minutes, the solution no longer gave a test for labile bromine when boiled with alcoholic silver nitrate and nitric acid. The solution, which showed no action toward Fehling's solution, consisted of a mixture of α-methylfructoside tetraacetate and a large amount of β-methylfructoside tetraacetate with orthoester structure. In order to prove the presence of the latter compound, a few drops of the solution was diluted with 2 cc. of cold water and 1 drop of dilute hydrochloric acid was added. After *ca.* ten seconds at room temperature, considerable reduction took place on boiling with Fehling's solution. To isolate the normal α-methylfructoside tetraacetate, the reaction mixture was now filtered free of silver salts, and evaporated *in vacuo* to a thick sirup. To this was added 50 cc. of boiling water, and the mixture kept at 100° with vigorous shaking to hydrolyze the orthoester. In ten minutes a clear yellow solution was obtained. After filtering with charcoal, the colorless solution was placed in the ice box. Upon seeding with α-methylfructoside tetraacetate, the solution deposited 0.28 g. of crystals having the specific rotation 42.3°, and m. p. 110–111°. The aqueous mother liquor reduced Fehling's solution strongly due to the tetraacetylfructose formed by the hydrolysis of the orthoester. The crystalline material obtained above reduced Fehling's solution only after long boiling with acid.

Summary

The recent discovery of the true α-pentaacetylfructose <2, 6> has made possible for the first time the study of the behavior of the α,β pair of ketose acetates toward different agents.

It has been shown that the use of zinc chloride as a catalyst in the isomerization of the sugar acetates is applicable in the ketose series.

The application of this method to the first and fourth octaacetates of turanose of supposed orthoester structure has revealed a strong similarity in properties to those of the normal fructose acetates. This similarity has been shown to exist also between the corresponding acetohalogeno derivatives of fructose and turanose although the former are generally assigned normal structure whereas an orthoester structure had been advanced for the latter. Application of Hudson's rules confirms the normal structure of the fructose acetates but excludes such for the turanose acetates.

The formation of a fifth octaacetate of turanose from the so-called second or α-octaacetylturanose <2, 6> has been observed. Marked difference in the behavior of this pair from that of the normal fructose pentaacetates makes the structure assumed for the second octaacetate of turanose uncertain.

The behavior of the crystalline acetochloro compounds of fructose and turanose toward pyridine has been found to be radically different from that of the corresponding acetobromo compounds.

PRINCETON, N. J. RECEIVED FEBRUARY 13, 1937

[CONTRIBUTION FROM THE CHEMICAL LABORATORY OF WASHINGTON SQUARE COLLEGE OF NEW YORK UNIVERSITY]

The Synthesis of Long Chain Substituted Isocyclics and Similarly Substituted Adipic Acids.[1] The Preparation of γ-t-Octylcyclohexanol, Hexene, Hexanone, Hydroxylamine, Amine, Phenol and β-t-Octyl Adipic Acid

BY JOSEPH B. NIEDERL AND RICHARD A. SMITH

Introduction

On account of the renewed interest and present-day commercial importance of the alkyladipic acids[2] it was considered appropriate to give in this communication an account of the synthesis of a long chain adipic acid, namely, the β-diisobutyladipic acid. For the preparation of this acid (VI) the γ-diisobutylcyclohexanol (I), obtained by the catalytic hydrogenation of *p*-diisobutylphenol (*p*-(α,α,γ,γ-tetramethyl)-butylphenol),[3] served as the starting material in the subsequent oxidation processes. The cyclic ketone (γ-diisobutylcyclohexanone) (III) as well as the above β-diisobutyladipic acid (VI) were obtained in excellent yields employing the conventional oxidation processes.[4] The oxime (IIIa) of the above ketone was prepared in the usual manner and from this oxime the γ-diisobutylcyclohexylhydroxylamine (IV) was prepared by catalytic hydrogenation. More strenuous reduction with sodium and alcohol yielded the γ-diisobutylcyclohexylamine (V). Dehydration of the γ-diisobutylcyclohexanol (I) yielded the corresponding γ-

(1) Presented at the St. Petersburg meeting of the American Chemical Society, March 27, 1934. Original manuscript received July 25, 1934.

