Syntheses based on Cyclohexadienes. Part 2.[1] Convenient Synthesis of 6-Alkylsalicylates, 6-Alkyl-2,4-dihydroxybenzoate, and 2,5-Dialkylresorcinols

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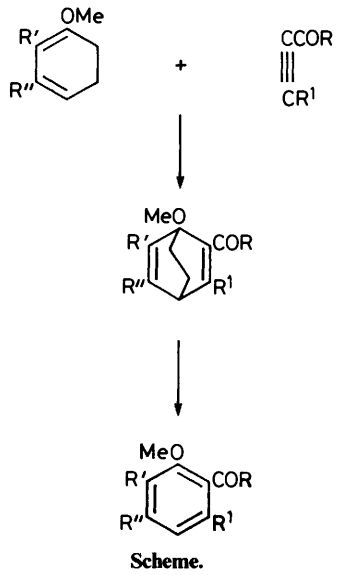
A one pot synthesis of 6-alkylsalicylates and 6-alkyl-2,4-dihydroxybenzoates is described. Cycloaddition of 1-methoxycyclohexa-1,4- or 1,3-dienes with alkylpropiolic esters results in the regiospecific formation of 2-alkyl-6-methoxybenzoates. Thus, methyl 2-methoxy-6-methyl benzoate, methyl 2,4-dimethoxy-6-methylbenzoate, methyl 2,5-dimethoxy-6-methylbenzoate, methyl 2-methoxy-4,6-dimethylbenzoate, and ethyl 2-butyl-4,6-dimethoxybenzoate, have been prepared. By making use of this method, the synthesis of two dihydroisocoumarins namely (±)-mellein (**12**) and (±)-6-methoxymellein (**14**) is described. Employing a similar strategy, a novel route to 2,5-dialkylresorcinols has been developed. Stemphol (**24b**) and the antibiotic DB2073 (**24d**) have been synthesized.

A large number of compounds containing a 6-alkylsalicylate or 2,4-dihydroxybenzoate skeleton are common in a number of aromatic polyketides of fungal and plant origin.[2,3] The synthesis of such compounds is difficult because of their unique substitution pattern. Existing methods for the synthesis of methyl orsellinate and other related compounds are: (*a*) condensation of methyl acetoacetate with methyl crotonate to yield[4,5] 6-methyl-2,4-dioxocyclohexanecarboxylate and subsequent oxidation; (*b*) biomimetic transformation[6] of methyl 3,5,7-trioxo-octanoate; and (*c*) Barton's reaction of the dianion derived from pentane-2,4-dione with sodiomalonate.[7] These methods are only suitable over a limited range of systems and are often restricted to typical experimental procedures.

As an alternative, we considered the possibility of the cycloaddition of 1-methoxycyclohexa-1,3- and -1,4-dienes with suitable acetylenic dienophiles for constructing 6-alkylsalicylates and 2,4-dihydroxybenzoates by making use of the Alder-Rickert reaction as depicted in the Scheme.



Scheme.

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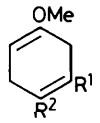
Birch and Hextal[8] reported the first facile addition of dimethyl acetylenedicarboxylate to 1-methoxycyclohexa-1,3-dienes and subsequent conversion of the products into methoxyphthalic acids. Reactions of dienes[9] and cyclohexadienes[10,11] with suitable dienophiles leading to polyketides has been reported. We report herein an efficient method for the construction of 6-alkylsalicylates and 2,4-dihydroxybenzoates involving the cycloaddition of methoxycyclohexadienes with substituted propiolic esters. The factors influencing the regiochemistry of addition are also discussed. This methodology is extended to the synthesis of (*a*) two dihydroisocoumarins; (±)-mellein (**12**) and (±)-6-methoxymellein (**14**) and (*b*) two 2,5-dialkylresorcinols namely stemphol (**24b**) and the antibiotic DB 2073 (**24d**). Preliminary results of this investigation have been reported[12-14] earlier.

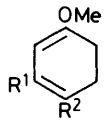
Results and Discussion

Synthesis of 6-Alkylsalicylates and 6-Alkyl-2,4-dihydroxybenzoates.—Methoxycyclohexa-1,4-dienes (**1a—e**) were obtained from anisoles by reduction with an alkali metal and an alcohol in liquid ammonia.[15] These unconjugated dienes are readily equilibrated to the corresponding 1-methoxycyclohexa-1,3-dienes (**2a—e**) using potassium amide in liquid ammonia,[16] or tris(triphenylphosphine)rhodium chloride in dichloromethane[17] or under the catalytic influence of dichloromaleic anhydride.[18] Since pure conjugated dienes are difficult to obtain, an equilibrium mixture containing 20% of the unconjugated isomer has been used. Cycloadditions were carried out by heating either (*a*) the unconjugated diene (**1**) and the acetylenic dienophile (**3**)—(**5**) in a sealed tube at 180 °C for 30 h; (*b*) by heating a mixture of the unconjugated diene (**1**) and the dienophile (**3**)—(**5**) in presence of a catalytic amount of dichloromaleic anhydride at 180 °C for 20 h; or (*c*) by heating an equilibrated mixture of the conjugated and unconjugated dienes (**1**) and (**2**) with the dienophiles (**3**)—(**5**) at 180 °C for 16 h. The temperature was then raised to 200 °C for 4 h and the resulting mixture was distilled to yield the product in 65—70% yield. The reaction is fairly general and facile and only one regioisomer was obtained. The intermediate adducts (**6**) or (**8**) were not isolated.

Reaction of the equilibrated mixture of 1-methoxycyclohexa-1,4- and -1,3-dienes (**1a**) + (**2a**) with methyl tetrolate (**3**) afforded methyl 2-methoxy-6-methylbenzoate (**7a**).[19] The structure of the product was deduced from its analytical and spectral



(1)



(2)

(3) $R^3 = R^4 = Me$

(4) $R^3 = Et$, $R^4 = Bu$

(5) $R^3 = Et$, $R^4 = C_5H_{11}$

a; $R^1 = R^2 = H$

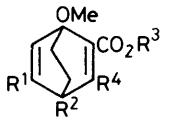
b; $R^1 = OMe$, $R^2 = H$

c; $R^1 = H$, $R^2 = OMe$

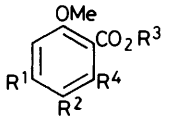
d; $R^1 = Me$, $R^2 = H$

e; $R^1 = H$, $R^2 = Me$

f; $R^1 = H$, $R^2 = C_8H_{17}$



(6)



