

Jordi Bolós*, Teresa Loscertales, Joan Nieto, Aurelio Sacristán and José A Ortiz

Department of Medicinal Chemistry, Centro de Investigación Grupo Ferrer,
Juan de Sada, 32, 08028-Barcelona, Spain
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An efficient and versatile synthesis of variously substituted 3-(hydroxymethyl)-4*H*-chromen-4-ones is reported. The compounds are prepared by hydroxymethylation of the precursor 2-hydroxy-4-chromanones followed by acid dehydration.

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Within the context of a research program aimed at the discovery of new antipsychotic compounds, we required an efficient procedure for the large-scale preparation of 3-(hydroxymethyl)chromen-4-ones, as the key intermediates for the synthesis of the antipsychotics FI-8194 [1] and FI-8602 (abaperidone) [2].

The synthesis of 3-(hydroxymethyl)chromen-4-one (**3a**) and several substituted derivatives has been reported through two synthetic strategies: a) reduction of 4-oxo-4*H*-chromene-3-carbaldehyde (**2**) and b) condensation of 2-sulfinyl-1-(2-hydroxyphenyl)ethanone (**5**) with formaldehyde, followed by thermal elimination of the sulfoxide (**6**) (Scheme 1). Conversion of 4-oxo-4*H*-chromene-3-carbaldehydes to the corresponding alcohols has been carried out in poor yields with sodium borohydride in the presence of aluminium chloride [3]. In a previous work, we reported the reduction of 7-(3-chloropropoxy)-4-oxo-4*H*-chromene-3-carbaldehyde with sodium borohydride [1]. This reaction yielded a complex mixture that required a

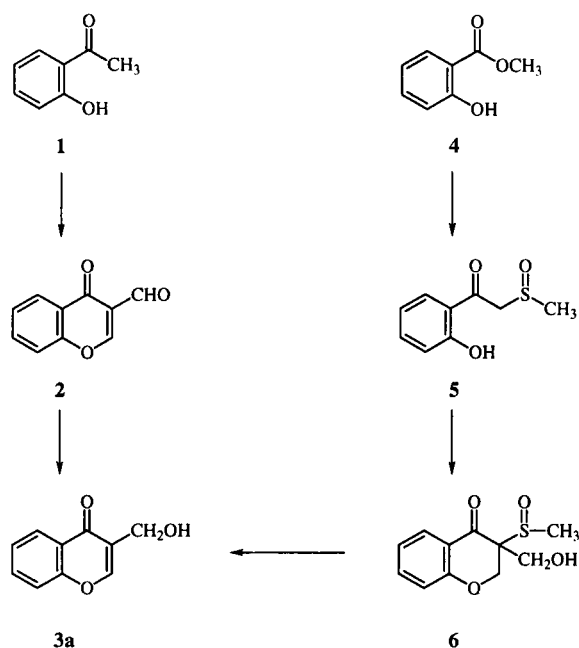
tedious purification process. Reduction of 4-oxo-4*H*-chromene-3-carbaldehyde and its 6-methyl- and 6-chloro derivatives has also been reported in good yields with borane in THF [4]. However, this method provided low and inconsistent yields for some of our alkoxy-substituted chromenones.

