TABLE II

PRODUCTS FROM MERCAPTALS, FORMALDEHYDE AND HYDROGEN CHLORIDE IN BOILING ACETIC ACID

Original mercaptal	Product[a] m. p., °C.	Analysis, % C	H	Miscellaneous	Remarks
Formaldehyde-diphenyl	181–184 (250)[b]	65.8	5.3	...	Shows double m. p.
Benzaldehyde-diphenyl	192–195 (250)[b]	66.7	5.6	...	Shows double m. p.
m-Nitrobenzaldehyde-diphenyl	192–195 (250)[b]	66.6	5.6	N absent	Shows double m. p.
Benzaldehyde-di-*p*-nitrophenyl	183[c]	48.7	3.4	N present	Mol. wt. in dioxane 318[f]
Benzaldehyde-di-*p*-tolyl	183–184[d]	70.2	6.13	S, 24.8	Mol. wt. in Bz 286[f]
Formaldehyde-di-*p*-tolyl[h]	186[e]	70.6	6.18	...	Mol. wt. in Bz 284;[f] mixed m. p. with previous product, 183[e,g]
m-Nitrobenzaldehyde-di-*p*-tolyl	180–181[d]	..	..	N absent	Cryst. with difficulty
2-Brom-5-hydroxybenzaldehyde-di-*p*-tolyl	179[d]	..	..	Br absent	Reaction slow; 10 hrs. boiling required
Benzophenone-diphenyl	No reaction				

[a] Weight of product obtained was about one-third to two-thirds the weight of mercaptal taken. [b] Colorless microcrystalline powder from dioxane. [c] Yellow plates from acetic acid. [d] Colorless prisms from acetic acid. [e] Colorless prisms from ethyl alcohol. [f] B. p. method using Menzies–Wright apparatus. [g] Approximate 1:1 mixture. [h] Reaction carried out at room temperature; inserted here for comparison with previous experiment.

acetic acid, 4 cc. of 40% aqueous formaldehyde added, and the clear solution saturated with hydrogen chloride. The mixture was then heated to gentle boiling in a 100-cc. side-neck flask fitted with a ground-on reflux condenser. A very slow current of hydrogen chloride was passed into the side-neck of the flask during the refluxing, which was continued until no further precipitate formed. This required from three to six hours in most cases, the product separating more completely on cooling. After filtering and washing, the product was recrystallized from glacial acetic acid, or dioxane in the case of less soluble materials. Table II gives data on eight experiments of this kind, involving seven mercaptals and one mercaptole.

Summary

1. Aromatic mercaptals have been found to undergo an apparent condensation reaction with formaldehyde in the presence of acetic acid and hydrogen chloride.

2. The crystalline products of this reaction given by eight different mercaptals have been described, and the possible nature of the reaction discussed.

3. Benzophenone diphenylmercaptole has been found to be unreactive under the conditions studied.

4. Five new crystalline mercaptals have been prepared and characterized.

PRINCETON, NEW JERSEY RECEIVED FEBRUARY 27, 1935

[CONTRIBUTION FROM THE CHEMICAL LABORATORY, CASE SCHOOL OF APPLIED SCIENCE]

Quinazolines. VII. The Interaction of 2,4-Dichloroquinazoline in Alcohol with Ammonia and with Methylamine

BY EDW. VOPICKA AND N. A. LANGE

The interaction of 2,4-dichloroquinazoline with ammonia and with methylamine received a very brief mention in a paper by Kötz[1] which he termed a preliminary report and in which he reserved the field to himself. A search of the literature to date does not disclose any further work with these reactions. Because of certain studies on the reaction of 2,4-dichloroquinazoline with aniline and other bases[2] it seemed desirable to repeat Kötz' work and to determine with more certainty just what products were formed.

When 2,4-dichloroquinazoline in alcohol is heated with ammonia or with methylamine, hydrochlorides of the monobasic diamines, 2,4-diaminoquinazoline and 2,4-dimethylaminoquinazoline, respectively, are formed. The corresponding free bases are readily obtained from their hydrochlorides by treatment with sodium alcoholates; they are colorless, easily soluble substances, crystallizing in needles, and forming characteristic salts. These two diaminoquinazolines and their salts show certain similarities to 2,4-dianilinoquinazoline:[2] like the dianilino derivative they are both monobasic as regards salt formation;

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(1) Kötz, *J. prakt. Chem.*, [2] **47**, 303 (1893).

(2) Lange and Sheibley, THIS JOURNAL, **53**, 3871 (1931).

and the acetic acid salts of diaminoquinazoline and dianilinoquinazoline both crystallize with one molecule of water of crystallization. The position of attachment of the molecule of acid in the salts of these bases remains in doubt.

All melting points given in this paper are corrected.

