tate with chromic acid gave only the C-22 keto acid (3-hydroxy-16-keto-*bis-nor*-cholanic acid).

2. 23-Bromodiosgenin acetate has been prepared and various reaction products from this are described.

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[CONTRIBUTION FROM THE DEPARTMENT OF CHEMISTRY, UNIVERSITY OF ROCHESTER]

The Action of Acids on β-Hydroxysulfonamides

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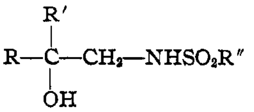
It is well known that prolonged treatment with acids will convert the benzenesulfonyl derivative of a primary amine to the corresponding amine.[1] However, it has been observed[2] that the sulfonamide of 1-amino-2-methyl-2-propanol (I) hydrolyzes in the presence of acid to give cleavage between the nitrogen and carbon atoms rather than between the nitrogen and sulfur. The products of this type of hydrolysis have been investigated, and a study has been made of the cleavage of the sulfonamides, (II) and (III), of 1-amino-2-propanol and ethanolamine.


$R{-}\overset{R'}{\underset{OH}{C}}{-}CH_2{-}NHSO_2R''$

(I) R, R' = CH_3
(II) R = H, R' = CH_3
(III) R, R' = H
R'' = p-BrC_6H_4-

Treatment of (I) and (II) with sulfuric acid at 100° gave rise to *p*-bromobenzenesulfonamide, and isobutyraldehyde and propionaldehyde, respectively. The reaction took place with greater ease and in better yields in the case of the tertiary derivative (I) than with the secondary derivative (II). Under no conditions was it possible to bring about an analogous reaction with the primary derivative (III) which was always recovered unchanged. The reaction is evidently an acid catalyzed cleavage, since with other common dehydrating agents such as phosphorus pentoxide[2] and acetyl chloride entirely different products were obtained.

The cleavage to an aldehyde and the sulfonamide appears to be analogous to the pinacol rearrangement and the semi-pinacolinic deamination of 1,2-aminoalcohols.[3,4] A possible mechanism for the reaction is, as the first step, an acid catalyzed removal of the hydroxy group to give (IV), followed by a migration of hydrogen to (V). This compound then loses a proton from the nitrogen atom to produce (VI) which is hydrolyzed to give the aldehyde and the sulfonamide

$$(\mathrm{I}) \xrightarrow{H^+} \underset{\mathrm{IV}}{[R_2C{-}CH_2{-}NHSO_2R'']^+} \longrightarrow \underset{\mathrm{V}}{[R_2CH{-}CH{-}NHSO_2R'']^+} \longrightarrow$$
$$H_3O^+ + \underset{\mathrm{VI}}{[R_2CH{-}CH{=}NSO_2R'']} \xrightarrow{H_2O} R_2CH{-}CHO + R''SO_2NH_2$$

It has also been observed that isobutylene oxide[5,6] and 1-amino-2-methyl-2-propanol give rise to isobutyraldehyde when treated with sulfuric acid at 100°.

Experimental[7]

1-Amino-2-methyl-2-propanol.[8]—To 567 g. of concd. aqueous ammonia was added 144 g. of isobutylene oxide and the mixture allowed to stand for two hours under a reflux condenser. Excess ammonia was removed by warming the homogeneous solution on a steam-bath. The mixture was then fractionated and the material coming over at 145–155° retained; yield, 52 g.

Methone Derivative of Isobutyraldehyde.[9,10]—To 50 cc. of water was added 2 cc. of isobutyraldehyde, a few drops of glacial acetic acid, and 50 cc. of alcohol containing 4 g. of methone (dimethyldihydroresorcinol). The mixture was shaken well and allowed to stand at room temperature for five days. The white crystals which were obtained were recrystallized from aqueous alcohol and dried at 65°, yield 3.2 g., m. p. 148–150°; the mixed melting point of this product with methone (m. p. 148–150°) was 128–138°.

Anal. Calcd. for $C_{20}H_{30}O_4$: C, 71.80; H, 9.05. Found: C, 71.95; H, 8.88.

Hydrolysis of 1-*p*-Bromobenzenesulfonamido-2-methyl-2-propanol.—This substance was prepared by the method of Adams and Cairns.[2]

(a) Five grams of 1-*p*-bromobenzenesulfonamido-2-methyl-2-propanol was added to 50 cc. of 50% sulfuric acid, and the mixture was steam distilled until 100 cc. of

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[1] Shriner and Fuson, "Identification of Organic Compounds," John Wiley and Sons, New York, N. Y., 2nd ed., 1940, p. 49.

[2] Adams and Cairns, THIS JOURNAL, **61**, 2464 (1939).

[3] Gilman, "Organic Chemistry," John Wiley and Sons, New York, N. Y., Vol. I, 1938, p. 738–740.

[4] *Cf.* McKenzie, Roger and Wills, *J. Chem. Soc.*, 779 (1926).

[5] Breuer and Zincke, *Ann.*, **198**, 141 (1879).

[6] Tiffeneau, Orekhov and Levy, *Compt. rend.*, **179**, 977 (1924).

[7] Analyses by Mr. R. King.

[8] Krassuski, *Chem. Zentr.*, **79**, I, 1257 (1908).

[9] Vorländer, *Z. anal. Chem.*, **77**, 241 (1929).

