# Reaction of Hydrogen Bromide with Diols of Long Chain α,β-Unsaturated Acids

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## ABSTRACT

The reaction of *erythro-* and *threo*-glycols of *trans*-2-hexadecenoic and *trans*-2-docosenoic acids with hydrogen bromide in the presence of acetic anhydride has been investigated. In each case, *erythro*-2,3-dihydroxy acid gave a separable mixture of isomeric *threo*-2(3)-bromo-3(2)-acetoxy acids. In contrast, *threo*-2,3-dihydroxy acid yielded only one isomeric *erythro*-2-bromo-3-acetoxy acid. The structures of individual bromo-acetoxy acids have been established by chemical as well as spectral studies. Stereoselectivity observed in the reaction of hydrogen bromide with *threo*-glycol has been explained on the basis of different conformations of the diastereoisomeric 2,3-glycols.

## INTRODUCTION

Although the reactions of olefinic fatty acids have always been a prominent part of fatty acid chemistry, long chain α,β-unsaturated fatty acids have not been studied in detail. In a study of the action of hydrogen bromide on vicinal glycols of 2-octadecenoic acid, Myers (1,2) reported that *erythro*-glycol yielded a separable mixture of isomeric *threo*-2(3)-bromo-3(2)-acetoxy octadecanoic acids, whereas *threo*-glycol afforded only one crystalline product, *erythro*-2-bromo-3-acetoxy octadecanoic acid. Commenting on the basis of theoretical grounds, Harwood (3) maintained that the product must be a mixture of two positional isomers, *erythro*-2(3)-bromo-3(2)-acetoxy octadecanoic acids. Recently, studies (4,5) on the action of hydrogen bromide on glycols of 13-docosenoic and 6-octadecenoic acids revealed that, in nonterminal glycols, inseparable diastereoisomeric bromo-acetoxy acids are formed predominantly along with keto acids as minor products. In light of these observations, it was considered desirable to study the action of hydrogen bromide on glycols of long chain α,β-unsaturated acids.

## EXPERIMENTAL PROCEDURES

All melting points are uncorrected. Infrared (IR) spectra were obtained with Perkin-Elmer 221 Spectrophotometer. Nuclear magnetic resonance (NMR) spectra were run in $CDCl_3$ in a Varian A-60 with tetramethyl silane as internal standard. Mass spectra (70 eV) were obtained with AE I MS-902 Mass Spectrometer. Thin layer chromatographic (TLC) plates were coated with silica gel. A 50% solution of chromic acid was used as the spraying reagent.

### *trans*-2-Hexadecenoic, *2a*, and *trans*-2-Docosenoic, *2c*, Acids Acids

α,β-Unsaturated acids, *2a* (mp = 54 C) and *2c* (mp = 69 C) were prepared from palmitic and behenic acids, respectively, by the method similar to that of Palameta and Prostenik (6) for the preparation of *trans*-2-enoic acids. It has been reported previously (7) that the mp of α,β-unsaturated, *2a* was 53.5 C and α,β-unsaturated, *2c* was 68.5-69 C. IR for *2b* and *2d* ($CCl_4$) = 980 (*trans*) and 1650 $cm^{-1}$ (α,β-unsaturation). NMR for *2b* = τ9.1 (t, terminal $-CH_3$), 8.7 (chain $-CH_2$), 6.2 (s, ester $-CH_3$), 4.2 (d, α-H, and 2.9 (β-H). NMR for *2d* = τ9.1, 8.7, 6.2, 4.3, and 3.0. Mass for *2d* = m/e 352 ($M^+$), 321 ($M - OCH_3$), 320 ($M - CH_3OH$), 278 (M - 74), 236 (M - 116), 141, and 113.

