CHEMISTRY LETTERS, pp. 1997-2000, 1988.

Optical Resolution of Sulfoximines by Complex Formation with Optically Active 2,2'-Dihydroxy-1,1'-binaphthyl or 1,6-Di(*o*-chlorophenyl)-1,6-diphenylhexa-2,4-diyne-1,6-diol

Koji MORI and Fumio TODA*

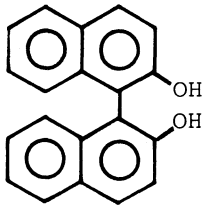
Department of Industrial Chemistry, Faculty of Engineering,
Ehime University, Matsuyama 790

Some alkyl aryl and dialkyl sulfoximines were resolved efficiently by complex formation with optically active 2,2'-dihydroxy-1,1'-binaphthyl and 1,6-di(*o*-chlorophenyl)-1,6-diphenylhexa-2,4-diyne-1,6-diol, respectively.

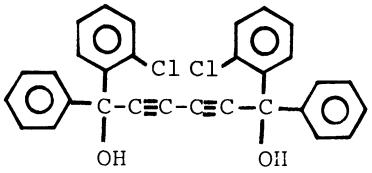
Although optically active sulfoximines are useful synthons,[1] only a few methods are available for their preparation. Stereoselective reaction of optically active sulfoxide with O-mesitylsulfonylhydroxylamine which gives optically active sulfoximine has been reported.[2] In this case, however, optically active sulfoxide should be prepared in advance. Direct optical resolution of sulfoximine is more useful but only one successful example by a diastereoisomeric method using (+)-10-camphorsulfonic acid has been reported for methyl phenyl sulfoximine.[3] Nevertheless, this method is not applicable to any other sulfoximine.[4,5]

We have already reported a simple method for optical resolution of sulfoxides[6,7] and selenoxides[8] by complex formation with optically active 2,2'-dihydroxy-1,1'-binaphthyl (1) or 1,6-di(*o*-chlorophenyl)-1,6-diphenylhexa-2,4-diyne-1,6-diol (2), and we have now found that this method can be applied to the optical resolution of sulfoximines. In this case, alkyl aryl (3) and dialkyl sulfoximine (5) were resolved efficiently by complex formation with optically active 1 and 2, respectively.

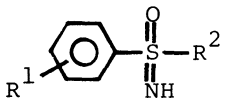
For example, when a solution of optically pure (+)-1 (6.7 g, 23 mmol) and racemic 3d (7.9 g, 46 mmol) in benzene (60 ml) was kept at room temperature for 12 h, a 1:1 complex of the (+)-1 and 90% ee (-)-3d was obtained as colorless prisms



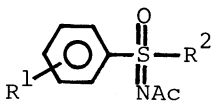
1



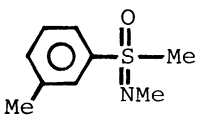
2



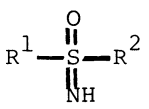
3



4



5



6

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=*m*-Me; R^2=Me
e: R^1=*m*-Me; R^2=Et
f: R^1=*m*-Me; R^2=*n*-Pr
g: R^1=*p*-Me; R^2=Me

4 a: R^1=Me; R^2=Et
b: R^1=Me; R^2=*n*-Pr
c: R^1=Me R^2=*n*-Bu
d: R^1=Me; R^2=*n*-C_5H_{11}
e: R^1=Me; R^2=*i*-C_5H_{11}
f: R^1=Et; R^2=*n*-C_6H_{13}

(8.5 g, 80% yield, $[\alpha]_D$ +11.9°[9]). The crude crystals were purified by two recrystallizations[10] from benzene to give the complex of 100% ee (-)-3d (7.9 g, 74% yield, $[\alpha]_D$ +8.8°). The complex was decomposed by treating with 3% aqueous NaOH, and water insoluble part was taken up in benzene. The benzene solution was washed with water and dried, and evaporated to give 100% ee (-)-3d (2.8 g, 70% yield, $[\alpha]_D$ -36.0°). The benzene solution left after the separation of the crude 1:1 complex of (+)-1 and (-)-3d was treated with optically active (-)-1 (3 g) to give finally 100% ee (+)-3d (3.2 g, 81% yield, $[\alpha]_D$ +36.0°). In both complexations, optically pure 1 was recovered by acidification of the NaOH solution. Since absolute configurations of (+)- and (-)-*p*-tolyl alkyl sulfoximines have been reported to be (*S*) and (*R*), respectively,[2] those of (+)- and (-)-3d would also be (*S*) and (*R*), respectively.

By the same method, 3b and 3e were resolved with (+)-1 and gave 100% ee (-)-3b (37% yield, $[\alpha]_D$ -33.2°) and (-)-3e (50% yield, $[\alpha]_D$ -28.0°), respectively. However, resolution of 3a was not effective and 35% ee (-)-3a was obtained in 45% yield by repeating 5 times recrystallization of its complex with (+)-1 from

benzene. 3c, 3f, and 3g did not form complex with (+)-1. *N*-Methyl derivative of 3, for example 5, also did not form complex with (+)-1.

