119. *The Condensation of Chloral with Salicylic Acid.*

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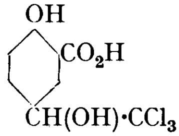
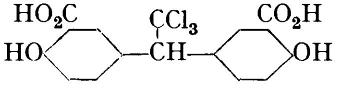
THE condensation of chloral with salicylic acid by the action of concentrated sulphuric acid produces 2-*hydroxy*-5-βββ-*trichloro*-α-*hydroxyethylbenzoic acid* (I) and by the reaction of this with a second molecule of salicylic acid, βββ-*trichloro*-4 : 4′-*dihydroxy*-3 : 3′-*dicarboxy*-αα-*diphenylethane* (II).


(I.)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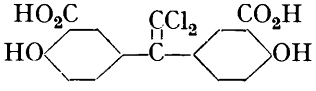
(III.)

The acid (I) gives a *monoacetyl* derivative and, by the action of diazomethane, a *methyl* ester, which is easily monoacetylated; the acetyl derivative and the ester of the original acid possess free phenolic hydroxyl groups, as both give colour reactions with ferric chloride. When the acid (I) is heated in concentrated sulphuric acid on the water-bath, hydrogen chloride is evolved and 6-hydroxy*iso*phthalaldehydic acid is obtained, identical with a specimen prepared by the action of chloroform and potash on salicylic acid (Reimer and Tiemann, *Ber.*, 1876, **9**, 1271). The aldehydic acid, which is also produced by the action of methyl-alcoholic potassium hydroxide on the acid (I), is oxidised to the corresponding hydroxy*iso*phthalic acid by potassium permanganate, the constitution of (I) thus being established.

The diphenylethane derivative (II) gives a *dimethyl* ester, which forms a *diacetyl* derivative. When the dimethyl ester is acted upon with boiling methyl-alcoholic potassium hydroxide or cold 30% aqueous potassium hydroxide, the normal hydrolysis of the two methyl groups is accompanied by loss of a molecule of hydrogen chloride, ββ-*dichloro*-4 : 4′-*dihydroxy*-3 : 3′-*dicarboxy*-αα-*diphenylethylene* (III) being produced.

EXPERIMENTAL.

Condensation of Chloral with Salicylic Acid.—A mixture of a freshly prepared solution of 10 g. of salicylic acid in 100 c.c. of concentrated sulphuric acid with 30 g. of chloral hydrate is shaken for ½ hour and poured after 2 days into 800 g. of water containing ice. The viscid colourless mass produced is collected and washed with much cold water; it then becomes microcrystalline, but cannot be recrystallised from any ordinary solvent (yield, 9·8 g.). A solution of the dried product (2 g. in 50 c.c. of methyl alcohol) is twice saturated at 0° with hydrogen chloride, with intermediate boiling, and is finally concentrated to a small bulk; the resinous product crystallises in contact with ethyl alcohol. Recrystallisation from this solvent or, better, acetic acid furnishes βββ-*trichloro*-4 : 4′-*dihydroxy*-3 : 3′-*dicarbomethoxy*-αα-*diphenylethane* (as II) in small nacreous blades, m. p. 200—202° (Found : C, 49·9; H, 3·4; Cl, 24·4. $C_{18}H_{15}O_6Cl_3$ requires C, 49·8; H, 3·5; Cl, 24·6%). The ester is soluble in dilute alkali solution, and develops a cherry-red colour with alcoholic ferric chloride.

The aqueous acid mother-liquor from which the crude diphenylethane derivative (II) has separated is concentrated to half its volume and allowed to cool slowly; 2-*hydroxy*-5-βββ-*trichloro*-α-*hydroxyethylbenzoic acid* (I) then crystallises. Recrystallised from hot water (charcoal), it forms highly refractive, colourless prisms (4·1 g.), m. p. 180—182° (Found : C, 37·7; H, 2·5; Cl, 37·5. $C_9H_7O_4Cl_3$ requires C, 37·8; H, 2·5; Cl, 37·3%). The acid is sparingly soluble in cold water, but dissolves readily in boiling water or in alcohol. The aqueous solution reddens on addition of ferric chloride.