### 2-Hydroxy Acids, *3a* and *3c*, and Their Jones' Oxidation

2-Hydroxyhexadecanoic, *3a* (mp = 87-88 C), and 2-hydroxydocosanoic, *3c* (mp = 97 C), acids (previous report [7], mp =87-88 C and 96-97 C, respectively) were obtained as coproducts during the preparation of *trans*-2-enoic acids. These acids were isolated in the pure form via copper chelate formation and subsequent decomposition. IR for *3b* and *3d* ($CCl_4$) = 3440 (OH) and 1740 $cm^{-1}$ (C=O). NMR for *3b* = τ9.1 (terminal $-CH_3$), 8.7 (chain $-CH_2$), 7.4 (*s*, $-CHOH$, extinguished by $D_2O$), 6.2 (ester $-CH_3$), and 5.95 (m, unresolved, $-CH$-OH). NMR for *3d* = τ9.1, 8.7, 7.4, 6.2, and 5.95. Mass for *3d* = m/e 370 ($M^+$), 338 (M - 32), 325 (M - 45), 311 (M - 59), 292 (M - 78), and 266 (M - 104).

Chromic acid oxidation of *3b* and *3d* yielded 2-keto esters, *4b* (mp = 54-55 C) and *4d* (mp = 66-67 C). IR for both ($CCl_4$) = 1740 (ester C=O) and 1710 $cm^{-1}$ (free C=O). NMR for *4b* = τ7.2 (t, $-CH_2C$=O) and for *4d* = τ7.4 (t, $-CH_2C$=O). Mass for *4d* = m/e 368 ($M^+$), 337 ($M - OCH_3$), 309 (M-59), and 103.

### *erythro*-2,3-Dihydroxy Alkanoic Acids, *5a* and *5c*

To a 11.2 g mixture of *trans*-2-hexadecenoic acid, *2a*, in 40 ml glacial acetic acid and 1.2 ml concentrated sulphuric acid, 46 ml hydrogen peroxide (30 vol) was added portionwise with stirring. After heating 6 hr, the solution was poured in water and the product extracted with ether. Hydrolysis of the residue with 12.8 g KOH in 200 ml water:ethanol (1:1) followed by acidification gave 3.6 g product (ca. 30%). Crystallization from ethanol yielded pure *erythro*-2,3-dihydroxyhexadecanoic acid, *5a* (mp = 103-4 C).

*trans*-Hydroxylation of *trans*-2-docosenoic acid, *2c*, by the same procedure afforded *erythro*-2,3-dihydroxydocosanoic acid, *5c* (mp = 108 C; previously reported [8] mp = 102 C); IR for both (KBr) = 3435 (br, OH) and 1695 $cm^{-1}$ (ester C=O).

### *threo*-2,3-Dihydroxy Alkanoic Acids, *6a* and *6c*

Pure *trans*-2-hexadecenoic acid, *2a* (8.4 g), was converted to *threo*-2,3-dihydroxyhexadecanoic acid, *6a* (2.4 g, 34%), by reaction with 11.1 g silver acetate, 7.2 g iodine, 15 ml acetic anhydride, and 200 ml glacial acetic acid by the method of Palameta and Prostenik (6). It melted at 124 C (previously reported [9] mp = 116 C). *threo*-2,3-Dihydroxydocosanoic acid, *6c* (mp = 131 C; previously reported [8] mp = 122 C), was obtained from *2c* by the same *cis* hydroxylation procedure. IR for both (KBr) = 3435 (br, OH) and 1745 $cm^{-1}$ (ester C=O).

### Reaction of *erythro-* and *threo*-Glycols with Hydrogen Bromide

The general procedure was as follows: *erythro*-2,3-Dihydroxy acid, *5a* (6.0 g), was treated with a 50 ml of 48% hydrogen bromide in 125 ml acetic anhydride for 6 hr at 90 C. The cooled reaction mixture was extracted with ether, washed, and dried. The brown product (6.5 g) obtained after evaporation of the solvent showed two distinct spots on a TLC plate (petroleum ether:ether:AcOH;

80:20:1, v/v) and responded to bromine test.

