preparation of the diazonium solutions varied in the usual fashion depending on the quantities of starting material, the hydrolysis was always done in the same manner.

PER CENT. YIELD OF CORRESPONDING PHENOL

Batch size, moles	0.15	0.5	1.0	1.5	2.0	3.5
o-Ethylaniline	88					
o-Toluidine		89		86	84	84
m-Toluidine		91				
p-Toluidine		89				
2,4-Dimethylaniline[a]			80+			

[a] Private communication from Dr. W. R. Nimmy, Department of Chemistry, University of Rochester.

DEPARTMENT OF PHYSIOLOGY AND VITAL ECONOMICS
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The Absorption Spectrum of 3,7-Dimethylxanthine[1]

BY ERNEST E. LOCKHART AND MABEL C. MERRITT

Gulland and Holiday[2] reported that the ultraviolet absorption spectrum of 3,7-dimethylxanthine (I) showed only one band in acid or alkaline solution and, from other studies,[3] concluded that the presence of a substituent (H–, CH_3–, sugar) in position 7 of the purine nucleus indicated a one-band spectrum, whereas the presence of a substituent in position 9 indicated a spectrum containing two bands. Conversely, the character of the spectrum (one or two bands) established the position of the double bond in the imidazole ring. This hypothesis was used as a basis for distinguishing xanthines from isoxanthines and for determining the position of substituents in xanthosines.

Gulland, *et al.*, did not state in the first paper at what *p*H in the alkaline region the absorption data were obtained, but in the second paper, in which the spectra of substituted xanthines (I omitted) were discussed, they reported that the *p*H of the alkaline solutions was 10. If one may assume that the earlier work was also done at *p*H 10, then one may infer that I shows only one band in solutions the *p*H of which is not greater than 10.

We have had occasion to study the spectra of 3,7- and 1,3-dimethyl- and 1,3,7-trimethylxanthines (I, II, III) in acid and in alkaline solution and have obtained data that seem to correlate more reasonably with the structure of I than do the data of Gulland, *et al.*

Our data for II and III agree essentially with those reported by Gulland, Holiday and Macrae[3] and by Loofbourow, Stimson and Hart.[4] The spectra of I, however, although similar to those of II and III at *p*H values between 1.3 and 6.9, showed definite secondary maxima at 235 mμ at *p*H values of 11.0 and 12.9. Molecular extinction coefficients calculated for selected wave lengths at seven *p*H values are summarized in Table I.

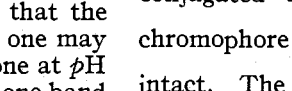
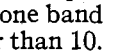
TABLE I

ABSORPTION CHARACTERISTICS OF 3,7-DIMETHYLXANTHINE[a]

	Maxima				Minima			
	I		II		I		II	
*p*H	λ	ε	λ	ε	λ	ε	λ	ε
1.3	273	9800			244	2540		
4.3	273	9950			244	2360		
6.9	273	9930			244	2320		
9.4	274	9960			246	3100		
10.6	274	10100	[b]		251	3980	[b]	
11.0	274	10000	235	6720	251	4000	230	6590
12.9	275	9930	235	7030	251	4050	230	6790

[a] λ, wave length, mμ; ε, molar absorbance; I, primary; II, secondary. [b] Shoulder.

Several conclusions may be drawn from these data: (1) the spectrum of I will show two bands in alkaline solution, (2) substitution in the 7-position of the xanthine nucleus does not inhibit the appearance of the second band, (3) the two-band spectra of xanthines do not necessarily determine the position of the substituent in the imidazole portion of the nucleus, (4) xanthines cannot be differentiated from isoxanthines by analysis of any spectral information that has been presented to date. Therefore, the Gulland hypothesis should be re-examined.

Other evidence[5] supports our belief that the imidazole portion of the purine molecule contributes little to the spectra of this group. Our data also show that the spectrum of a 3-substituted xanthine can have two bands and that enolization can occur at the 2-position, forming a second conjugated system and leaving the principal chromophore  of Cavalieri,[5] *et al.*, intact. The  in position 6 participates in both systems. The secondary band of I at 235 mμ coincides approximately with that of xanthine,[3,5] of 1-methylxanthine[3] and 9-methylxanthine.[3] We hope to examine the spectra of 7-methyl- and 3-methylxanthines to see whether these also have two bands in highly alkaline solution.

If the extinction data for each *p*H at 235 mμ are plotted against *p*H, according to the method of Stenström and Goldsmith[6] an approximate value for pK_a of 9.9 or K_a of 1.3×10^{-10} is obtained.

(1) This investigation was conducted with the assistance of grants-in-aid from the following ogranizations: American Can Company, Maywood, Illinois; Dow Chemical Company, Midland, Michigan; Nestlé Company, New York, N. Y.; Pillsbury Mills, Inc., Minneapolis, Minnesota; Standard Brands, Inc., New York, N. Y.; Wilson & Company, Chicago, Illinois.

(2) J. M. Gulland and E. R. Holiday, *Nature*, **132**, 782 (1933).

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(6) W. Stenström and N. Goldsmith, *J. Phys. Chem.*, **30**, 1683 (1926).

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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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.

(1) This work was performed with the aid of U. S. Navy funds under Sub-contract number 2, Contract NOrd 9709, and Sub-contract number 1, Contract NOrd 10431, both prime contracts being with the Hercules Powder Company, Allegany Ballistics Laboratory.

(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).