

Synthesis of New Hydroxy-2-styrylchromones

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Keywords: Rearrangements / Cyclizations / Protecting groups / Heterocycles

Hydroxy-2-styrylchromones **5a–i** were prepared by debenylation of benzyloxy-2-styrylchromones **3a–i**, which were synthesised by the Baker–Venkataraman method. The last step of this method, the cyclodehydration 5-aryl-3-hydroxy-1-(2-hydroxyaryl)-2,4-pentadien-1-ones **2a–i**, was carried out with a catalytic amount of iodine, or *p*-toluenesulfonic acid, in DMSO. Benzyloxy-3-cinnamoyl-2-styrylchromones **4a–f** were obtained as by-products in both procedures, but the latter procedure gave benzyloxy-2-styrylchromones **3a–i** in better yields. The structures of all new compounds were established by extensive NMR studies.

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Introduction

Chromones (1-benzopyran-4-ones) are one of the most abundant classes of naturally occurring oxygen-heterocycles.^[1–3] The significance of these compounds is due not only to the important biological functions they play in Nature, but also because certain derivatives have shown considerable pharmacological, biocidal, and antioxidant activities;^[2,4–10] some of them are being marketed as drugs.^[11] 2-Phenylchromones, also known as flavones, are the major constituents of this class of compounds and have a wide range of biological activities.^[4–10] Other groups of chromones, which are less widely-occurring in nature, have also shown important biological activities. For example, for the newly-discovered group of 2-styrylchromones, only two natural derivatives have been found, but they have shown potent in vitro cytotoxicity against human leukaemia cells.^[12] Prior to the isolation of these natural 2-styrylchromones, studies had already been carried out on numerous synthetic derivatives,^[13] which also showed promising anti-tumour and anti-allergic activities.^[14] More recently, it has been demonstrated that certain synthetic derivatives are inhibitors of the replication of both 1B and 14 serotypes of the human anti-rhinovirus,^[15] while we have found that 3'-allyl-5,7,4'-trimethoxy-2-styrylchromone uncouples oxidative phosphorylation,^[16] and that some hydroxy-2-styrylchromones act as potent xanthine oxidase inhibitors.^[17]

The mechanism of action of polyphenolic compounds as antioxidants can include the suppression of the formation of reactive oxygen species, either by the inhibition of enzymes (e.g. xanthine oxidase and protein kinase C) or the chelation of trace metal ions (e.g. Fe²⁺ or Cu⁺) involved

in free radical production. Alternatively, they may act by scavenging reactive oxygen species (e.g. superoxide anion, peroxy, alkoxyl, hydroxyl, and nitric oxide radicals and singlet oxygen), or protecting antioxidant defences. Flavones have been identified as fulfilling most of the necessary criteria, since several structure-activity studies have shown that the structural requirements for a strong antioxidant activity are a C2=C3 double bond conjugated to a carbonyl group at C-4, a *ortho*-dihydroxy substitution on ring B (a catechol moiety) and free OH groups at the C-3 and C-5 positions.^[5,7,9,18]

Taking into consideration the important biological activities of flavones, namely, their antioxidant activity and their similarity to 2-styrylchromones, we decided to devote some attention to the synthesis of hydroxy-2-styrylchromones. The diversity of the substitution pattern, including the presence of hydroxyl substituents at certain positions of the skeleton (5, 7, 3', and 4') and the inherent C-4 carbonyl group and C2=C3 double bond, was taken into consideration, having in mind that further antioxidant structure-activity studies would be carried out. Following our experience in the synthesis of 2-styrylchromones,^[19] we report here the synthesis of several new hydroxy- or polyhydroxy-2-styrylchromones, starting from 2'-hydroxyacetophenones and cinnamic acid-derivatives.

Results and Discussion

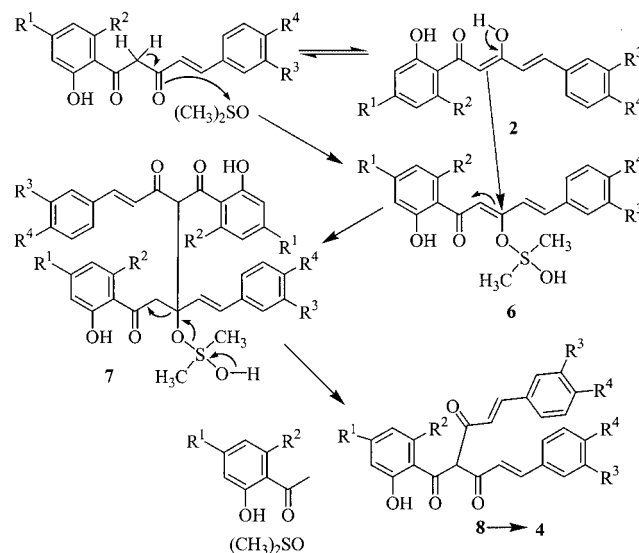
Chemistry

Benzyloxy-2-styrylchromones **3a–i** were prepared in good overall yields according to the three-step sequence shown in Scheme 1.^[20] For this purpose, benzyloxy-2'-cinnamoyloxyacetophenones **1** were obtained from the reaction of the 2'-hydroxyacetophenone derivatives with the appropriate cinnamoyl chloride, commercially available in

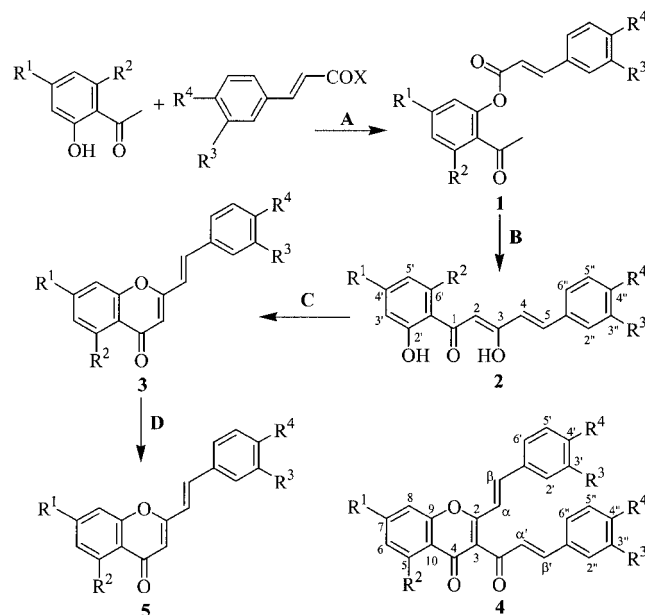
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the cases of **1a–c**, or prepared in situ from the cinnamic acids and phosphoryl chloride for **1d–i**. The Baker–Venkataraman rearrangement of compounds **1a–i** into 5-aryl-3-hydroxy-1-(2-hydroxyaryl)-2,4-pentadien-1-ones **2a–i** was carried out by their treatment with an excess of potassium hydroxide (powder) in DMSO. Cyclodehydration of ketone **2a** with a mixture of DMSO and a catalytic amount of iodine, at 90 °C^[21] led to the desired 7-benzyloxy-2-styrylchromone **3a** in good yield (74 %). However, treatment of the intermediate **2b** under the same reaction conditions led to the formation of 5-benzyloxy-3-cinnamoyl-2-styrylchromone **4b** (9 %) and the starting material 2'-benzyloxy-6'-hydroxyacetophenone (65 %), but the expected 5-benzyloxy-2-styrylchromone **3b** was not obtained. A plausible mechanism for the formation of these two compounds is depicted in Scheme 2. In the reaction medium, the structures involved in the keto-enol equilibrium may give rise to compound **6b** by reaction with DMSO.^[22] This compound can then react with **2b**, leading to the dimer **7b**. A retro-aldol-type reaction of **7b** could then give the starting 2'-benzyloxy-6'-hydroxyacetophenone and the triketo derivative **8b**, which could then cyclodehydrate to give the 5-benzyloxy-3-cinnamoyl-2-styrylchromone **4b**. Since we didn't use dry DMSO, compounds **6** could also react with water at their enolic carbon, and

this could be followed by a retro-aldol-type reaction leading to the 2-hydroxyacetophenone starting materials and the cinnamic acid-derivatives. This last proposal may explain the formation of such a large amount of the 2'-benzyloxy-6'-hydroxyacetophenone starting material.



Scheme 2

**For compounds 1, 2, 3, 4:**

- a) $R^1 = \text{OBn}$; $R^2 = R^3 = R^4 = \text{H}$
- b) $R^2 = \text{OBn}$; $R^1 = R^3 = R^4 = \text{H}$
- c) $R^1 = R^2 = \text{OBn}$; $R^3 = R^4 = \text{H}$
- d) $R^1 = R^4 = \text{OBn}$; $R^2 = R^3 = \text{H}$
- e) $R^2 = R^4 = \text{OBn}$; $R^1 = R^3 = \text{H}$
- f) $R^1 = R^2 = R^4 = \text{OBn}$; $R^3 = \text{H}$
- g) $R^1 = R^3 = R^4 = \text{OBn}$; $R^2 = \text{H}$
- h) $R^2 = R^3 = R^4 = \text{OBn}$; $R^1 = \text{H}$
- i) $R^1 = R^2 = R^3 = R^4 = \text{OBn}$

For compounds 5:

- a) $R^1 = \text{OH}$; $R^2 = R^3 = R^4 = \text{H}$
- b) $R^2 = \text{OH}$; $R^1 = R^3 = R^4 = \text{H}$
- c) $R^1 = R^2 = \text{OH}$; $R^3 = R^4 = \text{H}$
- d) $R^1 = R^4 = \text{OH}$; $R^2 = R^3 = \text{H}$
- e) $R^2 = R^4 = \text{OH}$; $R^1 = R^3 = \text{H}$
- f) $R^1 = R^2 = R^4 = \text{OH}$; $R^3 = \text{H}$
- g) $R^1 = R^3 = R^4 = \text{OH}$; $R^2 = \text{H}$
- h) $R^2 = R^3 = R^4 = \text{OH}$; $R^1 = \text{H}$
- i) $R^1 = R^2 = R^3 = R^4 = \text{OH}$

A: $X = \text{Cl}$, dry py or $X = \text{OH}$, POCl_3 , dry py;
C: *p*-Toluenesulfonic acid or I_2 , DMSO;

B: KOH, DMSO
D: HBr/AcOH

Scheme 1

Cyclodehydration of ketones **2c–i** under the same reaction conditions (i.e. a mixture of DMSO and a catalytic amount of iodine at 90 °C) led to the desired 2-styrylchromones **3c–i** in poor yields, contaminated in several cases by the corresponding 3-cinnamoyl-2-styrylchromones **4c–f** and the starting 2'-hydroxyacetophenones. The amount of the latter compounds was higher when the yields of 2-styrylchromone derivatives **3c–i** and **4c–i** were low. Since the yields we obtained of **3c–i** were not acceptable, we tried the cyclodehydration of ketones **2a–i** with *p*-toluenesulfonic acid in DMSO, at 90 °C.^[23] In general, the desired benzyloxy-2-styrylchromones **3a–i** were obtained in better yields, but the by-products 3-cinnamoyl-2-styrylchromones **4a,c** were also obtained in some cases. These results seem to indicate that the cyclodehydration of **2a–i** is favourable in the acidic medium.

Debenzylation of benzyloxy-2-styrylchromones **3a–i** was achieved by their treatment with a solution of hydrogen bromide in acetic acid at reflux, to give the corresponding hydroxy-2-styrylchromones **5a–i** in moderate yields.

NMR Spectroscopy

The most noticeable features of the ^1H and ^{13}C NMR spectra of 2'-cinnamoyloxyacetophenones **1a–i** are: i) the resonances of the 2- CH_3 proton and carbon atoms, which appear at $\delta = 2.47\text{--}2.53$ and $29.5\text{--}32.0$ ppm, respectively; ii) the resonances of the benzylic methylenic proton and carbon atoms, which appear at $\delta = 4.93\text{--}5.21$ and $70.0\text{--}71.2$ ppm, respectively; iii) the pair of doublets corre-

sponding to the resonances of the H_α ($\delta = 6.37\text{--}6.69$ ppm) and H_β ($\delta = 7.71\text{--}7.91$ ppm) protons; the corresponding coupling constant, $J_{H_\alpha-H_\beta} \approx 16$ Hz, indicates the presence of a *trans* configuration of this double bond; iv) the ester and ketone carbonyl groups' resonances, which appear at $\delta = 165.0\text{--}165.4$ and $195.6\text{--}200.7$ ppm, respectively. It is important to notice that the resonance of the ketone carbonyl group of 4'-benzyloxy-2'-cinnamoyloxyacetophenones **1a,d,g** appears at $\delta = 195.6\text{--}195.8$ ppm while those also bearing a 6'-benzyloxy group **1b,c,e,f,h,i** appear at $\delta = 200.5\text{--}200.7$ ppm. This deshielding effect is due to the lack of conjugation between this carbonyl group and the aryl ring of the acetophenone, caused by the steric clash between the two *ortho*-substituents and the acetyl group.

In the ^1H NMR spectra of each one of 5-aryl-3-hydroxy-1-(2-hydroxyaryl)-2,4-pentadien-1-ones **2a–i**, there are two signals, at $\delta = 12.68\text{--}13.73$ and $14.46\text{--}14.77$ ppm, which are due to protons involved in hydrogen bonding. One can conclude that these compounds **2a–i** exist in their enolic forms, as shown in Scheme 1, with the former signals corresponding to the resonances of the phenolic protons, and the latter ones being due to the 3-OH protons. The resonance of 3-OH appears, in most cases, as a doublet, due to the long-range coupling with 4-H ($J_{H4-3OH} \approx 0.6\text{--}1.2$ Hz). From the values of the vicinal coupling constants ($^3J_{4H-5H} \approx 16$ Hz), it was possible to establish the *trans* configuration of these two protons.

An important feature of the ^1H NMR spectra of 2-styrylchromones **3a–i** and **5a–i** is the singlet at $\delta = 6.13\text{--}6.47$ ppm, corresponding to the resonances of 3-H; this resonance is absent in the spectra of the 3-cinnamoyl-2-styrylchromones **4a–f**. The analysis of the ^{13}C NMR spectra of compounds **3a–i** and **5a–i** revealed the resonance of C-3 at $\delta = 106.8\text{--}112.2$ ppm, while in the cases of **4a–f** it appeared at $\delta = 122.2\text{--}123.7$ ppm. This deshielding effect is due to the presence of 3-cinnamoyl substituents in the cases of chromones **4a–f**. In the spectra of all these chromones **3a–i**, **4a–f** and **5a–i**, the resonances assigned to β -H ($\delta = 7.36\text{--}7.74$ ppm) and C- β ($\delta = 136.1\text{--}139.1$ ppm) appeared at higher frequency values than that of α -H ($\delta = 6.50\text{--}7.18$ ppm) and C- α ($\delta = 115.5\text{--}120.7$ ppm), due to the mesomeric deshielding effect of the carbonyl group. In the NMR spectra of compounds **4a–f**, one can also observe the resonances of the other vinylic moiety, α' -H ($\delta = 7.11\text{--}7.26$ ppm), β' -H ($\delta = 7.58\text{--}7.69$ ppm), C- α' ($\delta = 125.8\text{--}128.0$ ppm), and C- β' ($\delta = 144.1\text{--}144.2$ ppm). The coupling constant values, $^3J_{H_\alpha-H_\beta} \approx 16$ Hz, of all the chromones we synthesised **3a–i**, **4a–f** and **5a–i** and also $^3J_{H_{\alpha'}-H_{\beta'}} \approx 16$ Hz for **4a–i**, indicate a *trans*-configuration of these $C\alpha=C\beta$ and $C\alpha'=C\beta'$ double bonds.

