

SELECTIVE REDUCTION OF MONOESTERS OF DICARBOXYLIC ACIDS

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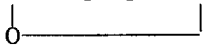
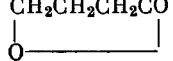
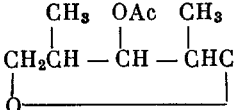
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The most widely used method for the preparation of ω -hydroxy acids is based on the hydrolysis of ω -halo acids [1], which, in turn, are usually synthesized by the degradation of the silver salts of the monoesters of dicarboxylic acids using the Hunsdiecker procedure [2], or else from the telomerization products of carbon tetrachloride and ethylene [3, 4]. However, the latter method makes it possible to obtain only acids with an odd number of C atoms.

We developed a new, more convenient synthesis method, according to which the esters of ω -hydroxy acids are obtained by the selective reduction of the monoesters of the higher dicarboxylic acids using diborane. It was found by Brown and co-workers [5, 6] that carboxylic acids are easily reduced with diborane to the alcohols, whereas the corresponding esters proved to be more stable toward the action of diborane. As our experiments disclosed, the selective action of diborane is also retained in the case of compounds simultaneously containing the carboxyl and the ester groupings. As an example, we investigated the reduction of the monoethyl esters of the following dicarboxylic acids: sebacic, pimelic, glutaric, succinic, and meso- α,α -dimethyl- β -acetoxylglutaric. At a temperature of -10 to -5° the reduction goes practically only at the carboxyl group and in the case of the monoethyl esters of sebacic and pimelic acid the ethyl esters of 10-hydroxycapric and 7-hydroxyenanthic acid are obtained in high yields (see table).

Reduction of Monoesters of Dicarboxylic Acids with Diborane

Starting monoester	Reaction product	Yield, %	Constants
$\text{HOOC}(\text{CH}_2)_8\text{COOEt}$	$\text{HO}(\text{CH}_2)_8\text{COOEt}^*$	74	B.p. $158-160^\circ$ (7mm); $n_D^{20}, 1.4478$
$\text{HOOC}(\text{CH}_2)_5\text{COOEt}$	$\text{HO}(\text{CH}_2)_5\text{COOEt}^\dagger$	72	B.p. $02-103^\circ$ (0,8 mm); n_D^{20} 1.4398; see [7]
$\text{HOOC}(\text{CH}_2)_3\text{COOEt}$	$\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CO}$ 	58	B.p. $111-112^\circ$ (13 mm); $n_D^{20}, 1.4598$
$\text{HOOC}(\text{CH}_2)_2\text{COOEt}$	$\text{CH}_2\text{CH}_2\text{CH}_2\text{CO}$ 	62	B.p. $91-93^\circ$ (13 mm); $n_D^{20}, 1.4346$
$\text{HOOC}\overset{\text{CH}_3}{\underset{ }{\text{CH}}}-\overset{\text{OAc}}{\underset{ }{\text{CH}}}-\overset{\text{CH}_3}{\underset{ }{\text{CH}}}\text{COOEt}$	$\text{CH}_2\text{CH}-\text{CH}-\text{CHCO}^\ddagger$ 	44	B. p. $78-79^\circ$ (0,2 mm); B. p. $52-53^\circ$ (from ether)

*Hydrolysis of the hydroxy ester gave 10-hydroxycapric acid, m. p. $75-76^\circ$ (from ethyl acetate); phenylurethan of the methyl ester, m. p. $53-54^\circ$ (from a benzene-petroleum ether mixture) [8].

†Based on its constants and chromatographic behavior, the compound was the same as the sample obtained from 7-chloroenanthic acid [1].

‡Found: C 58.11; H 7.71%. $\text{C}_9\text{H}_{14}\text{O}_4$. Calculated: C 58.05; H 7.58%. The bands corresponding to the hydroxyl groups are absent in the infrared spectrum.

Instead of the expected esters of hydroxy acids, the reduction under the same conditions of the monoethyl esters of the glutaric, succinic, and meso- α,α -dimethyl- β -acetoxyglutaric acids respectively gave valerolactone, butyrolactone and 2,4-dimethyl-3-acetoxyvalerolactone (see table). Apparently, the indicated lactones are formed as the result of the cleavage of a molecule of ethanol by the intermediate boron complexes, since the results of the reduction of the monoethyl ester of meso- α,α -dimethyl- β -acetoxyglutaric acid show that the ester grouping does not react directly with diborane. If the reaction is run at a higher temperature, then along with the esters of ω -hydroxy acids (or lactones), a considerable amount of diols is formed. The selectivity of the reaction is also noticeably decreased if it is run on a large scale.

EXPERIMENTAL

Monoethyl ester of meso- α,α -dimethyl- β -acetoxyglutaric acid. A mixture of 20.0 g of the anhydride of meso- α,α -dimethyl- β -acetoxyglutaric acid [9] and 15 ml of anhydrous ethanol was heated for 4 h at 100°, after which the excess alcohol was distilled off, and the residue was vacuum-distilled. We obtained 18.5 g (81%) of the monoethyl ester of meso- α,α -dimethyl- β -acetoxyglutaric acid; b. p. 133-134° (0.1 mm); n_D^{20} 1.4442. Found: C 53.70; H 7.51%. $C_{11}H_{18}O_6$. Calculated: C 53.65; H 7.37%.

Reduction of monoethyl esters of dicarboxylic acids with diborane. Diborane, obtained by the reduction of 60 mmole of boron trifluoride etherate with excess lithium aluminum hydride, was passed, in a nitrogen stream, for 30-40 min, into a solution of 50 mmole of the monoester in 50 ml of dry tetrahydrofuran, cooled to -10 to -5°. The mixture was stirred at the same temperature for another hour, and then the excess diborane was decomposed with water. To the mixture was added 5 ml of 5% hydrochloric acid solution, the mixture was stirred for 30 min at 20°, after which 10% sodium carbonate solution was added until the precipitate dissolved, and then the reaction product was extracted with ether. The combined ether extracts were washed with 5% sodium carbonate solution, then with water, and dried over magnesium sulfate. After distilling off the solvents, the residue was vacuum-distilled.

SUMMARY

A new laboratory method was proposed for the synthesis of esters of ω -hydroxy acids and lactones, based on the selective reduction of the monoesters of dicarboxylic acids with diborane.

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