

NUCLEAR REDUCTION OF ANTHOXANTHINS

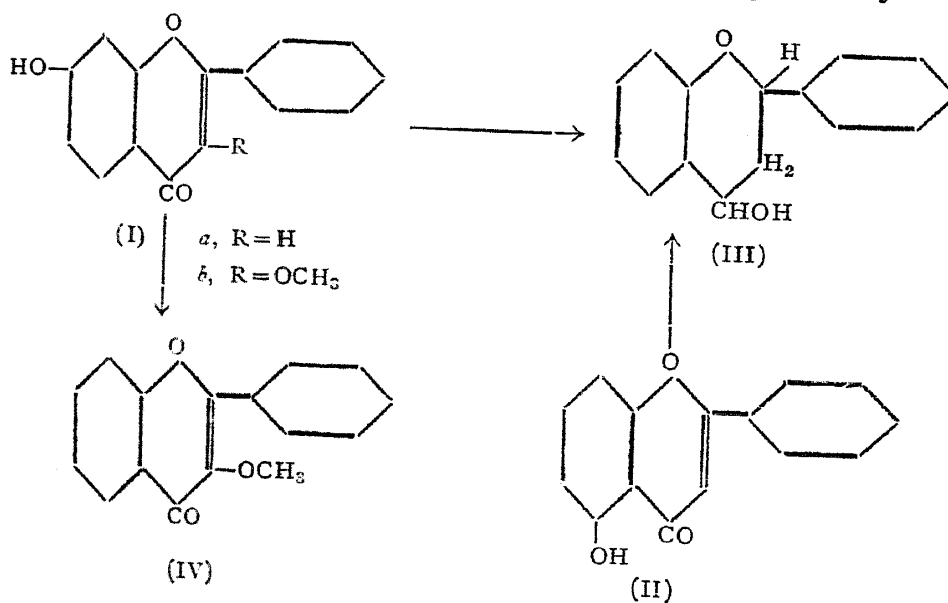
Complete Removal of Phenolic Hydroxyl Groups

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As compared with anthocyanins, a characteristic feature of anthoxanthins is the occurrence of complete nuclear reduction leading to the parent substance, flavone, which is found to occur free in plants. In previous communications¹ have been discussed the complete reduction in the side phenyl nucleus and the removal of a hydroxyl group from the 7 or 5-position of flavones. The removal of the final hydroxyl group in the condensed benzene ring has now been carried out. 7- or 5-Hydroxy flavone (I *a* and II) when tosylated and subjected to hydrogenolysis is found to yield a colourless product which could be identified as β -4-hydroxy-flavan (III). Obviously reduction has gone further than the removal of the tosyloxy group. The flavone first formed seems to be easily susceptible to reduction. From the results of all previous experiments on nuclear reduction in the flavone series, it is clear that the existence of a substituent either as hydroxyl or methoxyl gives stability to the flavone structure and the central γ -pyrone ring is left unreduced. But when all substituents are removed it seems to become susceptible to reduction. This conclusion has been supported by carrying



out the nuclear reduction of 3-methoxy-7-hydroxy flavone (1 *b*). The product is found to be simple flavonol methyl ether (IV) which has escaped further hydrogenation. Incidentally these experiments provide a simple method of preparing the parent substance of the flavonol series.

EXPERIMENTAL

7-Tosyloxy flavone

7-Hydroxy flavone was prepared by the method of Robinson and Venkataraman² with the additional treatment with boiling aqueous sodium carbonate in order to remove 3-acyl group. It (2 g.) was refluxed with tosyl chloride (1.9 g.) in dry acetone solution (150 c.c.) in presence of anhydrous potassium carbonate (5 g.) for 3 hours. The solvent was distilled off and the residue treated with water. The solid product was collected and crystallised from alcohol when it separated as long rectangular prisms and rods melting at 159–60° (Found: C, 67.1; H, 3.9. $C_{22}H_{16}O_5S$ requires C, 67.3; H, 4.1%).

