CHEMISTRY LETTERS, pp. 195-196, 1980.

ASYMMETRIC INDUCTION IN FREE RADICAL ADDITION OF THIOLS TO ℓ-MENTHYL CROTONATE

Masakuni YOSHIHARA, Hisashi FUJIHARA, and Toshihisa MAESHIMA
Department of Applied Chemistry, Faculty of Science and
Engineering, Kinki University, Kowakae, Higashi-Osaka 577

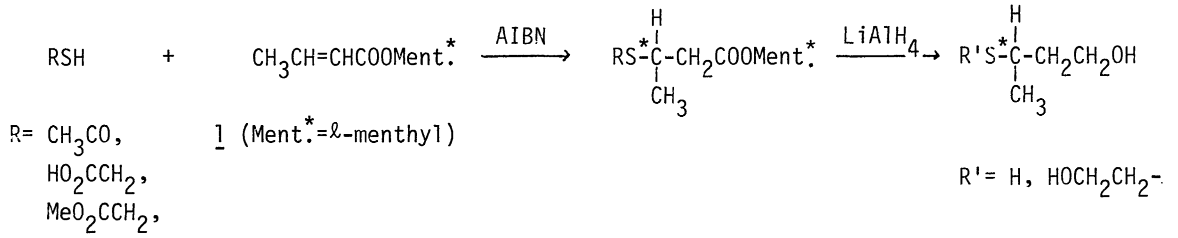
Diastereoface differentiation of ℓ-menthyl crotonate has been achieved in the radical addition with achiral thiols such as thiolacetic acid, mercaptoacetate, and mercaptoacetic acid.

Numerous investigations of asymmetric inductions have dealt almost exclusively with ionic reactions.[1)] There has been no systematic investigation of asymmetric induction in free radical reaction.

In a previous paper,[2)] we reported that an optically active copolymer was obtained by the radical copolymerization of maleic anhydride with styrene in ℓ-menthol. Recently we clarified the enantioface-differentiating radical addition of thiolacetic acid to 2-octene and of cyclohexanone to 2-octene in a chiral protic medium.[3, 4)]

We now have studied the diastereoface-differentiating radical addition of such thiols as thiolacetic acid, mercaptoacetic acid, and methyl mercaptoacetate to ℓ-menthyl crotonate.

ℓ-Menthyl crotonate 1 was prepared from crotonic acid ℓ-menthol by the usual esterification method: $CH_3CH=CHCOOC_{10}H_{19}$ (1); bp 92-94°C (2 Torr); $[\alpha]_D^{25}$ -91.2° (Benzene). The following is the experimental procedure of the reaction; An equimolar mixture of thiols (0.08 mol) and ℓ-menthyl crotonate containing 2,2'-azobisisobutyronitrile (AIBN) (0.2 g) was heated in a degassed ampule. The reaction mixture was treated with lithium aluminium hydride in ether under room temperature for 10 h. Excess hydride was then decomposed by dropwise addition of a dilute sulfuric acid solution. The resulting solution was extracted twice with ether. The combined organic materials were dride over sodium sulfate and distilled under reduced pressure to remove solvent and ℓ-menthol. The residue was distilled or treated with silica gel TLC to give the corresponding 3-mercapto-1-butanol (2) and 3-β-hydroxyethylthio-1-butanol (3) in good yields. These compounds, 2 and 3, were purified further by means of column chromatography until no other impurities were detected and then were identified by means of IR, NMR, and GC-MS.



$$RSH + CH_3CH{=}CHCOOMent^* \xrightarrow{AIBN} RS-\overset{H}{\underset{CH_3}{\overset{*}{C}}}-CH_2COOMent^* \xrightarrow{LiAlH_4} R'S-\overset{H}{\underset{CH_3}{\overset{*}{C}}}-CH_2CH_2OH$$

R= CH_3CO,
HO_2CCH_2,
MeO_2CCH_2,

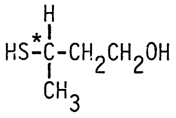
1 ($Ment^*$=ℓ-menthyl)

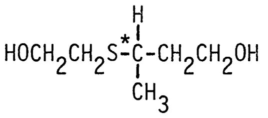
R'= H, $HOCH_2CH_2$-.

It was found that the reactions were completely inhibited with an addition of a small amount of hydroquinone, implying these reactions to proceed via a radical process. The values of specific rotations of 2[5)] and 3[6)] were summarized in the Table.

Table. Radical Addition of Thiols to ℓ-Menthyl Crotonate (1)

Run	Thiol	Temp. (°C)	Time (h)	Product	Yield (%)	$[\alpha]_D^{25}$ (C, $CHCl_3$)
1	CH_3COSH	80	11	2	72	+2.60° (2.54)
2	CH_3COSH	70	11	2	70	+3.49° (4.41)
3	$HSCH_2COOH$	70	10	3	78	-3.09° (37.0)
4	$HSCH_2COOMe$	70	10	3	81	-2.76° (36.5)


$HS-\overset{H}{\underset{CH_3}{\overset{*}{C}}}-CH_2CH_2OH$ (2)


$HOCH_2CH_2S-\overset{H}{\underset{CH_3}{\overset{*}{C}}}-CH_2CH_2OH$ (3)

For determining the enantiomeric excess of 2 and 3, the NMR spectra of the corresponding diacetyl compounds, which were obtained by treating 2 and 3 with acetic anhydride in pyridine, were taken in the presence of $Eu(hfmc)_3$. By calculation of the peak ratio of the methyl proton ($-OCOCH_3$) signals, the e.e. of 2 (Run 2) and 3 (Run 3) were determined to be 18 and 15%, respectively. We couldn't yet present a meaningful explanation for our novel asymmetric induction, however our observations are considered to demonstrate a valuable concept to develop a new type of asymmetric induction via free radical process.

In conclusion, we were successful in creating the asymmetric induction in free radical addition of thiol to olefin bearing a chiral group.

References and Notes

1) D. H. Morrison and H. S. Mosher, "Asymmetric Organic Reactions," Prentice Hall Inc., (1971).

2) H. Fujihara, K. Yamazaki, M. Yoshihara, and T. Maeshima, J. Polym. Sci., B, 17, 507 (1979).

3) H. Fujihara, M. Yoshihara, and T. Maeshima, J. Polym. Sci., B, in press.

4) M. Yoshihara, H. Fujihara, A. Yoneda, and T. Maeshima, Chem. Lett., in press.

5) 2: bp 85-87°C (17 Torr); IR (neat) 2560 (SH), 3320-3360 (OH) cm^{-1}; NMR ($CDCl_3$) δ 1.37 (3H, d, $>CHC\underline{H}_3$), 1.50 (1H, d, -SH), 1.80 (2H, m, $>CHC\underline{H}_2$), 3.09 (1H, m, $>CH$), 3.75 (2H, t, $-C\underline{H}_2OH$); MS (m/e) 106 (M^+, 35).

6) 3: bp 125-126°C (3 Torr); IR (neat) 3330-3370 cm^{-1} (OH); NMR ($CDCl_3$) δ 1.32 (3H, d, $>CHC\underline{H}_3$), 1.75 (2H, q, $>CHC\underline{H}_2$), 2.70 (2H, t, $-SC\underline{H}_2$), 3.01 (1H, m, $>CH$), 3.73 (4H, t, $-C\underline{H}_2OH$); MS (m/e) 150 (M^+, 50).

(Received November 14, 1979)