

REACTION OF SOME SUBSTITUTED 2-ALLYLPHENOLS WITH 2,3-DICHLORO-5,6-DICYANO-1,4-BENZOQUINONE (DDQ) - A NEW METHOD FOR THE SYNTHESIS OF COUMARINS

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Several methods are available for the synthesis of coumarin ring system¹. We now report a new method for the synthesis of coumarins by oxidative cyclisation of some substituted 2-allylphenols by 2,3-dichloro-5,6-dicyano-1,4-benzoquinone (DDQ).

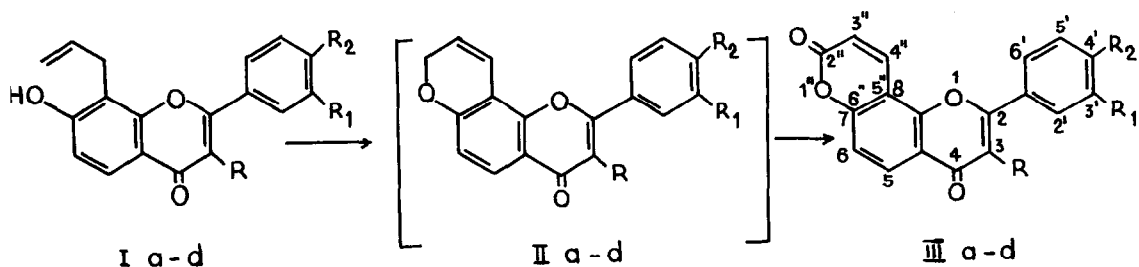
7-Allyloxy-3-methylflavone² on Claisen rearrangement in vacuo at 180° yielded 7-hydroxy-8-allyl-3-methylflavone (Ib) m.p. 229-30° (95% yield). Ib (0.001 mole) and DDQ (0.003 mole) in benzene were refluxed for 16 hours. The reaction mixture was worked up in the usual manner³ and chromatographed over silica gel and eluted with benzene to give a cyclised product (IIIb) C₁₉H₁₂O₄ (30% yield). Subsequent elution with chloroform-methanol mixture (9:1) gave the starting material (Ib), (50%). The i.r. spectrum of IIIb shows a lactone carbonyl and a flavone carbonyl (Table I). The n.m.r. spectrum (CF₃COOH) of IIIb reveals two AB doublets at δ 6.90 (J=10Hz) and δ 8.70 (J=10Hz) which are characteristic of α and β protons (C3"H and C4"H respectively) of coumarins⁴. In addition to these, another low field AB doublet due to C5 proton appears at δ 8.15 (J=8Hz). The corresponding AB doublet of the C6 proton merges with other aromatic protons of the side phenyl nucleus which appear in the region δ 7.50-7.90. The C3 methyl protons resonate at δ 2.35. Based on the above spectral data (Table I) and from the analytical data the 3-methyl-2"-pyrono-(5",6":8,7) flavone structure (IIIb) has been assigned to the DDQ reaction product. The structure IIIb has been confirmed by its identity (m.m.p., i.r.) with an authentic sample obtained by the Perkin reaction on 7-hydroxy-8-formyl-3-methylflavone⁵. IIIa⁶, IIIc and IIId were similarly prepared by oxidative cyclisation with DDQ from the corresponding 7-hydroxy-8-allylflavones Ia⁶, Ic and Id respectively. Ic and Id were in turn prepared from 7-allyloxy-3',4'-dimethoxy-3-methylflavone² and 7-allyloxy-3-phenylflavone⁷ respectively by Claisen migration. The spectral and analytical data (Table I) of IIIa, IIIc and IIId are in good agreement with the 2"-pyronoflavone structure. Further, the structure IIIa and IIIc were confirmed by their identity (m.m.p., i.r.) with authentic samples prepared by Perkin reaction on 7-hydroxy-8-formyl⁶-, and 7-hydroxy-8-formyl-3',4'-dimethoxy-3-methyl (m.p. 197-8°) - flavone. The latter compound was prepared from

7-hydroxy-3',4'-dimethoxy-3-methylflavone² using Duff reaction. Earlier, Duff reaction was used to introduce formyl group at 8 position of flavones^{5,6}.