The product (2.6 g) was chromatographed over a column of Silica Gel G and eluted with a mixture of petroleum ether:ether (85:15, v/v). The TLC monitored eluates were combined to give *threo*-2-bromo-3-acetoxy acid, *7*a (1.4 g, yield ca. 60%), as a brown liquid. Analysis calculated for $C_{18}H_{33}O_4Br$ = C, 54.96; H, 8.39; Br, 20.35; O, 16.30. The analysis actually found = C, 54.94; H, 8.34; Br, 20.32; O, 16.40%. For *7*b, IR ($CCl_4$) = 1745 (carbonyl) and 1245 $cm^{-1}$ (acetoxy). NMR = $\tau$7.88 (s, -OCOC*H*$_3$), 6.02 (m, unresolved, -C*H*OAc), and 5.65 (m, unresolved, -C*H*Br).

Subsequent elution with a mixture of petroleum ether: ether (65:35, v/v) gave the other isomeric *threo*-3-bromo-2-acetoxy hexadecanoic acid, *8*a, as a colorless crystalline solid (mp = 68 C). Analysis calculated for $C_{18}H_{33}O_4Br$ = C, 54.96; H, 8.39; Br, 20.35; O, 16.30. The analysis actually found = C, 54.93; H, 8.35; Br, 20.33; O, 16.39%. For *8*b, IR ($CCl_4$) = 1745 (carbonyl) and 1245 $cm^{-1}$ (acetoxy). NMR = $\tau$7.80 (s, -OCOC*H*$_3$), 5.90 (m, unresolved, -C*H*-OAc), and 5.60 (m, unresolved, -C*H*-Br).

The reaction of *erythro*-2,3-dihydroxydocosanoic acid, *5*c, with hydrogen bromide in acetic anhydride by the above procedure also yielded two isomeric bromo-acetoxy acids, *7*c and *8*c. *threo*-2-Bromo-3-acetoxydocosanoic acid, *7*c (mp = 55 C): Analysis calculated for $C_{24}H_{45}O_4Br$ = C, 60.37; H, 9.43; Br, 16.79; O, 13.41. The analysis actually found = C, 60.36; H, 9.40; Br, 16.70; O, 13.54%. *threo*-3-Bromo-2-acetoxydocosanoic acid, *8*c (mp = 88 C): Analysis calculated for $C_{24}H_{45}O_4Br$; C, 60.37; H, 9.43, Br, 16.79; O, 13.41. The analysis actually found = C, 60.34; H, 9.41; Br, 16.75; O, 13.50%. IR for 7d and *8*d ($CCl_4$) = 1745 (carbonyl) and 1245 $cm^{-1}$ (acetoxy). NMR for 7d = $\tau$7.85, 6.29, and 5.65; for *8*d = $\tau$7.8, 6.3, and 5.65.