The assignments of each AB spin-system, corresponding to the resonances of α -H/ β -H and α' -H/ β' -H of chromones **4a–i**, was made on the basis of the connectivities found in the HMBC spectra. The resonance assigned to β -H correlates with the signals of C-2', C-6', and C-2, whereas that ascribed to β' -H correlates with C-2'', C-6'', and C=O of the cinnamoyl group (Figure 1).

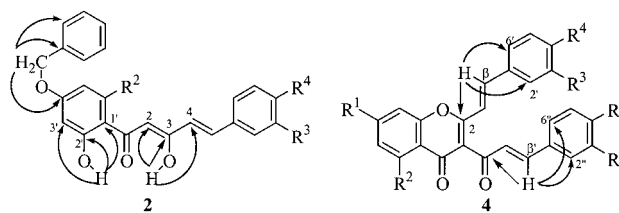


Figure 1. Main connectivities found in the HMBC spectra of compounds **2a–i** and **4a–i**

The ^1H NMR spectra of hydroxy-2-styrylchromones **5a–i** revealed the presence of hydroxyl proton resonances at $\delta \approx 10$ ppm, assigned to 7,3',4'-OH groups, and at $\delta \approx 13$ ppm, attributed to the 5-OH group. The higher frequency value of the latter is due to the intramolecular hydrogen bond of the 5-hydroxy group to the carbonyl group.

The assignments of the carbon resonances of all compounds **1a–i**, **2a–i**, **3a–i**, **4a–f**, and **5a–i** were made by analysis of their HSQC and HMBC spectra. Figure 1 shows some of the main long-range connectivities found in the HMBC spectra of 5-aryl-3-hydroxy-1-(2-hydroxyaryl)-2,4-pentadien-1-ones **2a–i**.

Conclusion

We have prepared several hydroxy-2-styrylchromones **5a–i** by acidic debenzoylation of the corresponding benzyloxy-2-styrylchromones **3a–i**, which were synthesised by the Baker–Venkataraman method. The cyclodehydration reaction of the intermediates 5-aryl-3-hydroxy-1-(2-hydroxyaryl)-2,4-pentadien-1-ones **2a–i** to give the corresponding benzyloxy-2-styrylchromones **3a–i** was studied. Better results were obtained when the cyclodehydration was carried out with *p*-toluenesulfonic acid in DMSO than with a catalytic amount of iodine in DMSO. In both procedures, benzyloxy-3-cinnamoyl-2-styrylchromones **4a–f** were obtained as by-products.

Experimental Section

General Remarks: Melting points were measured in a Reichert Thermovar apparatus fitted with a microscope and are uncorrected. NMR spectra were recorded on a Bruker DRX 300 spectrometer (300.13 for ^1H and 75.47 MHz for ^{13}C), with CDCl_3 as solvent, unless otherwise stated. Chemical shifts (δ) are reported in ppm, and coupling constants (J) in Hz. The internal standard was TMS. Unequivocal ^{13}C assignments were made with the aid of 2D gHSQC and gHMBC (delays for one bond and long-range J C/H couplings were optimised for 145 and 7 Hz, respectively) experiments. Electron impact (EI, 70 eV) MS were recorded on VG Autospec Q and M spectrometers. Elemental Analyses were obtained with a CHNS 932 Leco analyser (University of Aveiro). Preparative thin-layer chromatography was performed with Merck silica gel 60 DGF₂₅₄. Column chromatography was performed with Merck silica gel 60, 70–230 mesh. All other chemicals and solvents used were obtained from commercial sources and used as received or dried using standard procedures.

Synthesis of 2'-(Cinnamoyloxy)acetophenones 1a–i. Method 1: Cinnamoyl chloride (1.9 g, 11.4 mmol) was added to a solution of the appropriate acetophenone (5.7 mmol) in dry pyridine (150 mL). The solution was stirred under nitrogen at room temperature for 12 hours. After that period, the solution was poured into ice and water (100 mL), and the pH adjusted to 4 with dilute hydrochloric acid. The mixture was extracted with chloroform (2 × 100 mL), and the organic layer washed with water. The solvent was evaporated to dryness, and the residue was purified by silica gel column chromatography using a (3:7) mixture of light petroleum:dichloromethane as eluent. The solvent was evaporated to dryness in each case, and the residue was crystallised from ethanol to give the expected 2'-cinnamoyloxyacetophenones 1a–c.

4'-Benzyloxy-2'-(cinnamoyloxy)acetophenone (1a): Yield 84.9 % (1.80 g). M.p. 118–119 °C (recrystallised from ethanol). ¹H NMR: δ = 2.53 (s, 3 H, 2-CH₃), 5.12 (s, 2 H, 4'-OCH₂C₆H₅), 6.69 (d, *J* = 16.0 Hz, 1 H, α-H), 6.78 (br. s, 1 H, 3'-H), 6.92 (dd, *J* = 8.8, 2.4 Hz, 1 H, 5'-H), 7.35–7.44 (m, 8 H, 3'',4'',5''-H and 2,3,4,5,6-H of 4'-OCH₂C₆H₅), 7.61 (dd, *J* = 6.5, 2.1 Hz, 2 H, 2'',6''-H), 7.88 (d, *J* = 8.8 Hz, 1 H, 6'-H), 7.91 (d, *J* = 16.0 Hz, 1 H, β-H) ppm. ¹³C NMR: δ = 29.5 (C-2), 70.4 (4'-OCH₂C₆H₅), 110.0 (C-3'), 112.5 (C-5'), 116.8 (C-α), 123.8 (C-1'), 127.5 (C-2,6 of 4'-OCH₂C₆H₅), 128.3 (C-4 of 4'-OCH₂C₆H₅), 128.4 (C-2'',6''), 128.7 (C-3,5 of 4'-OCH₂C₆H₅), 128.9 (C-3'',5''), 130.8 (C-4''), 132.3 (C-6'), 134.0 (C-1''), 135.7 (C-1 of 4'-OCH₂C₆H₅), 147.3 (C-β), 151.3 (C-2'), 162.8 (C-4'), 165.1 (C=O), 195.8 (C-1) ppm. EI-MS: *m/z* (rel. int.) = 372 (8) [M⁺], 281 (2), 242 (1), 239 (2), 192 (1), 181 (2), 131 (100), 103 (32), 91 (43). C₂₄H₂₀O₄ (372.4): calcd. C 77.40, H 5.41; found C 77.48, H 5.51.

6'-Benzyloxy-2'-(cinnamoyloxy)acetophenone (1b): Yield 85.4 % (1.81 g). M.p. 90–93 °C (recrystallised from ethanol). ¹H NMR: δ = 2.53 (s, 3 H, 2-CH₃), 5.11 (s, 2 H, 6'-OCH₂C₆H₅), 6.58 (d, *J* = 16.0 Hz, 1 H, α-H), 6.82 (d, *J* = 8.2 Hz, 1 H, 3'-H), 6.89 (d, *J* = 8.2 Hz, 1 H, 5'-H), 7.31–7.42 (m, 9 H, 4'-H, 3'',4'',5''-H and 2,3,4,5,6-H of 6'-OCH₂C₆H₅), 7.54–7.57 (m, 2 H, 2'',6''-H), 7.83 (d, *J* = 16.0 Hz, 1 H, β-H) ppm. ¹³C NMR: δ = 31.7 (C-2), 70.8 (6'-OCH₂C₆H₅), 109.9 (C-5'), 115.4 (C-3'), 116.5 (C-α), 124.9 (C-1'), 127.2 (C-2,6 of 6'-OCH₂C₆H₅), 128.1 (C-4 of 6'-OCH₂C₆H₅), 128.3 (C-2'',6''), 128.6 (C-3,5 of 6'-OCH₂C₆H₅), 129.1 (C-3'',5''), 130.7 (C-4''), 130.9 (C-4'), 133.9 (C-1''), 136.0 (C-1 of 6'-OCH₂C₆H₅), 147.1 (C-β), 147.6 (C-2'), 156.4 (C-6'), 165.0 (C=O), 200.6 (C-1) ppm. EI-MS: *m/z* (rel. int.) = 372 (2) [M⁺], 281 (2), 267 (1), 241 (10), 224 (12), 191 (3), 131 (100), 103 (32), 91 (55). C₂₄H₂₀O₄ (372.4): calcd. C 77.40, H 5.41; found C 77.31, H 5.49.

4',6'-Dibenzyloxy-2'-(cinnamoyloxy)acetophenone (1c): Yield 95.1 % (2.59 g). M.p. 104–105 °C (recrystallised from ethanol). ¹H NMR: δ = 2.49 (s, 3 H, 2-CH₃), 5.04 and 5.08 (2s, 4 H, 4',6'-OCH₂C₆H₅), 6.42 (d, *J* = 2.2 Hz, 1 H, 3'-H), 6.53 (d, *J* = 2.2 Hz, 1 H, 5'-H), 6.59 (d, *J* = 16.0 Hz, 1 H, α-H), 7.35–7.42 (m, 8 H, 3'',4'',5''-H and 2,3,4,5,6-H of 4',6'-OCH₂C₆H₅), 7.56–7.59 (m, 2 H, 2'',6''-H), 7.84 (d, *J* = 16.0 Hz, 1 H, β-H) ppm. ¹³C NMR: δ = 32.0 (C-2), 70.4 and 70.9 (4',6'-OCH₂C₆H₅), 98.4 (C-5'), 101.2 (C-3'), 116.7 (C-α), 117.9 (C-1'), 127.4 and 127.6 (C-2,6 of 4',6'-OCH₂C₆H₅), 128.3 and 128.3 (C-4 of 4',6'-OCH₂C₆H₅), 128.4 (C-2'',6''), 128.7 and 128.9 (C-3,5 of 4',6'-OCH₂C₆H₅), 130.7 (C-3'',4'',5''), 134.0 (C-1''), 135.8 and 135.9 (C-1 of 4',6'-OCH₂C₆H₅), 147.2 (C-β), 149.5 (C-2'), 158.1 (C-6'), 161.2 (C-4'), 165.2 (C=O), 199.5 (C-1) ppm. EI-MS: *m/z* (rel. int.) = 478 (4) [M⁺], 435 (2), 387 (6), 373 (1), 347 (9), 345 (15), 330 (4), 181 (2), 131 (100), 103 (20), 91 (53). C₃₁H₂₆O₅ (478.5): calcd. C 77.81, H 5.48; found C 77.94, H 5.42.

Method 2: The appropriate cinnamic acid (9.5 mmol) and phosphorus oxychloride (4.0 mL, 43.0 mmol) were added to a solution of the appropriate acetophenone (8.6 mmol) in dry pyridine (170 mL). The solution was stirred under different conditions of time and temperature according to the substitution of the compound: **1d** and **1e**, 60 °C, 24 h; **1f**, room temperature, 24 h; **1g** and **1h**, 60 °C, 4 h; **1i**, room temperature, 1 h. After that, the solution was poured into ice and water (100 mL), and the pH adjusted to 4 with hydrochloric acid. The mixture was extracted with chloroform (100 mL), and the organic layer washed with water. The solvent was evaporated, and the residue was purified by silica gel column chromatography using a mixture of light petroleum:dichloromethane (3:7) as eluent. The solvent was evaporated to dryness in each case, and the residue was crystallised from ethanol to give the expected cinnamoyloxyacetophenones **1d–i**.

4'-Benzyloxy-2'-(4-benzyloxy)cinnamoyloxy)acetophenone (1d): Yield 86.1 % (3.54 g). M.p. 197–200 °C (recrystallised from ethanol). ¹H NMR: δ = 2.52 (s, 3 H, 2-CH₃), 5.11 and 5.12 (2s, 4 H, 4',4''-OCH₂C₆H₅), 6.55 (d, *J* = 16.0 Hz, 1 H, α-H), 6.77 (d, *J* = 2.4 Hz, 1 H, 3'-H), 6.91 (dd, *J* = 8.8, 2.4 Hz, 1 H, 5'-H), 7.01 (d, *J* = 8.7 Hz, 2 H, 3'',5''-H), 7.35–7.46 (m, 10 H, 2,3,4,5,6-H of 4',4''-OCH₂C₆H₅), 7.55 (d, *J* = 8.7 Hz, 2 H, 2'',6''-H), 7.86 (d, *J* = 8.8 Hz, 1 H, 6'-H), 7.87 (d, *J* = 16.0 Hz, 1 H, β-H) ppm. ¹³C NMR: δ = 29.7 (C-2), 70.1 (4',4''-OCH₂C₆H₅), 109.9 (C-3'), 112.5 (C-5'), 114.3 (C-α), 115.3 (C-3'',5''), 123.9 (C-1'), 127.0 (C-1''), 127.5 and 127.6 (C-2,6 of 4',4''-OCH₂C₆H₅), 128.2 and 128.3 (C-4 of 4',4''-OCH₂C₆H₅), 128.7 and 128.7 (C-3,5 of 4',4''-OCH₂C₆H₅), 130.2 (C-2'',6''), 132.2 (C-6'), 135.8 and 136.3 (C-1 of 4',4''-OCH₂C₆H₅), 147.0 (C-β), 151.5 (C-2'), 161.0 (C-4''), 162.8 (C-4'), 165.4 (C=O), 195.9 (C-1) ppm. EI-MS: *m/z* (rel. int.) = 478 (0.2) [M⁺], 372 (0.3), 281 (0.4), 267 (0.2), 254 (12), 237 (11), 224 (2), 131 (31), 103 (7), 91 (100). C₃₁H₂₆O₅ (478.5): calcd. C 77.81, H 5.48; found C 77.72, H 5.51.

6'-Benzyloxy-2'-(4-benzyloxy)cinnamoyloxy)acetophenone (1e): Yield 88.1 % (3.62 g). M.p. 133–134 °C (recrystallised from ethanol). ¹H NMR: δ = 2.52 (s, 3 H, 2-CH₃), 5.11 (s, 2 H, 4'-OCH₂C₆H₅), 5.13 (s, 2 H, 6'-OCH₂C₆H₅), 6.44 (d, *J* = 15.9 Hz, 1 H, α-H), 6.81 (d, *J* = 8.2 Hz, 1 H, 3'-H), 6.89 (d, *J* = 8.2 Hz, 1 H, 5'-H), 6.99 (d, *J* = 8.7 Hz, 2 H, 3'',5''-H), 7.32–7.45 (m, 11 H, 4'-H and 2,3,4,5,6-H of 6',4''-OCH₂C₆H₅), 7.52 (d, *J* = 8.7 Hz, 2 H, 2'',6''-H), 7.79 (d, *J* = 15.9 Hz, 1 H, β-H) ppm. ¹³C NMR: δ = 31.8 (C-2), 70.1 (4'-OCH₂C₆H₅), 70.8 (6'-OCH₂C₆H₅), 109.9 (C-5'), 114.1 (C-α), 115.2 (C-3'',5''), 115.5 (C-3'), 125.0 (C-1'), 127.0 (C-1''), 127.3 and 127.5 (C-2,6 of 6',4''-OCH₂C₆H₅), 128.2 (C-4 of 6',4''-OCH₂C₆H₅), 128.6 (C-3,5 of 6',4''-OCH₂C₆H₅), 130.2 (C-2'',6''), 130.8 (C-4'), 136.0 and 136.3 (C-1 of 6',4''-OCH₂C₆H₅), 146.8 (C-β), 147.8 (C-2'), 156.4 (C-6'), 160.9 (C-4''), 165.4 (C=O), 200.7 (C-1) ppm. EI-MS: *m/z* (rel. int.) = 478 (7) [M⁺], 435 (0.5), 387 (0.5), 345 (0.5), 298 (0.5), 254 (0.5), 237 (86), 146 (5), 91 (100). C₃₁H₂₆O₅ (478.5): calcd. C 77.81, H 5.48; found C 77.80, H 5.52.