(7)

a; $R^1 = R^2 = H$, $R^3 = R^4 = Me$

b; $R^1 = OMe$, $R^2 = H$, $R^3 = R^4 = Me$

c; $R^1 = H$, $R^2 = OMe$, $R^3 = R^4 = Me$

d; $R^1 = Me$, $R^2 = H$, $R^3 = R^4 = Me$;

e; $R^1 = H$, $R^2 = Me$, $R^3 = R^4 = Me$

f; $R^1 = OMe$, $R^2 = H$, $R^3 = Et$, $R^4 = Bu$

g; $R^1 = OMe$, $R^2 = H$, $R^3 = Et$, $R^4 = C_5H_{11}$

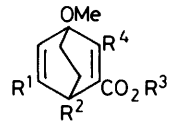
h; $R^1 = H$, $R^2 = C_8H_{17}$, $R^3 = Et$, $R^4 = Bu$

i; $R^1 = R^2 = R^3 = H$, $R^4 = Me$

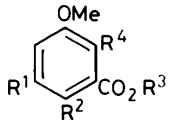
j; $R^1 = OMe$, $R^2 = R^3 = H$, $R^4 = Me$

k; $R^1 = OMe$, $R^2 = R^3 = H$, $R^4 = C_5H_{11}$

l; $R^1 = R^2 = H$, $R^3 = Et$, $R^4 = CH_2CH(Me)OTHP$



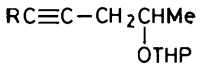
(8)



(9)

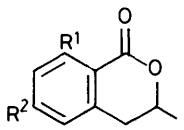
a; $R^1 = H$, $R^2 = R^3 = R^4 = Me$

b; $R^1 = H$, $R^2 = C_8H_{17}$, $R^3 = Et$, $R^4 = Bu$



(10) R = H

(11) R = CO_2Et

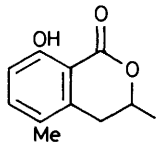


(12) $R^1 = OH$, $R^2 = H$

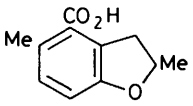
(13) $R^1 = OMe$, $R^2 = H$

(14) $R^1 = OH$, $R^2 = OMe$

(15) $R^1 = R^2 = OMe$



(16)



(17)

data and confirmed by comparison with an authentic sample. Similarly, methyl 2,4-dimethoxy-6-methylbenzoate (**7b**), methyl 2,5-dimethoxy-6-methylbenzoate (**7c**), and methyl 2-methoxy-4,6-dimethylbenzoate (**7d**) were obtained by treating the dienes (**2b**), (**2c**), and (**2d**) with methyl tetrolate (**3**). Reaction of the diene (**2b**) with ethyl hept-2-ynoate (**4**) and ethyl oct-2-ynoate (**5**) afforded ethyl 2-butyl-4,6-dimethoxybenzoate (**7f**) and ethyl 2,4-dimethoxy-6-pentylbenzoate (**7g**) respectively.

Although the Diels-Alder reaction between the acetylenic esters and 1-methoxy-, 1,3-dimethoxy-, and 1-methoxy-3-methyl-cyclohexa-1,3- or -1,4-dienes is regiospecific and yielded single products, the cycloaddition with a 4-alkyl-1-methoxycyclohexadiene afforded a (1:1) mixture of the regiomers. Thus a mixture of methyl 2-methoxy-5,6-dimethylbenzoate (**7e**) and methyl 3-methoxy-2,6-dimethylbenzoate (**9a**) was obtained from 1-methoxy-4-methylcyclohexa-1,3-diene (**2e**) and methyl tetrolate (**3**). Similar reaction of the diene (**2f**) with ethyl hept-2-ynoate (**4**) yielded a mixture of the benzoates (**7h**) and (**9b**), identified from their spectral data. The loss of regiospecificity in these cases may be attributed to the presence of two electron donating groups at the 1,4-position of the conjugated diene competing in the cycloaddition with acetylenic systems. Unlike this, cycloaddition of (**1e**) or (**2e**) with olefinic dienophiles such as methyl vinyl ketone or acrolein results in the regiospecific formation of a single product.

Hydrolysis of the esters (**7**) with potassium hydroxide[20] in dimethyl sulphoxide gave the corresponding benzoic acids in good yield. Thus 2-methoxy-6-methylbenzoic acid[19] (**7i**), 2,4-dimethoxy-6-methylbenzoic acid[21] (**7j**), and 2-butyl-4,6-dimethoxybenzoic acid[22] (**7k**) were obtained from (**7a**), (**7b**), and (**7f**), respectively.

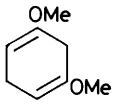
Synthesis of (±)-*Mellein* (**12**) *and* (±)-6-*Methoxymellein* (**14**).—We next turned our attention to the synthesis of naturally occurring dihydroisocoumarins based on the methodology of constructing the aromatic residue from 1-methoxycyclohexa-1,3-dienes and suitable acetylenic dienophiles. (−)-Mellein (**12**), (−)-6-methoxymellein (**14**), and (−)-5-methylmellein (**16**) were isolated from *Aspergillus mellus*,[23] carrots,[24] and *Fusicoccum amygdalate*[25] respectively. Although the structure of these compounds were deduced from spectral data and confirmed by synthesis, an alternative method of preparation of these compounds is reported here.

The required acetylenic ester (**11**) was prepared from 4-tetrahydropyran-2-yloxypent-1-yne (**10**).[26] Reaction of (**10**) with butyl-lithium followed by quenching with ethyl chloroformate afforded the ester (**11**) in 60% yield. An Alder-Rickert reaction between the diene (**1a**) and the acetylenic ester (**11**) in the presence of DCMA at 180 °C for 30 h afforded mellein methyl ether (**13**) in 52% yield. The direct isolation of (**13**) from (**1a**) and (**11**) involves initial formation of the adduct [**6l**; $R^1 = R^2 = H$, $R^3 = Et$, $R^4 = CH_2CH(OTHP)Me$] which undergoes aromatization to (**7l**). At higher temperature the tetrahydropyranyl ether undergoes fission resulting directly in the formation of the lactone (**13**). Similar reaction of the diene (**1b**) with (**11**) yielded 6-methoxymellein methyl ether (**15**). Demethylation of (**13**) with HBr in acetic acid and of (**15**) with BBr_3 in methylene dichloride gave mellein (**12**) and 6-methoxymellein (**14**) respectively. An attempt to synthesize 5-methylmellein (**16**) by this strategy from the diene (**1e**) and the dienophile (**11**) resulted in a mixture of products which on alkaline hydrolysis followed by acidification afforded 2,5-dimethyl-2,3-dihydrobenzofuran-4-carboxylic acid (**17**) as the only identifiable product. Formation of the acid can

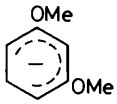
be explained as due to a reversal of the regiochemistry in the cycloaddition resulting in an adduct of the type (**8**) which on aromatization[29] followed by hydrolysis yields the acid (**17**).

Synthesis of 2,5-*Dialkylresorcinols: Stemphol* (**24b**), DB 2073 (**24d**), *and Regioisomers* (**24a**) *and* (**24c**).—Stemphol (**24b**)[32] is a metabolite isolated from *Stemphilium majusculum* and DB 2073 (**24d**)[33] was isolated from *Pseudomonas sp.* B-9004. Their structures have been deduced from spectral data and confirmed by synthesis.[34]

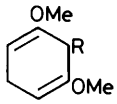
While contemplating the synthesis of stemphol and DB 2073 we felt that the shortest approach would involve a regiospecific Alder–Rickert reaction between a 6-alkyl-1,5-dimethoxycyclohexa-1,4-diene (**19**) and a substituted prop-2-ynyl aldehyde (**21**). The resulting 3,6-dialkyl-2,4-dimethoxybenzaldehyde (**22**) would in two steps, namely decarbonylation followed by demethylation, give the final product.