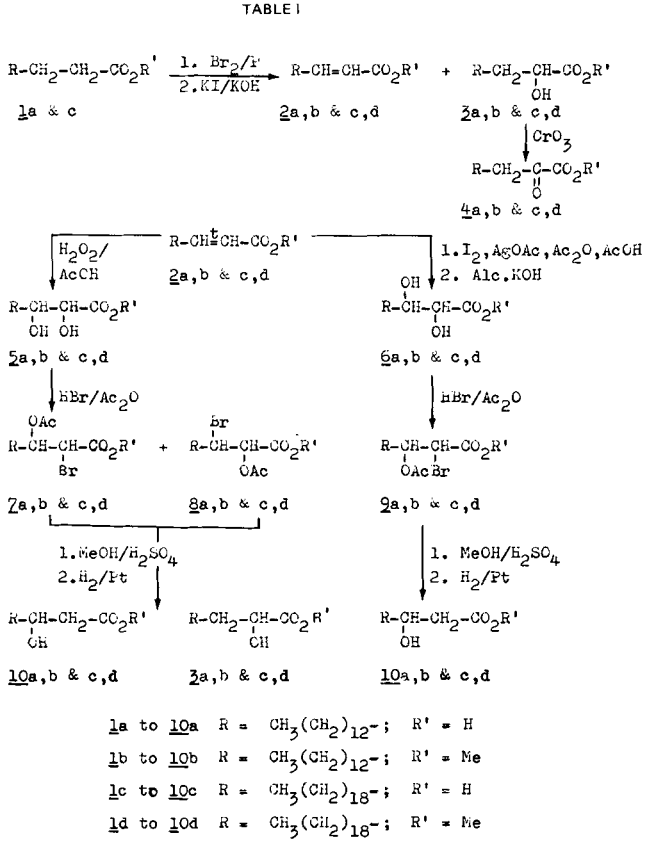
*threo*-2,3,-Dihydroxyhexadecanoic acid, *6*a (3.6 g), was treated with 24 ml of 48% hydrogen bromide in 60 ml acetic anhydride in the same way as described above. After the usual work up, 4.0 g of a brown product was obtained. It gave a single spot on TLC plate and was purified by passing over a silica gel column. Crystallization from petroleum ether gave *erythro*-2-bromo-3-acetoxyhexadecanoic acid, *9*a (mp = 47 C). Analysis calculated for $C_{18}H_{33}O_4Br$ = C, 54.96; H, 8.39; Br, 20.35; O, 16.30. The analysis actually found = C, 54.90; H, 8.36; Br, 20.32; O, 16.42%. For *9*b, IR ($CCl_4$) = 1745 (carbonyl), 1245 $cm^{-1}$ (acetoxy); NMR = $\tau$7.9 (s, -OCOC*H*$_3$), 5.91 (m, unresolved, -C*H*OAc), and 5.55 (m, unresolved, -C*H*Br).

The diol acid, *6*c, on similar treatment with hydrogen bromide afforded *erythro*-2-bromo-3-acetoxydocosanoic acid, *9*c (mp = 62 C). Analysis calculated for $C_{24}H_{45}O_4Br$ = C, 60.37; H, 9.43; Br, 16.79; O, 13.41. The analysis actually found = C, 60.32; H, 9.40; Br, 16.75; O, 13.53%. For *9*d, IR ($CCl_4$) = 1745 and 1245 $cm^{-1}$; NMR = $\tau$7.85, 6.25, and 5.60. Mass = m/e 431/433 (M - $OCOCH_3$), 430/432 (M - ACOH), 369 (M - Br+$CH_2$=C=O), 351 (M - Br), 350 (M - HBr), 319 (351 - MeOH), 181/183 ($C_4H_6O_3Br$), and 152/154.

### Catalytic Hydrogenolysis of Bromo-Acetoxy Acids

The *threo*-2-bromo-3-acetoxy acid, *7*a (0.7 g), was refluxed 20 hr with 50 ml methanol containing catalytic amount of sulphuric acid. The resulting solution was diluted with water, extracted with ether, and dried. The residue obtained after evaporation of solvent was taken up in 40 ml ethanol. After adding 0.2 g platinum oxide, the mixture was shaken in hydrogen and filtered. The filtrate was treated 2 hr with 20 ml of 10% aqueous caustic soda. After acidification, ether extraction finally yielded 0.36 g product (ca. 60%) which, on crystallization twice from ethanol, gave pure 3-hydroxy acid, *10*a (mp and mixed mp = 83-84 C). Co-chromatography on a TLC plate with an authentic sample gave a single spot. The *threo*-3-bromo-2-

TABLE I




acetoxy acid, *8*a (0.49 g), when subjected to hydrogenolysis as above, furnished the corresponding 2-hydroxy acid, *3*a (mp and mixed mp = 87-88 C). The *erythro*-2-bromo-3-acetoxy acid, *9*a, on similar treatment afforded 3-hydroxy acid, *10*a (mp and mixed mp = 83-84 C).

The isomeric bromo-acetoxydocosanoic acids, *7*c and *9*c, on hydrogenolysis yielded 3-hydroxydocosanoic acid, *10*c (mp and mixed mp = 92 C), whereas acid *8*c gave 2-hydroxy acid, *3*c (mp and mixed mp = 97 C).

