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CHROMATOGRAPHIC SEPARATION OF DIASTEREOISOMERIC 1,2:3,4-DIEPOXIDES ON SILICA GEL TLC PLATES IMPREGNATED WITH VARIOUS INORGANIC SALTS

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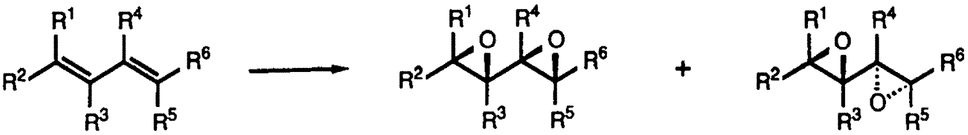
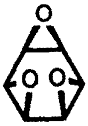
Summary - Silica gel plates impregnated with various inorganic salts were used for the analytical separation of diastereoisomeric 1,2:3,4-diepoxides, obtained from the bis-epoxidation of conjugated dienes. LiBr proved to give the best effect: considerably improved separations could be achieved in favorable cases.

1,2:3,4-Diepoxides are of interest as model compounds for natural products[1] and as intermediates in the synthesis of biologically active substances.[2] They can readily be prepared by epoxidation of the corresponding conjugated dienes with 3-chloroperbenzoic acid.[3,4] However, this procedure leads to a mixture of two diastereoisomers which have to be separated:



This separation has proved to be rather tedious in some cases, since the differences in the polarity of the isomers are usually quite small. We now wish to report on our studies on the improvement of this situation.

The chromatographic separation of olefins on silica gel impregnated with $AgNO_3$ is an established procedure;[5] it makes use of the ability of the silver ion to form complexes with olefins. Schwesinger et al. recently reported that the triepoxide 1



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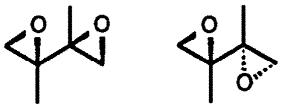
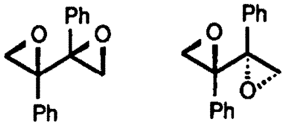
forms complexes with alkali cations.[6] Although the authors stated that the interactions between the triepoxide and the metal ions were weak in solution, we thought that these nevertheless could possibly be exploited for the separation of diastereoisomeric diepoxides. One would expect that the ability to form metal complexes should be different for the two diastereoisomers.

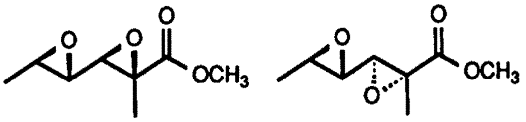
In order to find out whether any complexation increases the chromatographic difference between the stereoisomers, we investigated the behavior of four pairs of diastereoisomeric diepoxides, i.e. 2a/2b,[2] 3a/3b,[7] 4a/4b,[3] and 5a/5b[4] on silica gel tlc plates impregnated with various inorganic salts. For this purpose, commercially available precoated silica gel tlc plates were soaked for a short time in an aqueous solution of the desired salt, then air dried and finally activated at 130°C overnight. Variation of the soaking time from 1 min up to 2 h did not lead to any significant influence of the separation of the epoxides.



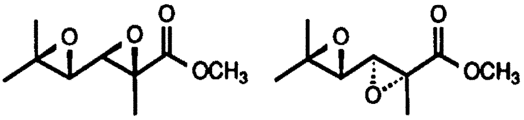
2a/2b



3a/3b



4a/4b



5a/5b

The optimal eluent was determined in a first step for each of the four pairs of diepoxides using untreated tlc plates. In view of a possible extension of the procedure to preparative separations on flash columns,[8] the eluent was considered optimal when the difference ΔR_f between the R_f values of the two isomers was maximal and the spots had R_f values around 0.3. Furthermore, rather volatile solvents were envisaged, which would be easy to remove in preparative runs on columns.

Next, the pairs of diepoxides were chromatographed on plates which were impregnated with different salts of alkali or alkaline earth cations; the same solvent was used for the elution as before. Representative R_f and ΔR_f values are compiled in the Table.

No improvement was obtained for the separation of the pairs 2a/2b and 3a/3b; but as an effect of the salt impregnation slightly higher R_f values were observed. The pairs of isomers 4a/4b and 5a/5b were distinctly better separated on impregnated plates. When LiBr was used, an increase of ΔR_f from 0.04 to 0.11 and from 0.05 to 0.12 was observed for 4a/4b and 5a/5b, respectively. The R_f values themselves were again somewhat higher for 5a/5b on the impregnated plates; 4a/4b showed an unsteady behavior in this respect; with the exception of LiBr, which gave distinctly increased R_f values, the salts mostly lead to smaller R_f values. The improvement of the separation in terms of ΔR_f showed a decreasing tendency for 4a/4b and 5a/5b from Li over Na to K. No significant effect of the nature of the anion on ΔR_f could be discerned; the bromides did, however, in general give the greatest increase of the R_f values themselves. On the whole, LiBr was clearly the best salt among those tested.

