Spectrochemical analysis of this material showed the hafnium–zirconium ratio to be 0.027 (Hf/Zr = 2.7). The theoretical % values in a compound of this composition are: oxides, 35.09; SO_3, 44.76; H_2O, 20.15.

Determination of the oxides by precipitation with ammonium hydroxide gave 35.0%. Determination of SO_3 by precipitation with barium chloride gave 44.5%. Determination of the water by difference gave 20.5%.

It was observed that samples of the $Zr(SO_4)_2 \cdot 4H_2O$ lost only 0.05% in weight when dried for 18 hours at 105°. The same samples when heated at 400° for 18 hours lost an average of 21.4% which was assumed to be mostly water. Further heating of these same samples at 600° for 18 hours caused them to lose SO_3 to the extent of 41%. The remaining SO_3 was evolved extremely slowly and probably not completely because at the end of 186 hours of heating at 600 to 650° the loss for SO_3 rose to a total of 43.1%. In the last 18 hours of heating at 650° the loss in weight amounted to only 0.15%. If the material remaining after ignition at 650° is oxides, a value of 35.5% oxides in the original salt is indicated.

Examination of the final ignited product, by X-ray diffraction showed it to be ZrO_2, monoclinic form. The zirconium oxide so produced was found to be readily soluble in strong sulfuric acid.

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Effect of Temperature and Aggregation on the Absorption Spectrum of the Amylose–Iodine Complex[1]

BY JOSEPH F. FOSTER AND EUGENE F. PASCHALL

RECEIVED DECEMBER 10, 1951

A relationship between the wave length of maximum absorption of the iodine complex and the molecular weight of the amylose has been indicated by Baldwin, *et al.*[2] Higginbotham[3] has recently shown that the maxima reported by Baldwin are obtained only under conditions of limited iodine binding and that at higher iodine levels there is a shift of approximately 30 mμ in the direction of longer wave lengths. He attributed this shift to the forcing of additional iodine into the amylose helices.

It is the purpose of this note to report some preliminary results which suggest that this shift in absorption spectrum may be related, instead, to the state of aggregation of the complex. The figure summarizes data on the wave length of maximum absorption of two amylose preparations in the presence of excess iodine as a function of temperature. In this experiment the complex was formed at room temperature, then the solution raised to successively higher temperatures. The solution was permitted to equilibrate for approximately 15 minutes at each temperature prior to measuring the absorption spectrum. It will be noted that both amylose preparations give initial absorption maxima which agree approximately with those found by Higginbotham in the presence of excess iodine. At 40° the values agree rather well with those reported by Baldwin, and by Higginbotham in the presence of limited amounts of iodine. Above 40° there is little if any further shift. Furthermore the shift is largely irreversible since the wave length shifts back only partially on re-cooling to room temperature. Solutions held at temperatures of 70° in the presence of excess iodine for many hours showed little if any further shift, which tends to rule out any possibility of explaining the results on the basis of oxidative degradation at temperatures as low as 40°. Solutions of amylose held at 80° for long periods of time and cooled to 25° prior to addition of iodine gave the high values of λ_{max}.

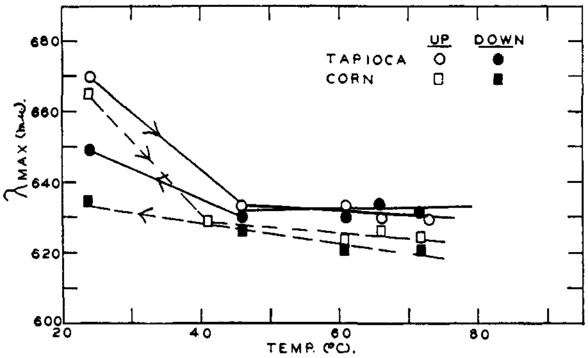

Fig. 1.

Other experiments led us to speculate on the possibility that the long wave lengths were a result of the presence of a special type of aggregate which we have shown to exist in amylose solutions even after dissolving in *N* KOH.[4] Therefore corn amylose was permitted to age in *N* KOH for two weeks, a treatment which has been found to result in an appreciable, though not complete, dissociation of these "native" aggregates.[4]

The λ_{max} shifted from 655 mμ, after 15 minutes and 3 hours standing, to 625 mμ after two weeks. Regeneration of the amylose by ethanol precipitation following this treatment did not affect the spectrum.

Another observation which suggests difference in the state of aggregation as the underlying cause of the spectral shift concerns the stability of the dispersions of the complex. Those showing the high λ_{max}. values invariably settled out of solution within three or four days. On the other hand, the heated complexes did not precipitate even after several weeks.

