duced pressure in an atmosphere of nitrogen. Unreacted acetophenone came over at 60–70° (3 mm.) followed by a fraction, a heavy red oil, (4 g.) boiling at 210–225° (1.5–2 mm.). A third fraction (4 g.) boiling at 225–250° (1.5–2 mm.) was a heavy red tar. The second fraction was dissolved in alcohol and treated with a saturated alcoholic solution of picric acid. The red picrate was recrystallized from boiling dioxane, washed with benzene and decomposed with 50% potassium hydroxide solution. The alkaline solution was extracted with benzene and the extract, after drying yielded a semi-solid which was sublimed at 185–235° (0.2 mm.). The sublimate was recrystallized from heptane and again converted to the picrate (0.1 g.). The picrate melted at 248–253° and did not depress the melting point of a known sample of the picrate of the imidazole, I.

Condensation of *n*-Heptaldehyde with 6-Methoxy-8-amino-1,2,3,4-tetrahydroquinoline.—A mixture of 18 g. of 6-methoxy-8-amino-1,2,3,4-tetrahydroquinoline and 23 g. of pure *n*-heptaldehyde was heated in an atmosphere of nitrogen at 150–250° for eight hours. The residue was distilled under reduced pressure, a main fraction (22 g.) boiling at 180–220° (0.3 mm.) being collected. After redistillation, the fraction boiling at 190–210° (0.35 mm.) (19 g.) consisting of a viscous yellow oil was treated with a saturated absolute alcoholic solution of an equal weight of picric acid. The yellow needles of the imidazole picrate were recrystallized from alcohol yielding 20 g. of material melting at 127°.

Anal. Calcd. for $C_{23}H_{27}O_8N_5$: C, 55.1; H, 5.4. Found: C, 55.1; H, 5.4.

The picrate was decomposed with 50% potassium hydroxide as before and the *n*-hexylimidazole derivative crystallized on refrigerating. It melted at 27°. The free base was very hygroscopic which prevented securing satisfactory analytical data. Both the above imidazole and its picrate were identified by mixed melting point with an authentic sample prepared from I and oenanthic acid.

Reaction of *o*-Phenylenediamine with Methylbenzyl Ketone.—A mixture of 10.8 g. of *o*-phenylenediamine and 27 g. of methyl benzyl ketone was heated in an atmosphere of nitrogen in a distilling flask at 200–250°. The distillate was dried over anhydrous magnesium sulfate and redistilled yielding a fraction (1.5 g.) boiling at 110–111° which was identified as toluene by oxidation to benzoic acid. The residue in the distilling flask was poured out while still molten and, after cooling, was rubbed up under ether. The ether insoluble portion was repeatedly recrystallized from 60% methanol–water yielding 8 g. of 2 benzylbenzimidazole melting at 186.5–187.5°. The picrate melted at 214–215° (dec.). Both substances were identified by mixed melting point with an authentic sample synthesized for the purpose. 2-Benzylbenzimidazole is reported as melting at 187° and its picrate at 214°.[15]

From the combined mother liquors of the above 2-benzylbenzimidazole about 1 g. of 2-methylbenzimidazole was obtained by taking advantage of the ready solubility of the latter as compared to the benzyl derivative in hot water. The methyl derivative melted at 175–176° after final recrystallization from benzene and was identified by mixed melting point with an authentic sample. It is reported as melting at 176° by Phillips[3] among other workers.

Reaction of *o*-Phenylenediamine with 1-Diethylaminopentanone-4.—When the reaction was carried out as in the preceding case, no 2-methylbenzimidazole could be isolated from the reaction mixture. On attempted distillation substantially complete decomposition occurred. The reaction was not investigated further.

Summary

1. Direct heating of *o*-phenylenediamine and a mono-N-alkyl derivative with representative aldehydes and ketones leads to 2-substituted benzimidazoles by elimination of one of the atoms or radicals of the carbonyl compound from the intermediate imidazoline.

2. A mechanism for the reaction is suggested.

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[15] Walther and V. Pulawski, *J. prakt. Chem.*, [2] **59**, 253 (1899).