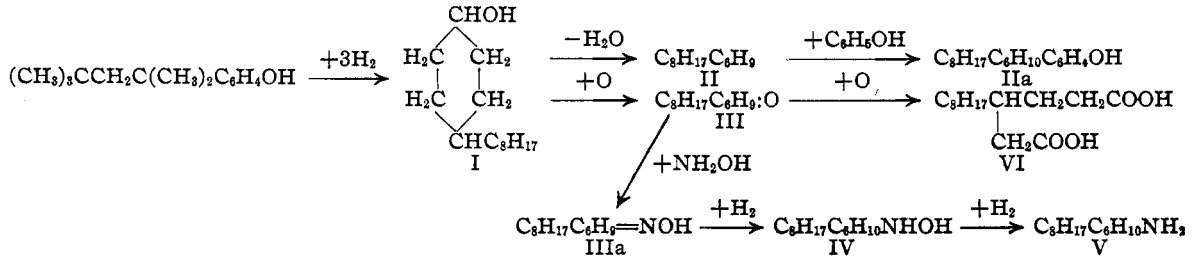
(2) R. Kuhn, *Ber.*, **67**, 1130 (1934); K. Ruzicka, *Helv. Chim. Acta*, **9**, 249 (1926); **16**, 1323, 1339 (1933); Ziegler and co-workers, *Ann.*, **504**, 94 (1933); R. P. Perkins, U. S. Patent 1,960,211 (1934).

(3) J. B. Niederl, U. S. Patent 2,008,032 (1935); Niederl and co-workers, THIS JOURNAL, **55**, 257 (1933).

(4) A. Baeyer, *Ann.*, **278**, 100 (1894); Bouveault and Locquin, *Bull. soc. chim.*, [4] **3**, 438 (1908); Mannich, *Ber.*, **39**, 1595 (1906); Wislicenus and Mager, *Ann.*, **275**, 363 (1893); Ciamician and Silber, *Ber.*, **46**, 3077 (1913).

diisobutylcyclohexene (II) which in turn was condensed with phenol according to the method of Niederl and co-workers[5] to form a *p*-diisobutylcyclohexylphenol (IIa).

The methods of preparation and the structural relationship of the various new products described herein may be illustrated as follows



Experimental

Methods of Preparation

I. 4-(α,α,γ,γ-Tetramethyl)-butylcyclohexanol-1.—This compound was prepared by catalytic hydrogenation under high pressure and at elevated temperature of *p*-diisobutylphenol:[6] m. p. 55.5–56°; b. p. 148–150° (11.5 mm.).

Anal. Calcd. for $C_{14}H_{18}O$: C, 79.24; H, 13.21. Found: C, 79.16; H, 13.22.

II. 4-(α,α,γ,γ-Tetramethyl)-butylcyclohexene-1.—To 42 g. of the above *t*-octylcyclohexanol (I) 0.6 cc. of sulfuric acid (95%) was added and the mixture, contained in a Claisen flask, was heated on an oil-bath at 130–140° at 12 mm. The *t*-octylcyclohexene distilled over as rapidly as it formed: b. p. 113° (12 mm.), sp. gr. (25°) 0.8565; $n^{25}D$ 1.4741.

Anal. Calcd. for $C_{14}H_{26}$: C, 86.60; H, 13.40. Found: C, 86.76; H, 13.37.

IIa. 4-(α,α,γ,γ-Tetramethyl)-butyl-1-(4-hydroxy)-phenylcyclohexane.—To a 0.1 molar mixture of the above *t*-octylcyclohexene (II) and phenol, 2 cc. of sulfuric acid (95%) was added slowly at 60° and the mixture was then allowed to stand overnight. The reaction product was worked up according to the procedure of McGreal and Niederl[7] and then subjected to fractional distillation under reduced pressure: m. p. 81° (uncorr.); b. p. 110–120° (2 mm.).

Anal. Calcd. for $C_{20}H_{32}O$: C, 83.28; H, 11.10. Found: C, 83.52; H, 11.08.