4',6'-Dibenzyloxy-2'-(4-benzyloxy)cinnamoyloxy)acetophenone (1f): Yield 89.0 % (4.47 g). M.p. 129–130 °C (recrystallised from ethanol). ¹H NMR: δ = 2.49 (s, 3 H, 2-CH₃), 5.04, 5.08, and 5.11 (3s, 6 H, 4',6',4''-OCH₂C₆H₅), 6.42 (d, *J* = 2.1 Hz, 1 H, 3'-H), 6.44 (d, *J* = 16.0 Hz, 1 H, α-H), 6.52 (d, *J* = 2.1 Hz, 1 H, 5'-H), 6.99 (d, *J* = 8.9 Hz, 2 H, 3'',5''-H), 7.34–7.46 (m, 15 H, 2,3,4,5,6-H of 4',6',4''-OCH₂C₆H₅), 7.52 (d, *J* = 8.9 Hz, 2 H, 2'',6''-H), 7.79 (d, *J* = 16.0 Hz, 1 H, β-H) ppm. ¹³C NMR: δ = 32.0 (C-2), 70.0, 70.4, and 70.9 (4',6',4''-OCH₂C₆H₅), 98.3 (C-5'), 101.2 (C-3'), 114.2 (C-α), 115.2 (C-3'',5''), 118.0 (C-1'), 127.0 (C-1''), 127.4, 127.5, and 127.6 (C-2,6 of 4',6',4''-OCH₂C₆H₅), 128.2 and 128.3 (C-4 of 4',6',4''-OCH₂C₆H₅), 128.7 (C-3,5 of 4',6',4''-OCH₂C₆H₅), 130.2

(C-2'',6''), 135.8, 135.9, and 136.3 (C-1 of 4',6',4''-OCH₂C₆H₅), 146.8 (C-β), 149.5 (C-2'), 158.0 (C-6'), 160.1 (C-4'), 161.1 (C-4''), 165.4 (C=O), 199.6 (C-1) ppm. EI-MS: *m/z* (rel. int.) = 584 (2) [M⁺], 541 (3), 493 (2), 451 (2), 400 (1), 348 (2), 345 (3), 257 (1), 237 (63), 181 (2), 147 (3), 91 (100). C₃₈H₃₂O₆ (584.7): calcd. C 78.06, H 5.52; found C 78.13, H 5.49.

4'-Benzyloxy-2'-(3,4-dibenzyloxy)cinnamoyloxy)acetophenone (1g): Yield 84.0 % (4.22 g). M.p. 127–128 °C (recrystallised from ethanol). ¹H NMR: δ = 2.51 (s, 3 H, 2-CH₃), 5.09 (s, 2 H, 4'-OCH₂C₆H₅), 5.19 and 5.21 (2s, 4 H, 3'',4''-OCH₂C₆H₅), 6.47 (d, *J* = 15.9 Hz, 1 H, α-H), 6.76 (d, *J* = 2.2 Hz, 1 H, 3'-H), 6.90 (dd, *J* = 8.7, 2.2 Hz, 1 H, 5'-H), 6.93 (d, *J* = 8.2 Hz, 1 H, 5''-H), 7.13 (dd, *J* = 8.2, 1.8 Hz, 1 H, 6''-H), 7.19 (d, *J* = 1.8 Hz, 1 H, 2''-H), 7.24–7.48 (m, 15 H, 2,3,4,5,6-H of 4',3'',4''-OCH₂C₆H₅), 7.78 (d, *J* = 15.9 Hz, 1 H, β-H), 7.86 (d, *J* = 8.7 Hz, 1 H, 6'-H) ppm. ¹³C NMR: δ = 29.6 (C-2), 70.3 (4'-OCH₂C₆H₅), 70.8 and 71.2 (3'',4''-OCH₂C₆H₅), 109.9 (C-3'), 112.4 (C-5'), 113.7 (C-2''), 114.0 (C-5''), 114.5 (C-α), 123.5 (C-6''), 123.8 (C-1'), 127.1 and 127.2 (C-2,6 of 4',6',4''-OCH₂C₆H₅), 127.3 (C-1''), 127.5, 127.9, and 128.3 (C-4 of 4',6',4''-OCH₂C₆H₅), 128.5 and 128.6 (C-3,5 of 4',6',4''-OCH₂C₆H₅), 132.2 (C-6'), 135.7 (C-1 of 4'-OCH₂C₆H₅), 136.5 and 136.7 (C-1 of 3'',4''-OCH₂C₆H₅), 147.1 (C-β), 148.8 (C-3''), 151.4 (C-2',4''), 162.7 (C-4'), 165.3 (C=O), 195.9 (C-1) ppm. EI-MS: *m/z* (rel. int.) = 584 (4) [M⁺], 360 (2), 343 (31), 251 (3), 242 (9), 181 (11), 131 (3), 106 (11), 91 (100). C₃₈H₃₂O₆ (584.7): calcd. C 78.06, H 5.52; found C 77.94, H 5.64.

6'-Benzyloxy-2'-(3,4-dibenzyloxy)cinnamoyloxy)acetophenone (1h): Yield 69.1 % (3.47 g). Yellow oil. ¹H NMR: δ = 2.51 (s, 3 H, 2-CH₃), 5.05 (s, 2 H, 6'-OCH₂C₆H₅), 5.14 (s, 4 H, 3'',4''-OCH₂C₆H₅), 6.37 (d, *J* = 15.9 Hz, 1 H, α-H), 6.78 (d, *J* = 8.2 Hz, 1 H, 3'-H), 6.83 (d, *J* = 8.2 Hz, 1 H, 5'-H), 6.89 (d, *J* = 8.4 Hz, 1 H, 5''-H), 7.06 (dd, *J* = 8.4, 1.8 Hz, 1 H, 6''-H), 7.14 (d, *J* = 1.8 Hz, 1 H, 2''-H), 7.26–7.46 (m, 16 H, 4'-H and 2,3,4,5,6-H of 6',3'',4''-OCH₂C₆H₅), 7.71 (d, *J* = 15.9 Hz, 1 H, β-H) ppm. ¹³C NMR: δ = 31.6 (C-2), 70.6 (6'-OCH₂C₆H₅), 71.0 (3'',4''-OCH₂C₆H₅), 109.8 (C-5'), 113.5 (C-2''), 113.8 (C-5''), 114.2 (C-α), 115.3 (C-3'), 123.3 (C-6''), 124.8 (C-1'), 127.0 and 127.1 (C-2,6 of 6',3'',4''-OCH₂C₆H₅), 127.2 (C-1''), 127.8 and 128.0 (C-4 of 6',3'',4''-OCH₂C₆H₅), 128.4 and 128.5 (C-3,5 of 6',3'',4''-OCH₂C₆H₅), 130.7 (C-4'), 135.9 (C-1 of 6'-OCH₂C₆H₅), 136.5 and 136.6 (C-1 of 3'',4''-OCH₂C₆H₅), 146.8 (C-β), 147.6 (C-2'), 148.7 (C-3''), 151.2 (C-4''), 156.2 (C-6'), 165.1 (C=O), 200.5 (C-1) ppm. EI-MS: *m/z* (rel. int.) = 584 (7) [M⁺], 343 (42), 253 (3), 251 (3), 181 (13), 91 (100). C₃₈H₃₂O₆ (584.7): calcd. C 78.06, H 5.52; found C 78.03, H 5.63.

4',6'-Dibenzyloxy-2'-(3,4-dibenzyloxy)cinnamoyloxy)acetophenone (1i): Yield 83.1 % (4.93 g). M.p. 110–111 °C (recrystallised from ethanol). ¹H NMR: δ = 2.47 (s, 3 H, 2-CH₃), 4.93 (s, 2 H, 6'-OCH₂C₆H₅), 4.97 (s, 2 H, 4'-OCH₂C₆H₅), 5.10 and 5.14 (2s, 4 H, 3'',4''-OCH₂C₆H₅), 6.38 (d, *J* = 15.8 Hz, 1 H, α-H), 6.40 (d, *J* = 2.1 Hz, 1 H, 3'-H), 6.48 (d, *J* = 2.1 Hz, 1 H, 5'-H), 6.86 (d, *J* = 8.3 Hz, 1 H, 5''-H), 7.03 (d, *J* = 8.3 Hz, 1 H, 6''-H), 7.12 (br. s, 1 H, 2''-H), 7.23–7.44 (m, 20 H, 2,3,4,5,6-H of 4',6',3'',4''-OCH₂C₆H₅), 7.71 (d, *J* = 15.8 Hz, 1 H, β-H) ppm. ¹³C NMR: δ = 31.8 (C-2), 70.1 (6'-OCH₂C₆H₅), 70.5 and 70.9 (3'',4''-OCH₂C₆H₅), 70.6 (4'-OCH₂C₆H₅), 98.0 (C-5'), 101.1 (C-3'), 113.3 (C-2''), 113.7 (C-5''), 114.2 (C-α), 117.6 (C-1'), 123.2 (C-6''), 126.9, 127.0 and 127.2 (C-2,6 of 4',6',3'',4''-OCH₂C₆H₅), 127.1 (C-1''), 127.4 and 127.7 (C-4 of 4',6',3'',4''-OCH₂C₆H₅), 128.0, 128.0, 128.3, and 128.4 (C-3,5 of 4',6',3'',4''-OCH₂C₆H₅), 135.6 and 135.7 (C-1 of 4',6'-OCH₂C₆H₅), 136.4 and 136.6 (C-1 of 3'',4''-OCH₂C₆H₅), 146.7 (C-β), 148.6 (C-3''), 149.3 (C-2'), 151.1

(C-4''), 157.8 (C-6'), 161.0 (C-4'), 165.1 (C=O), 199.4 (C-1) ppm. EI-MS: *m/z* (rel. int.) = 690 (1) [M⁺], 360 (1), 343 (18), 306 (2), 253 (2), 180 (8), 173 (7), 160 (8), 146 (5), 117 (2), 91 (100). C₄₅H₃₈O₇ (690.8): calcd. C 78.24, H 5.54; found C 78.26, H 5.53.

Synthesis of 5-Aryl-3-hydroxy-1-(2-hydroxyaryl)-2,4-pentadien-1-ones 2a–i: Potassium hydroxide (powder, 1.0 g, 25 mmol) was added to a solution of the appropriate 2'-cinnamoyloxyacetophenone **1a–i** (5 mmol) in dimethyl sulfoxide (30 mL). The solution was stirred under nitrogen at room temperature for 2 hours. After that period, the solution was poured into ice and water (200 mL), and the pH adjusted to 4 with dilute hydrochloric acid. The solid so obtained was removed by filtration, dissolved in dichloromethane (20 mL), and purified by silica gel column chromatography using dichloromethane as eluent. The solvent was evaporated to dryness in each case, and the residue was crystallised from ethanol to give the expected products **2a–i**.

1-(4-Benzyloxy-2-hydroxyphenyl)-3-hydroxy-5-phenyl-2,4-pentadien-1-one (2a): Yield 66.1 % (1.23 g). M.p. 168–169 °C (recrystallised from ethanol). ¹H NMR: δ = 5.09 (s, 2 H, 4'-OCH₂C₆H₅), 6.20 (s, 1 H, 2-H), 6.52 (br. s, 1 H, 3'-H), 6.54 (d, *J* = 8.3 Hz, 1 H, 5'-H), 6.57 (dd, *J* = 16.1, 0.8 Hz, 1 H, 4-H), 7.34–7.44 (m, 8 H, 3'',4'',5''-H and 2,3,4,5,6-H of 4'-OCH₂C₆H₅), 7.55 (dd, *J* = 7.6, 1.8 Hz, 2 H, 2'',6''-H), 7.62 (d, *J* = 8.3 Hz, 1 H, 6'-H), 7.61 (d, *J* = 16.1 Hz, 1 H, 5-H), 12.68 (s, 1 H, 2'-OH), 14.52 (d, *J* = 0.8 Hz, 1 H, 3-OH) ppm. ¹³C NMR: δ = 70.2 (4'-OCH₂C₆H₅), 96.8 (C-2), 102.2 (C-3'), 108.4 (C-5'), 112.9 (C-1'), 122.3 (C-4), 127.5, 127.9, 128.3, 128.7, and 128.9 (C-3'',4'',5'' and C-2,3,4,5,6 of 4'-OCH₂C₆H₅), 129.9 (C-6'), 130.1 (C-2'',6''), 135.1 (C-1''), 135.9 (C-1 of 4'-OCH₂C₆H₅), 139.0 (C-5), 164.9 (C-4'), 165.3 (C-2'), 173.1 (C-3), 194.6 (C-1) ppm. EI-MS: *m/z* (rel. int.) = 372 (56) [M⁺], 354 (3), 281 (7), 227 (27), 200 (4), 144 (4), 131 (49), 103 (15), 91 (100). C₂₄H₂₀O₄ (372.4): calcd. C 77.40, H 5.41; found C 77.35, H 5.41.

1-(6-Benzyloxy-2-hydroxyphenyl)-3-hydroxy-5-phenyl-2,4-pentadien-1-one (2b): Yield 90.9 % (1.69 g). M.p. 166–168 °C (recrystallised from ethanol). ¹H NMR: δ = 5.15 (s, 2 H, 6'-OCH₂C₆H₅), 6.16 (dd, *J* = 16.0, 1.2 Hz, 1 H, 4-H), 6.49 (dd, *J* = 8.3, 1.0 Hz, 1 H, 3'-H), 6.62 (dd, *J* = 8.3, 1.0 Hz, 1 H, 5'-H), 6.86 (s, 1 H, 2-H), 7.32 (t, *J* = 8.3 Hz, 1 H, 4'-H), 7.48 (d, *J* = 16.0 Hz, 1 H, 5-H), 7.37–7.54 (m, 10 H, 2'',3'',4'',5'',6''-H and 2,3,4,5,6-H of 2'-OCH₂C₆H₅), 12.89 (s, 1 H, 2'-OH), 14.63 (d, *J* = 1.2 Hz, 1 H, 3-OH) ppm. ¹³C NMR: δ = 71.2 (6'-OCH₂C₆H₅), 102.2 (C-2), 102.8 (C-3'), 110.6 (C-1'), 111.4 (C-5'), 122.8 (C-4), 127.8 (C-2'',6''), 128.1 (C-2,6 of 6'-OCH₂C₆H₅), 128.4 (C-4 of 6'-OCH₂C₆H₅), 128.7 (C-3'',5''), 128.8 (C-3,5 of 6'-OCH₂C₆H₅), 131.8 (C-4'), 135.0 (C-1''), 135.2 (C-4'), 136.0 (C-1 of 6'-OCH₂C₆H₅), 138.8 (C-5), 159.5 (C-6'), 164.4 (C-2'), 174.1 (C-3), 195.0 (C-1) ppm. EI-MS: *m/z* (rel. int.) = 372 (14) [M⁺], 354 (22), 281 (18), 226 (15), 223 (10), 194 (10), 137 (15), 131 (63), 103 (24), 91 (100). C₂₄H₂₀O₄ (372.4): calcd. C 77.40, H 5.41; found C 77.11, H 5.44.