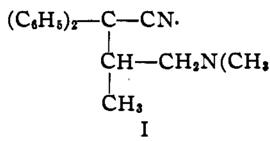
NEW YORK 27, N. Y. RECEIVED MARCH 21, 1947

[FROM THE DEPARTMENT OF ORGANIC CHEMISTRY, MEDICAL RESEARCH DIVISION, SHARP AND DOHME, INC.]

The Preparation and Rearrangements of 1,2-Dimethylaminochloropropanes

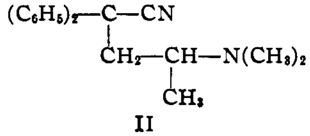
BY EVERETT M. SCHULTZ AND JAMES M. SPRAGUE

Recent work has shown that the chloroamine obtained from 1-dimethylamino-2-propanol reacts with diphenylacetonitrile in the presence of basic condensing agents to yield two isomeric nitriles, I and II.[1] The structures of these nitriles showed that a rearrangement had occurred, otherwise only the nitrile I should have resulted. In view of recent work dealing with the chemistry of chloroethylamines,[2] it seemed probable that, under the influence of the basic condensing agents, the chloroamine gave rise to an ethylenimonium ion which led to the isomeric nitriles on further reaction with diphenylacetonitrile. However, the possibility that the rearrangement occurred during the conversion of the aminoalcohol to the chloroamine was not excluded. More recently, Brode and Hill[3] have raised the question of the identity of the chloroamine employed in this reaction. These investigators failed to obtain different and distinct isomeric chloroamine bases from the treatment of 1-dimethylamino-2-propanol and 2-dimethylamino-1-propanol with thionyl chloride although apparently two distinct hydrochlorides were obtained. They conclude that the chloroamines rearranged, under the conditions used to isolate the bases from their salts,



$$\begin{array}{l}(C_6H_5)_2\text{—}C\text{—}CN\\ \qquad\quad\ |\\ \qquad\quad CH\text{—}CH_2N(CH_3)_2\\ \qquad\quad\ |\\ \qquad\quad CH_3\end{array}$$

I



$$\begin{array}{l}(C_6H_5)_2\text{—}C\text{—}CN\\ \qquad\quad\ |\\ \qquad\quad CH_2\text{—}CH\text{—}N(CH_3)_2\\ \qquad\qquad\qquad |\\ \qquad\qquad\qquad CH_3\end{array}$$

II

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[1] Schultz, Robb and Sprague, THIS JOURNAL, **69**, 188 (1947); **69**, 2454 (1947).

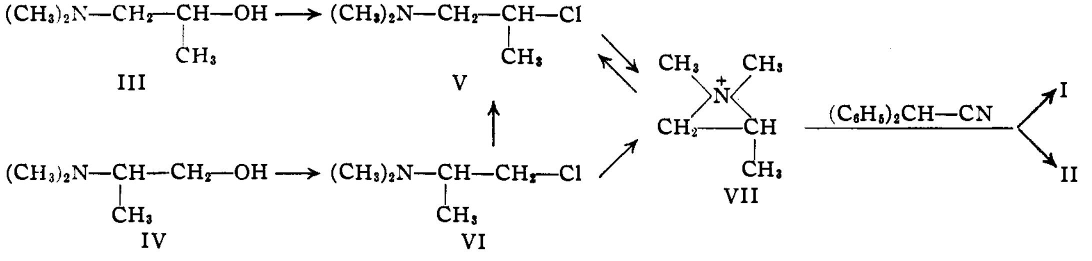
[2] Golumbic, Fruton, Bergmann, *et al.*, *J. Org. Chem.*, **11**, 518–591 (1947).

[3] Brode and Hill, THIS JOURNAL, **69**, 724 (1947).

to yield the same product and suggest that this product may be either of the two isomeric chloroamines or an equilibrium mixture of the two.

The results of work in this Laboratory are not in agreement with the observations and conclusions of Brode and Hill. It has been possible to prepare both of the isomeric chloroamines from the respective aminoalcohols and to show that 2-dimethylamino-1-chloropropane is rearranged by heat into 1-dimethylamino-2-chloropropane, whereas the latter is thermally stable and that both chloroamines give rise to the same mixture of aminonitriles on reaction with diphenylacetonitrile.

