

and 40 ml. was mixed with the malonaldehyde solution. After 5 hr. at 4°, the slowly separating crystals were collected and washed successively with cold 15 ml. aliquots of saturated bisulfite solution and 50% ethanol. Substantial quantities of crystals were obtained by mixing the mother liquor with an additional 40 ml. of saturated bisulfite solution and storing for several days in a refrigerator.

The sodium salt of malonaldehyde bis-bisulfite (II) was recrystallized, after storage at 4°, from saturated aqueous solution by the dropwise addition of 1/4 volume of absolute ethanol. A second crop was obtained by bringing the total ethanol concentration to about 50%. The combined crops were washed with cold 70% ethanol and anhydrous ether and stored overnight in a vacuum desiccator over calcium chloride. The colorless oblong hexagonal plates (40% yield) darkened above 185° without melting.

Anal. Calcd. for $C_5H_5O_8S_2Na_2 \cdot 2H_2O$: C, 11.39; H, 3.19; S, 20.28; Na, 14.54; H_2O , 11.39. Found: C, 11.57; H, 3.30; S, 20.16; Na, 14.58; wt. loss (vac. oven, 70°), 11.39.

Concentrated aqueous solutions of II exhibit a maximum in the ultraviolet at 265 $m\mu$. Distillates of concentrated aqueous solutions of II exhibit a maximum at 245 $m\mu$ and also give the red color, characteristic of I, with aqueous ferric chloride.⁵

Reaction with 2-thiobarbituric acid aids in identification of I. Three ml. of an aqueous solution of 5.5 micrograms of II and 12 mg. of 2-thiobarbituric acid, in a test tube fitted with a tear-drop condenser, was immersed in boiling water for 20 min. Examination of the visible absorption spectrum of the pink solution, with the use of a Warren Spectracord, revealed a maximum at about 530 $m\mu$ which was in agreement with spectra reported by other workers.^{6,7}

A highly sensitive method of estimating 2-deoxysugars based upon oxidation with periodate and subsequent estimation of the resulting I with 2-thiobarbituric acid has been developed. The usefulness of the bisulfite compound in enzymic studies based upon the observations of others^{8,9,10} has been explored. These studies will form the subject of separate communications.

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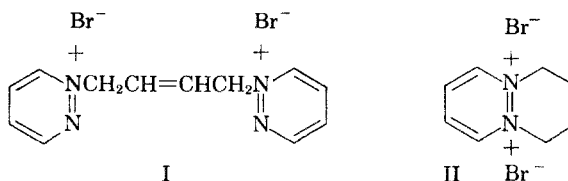
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Some Quaternary Salts of Pyridazine

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The reaction of either *cis*- or *trans*-1,4-dibromo-2-butene with pyridazine in mole ratios varying from 1:4 up to 4:1, in methanol, carbon tetrachloride, or acetone, and at different concentrations, gave only *trans*-1,4-dipyridazinium-2-butene bromide (I).



There was no evidence for the formation of the *cis* isomer, of *N*-(4-bromo-2-butenyl)pyridazinium bromide, of *N,N'*-di-(4-bromo-2-butenyl)pyridazinium bromide, of 9,10-diaza-1,4-dihydronaphthalene bromide (II), or of products that might result from allylic rearrangement of 1,4-dibromo-2-butene before or during reaction with pyridazine.

Attempts to prepare simpler diquaternary salts of pyridazine were equally unsuccessful. When pyridazine was heated with an excess of either methyl iodide or ethyl bromide at temperatures up to 100°, only the monoquaternary salts were obtained.

It has been pointed out¹ that compounds containing more than one tertiary nitrogen, phosphorus, or arsenic atom frequently do not give the maximum number of quaternary groups on reaction with alkyl halides. This behavior has been ascribed to the proximity of the positive charge produced when the first tertiary group forms a quaternary salt. However, hydrazine forms numerous diacid salts,² and both *p*-phenylenediamine³ and 2,2'-dipyridyl⁴ readily form diquaternary salts. Hence it cannot be predicted that the presence of a charge necessarily will prevent the introduction of an adjacent like charge or one separated by a conjugated system.

EXPERIMENTAL

trans-1,4-Dipyridazinium-2-butene bromide (I). To 25.6 g. (0.12 mole) of *cis*-1,4-dibromo-2-butene⁵ dissolved in 35 cc. of carbon tetrachloride was added dropwise with cooling and stirring a solution of 5.5 g. (0.069 mole) of pyridazine⁶ in 20 cc. of carbon tetrachloride. During the course of the addition a small amount of brown solid separated. The mixture was allowed to stand in an ice bath for 4 hr. during which time more solid was deposited. The carbon tetrachloride was decanted and the solid crystallized from 1-propanol to give 9.7 g. (71%) of gray hygroscopic crystals that melted with decomposition at 177–178°. Recrystallization for analysis raised the decomposition point to 179–180°.

Anal. Calcd. for $C_{12}H_{14}Br_2N_4$: C, 38.52; H, 3.77; Br, 42.73; N, 14.98. Found: C, 38.8; H, 3.5; Br, 42.6; N, 14.9.

Infrared spectrum, Nujol mull: maxima at 6.32, 7.05, 8.41, 9.16, 9.91, 10.0, and 12.56 μ . The lack of a band near 6 μ indicates that the double bond is *trans* and symmetrically substi-

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tuted.⁷ The same product was obtained in each of the following runs: (a) 0.028 mole of pyridazine was added to a solution of 0.0054 mole of *trans*-1,4-dibromo-2-butene and the mixture heated to refluxing; (b) a solution of 0.059 mole of pyridazine in 100 cc. of carbon tetrachloride was added dropwise with stirring and cooling to a solution of 0.24 mole of *cis*-1,4-dibromo-2-butene; (c) a solution of 0.016 mole of pyridazine in 620 cc. of acetone was added dropwise to 0.018 mole of *cis*-1,4-dibromo-2-butene in 560 cc. of acetone at room temperature.