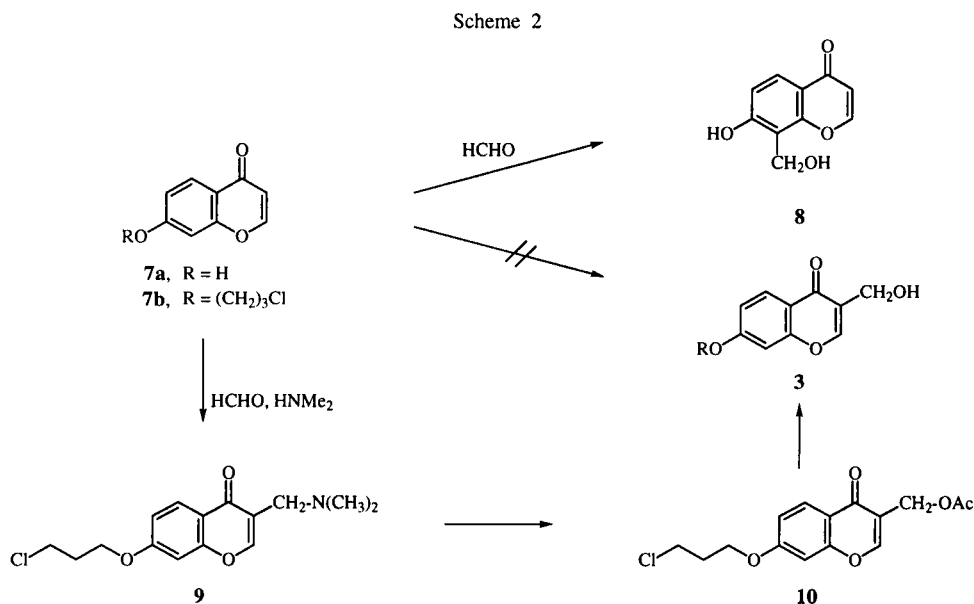
An alternative route consists in the condensation of 1-(2-hydroxyphenyl)-2-sulfinyl ethanones with two equivalents of formaldehyde, and subsequent thermal elimination of the sulfoxide group [5]. Following a procedure adapted from that of the literature, we obtained 7-benzyloxy-3-(hydroxymethyl)chromen-4-one by condensation of the corresponding 2-(methylsulfinyl)-1-phenylethanone with formaldehyde [6]. However, the synthesis of the precursor sulfinyl ketone from the salicylic ester required the use of sodium methylsulfinylmethide. The preparation of this reagent in large batches is cumbersome and has been reported to cause several laboratory explosions [7].

These drawbacks prompted us to investigate some alternative procedures. Direct hydroxymethylation of chromen-4-ones (**7**) with formaldehyde was attempted under a variety of experimental conditions, although in no case was the formation of the target 3-hydroxymethylated compounds observed. Interestingly, in the case of 7-hydroxychromen-4-one (**7a**), treatment with formaldehyde under basic conditions yielded 7-hydroxy-8-(hydroxymethyl)chromen-4-one (**8**). In contrast, Mannich reaction is reported to provide the corresponding 3-(dimethylaminomethyl)chromenones [8]. Thus, the condensation of 7-(3-chloropropoxy)chromen-4-one (**7b**) with formaldehyde and dimethylamine afforded the 3-(dimethylaminomethyl) derivative (**9**). Conversion into the (hydroxymethyl)chromenone (**3g**) was then achieved in low yields by substitution of the dimethylamino moiety for an acetate group (**10**) upon treatment with acetic anhydride, and further hydrolysis to alcohol.

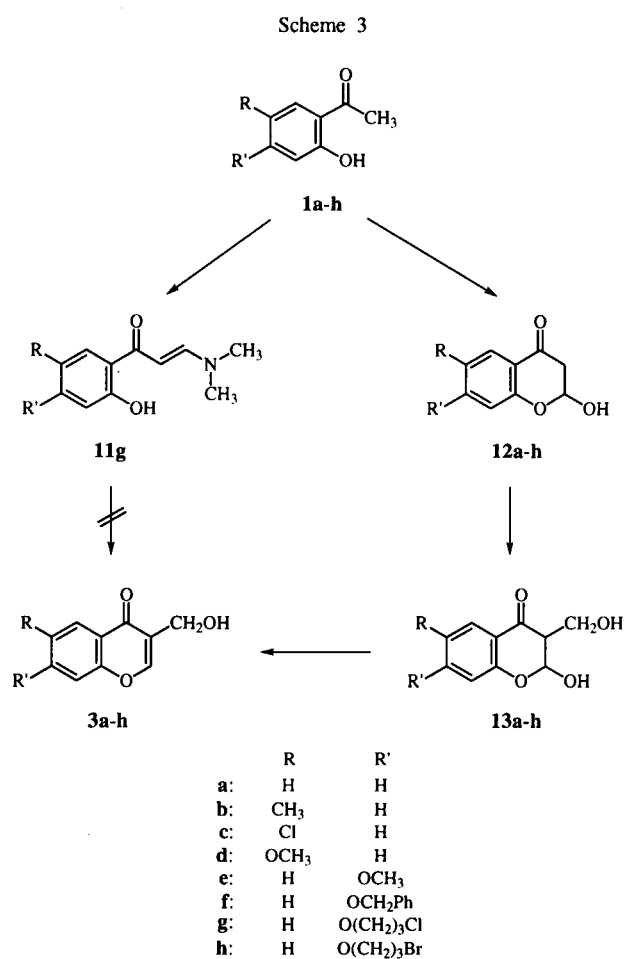
A more direct alternative route would be the hydroxymethylation of some synthetic precursors of the chromenones. Enaminoketones (**11**) can be prepared by treatment of phenylethanones (**1**) with *N,N*-dimethylformamide dimethyl acetal [9]. Acid cyclization gives rise to chromenones [9], whereas cyclization in the presence of

