Intramolecular Participation in Hypervalent Iodine Oxidation. The Synthesis of Coumaran-3-ones, Aurone, and Isoaurone

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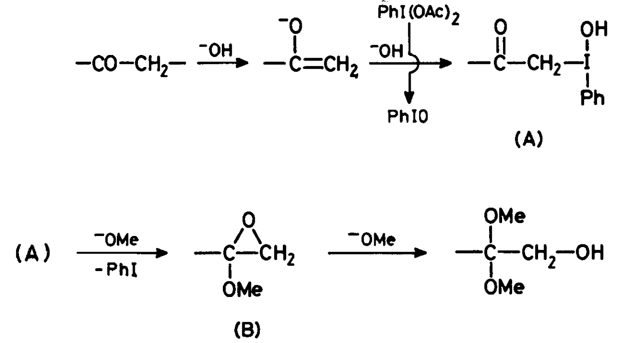
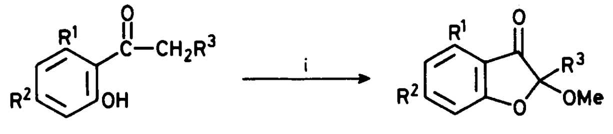
Oxidation of *o*-hydroxyphenyl alkyl ketones with $PhI(OAc)_2$/KOH–MeOH leads to 2,2-dimethoxycoumaran-3-ones which in the case of *o*-hydroxy-α-phenylpropiophenone offers a convenient route to aurone and isoaurone.

Oxidation of various acetophenone derivatives with PhI-$(OAc)_2$/KOH–MeOH yields the corresponding α-hydroxydimethyl acetal.[1] In this transformation ^-OMe plays the role of an external nucleophile.

We now show that an *o*-hydroxy group in various substituted *o*-hydroxyacetophenones acts analogously as an intramolecular nucleophile in the reductive cleavage of the C–I bond [(A) → (B), Scheme 1]. A series of substituted *o*-hydroxyacetophenones (**1a**—**d**) were treated with excess of $PhI(OAc)_2$ in KOH–MeOH to yield the corresponding

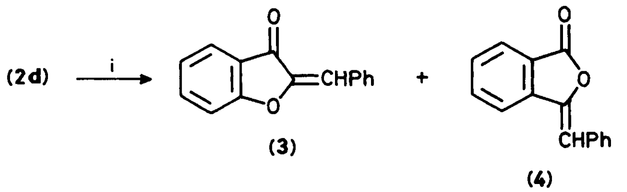


Scheme 1

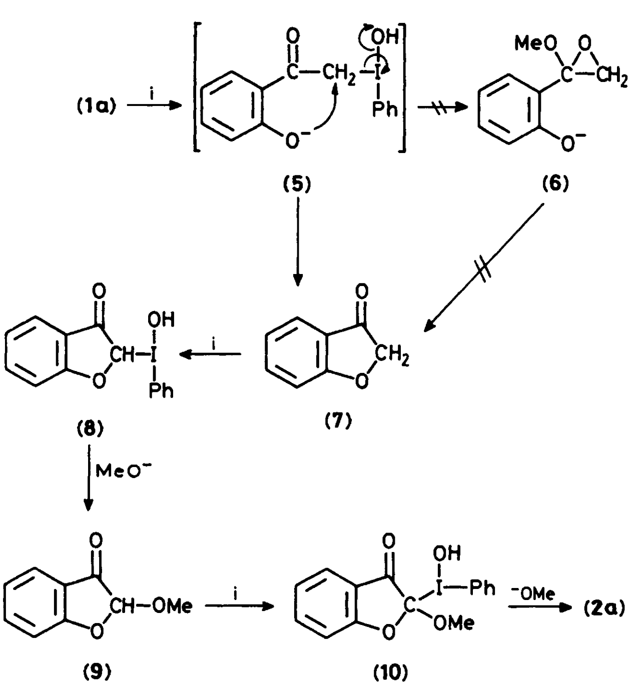


(1)	(2)
(1a) $R^1 = R^2 = R^3 = H$	(2a) $R^3 = OMe$
(1b) $R^1 = R^2 = H$; $R^3 = Me$	(2b) $R^3 = Me$
(1c) $R^1 = R^2 = Me$; $R^3 = H$	(2c) $R^3 = OMe$
(1d) $R^1 = R^2 = H$; $R^3 = CH_2Ph$	(2d) $R^3 = CH_2Ph$

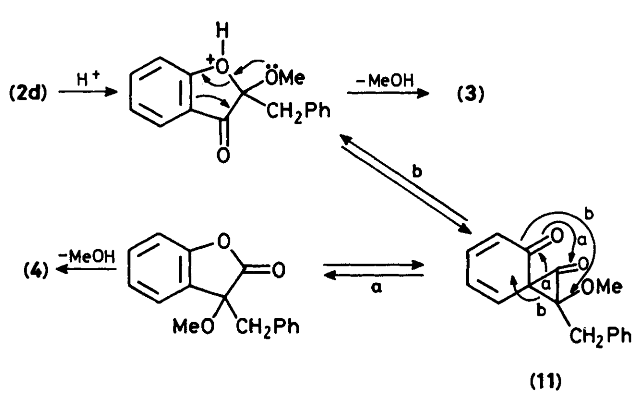
Reagent: i, $PhI(OAc)_2$, KOH–MeOH, 0 °C, then raised to room temperature.



Reagent: i, dilute H_2SO_4, heat.



