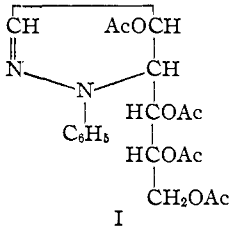

I

Experimental

To a suspension of 10 g. of D-mannose phenylhydrazone in 175 cc. of dry pyridine was added slowly 65 cc. of acetic anhydride and the resultant mixture was kept at room temperature for two days, whereupon it was poured with stirring into 7 volumes of ice and water. The resultant precipitated sirup was washed several times with water by decantation and crystallized from ethanol by the addition of water; yield 14.3 g. (92%) of crude product, 9.0 g. (58%) after one recrystallization from absolute ethanol, m. p. 123° (no dec.) unchanged on further crystallization from absolute ethanol or from acetone–water, $[\alpha]^{25}\text{D}$ + 12° (*c* 4, pyridine).

Anal. Calcd. for $C_{12}H_{12}O_4N_2(COCH_3)_4$: C, 57.13; H, 5.75; N, 6.67; CH_3CO, 9.5 cc. 0.1 *N* NaOH per 100 mg. Found: C, 57.32; H, 5.86; N, 6.77; O-acetyl as CH_3CO, 9.6 cc. (method of Kunz and Hudson[13]), 9.6 cc. (method of Freudenberg and Harder[13]).

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[13] A. Kunz and C. S. Hudson, THIS JOURNAL, **48**, 1982 (1926); K. Freudenberg and M. Harder, *Ann.*, **433**, 230 (1923); *cf.* ref. 7.

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RECEIVED JULY 15, 1946

5-Hydroxypentanal and Some of its Reactions

BY G. FORREST WOODS AND HERMAN SANDERS

R. Paul[1] has reported the preparation of 5-hydroxypentanal in 35–39% yield by the hydrolysis of 2,3-dihydropyrane in a dilute acid medium, and the preparation of pentamethylene glycol, in 50% yield starting from dihydropyrane, by the reduction of 5-hydroxypentanal with aluminum amalgam.

In exploring the chemistry of pyrane compounds we have repeated this work and found that, with changes and modifications of procedures, 2,3-dihydropyrane is an excellent starting material for the preparation of both 5-hydroxypentanal and pentamethylene glycol of excellent quality and in high yields.

5-Aminopentanol-1 has been obtained by several different procedures.[2,3,4,5] However, reductive amination of 5-hydroxypentanal is a more convenient and satisfactory method of preparing this otherwise difficultly obtainable compound. The product obtained from this procedure was contaminated with small amounts of pentamethylene glycol. It was found that purification was readily accomplished by the formation of the bisulfate salt. This substance has the advantage of being a stable, white crystalline solid with a sharp melting point, and capable of recrystallization from alcohol–ether. This salt can be titrated for one or two hydrogen ions upon choice of appropriate indicators and conditions.

5-Aminopentanol-1 bisulfate was refluxed with aqueous hydrogen bromide, the reaction mixture made alkaline, and subjected to steam distillation, whereupon piperidine was obtained in good yield.

Experimental

5-Hydroxypentanal.—A mixture of 300 ml. of water, 25 ml. of concentrated hydrochloric acid, and 100 g. of 2,3-dihydropyrane[6] was stirred vigorously until the mixture became homogeneous and then for an additional twenty minutes. The solution was neutralized with 20% sodium hydroxide using phenolphthalein as the indicator. The solution was extracted with ether for twelve hours using a continuous extraction apparatus. After removal of ether under reduced pressure the residue was distilled. There was obtained 95 g. (79%) of 5-hydroxypentanal, b. p. 62–66° (6–8 mm.), n^{18}D 1.4534.

2,4-Dinitrophenylhydrazone of 5-Hydroxypentanal.—The yellow product melted at 109°. *Anal.*[7] Calcd. for $C_{11}H_{14}O_5N_4$: C, 46.81; H, 5.00. Found: C, 46.66; H, 4.67.

Pentamethylene Glycol.—Catalytic reduction of 63 g. of 5-hydroxypentanal with Raney nickel at 3000 p. s. i. g. at 90° required approximately one hour. Pentamethylene glycol, after removal of the catalyst, was distilled, b. p. 103–105° (3–4 mm.), n^{20}D 1.4498, yield 61 g. (96%) (identified as the diphenylurethan, mixed m. p. 173–174°).

5-Aminopentanol-1.—Reductive amination of 80 g. of 5-hydroxypentanal with Raney nickel, 100 g. of liquid ammonia, and hydrogen at 3000 p. s. i. g. at 90° required approximately five hours. After removal of the catalyst, the product distilled at 85–95° (1–2 mm.); yield 70 g. (87%). This product had a neutral equivalent of 118 which corresponded to an 87% purity.