Monoacetyl Derivative and Methyl Ester of 2-*Hydroxy*-5-βββ-*trichloro*-α-*hydroxyethylbenzoic Acid.*—(1) A mixture of the hydroxy-acid (0·7 g.), acetic anhydride (2 c.c.), and sodium acetate is heated on the steam-bath for a short time and kept on a watch-glass; the acetic anhydride slowly absorbs water and a viscid solid separates. This crystallises in contact with cold alcohol and is then recrystallised from aqueous alcohol, the *acetyl* compound forming small colourless leaflets, m. p. 190—192° (Found : C, 40·4; H, 2·6; Cl, 32·6. $C_{11}H_9O_5Cl_3$ requires C, 40·3;

H, 2·8; Cl, 32·5%), which give a cherry-red colour with alcoholic ferric chloride. All attempts to prepare a diacetyl derivative failed.

(2) The finely powdered acid (2·0 g.) is suspended in 12 c.c. of absolute ether and treated with an excess of ethereal diazomethane. During spontaneous evaporation of the ether the *methyl* ester crystallises in tufted needles; recrystallised from dilute alcohol, it forms colourless rhombic tablets (1·2 g.), m. p. 97—99° (Found: C, 39·9; H, 2·8. $C_{10}H_9O_4Cl_3$ requires C, 40·1; H, 3·0%).

The *monoacetyl* derivative of this ester is prepared by means of acetic anhydride and a drop of concentrated sulphuric acid, the mixture being finally heated on the steam-bath and kept on a watch-glass. The resinous substance left after long standing becomes crystalline on treatment with alcohol; it is pressed on a porous plate and twice recrystallised from the same solvent by addition of water to the hot solution. It can also be recrystallised from methyl alcohol, forming colourless prisms, m. p. 90—92° (Found: C, 42·3; H, 2·9. $C_{12}H_{11}O_5Cl_3$ requires C, 42·2; H, 3·2%), which do not give a colour reaction with methyl-alcoholic ferric chloride.

Acetylation of ββ β-*Trichloro*-4 : 4′-*dihydroxy*-3 : 3′-*dicarbomethoxy*-αα-*diphenylethane*.—The ester (0·5 g.) is heated with acetic anhydride (2 c.c.) and anhydrous sodium acetate on the steam-bath. The *diacetyl* derivative, precipitated by water and twice crystallised from boiling ethyl alcohol, has m. p. 207—209° (Found: C, 51·3; H, 3·6. $C_{22}H_{19}O_8Cl_3$ requires C, 51·0; H, 3·7%). It is insoluble in water or aqueous alkali, moderately soluble in alcohol, and gives no colour with ferric chloride.

Condensation of 2-*Hydroxy*-5-βββ-*trichloro*-α-*hydroxyethylbenzoic Acid with Salicylic Acid*.—Salicylic acid (1·5 g.) is dissolved in concentrated sulphuric acid (25 c.c.), the substituted benzoic acid (3 g.) added, and the mixture stirred for ½ hour, kept for 1 day, and poured into ice-water. The solid product is boiled in a little alcohol with animal charcoal, and the filtered solution made turbid with water; on cooling, βββ-*trichloro*-4 : 4′-*dihydroxy*-3 : 3′-*dicarboxy*-αα-*diphenylethane* (II) separates in small colourless prisms (1·2 g.), m. p. 290—292° (Found: C, 47·1; H, 2·6. $C_{16}H_{11}O_6Cl_3$ requires C, 47·35; H, 2·7%). Treated with diazomethane or methyl-alcoholic hydrogen chloride, this yields the dimethyl ester already described.