1-Dimethylamino-2-propanol (III) was converted by the action of thionyl chloride into a chloroamine hydrochloride, m. p. 185–186°, that is relatively insoluble in chloroform. The chloroamine base (V) obtained from this hydrochloride was characterized both before and after distillation by conversion to the picrate, hydrochloride and methiodide. The properties of these derivatives and of the picrate prepared directly from the original hydrochloride indicated that no rearrangement had occurred either during the liberation of the chloroamine from the hydrochloride or during the distillation. The action of thionyl chloride on the isomeric alcohol IV, or its hydrochloride, gave a chloroamine hydrochloride, m. p. 104°, that is very soluble in chloroform. The properties of the picrate prepared from this hydrochloride or from the undistilled chloroamine as well as the properties of the methiodide of the undistilled base showed this chloroamine to be different from V. After distillation, however, it was identical with V as shown by a comparison of the hydrochloride, picrate and methiodide. Furthermore, the hydrochloride, m. p. 104°, on heating rearranged into the isomer, m. p. 185–186°.

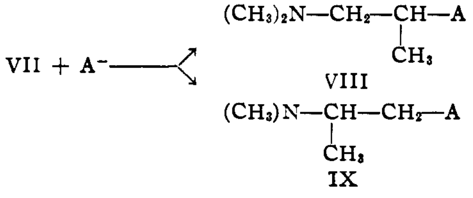


Although no irrefutable evidence is available concerning the structure of these isomeric chloroamines, it seems improbable that a rearrangement also occurred during the treatment of both of the isomeric dimethylaminopropanols with thionyl chloride or during the isolation of the resulting chloroamine hydrochlorides. Therefore, it must be concluded that 1-dimethylamino-2-chloropropane (V) and 2-dimethylamino-1-chloropropane (VI) are obtained from the respective alcohols, III and IV, and, furthermore, that VI, either as the hydrochloride or the free base, rearranges on heating to the more stable isomer, V.

Although a number of runs with IV, as well as its hydrochloride, yielded the hydrochloride of VI, m. p. 104°, one run gave only the hydrochloride of V, m. p. 185–186°. It is evident that some undetermined condition was responsible for the rearrangement in this experiment. When the chloroamine hydrochloride, m. p. 104°, was subjected to conditions comparable to the thionyl chloride reaction, it was recovered unchanged. It seems likely that the results of Brode and Hill may be similar to this anomalous experiment in our series.

In the earlier work, the stable chloroamine, V, was employed in the condensation with diphenylacetonitrile.[1] Therefore, it seems probable that the unexpected nitrile II arose through the intermediate formation of the ethylenimonium ion VII under the influence of the strong alkaline condensing agents. However, the expected nitrile I could arise either directly by replacement of the chlorine of V, or indirectly by the opening of the cyclic imonium ion in a manner opposite to that resulting in nitrile II. Under the conditions of this reaction, VI should yield the same imonium ion VII either directly or by first rearranging to V. In either event this chloroamine would give rise to the same mixture of nitriles on condensation with diphenylacetonitrile. This was found to be the case. The hydrochloride of VI was converted to the base at a low temperature. The dried undistilled base, VI, was condensed with diphenylacetonitrile to yield a mixture of equal amounts of the two isomeric nitriles, I and II.

All of the foregoing results suggest that the rearrangement of 2-dimethylamino-1-chloropropane (VI) into its isomer (V) as well as the reaction of either chloroamine, V or VI, with diphenylacetonitrile proceeds through the cyclic ion VII. The behavior of VII is governed, no doubt, by steric as well as polar factors, both within the cyclic ion and in the anion (A$^-$) with which it reacts. The rearrangement which involves the reaction of the ethylenimonium ion with a chloride ion leads predominately, if not exclusively, to structure VIII



(A = Cl). However, the reaction of VII with the relatively large anion of diphenylacetonitrile results in virtually equal amounts of the two possible isomers VIII and IX (*cf.* I and II).

Experimental[4,5]

1-Dimethylamino-2-propanol (III) was prepared in two ways: (A) from 1-chloro-2-propanol and dimethylamine in aqueous alkali by the German procedure[6] and (B) by the methylation of 1-amino-2-propanol with formaldehyde and formic acid by the method of Clarke, Gillespie and Weisshaus.[7] The physical constants were: b. p. 120–125°, d^{26}_{26} 0.855, n^{20}D 1.4210, n^{26}D 1.4182; molecular refraction: calcd., 30.75; found, 30.37.

