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CYCLODEHYDROGENATION OF ORTHO-(3,3-DIMETHYLALLYL) PHENOLS WITH TRITYL TETRAFLUOROBORATE ‡

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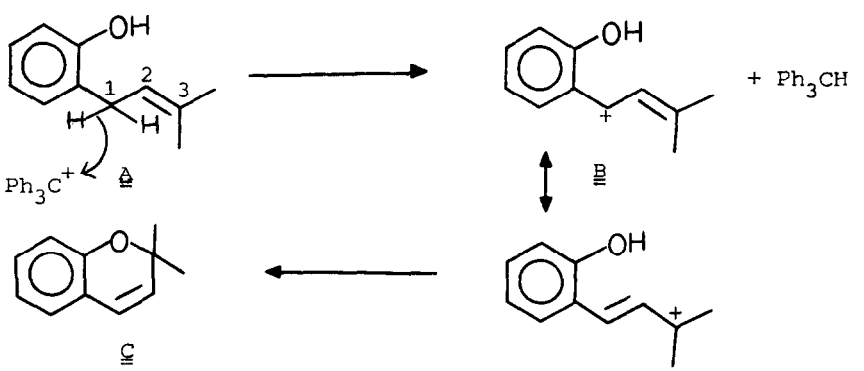
Summary : Trityl tetrafluoroborate has been shown to effect the cyclodehydrogenation of o-(3,3-dimethylallyl)phenols in an efficient manner.

Earlier methods of cyclodehydrogenation of o-(3,3-dimethylallyl)phenols describe chiefly the use of chloranil or 2,3-dichloro-5,6-dicyanobenzoquinone (DDQ)[1] but more recently potasium dichromate[2] and N-iodosuccinimide[3] (NIS) have been shown to effect this transformation in good yield. In connection with our work on the synthesis of isoprenylated phenolics, of interesting insecticidal properties[4], which were recently isolated by us from the natural source[5-7], we encountered problem of cyclodehydrogenation with DDQ and NIS and therefore sought an alternative method. During the past two decades trityl tetrafluoroborate has been exploited as a hydride abstracting reagent which led to its various applications in organic chemistry[8-12]. It was therefore, argued that in a o-(3,3-dimethylallyl)phenol A, since C-1 is sufficiently basic due to its benzylic and allylic nature, trityl tetrafluoroborate could easily abstract a hydride from it to give a highly resonance stabilized cation B whose capture by the hydroxyl would lead to the corresponding chrom-3-ene C.

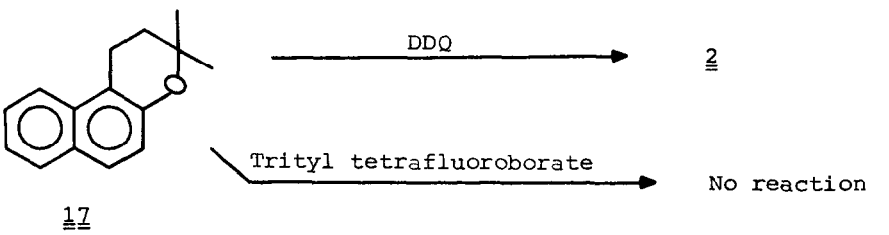


‡Dedicated to Prof D H R Barton on his 65th birthday.

The validity of this conception was successfully demonstrated by taking a number of substrates as shown in Table I from which it is evident that trityl tetrafluoroborate could be a useful alternative to DDQ and NIS.

In a typical experiment a solution of 1.0 mmol of 1 in 2 ml dry dichloromethane was treated with 1.50 mmol of trityl tetrafluoroborate with stirring at room temperature in a nitrogen atmosphere, monitoring the reaction on TLC. The reaction mixture was directly placed on the TLC (SiO_2) plate which was developed in benzene : ethyl acetate (4:1). The product-the only major band (in addition to triphenylmethane and a trace of triphenylmethanol which are easy to detect) was separated out and eluted with 5% MeOH in $CHCl_3$.Evaporation of the solvent furnished 2 as a gum, NMR ($CDCl_3$)δ 1.43s (6H), 5.58d (J=10 Hz,1H), 6.90d (J=10 Hz,1H).

However, trityl tetrafluoroborate failed to dehydrogenate the chromane 17 obtained by formic acid cyclization of 1, whereas the reaction of 17 with DDQ gave 60% yield of 2[13]. This less reactivity on the part of trityl tetrafluoroborate can be advantageous where selectivity is required.