Within the framework of the theory of the amylose–iodine complex suggested by Rundle, Foster and Baldwin[5] these results suggest the possibility that in the form of the "native" aggregates there is an interaction between adjacent amylose helices which enhances the dipolar field.

We are indebted to Drs. Dexter French and R. E. Rundle for helpful discussions of these observations.

Experimental

The amylose samples were prepared by Dr. T. J. Schoch by pentasol crystallization followed by subfractionation with

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[1] Journal paper Number J-2043 of the Iowa Agricultural Experiment Station, Project 817. Supported in part by a grant from the Corn Industries Research Foundation. Taken from a thesis presented by Eugene F. Paschall in partial fulfillment of the requirements for the degree of Doctor of Philosophy, Iowa State College, 1951.

[2] R. R. Baldwin, R. S. Bear and R. E. Rundle, THIS JOURNAL, **66**, 111 (1944).

[3] R. S. Higginbotham, *J. Textile Inst.*, **40**, T783 (1949).

[4] E. F. Paschall and J. F. Foster, *J. Polymer. Sci.*, in press.

[5] R. E. Rundle, J. F. Foster and R. R. Baldwin, THIS JOURNAL, **66**, 2116 (1944).

n-octyl alcohol.[6] Solutions were prepared by dispersing the required amount of amylose in 1 *N* KOH to yield a concentration of 0.267% following neutralization with 0.5 *N* HCl. Aliquots of the neutralized solutions were diluted to a final concentration of 0.002%. To those solutions which were heated a layer of mineral oil was frequently added to help prevent loss of iodine. Excess iodine was frequently added during the experiments, but with no effect on the wave length of maximum absorption. Spectra were determined in 19 × 105 mm. round cuvettes with the aid of a Model 14 Coleman Universal spectrophotometer.

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[6] S. Lansky, M. Kooi and T. J. Schoch, *ibid.*, **71**, 4066 (1949).

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The Chemotherapy of Tuberculosis. III. Thiosemicarbazide Derivatives

BY THOMAS S. GARDNER, F. A. SMITH, E. WENIS AND J. LEE

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In the course of a program[1,2] on the synthesis of compounds for the chemotherapy of tuberculosis, a number of hitherto unreported thiosemicarbazones, acyl thiosemicarbazides, thiadiazole derivatives, and related classes that have already been reported on by other workers[3–6] have been made.

The compounds in Table I were prepared by the reaction of the parent substance with thiosemicarbazide in aqueous ethanol or aqueous ethanol–acetic acid in cases wherein the parent substance was not soluble in aqueous ethanol.

TABLE I

						Analyses, %			
						Calcd.		Found	
Thiosemicarbazones	Formula	Crystallized from	Color	Yield, %	M.p., °C.	Nitrogen	Sulfur	Nitrogen	Sulfur
Streptomycin trihydrochloride[a]	$C_{22}H_{42}O_{11}N_{10}S\cdot 3HCl$	Aq. HCl + EtOH	Colorless	10	205		4.2		4.4
Anisil mono	$C_{17}H_{17}O_3N_3S$	Acetone	Orange	67	227–228		9.4		9.4
Naphthazarin mono	$C_{11}H_9O_3N_3S$	EtOH	Purple-black	27	160 dec.	16.0		15.7	
Acenaphthenequinone mono	$C_{13}H_9ON_3S\cdot H_2O$	Aq. EtOH	Yellow	50	223–224	15.4[b]		15.5	
Acenaphthenone	$C_{13}H_{11}N_3S$	EtOH	Yellow	88	227–228	17.4		17.1	
2-Methyl-3-hydroxy-5-hydroxymethylisonicotinaldehyde	$C_9H_{12}O_2N_4S\cdot {}^1/_2H_2SO_4$	Water	Yellow	63	194 dec.	9.7[c]	16.6	10.1[c]	16.5
2-Pyrryl methyl ketone	$C_7H_{10}N_4S$	EtOH	Colorless	74	184–185		17.5		16.9
D(+)-Mannose[d]	$C_7H_{15}O_5N_3S\cdot C_2H_5OH$	EtOH	Colorless	>90	175–176 dec.		10.5		10.4[c]
L(−)-Mannose[e]	$C_7H_{15}O_5N_3S$	Water	Colorless	>90	173–174 dec.	[f]			
D(+)-Glucose	$C_7H_{15}O_5N_3S$	80% EtOH	Colorless	>90	190[g] dec.		12.7		12.7
D(−)-Arabinose	$C_6H_{13}O_4N_3S$	[h]	Colorless	>90	151–152		14.4		13.9
L(+)-Arabinose	$C_6H_{13}O_4N_3S$	[h]	Colorless	>90	151–152		14.4		14.3
Nicotinaldehyde S-methyl[i]	$C_8H_{10}N_4S$	Aq. EtOH	Yellow	89	110–111		16.5		16.3
4-Acetamidobenzaldehyde-4'-phenyl-	$C_{16}H_{16}ON_4S$	HOAc	Yellow	94	200–201	[j]			