Scheme 1





some electrophiles is reported to produce 3-substituted chromenones [10]. However, upon treatment of our enamino-ketones with formaldehyde under several reaction conditions we only recovered either the starting compound or the 3-unsubstituted heterocycles. Chromenones have also been prepared by cyclization of the precursor ketoaldehydes [11]. These compounds are easily accessible by Claisen condensation of phenylethanones with ethyl formate [11]. Using a modified procedure, we prepared a series of compounds listed in Table 1. After smooth acidic workup, our ketoaldehyde condensation products were isolated as the cyclic hemiacetal 2-hydroxychromanones (**12a-h**). Ring-chain tautomerism has been described for some 2-hydroxychroman-4-ones, shown to exist in solution in an equilibrium between dicarbonyl and keto-enol open forms and the cyclic hemiacetal form [12]. Treatment of 2-hydroxychromanones **12a-h** with formaldehyde in the presence of a trace of basic catalysts at room temperature afforded the 2-hydroxy-3-(hydroxymethyl)chroman-4-ones (**13**). These intermediates proved to be unstable and difficult to isolate. Thus, the reaction mixture was acidified *in situ* in order to effect dehydration to the corresponding chromenones (**3a-h**), which were isolated in good yields. Although bis(hydroxymethylation) is a usual reaction for either chromanones [13] or 1,3-dicarbonyl compounds [14] we only obtained the mono(hydroxymethylated) derivatives even in the presence of an excess of formaldehyde. The above conditions were applied to the preparation of a series of 3-(hydroxymethyl)chromenones listed in Table 1. 1-(2,4-Dihydroxyphenyl)ethanone failed to produce the corresponding ketoaldehyde under our experimental conditions. Instead, preparation of 7-hydroxy-(3-hydroxymethyl)chromen-4-one (**3i**) was achieved by smooth cleavage of the benzyl



ether (**3f**) using boron trichloride. Halogen substituents were unaffected by the basic conditions employed either in the condensation of phenyl ethanones with ethyl formate or the subsequent condensation with formaldehyde. The 7-(3-halopropoxy)chromenones **3g** and **3h** constitute valuable intermediates for the synthesis of the antipsychotics FI-8194 and FI-8602.

In conclusion, he have described a new synthetic route to 3-(hydroxymethyl)chromen-4-ones **3** by hydroxy-methylation of the precursor 2-hydroxychromanones **12**. This simple and efficient experimental procedure allows the preparation of large amounts of these compounds, avoiding the hazards associated with the use of dangerous reagents or reaction conditions.