1-(4,6-Dibenzyloxy-2-hydroxyphenyl)-3-hydroxy-5-phenyl-2,4-pentadien-1-one (2c): Yield 81.2 % (1.94 g). M.p. 134–136 °C (recrystallised from ethanol). ¹H NMR: δ = 5.08 and 5.09 (2s, 4 H, 4',6'-OCH₂C₆H₅), 6.13 (dd, *J* = 15.8, 1.1 Hz, 1 H, 4-H), 6.14 (d, *J* = 2.5 Hz, 1 H, 5'-H), 6.20 (d, *J* = 2.5 Hz, 1 H, 3'-H), 6.82 (s, 1 H, 2-H), 7.44 (d, *J* = 15.8 Hz, 1 H, 5-H), 7.37–7.51 (m, 15 H, 2'',3'',4'',5'',6''-H and 2,3,4,5,6-H of 4',6'-OCH₂C₆H₅), 13.69 (s, 1 H, 2'-OH), 14.46 (d, *J* = 1.1 Hz, 1 H, 3-OH) ppm. ¹³C NMR: δ = 70.2 and 71.2 (4',6'-OCH₂C₆H₅), 92.9 (C-5'), 95.2 (C-3'), 103.4 (C-2), 104.9 (C-1'), 123.1 (C-4), 127.7 and 127.7 (C-2,6 of 4',6'-OCH₂C₆H₅), 128.2 (C-2'',6''), 128.4 and 128.5 (C-4'' and C-4 of

6'-OCH₂C₆H₅), 128.7, 128.8 and 128.9 (C-3'',5'' and C-3,5 of 4',6'-OCH₂C₆H₅), 129.6 (C-4 of 4'-OCH₂C₆H₅), 135.3 (C-1''), 135.8 and 135.9 (C-1 of 4',6'-OCH₂C₆H₅), 137.9 (C-5), 161.0 (C-6'), 164.6 (C-4'), 167.3 (C-2'), 172.9 (C-3), 193.8 (C-1) ppm. EI-MS: *m/z* (rel. int.) = 478 (9) [M⁺], 461 (9), 460 (14), 387 (11), 371 (7), 345 (1), 333 (5), 329 (6), 306 (6), 243 (8), 131 (35), 103 (13), 91 (100). C₃₁H₂₆O₅ (478.5): calcd. C 77.81, H 5.48; found C 77.51, H 5.36.

1-(4-Benzyloxy-2-hydroxyphenyl)-5-(4-benzyloxyphenyl)-3-hydroxy-2,4-pentadien-1-one (2d): Yield 64.0 % (1.53 g). M.p. 171–172 °C (recrystallised from ethanol). ¹H NMR: δ = 5.08 and 5.10 (2s, 4 H, 4',4''-OCH₂C₆H₅), 6.15 (s, 1 H, 2-H), 6.44 (d, *J* = 15.8 Hz, 1 H, 4-H), 6.51 (d, *J* = 2.3 Hz, 1 H, 3'-H), 6.53 (dd, *J* = 7.4, 2.3 Hz, 1 H, 5'-H), 6.99 (d, *J* = 8.7 Hz, 1 H, 3'',5''-H), 7.26–7.45 (m, 10 H, 2,3,4,5,6-H of 4',4''-OCH₂C₆H₅), 7.49 (d, *J* = 8.7 Hz, 2 H, 2'',6''-H), 7.57 (d, *J* = 15.8 Hz, 1 H, 5-H), 7.61 (d, *J* = 7.4 Hz, 1 H, 6'-H), 12.73 (s, 1 H, 2'-OH), 14.60 (s, 1 H, 3-OH) ppm. ¹³C NMR: δ = 70.0 and 70.1 (4' and 4''-OCH₂C₆H₅), 96.2 (C-2), 102.2 (C-3'), 108.2 (C-5'), 112.9 (C-1'), 115.2 (C-3'',5''), 119.9 (C-4), 127.4 and 127.5 (C-2,6 of 4',4''-OCH₂C₆H₅), 128.1 and 128.2 (C-4 of 4',4''-OCH₂C₆H₅), 128.6 (C-3,5 of 4',4''-OCH₂C₆H₅), 129.5 (C-2'',6''), 130.0 (C-6'), 130.4 (C-1''), 135.9 and 136.4 (C-1 of 4',4''-OCH₂C₆H₅), 138.8 (C-5), 160.2 (C-4''), 164.7 (C-4'), 165.1 (C-2'), 173.7 (C-3), 194.3 (C-1) ppm. EI-MS: *m/z* (rel. int.) = 478 (6) [M⁺], 460 (6), 251 (7), 237 (11), 227 (24), 197 (2), 147 (4), 91 (100). C₃₁H₂₆O₅ (478.5): calcd. C 77.81, H 5.48; found C 77.51, H 5.72.

1-(6-Benzyloxy-2-hydroxyphenyl)-5-(4-benzyloxyphenyl)-3-hydroxy-2,4-pentadien-1-one (2e): Yield 95.0 % (2.27 g). M.p. 127–128 °C (recrystallised from ethanol). ¹H NMR: δ = 5.11 and 5.15 (2s, 4 H, 6',4''-OCH₂C₆H₅), 6.05 (d, *J* = 15.7 Hz, 1 H, 4-H), 6.49 (d, *J* = 8.2 Hz, 1 H, 3'-H), 6.61 (d, *J* = 8.2 Hz, 1 H, 5'-H), 6.83 (s, 1 H, 2-H), 6.99 (d, *J* = 8.7 Hz, 2 H, 3'',5''-H), 7.31 (t, *J* = 8.2 Hz, 1 H, 4'-H), 7.35–7.53 (m, 12 H, 2'',6''-H and 2,3,4,5,6-H of 6',4''-OCH₂C₆H₅), 7.46 (d, *J* = 15.7 Hz, 1 H, 5-H), 12.91 (s, 1 H, 2'-OH), 14.76 (d, *J* = 0.6 Hz, 1 H, 3-OH) ppm. ¹³C NMR: δ = 70.0 and 71.2 (6',4''-OCH₂C₆H₅), 102.8 (C-3'), 103.5 (C-2), 110.6 (C-1'), 111.4 (C-5'), 115.2 (C-3'',5''), 120.5 (C-4), 127.4 and 128.0 (C-2,6 of 6',4''-OCH₂C₆H₅), 128.1 and 128.3 (C-4 of 6',4''-OCH₂C₆H₅), 128.6 and 128.7 (C-3,5 of 6',4''-OCH₂C₆H₅), 129.5 (C-2'',6''), 130.2 (C-1''), 135.0 (C-4'), 136.1 and 136.4 (C-1 of 6',4''-OCH₂C₆H₅), 138.6 (C-5), 159.4 (C-4''), 160.2 (C-6'), 164.3 (C-2'), 174.8 (C-3), 194.5 (C-1) ppm. EI-MS: *m/z* (rel. int.) = 478 (3) [M⁺], 460 (6), 387 (7), 371 (3), 300 (3), 237 (26), 226 (8), 197 (2), 147 (3), 137 (8), 91 (100). C₃₁H₂₆O₅ (478.5): calcd. C 77.81, H 5.48; found C 77.79, H 5.52.

1-(4,6-Dibenzyloxy-2-hydroxyphenyl)-5-(4-benzyloxyphenyl)-3-hydroxy-2,4-pentadien-1-one (2f): Yield 79.1 % (2.31 g). M.p. 178–180 °C (recrystallised from ethanol). ¹H NMR: δ = 5.08, 5.09, and 5.12 (3s, 6 H, 4',6',4''-OCH₂C₆H₅), 6.01 (d, *J* = 16.5 Hz, 1 H, 4-H), 6.14 (d, *J* = 2.4 Hz, 1 H, 5'-H), 6.20 (d, *J* = 2.4 Hz, 1 H, 3'-H), 6.79 (s, 1 H, 2-H), 6.98 (d, *J* = 8.7 Hz, 2 H, 3'',5''-H), 7.26–7.54 (m, 17 H, 2'',6''-H and 2,3,4,5,6-H of 4',6',4''-OCH₂C₆H₅), 7.43 (d, *J* = 16.5 Hz, 1 H, 5-H), 13.72 (s, 1 H, 2'-OH), 14.57 (d, *J* = 1.2 Hz, 1 H, 3-OH) ppm. ¹³C NMR: δ = 70.1, 70.2, and 71.2 (4',6',4''-OCH₂C₆H₅), 92.9 (C-5'), 95.2 (C-3'), 102.8 (C-2), 105.2 (C-1'), 115.2 (C-3'',5''), 120.9 (C-4), 127.5 (C-2,6 of 4',6',4''-OCH₂C₆H₅), 127.7 (C-4 of 4',6',4''-OCH₂C₆H₅), 128.7 (C-2'',6''), 129.3 (C-3,5 of 4',6',4''-OCH₂C₆H₅), 135.9 (C-1'' and C-1 of 4',6',4''-OCH₂C₆H₅), 137.8 (C-5), 160.1 (C-4''), 160.9 (C-6'), 160.5 (C-4'), 167.2 (C-2'), 173.6 (C-3), 193.5 (C-1) ppm. EI-MS: *m/z* (rel. int.) = 584 (1) [M⁺], 566 (2), 493 (1), 476 (3), 333

(1), 306 (3), 268 (1), 252 (1), 243 (1), 237 (5), 215 (1), 181 (2), 147 (4), 133 (2), 121 (3), 107 (1), 105 (2), 91 (100). C₃₈H₃₂O₆ (584.7): calcd. C 78.06, H 5.52; found C 78.02, H 5.53.

1-(4-Benzyloxy-2-hydroxyphenyl)-5-(3,4-dibenzyloxyphenyl)-3-hydroxy-2,4-pentadien-1-one (2g): Yield 83.9 % (2.45 g). M.p. 142–143 °C (recrystallised from ethanol). ¹H NMR: δ = 5.07 (s, 2 H, 4'-OCH₂C₆H₅), 5.19 (s, 4 H, 3'',4''-OCH₂C₆H₅), 6.14 (s, 1 H, 2-H), 6.36 (d, *J* = 15.7 Hz, 1 H, 4-H), 6.51 (d, *J* = 2.4 Hz, 1 H, 3'-H), 6.52 (d, *J* = 6.9, 2.4 Hz, 1 H, 5'-H), 6.92 (d, *J* = 8.3 Hz, 1 H, 5''-H), 7.08 (dd, *J* = 8.3, 1.7 Hz, 1 H, 6''-H), 7.13 (d, *J* = 1.7 Hz, 1 H, 2''-H), 7.25–7.52 (m, 15 H, 2,3,4,5,6-H of 4',3'',4''-OCH₂C₆H₅), 7.49 (d, *J* = 15.7 Hz, 1 H, 5-H), 7.59 (d, *J* = 6.9 Hz, 1 H, 6'-H), 12.71 (s, 1 H, 2'-OH), 14.57 (s, 1 H, 3-OH) ppm. ¹³C NMR: δ = 70.1 (4'-OCH₂C₆H₅), 70.9 and 71.3 (3'',4''-OCH₂C₆H₅), 96.3 (C-2), 102.2 (C-3'), 108.3 (C-5'), 112.9 (C-1'), 113.6 (C-2''), 114.3 (C-5''), 120.3 (C-4), 122.6 (C-6''), 127.1, 127.3, 127.5, 127.9, 128.2, 128.5 and 128.7 (C-2,3,4,5,6 of 4',3'',4''-OCH₂C₆H₅), 128.3 (C-1''), 130.0 (C-6'), 135.9 (C-1 of 4'-OCH₂C₆H₅), 136.7 and 136.9 (C-1 of 3'',4''-OCH₂C₆H₅), 138.9 (C-5), 149.0 (C-3''), 150.8 (C-4''), 164.8 (C-4'), 165.2 (C-2'), 173.6 (C-3), 194.3 (C-1) ppm. EI-MS: *m/z* (rel. int.) = 584 (3) [M⁺], 566 (3), 475 (4), 317 (2), 227 (9), 181 (2), 91 (100). C₃₈H₃₂O₆ (584.7): calcd. C 78.06, H 5.52; found C 78.00, H 5.49.

1-(6-Benzyloxy-2-hydroxyphenyl)-5-(3,4-dibenzyloxyphenyl)-3-hydroxy-2,4-pentadien-1-one (2h): Yield 81.2 % (2.37 g). M.p. 152–154 °C (recrystallised from ethanol). ¹H NMR: δ = 5.15, 5.17, and 5.20 (3s, 6 H, 6',3'',4''-OCH₂C₆H₅), 6.02 (d, *J* = 15.7 Hz, 1 H, 4-H), 6.49 (d, *J* = 8.1 Hz, 1 H, 3'-H), 6.61 (dd, *J* = 8.3, 0.7 Hz, 1 H, 5'-H), 6.84 (s, 1 H, 2-H), 6.92 (d, *J* = 8.4 Hz, 1 H, 6''-H), 7.00 (dd, *J* = 8.4, 1.8 Hz, 1 H, 5''-H), 7.05 (d, *J* = 1.8 Hz, 1 H, 2''-H), 7.28–7.53 (m, 16 H, 4'-H and 2,3,4,5,6-H of 6',3'',4''-OCH₂C₆H₅), 7.41 (d, *J* = 15.7 Hz, 1 H, 5-H), 12.92 (s, 1 H, 2'-OH), 14.77 (s, 1 H, 3-OH) ppm. ¹³C NMR: δ = 71.0, 71.2, and 71.5 (6',3'',4''-OCH₂C₆H₅), 102.8 (C-3'), 103.6 (C-2), 110.7 (C-1'), 111.4 (C-5'), 113.8 (C-2''), 114.3 (C-5''), 120.8 (C-4), 122.8 (C-6''), 127.2, 127.4, 128.0, 128.3, 128.6 and 128.7 (C-2,3,4,5,6 of 6',3'',4''-OCH₂C₆H₅), 135.0 (C-4'), 136.2, 136.7, and 136.9 (C-1'' and C-1 of 6',3'',4''-OCH₂C₆H₅), 138.8 (C-5), 149.0 (C-3''), 150.9 (C-4''), 159.4 (C-6'), 164.3 (C-2'), 174.7 (C-3), 194.6 (C-1) ppm. EI-MS: *m/z* (rel. int.) = 584 (3) [M⁺], 566 (2), 493 (3), 476 (4), 385 (3), 343 (4), 227 (6), 181 (6), 137 (8), 108 (1), 91 (100). C₃₈H₃₂O₆ (584.7): calcd. C 78.06, H 5.52; found C 78.04, H 5.50.

1-(4,6-Dibenzyloxy-2-hydroxyphenyl)-5-(3,4-dibenzyloxyphenyl)-3-hydroxy-2,4-pentadien-1-one (2i): Yield 64.9 % (2.24 g). M.p. 175–176 °C (recrystallised from ethanol). ¹H NMR: δ = 5.07 (s, 2 H, 6'-OCH₂C₆H₅), 5.09 (s, 2 H, 4'-OCH₂C₆H₅), 5.17 (s, 2 H, 3''-OCH₂C₆H₅), 5.21 (s, 2 H, 4''-OCH₂C₆H₅), 5.99 (d, *J* = 15.7 Hz, 1 H, 4-H), 6.13 (d, *J* = 2.3 Hz, 1 H, 5'-H), 6.20 (d, *J* = 2.3 Hz, 1 H, 3'-H), 6.80 (s, 1 H, 2-H), 6.92 (d, *J* = 8.3 Hz, 1 H, 5''-H), 6.99 (dd, *J* = 8.3, 1.8 Hz, 1 H, 6''-H), 7.04 (d, *J* = 1.8 Hz, 1 H, 2''-H), 7.35 (d, *J* = 15.7 Hz, 1 H, 5-H), 7.26–7.53 (m, 20 H, 2,3,4,5,6-H of 4',6',3'',4''-OCH₂C₆H₅), 13.73 (s, 1 H, 2'-OH), 14.59 (d, *J* = 0.8 Hz, 1 H, 3-OH) ppm. ¹³C NMR: δ = 70.2 (6'-OCH₂C₆H₅), 71.0 (4''-OCH₂C₆H₅), 71.1 (4'-OCH₂C₆H₅), 71.5 (3''-OCH₂C₆H₅), 92.9 (C-5'), 95.2 (C-3'), 102.9 (C-2), 104.9 (C-1'), 113.7 (C-2''), 114.3 (C-5''), 121.1 (C-4), 122.6 (C-6''), 127.2, 127.4, 127.7, and 128.1 (C-1'' and C-2,6 of 4',6',3'',4''-OCH₂C₆H₅), 127.9, 128.0, and 128.3 (C-4 of 4',6',3'',4''-OCH₂C₆H₅), 128.6, 128.7, 128.7, and 128.9 (C-3,5 of 4',6',3'',4''-OCH₂C₆H₅), 135.9 and 136.9 (C-1 of 4',6',3'',4''-OCH₂C₆H₅), 137.9 (C-5), 149.0 (C-3''), 150.6 (C-4''), 160.9 (C-6'), 164.5 (C-4'), 167.2 (C-2'), 173.5 (C-3), 193.5 (C-1) ppm. EI-MS: *m/z* (rel. int.) = 690 (1) [M⁺], 672 (1), 582 (1), 491

(2), 358 (3), 306 (7), 267 (3), 243 (1), 215 (2), 181 (8), 91 (100). $C_{45}H_{38}O_7$ (690.8): calcd. C 78.24, H 5.54; found C 78.16, H 5.54.

