Method (B).—To an ether solution of 0.0925 mole[10] (300 cc.) of isopropylmagnesium bromide[11] contained in a 500-cc. 3-necked flask equipped with a mechanical stirrer, reflux condenser and a dropping funnel, was added with stirring 35.5 cc. (29.2 g., 0.185 mole) of *t*-butyl isovalerate.[9] Gas was evolved and the mixture became warm. The mixture was refluxed for forty-five minutes (some gas being evolved). Another 0.0925 mole of isopropylmagnesium bromide was then added and the mixture allowed to stand overnight. After refluxing for four additional hours, 17 cc. of glacial acetic acid was added. The ether solution was washed with water, followed by bicarbonate solution, and dried. The solvent was distilled and the residue fractionated in a Claisen flask. *t*-Butyl isovalerate (4.5 g., 15%) boiling at 154.0–157.0° was recovered and 5.9 g. (29%) of *t*-butyl isovalerylisovalerate boiling at 125–128° at 15 mm. was obtained.

Anal.[15] Calcd. for $C_{14}H_{26}O_3$: C, 69.38; H, 10.81. Found: C, 69.39; H, 10.48.

When *t*-butyl isobutyrate[9] was treated with isopropylmagnesium bromide in a similar manner, no gas was evolved, and on working up the mixture, 45% of the ester was recovered boiling at 127–129°.

Summary

The acetoacetic ester condensation has been effected with certain esters having relatively reactive α-hydrogens or relatively unreactive carbonyl carbons by means of sodium or potassium amide and isopropylmagnesium bromide. Ethyl phenylacetate gives excellent yields, *t*-butyl acetate gives fair to good yields, and *t*-butyl isovalerate gives poor to fair yields of their respective condensation products.

DURHAM, NORTH CAROLINA RECEIVED JULY 6, 1943

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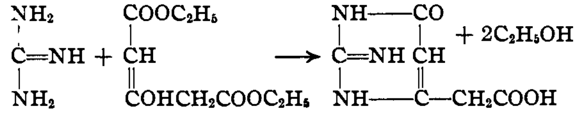
[15] Microanalysis by T. S. Ma, University of Chicago, Chicago, Ill.

[CONTRIBUTION FROM THE PEARSON MEMORIAL LABORATORY, TUFTS COLLEGE]

Derivatives of Pyrimidine-4-acetic Acid

BY DAVID E. WORRALL

It was found some years ago[1] that ethyl acetonedicarboxylate condensed smoothly with guanidine carbonate, producing a substance that was regarded as a pyrimidine derivative. Because of increasing interest in diazine derivatives, the reaction has been investigated more completely. Additional evidence has been obtained of the pyrimidine nature of the product, while certain derivatives have been prepared.



$$\begin{array}{l} NH_2 \\ | \\ C{=}NH \\ | \\ NH_2 \end{array} + \begin{array}{l} COOC_2H_5 \\ | \\ CH \\ \| \\ COHCH_2COOC_2H_5 \end{array} \longrightarrow \begin{array}{l} NH\text{—}CO \\ |\quad\;\; | \\ C{=}NH\;CH \\ |\quad\;\; \| \\ NH\text{—}C\text{—}CH_2COOH \end{array} + 2C_2H_5OH$$

(I) (II)

Experimental

1,2,3,6-Tetrahydro-2-imino-6-ketopyrimidine-4-acetic Acid (II).—Fifty grams of I and 44.5 g. of guanidine carbonate, mixed with 250 cc. of alcohol, was heated under a reflux condenser for a day, after which the insoluble product was removed and dissolved in the minimum volume of hot water containing charcoal. The filtrate was then made slightly acid with acetic acid, causing the separation of II as colorless plates. It forms soluble salts with both mineral acids and alkali, including ammonium hydroxide, but not with acetic acid. It partially melts with foaming at 189–190°, a fact which was overlooked in the previous communication.

The methyl ester was prepared by suspending 10 g. of II in methyl alcohol, followed by saturation with hydrogen chloride gas. On standing overnight, the clear solution deposited about 10 g. of the ester hydrochloride. This salt was dissolved in a small volume of water, neutralized with ammonia, and the insoluble product crystallized from alcohol as lustrous plates, m. p. 192–193° with slight foaming.

Anal. Calcd. for $C_7H_9N_3O_3$: C, 45.9; H, 4.9. Found: C, 46.2; H, 5.2. HCl salt. Calcd. for $C_7H_{10}ClN_3O_3$: Cl, 16.2. Found: Cl, 16.1.

1,2,3,6-Tetrahydro-2-imino-6-ketopyrimidine-4-acetamide.—One gram of II dissolved in concd. ammonia solution formed, in a few minutes, a crystalline product that was recrystallized from a large volume of water as slender needles, m. p. indefinite with decomposition above 285°.

Anal. Calcd. for $C_6H_8N_4O_2$: C, 42.8; H, 4.8. Found: C, 43.2; H, 4.7.

[β-Chloroethyl]-1,2,3,6-tetrahydro-2-imino-6-ketopyrimidine-4-acetate.—Prepared from 5 g. of II suspended in ethylene chlorohydrin using hydrogen chloride. The product separated after a few hours on stirring and crystallized from alcohol after neutralization with ammonia in the form of lustrous plates, m. p. 164°.