Scheme 2. *Reagent:* i, $PhI(OAc)_2$, KOH-MeOH.



coumaran-3-ones (**2a**—**d**).† Acid treatment of (**2d**) yielded a mixture of aurone (**3**) and isoaurone (**4**) in 60% yield as a 1 : 1 mixture which was separated by t.l.c.‡ A mechanism for the reactions (**1a**—**d**) → (**2a**—**d**), illustrated for (**1a**) → (**2a**), is shown in Scheme 2.

Coumaran-3-one (**7**)[3] was separately subjected to the reaction conditions and yielded (**2a**) in 50% yield. Intermediate (**5**) is based upon the general mechanism [*viz.* intermediate (A)] presented in Scheme 1. Intramolecular displacement with reductive elimination [(**5**) → (**7**)], a 5-*exo-tet* process, is stereoelectronically favourable.[4] Alternative intermolecular attack by MeO^- [(**5**) → (**6**)] is possible, but [(**6**) → (**7**)] is stereoelectronically unfavourable.§

Hyperiodination [(**7**) → (**8**)], bimolecular reductive displacement [(**8**) → (**9**)], followed by the same sequence, yields (**2a**). This pathway also is considered to occur for (**1b**—**d**) → (**2b**—**d**).

The formation of aurone (**3**) from (**2d**) results from acid-catalysed loss of MeOH. Isoaurone (**4**) is a rearrangement product which may result from a phenonium ion type intermediate (**11**).

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† (**2a**), 20%, oil, i.r. (neat): 1740 cm^{-1}; ^1H n.m.r. δ: ($CDCl_3$) 3.5 (s, 6H, OCH_3), 6.68—7.7 (m, 4H) [the ^1H n.m.r. spectrum of (**2a**) has been reported: 3.54 (OCH_3); S. Antus E. Baitz-Gács, F. Boross, M. Nogradi, and A. Solyom, *Liebigs Ann. Chem.*, 1980, 1271]; *m/z* 194(66%) M^+, 163(71) M^+-OCH_3, 166(59) M^+-CO, 120(23) $M^+-C(OCH_3)_2$, 121 (100) $M^+-[C(OCH_3)(OCH_2)]$. (**2b**), 35%, oil, i.r. (neat): 1730 cm^{-1}; δ: ($CDCl_3$) 1.55 (s, 3H, CH_3), 3.26 (s, 3H, OCH_3), and 6.9—7.8 (*m*, 4H); *m/z* 178(38) M^+, 147(14) M^+-OCH_3, 150(21) M^+-CO, 148(33) M^+-CH_2O, 91(100). (**2c**), 21%, m.p. 59—60 °C, i.r. (Nujol): 1730 cm^{-1}; δ: ($CDCl_3$) 2.33 (s, 3H, CH_3), 2.5 (s, 3H, CH_3), 3.4 (s, 6H, OCH_3), 6.6 (s, 2H); *m/z* 222(44) M^+, 191(43) M^+-OCH_3, 192(10) M^+-CH_2O, 148(14) $M^+-C(OCH_3)_2$, 132(100). (**2d**) was obtained from (**1d**), 40%, oil, i.r. (neat): 1725 cm^{-1}; δ: ($CDCl_3$) 3.15 (s, 5H, CH_2 and OCH_3), 6.63—7.4 (m, 9H, aromatic); *m/z* 254(16) M^+, 223(2) M^+-OCH_3, 163(100) M^+-CH_2Ph. The conversion of (**1a**) and (**1c**) into (**2a**) and (**2c**), respectively, is 30% and (**1b**) and (**1d**) into (**2b**) and (**2d**), respectively is 50% using equimolar amounts of $PhI(OAc)_2$ and ketone. The conversion is not increased with 2 or 3 equiv. of $PhI(OAc)_2$ relative to the ketone. Yields are of the pure isolated compounds by chromatography.

‡ Aurone (**3**), i.r. ($CHCl_3$): 1710 cm^{-1}; ^1H n.m.r. δ: ($CDCl_3$) 6.9 (s, C=CH); ^{13}C n.m.r. δ: ($CDCl_3$) 111.19 (s, C=*C*H), 183.5 (C=O); *m/z* 222(100) M^+, 120(34) $M^+-C{=}CHPh$. Isoaurone (**4**), i.r. ($CHCl_3$): 1780 cm^{-1}, δ: ($CDCl_3$) 7.86 (s, C=CH); ^{13}C n.m.r. δ: ($CDCl_3$) 133.6 (s, C=*C*H), 170 (C=O); *m/z* 222(100) M^+, 194(39) M^+-CO. ^1H, ^{13}C N.m.r. and i.r. data for (**3**) and (**4**) are in excellent agreement with the data reported for 6-methoxyaurone and 6-methoxyisoaurone (ref. 2).

§ Stork *et. al.* (ref. 5) have demonstrated convincingly that S_N2 ring-opening of oxiranes requires a colinear arrangement of the nucleophile and C–O bond undergoing cleavage. This stereoelectronic effect is not met in (**6**) → (**7**) even though an entropic advantage would exist in this intramolecular process. Both the favoured (**5**) → (**6**) and unfavoured (**6**) → (**7**) transformations are implicit in Eschenmoser's demonstration of the necessity for colinearity of reacting groups in intramolecular S_N2 processes (L. Tenud, S. Faroog, J. Seibl, and A. Eschenmoser, *Helv. Chim. Acta*, 1970, **53**, 2059).

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