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## EPOXIDATION STUDIES OF DECALIN-1,4-DIENONES AND RELATED ALCOHOLS

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*Received: 25 July 2000 / Uploaded: 29 July 2000*

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**Abstract:** The regio- and diastereoselectivities of epoxidations of decalin-1,4 -dienones and dienols obtained from the Birch reduction alkylation of different  $\alpha$ -tetralones is described. They appear to depend on the steric approach control of the peracid and show an important contribution of the directing effect of homoallylic alcohols.

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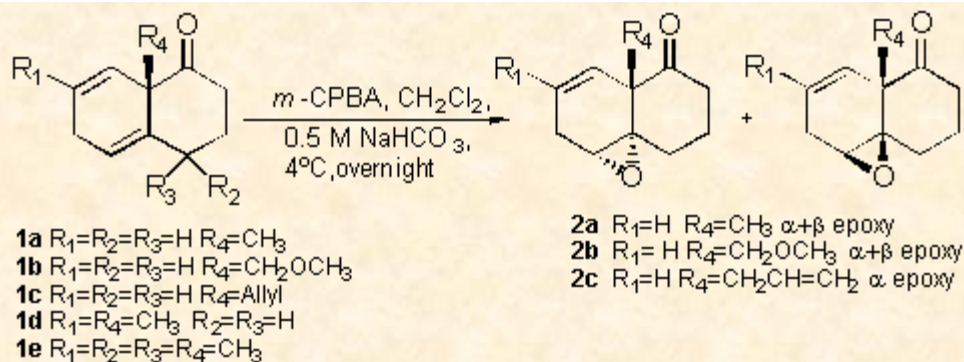
### Introduction

In connection with our project dealing with the development of synthetic intermediates to be utilized in the synthesis of natural products,<sup>1</sup> we decided to explore the regio and stereoselectivity of the epoxidation of 1,4-dienes generated from the Birch reductive alkylation reaction of substituted  $\alpha$ -tetralones. We choose *m*-chloroperbenzoic acid (*m*-CPBA) over dimethyldioxirane (DMDO), to carry the epoxidation, due to its previously reported<sup>2</sup> better stereocontrol. In spite of the well-known sensitivity of the products it was necessary to select very carefully the reaction conditions in order to minimize the undesired rearrangements.

### Results and Discussion

We used the dienone **1a** to optimize the procedure and tried mainly basic media due to the characteristics of the substrate (*m*-CPBA, CH<sub>2</sub>Cl<sub>2</sub>, -20 °C with or without NaHCO<sub>3</sub> (s);<sup>3</sup> *m*-CPBA, CHCl<sub>3</sub>, Na<sub>2</sub>CO<sub>3</sub> (s), 0 °C;<sup>4</sup> MMPP, CH<sub>2</sub>Cl<sub>2</sub>, RT;<sup>5</sup> all produced low yields and re-aromatization products). The best results were obtained when *m*-CPBA was used under buffered heterogeneous system CH<sub>2</sub>Cl<sub>2</sub>-0,5 M NaHCO<sub>3</sub> (pH = 8.3) at 4 °C<sup>6</sup> or, even better, with a phosphate buffer (pH= 8.0)<sup>7</sup> and were used for dienones **1a-e** as shown in **Scheme 1**. The dienones (**1a-e**) were prepared according to our previous publication.<sup>8</sup>

### Scheme 1



The dienone **1a**, as expected according to the literature precedents,<sup>9,10</sup> reacted regioselectively with the more substituted double-bond producing a diastereomeric a:b mixture of the mono epoxides in a 2.7:1 ratio. The moderate stereoselectivity found could be explained by the shape of the dienone, which is almost planar, with an axial substituent creating a steric impediment and making more difficult the approach of the peroxide on this face.

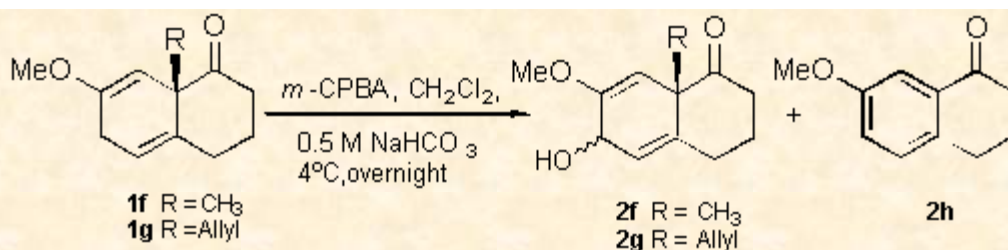
**Table 1** resumes the results obtained for all the ketones. As can be seen, the reaction with the dienone **1b** occurs with the same stereo and regio selectivity as for the dienone **1a**. In the case of the dienone **1c**, the stereoselectivity was complete.

