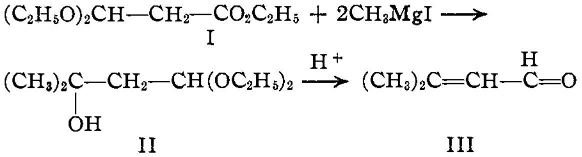
β-Methylcrotonaldehyde

BY N. L. WENDLER AND H. L. SLATES

The methods reported for the preparation of β-methylcrotonaldehyde are few in number[1] as well as seriously limited from a preparative standpoint. The present synthesis was developed in connection with work requiring the use of this isoprenoid aldehyde.

The reaction of ethyl β,β-diethoxypropionate (I) with methylmagnesium iodide followed by acid treatment of the intermediate β-hydroxyisovaleraldehyde diethyl acetal (II) afforded β-methylcrotonaldehyde (III) in 40% yield by direct isolation and in 60% yield when isolated as its 2,4-dinitrophenylhydrazone derivative. Since ethyl β,β-diethoxypropionate is now readily available from the reaction of ketene with ethyl orthoformate,[2] a relatively simple synthetic route is thus possible for the preparation of β-methylcrotonaldehyde.



$$\underset{\text{I}}{(C_2H_5O)_2CH—CH_2—CO_2C_2H_5} + 2CH_3MgI \longrightarrow$$

$$\underset{\text{II}}{(CH_3)_2\underset{\displaystyle OH}{\underset{|}{C}}—CH_2—CH(OC_2H_5)_2} \xrightarrow{H^+} \underset{\text{III}}{(CH_3)_2C{=}CH—\overset{H}{C}{=}O}$$

Experimental

β-Methylcrotonaldehyde.—A solution of 76 g. (0.4 mole) of ethyl β,β-diethoxypropionate in 100 cc. of anhydrous ether was added dropwise with stirring at 0–10° to a solution of 1 mole of methylmagnesium iodide prepared from 24 g. of magnesium and 150 g. of methyl iodide in 500 cc. of anhydrous ether. After addition was complete, the reaction mixture, which consisted of two phases, was allowed to stir for one to two hours at room temperature. During this period the reaction mixture became nearly homogeneous. The reaction product was poured onto ice and decomposed with saturated aqueous ammonium chloride solution. The organic material was extracted thoroughly with ether and the ether extracts washed successively with aqueous sodium bicarbonate solution and water and dried over anhydrous sodium sulfate. Evaporation of the ether *in vacuo* afforded crude β-hydroxyisovaleraldehyde diethyl acetal as a lemon-colored oil, wt. 68–70 g.

A solution of 25 g. of (II) in 25 ml. of ethanol was treated with 100 cc. of 3% aqueous sulfuric acid. The homogeneous solution was warmed 4–5 minutes on a steam-bath until turbidity developed and was then allowed to stand at room temperature for fifteen to eighteen hours. The reaction product, possessing an upper oily layer, was diluted with an equal volume of water, saturated with sodium chloride, and thoroughly extracted with ether. The ether extracts were washed with aqueous sodium bicarbonate until neutral to litmus and dried over anhydrous magnesium sulfate. Evaporation of the ether and fractional distillation of the residue in a stream of nitrogen afforded 4.8–5 g. of β-methylcrotonaldehyde, b. p. 130–135° (40%); reported 130–135°[1a]; *semicarbazone*, needles from methanol–m. p. 222–223°; $\lambda^{\text{ethanol}}_{\text{max.}}$ 2700 Å., $E^{1\%}_{1\text{ cm.}}$ 2270 (reported m. p. 221–222°[1c]; $\lambda_{\text{max.}}$ 2730, E = 33,500[3]).

β-Methylcrotonaldehyde-2,4-dinitrophenylhydrazone.—Obtained from 0.5 g. of the crude β-hydroxyisovaleraldehyde diethyl acetal as glittering red needles from ethanol–ethyl acetate; wt. 0.45–0.47 g. (60%); m. p. 184–185°; $\lambda^{\text{ethanol}}_{\text{max.}}$ 3800 Å., $E^{1\%}_{1\text{ cm.}}$ 1080 in chloroform. (Reported m. p. 182–183°[1c]; $\lambda_{\text{max.}}$ 3820, E = 29,000 in chloroform.[4])

Anal. Calcd. for $C_{11}H_{12}O_4N_4$: C, 50.00; H, 4.55; N, 21.21. Found: C, 50.17; H, 4.26; N, 21.21.