(**1a**)



(**18**)



(**19**)

$RC{\equiv}CCH_2OH$

(**20**)

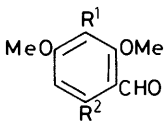
$RC{\equiv}CCHO$

(**21**)

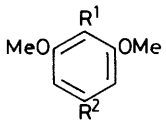
a ; R = Pr
b ; R = Bu
c ; R = C_5H_{11}
d ; R = C_6H_{13}

The required dienes (**19a—d**) were obtained by alkylation[31] of 1,5-dimethoxycyclohexa-1,4-diene with alkyl halides. Thus treatment of (**1a**) with 1.1 equiv. of potassium amide in liquid ammonia generated the mesomeric anion (**18**), which was alkylated with an alkyl bromide (propyl, butyl, pentyl, and hexyl). Excellent yields (75—80%) of the required 6-alkyl-1,5-dimethoxycyclohexa-1,4-dienes (**19**) were obtained.

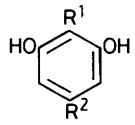
The dienophiles, namely the substituted prop-2-ynyl aldehydes (**21a—d**) were prepared by known procedures.[35,36] Thus prop-2-ynyl alcohol on treatment with 2 mol equiv. of lithium amide forms the dianion which is *C*-alkylated by treatment with alkyl bromides thereby affording substituted propynyl alcohols (**20a—d**) in very good yields (70—80%). The acetylenic alcohols, thus obtained were converted into the corresponding aldehydes by oxidation with manganese dioxide.[37]



(**22**)



(**23**)



(**24**)

The Alder–Rickert reactions of the diene with the corresponding dienophiles (**19a**) + (**21d**), (**19b**) + (**21c**), (**19c**) + (**21b**), (**19d**) + (**21a**) were separately carried out by heating the mixtures with a trace amount of dichloromaleic anhydride in an evacuated sealed tube at 180—190 °C. The benzaldehydes (**22a—d**) were obtained in 60—65% yield and were decarbonylated by refluxing with tris(triphenylphosphine)-chlororhodium[38] in toluene. Excellent yields of the 2,5-dialkylresorcinol dimethyl ethers (**23a—d**) were obtained (80—90%). Demethylation[39] of (**23**) by silicon tetrachloride and sodium iodide in refluxing toluene–acetonitrile gave stemphol (**24b**), DB-2073 (**24d**), and their isomers (**24c**) and (**24a**) in very good yields.

Thus a simple strategy for the construction of aromatic compounds of polyketide origin has been developed. Despite some limitations, this methodology is general and can be used for the synthesis of a number of natural products of fungal and plant origin.

Experimental

M.p.s. and b.p.s. are uncorrected. I.r. spectra were recorded as liquid films or Nujol mulls on a Perkin-Elmer, Model 397 instrument. The ^1H n.m.r. spectra were recorded on Varian T-60, JEOL FX-90Q, or Bruker WH 270 MHz spectrometers. Chemical shifts are given in p.p.m. (δ) downfield from tetramethylsilane (TMS) as internal standard with the usual abbreviations. Analytical and preparative t.l.c. were carried out on glass plates coated with silica gel (0.2 mm; commercial grade containing 10% calcium sulphate binder) activated at 70—90 °C for 12 h prior to use. In all the sealed-tube reactions, the reactants were taken in thick-walled Pyrex glass tube and sealed *in vacuo* prior to heating.

Preparation of 1-*Methoxycyclohexa*-1,4-*dienes* (**1**).—Sodium (0.1 mol) was added in small pieces to a rapidly stirred mixture of the aromatic ether (0.04 mol), ethanol (20 ml), and redistilled ammonia (200 ml). After the mixture had been stirred for 15 min, excess of the metal was destroyed by the addition of methanol (10 ml) and ammonia was allowed to evaporate. The residue was treated with water (100 ml) and extracted with hexane (3 × 50 ml). The combined extracts were washed with water and brine, dried, and evaporated to afford the 1-methoxycyclohexa-1,4-dienes (90%); $\nu_{max.}$ 1 660 and 1 690 cm^{-1}. Thus 1-methoxycyclohexa-1,4-diene (**1a**), 1,3-dimethoxycyclohexa-1,4-diene (**1b**), 1,4-dimethoxycyclohexa-1,4-diene (**1c**), 1-methoxy-5-methylcyclohexa-1,4-diene (**1d**), 1-methoxy-4-methylcyclohexa-1,4-diene (**1e**), and 1-methoxy-4-octylcyclohexa-1,4-diene (**1f**) were prepared[15] from anisole, 1,3-dimethoxybenzene, 1,4-dimethoxybenzene, 3-methylanisole, 4-methylanisole, and 4-octylanisole respectively.

Preparation of 1-*Methoxycyclohexa*-1,3-*dienes* (**2**).—Potassium amide was prepared by adding anhydrous ferric chloride (5 mg) to a stirred mixture of potassium (300 mg) in liquid ammonia (100 ml). A solution of 1-methoxycyclohexa-1,4-diene (**1a**) in dry ether (10 ml) was then added under nitrogen to the rapidly stirred mixture of potassium amide in liquid ammonia and after 20 min, the dark red solution was quenched with solid ammonium chloride (5 g). Ammonia was allowed to evaporate and the residue was diluted with water (100 ml) and extracted with ether (3 × 50 ml). The dried ethereal extracts on evaporation gave an equilibrium mixture containing 1-methoxycyclohexa-1,3-diene (**2a**) (80%) and 1-methoxycyclohexa-1,4-diene (**1a**) (20%) in 75% yield which was distilled *in vacuo*. Thus 1-methoxycyclohexa-1,3-diene (**2a**), 1,3-dimethoxycyclohexa-1,3-diene (**2b**), 1-methoxy-3-methylcyclohexa-1,3-diene (**2d**), and 1-methoxy-4-methylcyclohexa-1,3-diene (**2e**), were prepared[16] and these conjugated dienes showed characteristic spectral absorptions $\lambda_{max.}$ 274 nm (ε 9 800); $\nu_{max.}$ 1 610 and 1 660 cm^{-1}.

Preparation of Acetylenic Dienophiles (**3**), (**4**), *and* (**5**).—Methyl but-2-ynoate[27] (**3**), ethyl hept-2-ynoate[28] (**4**), ethyl oct-2-ynoate[28] (**5**), and ethyl 4-tetrahydropyran-2-yloxyhex-2-ynoate[28] (**11**) were prepared according to literature methods.