III. 4-(α,α,γ,γ-Tetramethyl)-butylcyclohexanone-1.—Twenty-eight grams of the above *t*-octylcyclohexanol (I) was added in four portions over a period of half an hour to a solution of 30 g. of crystalline potassium dichromate, 150 cc. of water, and 25 g. of sulfuric acid (sp. gr. 1.84) contained in a flask fitted with a mechanical stirrer. The temperature was held at 50–55° by means of an external bath. Heat was evolved during the additions, and a double compound which formed during the reaction disappeared as the reaction proceeded. At the completion of the reaction (one-half hour after heat ceased to be evolved), the whole was allowed to cool. The product was separated and purified by vacuum distillation. The yield was approximately 85%; b. p. 142–144° (11 mm.); sp. gr. (20°) 0.9850; $n^{23}D$ 1.4768.

Anal. Calcd. for $C_{14}H_{26}O$: C, 80.0; H, 12.6. Found: C, 79.3; H, 12.3.

IIIa. 4-(α,α,γ,γ-Tetramethyl)-butylcyclohexanone-1-oxime was prepared from the above cyclic ketone (III) in an alcoholic solution of hydroxylamine with heating on a steam-bath. The oxime was recrystallized from 70% alcohol; m. p. 152° (uncorr.).

Anal. Calcd. for $C_{14}H_{27}NO$: C, 74.66; H, 12.00; N, 6.23. Found: C, 74.60; H, 12.21; N, 6.17.

IIIb. Sodium Bisulfite Addition Compound of 4-(α,α,γ,γ-Tetramethyl)-butylcyclohexanone-1.—A saturated solution of sodium bisulfite (50% excess) was shaken with the *t*-octylcyclohexanone (III); white crystals separated. The crystals were heated with boiling 50% alcohol and cooled. A mass of fine snow-white crystals separated which were filtered off and washed with water and alcohol. A saturated solution of sodium carbonate was used to regenerate the ketone in a pure form.

IV. 4-(α,α,γ,γ-Tetramethyl)-butylcyclohexylhydroxylamine-1.—Ten and one-half grams octylcyclohexanonoxime (IIIa), 1 g. of active nickel catalyst, and 150 cc. of 95% ethyl alcohol as a solvent were shaken up in an atmosphere of hydrogen at a pressure of 50 pounds per sq. in. (3.3 atm.). One molar equivalent of hydrogen was taken up. The liquid was decanted, acidified with hydrochloric acid, and evaporated to dryness on a steam-bath. The resulting crystalline compound was purified by dissolving in the minimum quantity of absolute alcohol and precipitating with absolute ether; m. p. 240–245° with decomposition.

Anal. Calcd. for $C_{14}H_{30}ONCl$: N, 5.32. Found: N, 5.29.

V. 4-(α,α,γ,γ-Tetramethyl)-butylcyclohexylamine-1.—Two and one-half grams of octylcyclohexanonoxime (IIIa) was dissolved in 100 cc. of absolute alcohol, and the whole brought to boiling. Three grams of sodium in small pieces was added rapidly. The whole was then acidified with hydrochloric acid, cooled, and the solid sodium chloride filtered off. The solid was washed with dilute hydrochloric acid; the hydrochloric acid solutions were combined and evaporated to dryness. The residue was treated with 40% sodium hydroxide and extracted twice with ether. Concentrated hydrochloric acid was added to the ether extracts and the whole was again evaporated to dryness

(5) Niederl and co-workers, THIS JOURNAL, **56**, 2412 (1934); **55**, 3025, 4151, 4549 (1933).

(6) Röhm and Haas Company, Philadelphia, Penna., private communication.

(7) McGreal and Niederl, THIS JOURNAL, **57**, 2625 (1935).

on a steam-bath. The product was purified by recrystallizations from alcohol and acetone, m. p. 260–265° with decomposition.

Anal. Calcd. for $C_{14}H_{30}NCl$: N, 5.67. Found: N, 5.79.

