# Synthesis of 3,3'-arylmethylidenebis-4-hydroxycoumarin derivatives catalysed by KF-montmorillonite

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3,3'-Arylmethylidenebis-4-hydroxycoumarins derivatives have been synthesised in good yields by the Michael addition reaction of aromatic aldehydes with 4-hydroxycoumarin in DMF catalysed by KF-montmorillonite.

**Keywords:** biscoumarins, 3,3'-arylmethylidenebis-4-hydroxycoumarins, 4-hydroxycoumarin, KF-montmorillonite, heterogeneous catalyst

The biscoumarins are naturally occurring compounds.[1-3] A variety of biological activities are associated with coumarins.[4-6]

Recently, smectite clays, especially montmorillonite, have been used as heterogeneous catalysts in synthesis. Because of its stability, selectivity and ease of separation, KF-montmorillonite has found widespread use in a variety of heterogeneous reactions, such as rearrangement,[7-9] oxidation[10] and addition[11] reactions. In the previous reports, montmorillonite clays were used as the acidic catalyst.[12-14] Recently, we have reported its use as an alkaline catalyst for organic synthesis.[15] In this paper, we describe the first application of the KF-montmorillonite solid system as the basic catalyst for the synthesis of 3,3'-arylmethylidenebis-4-hydroxycoumarins derivatives in DMF.

When aromatic aldehydes (**1**) and 4-hydroxycoumarin (**2**) were stirred at 80°C for 6–10 h in DMF catalysed by KF-montmorillonite, 3,3'-arylmethylidenebis-4-hydroxycoumarin derivatives (**3**) were obtained in good yields (Scheme 1). The results are shown in Table 1. As can be seen from Table 1, aromatic aldehydes, with electron-donating group on the ring or electron-withdrawing group on the ring, have little effects on this reaction. In both cases, products can be obtained with good yield in a short reaction time.

In conclusion, the condensation reaction of aromatic aldehydes with 4-hydroxycoumarin has been efficiently performed in DMF. The milder reaction conditions and the easy purification of products simply by crystallisation, provided a new approach to the synthesis of 3,3'-arylmethylidenebis-4-hydroxycoumarins derivatives.

## Experimental

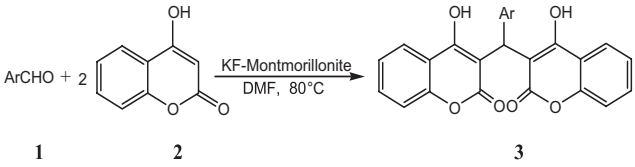
Melting points were determined in open capillaries and are uncorrected. IR spectra were recorded on a FT IR-8101 spectrometer in KBr with absorptions in $cm^{-1}$. $^1H$ NMR was measured on a Bruker 400 MHz spectrometer in DMSO-$d_6$ with TMS as internal standard. Elemental analysis were determined using Perkin-Elmer 2400 elemental analyser. KF-montmorillonite was prepared according to the literature.[16]

*Typical procedure for the synthesis of compound* **3**

A dry 50-ml flask was charged with KF-montmorillonite clay (250 mg), aromatic aldehydes (**1**) (2 mmol), 4-hydroxycoumarin (**2**) (2 mmol) and DMF (15 ml). The mixture was stirred at 80°C for 6–10 h. Then the solid material was filtered off and washed with a little DMF. The filterate was poured into 200 ml water. The white solid was filtered off, then washed with water. The crude solid was purified by recrystallisation from 95% EtOH to give pure compound (**3**).

*Spectroscopic data*

*3,3-(2',4'-dichlorobenzylidene)bis(4-hydroxycoumarin)* (**3a**): $^1H$ NMR (DMSO-$d_6$) δ: 6.30 (s, 1H, CH), 7.11–7.14(m, 2H, ArH), 7.23–7.33 (m, 4H, ArH), 7.44–7.46(m, 1H, ArH), 7.54–7.59 (m, 2H, ArH), 7.86–7.88 (m, 2H, ArH); IR (KBr) *v*: 3400, 3300, 1650, 1630, 1610, 1600, 1560, 1490, 1480, 1450 $cm^{-1}$. Anal. calcd for $C_{25}H_{14}Cl_2O_8$: C 68.39, H 2.39; found C 68.56, H 3.04%.




