Optical Resolution of Selenoxides by Complexation with Optically Active 2,2′-Dihydroxy-1,1′-binaphthol or 1,6-Di(*o*-chlorophenyl)-1,6-diphenylhexa-2,4-diyne-1,6-diol

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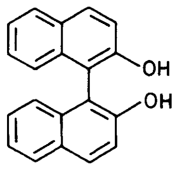
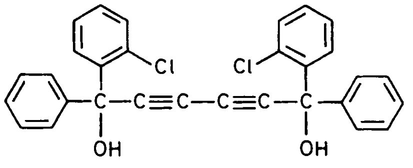
By complexation with optically active 2,2′-dihydroxy-1,1′-binaphthol or 1,6-di(*o*-chlorophenyl)-1,6-diphenylhexa-2,4-diyne-1,6-diol, some alkyl aryl and dialkyl selenoxides were resolved very efficiently; in some cases, optically pure selenoxides were obtained in yields of more than 100% by enantiomerisation through equilibration.

We have already reported a simple method for optical resolution of sulphoxides by complexation with optically active 2,2′-dihydroxy-1,1′-binaphthol (**1**),[1,2] and we have now found that this method can be applied to the optical resolution of selenoxides. We also found that the optically active diyne-diol (**2**)[3] can be used for the resolution instead of (**1**). Furthermore, racemic selenoxides may be converted into one optically active isomer in yields of >100% in the presence of (**1**) or (**2**), owing to the enantiomerisation of the selenoxides *via* equilibrium (1). This is not a simple optical resolution method but provides a novel method for preparation of optically active selenoxides. A similar enantiomerisation has been observed for cyanohydrins in the presence of brucine.[4]

Despite various attempts, no optically pure selenoxide has been obtained so far,[5] since racemisation easily occurs *via* the hydrate [reaction (1)].[6] However, successful optical resolution of steroidal selenoxides by chromatographic separation of their diastereoisomers has been reported.[7] Recently, a sele-



(1)



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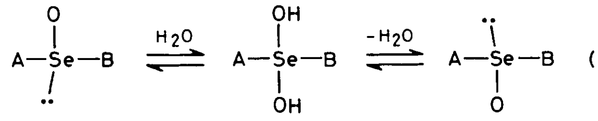

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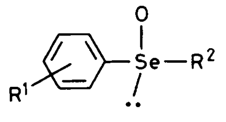
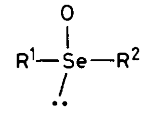


(3)

a; $R^1 = H$; $R^2 = Me$
b; $R^1 = H$; $R^2 = Et$
c; $R^1 = o$ - Me; $R^2 = Me$
d; $R^1 = o$ - Me; $R^2 = Et$
e; $R^1 = m$ - Me; $R^2 = Me$
f; $R^1 = m$ - Me; $R^2 = Et$
g; $R^1 = p$ - Me; $R^2 = Et$



(4)

a; $R^1 = Bu^n$; $R^2 = Et$
b; $R^1 = [CH_2]_4Me$; $R^2 = Me$
c; $R^1 = [CH_2]_4Me$; $R^2 = Et$

Table 1. Yields, m.p.s., and $[\alpha]_D$ values of the complexes with (+)-(**1**) of the optically pure selenoxides (**3**).

			$[\alpha]_D$ (°)	
(**3**)	Yield (%)	M.p. (t/°C)	$CHCl_3$	MeOH
(**3a**)	72	109—110	+30.6	—[a]
(**3b**)	25	89—90	+45.5	+50.8
(**3c**)	120	94—95	+59.1	+47.1
(**3d**)	64	105—107	−112.0	−52.5
(**3e**)	99	99—100	+50.8	—[a]
(**3f**)	123	85	−58.0	−29.0
(**3g**)	20	92—94	−79.4	−30.0

[a] Racemisation is too fast for accurate measurements.

noxide with sterically bulky substituents, 2,4,6-tri-isopropylphenyl 4-methoxycarbonylphenyl selenoxide, was resolved by a diastereoisomeric method using l-menthol to give the (−)-enantiomer in 88.1% enantiomeric excess (e.e.).[8] In contrast, our resolution method is simple and can be used to obtain optically pure alkyl aryl (**3**) and dialkyl selenoxides (**4**) in good yields. Moreover, this method can be used for storage of labile optically pure selenoxides in the complexed form.

