measured is equal to the partial specific volume (dV/dg) provided these quantities are independent of concentration. This appears to be true, at least in the case of zein. Less precision was obtained with gliadin than with zein, due in part to the greater fragility of the gliadin pellets and possibly in part to the fact that pressing into pellets caused a partial denaturation and insolubilization of gliadin[6] (of the order of a few tenths of one per cent.).

TABLE I

SUMMARY OF RESULTS

Preparation[a]	Initial concn.	Final concn.	$\Delta V/\Delta g$[b]
Standard Zein (commercial zein not further purified)	0.00	0.41	0.770
	.00	.71	.766
	.00	1.15	.773
	1.15	2.21	.772
	2.21	3.20	.773
			Av. = 0.771 ± 0.002
Washed Standard Zein (commercial zein repeatedly washed by suspension in H_2O)	0.00	0.83	0.773
	.83	1.59	.771
	1.59	2.49	.771
			Av. = 0.772 ± 0.001
Fractionated Standard Zein (main component of commercial sample after removal of the most and least soluble material)	0.00	0.50	0.778
	.00	.81	.776
	.81	1.81	.776
	1.81	2.81	.776
			Av. = 0.776 ± 0.001
Fractionated Standard Zein in 52% ethanol ($\bar{V}_w$ = 0.959)	0.00	0.67	0.778
	.67	1.54	.773
			Av. = 0.776 ± 0.003
Laboratory Zein (prepared by low temperature extraction of white corn)	0.00	0.80	0.775
	.80	1.72	.777
			Av. = 0.776 ± 0.001
Gliadin (Connecticut Agricultural Experiment Station preparation)	0.00	0.63	0.723
	.63	1.31	.723
	1.31	2.03	.733
	2.33	3.11	.718
			Av. = 0.724 ± 0.004

[a] The measurements on zein, except in the two cases indicated, were in 73% aqueous alcohol ($\bar{V}_w$ = 0.927). In the case of gliadin the solvent was 62% alcohol ($\bar{V}_w$ = 0.944). [b] The precision of the measurements is indicated in terms of mean deviations.

The differences between the various zein preparations are slight and probably due in large part to inorganic impurities which would be expected to cause a decrease in specific volume by electrostriction. The higher value, 0.776, obtained on the more purified preparations is probably closest to the true value for zein. To the authors' knowledge this is the highest value yet reported for any unconjugated protein (most values range from 0.73 to 0.75) and reflects the unusually high proportion of non-polar amino acids in zein. The results also indicate the partial specific volume of zein to be independent of alcohol concentration over the range 52–73%.

The large difference in partial specific volume between zein and gliadin is not unexpected on the basis of their amino acid compositions. Thus using the corrected molal volumes of the amino acid residues as given by Cohn and Edsall[7] together with the amino acid compositions collected by them, one calculates the values 0.75_2 and 0.70_5 for zein and gliadin, respectively, both of which are lower by 3% than the values found experimentally. This might be interpreted as indicating deficiencies in the present amino acid analyses of these proteins.

The dilatometric technique is most applicable to systems involving organic solvents (a large temperature coefficient of expansion and good drainage qualities are essential). Experiments involving water as solvent have proved quite unsatisfactory.

(6) This denaturing effect of pressing into pellets was also observed in an experiment with serum albumin.

(7) E. J. Cohn and J. T. Edsall, "Proteins, Amino Acids and Peptides," Chaps. 15 and 16, Reinhold Publishing Corporation, New York, N. Y., 1943.

DEPARTMENT OF PHYSICAL CHEMISTRY
HARVARD MEDICAL SCHOOL
BOSTON, MASS. RECEIVED DECEMBER 12, 1944

Preparation of Chloroacetaldehyde Hydrate

BY LEWIS F. HATCH AND HAROLD E. ALEXANDER[1]

Recently a method has been described[2] for the preparation of alkoxyacetaldehydes by the oxidation of the α-alkyl ethers of glycerol using periodic acid as the oxidizing agent. This method for the preparation of substituted acetaldehydes has been extended to the preparation of chloroacetaldehyde hydrate by the oxidation of glycerol α-monochlorohydrin with periodic acid.

Experimental

One-half mole of Eastman Kodak Co., "practical" grade glycerol α-monochlorohydrin was oxidized by 0.50 mole of periodic acid under the same conditions as used for the oxidation of the α-alkyl ethers of glycerol.[2] Eighteen ml. (25.2 g.) of material boiling at 84° (742 mm.) was obtained. Chloroacetaldehyde and its hydrate are both reported[3] to boil at 85–85.5°.