Table 1
Physical and Analytical Data of the 2-Hydroxychroman-4-ones (**12a-h**) and 3-(Hydroxymethyl)chromen-4-ones (**3a-h**)

| No. | R | Yield % | mp (°C) | | Molecular Formula | Analysis, Calcd./Found | | ir, ν (cm ⁻¹) | Solvent [a] | ¹ H nmr, δ (ppm) |
|------------|---------------------------------------|---------|---------|-----------------------------|--|------------------------|----------------|-------------------------------|-------------|--|
| | | | Found | Reported | | %C | %H | | | |
| 12a | H | 87 | 88-89 | 97-97.5 [16] 94-96 [11a] | | | | 3330, 1668, 1607 | M | 2.75 (dd, J = 16.5 and 4.2 Hz, 3-H _a), 3.02 (dd, J = 16.5 and 3.0 Hz, 3-H _b), 5.81 (t, J = 3.9 Hz, 2-H), 6.97-7.06 (m, 6-H + 8-H), 7.53 (m, 7-H), 7.80 (dd, J = 7.5 and 1.5 Hz, 5-H) |
| 12b | 6-CH ₃ | 100 | 135-137 | | C ₁₀ H ₁₀ O ₃ | 67.41 (67.26) | 5.66 (5.80) | 3300, 1663, 1619 | A | 2.29 (s, CH ₃), 2.72 (dd, J = 16.5 and 4.2 Hz, 3-H _a), 2.99 (dd, J = 16.5 and 3.3 Hz, 3-H _b), 5.89 (t, J = 3.6 Hz, 2-H), 6.47 (br s, OH), 6.88 (d, J = 8.7 Hz, 8-H), 7.36 (dd, 8.7 and 2.0 Hz, 7-H), 7.57 (d, J = 2.0 Hz, 5-H) |
| 12c | 6-Cl | 93 | 159-162 | | C ₉ H ₇ ClO ₃ | 54.43 (54.72) | 3.55 (3.76) | 3300, 1670, 1602 | D | 2.72 (dd, J = 16.5 and 4.2 Hz, 3-H _a), 3.10 (dd, J = 16.5 and 3 Hz, 3-H _b), 3.41 (br s, OH), 5.87 (m, 2-H), 7.09 (d, J = 9.0 Hz, 8-H), 7.59-7.70 (m, 5-H + 7-H) |
| 12d | 6-OCH ₃ | 92 | 145-147 | | C ₁₀ H ₁₀ O ₄ | 61.85 (61.47) | 5.19 (5.01) | 3350, 1663, 1616 | D | 2.66 (dd, J = 16.5 and 4.5 Hz, 3-H _a), 3.02 (dd, J = 16.5 and 2.0 Hz, 3-H _b), 3.38 (s, OH), 3.75 (s, OCH ₃), 5.76 (dd, J = 4.5 and 2.0 Hz, 2-H), 6.97 (d, J = 7.6 Hz, 8-H), 7.18 (m, 7H), 7.50 (d, J = 3.6 Hz, 5-H) |
| 12e | 7-OCH ₃ | 85 | 138-140 | | C ₁₀ H ₁₀ O ₄ | 61.85 (61.56) | 5.19 (4.96) | 3230, 1652, 1606 | A | 2.70 (dd, J = 14.0 and 2.7 Hz, 3-H _a), 2.88 (dd, J = 14.0 and 3.6 Hz, 3-H _b), 3.85 (s, OCH ₃), 5.90 (t, J = 3.0 Hz, 2-H), 6.47 (d, J = 2.1 Hz, 8-H), 6.64 (dd, J = 8.7 and 2.1 Hz, 6-H), 7.76 (d, J = 8.7 Hz, 5-H) |
| 12f | 7-OCH ₂ Ph | 92 | 170-173 | | C ₁₆ H ₁₄ O ₄ | 71.10 (70.87) | 5.22 (5.47) | 3260, 1651, 1608 | D | 2.60 (dd, J = 16.5 and 5.0 Hz, 3-H _a), 2.92 (dd, J = 16.5 and 3.0 Hz, 3-H _b), 5.17 (s, CH ₂ Ph), 5.79 (dd, J = 5.0 and 3.0 Hz, 2-H), 6.59 (d, J = 2.7 Hz, 8-H), 6.69 (dd, J = 8.7 and 2 Hz, 6-H), 7.30-7.45 (m, CH ₂ C ₆ H ₅), 7.56 (br d, OH), 7.66 (d, J = 8.7 Hz, 5-H) |
| 12g | 7-O(CH ₂) ₃ Cl | 80 | 118-120 | | C ₁₂ H ₁₃ ClO ₄ | 56.15 (55.85) | 5.11 (5.43) | 3270, 1652, 1607 | C | 2.26 (m, OCH ₂ CH ₂), 2.81 (dd, J = 16.5 and 5.7 Hz, 3-H _a), 2.93 (dd, J = 16.5 and 3.3 Hz, 3-H _b), 3.74 (t, J = 6.3 Hz, CH ₂ Cl), 4.16 (t, 6.0 Hz, OCH ₂), 5.77 (dd, J = 5.7 and 3.3 Hz, 2-H), 6.46 (d, J = 2.7 Hz, 8-H), 6.60 (dd, J = 8.7 and 2.7 Hz, 6-H), 7.80 (d, J = 8.7 Hz, 5-H) |

