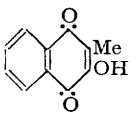
21. *Syntheses in the Naphthalene Series. Part II.* 3-*Hydroxy*-2-*alkyl*-1 : 4-*naphthaquinones.*

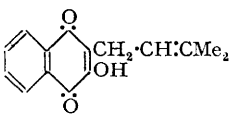
By GABRA SOLIMAN and (in part) ALBERT LATIF.

A new method for the synthesis of 3-hydroxy-2-alkyl-1 : 4-naphthaquinones is described in which 2-alkyl-1 : 3-dihydroxynaphthalenes are oxidised with atmospheric oxygen in presence of alcoholic potassium hydroxide.

ALKYLATED 1 : 4-naphthaquinones have recently been the subject of considerable study. These include phthiocol (I), the yellow pigment of human tubercle bacillus, which has recently been shown to possess vitamin-K activity (Almquist and Klose, *J. Amer. Chem. Soc.*, 1939, **61**, 2557), and dihydrolapachol (III), the reduction product of lapachol (II) occurring in *Lapacho* wood (*Bignoniaceæ*) (Paternò, *Gazzetta*, 1879, **9**, 505) and Bethabarra wood (Greene and Hooker, *J. Amer. Chem. Soc.*, 1889, **11**, 267).



(I.)



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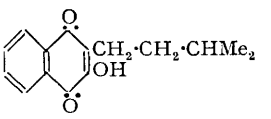
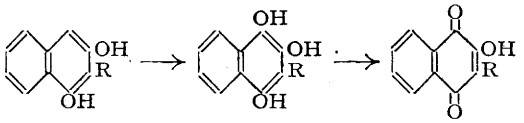


(III.)

The published syntheses of phthiocol and dihydrolapachol (Madinaveitia, *Anal. Fis. Quim.*, 1933, **31**, 750; Anderson and Newmann, *J. Biol Chem.*, 1933, **103**, 405; 1934, **105**, 279; Monti, *Gazzetta*, 1915, **45**, 51; Hooker,

J. Amer. Chem. Soc., 1936, **58**, 1163) leave much to be desired. They are, however, readily prepared by a method, first recorded by one of us (Soliman) in an M.Sc. thesis in 1931, which involves oxidation of a 2-alkyl-1 : 3-dihydroxynaphthalene by atmospheric oxygen in presence of alcoholic potassium hydroxide. This process gave phthiocol in almost quantitative yield. Similarly, 1 : 3-dihydroxynaphthalene was converted into 2-hydroxy-1 : 4-naphthaquinone, and the ethyl, propyl, *iso*propyl, butyl, *iso*butyl, and *iso*amyl homologues were prepared from the corresponding 1 : 3-dihydroxynaphthalenes, with melting points somewhat higher than those recorded in the literature (cf. Hooker, *J. Amer. Chem. Soc.*, 1936, **58**, 1163; Hooker and Steyermark, *ibid.*, p. 1168).

Koelsch and Byers (*J. Amer. Chem. Soc.*, 1940, **62**, 560) found that 2-ethyl- and 2-butyl-3-carbethoxy-1 : 4-naphthaquinone gave, on treatment with air and warm dilute sodium hydroxide solution, the corresponding 3-hydroxyquinones. This reaction involves hydrolysis of the ester group and decarboxylation prior to hydroxylation in position 3, whereas, in the reaction now described, hydroxylation involves carbon atom 4 :



(IV.) (V.) (VI.)

3-Hydroxy-2-phenyl-1 : 4-naphthaquinone (Gheorgiu and Radulescu, *Ber.*, 1927, **60**, 186) has also been obtained by the general reaction, and by Volhard (*Annalen*, 1897, **296**, 14) from 1 : 3-dihydroxy-2-phenylnaphthalene by treatment with dilute sodium hydroxide solution, and this indicates that the reaction now described may be successfully applied to aromatic derivatives.

Experimental.

2-Hydroxy-1 : 4-naphthaquinone.—When a solution of 1 : 3-dihydroxynaphthalene (3·5 g.) in alcohol (10 c.c.) and 5% alcoholic potassium hydroxide (30 c.c.) was exposed to air for 2 days, a red crystalline potassium salt separated. The salt dissolved freely in water, and on acidification gave a yellowish precipitate which crystallised from benzene in plates, m. p. 192°, identical with an authentic specimen (Found : C, 69·0; H, 3·5. Calc. for $C_{10}H_6O_3$: C, 69·0; H, 3·5%).

3-Hydroxy-2-alkyl-1 : 4-naphthaquinones.—The following homologues were prepared by the method described above and crystallised from dilute methanol: 2-Methyl-, canary-yellow needles, m. p. 174° (Found : C, 70·0; H, 4·3. Calc. for $C_{11}H_8O_3$: C, 70·1; H, 4·3%); acetate (acetic anhydride and sodium acetate), yellowish needles, m. p. 108°, from methanol (Found : C, 67·7; H, 4·4. Calc. : C, 67·8; H, 4·4%). 2-Ethyl-, yellow needles, m. p. 141° (Found : C, 71·2; H, 5·0. Calc. : C, 71·3; H, 5·0%); acetate (acetic anhydride and pyridine), needles, m. p. 91°, from methanol (Found : C, 68·8; H, 4·9. Calc. : C, 68·9; H, 4·9%). 2-Propyl-, plates, m. p. 103—104° (Found : C, 72·4; H, 5·5. Calc. : C, 72·2; H, 5·6%); acetate, plates, m. p. 52° (Found : C, 69·6; H, 5·7. Calc. : C, 69·7; H, 5·5%). 2-*iso*-Propyl-, plates, m. p. 95° (Found : C, 72·2; H, 5·6. Calc. : C, 72·2; H, 5·6%). 2-Butyl-, needles, m. p. 101—102° (Found : C, 73·1; H, 5·9. Calc. : C, 73·0; H, 6·1%). 2-*iso*Butyl-, prisms, m. p. 134° (Found : C, 73·1; H, 6·1. Calc. : C, 73·0; H, 6·1%); acetate, needles, m. p. 53° (Found : C, 70·5; H, 5·8. Calc. : C, 70·5; H, 5·9%). 2-*iso*-Amyl- (dihydrolapachol), yellow plates, m. p. 94° (Found : C, 73·8; H, 6·4. Calc. : C, 73·7; H, 6·6%); acetate, needles, m. p. 76—77°, from light petroleum. When dihydrolapachol (0·4 g.) was heated with zinc dust (0·5 g.) and acetic anhydride (15 c.c.) for 3 hours, the triacetate corresponding to the quinol was obtained; it crystallised from dilute methanol in needles, m. p. 120° (Monti, *loc. cit.*, gives m. p. 110—112°).

3-Hydroxy-2-phenyl-1 : 4-naphthaquinone, obtained in almost quantitative yield when 2-phenyl-1 : 3-dihydroxynaphthalene was subjected to the same process of oxidation, crystallised from methanol in orange needles, m. p. 147° (cf. Volhard, *loc. cit.*).

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