Anal. Calcd. for $C_8H_{10}ClN_3O_3$: Cl, 15.3. Found: Cl, 15.0.

1,2,3,6-Tetrahydro-2-imino-1-methyl-6-ketopyrimidine-4-acetic Acid.—Two grams of II dissolved in water containing two equivalents of sodium hydroxide after mixing with a slight excess of methyl iodide and sufficient alcohol

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[1] Worrall, THIS JOURNAL, **40**, 1133 (1918).

to make a homogeneous mixture, was heated under a reflux condenser for thirty minutes. The new salt which separated was precipitated from a water solution by acetic acid; yield 1.4 g. It crystallized from hot water as small needles which partially melted at 256–258° with foaming. It has been assumed that methylation occurs in position one.

Anal. Calcd. for $C_7H_9N_3O_3$: C, 45.9; H, 4.9. Found: C, 45.7; H, 5.0.

1,2,3,6-Tetrahydro-2-imino-5-amino-6-ketopyrimidine-4-acetic Acid.—Five grams of II dissolved in cold nitric acid quickly reprecipitated as the corresponding salt which charred if separated and heated to 100°. Sufficient water was added to the pasty mixture to clear it, after which it was evaporated to dryness in a porcelain dish on a water-bath. A vigorous reaction followed, in which oxides of nitrogen were released; yield 2–3 g. Two grams of the nitro compound suspended in hydrochloric acid containing tin slowly dissolved, following digestion on a steam-bath. The needle-like crystals that separated on standing were dissolved in water containing ammonia and reprecipitated by dilute acetic acid; yield 0.5 g. of microscopic plates; m. p. indefinite with decomp.

Anal. Calcd. for $C_6H_8N_4O_3$: H, 4.3; C. 39.1. Found: C, 38.7; H, 4.5.

1,2,3,6-Tetrahydro-2-imino-5-bromo-6-ketopyrimidine-4-acetic Acid.—Three grams of II suspended in a small volume of glacial acetic acid quickly reacted with the molar equivalent of bromine. No fumes of hydrogen bromide were noticed although, if the mixture was heated, bubbles of carbon dioxide escaped. A rather poor yield of product (3 g.) resulted on dilution with ice water and proved to be the hydrogen bromide salt of the expected product. Unless repeatedly recrystallized, the bromine content of the plate-like crystals ran high. The free base obtained by neutralization with ammonia followed by precipitation with acetic acid, crystallized from hot water or alcohol as small straw colored needles. Both substances melt indefinitely with blackening.

Anal. Calcd. for $C_6H_6BrN_3O_3$: Br, 32.3. Found: Br, 32.3. HBr salt. Calcd. for $C_6H_7Br_2N_3O_3$: Br, 48.6. Found: Br, 48.5.

Summary

The properties of 2-iminopyrimidine-4-acetic acid have been investigated. Certain nitric, amino and halogen derivatives have been prepared as well as an ester, a chlorinated ester and the acid amide.

MEDFORD, MASSACHUSETTS RECEIVED JULY 27, 1943

[CONTRIBUTION FROM NOYES CHEMICAL LABORATORY, UNIVERSITY OF ILLINOIS]

Copolymers of *p*-Chlorostyrene and Methyl Methacrylate[1]

BY C. S. MARVEL AND G. L. SCHERTZ[2]

It has been found that the polymerization of mixtures of vinyl chloride and vinyl acetate[3] gives heterogeneous copolymers because of the unequal tendency of the two monomers to enter the growing polymer chain. The high volatility of vinyl chloride made it difficult to measure accurately the α-value of Wall[4] which is the ratio of the rates at which the monomers enter the chain. It seemed worth while, therefore, to select a pair of monomers which were more readily handled and study the effect of the polymerization conditions on the α-value in order to see if changes in these conditions might lead to an α-value of one and thus permit the formation of more homogeneous products.

Some indication that the ratio of the rates at which vinyl chloride and vinyl acetate enter the growing copolymer chain approaches a value of one at 150° was noted by Jones[5] but the reliability of the results was questioned because of the practical difficulty in handling vinyl chloride. Lawson[6] has reported that polymerization of a mixture of vinyl chloride and vinyl acetate in ethyl acetate solution at 120° gives a copolymer in which the ratio of vinyl chloride to vinyl acetate is less than it was in the monomer mixture from which the copolymer is formed, thus indicating an α-value of less than one. These pieces of work indicate that the α-value for a given pair of monomers entering a copolymer can be changed by conditions of the reaction.

By selecting *p*-chlorostyrene and methyl methacrylate for this study it was possible to obtain pure, fairly high boiling monomers which could be weighed accurately to determine the composition of the monomer mixtures. The copolymers produced were readily isolated as solids which were easy to handle. The composition of the copolymers could be obtained by analysis for chlorine.

When bulk polymerizations of these two mono-

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[1] This is the seventeenth communication on the structure of vinyl polymers. For the sixteenth see THIS JOURNAL, **65**, 1710 (1943).

[2] Monsanto Fellow in Chemistry, University of Illinois, 1942–43.

[3] Marvel, Jones, Mastin and Schertz, THIS JOURNAL, **64**, 2356 (1942).

[4] Wall, *ibid.*, **63**, 1862 (1941).

[5] Jones, Ph.D. Thesis, University of Illinois, 1942.

[6] Lawson, U. S. Patent 1,867,014 (1932).