**Table 1:** Results of the epoxidation of the 1,4 dienones

Compounds	Products		
		a : b ratio	% yield
<b>1a</b>	<b>2aa + 2ab</b>	2.7 : 1	60
<b>1b</b>	<b>2ba + 2bb</b>	2.7 : 1	72
<b>1c</b>	<b>2ca</b>	1 : 0	62
<b>1d</b>	Complex mixtures of mono and di-epoxides		
<b>1e</b>	Complex mixtures of mono and di-epoxides		
<b>1f</b>	<b>2fa + 2fb</b>	1.6 : 1	32
<b>1g</b>	<b>2ga + 2gb</b>	1.8 : 1	35

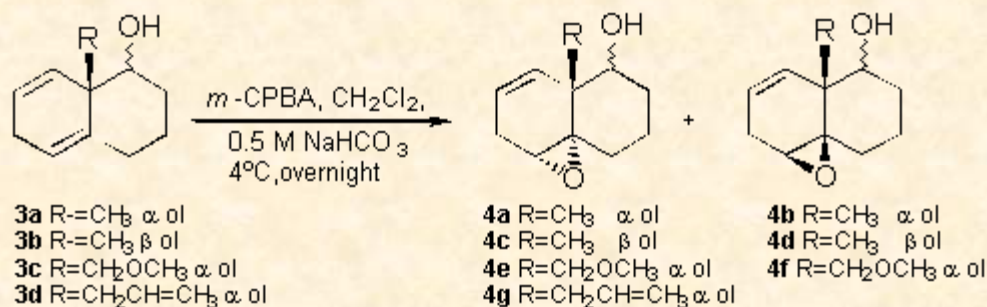
Surprisingly, dienone **1f** under the previously described conditions produced the alpha allylic alcohol **2fa** (20 %), the beta allylic alcohol **2fb** (12 %) and the re-aromatization product **2h** (63 %). In turn, from the dienone **1g**, we isolated the alpha allylic alcohol **2ga** (22,5 %), the beta allylic alcohol **2gb** (12,5 %) and the re-aromatization product **2h** (54 %) (**Scheme 2**).

### Scheme 2



In an attempt to improve the diastereoselectivity of the epoxidation, we devoted some efforts to study the stereochemical course of the epoxidation of the dienols, in order to determine the importance of the hydroxylic group directing effect toward the peracid approach. The alcohols were synthesized by selective reduction of the ketone<sup>8</sup> and epoxidized using the same conditions described for the ketones (**Scheme 3**).

**Scheme 3**



**Table 2:** Results of the epoxidation on the 1,4 dienols

Compound	Products			
	a epoxide	b epoxide	a : b ratio	% yield
<b>3a</b>	<b>4a</b>	<b>4b</b>	4.7 : 1	90
<b>3b</b>	<b>4c</b>	<b>4d</b>	1.5 : 1	71
<b>3c</b>	<b>4e</b>	<b>4f</b>	10 : 1	82
<b>3d</b>	<b>4g</b>		1 : 0	64

**Table 2**, shows that the homoallylic α-alcohols (**3a** and **3b**) have a noticeable directing effect, over the peracid, improving the stereoselectivity of the addition by two or three folds compared with that of the related ketone. On the other hand the β-alcohols produced a lower diastereoselectivity. This directing effect had been observed in homoallylic alcohols,<sup>11</sup> but it had not been reported for these 1,4 dienols systems. As expected, for **3d** the alpha epoxide was the only product obtained.

The relative stereochemistry of the epoxy alcohols was determined based on the analysis of its <sup>1</sup>H NMR spectra. The observation of a coupling between C-1 methine proton and C1-OH hydrogen was a clear indication that this hydrogen is involved in an intramolecular hydrogen bond and therefore this is a strong evidence of their relative orientations.

### Summary and Conclusions

- We studied the epoxidation reaction of the dienones products of Birch alkylation reaction of α-tetralones and how non-bonding interactions affect the stereochemical course of the reaction.

- The complete regioselectivity observed is based on the greater rate of the reaction of trisubstituted double bonds.
- We also established how the nature of the axial substituent of the dienone affects the selectivity of the reaction.
- We have examined the directing effect of different homoallylic alcohols and, as expected, a substantial preference toward the alpha epoxide for alpha alcohols was observed.

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