The observed changes in the chromatographic behavior of the diepoxides must be due to the salts present, since in a blank test, where a plate was soaked in distilled water and reactivated, the same R_f values were obtained as with untreated plates. Our results show that by using tlc plates impregnated with LiBr distinctly better chromatographic resolution of diastereoisomeric diepoxides can be achieved in favorable cases. The improvement is, however, neither general nor predictable.

Table. R_f and ΔR_f values for compounds 2a/2b - 5a/5b on silica gel tlc plates impregnated with salts.

	2a/2b		3a/3b		4a/4b		5a/5b	
Salt	R_f[a]	ΔR_f[b]	R_f	ΔR_f	R_f	ΔR_f	R_f	ΔR_f
none	.22 .27	.05	.32 .42	.10	.19 .23	.04	.16 .21	.05
LiBr	.35 .40	.05	.51 .60	.09	.29 .40	.11	.40 .52	.12
$LiClO_4$	.25 .30	.05	.47 .57	.10	.10 .17	.07	.17 .27	.10
LiI	.25 .30	.05	.35 .46	.11	.15 .22	.07	.19 .29	.10
NaBr	.32 .38	.06	.40 .50	.10	.19 .26	.07	.21 .31	.10
$NaClO_4 \cdot H_2O$	.31 .37	.06	.36 .46	.10	.09 .15	.06	.17 .27	.10
NaI	.26 .31	.05	.42 .52	.10	.12 .19	.07	.17 .28	.11
$NaNO_3$	.26 .31	.05	.30 .40	.10	.15 .20	.05	.18 .26	.08
KBr	.31 .36	.05	.31 .42	.11	.15 .19	.04	.22 .29	.07
KI	.24 .29	.05	.36 .47	.11	.14 .20	.06	.15 .24	.09
KNO_3	.23 .27	.04	.38 .49	.11	.13 .18	.05	.16 .24	.08
RbBr	.24 .29	.05	.35 .45	.10	.16 .21	.05	.17 .25	.08
RbI	.25 .30	.05	.33 .43	.10	.16 .22	.06	.20 .28	.08
CsBr	.22 .27	.05	.35 .44	.09	.17 .23	.06	.18 .26	.08
CsI	.24 .29	.05	.36 .46	.10	.19 .24	.05	.21 .29	.08
$CaBr_2$	.27 .33	.06	.44 .54	.10	.20 .27	.07	.23 .32	.09
$Ca(NO_3)_2 \cdot 4H_2O$	.29 .35	.06	.38 .48	.10	.19 .25	.06	.19 .27	.08
$CaI_2 \cdot 4H_2O$	.29 .35	.06	.38 .48	.10	.16 .23	.07	.20 .28	.08
$Sr(NO_3)_2$	.25 .30	.05	.34 .44	.10	.18 .23	.05	.18 .23	.05
$Ba(ClO_4)_2$	.23 .29	.06	.36 .47	.11	.07 .12	.05	.14 .25	.11
BaI_2	.25 .30	.05	.34 .44	.10	.19 .24	.05	.22 .30	.08
$Ba(NO_3)_2$	.25 .30	.05	.32 .42	.10	.18 .23	.05	.18 .24	.06
Solvent	CH_2Cl_2/Et_2O 95:5		CH_2Cl_2		pentane/Et_2O 6:4		CH_2Cl_2/Et_2O 98:2	

[a] R_f values were found to be reproducible to + 0.05, ΔR_f to + 0.01.

[b] ΔR_f = R_f (faster moving isomer) - R_f (slower moving isomer); no attempt was made to determine which spot belonged to which stereoisomer.

EXPERIMENTAL

Preparation of the diepoxides. - The four diastereoisomeric mixtures were prepared according to the literature: 2a/2b;[2] 3a/3b[7], the procedure was modified according to Sadhu and Matteson;[9] 4a/4b;[3] 5a/5b.[4]

Preparation of the tlc plates. - Precoated tlc plates SiO_2 G60 F_{254}, E. Merck, Darmstadt, 5 x 10 cm were used. The plates were soaked for a short time in a 10% aqueous solution of the desired salt (5% for RbBr, RbI, CsBr, CsI, and $Ba(NO_3)_2$), air dried and then activated overnight at 130°C.

General chromatography procedure. - The development chambers used were lined with filter paper and presaturated for at least 30 min with the appropriate solvent system. The activated tlc plates were then developed once to remove any contaminations and subsequently air dried briefly. The samples were applied (2 µl of a 5% solution of the diepoxide mixture) and the chromatograms developed in the usual way. For the detection of the spots the plates were sprayed with 10% H_2SO_4 in MeOH and then dried with a heat gun.

Reproducibility of the R_f and ΔR_f values. - Samples of the mixture 2a/2b were applied to separate tlc plates impregnated with LiBr. After development of the chromatograms with pentane/ether 6:4 the following values were obtained:

R_f:	.28	.28	.23	.28	.20	.24	.23	.24
	.39	.39	.33	.40	.30	.35	.33	.35
ΔR_f:	.11	.11	.10	.12	.10	.11	.10	.11

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