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(1) (a) Fischer and Löwenberg, *Ann.*, **494**, 263 (1932); *Ber.*, **69**, 30 (1931); (b) Burkhardt, Aldersley and Heilbron, British Patent 512,465; (c) Jones and Weedon, *J. Chem. Soc.*, 937 (1946).

(2) Gresham, U. S. 2,449,471; *C. A.*, **43**, 1055 (1949).

(3) Evans and Gillam, *J. Chem. Soc.*, 5656 (1943).

(4) Braude and Jones, *ibid.*, 498 (1945).

Further Observations on the Preparation and Reactions of Positive Iodine Salts

BY RALPH A. ZINGARO, CALVIN A. VANDERWERF AND JACOB KLEINBERG

In earlier reports[1,2] dealing with the preparation of monopyridine and monopicoline iodine (I) salts of aromatic acids, it was found that certain ortho and para substituted derivatives could not be prepared by the method employed. A number of these compounds have now been prepared by a slight modification of the original procedure. Their yields and decomposition points are reported in Table I. Attempts to prepare the *o*-iodobenzoate, *o*-toluate and *m*-toluate were still unsuccessful.

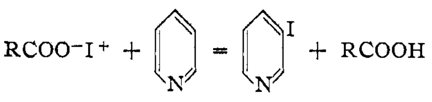
TABLE I

SOME NEW POSITIVE IODINE SALTS

Salt	Decompn. point, °C. (uncor.)	Yield, %	Iodine, %[a] Calcd.	Found
Mono-α-picoline iodine (I) *p*-bromobenzoate	119–121	75	30.2	30.2, 30.1
Monopyridine iodine (I)				
o-Chlorobenzoate	91–95	45	35.1	35.3, 35.1
m-Chlorobenzoate	94–97	51	35.1	35.1, 35.0
o-Bromobenzoate	101–106	68	31.2	31.2, 31.2

[a] For analytical method see ref. 1.

Very small amounts (1–2% of the theoretical) of 3-iodopyridine and 3,5-diiodopyridine were isolated in the reactions of the following representative silver salts with iodine and pyridine in chloroform: *o*-toluate, *o*-chlorobenzoate, *m*-chlorobenzoate and *m*-iodobenzoate. A yield of 1.7% of 5-iodo-2-methylpyridine was obtained in the reaction of silver *m*-chlorobenzoate with iodine in the presence of α-picoline. Thus, the formation of at least some of the free acid noted in the previous communication,[1] can be accounted for by reactions of the type indicated in the equation



Experimental

The solvents, acids and salts were prepared or purified as previously described.

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(1) Zingaro, Goodrich, Kleinberg and VanderWerf, THIS JOURNAL, **71**, 575 (1949).

(2) Carlsohn, "Über eine neue Klasse von Verbindungen des positiv einwertigen Jods," Verlag von S. Hirzel, Leipzig, 1932.

Method of Preparation of Positive Iodine Salts.—The reaction of the silver carboxylates with iodine was carried out as previously reported,[1] except that the chloroform filtrate in which the positive iodine salt was dissolved was treated with three volumes of Skellysolve A and permitted to cool in a Dry Ice chest for 48 hours. The crystalline salts were filtered, washed with dry ether, and dried *in vacuo* over sulfuric acid.

Formation of Iodopyridines.—A positive iodine salt[3] was refluxed in dry ether for 72 hours. The mixture was then filtered and the residue washed with dry ether and discarded. Any iodine present in the combined ether solutions was removed by treatment with aqueous thiosulfate. The ether solution was then extracted with sodium carbonate solution, washed with water and extracted with 20% HCl. The acid extract was concentrated and cooled, and treated with gaseous ammonia until precipitation occurred. Sublimation of the filtered precipitate gave colorless needles of **3-iodopyridine**, m. p. 53–54°, which with chlorine readily formed the yellow iodochloride, m. p. 127–129°. Yields of pure 3-iodopyridine obtained in typical runs were as follows: A, from 280 g. of silver *o*-chlorobenzoate, 1.6 g. (0.8%); B, from 76 g. of monopyridine iodine (I)-*o*-chlorobenzoate, 1.2 g. (2.7%); C, from 237 g. of silver *m*-chlorobenzoate, 1.2 g. (0.6%). Because of the extreme volatility of 3-iodopyridine, it is probable that the amounts isolated were considerably smaller than those actually formed in the reaction.