To a solution of 50 g. of crude 5-aminopentanol-1 in 200 ml. of anhydrous alcohol was added 50 g. of sulfuric acid in 200 ml. of anhydrous alcohol; the solution was cooled during the addition of the acid. After addition of 200 ml. of anhydrous ether and thorough chilling, the white crystalline product was filtered and washed with ether. Recrystallization of the crude 5-aminopentanol-1 bisulfate from alcohol–ether yielded white crystals stable in air, m. p. 102–103°; yield 85 g. (99%) based on the 5-aminopentanol-1 present in the crude product as indicated by its neutral equivalent. The neutral equivalent of the first hydrogen ion of 5-aminopentanol-1 bisulfate was determined by titration with sodium hydroxide using methyl red as the indicator. The second hydrogen ion titration was made in the presence of formaldehyde with phenolphthalein as the indicator. *Anal.* Neut. equiv. calcd. for $C_5H_{13}ON.H_2SO_4$: 201; 100.5. Found: 203, 203; 103, 101.

A concentrated aqueous solution of 28 g. of 5-aminopentanol-1 bisulfate and excess sodium hydroxide was subjected to continuous extraction with ether. After removal of the solvent under reduced pressure, the residue was distilled; yield 11 g. (77%) of pure 5-aminopentanol-1, b. p. 79–81° (1 mm.); m. p. 38–39°. This value is considerably higher than that (27–28°) recorded in the literature.[3] *Anal.* Calcd. for $C_5H_{13}ON$: C, 58.25; H, 12.70, neut. equiv., 103. Found: C, 58.48; H, 12.98, neut. equiv., 103, 103.

Conversion of 5-Aminopentanol-1 Bisulfate to Piperidine.—5-Aminopentanol-1 bisulfate (50 g.) was refluxed with a 75% excess of 48% aqueous hydrogen bromide for three hours. This solution was neutralized with 20% sodium hydroxide and an additional 20 g. of sodium hydroxide was added. The solution was subjected to steam

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(1) R. Paul, *Bull. Soc. Chim.*, [5] **1**, 971 (1934).

(2) v. Braun and Sobecki, *Ber.*, **44**, 2531 (1911).

(3) Putochin, *ibid.*, **59**, 630 (1926).

(4) Williams, *ibid.*, **60**, 2511 (1927).

(5) Keimatsu and Takamota, *J. Pharm. Soc. Japan*, 506 (1927).

(6) "Organic Syntheses," **23**, 25 (1943).

(7) Microanalyses by Miss Eleanor Werble.

distillation and the distillate collected until the odor of piperidine was no longer evident. The distillate was made strongly alkaline with sodium hydroxide and extracted with ether. After drying over sodium hydroxide, the solvent was removed and the piperidine was distilled; b. p. 104–105°; $n^{20}D$ 1.4532; yield 17 g. (81%) (identified as the benzenesulfonamide, mixed m. p. 93–94°).

DEPARTMENT OF CHEMISTRY
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RECEIVED JUNE 6, 1946

NEW COMPOUNDS

Some Substituted Anthranilic Acids

N-(2′,4′-Dinitrophenyl)-5-methoxyanthranilic Acid.—This compound was prepared from 5-methoxyanthranilic acid and 2,4-dinitrochlorobenzene by a procedure analogous to that described by Jourdan.[1] The yield was 88% of bright red needles, m. p. 290–291°. Recrystallization of a sample from phenol–acetic acid did not change the melting point.

It was not found possible to prepare a chloroacridine from this acid. Compare the work of Albert and Linnell.[2]

Anal. Calcd. for $C_{14}H_{11}O_7N_3$: C, 50.45; H, 3.33. Found: C, 50.39, 50.49; H, 3.58, 3.50.

The **acid chloride** was prepared by refluxing a mixture of 9.0 g. of the acid, 10.0 g. of phosphorus pentachloride, and 45 cc. of benzene for thirty minutes. The clear, red solution was diluted with an equal volume of hot heptane, and cooled. It deposited 7.8 g. (82%) of large, orange crystals of the acid chloride, m. p. 153–155°. Further recrystallization raised the melting point to 155–156°.

Anal. Calcd. for $C_{14}H_{10}O_6N_3Cl$: C, 47.81; H, 2.87. Found: C, 47.93, 47.97; H, 3.00, 3.05.

3-Diethylaminopropylamide of N-(2′,4′-Dinitrophenyl)-5-methoxyanthranilic Acid Hydrochloride Dihydrate.—Six grams of the acid chloride was dissolved in 60 cc. of warm benzene, and a solution of 2.3 g. of 3-diethylaminopropylamine in 20 cc. of benzene was added slowly. The mixture was refluxed for thirty minutes, and the benzene was removed by distillation. The residual red gum was purified by dissolving it in hot ethanol (which contained an excess of hydrogen chloride), cooling the solution, and diluting it with ether. After several hours 3.9 g. (44%) of large, orange crystals of the hydrochloride dihydrate separated. A final recrystallization from propanol–dibutyl ether was carried out. The anhydrous form (red, very hygroscopic), prepared by heating a sample of the dihydrate (orange) at 100° for twenty minutes, melted at 139°.