Synthesis of Benzyloxy-2-styrylchromones 3a–i. Method 1: A catalytic amount of iodine (254 mg, 1 mmol) was added to a solution of the appropriate 5-aryl-3-hydroxy-1-(2-hydroxyaryl)-2,4-pentadien-1-one **2a–i** (5 mmol) in dimethyl sulfoxide (30 mL). The solution was heated under nitrogen at 90 °C, until the complete consumption of the starting material was observed. After that period, the solution was poured into ice and a saturated aqueous solution of sodium thiosulfate (100 mL). The solid was removed by filtration, dissolved in dichloromethane (50 mL) and washed with a saturated aqueous solution of sodium thiosulfate (2×20 mL). After evaporation of the solvent, the residue was purified by silica gel column chromatography using a mixture of light petroleum:dichloromethane (1:1) as eluent. The solvent was evaporated to dryness in each case, and the residue was crystallised from ethanol to give benzyloxy-2-styrylchromones **3a–i** in the following yields: **3a** (74.0 %, 1.31 g), **4b** (9.0 %, 218 mg), **3c** (37.0 %, 851 mg) and **4c** (4.0 %, 118 mg), **3d** (9.0 %, 207 mg) and **4d** (9.0 %, 313 mg), **3e** (4 %, 92 mg) and **4e** (3.0 %, 105 mg), **3f** (56.9 %, 1.61 g) and **4f** (5.0 %, 201 mg), **3g** (62.9 %, 1.78 g), **3h** (47.0 %, 1.33 g), **3i** (50.9 %, 1.71 g).

Method 2: *p*-Toluenesulfonic acid monohydrate (0.48 g, 2.5 mmol) was added to a solution of the appropriate 5-aryl-3-hydroxy-1-(2-hydroxyaryl)-2,4-pentadien-1-one **2a–i** (5 mmol) in dimethyl sulfoxide (30 mL). The solution was heated under nitrogen at 90 °C, until the complete consumption of the starting material was observed. After that period, the solution was poured into ice and water (100 mL), and the solid so-obtained was removed by filtration. The solid was dissolved in dichloromethane (50 mL) and the organic phase washed with water (2×100 mL). After evaporation of the solvent, the residue was purified by silica gel column chromatography using a mixture of light petroleum:dichloromethane (1:1) as eluent. The solvent was evaporated to dryness in each case, and the residue was crystallised from ethanol to give the benzyloxy-2-styrylchromones **3a–i** in the following yields: **3a** (19.0 %, 336 mg) and **4a** (22.0 %, 532 mg), **3b** (93.2 %, 1.65 g), **3c** (19.0 %, 437 mg) and **4c** (48.8 %, 1.44 g), **3d** (96.1 %, 2.21 g), **3e** (95.2 %, 2.19 g), **3f** (82.0 %, 2.32 g), **3g** (96.1 %, 2.72 g), **3h** (84.1 %, 2.38 g), **3i** (83.9 %, 2.82 g).

7-Benzyloxy-2-styrylchromone (3a): M.p. 161–163 °C (recrystallised from ethanol). 1H NMR: δ = 5.16 (s, 2 H, 7-OCH₂C₆H₅), 6.24 (s, 1 H, 3-H), 6.72 (d, J = 16.2 Hz, 1 H, α -H), 6.99 (br. s, 1 H, 8-H), 7.02 (dd, J = 8.8, 2.3 Hz, 1 H, 6-H), 7.34–7.57 (m, 10 H, 2',3',4',5',6'-H and 2,3,4,5,6-H of 7-OCH₂C₆H₅), 7.53 (d, J = 16.2 Hz, 1 H, β -H), 8.08 (d, J = 8.8 Hz, 1 H, 5-H) ppm. ^{13}C NMR: δ = 70.4 (7-OCH₂C₆H₅), 101.2 (C-8), 110.6 (C-3), 114.5 (C-6), 118.1 (C-10), 120.2 (C- α), 127.0 (C-5), 127.4 (C-2,6 of 7-OCH₂C₆H₅), 127.5 (C-2',6'), 128.3 (C-4 of 7-OCH₂C₆H₅), 128.7 (C-3,5 of 7-OCH₂C₆H₅), 128.9 (C-3',5'), 129.7 (C-4'), 134.9 (C-1'), 135.7 (C-1 of 7-OCH₂C₆H₅), 136.2 (C- β), 157.5 (C-9), 161.2 (C-2), 163.1 (C-7), 177.7 (C-4) ppm. EI-MS: m/z (rel. int.) = 354 (69) [M^+], 263 (8), 235 (13), 178 (8), 128 (10), 103 (6), 91 (100). $C_{24}H_{18}O_3$ (354.4): calcd. C 81.34, H 5.12; found C 81.23, H 5.08.

5-Benzyloxy-2-styrylchromone (3b): M.p. 179–181 °C (recrystallised from ethanol). 1H NMR: δ = 5.28 (s, 2 H, 5-OCH₂C₆H₅), 6.24 (s, 1 H, 3-H), 6.74 (d, J = 16.0 Hz, 1 H, α -H), 6.83 (d, J = 8.3 Hz, 1 H, 6-H), 7.11 (d, J = 8.3 Hz, 1 H, 8-H), 7.29 (t, J = 7.3 Hz, 1 H, 4-H of 5-OCH₂C₆H₅), 7.37–7.44 (m, 5 H, 3',4',5'-H and 3,5-H of 5-OCH₂C₆H₅), 7.51 (t, J = 8.3 Hz, 1 H, 7-H), 7.54 (d, J = 16.0 Hz, 1 H, β -H), 7.57 (dd, J = 7.7, 1.4 Hz, 2 H, 2',6'-

H), 7.63 (d, J = 7.3 Hz, 2 H, 2,6-H of 5-OCH₂C₆H₅) ppm. ^{13}C NMR: δ = 70.8 (5-OCH₂C₆H₅), 108.3 (C-6), 110.3 (C-8), 112.3 (C-3), 115.2 (C-10), 119.9 (C- α), 126.6 (C-2,6 of 5-OCH₂C₆H₅), 127.5 (C-2',6'), 127.6 (C-4 of 5-OCH₂C₆H₅), 128.5 (C-3,5 of 5-OCH₂C₆H₅), 128.9 (C-3',5'), 129.6 (C-4'), 133.6 (C-7), 135.0 (C-1'), 136.2 (C- β), 136.6 (C-1 of 5-OCH₂C₆H₅), 158.0 (C-9), 158.5 (C-5), 159.5 (C-2), 178.1 (C-4) ppm. EI-MS: m/z (rel. int.) = 354 (91) [M^+], 353 (17), 277 (14), 264 (11), 248 (55), 247 (49), 231 (21), 218 (24), 91 (100). $C_{24}H_{18}O_3$ (354.4): calcd. C 81.34, H 5.12; found C 81.54, H 5.02.

5,7-Dibenzyloxy-2-styrylchromone (3c): M.p. 161–163 °C (recrystallised from ethanol). 1H NMR: δ = 5.07 (s, 2 H, 7-OCH₂C₆H₅), 5.14 (s, 2 H, 5-OCH₂C₆H₅), 6.13 (s, 1 H, 3-H), 6.42 (d, J = 2.2 Hz, 1 H, 6-H), 6.58 (d, J = 2.2 Hz, 1 H, 8-H), 6.63 (d, J = 16.0 Hz, 1 H, α -H), 7.24–7.44 (m, 9 H, 3',4',5'-H and 3,4,5-H of 5,7-OCH₂C₆H₅), 7.43 (d, J = 16.0 Hz, 1 H, β -H), 7.50 (dd, J = 7.2, 1.7 Hz, 4 H, 2',6'-H and 2,6-H of 7-OCH₂C₆H₅), 7.60 (d, J = 7.4 Hz, 2 H, 2,6-H of 5-OCH₂C₆H₅) ppm. ^{13}C NMR: δ = 70.3 (7-OCH₂C₆H₅), 70.4 (5-OCH₂C₆H₅), 93.9 (C-8), 97.9 (C-6), 109.8 (C-10), 112.2 (C-3), 119.8 (C- α), 126.4 (C-2,6 of 5-OCH₂C₆H₅), 127.4 (C-4 of 5-OCH₂C₆H₅), 127.4 and 127.5 (C-2',6' and C-2,6 of 7-OCH₂C₆H₅), 128.3 (C-4 of 7-OCH₂C₆H₅), 128.4, 128.6, and 128.8 (C-3',5' and C-3,5 of 5,7-OCH₂C₆H₅), 129.4 (C-4'), 135.0 (C-1'), 135.5 (C- β), 135.6 (C-1 of 7-OCH₂C₆H₅), 136.2 (C-1 of 5-OCH₂C₆H₅), 158.9 (C-2), 159.3 (C-9), 159.5 (C-5), 162.8 (C-7), 177.2 (C-4) ppm. EI-MS: m/z (rel. int.) = 460 (8) [M^+], 383 (4), 370 (18), 354 (12), 341 (9), 263 (3), 235 (2), 155 (1), 131 (4), 128 (4), 123 (3), 115 (3), 91 (100). $C_{31}H_{24}O_4$ (460.5): calcd. C 80.85, H 5.25; found C 80.48, H 5.19.

7,4'-Dibenzyloxy-2-styrylchromone (3d): M.p. 148–150 °C (recrystallised from ethanol). 1H NMR: δ = 5.10 (s, 2 H, 4'-OCH₂C₆H₅), 5.18 (s, 2 H, 7-OCH₂C₆H₅), 6.22 (s, 1 H, 3-H), 6.61 (d, J = 16.0 Hz, 1 H, α -H), 6.99–7.03 (m, 4 H, 6,8,3',5'-H), 7.25–7.45 (m, 10 H, 2,3,4,5,6-H of 7,4'-OCH₂C₆H₅), 7.51 (d, J = 8.7 Hz, 2 H, 2',6'-H), 7.50 (d, J = 16.0 Hz, 1 H, β -H), 8.10 (d, J = 8.5 Hz, 1 H, 5-H) ppm. ^{13}C NMR: δ = 70.1 (4'-OCH₂C₆H₅), 70.5 (7-OCH₂C₆H₅), 101.3 (C-8), 110.0 (C-3), 114.5 (C-3',5'), 115.3 (C-6), 118.0 (C- α), 118.2 (C-10), 127.1 (C-1'), 127.5 (C-5), 127.5 and 128.1 (C-2,6 of 7,4'-OCH₂C₆H₅), 128.2 and 128.4 (C-4 of 7,4'-OCH₂C₆H₅), 128.7 and 128.8 (C-3,5, of 7,4'-OCH₂C₆H₅), 129.2 (C-2',6'), 135.8 (C-1 of 7-OCH₂C₆H₅), 136.0 (C- β), 136.4 (C-1 of 4'-OCH₂C₆H₅), 157.6 (C-9), 160.1 (C-4'), 161.8 (C-2), 163.1 (C-7), 177.9 (C-4) ppm. EI-MS: m/z (rel. int.) = 460 (28) [M^+], 443 (1), 370 (7), 354 (4), 341 (2), 263 (2), 165 (2), 115 (2), 107 (1), 91 (100). $C_{31}H_{24}O_4$ (460.5): calcd. C 80.85, H 5.25; found C 80.69, H 5.16.

5,4'-Dibenzyloxy-2-styrylchromone (3e): M.p. 154–156 °C (recrystallised from ethanol). 1H NMR: δ = 5.09 (s, 2 H, 5-OCH₂C₆H₅), 5.26 (s, 2 H, 4'-OCH₂C₆H₅), 6.19 (s, 1 H, 3-H), 6.58 (d, J = 15.8 Hz, 1 H, α -H), 6.81 (d, J = 8.5 Hz, 1 H, 6-H), 6.99 (d, J = 8.7 Hz, 2 H, 3',5'-H), 7.08 (d, J = 8.5 Hz, 1 H, 8-H), 7.27–7.42 (m, 10 H, 2',6'-H, 3,4,5-H of 5-OCH₂C₆H₅ and 2,3,4,5,6-H of 4'-OCH₂C₆H₅), 7.47 (d, J = 15.8 Hz, 1 H, β -H), 7.48 (t, J = 8.5 Hz, 1 H, 7-H), 7.63 (d, J = 7.4 Hz, 2 H, 2,6-H of 5-OCH₂C₆H₅) ppm. ^{13}C NMR: δ = 70.0 (5-OCH₂C₆H₅), 70.7 (4'-OCH₂C₆H₅), 108.2 (C-6), 110.2 (C-8), 111.6 (C-3), 115.2 (C-10,3',5'), 117.6 (C- α), 126.5 (C-2,6 of 5-OCH₂C₆H₅), 127.4 (C-2,6 of 4'-OCH₂C₆H₅), 127.5 and 128.1 (C-4 of 5,4'-OCH₂C₆H₅), 128.0 (C-1'), 128.5 and 128.6 (C-3,5, of 5,4'-OCH₂C₆H₅), 129.1 (C-2',6'), 133.4 (C-7), 135.8 (C- β), 136.4 and 136.6 (C-1 of 5, 4'-OCH₂C₆H₅), 158.0 (C-9), 158.4 (C-4'), 159.9 (C-2), 160.0 (C-5), 178.1 (C-4) ppm. EI-MS: m/z (rel. int.) = 460 (33) [M^+], 370 (8), 354 (5), 263 (2), 115 (1),

91 (100). $C_{31}H_{24}O_4$ (460.5): calcd. C 80.85, H 5.25; found C 80.53, H 4.89.

5,7,4'-Tribenzyloxy-2-styrylchromone (3f): M.p. 170–172 °C (recrystallised from ethanol). 1H NMR: δ = 5.12 (s, 2 H, 4'- $OCH_2C_6H_5$), 5.13 (s, 2 H, 7- $OCH_2C_6H_5$), 5.22 (s, 2 H, 5- $OCH_2C_6H_5$), 6.15 (s, 1 H, 3-H), 6.49 (d, J = 2.2 Hz, 1 H, 6-H), 6.59 (d, J = 15.8 Hz, 1 H, α -H), 6.64 (d, J = 2.2 Hz, 1 H, 8-H), 7.01 (d, J = 8.7 Hz, 2 H, 3',5'-H), 7.30–7.48 (m, 15 H, 5,7,4'- $OCH_2C_6H_5$), 7.43 (d, J = 15.8 Hz, 1 H, β -H), 7.51 (d, J = 8.7 Hz, 2 H, 2',6'-H), 7.62 (d, J = 7.4 Hz, 2 H, 2,6-H of 5- $OCH_2C_6H_5$) ppm. ^{13}C NMR: δ = 70.1 (4'- $OCH_2C_6H_5$), 70.4 (7- $OCH_2C_6H_5$), 70.6 (5- $OCH_2C_6H_5$), 94.1 (C-8), 98.1 (C-6), 110.0 (C-10), 111.7 (C-3), 115.2 (C-3',5'), 117.7 (C- α), 126.5 (C-2,6 of 5- $OCH_2C_6H_5$), 127.5 and 127.6 (C-2,6 of 7,4'- $OCH_2C_6H_5$), 127.6 (C-4 of 5- $OCH_2C_6H_5$), 128.1 and 128.4 (C-4 of 7,4'- $OCH_2C_6H_5$), 128.2 (C-1'), 128.6, 128.7, and 128.8 (C-3,5 of 5,7,4'- $OCH_2C_6H_5$), 129.0 (C-2',6'), 135.2 (C- β), 135.7, 136.4, and 136.5 (C-1 of 5,7,4'- $OCH_2C_6H_5$), 159.5 (C-2,9), 159.6 (C-5), 160.0 (C-4'), 162.8 (C-7), 177.4 (C-4) ppm. EI-MS: m/z (rel. int.) = 566 (3) [M^+], 476 (7), 386 (1), 147 (5), 133 (3), 121 (4), 107 (4), 105 (3), 91 (100). $C_{38}H_{30}O_5$ (566.7): calcd. C 80.55, H 5.34; found C 80.49, H 5.10.

