

cis-6,7-*cis*-11,12-Tetracarbo-methoxy-8(14),9-chrysitadiene (IV).⁵—A suspension of 3.0 g. of the tetra-acid in ether was cooled in ice and treated with an ethereal solution of diazomethane from 9 ml. of nitrosomethylurethan. Solution took place rapidly, and after standing a few minutes the solution was filtered, evaporated, and the residue crystallized from methanol, furnishing 2.85 g. of colorless ester, m. p. 121–122.5°, and 0.25 g. of slightly lower m. p. (91%). The mixed m. p. with the stereoisomeric ester (I) was 97–121°.

Anal. Calcd. for C₂₆H₃₄O₈: C, 65.8; H, 7.2. Found: C, 65.6; H, 6.8.

cis-6,7-*cis*-11,12-Tetracarbo-methoxy-8-chrysitene (V).—A solution of 1.01 g. of the tetra-ester (IV) in 20 ml. of acetic acid was shaken with hydrogen in the presence of 100 mg. of Adams catalyst. One molecular equivalent of hydrogen was absorbed in about four hours and then the rate of absorption became negligible. After the catalyst was filtered, the solvent was evaporated under reduced pressure and the residue crystallized from methanol, yielding 0.86 g. (85%) of colorless needles; m. p. 157–159°. A portion recrystallized for analysis melted at 158–159°.

Anal. Calcd. for C₂₆H₃₆O₈: C, 65.5; H, 7.6. Found: C, 65.4; H, 7.6.

When the stereoisomeric tetramethyl ester I was treated under the same conditions no hydrogen was absorbed beyond that required to reduce the catalyst, and an almost quantitative recovery of starting material was obtained from the reaction mixture.

3-Methoxy-*trans*-6,7-*trans*-11,12-tetracarbo-methoxy-8(14),9-steradiene (VII).—Six grams of freshly distilled 4-

methoxycyclohexenylcyclopentenylacetylene (VI)¹⁰ and 10 g. of methyl fumarate were heated under nitrogen in a sealed tube for twenty-four hours at 175°. Upon vacuum distillation of the resulting mixture, 3.3 g. of dienyne and 6.3 g. of ester were recovered, leaving a viscous, amber residue in the flask (6.6 g., 45%). As yet this product has resisted all attempts at crystallization. It distills at 10⁻³ mm. (bath about 150°) yielding an almost colorless glass, which was used for analysis and absorption spectrum.

Anal. Calcd. for C₂₆H₃₄O₉: C, 63.7; H, 7.0. Found: C, 63.7; H, 6.9.

Summary

Dicyclohexenylacetylene combines with two moles of methyl or ethyl fumarate to form a 6,7,11,12-tetracarboalkoxy-8(14),9-chrysitadiene.⁴ A stereoisomeric tetramethyl ester was obtained via the adduct from this dienyne and maleic anhydride. The latter diene ester readily absorbs one mole of hydrogen whereas the diene ester from methyl fumarate absorbs no hydrogen under the same conditions.

A 3-methoxy-6,7,11,12-tetracarbo-methoxy-8(14),9-steradiene was obtained from 4-methoxycyclohexenylcyclopentenylacetylene and methyl fumarate.

BELTSVILLE, MARYLAND

RECEIVED MARCH 4, 1942

[CONTRIBUTION FROM THE CHEMISTRY DEPARTMENT, UNIVERSITY OF NORTH CAROLINA]

Vicinal Substituted Resorcinols. II. Alkylresorcinols. The Synthesis of γ -*n*-Hexyl, γ -*n*-Heptyl and γ -*n*-Octylresorcinols

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A series of the higher *n*-alkyl vicinal substituted resorcinols was prepared for the purpose of comparing their antiseptic properties with the well known isomeric 4-*n*-alkyl- and 5-*n*-alkylresorcinols. The lower alkyl vicinal resorcinols have previously been shown to have no value as antiseptics.² It is generally known that in the case of the 4-alkyl- and 5-alkylresorcinols, an increase in the number of carbon atoms in the alkyl group increases the antiseptic properties of the corresponding alkylresorcinol, reaching a maximum at hexylresorcinol.