[10] Weinberger, *Ind. Eng. Chem.*, *Anal. Ed.*, **3**, 365 (1931).

distillate had been collected. To this distillate was added 4 g. of methone in 50 cc. of alcohol and a few drops of glacial acetic acid. The mixture was allowed to stand at room temperature for eight to nine days, after which the white crystals were removed by filtration and washed with aqueous alcohol; yield, 1.43 g.; m. p. 146–149°. After recrystallization from aqueous alcohol the product melted at 148–150°; when mixed with an authentic sample of the methone derivative of isobutyraldehyde, the melting point showed no depression.

To the acid residue from the steam distillation was added an equal volume of water. The solid which separated was washed with water; yield, 2.80 g. (73%); m. p. 158–162°; its mixed melting point with *p*-bromobenzenesulfonamide (m. p. 162–163°) was 160.5–163°.

(b) Three grams of 1-*p*-bromobenzenesulfonamido-2-methyl-2-propanol was added to 50 cc. of 40% hydrogen bromide; the solution was steam distilled until 60 cc. of distillate had been collected. To the distillate was added 1–2 g. of sodium chloride, a few drops of glacial acetic acid, and 20 cc. of 5% methone in alcohol; the mixture was allowed to stand at room temperature for 4 days. White crystals were collected and washed with aqueous alcohol; m. p. 147–149°; mixed melting point with the known methone derivative of isobutyraldehyde was 147–150°.

To the residue from the steam distillation was added an equal volume of water. A white solid formed; it was removed and washed with water; yield, 1.30 g. (56.5%); m. p. 160–162°; mixed melting point with *p*-bromobenzenesulfonamide was 160–162°.

1-*p*-Bromobenzenesulfonamido-2-propanol.—To a solution of 20 g. of sodium hydroxide in 225 cc. of water was added 22 g. of 1-amino-2-propanol. The mixture was brought to 80–90° and 65 g. of *p*-bromobenzenesulfonyl chloride added with stirring; heating and stirring were continued until all the insoluble material solidified.[11] The hot basic solution was filtered by suction, the filtrate acidified with concd. hydrochloric acid, and allowed to cool. White crystals were filtered off and dried; they were dissolved in 400 cc. of benzene and the solution distilled to a volume of 150 cc. When cooled, 48 g. of product was obtained; m. p. 89–90.5°.

Anal. Calcd. for $C^9H_{12}O_3NSBr$: C, 36.72; H, 4.11. Found: C, 37.11; H, 4.13.

(a) To 5.0 g. of 1-*p*-bromobenzenesulfonamido-2-propanol was added 50 cc. of 75% sulfuric acid, and the mixture was steam distilled until 140 cc. of distillate had been collected. To the distillate was added 8–10 g. of sodium chloride, several drops of glacial acetic acid, and 35 cc. of 5% methone in alcohol. This solution was allowed to stand at room temperature for several days. The white crystals which had separated were recrystallized from aqueous alcohol; yield, 0.37 g.; m. p. 151–152°; mixed melting point with an authentic sample of the methone derivative of propionaldehyde[8] was 150.5–152°.

To the acid residue from the steam distillation was added an equal volume of water; a dark brown solid separated. This was filtered off and dissolved in 20–25 cc. of acetone; the solution was stirred for a few minutes with activated charcoal and then filtered. The clear yellow filtrate was treated with 15–20 cc. of water and heated on a hot-plate to remove the acetone. When cooled, white crystals were obtained and recrystallized from aqueous acetone; yield, 0.55 g.; m. p. 161–162°; mixed melting point with *p*-bromobenzenesulfonamide was 160.5–162°.

(b) To 3.0 g. of 1-*p*-bromobenzenesulfonamido-2-propanol was added 35 cc. of 48% hydrogen bromide, and the mixture was steam distilled until 60 cc. of distillate had been collected. The distillate gave no reaction with the 2,4-dinitrophenylhydrazine reagent, and, when treated with methone as in (a), gave no derivative on standing.

To the acid residue was added an equal volume of water. White crystals were obtained; yield, 1.86 g.; m. p. 88–90°; when mixed with 1-*p*-bromobenzenesulfonamido-2-propanol gave m. p. 89–90.5°.

2-*p*-Bromobenzenesulfonamidoethanol.—This substance was prepared by the method of Adams and Cairns.[2]

To 5.0 g. of 2-*p*-bromobenzenesulfonamidoethanol was added 50 cc. of 75% sulfuric acid, and the mixture was steam distilled until 100 cc. of distillate had been collected. The distillate gave negative tests with both Tollens reagent and the 2,4-dinitrophenylhydrazine reagent. From the acid residue of the steam distillation only starting material could be recovered.

Treatment of isobutylene oxide and 1-amino-2-methyl-2-propanol with 50% sulfuric acid followed by a steam distillation gave, in each case, isobutyraldehyde. The latter was identified as the methone derivative.

Summary

1. The *p*-bromobenzenesulfonamides of 1-amino-2-methyl-2-propanol and 1-amino-2-propanol have been found to cleave in the presence of acids to give *p*-bromobenzenesulfonamide and the corresponding aldehyde.

2. A possible mechanism is suggested to account for this reaction.

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[11] This product was di-(4-bromophenyl)-sulfone which was always found to be present in the technical *p*-bromobenzenesulfonyl chloride.