A solution of (+)-(**1**) (1.0 mmol), 100% e.e., $[\alpha]_D$ +39° (MeOH), −5° ($CHCl_3$),† and racemic ethyl *m*-tolyl selenoxide (**3f**) (1.0 mmol) in acetone (10 ml) was combined with n-hexane (10 ml) and the solution was kept at room temperature for 4 h to give a 1 : 1 complex of (+)-(**1**) and (−)-(**3f**) (0.31 g, 123%), m.p. 85 °C, $[\alpha]_D$ −29° (MeOH), −58° ($CHCl_3$). By the same procedure, (**3a**—**e**) and (**3g**) were also easily resolved (Table 1). When (−)-(**1**) was used for the resolution, 1 : 1 complexes of the opposite enantiomers to those shown in Table 1 were obtained in similar yields. The yields might be increased by adjusting the concentration of the solution for complexation. Compounds (**1**) and (**3**) can be isolated from their complex easily by column chromatography on Al_2O_3. However, since free optically active (**3**) racemises quite easily, the optical purity of (**3**) was determined for the complex by the n.m.r. method using the chiral shift reagent, Eu(hfc)$_3$ {tris-[3-heptafluoropropylhydroxymethylene-(+)-camphorato]europium(III)} (≥99%). The optical purity of (**3**) in the complex was found to be almost 100%. For example, the Me proton signal of the Et group of optically pure (−)-(**3f**) in the complex which appears as one triplet gradually becomes two triplets as the racemisation of (−)-(**3f**) proceeds. The half-life for the racemisation of (**3**) was determined for the complex from $[\alpha]_D$ measurements in MeOH and $CHCl_3$ (Table 2). The racemisation of (**3**) in MeOH, with the higher dielectric constant, is much faster than in $CHCl_3$. The half-life of (**3d**) is longer than those of (**3c**) and (**3g**) probably because of steric factors. This suggests that a sterically crowded selenoxide should give a stable optically active enantiomer. However, isopropyl *m*-tolyl selenoxide, for example, did not form a complex with (**1**).

Table 2. Half-lives of the optically active selenoxides (**3**).[a]

(**3**)	Half life time/min	Solvent
(**3c**)	6.5	MeOH
(**3d**)	19.5	MeOH
(**3f**)	9.5	MeOH
(**3g**)	8.5	MeOH
(**3d**)	222	$CHCl_3$

[a] Determined by measuring the $[\alpha]_D$ value in the form of complex with (+)-(**1**) at 19 °C.

Table 3. Yields, m.p.s., and $[\alpha]_D$ values of the complexes of optically active (**4**) and host compounds.

				$[\alpha]_D$ (°)[a]	
(**4**)	Host	Yield (%)	M.p. (t/°C)	(A)	(B)
(**4a**)	(+)-(**1**)	154	99—101	0	−6.9
(**4b**)	(−)-(**2**)	79	133—135	−39.5	−50.5
(**4c**)	(−)-(**2**)	74	114—117	−51.0	−57.1

[a] (A) values measured immediately for freshly prepared solutions in $CHCl_3$ at 19 °C; (B) values measured 10 min after the preparation of solution in $CHCl_3$ at 19 °C.

Optical resolution of selenoxides by complexation is more efficient than that of sulphoxides. For sulphoxides, only the methyl *m*-tolyl and ethyl *m*-tolyl sulphoxides were resolved by (**1**).[1] However, resolution of dialkyl selenoxides is not very successful. Only the resolution of n-butyl ethyl selenoxide by (**1**), and of methyl n-pentyl (**4b**) and ethyl n-pentyl selenoxide (**4c**) by (**2**) was successful. By a similar procedure to that for (**3f**), the selenoxides (**4a**), and (**4b**) and (**4c**) were treated with (+)-(**1**), and (−)-(**2**), respectively, to give the complexes shown in Table 3. The racemisation of these selenoxides is too rapid to determine optical purities, and after about 10 min the $[\alpha]_D$ value of the complex became constant at the $[\alpha]_D$ value of

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† All the $[\alpha]_D$ values were measured at c 0.2 and 19 °C.

the host compound. Nevertheless, the excellent chiral recognition ability of (**1**)[1,2] and (**2**)[3,9,10] strongly suggests that the complexes in Table 3 are of the optically pure selenoxides. The half-life of (**4a**), measured assuming optical purity was about 4.5 min in $CHCl_3$ at 19 °C.

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