Refluxing two 3-g. samples of the product for three hours with 20% alcoholic potassium hydroxide gave 35.6% saponifiable chlorine. The theoretical chlorine for $CH_2ClCHO \cdot H_2O$ is 36.8%. This would indicate a purity of 97% and a yield of 50%. This yield can be increased to about 60% by redistilling the material boiling between 84–98° obtained after removal of the material boiling at 84°.

The semicarbazone melted at 133–134° (literature 134°[4]) and decomposed in hot aqueous solutions.

(1) At present on active duty with the U. S. N. R.
(2) Hatch and Nesbitt, THIS JOURNAL, 67, 39 (1945).
(3) Natterer, *Monatsh.*, 3, 442 (1882).
(4) Kling, *Compt. rend.*, 148, 568 (1909).

DEPARTMENT OF CHEMISTRY
THE UNIVERSITY OF TEXAS
AUSTIN, TEXAS RECEIVED DECEMBER 9, 1944

Derivatives of Ipral, Neonal, Nostal and Sandoptal: an Optical Crystallographic Study

BY MARTIN E. HULTQUIST, CHARLES F. POE AND NORMAN F. WITT

In previous studies, the optical properties of ten substituted benzyl esters of barbital and

TABLE I

ANALYTICAL DATA

Derivative	Crystal form	Formulas	M. p., °C. Block	M. p., °C. Tube	Halogen Calcd.	Halogen Found	
Ipral	Rods	$C_9H_{14}N_2O_3$	202	199.5	...	...	...
p-Nitrobenzyl	Thin plates	$C_{23}H_{24}N_4O_7$	157	157	N, 11.97	11.85	12.02
p-Bromobenzyl	Rods and plates	$C_{23}H_{24}N_2O_3Br_2$	153	151	Br, 29.87	29.98	30.05
p-Chlorobenzyl	Rods and plates	$C_{23}H_{24}N_2O_3Cl_2$	146	145	Cl, 15.90	15.99	15.86
Neonal	Needles	$C_{10}H_{16}N_2O_3$	129	127–8	...	...	...
p-Nitrobenzyl	Yellow needles and rods	$C_{24}H_{26}N_4O_7$	149	148	N, 11.62	11.46	11.66
p-Bromobenzyl	Rods and plates	$C_{24}H_{26}N_2O_3Br_2$	98	99	Br, 29.06	29.15	29.01
p-Chlorobenzyl	Rods and plates	$C_{24}H_{26}N_2O_3Cl_2$	96	95	Cl, 15.38	15.35	15.55
Nostal	Plates	$C_{10}H_{13}N_2O_3Br$	169	178	...	...	...
p-Nitrobenzyl	Yellow rods and plates	$C_{24}H_{24}N_4O_7Br$	206	204	N, 10.00	10.00	9.91
p-Bromobenzyl	Thick plates	$C_{24}H_{24}N_2O_3Br_3$	147	146	Br, 38.18	38.21	38.32
p-Chlorobenzyl	Diamond shaped plates	$C_{24}H_{24}N_2O_3Cl_2Br$	142	141	Cl, 27.98	28.25	28.02
Sandoptal	Plates and rods	$C_{11}H_{16}N_2O_3$	139	138	...	...	...
p-Nitrobenzyl	Yellow rods and needles	$C_{25}H_{27}N_4O_7$	180	178	N, 11.31	11.25	11.15
p-Bromobenzyl	Diamond shaped plates	$C_{25}H_{27}N_2O_3Br_2$	128	127	Br, 28.28	28.20	28.36
p-Chlorobenzyl	Diamond shaped plates	$C_{25}H_{27}N_2O_3Cl_2$	122	122	Cl, 14.95	14.94	15.08

phenobarbital were reported.[1] A similar study[2] has been reported from this Laboratory for the detection of amytal, pentobarbital, and dial. Castle and Poe[3] prepared the *o*-chlorobenzyl, *p*-chlorobenzyl, *o*-bromobenzyl, *p*-bromobenzyl, and *p*-nitrobenzyl derivatives of cyclopal, delvinal, seconal and sigmodal, and suggested that the detection of these barbiturates could be made from the melting points of the derivatives.