VI. β-(α,α,γ,γ-Tetramethyl)-butyl-adipic Acid.—This compound was prepared both by the oxidation of the corresponding alcohol (I), cyclohexene (II) and ketone. Oxidations with and without the aid of a vanadium catalyst were employed. The most satisfactory oxidation was the following: 125 cc. of nitric acid (50%) was heated to 110° in a flask fitted with a stirrer. A pinch of sodium vanadate (about 0.2 g.) was added. A few grams of the *t*-octylcyclohexanol (I) was then added, fumes of oxides of nitrogen being given off immediately. The whole was then cooled to 60° by means of an external bath. Then more diisobutylcyclohexanol (I) was added (42 g.) at such a rate that the temperature was kept within 55–65°. Rapid stirring was maintained throughout the entire reaction; the stirring was continued for one hour after the final addition of alcohol. Upon completion, the whole was cooled with an external ice-bath, and the mass of white crystals filtered off and air dried. The product was quite pure at this stage. The crystals were further purified by recrystallization from concentrated nitric acid; a saturated solution was made up at 65°, and allowed to cool. The yield of pure product was 60%; m. p. 133–134° (uncorr.).

Anal. Calcd. for $C_{14}H_{26}O$: C, 65.11; H, 10.08. Found: C, 64.94; H, 9.88.

This work was done in collaboration with the Chemical Laboratories of the Röhm and Haas Company, Philadelphia, Penna., who furnished the intermediate hydrogenated *p*-diisobutylphenol.

Summary

1. γ-Diisobutylcyclohexanol, hexene, hexanone, oxime, hydroxylamine amine and phenol were prepared, identified and their physical and chemical characteristics described.

2. β-Diisobutyladipic acid was prepared by a simple oxidation process, indicating the feasibility of preparing long chain adipic acid by similar methods.

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[CONTRIBUTION FROM THE CHEMICAL LABORATORY OF WASHINGTON SQUARE COLLEGE OF NEW YORK UNIVERSITY]

The Synthesis of Long Chain Substituted Isocyclics and Similarly Substituted Adipic Acids.[1] The Preparation of α-t-Octylcyclohexanone and a Method of Indirect Structure Proof for Ortho and Para Alkylphenols

BY JOSEPH B. NIEDERL AND J. BRADLEY WHITMAN

Introduction

The existing methods of structure proof for ortho and para substituted alkylphenols can be divided into two main classes, the direct[2] and the indirect[3] methods. Both types of methods can be subdivided into analytical methods, and into procedures involving synthesis. The following report gives an indirect method which appears to be capable of wide application and which has served as a method of structure proof for ortho- and para-substituted alkylphenols. First a comparison of the solid derivatives (esters) of the hydrogenation products of the phenols, α- or γ-cyclohexanols may be made. These cyclohexanols can then be further oxidized conveniently to the corresponding α- or γ-cyclohexanones, of which solid, crystalline derivatives, such as the oximes, the semicarbazones, the phenylhydrazones, etc., can be prepared easily and again subjected to comparison by mixed melting points. Since the α-alkylcyclohexanones can be prepared independently by the interaction of the sodium salt of the desmotropic cyclohexanol,[4] ortho substitution of the original phenol certainly can be proved conclusively by the absence of a depression in the melting points of the cyclo ketone derivative, other constants having been determined to be identical. On further oxidation of the alkylcyclohexanones, only the γ-alkylcyclohexanone yields the corresponding β-alkyladipic acid, whereas the α-alkylhexanone yields adipic acid itself as the final oxidation product. Schematically such a structure proof can be presented as follows

(1) Original manuscript received July 25, 1934.

(2) Barth, *Ann.*, **154**, 360 (1870); Jacobsen, *Ber.*, **11**, 376, 570, 1058, 2052 (1878); Friedländer and Low, German Patent 170,230 (1906); Oppenheim and Pfaff, *Ber.*, **8**, 887 (1875); Königs and Heymann, *ibid.*, **19**, 1704 (1886).

(3) Koerner, *Gazz. chim. ital.*, 419 (1874); Noelting, *Ber.*, **16**, 2687 (1885); Meyer and Jacobsen, "Lehrbuch der org. Chemie," Vol. II, Part 1, Veit and Co., Leipzig., 1902, p. 68.

(4) Haller, *Compt. rend.*, **138**, 1140 (1904); Tarbouriech, *ibid.*, **149**, 604 (1909); Bouveault and Chereau, *ibid.*, **142**, 1086 (1906); Mannich and co-workers, *Ber.*, **39**, 1594 (1906); **41**, 467 (1908); Koetz and co-workers, *J. prakt. Chem.*, [2] **80**, 505 (1909); *Ann.*, **350**, 210 (1906).