Action of Methyl-alcoholic Potassium Hydroxide on βββ-*Trichloro*-4 : 4′-*dihydroxy*-3 : 3′-*dicarbomethoxy*-αα-*diphenylethane*.—The ester (2 g.) is boiled with 2 g. of potassium hydroxide in 10 c.c. of methyl alcohol for ½ hour, sodium chloride separating. After addition of boiling water (6 c.c.) and removal of the alcohol in steam, the solution is filtered and acidified with hydrochloric acid. The solid product, twice crystallised from dilute alcohol, gives ββ-*dichloro*-4 : 4′-*dihydroxy*-3 : 3′-*dicarboxy*-αα-*diphenylethylene* (III) in prisms, m. p. 295—297° (Found: C, 52·0; H, 2·7. $C_{16}H_{10}O_6Cl_2$ requires C, 52·0; H, 2·7%). This substance does not react with bromine in cold carbon tetrachloride and is not hydrogenated in dilute acetic acid with platinum oxide as catalyst. Treated with diazomethane in ether, it yields the *dimethyl* ester (also produced by the action of methyl-alcoholic hydrogen chloride), which crystallises from alcohol in fine tufted needles, m. p. 120—122° (Found: C, 54·3; H, 3·6. $C_{18}H_{14}O_6Cl_2$ requires C, 54·4; H, 3·5%), soluble in aqueous alkali.

Action of Alcoholic Potassium Hydroxide on 2-*Hydroxy*-5-βββ-*trichloro*-α-*hydroxyethylbenzoic Acid*.—The powdered acid (2 g.) and a solution of 2 g. of potassium hydroxide in 10 c.c. of methyl alcohol are submitted to the treatment described in the preceding paragraph. The 6-hydroxy*iso*phthalaldehydic acid liberated on acidification with hydrochloric acid is extracted with ether, recovered, and recrystallised from hot water, forming plates (0·8 g.), m. p. 248—250° (Found: C, 57·6; H, 3·3. Calc. for $C_8H_6O_4$: C, 57·8; H, 3·6%). The oxime crystallises from hot water in colourless needles, m. p. 179—180° (cf. Fürth, *Ber.*, 1883, **16**, 2182). The aldehydic acid (0·8 g.) in 25 c.c. of acetone is oxidised with potassium permanganate (1·2 g.), the mixture being finally boiled. The precipitate of manganese dioxide and potassium hydroxy*iso*phthalate is extracted with boiling water (3 × 50 c.c.), and this solution acidified with hydrochloric acid; the 4-hydroxy*iso*phthalic acid, recrystallised from water, separates in very fine needles, m. p. 308—310° (decomp.) (Found: C, 52·4; H, 3·35. Calc. for $C_8H_6O_5$: C, 52·7; H, 3·3%). The dimethyl ester has m. p. 96—98° (cf. Jacobsen, *Ber.*, 1878, **11**, 379; Loewenherz, *Ber.*, 1892, **25**, 2796).

Hydroxy*iso*phthalic acid is also obtained when a solution of 1 g. of 2-hydroxy-5-βββ-trichloro-α-hydroxyethylbenzoic acid in 8 c.c. of *N*-sodium hydroxide and 200 c.c. of water is oxidised with 3 g. of potassium permanganate, the mixture being boiled after 24 hours; the filtered liquid is evaporated to 40 c.c. and acidified with hydrochloric acid, and the hydroxy*iso*phthalic acid twice recrystallised from boiling water.

Action of Warm Sulphuric Acid on 2-*Hydroxy*-5-βββ-*trichloro*-α-*hydroxyethylbenzoic Acid*.—A solution of 1 g. of the acid in 10 c.c. of concentrated sulphuric acid is heated on the steam-bath for 10 minutes, hydrogen chloride being evolved, and is then poured into 50 g. of water containing ice. The solid which separates is recrystallised from methyl alcohol, giving colourless needles of 6-hydroxy*iso*phthalaldehydic acid.

Reduction of 2-*Hydroxy*-5-βββ-*trichloro*-α-*hydroxyethylbenzoic Acid.*—To a mixture of 2 g. of the acid, 16 c.c. of concentrated hydrochloric acid, 15 c.c. of alcohol, and 10 c.c. of water boiling under reflux, 6 g. of granulated zinc are added during 3 hours. The product separates on cooling and is recrystallised from aqueous alcohol, forming needles, m. p. 170—172° (Found: C, 46·3; H, 2·8. $C_9H_6O_3Cl_2$ requires C, 46·35; H, 2·6%). It is vigorously attacked by potassium permanganate in the cold, and has probably the constitution of 2-*hydroxy*-5-ββ-*dichlorovinylbenzoic acid.*

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