Preparation of Substituted 2-Methoxybenzoates (**7a**—**h**).—Three different procedures were adopted. *Method A*. The 1-methoxycyclohexa-1,4-diene (**1a**—**f**) and the acetylenic compound (**3**), (**4**), or (**5**) were mixed in a glass tube under nitrogen. After evacuation the tube was sealed and heated to 180 °C for 30 h. The temperature was further raised to 200 °C and kept for 4 h. The crude product obtained was sublimed at 180—190 °C at 3 mmHg. 2-Methoxybenzoates (**7a**—**h**) were obtained in yields in the range 65—75%.

Method B. The 1-methoxycyclohexa-1,4-diene (**1a**—**f**), and the appropriate acetylenic compound were heated with dichloromaleic anhydride[30] (5 mg) at 180 °C for 20 h, and finally at 200 °C for 4 h under a nitrogen atmosphere. The crude product was diluted with chloroform (20 ml), washed with 1% aqueous sodium hydroxide, water, and brine, dried (Na_2SO_4), and evaporated to afford the corresponding 2-methoxybenzoate (63—70%). These compounds were identical in all respects with compounds obtained by Method A.

Method C. The equilibrated mixture of methoxycyclohexa-1,4- and -1,3-dienes, and the acetylenic dienophile were heated at 180 °C for 16 h under a nitrogen atmosphere. The reaction temperature was then raised to 200 °C and maintained for 4 h. The crude product was purified by column chromatography to afford compounds identical with those obtained by Methods A and B; yields 65—70%.

Methyl 2-methoxy-6-methylbenzoate (**7a**). This was obtained from (**1a**) or (**2a**) and (**3**) as per method A or B or C as described above: b.p. 120 °C at 10 mmHg (lit.,[19] b.p. 140 °C at 18 mmHg) (Found: C, 66.6; H, 6.7. Calc. for $C_{10}H_{12}O_3$: C, 66.67; H, 6.67%); $\nu_{max.}$ 1 725, 1 610, and 1 590 cm^{-1}; δ 2.28 (3 H, s, $ArCH_3$), 3.72 (3 H, s, OCH_3), 3.82 (3 H, s, CO_2CH_3), 6.7 (2 H, dd, *J* 8 and 3 Hz, *o*- and *p*-H to OCH_3), and 7.1 (1 H, t, *J* 8 Hz, *m*-H to OMe).

Methyl 2,4-dimethoxy-6-methylbenzoate (**7b**). Prepared from (**1b**) or (**2b**) and (**3**) as per method A or B or C; b.p. 135 °C at 10 mmHg (Found: C, 62.8; H, 6.71. Calc. for $C_{11}H_{14}O_4$: C, 62.85; H, 6.7%). $\nu_{max.}$ 1 725, 1 610, and 1 590 cm^{-1}; δ 2.28 (3 H, s, $ArCH_3$), 3.72 (6 H, s, $ArOCH_3$), 3.82 (3 H, s, CO_2CH_3), and 6.22 (2 H, s, ArH).

Methyl 2,5-dimethoxy-6-methylbenzoate (**7c**). This was prepared from (**1c**) and (**3**) according to method A and crystallized from methanol, m.p. 71 °C (Found: C, 62.8; H, 6.8. $C_{11}H_{14}O_4$ requires C, 62.85; H, 6.7%); $\nu_{max.}$ 1 730 and 1 600 cm^{-1}; δ 2.22 (3 H, s, $ArCH_3$), 3.72 (6 H, s, $ArOCH_3$), 3.8 (3 H, s, CO_2CH_3), and 6.78 (2 H, d, *J* 5 Hz, ArH).

Methyl 2-methoxy-4,6-dimethylbenzoate (**7d**). Obtained from (**1d**) or (**2d**) and (**3**) as per method A or B or C: b.p. 125 °C at 8 mmHg (Found: C, 67.85; H, 7.2. $C_{11}H_{14}O_3$ requires C, 68.04; H, 7.22%); $\nu_{max.}$ 1 725, 1 610, and 1 590 cm^{-1}; δ 2.2 (3 H, s, $ArCH_3$) and 6.52 (2 H, br d, Ar H).

Methyl 2-methoxy-5,6-dimethylbenzoate (**7e**) *and methyl 3-methoxy-2,6-dimethylbenzoate* (**9a**). Obtained from (**1e**) or (**2e**) and (**3**) as per method A or B or C; b.p. 130 °C at 100 mmHg (Found: C, 68.0; H, 7.1. $C_{11}H_{14}O_3$ requires C, 68.04; H, 7.11%); $\nu_{max.}$ 1 725 and 1 590 cm^{-1}; δ 2.18 and 2.25 (6 H, 2 s, $ArCH_3$), 3.75 and 3.8 (3 H, 2 s, OCH_3), 3.85 and 3.9 (3 H, 2 s, CO_2CH_3), and 6.5—7.2 (2 H, m, ArH) (integration of peaks at 2.18, 2.25, 3.7 and 3.8 showed a 1:1 ratio).

Ethyl 2-butyl-4,6-dimethoxybenzoate (**7f**). Obtained from (**1b**) and (**3**) as per method A or B; b.p. 140—142 °C at 2 mmHg (Found: C, 67.6; H, 8.2. $C_{15}H_{22}O_4$ requires C, 67.67; H, 8.27%); $\nu_{max.}$ 1 730, 1 610, and 1 590 cm^{-1}; δ 0.8—1.68 (12 H, m), 2.5 (2 H, t, *J* 7Hz, benzylic), 3.72 (6 H, s, OCH_3), 4.22 (2 H, q, *J* 8 Hz, OCH_2Me), and 6.22 (2 H, s, ArH).

Ethyl 2-butyl-6-methoxy-3-octylbenzoate (**7h**) *and ethyl 2-butyl-3-methoxy-6-octylbenzoate* (**9b**). Obtained from (**1f**) and (**3**) as per method A or B in 40% yield; b.p. 165 °C at 3 mmHg (Found: C, 75.85; H, 9.95. $C_{22}H_{36}O_3$ requires C, 75.72; H, 10.04%); $\nu_{max.}$ 1 725, 1 610, and 1 590 cm^{-1}; δ 0.8—2.4 (29 H, m), 3.3 and 3.58 [3 H, 2 s (3:1), OCH_3], 4.15 (2 H, q, *J* 8 Hz, OCH_2Me), and 6.4—7.4 (2 H, m, ArH).

General Procedure[20] *for the Hydrolysis of Esters*.—The ester (200 mg) was stirred and heated with potassium hydroxide (3 g) in dimethyl sulphoxide (30 ml) at 70 °C under nitrogen for 4 h. The reaction mixture was cooled, diluted with water, and acidified with 4M HCl. After saturation with sodium chloride, the mixture was extracted with chloroform (3 × 25 ml), washed with water and brine, dried, and evaporated to give the corresponding acids.