7,3',4'-Tribenzyloxy-2-styrylchromone (3g): M.p. 161–163 °C (recrystallised from ethanol). 1H NMR: δ = 5.19 (s, 2 H, 7- $OCH_2C_6H_5$), 5.22 (s, 2 H, 3'- $OCH_2C_6H_5$), 5.23 (s, 2 H, 4'- $OCH_2C_6H_5$), 6.22 (s, 1 H, 3-H), 6.54 (d, J = 15.9 Hz, 1 H, α -H), 6.95 (d, J = 8.3 Hz, 1 H, 5'-H), 7.00–7.02 (m, 1 H, 6-H), 7.05 (d, J = 2.3 Hz, 1 H, 8-H), 7.10 (dd, J = 8.3, 1.9 Hz, 1 H, 6'-H), 7.17 (d, J = 1.9 Hz, 1 H, 2'-H), 7.32–7.50 (m, 15 H, 2,3,4,5,6-H of 7,3',4'- $OCH_2C_6H_5$), 7.43 (d, J = 15.9 Hz, 1 H, β -H), 8.11 (d, J = 8.7 Hz, 1 H, 5-H) ppm. ^{13}C NMR: δ = 70.5 (7- $OCH_2C_6H_5$), 71.0 (3'- $OCH_2C_6H_5$), 71.4 (4'- $OCH_2C_6H_5$), 101.3 (C-8), 110.1 (C-3), 113.3 (C-2'), 114.4 (C-5'), 114.5 (C-6), 118.2 (C-10), 118.3 (C- α), 122.3 (C-6'), 127.2, 127.3, and 127.5 (C-2,6 of 7,3',4'- $OCH_2C_6H_5$), 127.5 (C-5), 128.0 and 128.4 (C-1' and C-4 of 7,3',4'- $OCH_2C_6H_5$), 128.6 and 128.8 (C-3,5 of 7,3',4'- $OCH_2C_6H_5$), 135.8, 136.7, and 136.9 (C-1 of 7,3',4'- $OCH_2C_6H_5$), 136.1 (C- β), 149.1 (C-3'), 150.6 (C-4'), 157.6 (C-9), 161.7 (C-2), 163.2 (C-7), 177.8 (C-4) ppm. EI-MS: m/z (rel. int.) = 566 (9) [M^+], 475 (11), 131 (3), 118 (2), 106 (15), 91 (100). $C_{38}H_{30}O_5$ (566.6): calcd. C 80.55, H 5.34; found C 80.24, H 5.50.

5,3',4'-Tribenzyloxy-2-styrylchromone (3h): M.p. 172–173 °C (recrystallised from ethanol). 1H NMR: δ = 5.21 and 5.22 (2s, 4 H, 3',4'- $OCH_2C_6H_5$), 5.28 (s, 2 H, 5- $OCH_2C_6H_5$), 6.19 (s, 1 H, 3-H), 6.52 (d, J = 15.9 Hz, 1 H, α -H), 6.83 (d, J = 8.0 Hz, 1 H, 6-H), 6.94 (d, J = 8.2 Hz, 1 H, 5'-H), 7.09 (d, J = 8.0 Hz, 1 H, 8-H), 7.11 (dd, J = 8.2, 1.8 Hz, 1 H, 6'-H), 7.17 (d, J = 1.8 Hz, 1 H, 2'-H), 7.30–7.53 (m, 14 H, 7-H, 3,4,5-H of 5- $OCH_2C_6H_5$ and 2,3,4,5,6-H of 3',4'- $OCH_2C_6H_5$), 7.42 (d, J = 15.9 Hz, 1 H, β -H), 7.63 (d, J = 7.4 Hz, 2 H, 2,6-H of 5- $OCH_2C_6H_5$) ppm. ^{13}C NMR: δ = 70.8 and 71.4 (3',4'- $OCH_2C_6H_5$), 71.0 (5- $OCH_2C_6H_5$), 108.3 (C-6), 110.3 (C-8), 111.8 (C-3), 113.3 (C-2'), 114.4 (C-5'), 115.2 (C-10), 118.0 (C- α), 122.3 (C-6'), 126.6 (C-2,6 of 5- $OCH_2C_6H_5$), 127.2 and 127.3 (C-2,6 of 3',4'- $OCH_2C_6H_5$), 127.6 and 128.0 (C-4 of 5,3',4'- $OCH_2C_6H_5$), 128.4 and 128.7 (C-3,5 of 5,3',4'- $OCH_2C_6H_5$), 128.6 (C-1'), 133.5 (C-7), 136.0 (C- β), 136.6, 136.8, and 136.9 (C-1 of 5,3',4'- $OCH_2C_6H_5$), 149.1 (C-3'), 150.6 (C-4'), 158.1 (C-9), 158.5 (C-5), 159.8 (C-2), 178.2 (C-4) ppm. EI-MS: m/z (rel. int.) = 566 (9) [M^+], 476 (9), 385 (5), 181 (3), 106 (3), 91 (100). $C_{38}H_{30}O_5$ (566.6): calcd. C 80.55, H 5.34; found C 80.47, H 5.67.

5,7,3',4'-Tetabenzyloxy-2-styrylchromone (3i): M.p. 92–94 °C (recrystallised from ethanol). 1H NMR: δ = 5.12 (s, 2 H, 7-

$OCH_2C_6H_5$), 5.21 and 5.22 (2s, 6 H, 5,3',4'- $OCH_2C_6H_5$), 6.13 (s, 1 H, 3-H), 6.48 (d, J = 2.3 Hz, 1 H, 6-H), 6.50 (d, J = 15.9 Hz, 1 H, α -H), 6.62 (d, J = 2.3 Hz, 1 H, 8-H), 6.94 (d, J = 8.4 Hz, 1 H, 5'-H), 7.10 (dd, J = 8.4, 1.9 Hz, 1 H, 6'-H), 7.16 (d, J = 1.9 Hz, 1 H, 2'-H), 7.36 (d, J = 15.9 Hz, 1 H, β -H), 7.27–7.50 (m, 13 H, 3,4,5-H of 5- $OCH_2C_6H_5$ and 7,4'- $OCH_2C_6H_5$), 7.62 (d, J = 7.2 Hz, 2 H, 2,6-H of 5- $OCH_2C_6H_5$) ppm. ^{13}C NMR: δ = 70.5, 70.7, 71.0, and 71.4 (5,7,3',4'- $OCH_2C_6H_5$), 94.1 (C-8), 98.1 (C-6), 110.0 (C-10), 111.8 (C-3), 113.3 (C-2'), 114.4 (C-5'), 118.1 (C- α), 122.1 (C-6'), 126.5 (C-2,6 of 5- $OCH_2C_6H_5$), 127.2, 127.3, and 127.6 (C-2,6 of 7,3',4'- $OCH_2C_6H_5$), 128.0 and 128.4 (C-4 of 5,7,3',4'- $OCH_2C_6H_5$), 128.6 (C-1'), 128.6, 128.8 (C-3,5 of 5,7,3',4'- $OCH_2C_6H_5$), 135.4 (C- β), 135.7 (C-1 of 7- $OCH_2C_6H_5$), 136.4, 136.8, and 136.9 (C-1 of 5,3',4'- $OCH_2C_6H_5$), 149.1 (C-3'), 150.5 (C-4'), 159.4 (C-2), 159.5 (C-9), 159.7 (C-5), 162.9 (C-7), 177.4 (C-4) ppm. EI-MS: m/z (rel. int.) = 672 (3) [M^+], 582 (5), 491 (5), 292 (12), 277 (11), 263 (10), 247 (4), 181 (4), 115 (7), 106 (3), 91 (100). $C_{45}H_{36}O_6$ (672.8): calcd. C 80.34, H 5.39; found C 80.30, H 5.66.

7-Benzyloxy-3-cinnamoyl-2-styrylchromone (4a): M.p. 82–83 °C (recrystallised from ethanol). 1H NMR: δ = 5.23 (s, 2 H, 7- $OCH_2C_6H_5$), 7.07 (br. s, 1 H, 8-H), 7.09 (dd, J = 7.6, 2.1 Hz, 1 H, 6-H), 7.17 (d, J = 15.9 Hz, 1 H, α -H), 7.26 (d, J = 15.9 Hz, 1 H, α' -H), 7.37–7.51 (m, 11 H, 3',4',5'-H, 3'',4'',5''-H and 2,3,4,5,6-H of 7- $OCH_2C_6H_5$), 7.57–7.64 (m, 4 H, 2',6'-H and 2'',6''-H), 7.67 (d, J = 15.9 Hz, 1 H, β' -H), 7.74 (d, J = 15.9 Hz, 1 H, β -H), 8.15 (d, J = 7.6 Hz, 1 H, 5-H) ppm. ^{13}C NMR: δ = 70.6 (7- $OCH_2C_6H_5$), 101.2 (C-8), 115.1 (C-6), 117.8 (C-10), 118.0 (C- α), 122.2 (C-3), 127.5 (C- α'), 128.1 (C-5), 128.4, 128.7, 128.8, and 128.9 (C-3',4',5',3'',4'',5'' and C-2,3,4,5,6 of 7- $OCH_2C_6H_5$), 130.2 (C-2',6'), 130.6 (C-2'',6''), 134.6 (C-1'), 134.9 (C-1'), 135.6 (C-1 of 7- $OCH_2C_6H_5$), 139.1 (C- β), 144.2 (C- β'), 156.9 (C-9), 161.1 (C-2), 163.7 (C-7), 175.8 (C-4), 192.1 (C=O) ppm. EI-MS: m/z (rel. int.) = 484 (55) [M^+], 483 (8), 407 (17), 393 (5), 365 (6), 131 (9), 122 (7), 103 (15), 91 (100), 77 (8), 65 (8). $C_{33}H_{24}O_4$ (484.5): calcd. C 81.80, H 4.99; found C 81.84, H 4.97.

5-Benzyloxy-3-cinnamoyl-2-styrylchromone (4b): M.p. 184–186 °C (recrystallised from ethanol). 1H NMR: δ = 5.31 (s, 2 H, 5- $OCH_2C_6H_5$), 6.88 (d, J = 8.2 Hz, 1 H, 6-H), 7.15 (d, J = 8.2 Hz, 1 H, 8-H), 7.06 (d, J = 15.9 Hz, 1 H, α -H), 7.25 (d, J = 16.0 Hz, 1 H, α' -H), 7.31–7.40 (m, 9 H, 3',4',5',3'',4'',5''-H and 3,4,5-H of 5- $OCH_2C_6H_5$), 7.54–7.62 (m, 7 H, 2',6',2'',6''-H and 2,6-H of 5- $OCH_2C_6H_5$), 7.69 (d, J = 16.0 Hz, 1 H, β' -H), 7.71 (d, J = 15.9 Hz, 1 H, β -H) ppm. ^{13}C NMR: δ = 71.0 (5- $OCH_2C_6H_5$), 108.7 (C-6), 110.2 (C-8), 114.9 (C-10), 117.8 (C- α), 123.7 (C-3), 126.6 (C-2,6 of 5- $OCH_2C_6H_5$), 127.6 (C- α'), 127.7 (C-4 of 5- $OCH_2C_6H_5$), 128.1 (C-2',6'), 128.6 (C-2'',6''), 128.8 (C-3',5' and C-3,5 of 5- $OCH_2C_6H_5$), 128.9 (C-3',5'), 130.1 (C-4'), 130.6 (C-4''), 134.2 (C-1'), 134.6 (C-1'), 135.0 (C-7), 136.3 (C-1 of 5- $OCH_2C_6H_5$), 139.0 (C- β), 144.2 (C- β'), 157.3 (C-9), 158.8 (C-5), 159.1 (C-2), 176.2 (C-4), 192.4 (C=O) ppm. EI-MS: m/z (rel. int.) = 484 (41) [M^+], 393 (100), 365 (11), 291 (13), 127 (17), 103 (16), 91 (100), 77 (16), 65 (15). $C_{33}H_{24}O_4$ (484.5): calcd. C 81.80, H 4.99; found C 81.71, H 5.03.

5,7-Dibenzyloxy-3-cinnamoyl-2-styrylchromone (4c): M.p. 194–196 °C (recrystallised from ethanol). 1H NMR: δ = 5.16 (s, 2 H, 7- $OCH_2C_6H_5$), 5.24 (s, 2 H, 5- $OCH_2C_6H_5$), 6.53 (d, J = 2.0 Hz, 1 H, 6-H), 6.69 (d, J = 2.0 Hz, 1 H, 8-H), 7.04 (d, J = 15.9 Hz, 1 H, α -H), 7.25 (d, J = 15.9 Hz, 1 H, α' -H), 7.28–7.46 (m, 14 H, 3',4',5',3'',4'',5''-H, 3,4,5-H of 5- $OCH_2C_6H_5$ and 2,3,4,5,6-H of 7- $OCH_2C_6H_5$), 7.55–7.61 (m, 6 H, 2',6',2'',6''-H and 2,6-H of 5- $OCH_2C_6H_5$), 7.66 (d, J = 15.9 Hz, 1 H, β' -H), 7.68 (d, J = 15.9 Hz, 1 H, β -H) ppm. ^{13}C NMR: δ = 70.6 (7- $OCH_2C_6H_5$), 70.8

(5-OCH₂C₆H₅), 94.0 (C-8), 98.5 (C-6), 109.6 (C-10), 117.8 (C- α), 123.6 (C-3), 126.6 (C-2,6 of 5-OCH₂C₆H₅), 127.2 (C-2,6 of 7-OCH₂C₆H₅), 128.0 (C- α'), 128.5, 128.6, 128.7, 128.8, and 128.9 (C-3',4',5' and 3'',4'',5'' and C-3,4,5 of 5,7-OCH₂C₆H₅), 130.0 (C-2',6'), 130.5 (C-2'',6''), 134.7 (C-1'), 135.0 (C-1'), 135.5 (C-1 of 7-OCH₂C₆H₅), 136.1 (C-1 of 5-OCH₂C₆H₅), 138.3 (C- β), 144.0 (C- β'), 158.6 (C-2), 158.8 (C-9), 160.0 (C-5), 163.4 (C-7), 175.4 (C-4), 192.6 (C=O) ppm. EI-MS: *m/z* (rel. int.) = 590 (9) [M⁺], 500 (18), 499 (14), 132 (9), 131 (9), 117 (5), 103 (7), 91 (100), 77 (6), 65 (10). C₄₀H₃₀O₅ (590.7): calcd. C 81.34, H 5.12; found C 81.01, H. 5.09.

