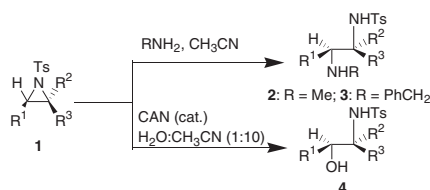
Efficient Ring Opening Reactions of *N*-Tosyl Aziridines with Amines and Water in Presence of Catalytic Amount of Cerium(IV) Ammonium Nitrate

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While methyl- and benzylamines opened *N*-tosyl aziridines **1** very efficiently in acetonitrile with complete regio- and stereoselectivity to give the corresponding diamines **2** and **3**, respectively, in excellent yields, similar openings with water could only be achieved in the presence of a catalytic amount of cerium(IV) ammonium nitrate under very mild conditions furnishing the amino alcohols **4**.

The importance of aziridiny compounds as precursors of amines, diamines, amino alcohols and various other nitrogen containing products are attracting increasing attentions as organic chemists develop new methodologies for regio- and stereoselective opening of aziridine rings using various nucleophiles.¹⁻¹⁸ In this paper we describe efficient openings of *N*-tosyl aziridines **1** with methyl- and benzylamines in CH₃CN leading to the formation of diamines **2** and **3**. However, similar ring opening reactions with water required catalytic amounts of cerium(IV) ammonium nitrate (CAN)¹⁹⁻²¹ that provided amino alcohols **4** in good yields under very mild conditions.



The starting aziridines **1a-f** were prepared from the corresponding epoxides in four steps: (a) ring opening of the epoxides with NaN₃ in MeOH : H₂O (8 : 1) in presence of NH₄Cl;²² (b) reduction of the resulting azides to amines using Ph₃P in dry THF; (c) protection of the amines as tosylates using TsCl, Et₃N in CH₂Cl₂ and (d) treatment of *N*-tosyl amino alcohols with diethyl azodicarboxylate and Ph₃P in dry THF. The remaining aziridines **1g** and **1h** were made by reacting the respective olefins with chloramine-T and I₂ (cat.) in CH₃CN. The aziridines, thus prepared, were treated with MeNH₂·HCl or benzylamine, with equimolar amounts of Et₃N for the former, at 0 °C in dry CH₃CN under N₂ atmosphere. Reactions were continued at room temperature until the starting materials completely disappeared. Aqueous work-up was followed by chromatographic purification to furnish the diamines in excellent yields. Reactions with benzylamine were faster compared to those with methylamine. The results are summarized in Table 1.

Only one regioisomer was obtained in aryl-substituted aziridines when the reactions were carried out at room temperature and the ring openings occurred exclusively at the benzylic positions. The *N*-tosyl aziridine of styrene (**1b**, entry 2, Table 1) did not undergo any reaction when treated with BnNH₂ at room temperature even after long reaction hours. When the temperature

Table 1. Opening of *N*-tosyl aziridines (**1**) with amines RNH₂ in CH₃CN

Entry	Starting Aziridines	Product Diamines	Reaction conditions ^a [Time (h); Yield (%)]
1.			A [10; 82] B [4; 98]
2.			A [12; 81] B [12; no reaction]
3.			A [12; 84] B [3; 73]
4.			A [8; 90] B [5; 92]
5.			A [10; 78] B [4; 92]
6.			A [12; no reaction] B [8; ^b 70]
7.			A [12; no reaction] B [7; 87]
8.			A [12; no reaction] B [3; ^c 92]

^a A: MeNH₂·HCl (10 eq), Et₃N (10 eq), CH₃CN, 0 °C to rt; B: PhCH₂NH₂ (10 eq), CH₃CN, 0 °C to rt. ^b reaction went to completion only under refluxing condition. ^c reaction was carried out at 55 °C.

was raised to 45 °C, two regioisomers were obtained in 4 : 1 ratio, the major one being formed by opening of the ring at the benzylic position. The selectivity was completely lost at refluxing temperature.

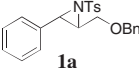
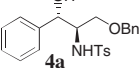
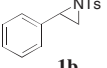
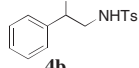
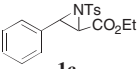
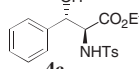
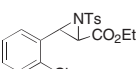
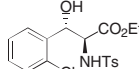

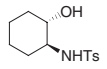

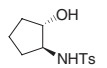
The trisubstituted aziridine **1f** did not undergo any reaction

with methylamine. However, with benzylamine, the opening could be achieved only under refluxing condition to give the expected diamine **3f**. No double ring opening was observed in any of these reactions.⁵ The aziridines with aliphatic substituents **1g** and **1h** did not undergo any reaction with MeNH₂.

The structural assignments were made on the basis of ¹H NMR studies and decoupling experiments. The diamine **2a**, for example, showed connectivity among the CH₂OBn, CH(CH₂OBn) and NHTs protons determined by irradiating the CH(CH₂OBn) signal that caused decoupling of the protons attached to it. This was further supported by two-dimensional double quantum filtered correlation spectroscopy (DQF COSY) experiment.²³ The structures of other diamines were similarly assigned.

Next, six of these aziridines **1a–d**, **1g**, and **1h** were taken in water–CH₃CN (1 : 10), cooled to 0 °C and treated with catalytic amounts of CAN (0.1–0.2 eq). This led to facile opening of the aziridine rings with hydroxyl group to furnish the amino alcohols **4a–d**, **4g**, and **4h** in good yields. The results are summarized in Table 2. Here, once again, only one regioisomer was obtained in aryl-substituted aziridines. The structural assignments were made in the same way as they were done for the diamines. Both ¹H NMR decouplings and DQF COSY experiments were utilized to prove the observed regioselectivities.

Table 2. Opening of *N*-tosyl aziridines (**1**) with water using catalytic amount of CAN^a

Entry	Starting Aziridines	Product Amino alcohols	Time (h); Yield (%)
1.			2.5; 82
2.			2; 85
3.			8; 75
4.			5 (50 °C); 72
5.			7; ^b 88
6.			7; ^b 61

^a CAN (0.1 eq), H₂O:CH₃CN (1:10), 0 °C to rt (50 °C in entry 4). ^b 0.2 eq CAN was used.

The ring openings with amines and water occurred presumably via S_N2 mechanism and the stereochemistries were assigned accordingly. This was further confirmed by converting the amino alcohols to their corresponding oxazolidinone derivatives on treatment with 1,1'-carbonyldiimidazole. The ³J couplings of 8–10 Hz between the C4-*H* and C5-*H* of these five membered rings

(9 Hz, for example, for the oxazolidinone from **4c**) confirmed the *cis* orientations of the ring protons²⁴ and that, in turn, supported the assigned stereochemistries of the products.

In conclusion, the methods described here for efficient ring openings of *N*-tosyl aziridines with amines and particularly, the CAN-catalyzed openings with water under very mild conditions will find useful applications in the synthesis of various diamines and amino alcohols. Further work is under progress.

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