## RESULTS AND DISCUSSION

The present work describes the results (Table I) of the reaction of hydrogen bromide on the *erythro*- and *threo*-diols of *trans*-2-hexahecenoic and *trans*-2-docosenoic acids, and a proof of structure of the products by NMR and mass spectra. Some observations relating to the difference in behavior of the two glycols are discussed.

The *trans*-2-hexadecenoic, *2*a, and *trans*-2-docosenoic, *2*c, acids were synthesized by the procedure of Palameta and Prostenik (6). The *trans*-2-enoic structures of the two parent acids were established by IR absorptions at 980 (*trans*) and 1650 $cm^{-1}$ ($\alpha,\beta$-unsaturation). Assignment of the *trans* geometry to the $\alpha,\beta$-unsaturation was confirmed by the NMR spectra of their methyl esters. Besides the usual signals, the $\alpha$-proton signal centered at $\tau$4.2 (*2*b) and 4.33 (*2*d) was split into a doublet by a $\beta$-proton, Ja = 14 MHz. The $\beta$-proton signal was well separated into two triplets appearing downfield at $\tau$2.9 (*2*b) and 3.0 (*2*d). Pure 2-hydroxyhexadecanoic, *3*a, and 2-hydroxydocosanoic, *3*c, acids were isolated as coproducts. The structures of these two hydroxy acids were established by IR and NMR spectra of their esters and by preparation of 2-keto esters by Jones' oxidation. The esters *3*b and *3*d had IR bands at 3440 (hydroxyl) and 1740 $cm^{-1}$ (ester carbonyl), and NMR signals at $\tau$7.4 (singlet, -CHO*H*, extinguished by $D_2O$) and 5.95 (unresolved multiplet, -C*H*OH). The spectra of 2-keto esters showed signals at $\tau$7.2 (*4*b) and 7.4 (*4*d,

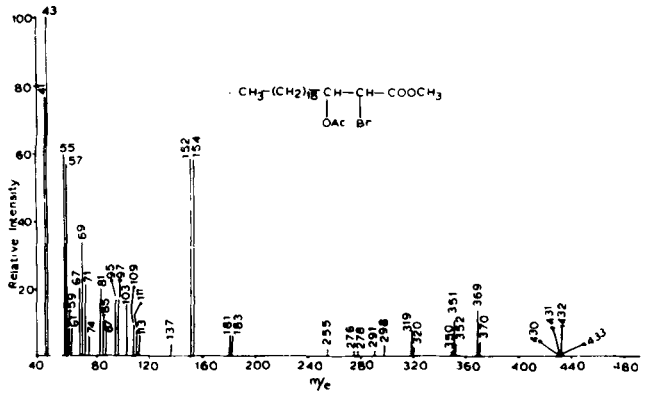



FIG. 1. Mass spectrum of methyl-2-bromo-3-acetoxy decosanoate.

triplet, -$CH_2$-C-). The signal appearing downfield with respect to α-methylene protons (τ7.7) is attributed to deshielding effect of the oxo-group.

The mass spectra of esters of *trans*-2-docosenoic, *2*d, 2-hydroxy, *3*d, and 2-keto, *4*d, acids were more informative regarding their structures. Spectrum of *2*d showed the diagnostic fragment ions at m/e 141 (γ-hydrogen abstraction followed by β-cleavage) and m/e 113, which is characteristic for 2-enoic esters (10). In the spectrum of *3*d, the diagnostic peak at m/e 311 (M - 59, equal in intensity to $M^+$ peak at m/e 370) was observed, whereas in the spectrum of *4*d the peaks characteristic of 2-oxo esters (10) were observed at m/e 337 (M - $OCH_3$), 309 (M - 59), and 103 (formed through 3,4-cleavage with rearrangement of two hydrogen atoms).

The *erythro*- and *threo*-2,3-dihydroxyhexadecanoic and docosanoic acids were prepared by the usual *cis* and *trans* hydroxylation procedures. The striking feature of the IR spectra of their esters was the differences in the wavelength of carbonyl stretching absorptions at 1695 (*erythro*) and 1745 $cm^{-1}$ (*threo*) glycols as earlier reported by Palameta and Prostenik (6).