Experimental Part

Interaction of 2,4-Dichloroquinazoline with Ammonia and with Methylamine.—A mixture of 2,4-dichloroquinazoline (I) and alcoholic ammonia was heated in a sealed glass tube for two hours at 150°. The tube was cooled to room temperature and placed in cold water before it was opened. There was no pressure in the cold tube. The ammonium chloride which had separated during the heating was removed by filtering and washed with alcohol. The filtrate and washings were concentrated by evaporation and then 50 cc. of ether was added. The precipitate which formed on the addition of the ether was removed by filtering and consisted of a mixture of 2,4-diaminoquinazoline (free base) and its hydrochloride. After washing with alcohol and drying at 40° it melted at 281°. This product was dissolved in alcohol and to it was added an equal volume of sodium ethylate in alcohol (0.1 g. of sodium per 10 cc. of alcohol). The mixture was warmed over a flame for five minutes with stirring. The sodium chloride which precipitated was removed by filtering and washed with alcohol. The filtrate and washings were evaporated to a small volume and set aside to crystallize. The 2,4-diaminoquinazoline (II), $\overline{\mathrm{N{=}C(NH_2)C_6H_4N{=}C}}\mathrm{NH_2}$, which crystallized from the solution was filtered with suction, washed with ether and dried at 40°. Sometimes it was necessary to seed the solution with 2,4-diaminoquinazoline from a previous preparation. Attempts to crystallize it from slightly alkaline water were not successful, an amorphous product being obtained. Attempts to hydrolyze 2,4-diaminoquinazoline to benzoylene urea by prolonged boiling with *N* sodium hydroxide were also unsuccessful.

Similarly, when 2,4-dichloroquinazoline and an alcoholic solution of methylamine were heated in a sealed glass tube and the reaction product allowed to evaporate in the open air, white tufts of needles separated. These melted at about 264–270° and are no doubt the chlorine containing product which Kötz described as melting at 282–285°. This product consisted of a mixture of 2,4-dimethylaminoquinazoline hydrochloride, m. p. 312°, and methylamine hydrochloride, m. p. 226–227°; both of these are formed in the reaction. After treatment of this product with sodium ethylate in alcohol to liberate the bases from their salts,

TABLE I

PRODUCTS OBTAINED ON HEATING 2,4-DICHLOROQUINAZOLINE (I) WITH ALCOHOLIC SOLUTIONS OF AMMONIA[a] OR DIMETHYLAMINE[b]

Weight of (I), g.		2.0		3.5
Alc. amine soln., cc.		20 NH_3		35 $(CH_3)NH_2$
Prod. after EtONa treatment		2,4-Diaminoquinazoline (II)[c]		2,4-Dimethylaminoquinazoline (III)[d]
Yield, g.		0.7		2.0
M. p., °C.		259		120
Formula		$C_8H_8N_4$		$C_{10}H_{12}N_4$
Carbon, %	Calcd.	59.96		
	Found	59.79	59.73	
Hydrogen, %	Calcd.	5.04		
	Found	4.99	4.94	
Nitrogen, %	Calcd.	35.00		29.78
	Found	35.22	34.92	29.70

[a] Prepared by passing dry ammonia gas into 95% alcohol for thirty minutes. [b] Prepared by passing methylamine generated from methylamine hydrochloride and aqueous sodium hydroxide into 95% alcohol. [c] Colorless crystals from alcohol; soluble in acetone or hot water; slightly soluble in cold water; insoluble in ether or toluene. [d] Colorless crystals from chloroform; soluble in alcohol, acetone or benzene; insoluble in ether or water.

TABLE II

SALTS OF 2,4-DIAMINOQUINAZOLINE (II) AND 2,4-DIMETHYLAMINOQUINAZOLINE (III)

	M. p., °C.	Formula	Analyses, % Calcd.	Analyses, % Found
2,4-Diaminoquinazoline hydrochloride[a]	308	$C_8H_8N_4{\cdot}HCl$	Cl, 18.04	17.96
2,4-Diaminoquinazoline sulfate[b]	330	$(C_8H_8N_4)_2{\cdot}H_2SO_4$	S, 7.67	7.86
2,4-Diaminoquinazoline acetate[c]	208	$C_8H_8N_4{\cdot}C_2H_4O_2{\cdot}H_2O$	C, 50.39 H, 5.93	50.47 5.89
2,4-Diaminoquinazoline nitrate[d]	280	....	......	...
2,4-Diaminoquinazoline oxalate[e]	274	....	......	...
2,4-Diaminoquinazoline picrate[f]	304 (dec.)	....	......	...
2,4-Dimethylaminoquinazoline hydrochloride[g]	312	$C_{10}H_{12}N_4{\cdot}HCl$	Cl, 15.79	15.45
2,4-Dimethylaminoquinazoline picrate[h]	232	....	......	...