On standing, the filtrate remaining after removal of the 3-iodopyridine in C deposited 0.9 g. (0.3%) of **3,5-diiodopyridine**, m. p. after recrystallization from high boiling petroleum ether 172–172.8°. The hydrochloride melted at 193.9–194.7°.[4]

5-Iodo-2-methylpyridine.—In one experiment in which α-picoline was used in place of pyridine, 127 g. of silver *m*-chlorobenzoate gave a basic fraction from which there was isolated 1.4 g. (1.7%) of **5-iodo-2-methylpyridine**, a heavy oil, b. p. 205–210°. The picrate melted at 149°.[5]

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[3] The same results were obtained if, in place of the positive iodine salt, one used the residue isolated by removal of silver iodide and evaporation of the solvent from the mixture obtained in the reaction of a silver carboxylate with iodine in the presence of pyridine in chloroform solution.

[4] Baumgarten, *Ber.*, **72B**, 567 (1939), reported a m. p. of 171.5° for 3,5-diiodopyridine and of 195–196° for the hydrochloride.

[5] Plazek and Rodewald, *Roczniki Chem.*, **21**, 150 (1947) [*C. A.*, **42**, 5456b (1948)] reported the b. p. of 5-iodo-2-methylpyridine as 205–215° and the m. p. of the picrate as 150°.

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NEW COMPOUNDS

Allophanates[1,2]

These allophanates were prepared in order to establish them as easily made derivatives for the alcohols. The procedure employed was to depolymerize cyanuric acid in a slow stream of carbon dioxide at 360–400° by means of an electrically operated heater and to pass the cyanic acid

TABLE I

ALLOPHANATES, $ROCONHCONH_2$

R	Alcohol B. p. °C.	Alcohol B. p. Mm.	n^{25}_D	M. p., °C.	Solvents for recrystn.	Formula	Carbon, % Calcd.	Carbon, % Found	Hydrogen, % Calcd.	Hydrogen, % Found	Nitrogen, % Calcd.	Nitrogen, % Found
d,l-iso-$C_3H_7CH(CH_3)$–	111.5–112.0	760	1.4071 1.4091(20)	163[a]	Acetone(2×) Ethanol	$C_7H_{14}N_2O_3$	48.26	48.56	8.10	8.24	16.08	15.8 15.8
$(C_2H_5)_2CHCH_2$–	147.7	751	1.4200	161.0–161.5[b]	Ethanol(3×) Acetone(2×)	$C_8H_{16}N_2O_3$	51.04	51.09 50.84	8.57	8.47 8.70	14.89	14.94
(iso-$C_3H_7)_2CH$–	138	762	1.4214 1.4230(20)	173.5–174.5	Ethanol(2×) Acetone(2×)	$C_9H_{18}N_2O_3$	53.44	53.42	8.97	8.97	13.85	13.70
t-$C_4H_9CH_2CH(CH_3)CH_2CH_2$–	191	752	1.4308	148.5–149.0	Ethanol(2×)	$C_{11}H_{22}N_2O_3$	57.36	57.11 57.06	9.63	9.63 9.65	12.17	12.17
n-$C_{14}H_{29}$–	M. p. 38			156.0–156.5	Ethanol(2×) Acetone(2×)	$C_{16}H_{30}N_2O_3$	63.96	64.00 63.66	10.74	10.59 10.51	9.33	9.49

[a] Ref. 5 reports 169–170°. [b] Ref. 5 reports 156–158°.

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[1] Taken from a thesis by H. W. B. for the B.S. degree, Polytechnic Institute of Brooklyn, June, 1950.

[2] A review of the literature including methods of preparation, a detailed experimental procedure, and a list of 297 known allophanates may be obtained in Document 2858 from American Documentation Institute, 1719 N Street, N. W., Washington 6, D. C., remitting $0.65 for 35 mm. microfilm or $6.30 for photocopies (6 × 8 inches).