The **methiodide** was prepared in ether; m. p. 153–154° after recrystallization from isopropyl alcohol.

Anal. Calcd. for $C_6H_{16}INO$: N, 5.75. Found: N, 5.68.

1-Dimethylamino-2-chloropropane Hydrochloride. **A. In Chloroform.**—Dry chloroform (200 ml.) and purified thionyl chloride (68 g., 0.58 mole) were placed in a round-bottomed flask equipped with a stirrer, reflux condenser and dropping funnel. The flask was placed in an ice-bath and 1-dimethylamino-2-propanol (50 g., 0.49 mole) added to the cooled, stirred mixture over a period of one hour. Near the end of the addition, the reaction mixture became semisolid due to the separation of a white precipitate. The mixture then was heated to gentle boiling whereupon the white solid dissolved gradually. After boiling for one-half hour, the whole reaction mixture solidified suddenly. The mixture was cooled at once, the solid collected by filtration and recrystallized from isopropyl alcohol. The product was washed with ether and dried in air at about 60°; yield 47 g. (61.5%) m. p. 185–186°.

B. **In Benzene.**—The German procedure[6] was followed. From 75 g. (0.56 mole) of thionyl chloride and 50 g. (0.48 mole) of III in 190 ml. of dry benzene there was obtained 51.5 g. (67.5%) of pure white needles, m. p. 185–186° after crystallization from chloroform (Norit) and then from isopropyl alcohol.

This salt is quite soluble in isopropyl alcohol, sparingly soluble in acetone and dissolves in chloroform to the extent of about one gram in 40 ml. at 26°. It is only slightly hygroscopic and sublimes readily without change at temperatures below its melting point.

Anal. Calcd. for $C_5H_{12}NCl \cdot HCl$: N, 8.85. Found: N, 8.87.

The **picrate** was prepared from the hydrochloride in water solution. After crystallization from benzene and from water, it melted at 101–103°.

1-Dimethylamino-2-chloropropane (V).—The hydrochloride (30 g.) was dissolved in 40–50 ml. of water and made strongly basic with 20% sodium hydroxide. The chloroamine layer was separated, dried over solid potassium hydroxide and distilled, b. p. 62–63° (100–110 mm.); yield, 19 g., n^{20}D 1.4250. The recorded boiling point[6] is 60° (110 mm.). On addition of this chloroamine to an acidified solution of silver nitrate, no silver chloride precipitated even after several days at room temperature. Precipitation was rapid when the solution was heated.

The distilled base (2.7 g.) in ether was converted to the **hydrochloride**, (3.35 g., m. p. 181–183°). After crystallization from isopropyl alcohol and from chloroform, it melted at 185–186° (1.6 g.).

Anal. Calcd. for $C_5H_{12}NCl \cdot HCl$: C, 37.97; H, 8.24; N, 8.85; Cl (ionic), 22.47. Found: C, 38.0; H, 8.34; N, 8.87; Cl (ionic), 22.45.

The distilled base (2 g.) in chloroform was converted to its hydrochloride, m. p. 185–186°, yield 2.28 g., 97%, after correcting for the solubility in chloroform. Therefore, little, if any, of the isomer, VI, was present since its hydrochloride is very soluble in chloroform, 1 g./2 ml.

The **picrate** was prepared from the distilled base in ether. The melting point was 101–103° and was not changed by crystallization from benzene. The picrate was prepared from the undistilled base as follows: 1-dimethylamino-2-chloropropane hydrochloride (1.0 g.) (m. p. 185–186°) was taken up in a little water, the solution chilled to 0° in an ice-bath and made basic with 20% sodium hydroxide. The oil was removed and the picrate was prepared in alcohol; yellow needles, m. p. 101–103°, 0.84 g. The picrate is very soluble in alcohol and hot water but less soluble in benzene. Crystallization from alcohol or benzene did not change the melting point.

Anal. Calcd. for $C_{11}H_{15}ClN_4O_7$: C, 37.66; H, 4.31; N, 15.97. Found: C, 37.7; H, 4.28; N, 16.00.