Table 1 (continued)

| No. | R | Yield % | mp (°C) | | Molecular Formula | Analysis, Calcd./ (Found) | | ir, ν (cm ⁻¹) | Solvent [a] | ¹ H nmr, δ (ppm) |
|-----|---------------------------------------|---------|---------|-----------------------------|--|---------------------------|----------------|---------------------------------|-------------|--|
| | | | Found | Reported | | %C | %H | | | |
| 12h | 7-O(CH ₂) ₃ Br | 69 | 103-105 | | C ₁₂ H ₁₃ BrO ₄ | 47.86 (47.56) | 4.35 (4.17) | 3300, 1647, 1603 | C | 2.34 (m, OCH ₂ CH ₂), 2.83 (dd, J = 16.5 and 4.8 Hz, 3-H _a), 2.97 (dd, J = 16.5 and 2.7 Hz, 3-H _b), 3.59 (t, J = 6.3 Hz, CH ₂ Br), 4.14 (t, J = 6.0 Hz, OCH ₂), 5.78 (dd, J = 4.8 and 2.7 Hz, 2-H), 6.45 (d, J = 2.1 Hz, 8-H), 6.62 (dd, J = 8.7 and 2.1 Hz, 6-H), 7.83 (d, J = 8.7 Hz, 5-H) |
| 3a | H | 82 | 108-110 | 108-110 [5] 109-111 [3b] | | | | 3360, 1636, 1605 | M | 4.53 (d, 1.0 Hz, CH ₂), 7.43 (td, J = 5.8 and 0.6 Hz, 6-H), 7.52 (dd, 8.7 and 0.6 Hz, 8-H), 7.74 (ddd, J = 8.7, 7.5 and 1.5 Hz, 7-H), 8.10 (dd, J = 7.5 and 1.5 Hz, 5-H), 8.17 (t, J = 1.2 Hz, 2-H) |
| 3b | 6-CH ₃ | 70 | 142-144 | 141 [4] | | | | 3430, 1635, 1485 | D | 2.42 (s, CH ₃), 4.39 (d, J = 4.5 Hz, CH ₂), 5.16 (t, J = 4.5 Hz, OH), 7.52 (d, J = 4.9 Hz, 8-H), 7.60 (dd, J = 4.9 and 0.8 Hz, 7-H), 7.84 (s, 5-H), 8.20 (br s, 2-H) |
| 3c | 6-Cl | 71 | 163-165 | 163-164 [5] | | | | 3500, 1633, 1602 | D | 4.39 (d, J = 5.1 Hz, CH ₂), 5.28 (t, J = 5.1 Hz, OH), 7.70 (d, J = 8.7 Hz, 8-H), 7.82 (dd, J = 8.7 and 2.4 Hz, 7-H), 7.94 (d, J = 2.4 Hz, 5-H), 8.26 (br s, 2-H) |