Various investigators have prepared vicinal or 2-alkylresorcinols readily by the general scheme of Limaye.³ Russell, *et al.*,² however, were unable to prepare 2-*n*-hexylresorcinol by this scheme

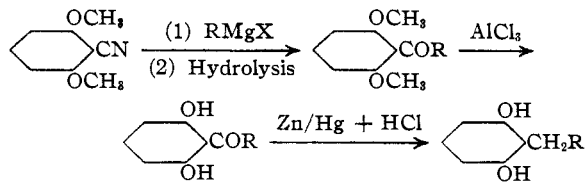
(1) Present address: Krebs Pigments Department, E. I. du Pont de Nemours and Company, Inc., Newport, Delaware.

(2) Russell, Frye and Mauldin, *THIS JOURNAL*, **62**, 1441 (1940).

(3) Limaye, *Ber.*, **67B**, 12 (1934).

due to the fact that the intermediate 4-methyl-7-caproyl-oxycoumarin did not undergo the Fries rearrangement.

Haller⁴ obtained 2-isoamylresorcinol in good yield from 2,6-dimethoxybenzotrile. The general scheme of Haller was chosen as the most likely route to the preparation of the higher vicinal alkylresorcinols since in this Laboratory 2,6-dimethoxybenzotrile had been prepared in fair yields (25%) from *m*-dinitrobenzene by a modification of Mauthner's⁵ method.



(4) Haller, *THIS JOURNAL*, **55**, 3032 (1933).

(5) Mauthner, *J. prakt. Chem.*, [2] **121**, 261 (1929).

This general scheme has been applied in the present investigation with good yields to the preparation of 2-*n*-hexylresorcinol, 2-*n*-heptylresorcinol and 2-*n*-octylresorcinol. Attempts to prepare the corresponding 2-*n*-tridecylresorcinol were unsuccessful, the only recognizable product obtained from the Grignard reaction mixture after hydrolysis being tetracosane.

The three alkylresorcinols are being tested for their antiseptic properties.⁶

Experimental

2-*n*-Hexanoyl-, 2-*n*-Heptanoyl- and 2-*n*-Octanoylresorcinol Dimethyl Ether.—The Grignard reagent was prepared in the usual manner from *n*-amyl chloride (25.13 g., 2.375 mols.) in 100 cc. of dry ether and magnesium (6.07 g., 0.25 mol.) suspended in 100 cc. of ether. The ethereal solution was decanted from the unreacted magnesium (0.8 g.). To this clear ether solution was added in the course of eight minutes and with constant stirring 2,6-dimethoxybenzotrile dissolved in 200 cc. of hot dry toluene. The reaction mixture was then heated on a steam-bath for thirty minutes and the ether was removed by distillation. When the temperature reached 60° the steam-bath was replaced by an oil-bath, 100 cc. of dry toluene was added, and the distillation was continued until only pure toluene distilled over. An additional 100 cc. of toluene was added and the reaction mixture was refluxed in an atmosphere of nitrogen for three and one-half hours and left standing overnight. The reaction flask was almost filled with a yellow solid.

The reaction mixture was poured on ice and hydrochloric acid. The acid solution, while still cold, was extracted first with benzene and then with ether. After the excess ether had been removed from the acid solution by heating on a steam-bath, it was refluxed vigorously for two hours. Even after warming on the steam-bath a heavy dark oil began to separate. After the mixture had cooled, the oil was separated and the solution extracted with ether several times. The oil and ether extracts were combined and washed with sodium bicarbonate solution then with water and dried over sodium sulfate. After removal of the ether, the oil was distilled. The yield was 16.6 g. or 70% of the theoretical.

Each product was light in color, very soluble in ether, alcohol and toluene, but insoluble in water. Each gave a negative dinitrophenylhydrazine test and gave no color with alcoholic ferric chloride solution.

Anal. (2-*n*-Hexanoyl, b. p. 142° (2 mm.)). Calcd. for C₁₃H₂₀O₃: C, 71.14; H, 8.54. Found: C, 70.86; H, 8.40.