The **methiodide** of V was prepared from the undistilled base in the following manner: the hydrochloride was dissolved in water and the cold solution made basic with 20% sodium hydroxide solution. The organic material was taken up in ether and dried over anhydrous sodium sulfate. An excess of methyl iodide was added to the ether solution. After a few hours at room temperature, a white precipitate separated, m. p. 180–181°. After crystallizing once from absolute alcohol and three times from acetone, the rectangular prisms melted at 184–185°. (The melting point depends upon the manner in which it is taken but did not change between the last two crystallizations.) This methiodide was prepared also from the distilled base in ether solution. After crystallization from acetone, it melted at 185–186° with decomposition and a mixed melting point with the previous sample showed no depression.

Anal. Calcd. for $C_6H_{15}ClIN$: C, 27.34; H, 5.73; N, 5.32. Found: C, 27.25; H, 5.76; N, 5.31.

2-Dimethylamino-1-hydroxypropane (IV) was prepared from ethyl α-dimethylaminopropionate[8] by reduction with sodium according to the method of Stoll[9] and also from the reductive methylation[7] of 2-amino-1-propanol that was obtained by the reduction of 2-nitro-1-propanol according to the method of Gakenheimer and Hartung[10]: b. p. 145–148° (765 mm.), n^{20}D 1.4365, d^{26}_{26} 0.889, molecular refraction, calcd., 30.75; found, 30.16.

The **methiodide** was prepared in absolute alcohol and precipitated with ether,[11] m. p. 293°. The melting point depends upon the rate of heating.

2-Dimethylamino-1-chloropropane Hydrochloride. **A. In Benzene.**—Dry benzene (200 ml.) and thionyl chloride (63 g., 0.53 mole), were placed in a round-bottomed flask fitted with a reflux condenser, a dropping funnel and a mechanical stirrer. The flask was cooled in an ice-bath and 2-dimethylamino-1-propanol (46 g., 0.448 mole) in dry benzene (100 ml.) was added to the vigorously stirred mixture during a period of thirty minutes. A gummy yellow precipitate formed. The flask was allowed to warm to room temperature and then placed in a water-bath that was heated slowly to 60°. At 60–70° sulfur dioxide was evolved. After heating at 60–70° for one hour, the mixture was refluxed for two hours. During the heating, the original yellow precipitate was converted to a black tarry oil. Upon allowing the reaction mixture to cool, the oil solidified. The solid was collected by filtration and dried *in vacuo* over solid potassium hydroxide and concentrated sulfuric acid. The dark-brown product was taken up in 300 ml. of boiling acetone, the solution filtered and decolorized with charcoal. Upon cooling, pure white crystals separated, 29 g. (41%), m. p. 103–104°. Further recrystallization from acetone did not change the melting point. When the temperature was raised slowly above 104°, the

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[4] All melting points and boiling points are uncorrected.

[5] We are indebted to Mr. K. B. Streeter, Miss Ruth Lynch and Miss Thelma Plank for the analytical data and to Miss Sally Mickey for assistance with some of the syntheses.

[6] Office of the Publication Board, Department of Commerce, Report PB-981, p. 96.

[7] Clarke, Gillespie and Weisshaus, THIS JOURNAL, **55**, 4571 (1933).

[8] Major and Kline, *ibid.*, **54**, 242 (1932).

[9] Stoll, *Helv. Chim. Acta*, **26**, 936 (1943).

[10] Gakenheimer and Hartung, *J. Org. Chem.*, **9**, 87 (1944).

[11] Karrer, *et al.*, *Helv. Chim. Acta*, **5**, 477 (1922), reports m. p. 296°.

melt resolidified at 140–150° and then remelted with decomposition at 175–177°. This hydrochloride is exceedingly hygroscopic and it is difficult to obtain a reproducible melting point.

Anal. Calcd. for $C_5H_{12}NCl{\cdot}HCl$: N, 8.85; Cl, 44.86; Cl (ionic), 22.47. Found: N, 8.90; Cl, 44.35; Cl (ionic), 22.77.

The above salt (0.5 g.) m. p. 104° was sublimed at a pressure of 18 mm. and a bath temperature of 150°. The compound first melted and then resolidified. Sublimation was rapid. The sublimate melted at 185–186° after one crystallization from isopropyl alcohol. A mixed melting point with the chloroamine hydrochloride prepared from 1-dimethylamino-2-propanol showed no depression.

