

upon acetonitrile in the same manner as the experiment just described. It melted at 106–107° (percentage of nitrogen determined, 10.39; calculated, 10.37).

It is absolutely essential that all materials used in these experiments be anhydrous and that care be taken to pre-

vent the introduction of moisture in transferring the addition compounds to the sealed tubes, in order to have success with this reaction.

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RECEIVED JANUARY 3, 1944

COMMUNICATIONS TO THE EDITOR

RESYNTHESIS OF DESTHIOBIOTIN FROM DIAMINOPELARGONIC ACID¹

Sir:

Work in this Laboratory has demonstrated² that desthiobiotin, derived from biotin by hydrolysis of the sulfide linkage,³ is equally as effective as biotin in promoting the growth of yeast. Desthiobiotin has been shown to be 4-methyl-5-imidazolidone-2-caproic acid, and is converted by acid or alkaline hydrolysis to ζ,η -diaminopelargonic acid.³

In view of the high yeast-growth-promoting activity of desthiobiotin, it became of interest particularly from the standpoint of possible synthetic approaches to desthiobiotin, to investigate the effect of phosgene on the diaminopelargonic acid derived from desthiobiotin, since it has been shown⁴ that nearly quantitative yields of biotin can be obtained by treatment with phosgene of the sulfur-containing diamino acid derived from biotin.

Diaminopelargonic acid was prepared in good yield from pure desthiobiotin² by hydrolysis with barium hydroxide.³ The product was isolated as the sulfate, which crystallized in small diamond-shaped plates, micro m. p. 245–246°.

For the treatment with phosgene, 15 mg. of the diaminopelargonic acid sulfate was dissolved in 2 cc. of aqueous 10% sodium carbonate and phosgene gas was passed into the solution until the solution became acid to congo red. The clear solution was concentrated *in vacuo* to a volume of approximately 0.5 cc. Crystalline material separated from the solution and was removed and washed with a few drops of water. The combined washings and mother liquors were extracted continuously with ether for two hours; a small amount of crystalline material separated in the ether extract. The crystalline fractions were combined, dissolved in methanol and filtered, and the filtrate was concentrated to dryness. The residue was crystallized from a few drops of hot water, washed with water, and dried. The yield

(1) The desthiobiotin used in this investigation was prepared from natural biotin generously supplied by Merck and Company, Inc. Appreciation is also expressed to Dr. Karl Dittmer and Mrs. Glenn Ellis for carrying out the microbiological assays.

(2) Melville, Dittmer, Brown and du Vigneaud, *Science*, **98**, 497 (1943).

(3) Du Vigneaud, Melville, Folkers, Wolf, Mazingo, Keresztesy and Harris, *J. Biol. Chem.*, **146**, 475 (1942).

(4) Melville, Hofmann and du Vigneaud, *Science*, **94**, 308 (1941)

of product in the form of long, colorless needles, micro m. p. 156–158°, was 7.4 mg. (66% of the theoretical yield).

The reaction product possessed the same crystalline form, solubility, and melting point as desthiobiotin. A mixture of the reaction product with a sample of pure desthiobiotin, micro m. p. 156–158°, showed no depression of the melting point. Furthermore, the resynthesized material possessed the same yeast-growth-promoting activity as desthiobiotin. The diaminopelargonic acid from which it was synthesized, on the other hand, exhibited approximately 10% of the activity of desthiobiotin under the same conditions of assay and at levels which produced half-maximum growth.

It is concluded from these data that the chief product formed by the action of phosgene on the diaminopelargonic acid is desthiobiotin. The yield obtained suggests the use of this reaction as a step in the total synthesis of desthiobiotin.

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THE MECHANISM OF THE ALKYLATION OF PARAFFINS WITH OLEFINS IN THE PRESENCE OF ALUMINUM CHLORIDE

Sir:

The previously proposed mechanisms¹ for the catalytic alkylation of paraffins are unsatisfactory either in explaining how the reaction occurs or accounting for the structure of the products obtained. An investigation of the reaction of alkyl chlorides with olefins and of isoparaffins with chloroolefins has now led to the conclusion that the alkylation of isoparaffins with olefins in the presence of aluminum chloride proceeds via the conversion of the paraffin to an alkyl chloride. The mechanism is outlined below for the reaction of isobutane with ethylene. Similar reactions occur with other paraffins and olefins.

The *t*-butyl chloride formed in Eq. 3 starts a new cycle by reacting with ethylene as in Eq. 2. Ethane is produced only in the initiating step and the amount formed will therefore be small.

(1) (a) Ipatieff and Grosse, *This Journal*, **57**, 1616 (1935); (b) Birch and Dunstan, *Trans. Faraday Soc.*, **35**, 1013 (1939); (c) Caesar and Francis, *Ind. Eng. Chem.*, **33**, 1426 (1941); (d) McAllister, Anderson, Ballard and Ross, *J. Org. Chem.*, **6**, 647 (1941).