113. *Synthetical Experiments in the Chromone Group. Part XI. Synthesis of* iso*Flavone.*

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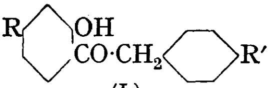
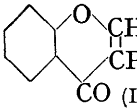
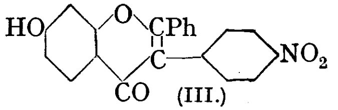
2-Phenylacetyl-1-naphthol and 1-phenylacetyl-2-naphthol do not react with ethyl formate and sodium (Cheema and Venkataraman, J., 1932, 918; Chadha, Mahal, and Venkataraman, J., 1933, 1459). Minute amounts of *iso*flavone derivatives, however, have been obtained by Späth and Lederer (*Ber.*, 1930, **63**, 743) and Wessely, Kornfeld, and Lechner (*Ber.*, 1933, **66**, 685) from *o*-hydroxyphenyl benzyl ketones by a procedure involving the use of sealed tubes. We have now studied the reaction under ordinary conditions. The interaction of *o*-hydroxyphenyl benzyl ketone itself (I; R = R′ = H), ethyl formate, and sodium gave iso*flavone* (II).


(I.)


(II.)


(III.)

2 : 4-*Dihydroxyphenyl* 4-*nitrobenzyl ketone* (I; R = OH, R′ = NO_2) was obtained by the Hoesch method from resorcinol and *p*-nitrophenylacetonitrile (contrast Yamashita, *Sci. Rep. Tôhoku Imp. Univ.*, 1929, **18**, 615) and converted into 7-*hydroxy*-2-*phenyl*-3-p-*nitrophenylchromone* (III).

By the Hoesch reaction *p*-nitrophenylacetonitrile and *m*-methoxyphenol yielded 2-*hydroxy*-4-*methoxyphenyl* 4-*nitrobenzyl ketone* (I; R = OMe, R′ = NO_2) and 4-*hydroxy*-2-*methoxyphenyl* 4-*nitrobenzyl ketone*, which were separated by means of their different solubility in caustic soda solution. The former did not react with ethyl formate.

Experimental.

iso*Flavone* (II).—A mixture of *o*-hydroxyphenyl benzyl ketone (2 g.), sodium dust (1 g.), and ethyl formate (20 g.) was kept for 40 hours and then shaken with ice and ether. The ethereal solution was washed with water and dried (magnesium sulphate), ether and ethyl formate removed on the water-bath, and the residual oil, after solidifying, crystallised from alcohol; colourless needles (0·8 g.), m. p. 142°, were obtained (Found: C, 81·2; H, 4·5. $C_{15}H_{10}O_2$ requires C, 81·1; H, 4·5%). Recrystallisation from light petroleum (b. p. 50—60°) gave a mixture of leaflets and needles, m. p. 148°. The *substance* was unaffected by boiling acetic anhydride or cold concentrated sulphuric acid. Its colourless solution in sulphuric acid had a weak blue fluorescence which slowly became bright blue. The colourless solution in alcohol gave no coloration with ferric chloride or with magnesium and hydrochloric acid. A drop of sulphuric acid added to the colourless solution in boiling glacial acetic acid did not produce a colour.

2 : 4-*Dihydroxyphenyl* 4-*Nitrobenzyl Ketone* (I; R = OH, R′ = NO_2).—Dry hydrogen chloride was passed for 4 hours into a mixture of *p*-nitrophenylacetonitrile (8·6 g.), resorcinol (7 g.), fused zinc chloride (2 g.), and dry ether (50 c.c.) at 0°. After 2 days the ether was decanted and the red residue was washed with ether, boiled with water for 1 hour and cooled; the *product* crystallised from alcohol in stout colourless needles (5 g.), m. p. 210° (Found: N, 5·4. $C_{14}H_{11}O_5N$ requires N, 5·2%). An alcoholic solution gave a deep blue colour with ferric chloride. The 2 : 4-*dinitrophenylhydrazone* crystallised from quinoline–light petroleum in orange needles, m. p. 238° (Found: N, 15·5. $C_{20}H_{15}O_8N_5$ requires N, 15·4%). The *chromone* (III), obtained in the usual manner, crystallised from acetone in yellow needles, m. p. 301° (Found: N, 4·0. $C_{21}H_{13}O_5N$ requires N, 3·9%). The *dibenzyl ether* of the ketone was produced when the ketone (4 g.), benzyl chloride (6·6 g.), fused potassium carbonate (6·3 g.), and acetone (25 c.c.) were refluxed for 8 hours. The mixture was poured into water and steam-distilled to remove benzyl chloride. The residual solid was dissolved in alcohol–acetic acid: a small amount of yellow needles, m. p. 193°, separated first (Found, micro.: N, 10·1%) and then, after concentration of the filtrate, the dibenzyl ether, which, thrice crystallised from benzene–light petroleum, formed colourless needles, m. p. 121° (Found: N, 2·9. $C_{28}H_{23}O_5N$ requires N, 3·0%); neither product gave a ferric chloride reaction.

4-*Hydroxy*-2-*methoxy*- *and* 2-*Hydroxy*-4-*methoxy*-*phenyl* 4-*Nitrobenzyl Ketones*.—Dry hydrogen chloride was rapidly passed into an ice-cooled mixture of *p*-nitrophenylacetonitrile (5 g.), resorcinol monomethyl ether (3·8 g.), zinc chloride (1 g.), and dry ether (20 c.c.) for 4 hours. After 48 hours, the ethereal layer was decanted, and the orange residue boiled with water for 1 hour. The solid which separated on cooling was dissolved in alcohol and mixed with ether, the mixture washed with brine, and the ethereal layer extracted with 5% sodium carbonate solution and then with cold 1% caustic soda solution. Acidification of the alkaline layer and crystallisation from alcohol gave colourless needles of the 2-*methoxy*-4-*hydroxy*-ketone, m. p. 149—150° after sintering at 130° (Found: N, 5·0. $C_{15}H_{13}O_5N$ requires N, 4·9%), an alcoholic solution of which gave no colour with ferric chloride. The 2 : 4-*dinitrophenylhydrazone* crystallised from alcohol–chloroform in orange-red needles, m. p. 229° (Found: N, 14·8. $C_{21}H_{17}O_8N_5$ requires N, 15·0%). The ethereal extract was dried, the ether removed, and the yellow crystalline residue recrystallised from aqueous alcohol, giving the 2-*hydroxy*-4-*methoxy*-ketone in almost colourless needles (0·8 g.), m. p. 136° (Found: N, 5·1%), an alcoholic solution of which gave a deep blue coloration with ferric chloride. The 2 : 4-*dinitrophenylhydrazone* crystallised from acetic acid in orange-red needles, m. p. 232° (Found: N, 15·2%).

α-*Naphthyl* p-*Nitrophenylacetate*.—A mixture of *p*-nitrophenylacetic acid (2 g.), α-naphthol (1·5 g.), and phosphorus oxychloride (5 g.) was heated at 110—120° for 1 hour, the product poured into water, and the yellow solid crystallised from acetic acid. The yellow prismatic needles obtained, m. p. 152°, did not yield a dinitrophenylhydrazone and gave no coloration with alcoholic ferric chloride (Found: N, 4·7. $C_{18}H_{13}O_4N$ requires N, 4·5%). The substance exists in dimorphic forms, as crystallisation from alcohol gives pale yellow, elongated plates, m. p. 146° (Found: N, 4·5%).

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