The **picrate** was prepared from the hydrochloride (m. p. 103–104°) in a cold aqueous solution. The solid that separated melted at 153°. After one crystallization from alcohol, it melted at 166–167°, and further recrystallization did not change the melting point.

B. In Chloroform.—Dry chloroform (200 ml.) and purified thionyl chloride (68 g., 0.575 mole) were placed in the apparatus described in A. The flask was placed in an ice-bath and 2-dimethylamino-1-propanol (50 g., 0.485 mole) in chloroform (100 ml.) was added with stirring during one-half hour. A clear, amber, homogeneous solution resulted. The solution was boiled for two and one-half hours. No solid appeared at any time. The reaction mixture was divided into two equal parts.

(**a**) To the clear solution 500 ml. of dry benzene and 200 ml. of absolute ether were added. A white solid, 36 g., m. p. 98–100°, separated. After crystallization from acetone, using decolorizing charcoal, the product melted at 102–104° (29 g.). The picrate prepared from the hydrochloride melted at 166–167° after purification.

(b) The chloroform was distilled by heating on a steam-bath leaving a dark oil that solidified on cooling. Trituration of the residue with dry benzene gave a tan solid (30 g.) m. p. 95°. After purification as described in a, the product (20 g.) was identical with that obtained in **a**. Total yield from **a** and b was 49 g. (64%).

In one run, chlorination of 2-dimethylamino-1-propanol (50 g.) with thionyl chloride (68 g.) in chloroform (300 ml.) gave an anomalous result. The isolation was carried out as in **b**. No difference was observed during the reaction. Upon distillation of the chloroform, the hot mixture solidified when the volume became small. The product (54 g.) melted at 180° and, after crystallization from isopropyl alcohol, using decolorizing charcoal, a pure white product was obtained, 37 g. (52%), m. p. 185–186°. The picrate prepared from the hydrochloride melted at 101–103°. The mother liquors from the reaction mixture and recrystallization were evaporated. The only substances obtained were tar and about 5 g. of hydrochloride melting at 178–180°.

C. In sym-Tetrachloroethane.—2-Dimethylamino-1-propanol (25 g.) was added slowly to *sym*-tetrachloroethane (50 ml.) at 80°. At this temperature the aminoalcohol reacted with the tetrachloroethane to yield the hydrochloride and trichloroethylene. The flask then was placed in an ice-bath and thionyl chloride (34 g.) in *sym*-tetrachloroethane (100 ml.) was added during a period of fifteen minutes. The mixture then was heated to boiling for two hours. The solvent was removed by vacuum distillation and the residual dark sirup solidified on adding dry benzene. After one crystallization from acetone, 26.6 g. (69.5%) of product, m.p. 102–103°, was obtained.

2-Dimethylamino-1-chloropropane (VI).—The picrate and methiodide were prepared from this chloroamine immediately after liberation from the hydrochloride as follows:

A. Picrate.—The hydrochloride (1 g.) was taken up in water (5–6 ml.). The solution was cooled in an ice-bath and made basic by addition of 20% sodium hydroxide. The oil that separated was removed and added to 3 ml. of ethanol. To the resulting solution was added 20 ml. of saturated ethanolic picric acid solution. After the mixture had stood at room temperature for four hours, the product was removed by filtration; yield, 1.1 g., m. p., 162–163°. After one crystallization from alcohol, the m. p. was 166–167° and was not changed by subsequent recrystallizations.

Anal. Calcd. for $C_{11}H_{15}ClN_4O_7$: C, 37.66; H, 4.31; N, 15.97. Found: C, 37.90; H, 4.27; N, 15.89.

B. Methiodide.—The hydrochloride (1 g.) was taken up in 5–6 ml. of water. The solution was cooled in ice and made basic with 20% sodium hydroxide solution. The oil that separated was removed, taken up in ether and the solution dried over anhydrous magnesium sulfate at 0–5°. To the dried solution was added 2 ml. of methyl iodide. After standing at 25–30° for sixteen hours, the white precipitate (1.1 g.) was collected by filtration. It decomposed at 190–191°, with evolution of gas, after extensive darkening at about 170°. The melting behavior was not changed by four crystallizations from absolute alcohol. A mixture with an equal amount of its isomer (m. p. 185–186°) melted at 181–184°.