Since chemical tests are not entirely satisfactory for the identification of some of the newer derivatives of barbituric acid, the optical crystallographic study has been extended to include four additional barbiturates: ipral (5-ethyl-5-isopropylbarbituric acid), neonal (5-ethyl-5-butylbarbituric acid), nostal (5-isopropyl-5-β-bromoallylbarbituric acid) and sandoptal (5-allyl-5-isobutyl-1,3-barbituric acid).[4] The preparation of none of the derivatives reported in this investigation, however, had been reported in the literature with the exception of the *p*-nitrobenzyl derivatives of ipral, neonal, nostal, and sandoptal.[5]

Preparation and Analysis.—Equivalent amounts of the barbituric acid derivatives and potassium or sodium carbonate were dissolved in a little more than enough boiling water to make a saturated solution. This solution was added to a solution of the substituted benzyl halide (two molecular quantities) dissolved in an amount of alcohol twice as large as the amount of water used to dissolve the barbituric acid salt. The resulting mixture was refluxed until the reaction was completed. Crystals of the derivative usually separated out of the solution during the heating. After being cooled the derivatives were separated by filtration and purified by recrystallization from a mixture of chloroform and alcohol until there was no change in the melting point of the given compound. The crystals were dried in air; none of the compounds contained water of crystallization.

Each compound was analyzed for halogen or nitrogen. The melting points were determined by both the tube method and the "Bloc Maquenne" method.

The *p*-nitrobenzyl, *p*-bromobenzyl and *p*-chlorobenzyl derivatives were prepared with each of the medicinal substances. The analytical results are presented in Table I.

Optical Crystallographic Data.—The optical properties were obtained by the use of a petro-

TABLE II

OPTICAL CRYSTALLOGRAPHIC DATA; ALL MONOCLINIC

Derivative	Optical sign	Elongation	Extinction angle in degrees	Refractive indices at 25° Alpha	Beta	Gamma	Axial dispersion
Ipral	−	+	32	1.477	1.573	1.624	None
p-Nitrobenzyl	[a]	−	35	1.563	[a]	1.696	[a]
p-Bromobenzyl	+	−	6	1.567	1.582	1.705	None
p-Chlorobenzyl	+	−	7	1.551	1.568	1.674	None
Neonal	−	−	26	1.456	1.520	1.552	None
p-Nitrobenzyl	+	+	20	1.546	1.556	1.705	$v > r$
p-Bromobenzyl	−	≐	40	1.519	1.644	1.705	None
p-Chlorobenzyl	−	≐	40	1.516	1.640	1.699	None
Nostal	−	≐	36	1.524	1.598	1.633	$v > r$
p-Nitrobenzyl	+	+	20	1.587	1.593	1.725	$r > v$
p-Bromobenzyl	+	+	12	1.606	1.611	1.720	$r > v$
p-Chlorobenzyl	+	+	20	1.599	1.605	1.710	None
Sandoptal	−	+	20	1.511	1.574	1.584	$r > v$[b]
p-Nitrobenzyl	+	+	20	1.553	1.559	1.710	$r > v$
p-Bromobenzyl	+	+	10	1.548	1.574	1.706	None
p-Chlorobenzyl	+	≐	12	1.545	1.567	1.690	None

[a] Could not be determined as no optic axis interference figure could be seen. [b] Sandoptal showed both axial and crossed dispersion.

(1) M. E. Hultquist and C. F. Poe, *Ind. Eng. Chem., Anal. Ed.*, **7**, 398 (1935).

(2) M. E. Hultquist, C. F. Poe and N. F. Witt, *ibid.*, **14**, 219 (1942).

(3) R. N. Castle and C. F. Poe, THIS JOURNAL, **66**, 1440 (1944).

(4) The authors wish to thank the following firms which furnished the barbiturates: The Abbot Laboratories, North Chicago, Illinois; Riedel-de Haen, Inc., New York, N. Y.; The Sandoz Chemical Works, Inc., New York, N. Y.; E. R. Squibb and Sons, New York, N. Y.

(5) E. Lvons and A. W. Dox, THIS JOURNAL, **51**, 288 (1929).

graphic microscope, and are presented in Table II. The refractive indices were determined by the immersion method, with the interference figures being used as a means of determining the optical orientation of the crystals. The light source was that from the northern sky. The extinction angle on these compounds was the most commonly observed angle between the elongation of the crystal and an extinction direction. The most usual orientations are noted in order to facilitate the use of the optical properties in the detection of the barbiturates. The temperature at which the indices were taken was 25 ± 1°.

