Experimental

Samples of I, II and III, each of 25 mg., were dissolved in distilled water (250 ml.), and 20-ml. aliquots were diluted to 100 ml. with appropriate solvents to give working solutions containing uniformly 20 mcg. per ml. The diluents were 0.1 and 0.0001 *N* hydrochloric acid, phosphate buffer (*p*H approx. 7.0) and 0.0002, 0.0001 and 0.1018 *N* NaOH. The *p*H values of the working solutions, with the exception of the most alkaline, were measured with a Beckman, model G, meter. The most alkaline value was calculated (*p*H 12.88). Absorption measurements on solutions in 1-cm. cells were made in the usual manner with a Beckman spectrophotometer.

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α,α-Diethylhydracrylic Acid

BY B. J. LUDWIG

In connection with a study of the metabolic products of 2,2-diethyl-1,3-propanediol when administered orally to humans in the clinical treatment of certain forms of epilepsy, a compound was obtained from urine which was believed to be α,α-diethylhydracrylic acid.[1] The identity of this substance was established on the basis of its elementary analysis and neutral equivalent. Since no reference to this compound could be found in the literature it was of interest to prepare this hydroxy acid for comparison with the substance isolated.

Experimental

2,2-Diethyl-1,3-propanediol was prepared from 2-ethylbutyraldehyde and formaldehyde following the procedure of Shortridge, *et al.*[2] To a solution of 15 g. of 2,2-diethyl-1,3-propanediol and 3.0 g. of sodium hydroxide in 150 ml. of water there was added with stirring over a period of 90 minutes a solution of 30.3 g. of potassium permanganate in 500 ml. of water. The mixture was heated to boiling and refluxed until the permanganate color disappeared. After cooling, it was acidified, filtered to remove manganese dioxide and extracted with ether. The acidic portion of this extract was separated using sodium bicarbonate solution. The crude acid obtained as a thick oil was distilled, giving a clear viscous liquid which solidified on standing, b. p. 110–112° (5 mm.). Crystallization of the acid from petroleum ether–benzene gave 8 g. of white needles; m. p. 62–62.5°, n^{65}D 1.4458.

Anal. Calcd. for $C_7H_{14}O_3$: C, 57.50; H, 9.65; neut. equiv., 146.2. Found: C, 57.43; H, 9.50; neut. equiv., 145.

Further confirmation of the identity of this acid as α,α-diethylhydracrylic acid was gained from its conversion to diethylmalonic acid by alkaline permanganate oxidation. The product obtained was shown by its physical constant and analysis to be diethylmalonic acid.

The acidic substance isolated from urine possessed a refractive index and melting point identical to those of the synthesized α,α-diethylhydracrylic acid, and a mixture of the two substances gave no depression in melting point.

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(1) F. M. Berger and B. J. Ludwig, *J. Pharmacol. Exptl. Therap.*, **100**, 27 (1950).

(2) R. W. Shortridge, R. A. Craig, K. W. Greenlee, J. M. Derfer and C. E. Boord, THIS JOURNAL, **70**, 946 (1948).

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2,2,2-Trinitroethanol: Preparation and Properties[1]

BY N. S. MARANS AND R. P. ZELINSKI

2,2,2-Trinitroethanol has not been reported in the literature, but its synthesis, according to a method essentially like that reported below, was accomplished in 1941 by C. D. Hurd and A. C. Starke of Northwestern University.[2] They found these properties: b. p. 77–80° (4 mm.), n^{20}D 1.4578, m. p. about 27°.

Investigation of the acid strength of this compound seemed attractive, since it contained three strongly electronegative groups attached to one carbon. It was prepared by a non-catalyzed type aldol condensation of nitroform and paraformaldehyde. This alcohol gave typical esterification reactions with both acetyl chloride and propionyl chloride to form 2,2,2-trinitroethyl acetate and propionate. Nine-tenths of the trinitroethanol was recovered after heating at 100° with an excess of concentrated hydrochloric acid for two hours, but the compound was decomposed in mildly alkaline solution at 25°.

Determination of the acid ionization constant of 2,2,2-trinitroethanol indicated that it was a relatively strong acid, K_a 4.3 × 10^{-3}. The high acidity is readily explained by the strong electron attracting properties of the nitro group.

Experimental

Nitroform was prepared by a modification of the procedures in the literature[3] starting with tetranitromethane.

To a solution of 30 g. of potassium hydroxide in 40 g. of 1:1 glycerol–water mixture there was added with continual shaking 25 g. of tetranitromethane. The potassium salt of nitroform was separated by filtration. The air dried salt was added slowly with stirring to concentrated sulfuric acid, the temperature being maintained below 50°. The upper organic layer, 3 g. of nitroform, was separated and the sulfuric acid layer added to water. Ethereal extracts of the aqueous layer were combined with the separated nitroform layer. Distillation of this material gave 11 g. of nitroform, b. p. 50° (50 mm.), 57% yield based on tetranitromethane.

2,2,2-Trinitroethanol.—To 11 g. of nitroform there was added 5 g. of paraformaldehyde with a slight exothermic reaction occurring. The mixture was allowed to stand for 12 hours and then poured into water. From the mixture material boiling below 70° was distilled. The undistilled portion was cooled to room temperature, the organic layer was separated and the aqueous layer extracted with ether. The combined organic layers gave on distillation (oil-bath temperature kept below 150°) 10 g. of trinitroethanol, b. p. 103° (14 mm.), m. p. 30°, a 75% yield based on nitroform, a 41% yield based on tetranitromethane.

Anal. Calcd. for $C_2H_3N_3O_7$: C, 13.27; H, 1.67. Found: C, 13.20; H, 1.80.

Explosions were encountered during distillation of both nitroform and trinitroethanol. Careful control of temperature in all operations is extremely important.

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(2) Private communication from C. D. Hurd.

(3) "Organic Syntheses," Vol. 21, John Wiley and Sons, Inc., New York, N. Y., 1941, p. 105; Macbeth and Orr, *J. Chem. Soc.*, 538 (1932); Hantzsch and Rinckenberger, *Ber.*, **32**, 635 (1899); and Andrew and Hammick, *J. Chem. Soc.*, 244 (1934).