Anal. Calcd. for $C_6H_{15}ClIN$: C, 27.34; H, 5.73; N, 5.32. Found: C, 27.27; H, 5.63; N, 5.23.

Distillation of 2-Dimethylamino-1-chloropropane (VI).—The hydrochloride (20 g.) was converted to the base and distilled in the manner described for V, b. p. 64–67° (97–100 mm.), $n^{20}D$ 1.4252. The yield of distilled free base was about 10 g. There was some mechanical loss in drying and a few ml. of high boiling, sirupy residue remained in the distilling flask. This chloroamine base, before or after distillation, did not give an immediate precipitate with acidified silver nitrate solution. After long standing or upon heating silver chloride formed.

The **hydrochloride** was prepared from the distilled base (2 ml.) in ether (2.1 g., m. p. 173–175°). After recrystallization from isopropyl alcohol, it melted at 186–187°. The **picrate** of the distilled base (0.8 ml.) was prepared in ether; yield, 1.0 g., m. p. 96–99°. After crystallization from water and from benzene it melted at 101–103°. The **methiodide** was prepared from 0.8 ml. of the distilled base and 3 ml. of methyl iodide in ether solution; yield 1.17 g., m. p. 172°. After crystallization from absolute alcohol and from acetone, the m. p. was 185–186°.

As shown by melting points and mixed melting points, all three derivatives, the hydrochloride, the picrate and the methiodide, of the distilled base were different from the derivatives that were prepared before distillation and were identical with the derivatives of 1-dimethylamino-2-chloropropane, V.

Reaction of 2-Dimethylamino-1-chloropropane with Diphenylacetonitrile.—In a 500-ml. flask equipped with a sealed stirrer, a gas inlet tube and air condenser, potassium metal (4 g., 0.1 mole) was dissolved in hot *t*-butyl alcohol (135 ml.) under an atmosphere of nitrogen. Diphenylacetonitrile (19.3 g., 0.1 mole) was added to the hot solution. The mixture was heated to boiling and undistilled 2-dimethylamino-1-chloropropane (15 g., 0.124 mole) in xylene (12 ml.) was added during a period of twenty-five minutes. After boiling for six hours, the alcohol was distilled and water and ether were added to the residue. The basic substances were extracted from the ether layer with dilute hydrochloric acid. The acid solution was made basic with dilute sodium hydroxide solution and the semisolid organic material was taken up in ether. The ether solution was washed with water, dried over anhydrous sodium sulfate and the ether evaporated. The semisolid residue was triturated with hexane (35 ml.) and cooled in an ice-bath. White crystals of 2,2-diphenyl-4-dimethylaminopentanenitrile were obtained by filtration. After crystallization from benzine, the product was obtained as long needles, m. p. 90–91° (11.05 g., 40%). The evaporation of the hexane filtrate yielded a thick oil that was distilled, b. p. 165° (1–2 mm.). The distillate soon solidified, and was identified as 2,2-diphenyl-3-methyl-4-dimethylaminobutanenitrile by means of its picrate,[1] m. p. 204–205°

The chloroamine used in this preparation was obtained from 2-dimethylamino-1-chloropropane hydrochloride, m. p. 103–104°. The salt (45 g.) was dissolved in water (20–30 ml.) and, while cooling in an ice-bath, the solution was made basic with 20% sodium hydroxide solution. The base was taken up in ether and the solution was dried over anhydrous magnesium sulfate. The solvent was removed by vacuum distillation at 30–35°. Immediately before using the residual oil in the condensation reaction, a sample was withdrawn and converted to the picrate, (m. p. 158–160°). After crystallization from alcohol, the melting point was 166–167°. Therefore, the chloroamine added to the reaction was 2-dimethylamino-1-chloropropane.

Summary

1-Dimethylamino-2-chloropropane and 2-dimethylamino-1-chloropropane were prepared from the corresponding dimethylaminopropanols by the action of thionyl chloride.

2-Dimethylamino-1-chloropropane, either as the free base or as the hydrochloride, rearranges on heating into 1-dimethylamino-2-chloropropane which is thermally stable.

Both chloroamines reacted with diphenylacetonitrile to give the same mixture of isomeric aminonitriles.