*erythro*-2,3-Dihydroxyhexadecanoic acid, *5*a (mp = 103-4 C), on treatment with 48% hydrogen bromide in acetic anhydride under the conditions similar to those reported by Myers (1), yielded an isomeric mixture of bromo-acetoxy acids, *7*a and *8*a, separable into two products, a semisolid (major, *7*a) and a crystalline product (minor, *8*a) (mp = 68 C).

Elemental analyses of compounds *7*a and *8*a corresponded to formulae $C_{18}H_{33}O_4Br$. Resistance to acetylation showed the absence of hydroxyl function. In the IR spectra of their esters, acetoxy chromophore was indicated by a band at 1245 $cm^{-1}$. The bromo-acetoxy structures were substantiated by the NMR spectra of their esters. The compound *7*b showed signals, one at τ7.88 (singlet, integrated for 3H) for acetoxy protons and two unresolved multiplets centered at τ6.02 (-C*H*-OAc) and 5.60 (C*H*-Br), in addition to the signals normally present in the spectrum of long chain esters. In the spectrum of compound *8*b, these characteristic signals were observed at τ7.80, 5.90, and 5.60.

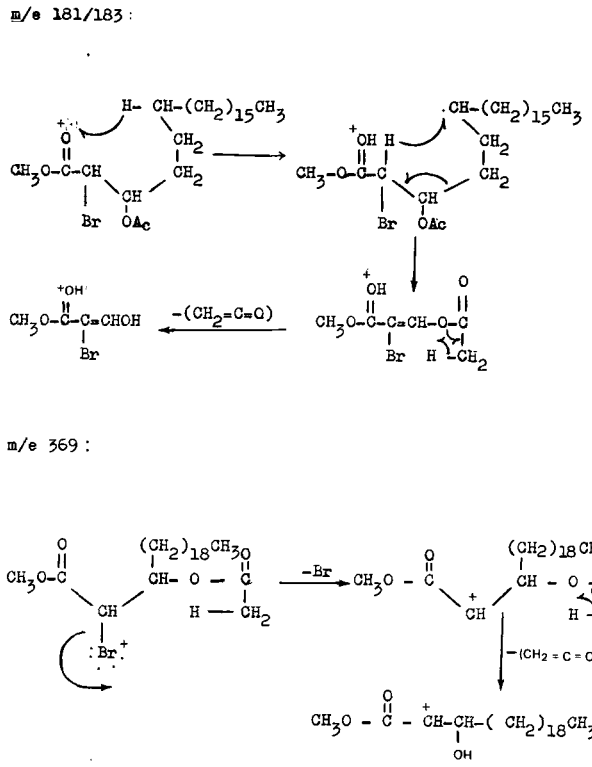
On the other hand, *threo*-2,3-dihydroxyhexadecanoic acid, *6*a (mp = 124 C), on similar treatment with hydrogen bromide yielded only one TLC homogenous product, *9*a (mp = 47 C) (positive test for bromine). It analyzed correctly for $C_{18}H_{33}O_4Br$. Its ester, *9*b, had an IR band at 1245 $cm^{-1}$ ascribable to acetoxy group. The NMR spectrum of *9*b showed signals at τ7.9 (acetoxy protons), 5.95 (-C*H*-OAc), and 5.55 (-C*H*-Br) consistent with the bromo-acetoxy structure.