Anal. (2-*n*-Heptanoyl, b. p. 160–164° (2 mm.)); yield 20.89 or 83.2% of the theoretical). Calcd. for C₁₅H₂₂O₃: C, 71.95; H, 8.87. Found: C, 72.27; H, 8.91.

Anal. (2-*n*-Octanoyl, b. p. 163–165° (1.5 mm.)); yield 15 g. or 57% of the theoretical). Calcd. for C₁₇H₂₄O₃: C, 72.69; H, 9.15. Found: C, 71.51; H, 8.71.

Attempted Preparation of 2-*n*-Tridecanoylresorcinol Dimethyl Ether.—The above procedure did not prove satis-

factory in the attempted synthesis of tridecanoylresorcinol dimethyl ether. Instead of the desired product, tetracosane was isolated from the reaction mixture. The tetracosane was purified by repeated recrystallization from acetone to a constant melting point of 51–52°; yield 6 g., or 21% of the theoretical based on the lauryl bromide used.

2-*n*-Hexanoyl-, 2-*n*-Heptanoyl- and 2-*n*-Octanoylresorcinol.—2-*n*-Hexanoylresorcinol dimethyl ether (14 g.) was dissolved in dry toluene (150 cc.). The solution was cooled and anhydrous aluminum chloride (25 g.) was added cautiously. The mixture was warmed slowly in an oil-bath and finally refluxed for one hour, the temperature of the oil not exceeding 120°. The cooled reaction mixture was poured into ice-cold dilute hydrochloric acid. After the gummy complex had decomposed, the mixture was extracted several times with ether. The combined ether extracts were washed with sodium bicarbonate solution, then with water. The phenol was extracted from the ether solution with 5% sodium hydroxide and after acidification of the alkaline extract a heavy oil separated which soon began to crystallize on rubbing. The solid was removed and the solution extracted with ether. The combined solid and ether extracts were dried with sodium sulfate. When the ether was evaporated, 12 g. of crude product was obtained. This was recrystallized from 1000 cc. of petroleum ether (90–100°) with charcoal. The product crystallized in flat yellow leaflets. The yield was 8 g. or 64.8% theoretical. Repeated recrystallizations from petroleum ether gave a product melting at 74°.

All three ketones so obtained were soluble in alcohol, benzene, ether, carbon tetrachloride, and hot petroleum ether. Each gave a greenish dark color with ferric chloride.

Anal. (2-*n*-Hexanoyl) Calcd. for C₁₂H₁₈O₃: C, 69.19; H, 7.75. Found: C, 69.36; H, 7.78.

Anal. (2-*n*-Heptanoyl, slight yellowish plates; m. p. 75°, the yield was 71% of the theoretical). Calcd. for C₁₃H₁₈O₃: C, 70.22; H, 8.17. Found: C, 70.45; H, 8.00.

Anal. (2-*n*-Octanoyl, light yellow crystals, m. p. 77.5–78°; the yield was 61.5% of the theoretical). Calcd. for C₁₄H₂₀O₃: C, 71.16; H, 8.53. Found: C, 71.07; H, 8.96.

2-*n*-Hexyl-, 2-*n*-Heptyl- and 2-*n*-Octylresorcinol.—Seven grams of 2-*n*-hexanoylresorcinol was added to amalgamated zinc (50 g.), concentrated hydrochloric acid (100 cc.), acetic acid (50 cc.), and water (50 cc.). The mixture was refluxed six hours. At the end of each hour, 5 cc. of concentrated hydrochloric acid was added. The acid solution was left overnight, then extracted with ether. The ether solution was dried over sodium sulfate, the ether distilled on a steam-bath, and finally the acetic acid removed by distillation under reduced pressure. There remained a heavy oil which crystallized on standing. Difficulty was encountered in recrystallizing the solid the first time. The product invariably had a tendency to separate from the solvent as an oil. However, slow evaporation of a benzene-petroleum ether solution at a low temperature did give a crystalline product which melted 57–63°. The solid obtained could be recrystallized from benzene-petroleum ether, one part benzene to three parts petroleum ether. The product was finally recrystallized from carbon

(6) Arranged through the courtesy of the Rohm and Haas Company, Inc.