| 3d | 6-OCH ₃ | 80 | 150-152 | 150-153.5 [5] | | | | 3400, 1634, 1601 | D | 3.86 (s, OCH ₃), 4.40 (d, J = 4.8 Hz, CH ₂), 5.20 (t, J = 4.8 Hz, OH), 7.40 (br s, 5-H + 7-H), 7.60 (d, J = 8.4 Hz, 8-H), 8.21 (br s, 2-H) |
| 3e | 7-OCH ₃ | 78 | 118-120 | | C ₁₁ H ₁₀ O ₄ | 64.07 (64.07) | 4.89 (4.87) | 3410, 1640, 1624 | D | 3.11 (s, OCH ₃), 4.40 (br s, OH), 4.51 (d, J = 4.5 Hz, CH ₂), 7.00-7.01 (m, 6-H + 8-H), 8.00 (d, J = 7.6 Hz, 5-H), 8.07 (br s, 2-H) |
| 3f | 7-OCH ₂ Ph | 70 | 134-136 | | C ₁₇ H ₁₄ O ₄ | 72.33 (72.35) | 5.00 (4.97) | 3340, 1632, 1600 | C | 3.19 (t, J = 5.4 Hz, OH), 4.55 (d, J = 5.4 Hz, CH ₂ OH), 5.15 (s, CH ₂ Ph), 6.91 (d, J = 2.4 Hz, 8-H), 7.05 (dd, J = 8.7 and 2.4 Hz, 6-H), 7.30-7.45 (m, CH ₂ C ₆ H ₅), 7.85 (br s, 2-H), 8.12 (d, J = 8.7 Hz, 5-H) |
| 3g | 7-O(CH ₂) ₃ Cl | 75 | 102-103 | 102-104 [1] | | | | 3330, 1638, 1625, 1590 | C | 2.30 (m, OCH ₂ CH ₂), 3.37 (t, J = 6.3 Hz, OH), 3.77 (t, J = 6.0 Hz, CH ₂ Cl), 4.21 (t, J = 5.7 Hz, OCH ₂ CH ₂), 4.57 (d, J = 6.3 Hz, CH ₂ OH), 6.85 (d, J = 2.4 Hz, 8-H), 6.98 (dd, J = 9.0 and 2.4 Hz, 6-H), 7.88 (s, 2-H), 8.11 (d, J = 9.0 Hz, 5-H) |
| 3h | 7-O(CH ₂) ₃ Br | 75 | 104-106 | | C ₁₃ H ₁₃ BrO ₄ | 49.86 (49.70) | 4.18 (4.02) | 3325, 1636, 1626, 1591 | C | 2.37 (m, OCH ₂ CH ₂), 3.63 (t, J = 6.3 Hz, CH ₂ Cl), 3.68 (br s, OH), 4.19 (t, J = 5.7 Hz, OCH ₂ CH ₂), 4.56 (br s, CH ₂ OH), 6.84 (d, J = 2.4 Hz, 8-H), 6.96 (dd, J = 8.7 and 2.4 Hz, 6-H), 7.96 (br s, 2-H), 8.07 (d, J = 9.0 Hz, 5-H) |

