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THE ASYMMETRIC OXYMERCURATION-DEMERCURATION OF OLEFINS AS A ROUTE TO OPTICALLY ACTIVE ALCOHOLS

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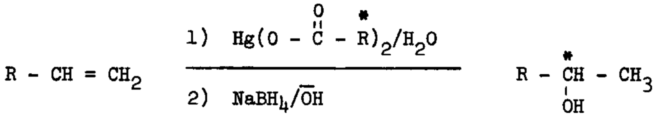
The recent development of the oxymercuration-demercuration procedure[1] has provided a convenient route from an olefin to its corresponding Markovnikov hydration product. We would like to report that the synthesis of optically active alcohols can be accomplished by using chiral mercury(II) carboxylates in the oxymercuration step.[2,3]



$$R-CH=CH_2 \xrightarrow[\text{2) } NaBH_4/\bar{O}H]{\text{1) } Hg(O-\overset{O}{\overset{\|}{C}}-\overset{*}{R})_2/H_2O} R-\underset{OH}{\overset{*}{C}H}-CH_3$$

Equation 1

The optically active mercury(II) carboxylates were prepared from mercuric oxide and the corresponding optically active carboxylic acid in a manner similar to that used by Romeyn and Wright[4] for the preparation of mercury(II)-(+)-lactate. The experimental techniques involved are uncomplicated and provide alcohols of moderate optical purity. The summary of results obtained with mercury(II)-(+)-tartrate and mercury(II)-(+)-lactate is contained in Tables I and II.

The mercury(II)-(-) mandelate, O-acetyl (-)-mandelate, O-benzoyl-(-)-mandelate, and (+)-camphorate gave alcohols of 2-3% enantiomeric excess but with lower isolated yields of alcohols than with the mercury(II)-(+)-lactate. Less than 1% enantiomeric excess was observed with mercury salts of D-glucuronic acid, (-)-malic acid, and L-2-pyrrolidone-5-carboxylic acid. Glutamic acid and N-acetyl glutamic acid formed the mercuric salt but under our conditions were unreactive towards the olefin.

TABLE I. Hg(II)-(+)-Tartrate in $CH_3C{\equiv}N/THF/H_2O$ ratio 3/2/3-50% Excess Tartaric Acid

Olefin → Alcohol	% Enantiomeric Excess* (rotation)	% Isolated Yield	Time for Salt Formation (hrs.)	Hg(II) Tartrate/Olefin Reaction Time (hrs.)
Decene to 2-decanol	17.4 (-)	78	7	47
Octene to 2-octanol	15.9 (-)	58	7	23
Heptene to 2-heptanol	13.3 (-)	43	7	42
Allyl benzene to 1-phenyl-2-propanol	6.4 (-)	76	7	28

TABLE II. Hg(II)-(+)-Lactate in THF/H_2O[1] - No Excess Lactic Acid

Olefin → Alcohol	% Enantiomeric Excess* (rotation)	% Isolated Yield	Time for Salt Formation (hrs.)	Hg(II) Tartrate/Olefin Reaction Time (hrs.)
Decene to 2-decanol	2.3 (-)	70	0.3	0.7
Octene to 2-octanol	4.5 (-)	63	1	1.0
Hexene to 2-hexanol	2.5 (-)	44	1	0.5
Allyl benzene to 1-phenyl-2-propanol	8.2 (-)	68	1	0.5

* The extent to which one enantiomer is produced in excess over the other.

An attempt was made to optimize the solvent, the reaction time, and the ratio of Hg(II) carboxylate: olefin: excess acid. Such variation in conditions often resulted in changes in enantiomeric excess in the alcohol. For example, a change from 11.6% to 17.4% enantiomeric excess was noted in the hydration of decene with Hg(II)-(+)-tartrate when the solvent was changed from DMF/THF/H_2O to CH_3CN/THF/H_2O. The variation in the length of time required for reaction is attributed predominantly to differences in solubility of the Hg(II) carboxylates.

An *a priori* correlation of the absolute configuration of reagent to product is presently impossible due to the observation of some unexpected correspondence in the direction of rotation of the product produced from structurally unrelated salts [i.e., (-)-2-decanol was produced from both mercuric (-)-mandelate and mercuric (+)-lactate] and due to the absence of structural knowledge of the aqueous mercuric carboxylates.

General Experimental Procedure

The chiral reagent, mercury(II)-*d*-tartrate was generated by stirring red mercuric oxide (5.42 g, 25 mmoles) and *d*-tartaric acid (5.63 g, 37.5 mmoles, 50% excess) in 30 ml H_2O and 20 ml THF at room temperature (7 hrs) in a round-bottom flask equipped with a magnetic stirrer. 1-Decene (20 mmoles, 2.80 g) in 30 ml of acetonitrile was then added and allowed to react until the initially formed lumpy material was transformed into a white foamy suspension (47 hrs). Sodium borohydride (0.70 g) in 20 ml 3*M* sodium hydroxide solution was added to the reaction mixture. The white suspension was made basic with 3*M* sodium hydroxide solution and then the mixture slowly stirred for 2 hours to complete the reduction and to permit the settling of the free mercury. The mixture was saturated with sodium chloride and the upper organic layer containing the product isolated by means of a separatory funnel.

The organic layer was then dried with anhydrous sodium sulfate and the solvent removed by distillation from some remaining solids. Redistillation of the product to remove discolorization was carried out and an isolated yield of 78% having a rotation of $\{\alpha\}_D^{20} = -1.50^\circ$ was realized. Purity of product was confirmed by Varian 60-D NMR. Optical rotation was established using pure liquids in a one decimeter tube.

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