7,4'-Dibenzyloxy-3-(4-benzyloxycinnamoyl)-2-styrylchromone (4d): Yellowish oil. ¹H NMR: δ = 5.09 and 5.09 (2s, 4 H, 4',4''-OCH₂C₆H₅), 5.30 (s, 2 H, 5-OCH₂C₆H₅), 6.85 (s, 1 H, 8-H), 6.90 (d, *J* = 15.8 Hz, 1 H, α -H), 6.96 (d, *J* = 8.8 Hz, 2 H, 3'',5''-H), 6.97 (d, *J* = 8.7 Hz, 2 H, 3',5'-H), 7.11 (d, *J* = 16.0 Hz, 1 H, α' -H), 7.13 (d, *J* = 8.0 Hz, 1 H, 6-H), 7.28–7.44 (m, 13 H, 3,4,5-H of 7-OCH₂C₆H₅ and 2,3,4,5,6-H of 4',4''-OCH₂C₆H₅), 7.51 (d, *J* = 8.7 Hz, 2 H, 2',6'-H), 7.53 (t, *J* = 8.0 Hz, 1 H, 5-H), 7.55 (d, *J* = 8.8 Hz, 2 H, 2'',6''-H), 7.59 (d, *J* = 7.2 Hz, 2 H, 2,6-H of 7-OCH₂C₆H₅), 7.64 (d, *J* = 16.0 Hz, 1 H, β' -H), 7.64 (d, *J* = 15.8 Hz, 1 H, β -H) ppm. ¹³C NMR: δ = 70.0 and 70.1 (4',4''-OCH₂C₆H₅), 70.6 (7-OCH₂C₆H₅), 101.2 (C-8), 114.9 (C-6), 115.2 (C-3'',5''), 115.3 (C-3',5'), 115.9 (C- α), 117.9 (C-10), 121.7 (C-3), 125.7 (C- α'), 127.5 (C-5), 127.6, 128.1, 128.1, 128.1, 128.4, 128.6, and 128.8 (C-1',1'' and C-2,3,4,5,6 of 4',4''-OCH₂C₆H₅), 129.8 (C-2',6'), 130.5 (C-2'',6''), 135.6 (C-1 of 7-OCH₂C₆H₅), 136.4 (C-1 of 4',4''-OCH₂C₆H₅), 138.6 (C- β), 144.1 (C- β'), 156.9 (C-9), 160.5 (C-4'), 160.9 (C-4''), 161.3 (C-2), 163.5 (C-7), 175.8 (C-4), 192.2 (C=O) ppm. MS-FAB(+): *m/z* (rel. int.) = 697 (30) [M + H]⁺, 696 (12), 605 (4), 461 (5), 397 (8), 307 (28), 289 (3), 237 (8), 154 (88), 137 (57), 136 (56), 120 (10), 107 (18), 91 (100), 77 (16). FAB-HRMS (C₄₇H₃₇O₆, [M + H]⁺): calcd. 697.2512, found 697.2505.

5,4'-Dibenzyloxy-3-(4-benzyloxycinnamoyl)-2-styrylchromone (4e): M.p. 192–194 °C (recrystallised from ethanol). ¹H NMR: δ = 5.09 (s, 4 H, 4',4''-OCH₂C₆H₅), 5.29 (s, 2 H, 5-OCH₂C₆H₅), 6.86 (d, *J* = 8.0 Hz, 1 H, 6-H), 6.90 (d, *J* = 15.9 Hz, 1 H, α -H), 6.94 (d, *J* = 8.7 Hz, 2 H, 3'',5''-H), 6.97 (d, *J* = 8.7 Hz, 2 H, 3',5'-H), 7.11 (d, *J* = 15.9 Hz, 1 H, α' -H), 7.12 (d, *J* = 8.0 Hz, 1 H, 8-H), 7.28–7.44 (m, 13 H, 3,4,5-H of 5-OCH₂C₆H₅ and 2,3,4,5,6-H of 4',4''-OCH₂C₆H₅), 7.50 (d, *J* = 8.8 Hz, 2 H, 2',6'-H), 7.54 (t, *J* = 8.0 Hz, 1 H, 7-H), 7.55 (d, *J* = 8.8 Hz, 2 H, 2'',6''-H), 7.58 (d, *J* = 8.2 Hz, 2 H, 2,6-H of 5-OCH₂C₆H₅), 7.64 (d, *J* = 15.9 Hz, 2 H, β , β' -H) ppm. ¹³C NMR: δ = 70.1 (4',4''-OCH₂C₆H₅), 70.9 (5-OCH₂C₆H₅), 108.6 (C-6), 110.1 (C-8), 114.9 (C-10), 115.1 (C-3'',5''), 115.2 (C-3',5'), 115.5 (C- α), 123.2 (C-3), 125.7 (C- α'), 126.7 (C-2,6 of 5-OCH₂C₆H₅), 127.5 (C-2,6 of 4',4''-OCH₂C₆H₅), 127.6, 128.0, 128.1, and 128.6 (C-1',1'' and C-3,4,5 of 5,4',4''-OCH₂C₆H₅), 129.7 (C-2',6'), 130.6 (C-2'',6''), 134.0 (C-7), 136.4 (C-1 of 5,4',4''-OCH₂C₆H₅), 138.3 (C- β), 144.2 (C- β'), 157.3 (C-9), 158.8 (C-5), 159.2 (C-2), 160.4 (C-4'), 160.8 (C-4''), 176.1 (C-4), 192.5 (C=O) ppm. MS-FAB(+): *m/z* (rel. int.) = 697 (25) [M + H]⁺, 696 (10), 605 (3), 460 (6), 397 (6), 307 (38), 289 (16), 212 (8), 180 (7), 154 (100), 137 (63), 136 (62), 120 (11), 107 (19), 91 (59), 77 (16), 65 (87), 51 (7). FAB-HRMS (C₄₇H₃₇O₆, [M + H]⁺): calcd. 697.2512, found 697.2519.

5,7,4'-Tribenzyloxy-3-(4-benzyloxycinnamoyl)-2-styrylchromone (4f): Yellowish oil. ¹H NMR: δ = 5.08 (s, 4 H, 4',4''-OCH₂C₆H₅), 5.14 (s, 2 H, 7-OCH₂C₆H₅), 5.21 (s, 2 H, 5-OCH₂C₆H₅), 6.49 (d, *J* = 2.1 Hz, 1 H, 6-H), 6.66 (d, *J* = 2.1 Hz, 1 H, 8-H), 6.87 (d, *J* = 15.9 Hz, 1 H, α -H), 6.95 (d, *J* = 8.8 Hz, 2 H, 3'',5''-H), 6.95 (d, *J* = 8.7 Hz, 2 H, 3',5'-H), 7.11 (d, *J* = 16.1 Hz, 1 H, α' -H), 7.27–7.52 (m, 24 H, 2',6',2'',6''-H and 2,3,4,5,6-H of 5,7,4',4''-

OCH₂C₆H₅), 7.58 (d, *J* = 16.1 Hz, 1 H, β' -H), 7.63 (d, *J* = 15.9 Hz, 1 H, β -H) ppm. ¹³C NMR: δ = 70.1 (4',4''-OCH₂C₆H₅), 70.6 (7-OCH₂C₆H₅), 70.8 (5-OCH₂C₆H₅), 94.0 (C-8), 98.4 (C-6), 109.6 (C-10), 115.1 (C-3'',5''), 115.2 (C-3',5'), 115.6 (C- α), 123.2 (C-3), 125.9 (C- α'), 126.6, 127.5, 127.7, 127.9, 128.1, 128.5, 128.6, and 128.8 (C-1', C-1'' and C-2,3,4,5,6 of 5,7,4',4''-OCH₂C₆H₅), 129.6 (C-2',6'), 130.6 (C-2'',6''), 135.6 (C-1 of 7-OCH₂C₆H₅), 136.2 (C-1 of 5-OCH₂C₆H₅), 136.4 (C-1 of 4',4''-OCH₂C₆H₅), 137.8 (C- β), 144.1 (C- β'), 158.8 (C-2,9), 160.0 (C-5), 160.3 (C-4'), 160.8 (C-4''), 163.3 (C-7), 175.4 (C-4), 192.7 (C=O) ppm. MS-FAB(+): *m/z* (rel. int.) = 803 (10) [M + H]⁺, 802 (5), 711 (5), 503 (6), 237 (10), 154 (8), 136 (12), 107 (6), 91 (100), 77 (8), 73 (19). FAB-HRMS (C₅₄H₄₃O₇, [M + H]⁺): calcd. 803.2931, found 803.2941.

Synthesis of Hydroxy-2-styrylchromones 5a–i: The appropriate benzyloxy-2-styrylchromone **3a–i** (2.5 mmol) was added to a solution of hydrogen bromide in acetic acid (33 %, 50 mL). The mixture was refluxed for 1–2 hours. The solution was carefully poured into ice and water, and the solid so-obtained was removed by filtration. The solid was dissolved in ethyl acetate (20 mL) and washed with water several times. After evaporation of the solvent, the residue was purified by silica gel column chromatography using a mixture of chloroform:acetone (8:2) as eluent. The solvent was evaporated to dryness in each case, and the residue was precipitated from ethanol with water to give the expected products **5a–i**.

7-Hydroxy-2-styrylchromone (5a): Yield 58.0 % (383 mg). M.p. 195–197 °C (recrystallised from a mixture of ethanol and water). ¹H NMR ([D₆]DMSO): δ = 6.34 (s, 1 H, 3-H), 6.90 (dd, *J* = 8.7, 2.2 Hz, 1 H, 6-H), 6.95 (d, *J* = 2.2 Hz, 1 H, 8-H), 7.18 (d, *J* = 16.2 Hz, 1 H, α -H), 7.40–7.48 (m, 3 H, 3',4',5'-H), 7.65 (d, *J* = 16.2 Hz, 1 H, β -H), 7.72 (d, *J* = 6.9 Hz, 2 H, 2',6'-H), 7.85 (d, *J* = 8.7 Hz, 1 H, 5-H), 10.84 (br. s, 1 H, 7-OH) ppm. ¹³C NMR ([D₆]DMSO): δ = 102.4 (C-8), 110.0 (C-3), 114.8 (C-6), 116.4 (C-10), 120.7 (C- α), 126.6 (C-5), 127.7 (C-2',6'), 129.0 (C-3',5'), 129.7 (C-4'), 135.1 (C-1'), 135.7 (C- β), 157.3 (C-9), 161.0 (C-2), 162.8 (C-7), 176.4 (C-4) ppm. EI-MS: *m/z* (rel. int.) = 264 (83) [M⁺], 263 (100), 247 (43), 235 (13), 207 (6), 178 (6), 155 (12), 137 (32), 128 (47), 118 (9), 108 (12), 102 (12), 91 (6), 77 (9), 63 (7), 51 (11). C₁₇H₁₂O₃ (264.3): calcd. C 77.26, H 4.58; found C 76.83, H 5.02.

5-Hydroxy-2-styrylchromone (5b): Yield 51.1 % (337 mg). M.p. 152–154 °C (recrystallised from a mixture of ethanol and water). ¹H NMR: δ = 6.24 (s, 1 H, 3-H), 6.75 (d, *J* = 16.0 Hz, 1 H, α -H), 6.79 (dd, *J* = 8.3, 0.8 Hz, 1 H, 6-H), 6.96 (dd, *J* = 8.3, 0.8 Hz, 1 H, 8-H), 7.42 (m, 3 H, 3',4',5'-H), 7.52 (t, *J* = 8.3 Hz, 1 H, 7-H), 7.58 (m, 2 H, 2',6'-H), 7.61 (d, *J* = 16.0 Hz, 1 H, β -H), 12.60 (s, 1 H, 5-OH) ppm. ¹³C NMR: δ = 106.8 (C-8), 109.0 (C-3), 110.9 (C-10), 111.3 (C-6), 119.5 (C- α), 127.8 (C-2',6'), 129.0 (C-3',5'), 130.2 (C-4'), 134.7 (C-1'), 135.3 (C-7), 138.0 (C- β), 156.2 (C-9), 160.8 (C-5), 162.8 (C-2), 183.6 (C-4) ppm. EI-MS: *m/z* (rel. int.) = 264 (100) [M⁺], 263 (84), 246 (32), 235 (6), 218 (8), 189 (7), 155 (7), 136 (22), 128 (35), 127 (11), 108 (24), 102 (8), 91 (6), 77 (8), 51 (7). C₁₇H₁₂O₃ (264.3): calcd. C 77.26, H 4.58; found C 77.13, H 4.57.

5,7-Dihydroxy-2-styrylchromone (5c): Yield 48.0 % (336 mg). M.p. 246–248 °C (recrystallised from a mixture of ethanol and water). ¹H NMR ([D₆]DMSO): δ = 6.19 (d, *J* = 2.1 Hz, 1 H, 6-H), 6.39 (s, 1 H, 3-H), 6.47 (d, *J* = 2.1 Hz, 1 H, 8-H), 7.18 (d, *J* = 16.2 Hz, 1 H, α -H), 7.41–7.49 (m, 3 H, 3',4',5'-H), 7.67 (d, *J* = 16.2 Hz, 1 H, β -H), 7.73 (dd, *J* = 7.3, 1.6 Hz, 2 H, 2',6'-H), 10.9 (br. s, 1 H, 7-OH), 12.86 (br. s, 1 H, 5-OH) ppm. ¹³C NMR ([D₆]DMSO): δ = 94.0 (C-8), 98.8 (C-6), 104.1 (C-10), 108.3 (C-3), 120.1 (C- α), 127.9 (C-2',6'), 129.1 (C-3',5'), 130.0 (C-4'), 134.9 (C-1'), 136.9 (C- β),

157.3 (C-9), 161.6 (C-5), 162.3 (C-2), 164.4 (C-7), 181.7 (C-4) ppm. EI-MS: m/z (rel. int.) = 280 (100) (M^+), 279 (89), 262 (20), 251 (8), 234 (6), 165 (5), 153 (19), 128 (38), 124 (18), 102 (8), 77 (9), 69 (15), 63 (4), 51 (8). $C_{17}H_{12}O_4$ (280.3): calcd. C 72.85, H 4.32; found C 72.84, H 4.10.

7,4'-Dihydroxy-2-styrylchromone (5d): Yield 86.0 % (602 mg). M.p. 306–307 °C (recrystallised from a mixture of ethanol and water). 1H NMR ($[D_6]DMSO$): δ = 6.25 (s, 1 H, 3-H), 6.83 (d, J = 8.6 Hz, 2 H, 3',5'-H), 6.88 (dd, J = 8.7, 2.2 Hz, 1 H, 6-H), 6.92 (d, J = 2.2 Hz, 1 H, 8-H), 6.92 (d, J = 16.2 Hz, 1 H, α -H), 7.55 (d, J = 16.2 Hz, 1 H, β -H), 7.56 (d, J = 8.6 Hz, 2 H, 2',6'-H), 7.83 (d, J = 8.7 Hz, 1 H, 5-H), 9.98 (br. s, 1 H, 4'-OH), 10.78 (br. s, 1 H, 7-OH) ppm. ^{13}C NMR ($[D_6]DMSO$): δ = 102.4 (C-8), 108.8 (C-3), 114.6 (C-6), 115.9 (C-3',5'), 116.4 (C-10), 117.1 (C- α), 126.3 (C-1'), 126.6 (C-5), 129.7 (C-2',6'), 136.1 (C- β), 157.3 (C-9), 159.2 (C-4'), 161.8 (C-2), 162.7 (C-7), 176.3 (C-4) ppm. EI-MS: m/z (rel. int.) = 280 (100) [M^+], 279 (97), 263 (45), 251 (15), 234 (5), 223 (5), 171 (7), 144 (25), 137 (38), 126 (11), 115 (38), 108 (10), 89 (7), 84 (34), 66 (40), 63 (8), 52 (8), 51 (8). $C_{17}H_{12}O_4$ (280.3): calcd. C 72.85, H 4.32; found C 72.54, H 4.42.