[a] A, deuterioacetone; C, deuteriochloroform; D, deuteriodimethyl sulfoxide; M, deuteriomethanol.

EXPERIMENTAL

Melting points were determined with a Büchi apparatus and are uncorrected. ¹H and ¹³C nmr spectra were recorded on a Varian Gemini 300 spectrometer. Chemical shifts (δ) are expressed in parts per million downfield from tetramethylsilane as internal standard. Ir spectra were registered with a Perkin-

Elmer 1710 apparatus. Microanalyses were obtained using a Perkin-Elmer 2400 elemental analyzer.

7-Hydroxy-8-(hydroxymethyl)chromen-4-one (8).

To a solution of 7-hydroxychromen-4-one [15] (4.0 g, 25 mmoles) and potassium carbonate (3.4 g, 25 mmoles) in water (30 mL) was added a 37% aqueous solution of formaldehyde (10 mL, 123 mmoles) and the mixture was heated at 50 °C for 2 hours.

After cooling to room temperature, the solution was acidified with hydrochloric acid and stirred for 1 hour. The precipitates were filtered, washed with water, then with acetone, and vacuum dried to yield 3.0 g (63%) of **8**, mp 155-156 °C; ir (potassium bromide): 1626, 1436, 1311 cm^{-1} ; ^1H nmr (deuteriodimethyl sulfoxide): δ 3.42 (broad s, 2H, OH), 4.63 (2H, CH_2), 6.20 (d, $J = 6$ Hz, 1H, 3-H), 6.96 (d, $J = 8.7$ Hz, 1H, 6-H), 7.80 (d, $J = 8.7$ Hz, 1H, 5-H), 8.19 (d, $J = 6$ Hz, 1H, 2-H); ^{13}C nmr (deuteriodimethyl sulfoxide) δ 51.7 (CH_2), 112.0 (3-C), 114.7 (6-C), 115.4 (8-C), 117.3 (4a-C), 125.6 (5-C), 156.5 (2-C + 8a-C), 160.9 (7-C), 176.3 (4-C).

7-(3-Chloropropoxy)-3-(dimethylaminomethyl)chromen-4-one (**9**).

A mixture of 7-(3-chloropropoxy)chromen-4-one (**7b**) [1] (7.1 g, 25 mmoles), dimethylamine hydrochloride (3.5 g, 43 mmoles) and a 37% aqueous solution of formaldehyde (3.7 mL, 50 mmoles) in ethanol (50 mL) was heated to reflux for 22 hours. After cooling to room temperature, the reaction mixture was diluted with chloroform, and washed with water and 5% sodium bicarbonate solution. The organic layer was dried over anhydrous sodium sulfate and evaporated. The residue was suspended in acetone, filtered and vacuum dried to afford 2.4 g (28%) of **9**, mp 80-81 °C; ir (potassium bromide): 1639, 1610, 1447, 1244 cm^{-1} ; ^1H nmr (deuteriodimethyl sulfoxide): δ 2.26 (m, $J = 6$ Hz, 2H, OCH_2CH_2), 2.30 (s, 6H, NCH_3), 3.40 (s, 2H, CH_2N), 3.79 (t, $J = 6$ Hz, 2H, CH_2Cl), 4.24 (t, $J = 6$ Hz, 2H, OCH_2), 7.02 (d, $J = 8.6$ Hz, 1H, 6-H), 7.03 (s, 1H, 8-H), 8.00 (d, $J = 8.6$ Hz, 1H, 5-H), 8.15 (s, 1H, 2-H).

Anal. Calcd. for $\text{C}_{15}\text{H}_{18}\text{ClNO}_3$: C, 60.91; H, 6.13; N, 4.74. Found: C, 60.63; H, 6.20; N, 4.45.

3-(Acetoxymethyl)-7-(3-chloropropoxy)chromen-4-one (**10**).

A solution of **9** (1.4 g, 4.1 mmoles) in acetic anhydride (15 mL) was heated to reflux for 90 minutes. The cooled reaction mixture was poured on water and extracted with chloroform. The organic layer was washed with 5% sodium bicarbonate solution, dried over anhydrous sodium sulfate and evaporated. The residue was suspended in diethylether, filtered and vacuum dried to afford 0.6 g (42%) of **10**, mp 82-83 °C; ir (potassium bromide): 1739, 1636, 1605, 1455, 1239 cm^{-1} ; ^1H nmr (deuteriomethanol): δ 2.10 (s, 3H, CH_3), 2.39 (m, $J = 6$ Hz, 2H, OCH_2CH_2), 3.63 (t, $J = 6$ Hz, 2H, CH_2Cl), 4.23 (t, $J = 6$ Hz, 2H, OCH_2CH_2), 5.03 (s, 2H, CH_2OAc), 6.90 (s, 1H, 8-H), 7.01 (d, $J = 8.6$ Hz, 1H, 6-H), 8.05 (s, 1H, 2-H), 8.18 (d, $J = 8.6$ Hz, 1H, 5-H).