Position assignment of bromo- and acetoxy- groups in the bromo-acetoxy acids was made by treatment of the individual product with methanol-sulphuric acid and subsequent debromination by catalytic hydrogenolysis. Acid *7*a by the above treatment yielded a product, *10*a (mp = 83-84 C). Its structure was established as 3-hydroxyhexadecanoic acid *10*a, by its mp, mixed mp, superimposable spectra, and co-chromatography with an authentic sample. The acid *8*a (mp = 68 C), on similar treatment, furnished a product, *3*a (mp = 87-88 C), characterized as 2-hydroxyhexadecanoic acid. On the other hand, the bromo-acetoxy acid, *9*a, obtained from *threo*-glycol, *6*a, on hydrolysis and debromination yielded a product melting at 83-84 C identical in all respects to the 3-hydroxy acid, *10*a. Thus, the structures assigned to the isomeric bromo-acetoxy derivatives are *threo*-2-bromo-3acetoxy, *7*a, *threo*-3-bromo-2-acetoxy, *8*a, and *erythro*-2-bromo-3-acetoxy, *9*a, hexadecanoic acids. The *erythro*- and *threo*-configurations assigned to these acids are based on the stereochemical relationships (4), now settled, between the vicinal glycol, bromo-acetoxy, and corresponding epoxy acids.

To obtain additional evidence to support the observation that, of the two glycols, the *threo*-compound on treatment with hydrogen bromide gives only one *erythro*-bromo-acetoxy acid, the reactions of *erythro*- and *threo*-glycols of *trans*-2-docosenoic acid, *2*c, were also studied. It was observed that the reaction of hydrogen bromide with the *erythro*-glycol, *5*c (mp = 108 C), gave a brownish liquid, which after purification showed two clear spots on a TLC plate. Column fractionation yielded two products, the major one, *7*c (mp = 54-55 C), and the minor one, *8*c, melting at 88 C. The esters *7*d and *8*d of the bromo-acetoxy acids showed IR absorption bands at 1245 $cm^{-1}$ arising from the acetoxy function and had the expected signals (*7*d; τ7.85, 6.25, 5.65; *8*d, τ7.8, 6.3, and 5.65) in their NMR spectra.

Structures of isomeric bromo-acetoxy acids were established from the results of catalytic hydrogenolysis. The acid *7*c readily yielded a hydroxy acid, *10*c (mp = 92 C), characterized as 3-hydroxydocosanoic acid by elemental analysis and spectral data. Its methyl ester, *10*d, showed IR absorption at 3445 $cm^{-1}$ for hydroxyl function. The NMR spectra of *10*d exhibited a doublet at τ7.8 (α-methylene protons) and two unresolved multiplets at τ7.40 (-CH-O*H*, extinguished by $D_2O$) and at 6.15 (-C*H*-OH). Hydrogenolysis of compound *8*c, on the other hand, gave 2-hydroxydocosanoic acid, *3*c (mp = 97 C). Its ester had identical IR spectrum with that of authentic sample. The 2-hydroxy structure was supported by the NMR signals of its ester, *3*d, at τ7.40 (-CH-O*H*, extinguished by $D_2O$) and at 5.95 for -C*H*-OH proton. On the basis of the above results, the low melting bromo-acetoxy acid, *7*c, was assigned the structure as *threo*-2-bromo-3-acetoxydocosanoic acid and the high melting acid, *8*c, was characterized as *threo*-3-bromo-2-acetoxydocosanoic acid.

The *threo*-glycol, *6*c, on treatment with hydrogen bromide, furnished only a single product, *9*c, melting at 61-62 C. Its ester, *9*d, had IR and NMR spectra almost identical with the spectra of *7*d. On hydrogenolysis, compound *9*c yielded a product (mp = 92 C) characterized as 3-hydroxydocosanoic acid, *10*c, by a comparison of its spectral data with an authentic sample. Thus, the structure *9*c was established as *erythro*-2-bromo-3-acetoxydocosanoic acid. The mass spectrum of this compound *9*d (Fig. 1) was of interest as it confirmed the 2-bromo-3-acetoxy sttucture. The molecular ion peak at m/e 490/492 was absent. The peak at m/e 431/433 (M-$OCOCH_3$), 430/432 (M-AcOH), 152/154 (McLafferty, most prominent next to base peak at m/e 43), and low intensity peaks at m/e 350 (430-HBr), 351 (430-Br), and 319 (351-MeOH) were observed in the spectrum. Two other significant peaks characteristic of a 2-bromo-3-acetoxy chromophore were observable at m/e



STRUCTURE I. Mass spectral fragmentation of methyl 2-bromo-3-acetoxy docosanoate *9d*.