5,4'-Dihydroxy-2-styrylchromone (5e): Yield 63.0 % (441 mg). M.p. 278–280 °C (recrystallised from a mixture of ethanol and water). 1H NMR ($[D_6]DMSO$): δ = 6.44 (s, 1 H, 3-H), 6.78 (d, J = 8.2 Hz, 1 H, 6-H), 6.84 (d, J = 8.6 Hz, 2 H, 3',5'-H), 6.99 (d, J = 16.1 Hz, 1 H, α -H), 7.11 (dd, J = 8.2, 0.7 Hz, 1 H, 8-H), 7.59 (d, J = 8.6 Hz, 2 H, 2',6'-H), 7.65 (t, J = 8.2 Hz, 1 H, 7-H), 7.66 (d, J = 16.1 Hz, 1 H, β -H), 10.10 (br. s, 1 H, 4'-OH), 12.79 (s, 1 H, 5-OH) ppm. ^{13}C NMR ($[D_6]DMSO$): δ = 107.2 (C-8), 107.4 (C-3), 110.2 (C-10), 110.8 (C-6), 116.0 (C-3',5'), 116.2 (C- α), 125.9 (C-1'), 130.0 (C-2',6'), 135.8 (C-7), 138.3 (C- β), 155.7 (C-9), 159.7 (C-4'), 160.0 (C-5), 164.1 (C-2), 182.9 (C-4) ppm. EI-MS: m/z (rel. int.) = 280 (100) [M^+], 279 (81), 262 (36), 251 (11), 234 (7), 205 (6), 171 (6), 144 (41), 137 (33), 126 (7), 115 (36), 108 (19), 89 (8), 63 (8), 52 (8), 51 (8). $C_{17}H_{12}O_4$ (280.3): calcd. C 72.85, H 4.32; found C 72.68, H 4.35.

5,7,4'-Trihydroxy-2-styrylchromone (5f): Yield 50.0 % (370 mg). M.p. 225–226 °C (recrystallised from a mixture of ethanol and water). 1H NMR ($[(CD_3)_2CO]$): δ = 6.22 (s, 1 H, 3-H), 6.24 (s, 1 H, 6-H), 6.49 (s, 1 H, 8-H), 6.92 (d, J = 8.8 Hz, 2 H, 3',5'-H), 6.92 (d, J = 15.9 Hz, 1 H, α -H), 7.60 (d, J = 8.8 Hz, 2 H, 2',6'-H), 7.64 (d, J = 15.9 Hz, 1 H, β -H), 13.01 (s, 1 H, 5-OH) ppm. ^{13}C NMR ($[(CD_3)_2CO]$): δ = 93.3 (C-8), 98.2 (C-6), 104.2 (C-10), 106.8 (C-3), 115.4 (C-3',5'), 116.2 (C- α), 126.4 (C-1'), 129.3 (C-2',6'), 136.8 (C- β), 157.3 (C-9), 159.0 (C-4'), 162.1 (C-5), 162.8 (C-2), 163.6 (C-7), 181.7 (C-4) ppm. EI-MS: m/z (rel. int.) = 296 (100) [M^+], 295 (98), 279 (32), 267 (15), 250 (7), 241 (6), 213 (8), 171 (9), 165 (17); 153 (44), 144 (37), 134 (18), 123 (12), 115 (39), 96 (7), 91 (10), 78 (7), 69 (21), 55 (6), 51 (5). $C_{17}H_{12}O_5$ (296.3): calcd. C 68.92, H 4.08; found C 68.98, H 4.05.

7,3',4'-Trihydroxy-2-styrylchromone (5g): Yield 80.0 % (592 mg). M.p. 310–311 °C (recrystallised from a mixture of ethanol and water). 1H NMR ($[D_6]DMSO$): δ = 6.27 (s, 1 H, 3-H), 6.79 (d, J = 8.2 Hz, 1 H, 5'-H), 6.82 (d, J = 16.1 Hz, 1 H, α -H), 6.86 (dd, J = 8.7, 2.2 Hz, 1 H, 6-H), 6.93 (d, J = 2.2 Hz, 1 H, 8-H), 7.02 (dd, J = 8.2, 1.8 Hz, 1 H, 6'-H), 7.10 (d, J = 1.8 Hz, 1 H, 2'-H), 7.47 (d, J = 16.1 Hz, 1 H, β -H), 7.83 (d, J = 8.7 Hz, 1 H, 5-H), 10.8 (br. s, 1 H, 7-OH) ppm. ^{13}C NMR ($[D_6]DMSO$): δ = 102.4 (C-8), 108.8 (C-3), 114.3 (C-2'), 114.6 (C-6), 115.8 (C-5'), 116.4 (C-10), 116.9 (C- α), 120.8 (C-6'), 126.5 (C-5), 126.7 (C-1'), 136.4 (C- β), 145.7 (C-3'), 147.8 (C-4'), 157.3 (C-9), 161.8 (C-2), 162.6 (C-7), 176.3 (C-4) ppm. EI-MS: m/z (rel. int.) = 296 (100) [M^+], 295 (58),

279 (25), 267 (9), 249 (9), 221 (8), 187 (9), 176 (17), 160 (18), 137 (58), 114 (12), 84 (32), 66 (38), 63 (8), 52 (6), 51 (8). $C_{17}H_{12}O_5$ (296.3): calcd. C 68.92, H 4.08; found C 68.99, H 4.23.

5,3',4'-Trihydroxy-2-styrylchromone (5h): Yield 55.0 % (407 mg). M.p. 275–276 °C (recrystallised from a mixture of ethanol and water). 1H NMR ($[D_6]DMSO$): δ = 6.47 (s, 1 H, 3-H), 6.78 (d, J = 8.2 Hz, 1 H, 6-H), 6.81 (d, J = 8.1 Hz, 1 H, 5'-H), 6.88 (d, J = 16.1 Hz, 1 H, α -H), 7.02 (br. d, J = 8.1 Hz, 1 H, 6'-H), 7.12 (d, J = 8.2 Hz, 1 H, 8-H), 7.13 (d, J = 2.7 Hz, 1 H, 2'-H), 7.59 (d, J = 16.1 Hz, 1 H, β -H), 7.64 (t, J = 8.2 Hz, 1 H, 7-H), 9.23 (br. s, 1 H, 3'-OH), 9.69 (br. s, 1 H, 4'-OH), 12.80 (s, 1 H, 5-OH) ppm. ^{13}C NMR ($[D_6]DMSO$): δ = 107.2 (C-8), 107.4 (C-3), 110.2 (C-10), 110.8 (C-6), 114.5 (C-2'), 115.9 (C-5'), 116.1 (C- α), 121.3 (C-6'), 126.4 (C-1'), 135.7 (C-7), 138.7 (C- β), 145.7 (C-3'), 148.4 (C-4'), 155.7 (C-9), 160.0 (C-5), 164.1 (C-2), 182.9 (C-4) ppm. EI-MS: m/z (rel. int.) = 296 (100) [M^+], 295 (63), 279 (25), 267 (7), 249 (11), 221 (8), 186 (7), 176 (8), 160 (40), 137 (65), 114 (20), 108 (17), 88 (7), 77 (9), 63 (8), 52 (9), 51 (10). $C_{17}H_{12}O_5$ (296.3): calcd. C 68.92, H 4.08; found C 68.86, H 4.30.

5,7,3',4'-Tetrahydroxy-2-styrylchromone (5i): Yield 27.1 % (211 mg). M.p. 304–306 °C (recrystallised from a mixture of ethanol and water). 1H NMR ($[D_6]DMSO$): δ = 6.17 (d, J = 2.0 Hz, 1 H, 6-H), 6.32 (s, 1 H, 3-H), 6.45 (d, J = 2.0 Hz, 1 H, 8-H), 6.79 (d, J = 8.2 Hz, 1 H, 5'-H), 6.82 (d, J = 16.0 Hz, 1 H, α -H), 7.02 (dd, J = 8.2, 2.0 Hz, 1 H, 6'-H), 7.10 (d, J = 2.0 Hz, 1 H, 2'-H), 7.51 (d, J = 16.0 Hz, 1 H, β -H), 9.20 (br. s, 1 H, 3'-OH), 9.64 (br. s, 1 H, 4'-OH), 10.85 (br. s, 1 H, 7-OH), 12.96 (br. s, 1 H, 5-OH) ppm. ^{13}C NMR ($[D_6]DMSO$): δ = 93.9 (C-8), 98.7 (C-6), 104.0 (C-10), 107.0 (C-3), 114.4 (C-2'), 115.9 (C-5'), 116.2 (C- α), 121.1 (C-6'), 126.5 (C-1'), 137.7 (C- β), 145.7 (C-3'), 148.1 (C-4'), 157.2 (C-9), 161.5 (C-5), 163.2 (C-2), 164.2 (C-7), 181.7 (C-4) ppm. EI-MS: m/z (rel. int.) = 312 (13) [M^+], 311 (9), 295 (2), 281 (3), 191 (10), 160 (4), 153 (8), 146 (35), 122 (3), 91 (4), 78 (85), 63 (100), 51 (2). $C_{17}H_{12}O_6$ (312.3): calcd. C 65.39, H 3.87; found C 65.53, H 4.07.

Acknowledgments

Sincere thanks are expressed to the University of Aveiro and “Fundação para a Ciência e a Tecnologia”, Portugal, for funding the Organic Chemistry Research Unit. One of us (CMMS) also thanks the University of Aveiro for the award of a MSc grant.

- [1] *The Flavonoids* (Eds.: J. B. Harborne, T. J. Mabry, H. Mabry), Chapman and Hall, London, **1975**.
- [2] *Chromenes, Chromanones and Chromones* (Ed.: G. P. Ellis), John Wiley & Sons, New York, **1977**.
- [3] *The Flavonoids – Advances in Research Since 1986* (Ed.: J. B. Harborne), Chapman and Hall, London, **1994**.
- [4] J. W. McClure, in: *The Flavonoids* (Eds.: J. B. Harborne, T. J. Mabry, H. Mabry), Chapman and Hall, London, **1975**, p. 970–1055.
- [5] E. Middleton Jr., C. Kandaswami, in: *The Flavonoids Advances in Research Since 1986* (Ed.: J. B. Harborne), Chapman and Hall, London, **1994**, p. 619–652.
- [6] H. Wagner, M.-A. Lacaille-Dubois, in: *Flavonoids and Bioflavonoids 1995 – Proceedings of the International Bioflavonoid Symposium* (Eds.: S. Antus, M. Gábor, K. Vetschera), Akadémiai Kiadó, Budapest, **1996**, p. 53–72.
- [7] [7a] W. Bors, W. Heller, C. Michel, K. Stettmaier, in: *Handbook of Antioxidants* (Eds.: E. Cadenas, L. Packer), Marcel Dekker, New York, **1996**, p. 409–466. [7b] *Flavonoids in Health and Dis-*

- ease (Eds.: C. A. Rice-Evans, L. Packer), Marcel Dekker, New York, **1998**.
- [8] [8a] T. Akama, H. Ishida, Y. Shida, U. Kimura, K. Gomi, H. Saito, E. Fuse, S. Kobayashi, N. Yoda, M. Kasai, *J. Med. Chem.* **1997**, *40*, 1894–1900. [8b] J. M. Gee, I. T. Johnson, *Curr. Med. Chem.* **2001**, *8*, 1245–1255. [8c] T. C. Theoharides, M. Alexandrakis, D. Kempuraj, M. Lytinas, *Int. J. Immunopathol. Pharmacol.* **2001**, *14*, 119–127.
- [9] [9a] C. A. Rice-Evans, N. J. Miller, G. Paganga, *Free Rad. Biol. Med.* **1996**, *20*, 933–956. [9b] P.-G. Pietta, *J. Nat. Prod.* **2000**, *63*, 1035–1042. [9c] C. Rice-Evans, *Curr. Med. Chem.* **2001**, *8*, 797–807.
- [10] [10a] M. Weidenbörner, H. C. Jha, *Pest. Sci.* **1993**, *38*, 347–351. [10b] M. L. Borges, O. C. Matos, I. Pais, J. S. Melo, C. P. Ricardo, A. Macanita, R. S. Becker, *Pest. Sci.* **1995**, *44*, 155–162. [10c] V. S. Parmar, K. S. Bisht, R. Jain, S. Singh, S. K. Sharma, S. Gupta, S. Malhotra, O. D. Tyagi, A. Vardhan, H. N. Pati, D. V. Berghe, A. J. Vlietinck, *Indian J. Chem.* **1996**, *35B*, 220–232. [10d] A. M. S. Silva, M. Weidenbörner, J. A. S. Cavaleiro, *Mycol. Res.* **1998**, *102*, 638–640.
- [11] J. A. Manthey, N. Guthrie, K. Grohmann, *Curr. Med. Chem.* **2001**, *8*, 135–153.
- [12] [12a] W. H. Gerwick, A. Lopez, G. D. Van Duyne, J. Clardy, W. Ortiz, A. Baez, *Tetrahedron Lett.* **1986**, *27*, 1979–1982. [12b] W. H. Gerwick, *J. Nat. Prod.* **1989**, *52*, 252–256.
- [13] W. A. Price, A. M. S. Silva, J. A. S. Cavaleiro, *Heterocycles* **1993**, *36*, 2601–2612.
- [14] [14a] G. Doria, C. Romeo, A. Forgione, P. Sberze, N. Tibolla, M. L. Corno, G. Cruzzola, G. Cadelli, *Eur. J. Med. Chem. Chim. Ther.* **1979**, *14*, 347–351. [14b] J. D. Brion, G. Le Baut, F. Zammattio, A. Pierre, G. Atassi, L. Belachmi, *Eur. Pat. Appl.* EP 454.587, **1991**, (*Chem. Abstr.* **1992**, *116*, 106092k).
- [15] N. Desideri, C. Conti, P. Mastromarino, F. Mastropalo, *Antiviral Chem. Chemoth.* **2000**, *11*, 373–381.
- [16] F. Peixoto, A. I. R. N. A. Barros, A. M. S. Silva, *J. Biochem. & Mol. Toxicol.* **2002**, *16*, 209–219.
- [17] E. Fernandes, F. Carvalho, A. M. S. Silva, C. M. M. Santos, D. C. G. A. Pinto, J. A. S. Cavaleiro, M. L. Bastos, *J. Enz. Inhib. Med. Chem.* **2002**, *17*, 45–48.
- [18] J. S. Wright, E. R. Johnson, G. A. DiLabio, *J. Am. Chem. Soc.* **2001**, *123*, 1173–1183.
- [19] [19a] D. C. G. A. Pinto, A. M. S. Silva, J. A. S. Cavaleiro, *J. Heterocycl. Chem.* **1996**, *33*, 1887–1893. [19b] A. M. S. Silva, D. C. G. A. Pinto, H. R. Tavares, J. A. S. Cavaleiro, M. L. Jimeno, J. Elguero, *Eur. J. Org. Chem.* **1998**, 2031–2038. [19c] D. C. G. A. Pinto, A. M. S. Silva, J. A. S. Cavaleiro, *New J. Chem.* **2000**, *24*, 85–92.
- [20] [20a] W. Baker, *J. Chem. Soc.* **1933**, 1381. [20b] H. S. Mahal, K. Venkataraman, *J. Chem. Soc.* **1934**, 1767. [20c] W. A. Price, A. M. S. Silva, J. A. S. Cavaleiro, *Heterocycles* **1993**, *36*, 2601–2612.
- [21] [21a] J. K. Makrandi, V. Kumari, *Chem. Ind. (London)* **1988**, 630–631 (for the conversion of 2-hydroxydibenzoylmethanes into 2-phenylchromones). [21b] D. C. G. A. Pinto, A. M. S. Silva, J. A. S. Cavaleiro, *New J. Chem.* **2000**, *24*, 85–92.
- [22] S. Mashhood, M. Ilyas, *J. Chem. Res. (S)* **1987**, 52–53.
- [23] J. K. Makrandi, V. Kumari, *Synth. Commun.* **1989**, *19*, 1919–1922.

Received July 25, 2003