2-Methoxy-6-methylbenzoic acid (**7i**). M.p. 139—140 °C (lit.,[19] m.p. 140 °C) (Found: C, 65.0; H, 6.0. Calc. for $C_9H_{10}O_3$: C, 65.06; H, 6.02%), $\nu_{max.}$ 1 690, 1 610, and 1 590 cm^{-1}; δ 2.28 (3 H, s, CH_3), 3.72 (3 H, s, OCH_3), 6.8 (2 H, dd, *J* 8 and 3 Hz, ArH), 7.25 (1 H, t, *J* 8 Hz, ArH) and 10.2 (1 H, br s, CO_2H).

2,4-Dimethoxy-6-methylbenzoic acid (**7j**), M.p. 139 °C (Lit.,[21] m.p. 140 °C) (Found: C, 60.8; H, 6.08. Calc. for $C_{10}H_{12}O_4$: C, 61.02; H, 6.12%); $\nu_{max.}$ 1 690, 1 610, and 1 590 cm^{-1}; δ 2.28 (3 H, s, CH_3), 3.72 (6 H, s, OCH_3), 6.22 (2 H, s, ArH), and 9.8 (1 H, br s, CO_2H).

2-Butyl-4,6-dimethoxybenzoic acid (**7k**). M.p. 49—50 °C (lit.,[22] m.p. 53 °C) (Found: C, 65.5; H, 7.7. Calc. for $C_{14}H_{20}O_4$: C, 65.5; H, 7.56%); $\nu_{max.}$ 1 690, 1 610, and 1 590 cm^{-1}; δ 1—1.7 (9 H, m, aliphatic), 2.5 (2 H, t, *J* 7 Hz, benzylic), 3.72 (6 H, s, OCH_3), 6.22 (2 H, s, ArH), and 9.5 (1 H, br s, CO_2H).

4-Tetrahydropyran-2-yloxypent-1-yne (**10**). A mixture of pent-1-yn-4-ol (4.2 g, 0.05 mol), dihydropyran (5 g, 0.06 mol), and toluene-*p*-sulphonic acid (5 mg) in dry ether (20 ml) was stirred for 2 h and left overnight. The mixture was then poured into dilute aqueous sodium hydrogen carbonate and extracted with ether (3 × 25 ml). The combined ether extracts were washed with water and brine, dried, and evaporated to afford a liquid which was distilled, b.p. 58 °C at 5 mmHg (Found: C, 71.35; H, 9.4. $C_{10}H_{16}O_2$ requires C, 71.4; H, 9.5%); $\nu_{max.}$ 3 330 (≡CH), 2 120 (C≡C), and 1 450 cm^{-1} (C–O); δ 4.7 (1 H, m), 3.94—3.4 (3 H, m), 2.34 (2 H, m), 1.8—1.4 (6 H, m), and 1.18 (3 H, dd, *J* 6 and 5 Hz).

Ethyl 5-Tetrahydropyran-2-yloxyhex-2-ynoate (**11**).—To a solution of butyl-lithium (20 mmol) in ether (100 ml) was added 4-tetrahydropyran-2-yloxypent-1-yne (**10**) (3.36 g, 20 mmol) in dry ether (20 ml) at −50 °C. After 15 min ethyl chloroformate (2.71 g, 25 mmol) was added, in one portion and the temperature maintained at −30 °C for 5 h. After warming to room temperature the mixture was poured into ice-cold water (50 ml) and immediately extracted with ether (3 × 50 ml). The combined ethereal extracts were washed with water, dried, and evaporated under reduced pressure and the residual liquid (3.12 g) was purified by column chromatography using silica gel (ether–hexane; 1:1) (Found: C, 68.85; H, 6.5. Calc. for $C_{13}H_{20}O_4$: C, 68.73; H, 6.49%); $\nu_{max.}$ 2 240 (C≡C), 1 720 (C=O), and 1 455 cm^{-1} (C–O); δ 4.8 (1 H, m), 4.2 (2 H, br), 4.4 (3 H, m), 2.5 (2 H, m), 1.8—1.4 (6 H, br, aliphatic CH_2), and 1.35 (6 H, m, CH_2CH_3 and CH_3CH).

Mellein Methyl Ether (**13**).—1-Methoxycyclohexa-1,3-diene (**2a**) (550 mg, 5 mmol) and ethyl 5-tetrahydropyran-2-yloxyhex-2-ynoate (**11**) (1.2 g, 5 mmol) were mixed and heated under nitrogen at 175—180 °C for 30 h and at 200 °C for 4 h. The product was then sublimed to give a pale yellow oil which was dissolved in 10% aqueous ethanolic KOH (25 ml) and refluxed for 30 min. The mixture was acidified with hydrochloric acid and extracted with chloroform (2 × 50 ml). The chloroform extract was washed with water and brine, dried, and evaporated to afford a yellow oil which was purified by column chromatography (silica gel, ethyl acetate–hexane, 1:9). The pale yellow gum (500 mg, 52%) crystallized from ether–hexane (1:4),

m.p. 69 °C (lit.,[23] 67 °C) (Found: C, 68.7; H, 6.4. Calc. for $C_{11}H_{12}O_3$: C, 68.73; , 6.29%); $\nu_{max.}$(Nujol) 1 720 and 1 605 cm^{-1}; δ 1.5 (3 H, d, CH_3CH), 2.93 (2 H, d, $ArCH_2CH$), 3.9 (3 H, s, ArOMe), 4.64 (1 H, m, CH), 6.7 (2 H, dd, *J* 7 and 3 Hz, *o*- and *p*-H to OCH_3), and 7.1 (1 H, t, *J* 8 Hz, *m*-H to OMe).

(±) *Mellein* (**12**).—The methyl ether (**13**) (100 mg) was refluxed with HBr in acetic acid (5%; 10 ml) for 5 h. The reaction mixture was diluted with water (50 ml) and extracted with ether (3 × 25 ml) and the ethereal extracts were thoroughly washed with water and dried. Removal of the solvent afforded a crystalline mass (90 mg) which was recrystallized from ether–hexane. Mellein was obtained as white crystals, m.p. 39 °C (lit.,[23] m.p. 39 °C) (Found: C, 67.5; H, 5.6. $C_{10}H_{10}O_3$ requires C, 67.4 and H, 5.66%).

Methyl Ether of 6-Methoxymellein (**15**).—1,3-Dimethoxycyclohexa-1,3-diene (**2b**) (700 mg, 50 mmol) and ethyl 5-tetrahydropyran-2-yloxyhex-2-ynoate (**11**) (1.2 g, 50 mmol) were heated together under nitrogen at 180 °C for 35 h and then at 200 °C for 4 h. The product was then distilled 150—160 °C at 2 mmHg. The yellow viscous oil was taken up in 10% aqueous alcoholic KOH and refluxed for 1 h. The cooled solution was acidified and extracted with chloroform (3 × 50 ml) and the combined extracts were washed with water and brine, and dried. The crude product (**15**) (65%) was purified by t.l.c. (chloroform–methanol, 96.5:3.5) to give a pale yellow gum which was crystallized from ethyl acetate–hexane (1:4), m.p. 126—127 °C (lit.,[24] m.p. 126—128 °C) (Found: C, 64.8; H, 6.4. Calc. for $C_{12}H_{14}O_4$: C, 64.85; H, 6.43); $\nu_{max.}$(Nujol) 1 710, 1 605, and 1 463 cm^{-1}; δ 1.42 (3 H, d, CH_3), 2.8 (2 H, d, CH_2Ar), 3.83 (3 H, s, $ArOCH_3$), 3.9 (3 H, s, $ArOCH_3$), 4.45 (1 H, m, CH), and 6.33 (1 H, split singlets, ArH).