[a] Colorless needles; soluble in alcohol or water; insoluble in ether, acetone or toluene. [b] Small, fine, colorless needles from hot water; thorough washing with water was necessary to remove the last traces of sulfuric acid, the presence of which caused a decided lowering of the melting point. It is soluble in hot water, slightly soluble in cold water, and insoluble in alcohol, ether, acetone or toluene. [c] This salt separated rather slowly on the addition of glacial acetic acid to an alcoholic solution of the base. Recrystallized from alcohol it forms colorless crystals soluble in water or alcohol, slightly soluble in acetone, and insoluble in ether or toluene. [d,e,f] These salts were not analyzed. The picrate forms fine, feathery, yellow needles, slightly soluble in hot alcohol, acetone or water. [g] Fine, colorless needles from alcohol. [h] This salt precipitated on mixing alcoholic solutions of picric acid and 2,4-dimethylaminoquinazoline. The precipitate was collected, washed with alcohol, and dried. It was not analyzed.

the alcoholic solution was boiled to remove the excess methylamine. The sodium chloride which separated was removed by filtration and washed with alcohol; the filtrate was concentrated by evaporation and poured into cold water. Some of the free base, 2,4-dimethylaminoquinazoline (III), $N{=}C(NHCH_3)C_6H_4N{=}CNHCH_3$, separated in white flakes while the remainder formed an oil which gradually solidified in the course of four or five days. The solid product thus obtained was filtered and crystallized from chloroform using a carbon dioxide snow–ether mixture as the cooling medium.

The yields obtained, the composition, and some of the physical properties of these two bases are tabulated in Table I. A number of salts of these bases were readily obtained from their alcoholic solutions by adding acid either alone or in alcoholic solution. The properties of these salts are collected in Table II.

Preparation of 2,4-Diacetaminoquinazoline, $N{=}C(NHCOCH_3)C_6H_4N{=}C(NHCOCH_3)$.—A solution of 0.3 g. of 2,4-diaminoquinazoline and a small piece of fused sodium acetate in 10 cc. of acetic anhydride was refluxed on a water-bath for one hour. The colorless needles which separated were removed by filtration, washed with alcohol, then with ether, recrystallized from alcohol, and dried at 40°. A further quantity was obtained by pouring the acetic anhydride filtrate into 50 cc. of water, stirring until all was dissolved and adding dry sodium carbonate to the solution until effervescence ceased. The precipitate which formed was collected, washed with water, recrystallized from alcohol and dried at 40°. The total yield of 2,4-diacetaminoquinazoline was 0.2 g. It is soluble in hot water or hot alcohol, slightly soluble in acetone, and insoluble in ether; m. p. 230°.

Anal. Calcd. for $C_{12}H_{12}O_2N_4$: C, 58.99; H, 4.95; N, 22.95. Found: C, 58.68; H, 4.90; N, 23.08.

Summary

Ammonia or methylamine reacts with 2,4-dichloroquinazoline, splitting out two moles of hydrogen chloride and substituting the corresponding amino groups for the two halogens. The resulting diaminoquinazolines are monobasic. The following new compounds have been prepared: 2,4-dimethylaminoquinazoline and two of its salts, 2,4-diaminoquinazoline and six of its salts, and 2,4-diacetaminoquinazoline.

CLEVELAND, OHIO RECEIVED MARCH 6, 1935

[CONTRIBUTION FROM THE DEPARTMENT OF CHEMISTRY, COLUMBIA UNIVERSITY]

The Properties of the Amyloses. Corn α-Amylose and Retrograded β-Amylose[1]

BY T. C. TAYLOR AND S. G. MORRIS

In a cereal starch such as that from corn, there remains after disorganization of the granule a certain amount of material which is very resistant to attempts at dispersion in water. In contrast the other and larger part may be dispersed readily. A further distinction may be made between the two parts by the fact that the insoluble residue carries combined with its carbohydrate certain high molecular weight fatty acid groups.[2] This insoluble fraction is called α-amylose and the soluble fatty-acid free is called β-amylose.[3]

On long standing, especially under conditions that lower the solubility of the dispersed or soluble β-amyloses such as freezing temperatures, addition of alcohol or other reagents,[4] a portion of this one-time soluble material will become insoluble. Even on raising the temperature of its aqueous suspension mixture, some of the material will not disperse again to give a clear solution, but remains behind as a residue which is similar in appearance to the α-amylose. This insoluble residue is called retrograded amylose.

The soluble portions of all the common starches so far studied which are not degraded hydrolytically too greatly, have the property of retrograding after the granule has been disorganized and the dispersion in water made. It is this type of retrograded material that is under discussion here. Retrogradation, however, may apparently also take place in the granule itself.

In certain starches, notably potato, all the amyloid material may be dispersed[5] and since there are apparently no fatty acids esterified with any part of this material, there is, according to our view, no α-amylose fraction in the sense that it exists in corn starch.

Because of rapid retrogradation, however, of the dispersed amylose material from potato starch, large amounts of amylopectin (α-amylose) are often reported to be present in this starch also,

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[1] Taken from a dissertation presented by S. G. Morris to the Faculty of Pure Science of Columbia University in partial fulfilment of the requirements for the degree of Doctor of Philosophy.

[2] (a) Taylor and Nelson, THIS JOURNAL, **42**, 1726 (1920); (b) Taylor and Lehrman, *ibid.*, **48**, 1739 (1926).

[3] (a) Taylor and Iddles, *Ind. Eng. Chem.*, **18**, 713 (1926); (b) Taylor and Beckmann, THIS JOURNAL, **51**, 294 (1929).

[4] T. J. Schoch, Dissertation, Columbia University, 1933.

[5] Taylor and Schoch, THIS JOURNAL, **55**, 4248 (1933).