GLENOLDEN, PA. RECEIVED JULY 7, 1947

[CONTRIBUTION FROM THE EASTERN REGIONAL RESEARCH LABORATORY[1]]

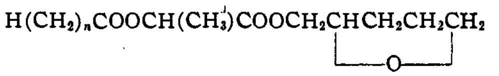
n-Alkanoyl Derivatives of n-Butyl and Tetrahydrofurfuryl Lactates

BY M. L. FEIN AND C. H. FISHER

Several alkyl lactates have been acylated[2] with the lower acid anhydrides and chlorides, but little is known about acylated lactic esters of relatively high molecular weight. The present paper describes several homologous acyl derivatives (I and II, n-1, 2, 3, 6, 8 and 11) of n-butyl lactate and tetrahydrofurfuryl lactate, prepared in high yields by treating the corresponding lactic esters with various aliphatic acid chlorides or anhydrides.

$H(CH_2)_nCOOCH(CH_3)COO(CH_2)_4H$

I



$$H(CH_2)_nCOOCH(CH_3)COOCH_2\underset{\lfloor\_\_\_\_O\_\_\_\_\rfloor}{CHCH_2CH_2CH_2}$$

II

The n-alkanoyl derivatives (I and II) were purified carefully by fractional distillation. The resulting colorless liquids were used in the determination of density (d), refractive index (n), viscosity (η), and boiling points (T) under different pressures. These physical properties of the two homologous series (I and II) were related to the number of carbon atoms, x (or molecular weight) by plotting certain functions of the physical properties (x/d, x/n, $\log \eta$, and T^2) against x. The resulting straight line relationships are useful in estimating properties of other homologous members of I and II by interpolation and extrapolation, comparing the properties of I and II with those of other homologous series, and correlating x/d, x/n, $\log \eta$ and T^2 with one another (within a homologous series, *i.e.*, I or II).

Experimental

Materials.—Redistilled n-butyl lactate (b.r. 79–80° at 12.4 mm.) from a commercial source and tetrahydrofurfuryl lactate[3] (b.p. 92° at 1 mm.) prepared by alcoholysis of methyl lactate were used. Commercial grades of acetic, propionic, and butyric anhydrides and pelargonyl chloride were used; the n-heptanoyl and n-dodecanoyl chlorides were Eastman Kodak Co. White Label grade.

Acylation: Acid Anhydrides.—The previously described[2b] method was used to acylate the lactic esters.

Acid Chlorides.—The acid chloride (1 mole per mole of lactic ester) was added slowly with stirring to a mixture of the lactic ester, reagent-grade pyridine (10% excess), and benzene (100 ml. per mole of lactic ester) contained in a 3-necked flask fitted with a condenser, mechanical stirrer, and glass-stoppered funnel. In most instances, the temperature of the reaction mixture was kept at 10 to 20° by external cooling. Cooling is recommended, although it was omitted in some experiments (temperature rose to 80°). When the reaction was complete (shortly after the addition of all the acid chloride), a small quantity of water was added to dissolve the pyridine hydrochloride. The oil layer was separated and washed in succession with dilute hydrochloric acid, saturated brine, and dilute sodium bicarbonate. In some instances, water was removed by drying over anhydrous sulfate; in others this treatment was omitted, and the water was distilled azeotropically with the benzene already present. The low- and high-boiling materials were then distilled under reduced pressures with a water aspirator and oil pump, respectively. Vigreux columns approximately 50 cm. high were used for most of the distillations. Yields and properties of the products are given in Tables I and II.

Determination of Physical Constants.—The boiling points used for the construction of Fig. 1 were determined, as in a previous study,[4] by carefully distilling narrow-boiling fractions either through a 60-cm. Vigreux column or with an alembic flask[5]; pressures were read from a Dubrovin gage.[6] When the same equipment and technique were used to determine boiling points of butyl phthalate at several pressures between 2 and 10 mm., data agreeing with those of Hickman[7] were obtained. The boiling points of the acylated lactic esters (I and II) were plotted on a Cox chart[8]; boiling points at 10 mm. were taken from the chart (Fig. 1).

Refractive indices and specific gravities (Table I) were determined with an Abbe type refractometer and a 10-ml.

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