(±)-6-*Methoxymellein* (**14**).—A solution of the ether (**15**) (100 mg) in methylene dichloride (10 ml) cooled to −10 °C was added to a cooled solution of BBr_3 (0.4 ml) in methylene dichloride (10 ml) under nitrogen. The mixture was stirred for 24 h, poured into water, and extracted with chloroform. Removal of the solvent gave (±)-6-methoxymellein (**14**) as crystals (92 mg), m.p. 74 °C (lit.,[24] m.p. 76 °C). The i.r. and ^1H n.m.r. data were identical with published values (Found: C, 63.35; H, 5.8. Calc. for $C_{11}H_{12}O_4$: C, 63.45 and H, 5.8%).

2,3,-*Dihydro*-2,6-*dimethylbenzofuran*-4-*carboxylic Acid* (**17**).—A mixture of 1-methoxy-4-methylcyclohexa-1,4-diene (**1e**) (620 mg), ethyl 5-tetrahydropyran-2-yloxyhex-2-ynoate (**11**) (1.2 g), and dichloromaleic anhydride (5 mg) was heated in a sealed tube at 180 °C for 36 h. After this the reaction mixture was refluxed with 10% ethanolic potassium hydroxide (30 ml) and then extracted with ether (2 × 25 ml). The aqueous extract was neutralized with dilute HCl and extracted with ethyl acetate (3 × 25 ml). The combined ethyl acetate extracts were washed with water, dried, and evaporated to give a pale yellow mass which was recrystallized from benzene to give the benzofurancarboxylic acid (**17**) (480 mg, 50%) as colourless prisms, m.p. 134—136 °C (Found: C, 68.65; H, 5.8. $C_{11}H_{12}O_3$ requires C, 68.8 and H, 5.6%); $\nu_{max.}$(Nujol) 3 500 (OH), 1 690 (C=O), and 1 600 cm^{-1} (aromatic); δ 1.4 (3 H, d, *J* 5 Hz), 2.5 (3 H, s), 3.38 (2 H, m), 4.9 (1 H, m), and 6.9 (2 H, dd, *J* 8 and 12 Hz).

Alkylation of 1,5-*Dimethoxycyclohexa*-1,4-*dienes* (**19a—d**).—1,5-Dimethoxycyclohexa-1,4-diene (0.02 mol) was added with stirring to potassium amide in liquid ammonia [prepared from liquid ammonia (80 ml), $FeCl_3$ (catalytic quantity), and potassium (500 mg)] to give a dark red solution. After 10 min of vigorous stirring, the reaction mixture was quenched with alkyl bromide (excess). Ammonia was slowly evaporated off and the residue diluted with water and extracted with ether. The extract was washed until neutral with water and then with brine; it was then dried and evaporated under reduced pressure and the residue distilled (yields 75—80%).

1,5-*Dimethoxy*-6-*propylcyclohexa*-1,4-*diene* (**19a**). B.p. 92 °C at 3 mmHg (Found: C, 72.45; H, 9.9. $C_{11}H_{18}O_2$ requires C, 72.53; H, 9.9%); $\nu_{max.}$ 1 690 and 1 660 cm^{-1} (diene); δ 0.95 (3 H, t, *J* 7 Hz, CH_3), 1.2—1.6 (5 H, m, aliphatic CH), 2.8 (2 H, s, doubly allylic CH_2), 3.5 (6 H, s, OCH_3 × 2), and 4.6 (2 H, m, olefinic H).

6-*Butyl*-1,5-*dimethoxycyclohexa*-1,4-*diene* (**19b**). B.p. 98—102 °C at 3 mmHg (Found: C, 73.5; H, 10.2. $C_{12}H_{20}O_2$ requires C, 73.47; H, 10.2%); $\nu_{max.}$ 1 695 and 1 660 cm^{-1} (diene); δ 0.9 (3 H, t, *J* 7.2 Hz, CH_3), 1.2—1.9 (7 H, m, aliphatic CH), 2.8 (2 H, s, doubly allylic CH_2), 3.5 (6 H, s, OCH_3 × 2), and 4.6 (2 H, m, olefinic H).

1,5-*Dimethoxy*-6-*pentylcyclohexa*-1,4-*diene* (**19c**). B.p. 114—115 °C at 3 mmHg (Found: C, 74.35; H, 10.5. $C_{13}H_{22}O_2$ requires C, 74.28; H, 10.48%); $\nu_{max.}$ 1 690 and 1 660 cm^{-1} (diene); δ 0.9 (3 H, t, *J* 7.8 Hz, CH_3), 1.2—1.9 (9 H, m, aliphatic H), 2.8 (2 H, s, doubly allylic CH_2), 3.5 (6 H, s, OCH_3 × 2), and 4.6 (2 H, m, olefinic H).

6-*Hexyl*-1,5-*dimethoxycyclohexa*-1,4-*diene* (**19d**).—B.p. 127 °C at 3 mmHg (Found: C, 74.8; H, 10.65. $C_{14}H_{24}O_2$ requires C, 75.0; H, 10.71%) $\nu_{max.}$ 1 690 and 1 665 cm^{-1} (diene); δ 0.9 (3 H, t, *J* 7.8 Hz, CH_3), 1.2—1.9 (11 H, m, aliphatic H), 2.8 (2 H, s, doubly allylic CH_2), 3.5 (6 H, s, OCH_3 × 2), and 4.6 (2 H, m, olefinic H).

Preparation of Alk-2-*yn*-1-*ols* (**20a—d**).—Prop-2-ynyl alcohol (5 g, 0.09 mol) in dry THF (15 ml) was added to a solution of lithium amide in liquid ammonia [prepared from ammonia (300 ml), $FeCl_3$ (catalytic quantity), and lithium (1.49 g, 0.2 mol)]. The mixture was stirred for 1 h after which alkyl bromide (0.1 mol) was added in dry THF (50 ml). The mixture was stirred for 8 h after which ammonia was slowly evaporated off and the residue diluted with water and extracted with ether. The ethereal extract was washed with water and brine, dried, and evaporated, and the residue was distilled under reduced pressure (yields 70—80%).

Hex-2-*yn*-1-*ol* (**20a**). B.p. 88—91 °C at 60 mmHg (Found: C, 73.3; H, 10.2. $C_6H_{10}O$ requires C, 73.4; H, 10.2%); $\nu_{max.}$ 3 450 (OH) and 2 180 cm^{-1} (C≡C); δ 0.9 (3 H, t, *J* 7.2 Hz, CH_3), 1.3 (2 H, m, CH_2), 2.2 (2 H, t, *J* 7Hz, CH_2Et), and 3.6 (2 H, br s, CH_2OH).