Anal. Calcd. for $\text{C}_{15}\text{H}_{15}\text{ClO}_5$: C, 57.98; H, 4.87. Found: C, 57.65; H, 4.74.

7-(3-Chloropropoxy)-3-(hydroxymethyl)chromen-4-one (**3g**).

To a solution of **10** (0.6 g, 1.7 mmoles) in tetrahydrofuran (5 mL) was added 5 *M* hydrochloric acid (5 mL), and the mixture was heated to reflux for 12 hours. The cooled mixture was extracted with chloroform, dried over anhydrous sodium sulfate, and evaporated. Recrystallization from ethyl acetate afforded 0.52 g (50%) of **3g**, identical to the product obtained below.

General Procedure for the Preparation of 2-Hydroxychroman-4-ones (**12**).

Sodium methoxide (3.25 g, 60 mmoles) was suspended in 60 mL of ethyl formate at 0 °C. The mixture was allowed to warm to room temperature and a solution of the appropriate 1-(2-hydroxyphenyl)ethanone (**1**) (20 mmoles) in the minimum amount of

tetrahydrofuran was added dropwise. After stirring for 30 minutes, water (100 mL) was added to the thick suspension, and then acetic acid (4.5 mL). The mixture was stirred for 10 minutes and the aqueous layer was decanted and extracted with further 40 mL of ethyl formate. The organic extracts were washed with 5% sodium bicarbonate solution, dried over anhydrous sodium sulfate, and evaporated to dryness. The residue was suspended in 40 mL of diisopropyl ether, filtered and vacuum dried.

General procedure for the Preparation of 3-(Hydroxymethyl)chromen-4-ones (**3**).

A solution of 10 mmoles of **12**, sodium acetate (40 mg, 0.5 mmole) and a 37% aqueous solution of formaldehyde (1 mL, 12 mmoles) in 40 mL of acetone was stirred for 2 hours at room temperature. Then, concentrated hydrochloric acid (1 mL) was added and the solution was stirred overnight at room temperature. After neutralization by addition of an aqueous solution of sodium acetate, the solvent was evaporated *in vacuo*. Water (50 mL) was then added, and the product was extracted with ethyl acetate (2 x 50 mL). The organic extracts were dried over anhydrous sodium sulfate, and then concentrated to a volume of 15 mL. After standing overnight in the refrigerator, the resulting crystals were filtered, washed with ethyl acetate, and vacuum dried.

7-Hydroxy-3-(hydroxymethyl)chromen-4-one (**3i**).

To an ice bath-cooled suspension of 7-(benzyloxy)-3-(hydroxymethyl)chromen-4-one (**3f**) (10 g, 35 mmoles) in dichloromethane (100 mL) was added dropwise a 1 *M* solution of boron trichloride in dichloromethane (70 mL, 70 mmoles), and the mixture was stirred for 15 minutes at 0 °C and then for 1 hour at room temperature. The resulting precipitates were filtered, washed with dichloromethane, and then dissolved in 125 mL of 2 *M* sodium hydroxide (250 mmoles). The filtered solution was slowly acidified to pH 3 with 6 *M* hydrochloric acid, and the crystals were collected by filtration, washed with water, and vacuum dried at 45 °C to afford 5.6 g (82%) of **3i**. An analytical sample was obtained by recrystallization from methanol, mp 207-209 °C; ir (potassium bromide): 3350, 1640, 1590, 1240 cm^{-1} ; ^1H nmr (deuteriodimethyl sulfoxide): δ 4.34 (s, 2H, CH_2), 5.06 (br s, 1H, OH), 6.84 (d, $J = 2$ Hz, 1H, 8-H), 6.91 (dd, $J = 8.6$ and 2 Hz, 1H, 6-H), 7.90 (d, $J = 8.6$ Hz, 1H, 5-H), 8.07 (s, 1H, 2-H), 10.80 (br s, 1H, OH).

Anal. Calcd. for $\text{C}_{10}\text{H}_8\text{O}_4$: C, 62.50; H, 4.20. Found: C, 62.16; H, 4.43.

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