The optical properties of the derivatives of the three compounds differ sufficiently from each other to allow the use of the optical data in the identification of the original barbituric acid derivatives. No previous optical crystallographic data have been reported for the derivatives of these barbiturates.

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF COLORADO
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The Storing of Hydrocyanic Acid

BY VERNON K. KRIEBLE AND ROBERT SMELLIE, JR.

During the last few years it has been difficult to obtain liquid hydrocyanic acid promptly. Laboratories using this chemical have apparently retained the metal cylinders in which it was shipped until the acid was used up.

We have found that hydrocyanic acid mixed with an equal volume of glacial acetic acid makes a solution which can be kept indefinitely. Such solutions have been kept on our shelves for as long as two years with the temperature in the laboratory above 90° F. during the summer with no loss or deterioration of hydrocyanic acid. The containers never exhibit any pressure when opened. Whenever hydrocyanic acid is wanted it is distilled out of the acetic acid through any ordinary fractionating column and the acetic acid used over again. As the acid in the cylinders needs to be distilled anyway, if a pure sample is desired, there is little more trouble in distilling it out of the acetic acid than distilling it directly.

There is no difficulty in mixing hydrocyanic acid and acetic acid. The hydrocyanic acid can be poured into a container holding an equal quantity of acetic acid and the container rotated until the solution is uniform. If glass bottles are used they should be insulated against breakage preferably with an outside container filled with some absorbent material. This hydrocyanic acid–acetic acid solution should be poured and distilled in a well-ventilated hood only. In fact, this solution should be treated with the same care as pure *hydrocyanic acid*.

DEPARTMENT OF CHEMISTRY
TRINITY COLLEGE
HARTFORD, CONNECTICUT RECEIVED DECEMBER 11, 1944

The Preparation and Alcoholysis of Phenyl Iminoester Hydrochlorides

BY S. M. MCELVAIN AND BERNARDO FAJARDO-PINZÓN

The chief difficulty encountered in the conversion of a nitrile to an orthoester by the Pinner method[1] is the decomposition of the intermediate iminoester hydrochloride (I) into an amide (II) and an alkyl chloride (reaction 1) during the alcoholysis to the orthoester (reaction 2).

$$RCN + R'OH \xrightarrow{HCl} RC(OR')=NH\cdot HCl \longrightarrow RC(=O)NH_2 + R'Cl \quad (1)$$

(I → II)

$$I + R'OH \longrightarrow RC(OR')_3 + NH_4Cl \quad (2)$$

Some of the competitive reaction (1) always occurs, but it may be minimized in those cases in which the R of I is an unsubstituted methyl group or one that is monosubstituted with alkyl, halogen or ethoxy[2] by keeping the temperature of the alcoholysis below 40°. However, when the α-carbon of R carries two or more of these substituents, experience[3] in this Laboratory has shown that the yield of the orthoester drops sharply and that the amide is the major if not the sole reaction product when such an iminoester hydrochloride is merely dissolved in an alcohol.

It seemed that this undesirable decomposition of the iminoester salt could be avoided if R′ in I were phenyl, since the strength of the O—C_6H_5 linkage would prevent its facile rupture to produce the amide (II) and chlorobenzene. This has proved to be the case with phenyl chloro- and bromoacetiminoester hydrochlorides. These salts —which are formed in 70% and 41% yields, respectively, from the corresponding nitriles, phenol and hydrogen chloride—may be heated in boiling absolute alcohol solution without excessive amide formation.

The structures of the halogeno-orthoesters (III) resulting from this alcoholysis are shown by the fact that they are identical with those obtained from the addition of phenol to the halogenoketene diethylacetals.

$$XCH{=}C(OC_2H_5)_2 + C_6H_5OH \longrightarrow \underset{\text{III}}{XCH_2C(OC_2H_5)_2OC_6H_5}$$

In contrast to the halogenacetonitriles, acetonitrile reacts very slowly and incompletely with phenol and hydrogen chloride in ether solution; only 27% of the iminoester hydrochloride is formed after 15 days. Alcoholysis converts this salt to the orthoester (III, X = H) which also may be formed from the reaction of phenol with ketene diethylacetal.[4]

(1) Pinner, *Ber.*, **16**, 356, 1644 (1883).
(2) McElvain, *et al.*, THIS JOURNAL, **64**, 1825, 1963, 1966 (1942).
(3) Unpublished work of R. L. Clarke, R. E. Kent and Bryce Tate.
(4) McElvain and Kundiger, THIS JOURNAL, **64**, 259 (1942).