N-Methylpyridazinium iodide. A mixture of 5.5 g. (0.069 mole) of pyridazine and 34 g. (0.24 mole) of methyl iodide was heated in a sealed tube at 100° for 12 hr. After chilling in an ice bath, two phases were present, a dark upper phase containing yellow crystals, and a light red bottom phase of methyl iodide. The total content was added to 40 cc. of acetone, the mixture chilled in an ice bath, and filtered. The yellow prisms weighed 11.3 g. (75%) and melted with decomposition at 93–94°. Crystallization from 1-propanol gave yellow hygroscopic needles, m.p. 95–96° (dec.).

Anal. Calcd. for C₅H₇IN₂: C, 27.04; H, 3.18; I, 57.16; N, 12.62. Found: C, 27.3; H, 3.2; I, 56.6; N, 12.4.

Infrared spectrum, Nujol mull: maxima at 6.30, 6.88, 10.18, and 12.84 μ. The same product was obtained in the absence of solvent at 0° and in methanol solution at 110°.

N-Ethylpyridazinium bromide. A mixture of 2.21 g. (0.0028 mole) of pyridazine and 14.5 g. (0.13 mole) of ethyl bromide was heated in a sealed tube at 110° for 20 hr. On cooling an upper light yellow phase separated from a lower dark red phase of ethyl bromide. The upper phase solidified on further cooling in an ice bath. The mixture was filtered in a dry box and the solid washed with dry acetone. Crystallization from 1-propanol gave pale tan plates that melted in a sealed tube at 118–120° (dec.). The product was very hygroscopic and all transfers were made in a dry box.

Anal. Calcd. for C₆H₉BrN₂: C, 38.11, H, 4.80; Br, 42.27; N, 14.82. Found: C, 37.9; H, 4.8; Br, 42.0; N, 15.0.

Infrared spectrum, Nujol mull: maxima at 6.30, 8.44, 10.08, and 12.84 μ.

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Isomerization of

1,4-Dibenzoyl-1,4-Dimesitylbutane¹

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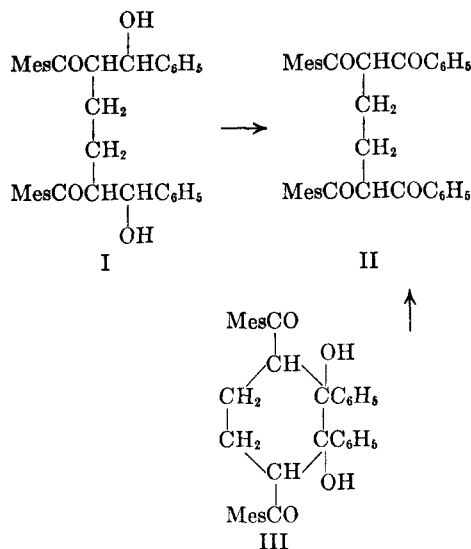
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1,4-Dibenzoyl-1,4-dimesitylbutane (II), prepared from the diol I by the action of chromic anhydride in glacial acetic acid, was found to melt at 201–203°.² The same substance was obtained by the oxidation of the cyclic glycol III by way of a compound melting at 124–126°. Evidence has now been found which indicates that this intermediate

(1) This investigation was supported in part by a grant from the Office of Ordnance Research, U. S. Army (Contract No. DA-11-022-ORD-874).

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compound and that melting at 201–203° are diastereoisomers.



Repetition of the oxidation of the linear glycol I was accomplished without difficulty, but more extensive purification raised the melting point to 133°. When this material, or the less pure sample, is recrystallized repeatedly from ethanol, it is transformed into the high-melting compound (m.p. 201–203°).³ This change can be accomplished also merely by heating the low-melting isomer in benzene. It seemed probable that the change from the low- to the high-melting isomer is an epimerization, realized by way of an enol form. As was to be expected on this basis, treatment with sodium methoxide was found to bring about the conversion. In these experiments the high-melting isomer was always obtained as a colorless powder.³ It was observed also that this isomer could not be formed by seeding solutions of the low-melting isomer.

EXPERIMENTAL

Chromic anhydride oxidation. A solution of 1 g. of the linear glycol I was prepared by shaking it with 25 ml. of glacial acetic acid for 30 min. at room temperature. The chromic anhydride reagent, made from 1.1 g. of the anhydride, 10 ml. of glacial acetic acid, and 3 ml. of water, was added in portions over a period of 5 min. during which time the reaction mixture was swirled vigorously. The brown solution was allowed to stand at room temperature, with occasional agitation, for 2 hr.; during the latter part of this time the tetraketone II separated in the form of pale yellow needles. The product was washed on the filter, first with cold glacial acetic acid and then with cold water. The water caused the separation of a second crop of the tetraketone from the filtrate. The two crops of material were recrystallized separately from ether-petroleum ether mixtures. In each case the product formed pale yellow needles, m.p. 133–134°.³

Anal. Calcd. for C₂₅H₃₈O₄: C, 81.69; H, 6.86. Found: C, 81.74; H, 6.82.

The infrared spectrum contains absorption bands corresponding to a conjugated (1677 cm.⁻¹) and to an unconjugated carbonyl group (1705 cm.⁻¹). There is no evidence of

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