[a] Reported in solution without being isolated, R. Donovick, G. Rake and J. Fried, *J. Biol. Chem.*, **164**, 173 (1946). [b] Calcd.: C, 57.2; H, 4.0. Found: C, 56.5; H, 3.4. [c] Two nitrogens by Kjeldahl. [d] % volatile calcd. 18.2; Found: 18.5. [e] The L(−)-mannose thiosemicarbazone also formed the alcoholate from ethanol similar to the D(+)-isomer and was not analyzed because it had the same melting point as the D(+)-isomer and did not exhibit a mixed m.p. depression with the D-isomer. [f] Calcd.: C, 33.2; H, 5.9. Found: C, 33.1; H, 5.9. [g] Reported m.p. 204°; Neuberg and W. Neiman, *Ber.*, **35**, 2049 (1902). [h] Triturated with hot methanol instead of being recrystallized. [i] Method of E. Hoggarth *J. Chem. Soc.*, 1579 (1950). [j] Calcd.: C, 61.5, H, 5.1. Found: C, 61.3; H, 5.1.

All of the compounds prepared were inactive in experimental mouse tuberculosis.

Acknowledgment.—We are indebted to Dr. Al Steyermark and his associates for the microanalyses and Drs. R. J. Schnitzer and E. Grunberg for the chemotherapeutic screening.

Experimental

1-(3-Pyridyl)-thiosemicarbazide.—3-Pyridylhydrazine (15 g., 0.137 mole) was refluxed for 6 hours with 12.7 g. of ammonium thiocyanate and 18 ml. of 9 *N* HCl in ethanol in 350 ml. of ethanol. The separated crude product was recovered by filtration and crystallized from aqueous ammonia solution; yield 5 g. (21%), m.p. 223–224°.

Anal. Calcd. for $C_6H_8N_4S$: C, 42.8; H, 4.8. Found: C, 43.0; H, 4.6.

2,3-Dihydro-5-(2'-acetoxy-4'-nitrophenyl)-2-phenylamino-1,3,4-thiadiazole.—Acetyl *p*-nitrosalicylic acid (67.5 g., 0.3 mole) was converted to the acid chloride by 62.4 g. of PCl_5. The acid chloride obtained was treated with 50.1 g. (0.3 mole) of 4-phenyl-3-thiosemicarbazide in nitromethane as a solvent. The reaction solution was heated for 4 hours on the steam-bath. On cooling, 30 g. of the product separated, and further heating and cooling gave 4.3 g. more of the crude product. The combined crude fractions (34.3 g.) were recrystallized from nitrobenzene; yield 23.3 g. (20%), m.p. 316–317°.

Anal. Calcd. for $C_{16}H_{12}O_4N_4S$: C, 53.9; H, 3.4. Found: C, 54.0; H, 3.2.

2,3-Dihydro-5-(2'-hydroxy-4'-aminophenyl)-2-phenylamino-1,3,4-thiadiazole.—2,3-Dihydro-5-(2'-acetoxy-4'-nitrophenyl)-2-phenylamino-1,3,4-thiadiazole (13 g., 0.036 mole) was added in portions to 100 ml. of phenylhydrazine and 150 ml. of anisole. The reduction was heated at reflux for 2 hours and on cooling crystallized a buff-colored product. The recovered product was recrystallized twice from anisole; yield 9.6 g. (92%), m.p. 282–283°.

Anal. Calcd. for $C_{14}H_{12}ON_4S$: C, 59.2; H, 4.2. Found: C, 59.5; H, 4.3.

1-(*p*-Acetamidobenzoyl)-thiosemicarbazide.—*p*-Acetamidobenzoyl chloride (9.5 g., 0.048 mole) was added to 20 ml. of 10% sodium hydroxide solution containing 4.4 g. (0.048 mole) of thiosemicarbazide. The reaction solution became warm and was cooled and stirred for 2 hours. The product was recovered by filtration and washed with water; crude yield 9.1 g. (75%), m.p. 192–194° (dec.). A small sample was recrystallized by solution in ethylene glycol and addition of water to turbidity, m.p. 221° (dec.) of the colorless crystals.

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