Anal. Calcd. for $C_{21}H_{28}O_6N_5Cl \cdot 2H_2O$: C, 48.70; H, 6.23. Found: C, 48.97, 48.90; H, 6.28, 6.35.

N-(3′-Trifluoromethylphenyl)-4-chloroanthranilic Acid.—A mixture of 35 g. of the potassium salt of 2,4-dichlorobenzoic acid, 28 g. of *m*-aminobenzotrifluoride, 14 g. of potassium carbonate, 110 cc. of amyl alcohol and 0.5 g. of copper powder was heated at 125–130° for nine hours. The crude product was isolated by a procedure similar to that used for the naphthylanthranilic acid derivatives.[3] One recrystallization from ethanol gave 9.5 g. (20%) of a white, microcrystalline product, m. p. 205–208°. Further recrystallization raised the melting point to 208–209.5°.

Anal. Calcd. for $C_{14}H_9O_2NClF_3$: C, 53.26; H, 2.87. Found: C, 53.00, 53.12; H, 2.80, 2.88.

This acid reacted with phosphorus oxychloride in the usual way to give a 70% yield of the two possible, isomeric chloroacridines. These were not separated in a degree of purity sufficient for accurate characterization.

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RECEIVED JUNE 8, 1946

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[1] Jourdan, *Ber.*, **18**, 1448–1449 (1885).

[2] Albert and Linnell, *J. Chem. Soc.*, 25 (1938).

[3] Bachman and Picha, THIS JOURNAL, **68**, 1599 (1946).

Preparation and Reactions of 2,4-Dichlorophenoxyacetyl Chloride[1]

We have found that the use of phosphorus pentachloride in the preparation of 2,4-dichlorophenoxyacetyl chloride is unsatisfactory, but that this substance may be prepared in the conventional manner employing thionyl chloride.

Procedure.—A mixture of 10 g. of 2,4-dichlorophenoxyacetic acid and 15 cc. of thionyl chloride was refluxed on a steam-bath for one hour. The excess thionyl chloride distilled off at atmospheric pressure. The product was then distilled at 180 mm. from a Claisen flask connected directly to a water-cooled receiver. The acyl halide crystallized out in the receiver in white needle-like crystals; m. p. 44.5–45.5°; yield 7.9 g. (67%).

Anal. Calcd. for $C_8H_5Cl_3O$: Cl (ionizable), 14.78. Found: Cl, 14.71.

This substance, as well as the methyl ester derivative of the parent acid, may be supercooled after melting without crystal formation. In its reactions it resembles more nearly aromatic rather than aliphatic acyl halides; *e. g.*, it undergoes the Schotten–Baumann reaction; it does not react with water, alcohol or amines in the cold. It reacts smoothly with sodium alkoxides to form esters. This substance has been found advantageous in the preparation of esters of alcohols that are affected by normal esterifying catalysts.

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[1] Published as Technical Paper No. 493 with the approval of the Director of the Oregon Agricultural Experiment Station. Contribution of the Department of Farm Crops.

FARM CROPS DEPARTMENT
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RECEIVED JULY 1, 1946

6-Bromo-1,2,3,4-tetrahydroquinaldine Hydrobromide

The bromination was carried out according to the method of Hoffmann and Königs[1] for 6-bromo-1,2,3,4-tetrahydroquinoline. To 25 g. of 1,2,3,4-tetrahydroquinaldine (0.17 mole) in 250 ml. of chloroform, 27.2 g. (0.17 mole) of bromine was added over a period of one-half hour with vigorous stirring. The temperature was kept below 40°. The chloroform was removed from the reaction mixture by distillation, and the colorless portion of the solid residue was dissolved in the minimum quantity of hot, dilute hydrobromic acid. Filtration removed the dark green, insoluble oil. When the filtrate was cooled, colorless needles of 6-bromo-1,2,3,4-tetrahydroquinaldine hydrobromide separated. The product was recrystallized twice from dilute hydrobromic acid and once from water; yield, 35 g. (67%); m. p. 200–201°.

Anal. Calcd. for $C_{10}H_{13}Br_2N$: C, 39.11; H, 4.28. Found: C, 39.20; H, 4.38.

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[1] Hoffmann and Königs, *Ber.*, **16**, 727 (1883).

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MARIAN PERKINS FOX

RECEIVED JULY 20, 1946

Some New Compounds as Possible Insect Repellents

A number of new compounds were synthesized for testing as insect repellents. These compounds are listed below and brief descriptions of their preparation are given.