Hept-2-*yn*-1-*ol* (**20b**). B.p. 81 °C at 10 mmHg (Found: C, 75.1; H, 10.6. $C_7H_{12}O$ requires C, 75.0; H, 10.7%); $\nu_{max.}$ 3 450 (OH) and 2 190 cm^{-1} (C≡C); δ 0.9 (3 H, t, *J* 7.2 Hz, CH_3), 1.2—1.3 (4 H, m, CH_2CH_2), 2.2 (2 H, t, *J* 7 Hz, CH_2Pr), and 3.6 (2 H, br s, CH_2OH).

Oct-2-*yn*-1-*ol* (**20c**). B.p. 93 °C at 10 mmHg (Found: C, 76.1; H, 11.2. $C_8H_{14}O$ requires C, 76.2; H, 11.1%); $\nu_{max.}$ 3 450 (OH) and 2 190 cm^{-1} (C≡C); δ 0.9 (3 H, br t, *J* 7.2 Hz, CH_3), 1.2—1.3 (6 H, m, aliphatic CH_2), 2.2 (2 H, t, *J* 7 Hz, CH_2Bu), and 3.6 (2 H, br s, CH_2OH).

Non-2-*yn*-1-*ol* (**20d**). B.p. 108 °C at 10 mmHg (Found: C, 77.2; H, 11.4. $C_9H_{16}O$ requires C, 77.1; H, 11.4%); $\nu_{max.}$ 3 450 (OH) and 2 200 cm^{-1} (C≡C); δ 0.9 (3 H, br t, *J* 7.2 Hz, CH_3), 1.2—1.4 (8 H, br m, aliphatic CH_2), 2.2 (2 H, t, *J* 7 Hz, $CH_2C{\equiv}C$), and 3.6 (2 H, br s, CH_2OH).

Preparation of Alk-2-*yn*-1-*als* (**21a—d**).—The alk-2-yn-1-ols (30 mmol) in dry methylene dichloride (25 ml) were added to a suspension of active manganese dioxide (25 g) in dry methylene dichloride (100 ml) and the mixture was stirred for 24 h at room temperature. Dry ether (50 ml) was added and the slurry was filtered through a column of neutral alumina. The filtrate was dried and evaporated to afford a pale yellow residue which was distilled under required pressure. The acetylenic aldehydes which were collected in a receiver cooled in liquid nitrogen were

unstable and became dark on storage. They were prepared and immediately used in the next reaction.

Hex-2-yn-1-al (**21a**). B.p. 56—62 °C at 20 mmHg (Found: C, 75.1; H, 8.4. C_6H_8O requires C, 75.0; H, 8.3%); $\nu_{max.}$ 2 170 (C≡C) and 1 680 cm^{-1} (CO); δ 1.0 (3 H, t, *J* 7 Hz, CH_3), 1.3 (2 H, m, CH_2CH_3), 2.6 (2 H, br t, *J* 7 Hz, $CH_2C{\equiv}C$), and 9.4 (1 H, t, *J* 2 Hz, CHO).

Hept-2-yn-1-al (**21b**). B.p. 45 °C at 5 mmHg (Found: C, 76.2; H, 9.2. $C_7H_{10}O$ requires C, 76.3; H, 9.1%); $\nu_{max.}$ 2 180 (C≡C) and 1 680 cm^{-1} (CO); δ 1.0 (3 H, br t, CH_3), 1.3 (4 H, m, aliphatic H), 2.6 (2 H, br t, *J* 7 Hz, $CH_2C{\equiv}C$), and 9.3 (1 H, t, *J* 2 Hz, CHO).

Oct-2-yn-1-al (**21c**). B.p. 61 °C at 2 mmHg (Found: C, 77.1; H, 9.7. $C_8H_{12}O$ requires C, 77.4; H, 9.7%); $\nu_{max.}$ 2 180 (C≡C) and 1 680 cm^{-1} (C=O); δ 1.0 (3 H, br t, CH_3), 1.3 (6 H, br, aliphatic H), 2.6 (2 H, br t, *J* 7 Hz, $CH_2C{=}C$), and 9.3 (1 H, t, 2 Hz, CHO).

Non-2-yn-1-al (**21d**). B.p. 66—70 °C at 1 mmHg (Found: C, 78.3; H, 10.2. $C_9H_{14}O$ requires C, 78.2; H, 10.1%; $\nu_{max.}$ 2 180 (C≡C) and 1 680 cm^{-1} (C=O); δ 1.0 (3 H, br t, CH_3), 1.3 (8 H, br, aliphatic H), 2.6 (2 H, br t, *J* 7 Hz, CH_2), and 9.3 (1 H, t, *J* 2 Hz, CHO).

3,6-*Dialkyl*-2,4-*dimethoxybenzaldehydes* (**22a—d**).—The acetylenic aldehyde (**21**) (0.01 mol) and 6-alkyl-1,5-dimethoxycyclohexa-1,4-diene and dichloromaleic anhydride (2 mg) were introduced into a glass tube under nitrogen. The tube was evacuated to 0.2 mmHg, sealed, and then heated to 180—190 °C; it was maintained at this temperature for 10 h. After cooling the contents of the tube were sublimed at 200—210 °C at 2 mmHg. The pale yellow liquid obtained was purified by t.l.c. using silica gel and chloroform–hexane (3:2) followed by short-path distillation which afforded the aldehydes as pale yellow oils (yields 60%).

2-*Hexyl*-4,6-*dimethoxy*-5-*propylbenzaldehyde* (**22a**). (Found: C, 74.1; H, 9.6. $C_{18}H_{28}O_3$ requires C, 73.9, H, 9.6%); $\nu_{max.}$(neat) 1 700 (C=O), and 1 600 and 1 500 cm^{-1} (aromatic); δ 0.9 (6 H, br t, CH_3), 1.2—1.6 (10 H, m, CH_2 × 5), 2.4—3 (4 H, m, $ArCH_2$ × 2), 3.8 (3 H, s, OCH_3), 4.0 (3 H, s, OCH_3), 6.4 (1 H, s, ArH), and 10.1 (1 H, s, CHO).

3-*Butyl*-2,4-*dimethoxy*-6-*pentylbenzaldehyde* (**22b**). (Found: C, 73.7; H, 9.7. $C_{18}H_{28}O_3$ requires C, 73.9; H, 9.6%); $\nu_{max.}$(neat) 1 705 (CO) and 1 610 and 1 500 cm^{-1} (aromatic); δ 0.9 (6 H, br t, CH_3 × 2), 1.2—1.6 (10 H, m, CH_2 × 5), 2.4—3.0 (4 H, m, $ArCH_2$ × 2), 3.8 (3 H, s, OCH_3), 4.0 (3 H, s, OCH_3), 6.4 (1 H, s, ArH), and 10.0 (1 H, s, CHO).