5-Tosyloxy flavone

5-Hydroxy flavone (II) was obtained by the method of Rao, Rajagopalan and Seshadri.³ It was newly observed that pyridine was better than alcohol as solvent for deacylation and by its use the product was obtained more readily in a purer form. It was tosylated with excess of tosyl chloride (3 moles) using the potassium carbonate-acetone method and boiling the mixture till it gave no colour with ferric chloride (20 hours). The product crystallised from alcohol as colourless long rectangular tablets melting at 188–89° (Found: C, 67.1; H, 4.4.; $C_{22}H_{16}O_5S$ requires C, 67.3; H, 4.1%).

Hydrogenolysis of 7- and 5-tosyloxy flavones

A slow current of purified hydrogen gas was passed through an agitated alcoholic solution of 7- or 5-tosyloxy flavone (1 g.) containing Raney nickel (one tea-spoonful) at room temperature for an hour. The alcoholic solution (A) was decanted and the nickel residue after decomposition with dilute hydrochloric acid was extracted with ether. The ether concentrate was mixed with the alcoholic solution (A) and the solvents were completely removed. The resulting solid was refluxed with 5% aqueous sodium carbonate (100 c.c.) for 2 hours. After cooling it was extracted with ether. The residue left after evaporating the ether extract was crystallised from ether-petroleum ether mixture when a colourless crystalline solid melting at 142–43° was obtained. It was found to agree with β -4-hydroxy flavan (III) obtained earlier by Mzingo and Adkins⁴ by the reduction of flavone with Raney nickel. The identity was confirmed by acetylating it with acetic anhydride

and fused sodium acetate. The acetate crystallised from dilute methyl alcohol as colourless needles melting at 97–98°. Karrer, Yen and Reichstein⁵ gave the melting point of 98–99° for this acetate.

The above experiment was repeated with 7-tosyloxy flavone at a lower temperature (15°) and using a shorter period (40 minutes). The product obtained after treatment with sodium carbonate and ether extraction was dissolved in the minimum quantity of alcohol, treated with caustic potash (0.5 g.) and the resulting solution kept for 15 minutes at room temperature. After dilution with water it was extracted with ether and the ether solution evaporated. The residue crystallised from petroleum ether as colourless needles melting at 142–43°. It was identical with β -4-hydroxy flavan (III) obtained in the earlier experiment. The yield was however poorer than in the earlier experiment.

Reduction of 7-hydroxy-3-methoxy flavone

7-Hydroxy-3-methoxy flavone⁶ (I b) was tosylated as in the case of 7-hydroxy flavone. The product crystallised from alcohol as pale yellow rhombic prisms melting at 132–33° (Found: C, 65.1; H, 4.1. $C_{23}H_{18}O_6S$ requires C, 65.4; H, 4.3%).

The above tosyl ester (1 g.) was subjected to hydrogenolysis for 1 hour at room temperature. The product obtained after treatment with sodium carbonate and ether extraction of the resulting solution was sticky in nature. It was kept in alcoholic potash (0.5 g. in 10 c.c.) for 7 minutes, diluted with water and extracted with ether. The residue left after evaporating the solvent crystallised from methyl alcohol as colourless very large rectangular prisms melting at 114–15° identical with 3-methoxy flavone as reported by Oyamada.⁷ Yield, 0.3 g. The identity was confirmed by demethylation with hydriodic acid to flavonol which crystallised from ethyl acetate-petroleum ether mixture as pale yellow needles and rectangular plates melting at 168–69° identical with the one obtained by Kostanecki.⁸

When the above experiment was repeated at a lower temperature (15°) and for a shorter period (40 minutes) most of the original compound was recovered unchanged and only a very small amount of flavonol methyl ether (IV) was obtained.

SUMMARY

Nuclear reduction of 7-hydroxy and 5-hydroxy flavones yields β -4-hydroxy flavan whereas 3-methoxy-7-hydroxy flavone yields 3-methoxy flavone. The pyrone ring escapes further reduction if there should be a substituent.

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