181/183 $(C_4H_6O_3Br)^+$ and 369 (M - Br + $CH_2$=C=O).

The genesis of these ions may be explained according to the fragmentation indicated in Structure I.

The results of the present study of the reaction of hydrogen bromide with the *erythro*-glycols of both *trans*-2-hexadecenoic and *trans*-2-docosenoic acids lead to the conclusion that the *erythro*-glycol of a *trans*-2-enoic acid gives two isomeric bromo-acetoxy acids, whereas the *threo*-glycol on similar treatment yields only one bromo-acetoxy acid. This behavior of glycols of $\alpha,\beta$-unsaturated acids is consistent with the findings of Myers (1,2). Models (Fig. 2, *11* and *12*) show that the different conformations of the diastereoisomeric 2,3-diol acids might explain why the *erythro*-dihydroxy acid affords two isomeric bromo-acetoxy derivatives, whereas with the *threo*-dihydroxy acid only one isomeric bromo-acetoxy acid is exclusively formed. Intramolecular hydrogen bonding is possible between the carbonyl and C-2/C-3 hydroxyls in the *erythro*-2,3-dihydroxy acid (*11*). C-2 hydroxyl participation would lead to a less stable five-membered hydrogen-bonded ring, whereas C-3 hydroxyl would form a relatively more

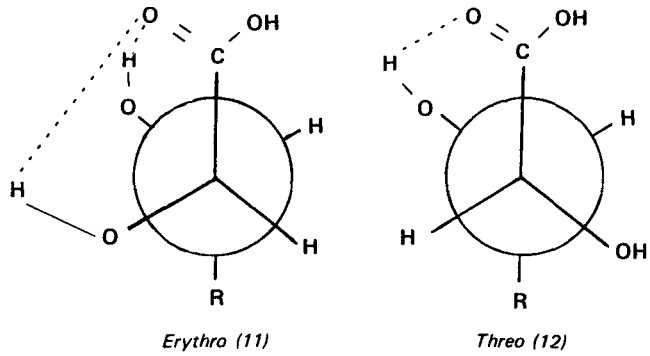


FIG. 2. Intramolecular hydrogen bonding in 2,3-dihydroxy acids.

stable six-membered ring. Obviously, C-2 hydroxyl is now more free for attack by bromine, and thus 2-bromo-3-acetoxy derivative is formed as a predominant reaction product. The other isomer 3-bromo-2-acetoxy acid is obtained as a minor product of the reaction. On the other hand, in the case of *threo*-dihydroxy acid (*12*), only C-3 hydroxyl is capable of forming the stable six-membered hydrogen-bonded ring. As C-2 hydroxyl does not participate in cyclization, this hydroxyl is substituted by bromine to yield exclusively the one isomeric derivative, 2-bromo-3-acetoxy acid.

From the above discussion, it is apparent that the reaction of hydrogen bromide with the *threo*-2,3-dihydroxy acid (*12*) is basically stereoselective.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## REFERENCES


1. Myers, G.S., J. Am. Chem. Soc. 73:2100 (1951).
2. Myers, G.S., Ibid. 74:1390 (1952).
3. Harwood, H.J., Chem. Rev. 62:99 (1962).
4. Osman, S.M., and M. Ahmad, Fette Seifen Anstrichm. 74:279 (1972).
5. Osman, S.M., G.A. Qazi, and I.A. Siddiqui, Ibid. (In press).
6. Palameta, B., and M. Prostenik, Tetrahedron 19:1463 (1963).
7. Artamonov, P.A., Zh. Obshch. Khim. 22:1992 (1952).
8. Roomi, M.W., M.R. Subbaram, and K.T. Achaya, Fette Seifen Anstrichm. 70:340 (1968).
9. Artamonov, P.A., Zh. Obshch. Khim. 28:1355 (1958).
10. Otham, G., and E. Stenhagen, in "Biochemical Application of Mass Spectrometry," Edited by G.R. Waller, John Wiley & Sons, New York, NY, 1972, p. 211.


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