These results show that the efficiency of the resolution of 3 depends on its alkyl and aryl group. The efficiency is best when the alkyl group is methyl or ethyl and the aryl group is *m*-tolyl. Since this tendency is similar to that in the case of sulfoxide,[6,7] the efficiency of the resolution of 3 is probably dependent on packing of 1 and 3 in crystal lattice of their complex as has been reported for the complex of (+)-1 and (+)-methyl *m*-tolyl sulfoxide.[7]

Optical purity of 3a, 3b, 3d, and 3e was determined by measuring ^{1}H-NMR spectra of their acetates 4a, 4b, 4d, and 4e in $CDCl_3$ in the presence of the chiral shift reagent, tris[3-(heptafluoropropylhydroxymethylene)-(+)-camphorato]-europium(III) (Aldrich, 99+%).

The efficient optical resolution of 3d by the complex formation with (+)-1 suggests that racemic 1 would be resolved by a similar complex formation with (+)-3d. We succeeded in this reverse optical resolution. When a solution of racemic 1 (2.7 g, 9 mmol) and (+)-3d (1.5 g, 9 mmol) in benzene (9 ml) was kept at room temperature for 12 h, a 1:1 complex of 93% ee (+)-1 and (+)-3d was obtained as colorless prisms (1.5 g, 71% yield, $[\alpha]_D$ -6.8°). Two recrystallizations of the crude crystals from benzene gave the complex of 100% ee (-)-1 and (+)-3d (1.24 g, 59% yield, $[\alpha]_D$ -8.8°). A solution of the complex in benzene (10 ml) was decomposed with 3% aqueous NaOH, and the aqueous solution was acidified to give 100% ee (-)-1 (0.4 g, 53% yield, $[\alpha]_D$ -39.0°). From the benzene solution, 100% ee (+)-3d was recovered (1.4 g, 94% yield, $[\alpha]_D$ +36.0°). This mutual optical resolution of 1 and 3 is similar to that of 1 and sulfoxide.[6,7]

Although (+)-1 did not form complex with dialkyl sulfoximines (6), optically active 2 formed complex with some of them, and some were resolved efficiently by the complexation. For example, when a solution of optically pure (-)-2[11] (3.1 g, 7.5 mmol) and racemic 6e (1.0 g, 7.5 mmol) in dibutyl ether (20 ml) was kept at room temperature for 12 h, a 1:1 complex of 17% ee 6e and (-)-2 was obtained (2.6 g, 126% yield, $[\alpha]_D$ -96° (EtOH)). The crude complex was purified by four recrystallizations from dibutyl ether to give the complex of 100% ee (-)-6e as colorless prisms (0.92 g, 90% yield, $[\alpha]_D$ -98° (EtOH)). Column chromatography of the complex on silica gel gave 100% ee (-)-6e (0.4 g, 80% yield, $[\alpha]_D$ -5.5°). By the same method, 6f was resolved with (-)-2 and finally gave 100% ee (+)-6f in 88% yield ($[\alpha]_D$ +2.0 °).

Optical purity of (-)-6e and (+)-6f resolved could not be analyzed directly by the NMR method. However, these were tentatively determined to be 100% pure because the $[\alpha]_D$ values did not change by repeating further the complexation with (-)-2.

In the case of 6a-d, 6d was not resolved by the complex formation with (-)-2, and 6a-c did not form complex with (-)-2. These results again show that the substituents of sulfoximines are important for the complex formation and the efficiency of the optical resolution.

References

1) C. R. Johnson, Acc. Chem. Res., 6, 481 (1973).

2) C. R. Johnson, R. A. Kirchhoff, and H. G. Corkins, J. Org. Chem., 39, 2458 (1974).

3) R. Fusco and F. Tericoni, Chim. Ind. (Milan), 47, 61 (1965).

4) C. R. Johnson and C. W. Schroeck, J. Am. Chem. Soc., 95, 7418 (1973).

5) F. G. Yamayishi, D. R. Rayner, E. T. Zuricker, and D. J. Cram, J. Am. Chem. Soc., 95, 1916 (1973).

6) F. Toda, K. Tanaka, and S. Nagamatsu, Tetrahedron Lett., 25, 4929 (1984).

7) F. Toda, K. Tanaka, and T. C. W. Mak, Chem. Lett., 1984, 2085.

8) F. Toda and K. Mori, J. Chem. Soc., Chem. Commun., 1986, 1358.

9) All the $[\alpha]_D$ values were measured in THF (c 0.2) with a 1 dm cell at 25 °C, unless otherwise stated.

10) All yields of the optical resolution were calculated on the basis of the theoretical amount of the optical isomer contained in the initial racemic compound.

11) F. Toda, K. Tanaka, T. Omata, K. Nakamura, and T. Ōshima, J. Am. Chem. Soc., 105, 5151 (1983). Both the (-)-2 and (+)-2 (commercial name is Chiral Host Ace) are available from Ube Industries, Ltd., Tokyo, Japan.

(Received September 12, 1988)