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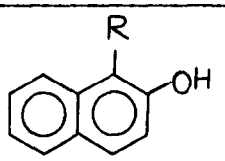
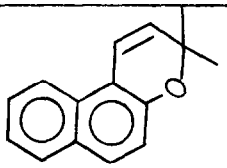
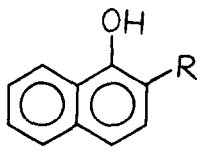
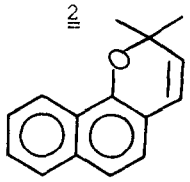
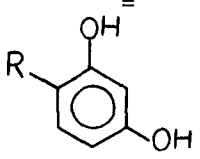
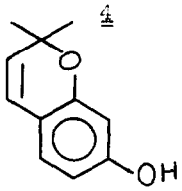
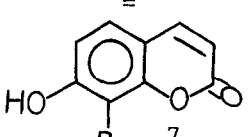
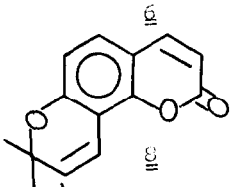
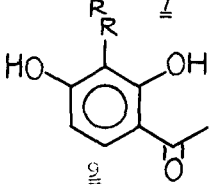
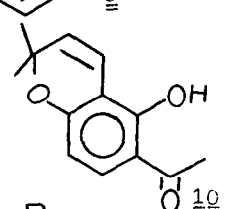
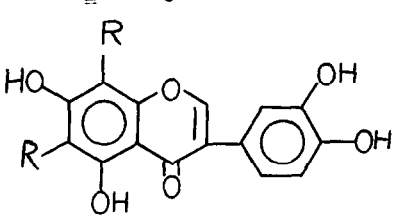
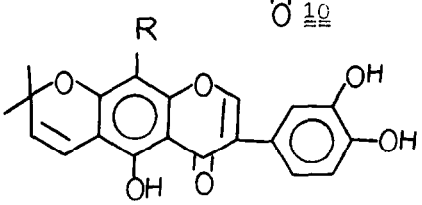
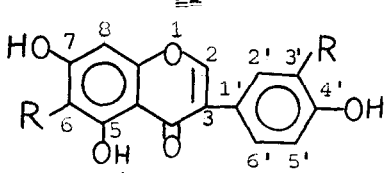
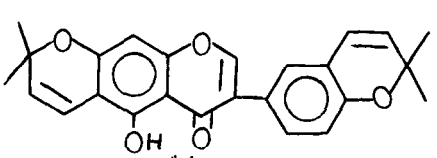
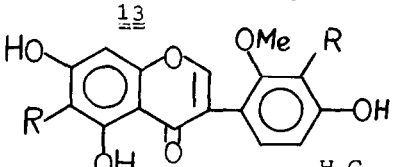
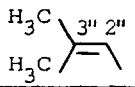
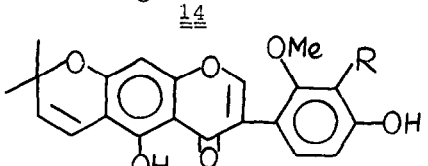
It is interesting to note that in compound 15, only one of the isoprenyl unit undergoes cyclodehydrogenation with trityl tetrafluoroborate and the reaction of 15 with DDQ in refluxing benzene also furnished 16 only[7]. Longer reaction period or higher temperature failed to cyclodehydrogenate the second isoprenyl unit in ring B. On the otherhand, in compound 13 where no substituent is present at C-2', the reaction occurs smoothly with trityl tetrafluoroborate as well as with DDQ[5] to give the corresponding cyclodehydrogenated product 14. This difference in reactivity of the isoprenyl units in 13 and 15 is probably due to steric compression rather than steric hindrance[14].

Cyclodehydrogenation is a reaction of immense utility for the synthesis of chromene moiety which is present in numerous natural products of biological importance and recently chromenes have been shown to possess antijuvenile hormone effects[15] and insecticidal properties[16] as well.

Table I : Cyclodehydrogenation of o-(3,3-dimethylallyl) phenols with TTFB[a,b]

Substrate	Product	Time in hr	Yield (%)
 1	 2	3.5	85
 3	 4	3.5	90
 5	 6	3.5	75
 7	 8	2.45	85
 9	 10	2.30	90
 11	 12	0.50	90
 13	 14	0.75	75
 15	R= 	 16	1.25	80

TTFB = Trityl tetrafluoroborate

a) Authentic samples of all the products mentioned in Table I were prepared by reacting the substrates with DDQ in refluxing benzene. The yields refer to pure isolated products.

b) Compounds 1, 3, 5 and 9 were prepared by reacting the corresponding phenols with 3,3-dimethylallyl bromide in the presence of sodium methoxide in methanol. Compounds 7, 11, 13, & 15 were isolated from the natural source in our laboratory[5-7].

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