2-*Butyl*-6-*dimethoxy*-3-*pentylbenzaldehyde* (**22c**). (Found: C, 73.8; H, 9.8. $C_{18}H_{28}O_3$ requires C, 73.9; H, 9.6%); $\nu_{max.}$(neat) 1 695 (C=O) and 1 610 and 1 500 cm^{-1} (aromatic); δ 0.9 (6H, br t, CH_3 × 2), 1.2—1.6 (10 H, m, CH_2 × 5), 2.4—3 (4 H, m, $ArCH_2$ × 2), 3.8 (3 H, s, OCH_3), 4.0 (3 H, s, OCH_3), 6.38 (1 H, s, ArH), and 10.1 (1 H, s, CHO).

3-*Hexyl*-2,4-*dimethoxy*-6-*propylbenzaldehyde* (**22d**). (Found: C, 74.0; H, 9.6. $C_{18}H_{28}O_3$ requires C, 73.9; H, 9.6%); $\nu_{max.}$ 1 700 (C=O) and 1 610 and 1 500 cm^{-1} (aromatic); δ 0.9 (6 H, br t, CH_3 × 2), 1.2—1.6 (10 H, m, CH_2 × 5), 2.4—3.0 (4 H, m, $ArCH_2$ × 2), 3.81 (3 H, s, OCH_3), 4 (3 H, s, OCH_3), 6.4 (1 H, s, ArH), and 10.1 (1 H, s, CHO).

2,5-*Dialkylresorcinol Dimethyl Ethers* (**23a—d**).—3,6-Dialkyl-2,4-dimethoxybenzaldehyde (1 mmol) dissolved in dry xylene (10 ml) was added to a suspension of tris(triphenylphosphine)chlororhodium (TTCR) (200 mg) in dry xylene (10 ml). The mixture was refluxed under nitrogen for 24 h. The yellow precipitate of bis(triphenylphosphine)carbonylchlororhodium was filtered off and the precipitate was thoroughly washed with ethanol (25 ml). The filtrate was concentrated and the residue was purified by t.l.c. using silica gel and benzene–hexane (2:3). The 2,5-dialkylresorcinol dimethyl ethers (**23a—d**) were obtained in 85—90% yield.

1-*Hexyl*-4-*propyl*-3,5-*dimethoxybenzene* (**23a**). (Found: C, 77.8; H, 10.6%; M^+, 264. Calc. for $C_{17}H_{28}O_2$: C, 78.0; H, 10.7%; M^+, 264); $\nu_{max.}$(film) 1 615, 1 590, 1 470, and 1 460 cm^{-1}; δ 0.9 (6 H, br t, CH_3 × 2), 1.2—1.8 (10 H, m, CH_2 × 5), 2.4—2.8 (4 H, $ArCH_2$ × 2), 3.8 (6 H, s, OCH_3 × 2), and 6.4 (2 H, s, ArH × 2).

1-*Butyl*-4-*pentyl*-2,6-*dimethoxybenzene* (**23b**). (Found: C, 77.7; H, 10.7%; M^+, 264. Calc. for $C_{17}H_{28}O_2$: C, 78.0; H, 10.7%; M^+, 264); $\nu_{max.}$(film) 1 615, 1 590, and 1 460 cm^{-1}; δ 0.9 (6 H, br t, CH_3 × 2), 1.2—1.8 (10 H, m, CH_2 × 5), 2.4—2.8 (4 H, m, $ArCH_2$), 3.8 (6 H, s, OCH_3 × 2), and 6.4 (2 H, s, ArH × 2).

1-*Butyl*-3,5-*dimethoxy*-4-*pentylbenzene* (**23c**). (Found: C, 77.9; H, 10.5%; M^+, 264. Calc. for $C_{17}H_{28}O_2$: C, 78.0; H, 10.7%; M^+, 264), $\nu_{max.}$(film) 1 610, 1 600, 1 475, and 1 470 cm^{-1}; δ 0.9 (6 H, br t, CH_3 × 2), 1.2—1.8 (10 H, m, CH_2 × 5), 2.5—2.8 (4 H, m, $ArCH_2$ × 2), 3.81 (6 H, s, OCH_3 × 2), and 6.4 (2 H, s, ArH × 2).

1-*Hexyl*-2,6-*dimethoxy*-4-*propylbenzene* (**23d**). (Found: C, 77.6; H, 10.5%; M^+, 264. $C_{17}H_{28}O_2$ requires: C, 78.0; H, 10.7%; M^+, 264); $\nu_{max.}$(film) 1 620, 1 605, 1 475, and 1 470 cm^{-1}; δ 0.9 (6 H, br t, CH_3 × 2), 1.2—1.8 (10 H, m, CH_2 × 5), 2.4—2.8 (4 H, m, $ArCH_2$ × 2), 3.8 (6 H, s, OCH_3 × 2), and 6.4 (2 H, s, ArH × 2).

2,5-*Dialkylresorcinols; Iso-DB 2073* (**24a**), *Stemphol* (**24b**), *Isostemphol* (**24c**), *and DB 2073* (**24d**).—Silicon tetrachloride (250 mg) and sodium iodide (40 mg) were added to a solution of the 2,5-dialkylresorcinol dimethyl ether (**23a—d**) (100 mg) in dry toluene (10 ml) and dry acetonitrile (10 ml). The mixture was refluxed for 24 h and then poured into water (100 ml). The product was extracted with ether and the extract washed with water, dried and evaporated to afford the dialkylresorcinol as a white solid which was crystallized from hexane.

5-*Hexyl*-2-*propylresorcinol, Isomer of DB 2073* (**24a**). M.p. 88 °C (hexane) (Found: C, 76.3; H, 10.4. $C_{15}H_{24}O_2$ requires C, 76.2; H, 10.2%); $\nu_{max.}$(film) 3 450 (OH) and 1 610 and 1 490 cm^{-1} (aromatic).

2-*Butyl*-5-*pentylresorcinol, Stemphol* (**24b**). M.p. 91 °C (hexane) (lit.,[34] 91 °C) (Found: C, 76.1; H, 10.3. Calc. for $C_{14}H_{24}O_2$: C, 76.2; H, 10.2%); $\nu_{max.}$(film) 3 450 (OH) and 1 620 and 1 496 cm^{-1} (aromatic).

5-*Butyl*-2-*pentylresorcinol, Isomer of Stemphol* (**24c**). M.p. 90 °C (hexane) (lit.,[34] 91—93 °C) (Found: C, 76.1; H, 10.1. Calc. for $C_{15}H_{24}O_2$: C, 76.2; H, 10.2%); $\nu_{max.}$(film) 3 450 (OH), 1 610 and 1 495 cm^{-1} (aromatic).

2-*Hexyl*-5-*propylresorcinol, DB 2073* (**24d**). M.p. 87 °C (hexane) (lit.,[34] 87—89 °C) (Found: C, 76.3; H, 10.2. Calc. for $C_{15}H_{24}O_2$: C, 76.2; H, 10.2%); $\nu_{max.}$(film) 3 450 (OH), and 1 610 and 1 495 cm^{-1} (aromatic).

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