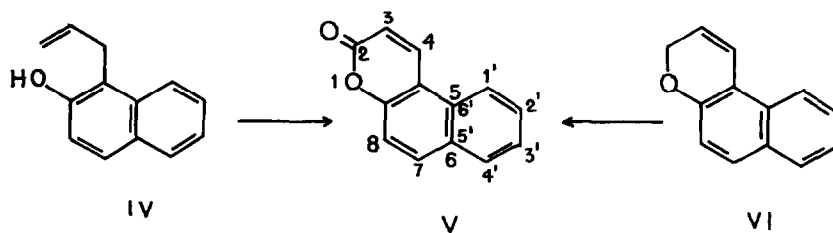
The conversion of 2-allylphenols to coumarins by DDQ seems to be versatile since we have now found that 1-allyl-2-hydroxynaphthalene⁸ (IV) on treatment with DDQ (three mole equivalents) gave benz-(5',6':6,5)-coumarin (V) (20% yield) identical (m.m.p., i.r.) with an authentic sample prepared by a reported method⁹.

Table I
Physical and Spectral data of 2"-pyrono flavones

Sl. No.	Compound	M _t by mass spectrum	m.p. °C.	i.r. ν C=O, cm ⁻¹		UV nm
				lactone	flavone	λ _{max} MeOH (log. ε)
1.	IIIa	290	250 (lit. ⁹ 250)	1725	1635	249(4.20), 274(4.24)
2.	IIIb	304	231-32	1730	1640	244(4.16), 277(4.15)
3.	IIIc	-	184-85	1735	1630	259(4.20), 284(4.18)
4.	IIId	366	254-55	1730	1640	249(4.19), 304(3.90)



- I, II, III (a) R = R₁ = R₂ = H
 (b) R = Me; R₁ = R₂ = H
 (c) R = Me; R₁ = R₂ = OMe
 (d) R = Ph; R₁ = R₂ = H



Oxidative cyclisation of 2-(3',3'-dialkyl allyl)- and 2-(3'-phenyl allyl)-phenol using DDQ to the corresponding chromenes is well known¹⁰⁻¹³. However, in the present investigation, the cyclisation of 2-allylphenols (I and IV) with DDQ gave coumarins III and V respectively rather than expected chromenes II and VI. It has also been observed now that 3H naphtho-(2,1b)pyran (VI) which was prepared by method described in literature¹⁴, on oxidation with two mole equivalents of DDQ gave benz-(5',6':6,5)-coumarin in good yields (20%). By analogy it can be presumed that oxidative cyclisation of 7-hydroxy-8-allylflavones (I) may involve pyran intermediate (II). Attempts to isolate the expected pyran intermediate IIb using lesser amounts (one and two mole equivalents) of DDQ in the case of Ib invariably gave IIIb in diminished yields (5 and 10% respectively). Therefore, it could be concluded that for the oxidative cyclisation of 2-allylphenols to the corresponding coumarin derivatives, 3 mole equivalents of DDQ is necessary for maximum yields. Oxidation of benzylic ring methylene¹⁵ and reactive methyl groups^{16,17} to keto group was reported.

It was earlier reported that 2-allyl-, and 2-(but-2-enyl)-phenol did not undergo cyclisation with DDQ¹². This reported failure of the reaction may be due to insufficient amount of DDQ used in the reaction.

The overall yield of 2"-pyronoflavones starting from the corresponding 7-hydroxyflavones is worked out to be 25% through DDQ method. Further work is in progress to study the scope and limitations of this reaction for the synthesis of several substituted coumarins. All the compounds reported in this paper gave satisfactory elemental analysis.

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