**Scheme 1**

**Table 1** Synthesis of 3,3'-arylmethylidenebis-4-hydroxycoumarin derivatives catalysed by KF-montmorillonite

| Entry | Ar | Isolated yield/% | M.p./Lit. m.p./°C |
|---|---|---|---|
| **3a** | 2,4-$Cl_2C_6H_3$ | 80 | 263–264 |
| **3b** | 3,4-$(OCH_2O)C_6H_3$ | 80 | 259–260 |
| **3c** | 4-$HOC_6H_4$ | 87 | 169–171 |
| **3d** | 4-$BrC_6H_4$ | 87 | 270–272 |
| **3e** | 4-$CH_3OC_6H_4$ | 88 | 250–252 (242)[16] |
| **3f** | 2,4-$(CH_3O)_2C_6H_3$ | 70 | 198–199 |
| **3g** | 3,4-$(CH_3)_2C_6H_3$ | 72 | 284–285 |
| **3h** | 4-$ClC_6H_4$ | 83 | 260–292 |
| **3i** | 3,4-$Cl_2C_6H_3$ | 89 | 264–266 |
| **3j** | 4-$NO_2C_6H_4$ | 82 | 220–222 (219)[16] |
| **3k** | 3,4-$(CH_3O)_2C_6H_3$ | 81 | 265–267 |

*3,3-(3',4'-methylenedioxybenzylidene)bis(4-hydroxycoumarin)* (**3b**): $^1H$ NMR (DMSO-$d_6$) δ: 5.92 (s, 2H, $OCH_2O$), 6.19 (s, 1H, CH), 6.56–6.61 (m, 2H, ArH), 6.70(d, $J$ = 7.6 Hz, 1H, ArH), 7.24–7.29(m, 4H, ArH), 7.51–7.55 (m, 2H, ArH), 7.84 (d, $J$ = 7.6 Hz, 2H, ArH); IR (KBr) *v*: 3446, 3075, 1663, 1566, 1488, 1436, 1345, 1309, 1235, 1185, 1098, 1039, 934, 809, 764 $cm^{-1}$. Anal. calcd for $C_{26}H_{16}O_8$: C 68.42, H 3.53; found C 68.64, H 3.39%.

*3,3-(4'-hydroxybenzylidene)bis(4-hydroxycoumarin)* (**3c**): $^1H$ NMR (DMSO-$d_6$) δ: 6.25 (s, 1H, CH), 6.62–6.64 (m, 2H, ArH), 6.69–6.95 (m, 2H, ArH), 7.31–7.38 (m, 4H, ArH), 7.58–7.62 (m, 2H, ArH), 7.89–7.92 (m, 2H, ArH); IR (KBr) *v*: 3400, 3300, 1670, 1660, 1620, 1630, 1570, 1450, 1430, 1350, 1310, 1260, 1220, 1180, 1110, 810, 760 $cm^{-1}$. Anal. calcd for $C_{25}H_{16}O_7$: C 70.09, H 3.76; found C 70.16, H 3.59%.

*3,3-(4'-bromobenzylidene)bis(4-hydroxycoumarin)* (**3d**): $^1H$ NMR (DMSO-$d_6$) δ: 6.28 (s, 1H, CH), 7.08–7.12 (m, 2H, ArH), 7.28–7.41 (m, 6H, ArH), 7.56–7.60 (m, 2H, ArH), 7.84–7.89 (m, 2H, ArH); IR (KBr) *v*: 3440, 3300, 3060, 1670, 1640, 1630, 1620, 1600, 1560, 1480, 1450, 1350, 1310, 1260, 1220, 1180, 1110, 820, 760 $cm^{-1}$. Anal. calcd for $C_{25}H_{15}BrO_6$: C 61.12, H 3.08; found C 61.29, H 3.12%.

*3,3-(3'-methoxybenzylidene)bis(4-hydroxycoumarin)* (**3e**): $^1H$ NMR (DMSO-$d_6$) δ: 3.69 (s, 3H, $CH_3O$), 6.25 (s, 1H, CH), 6.76 (d, $J$ = 8.4 Hz, 2H, ArH), 7.03 (d, $J$ = 8.4 Hz, 2H, ArH), 7.27–7.33 (m, 4H, ArH), 7.54–7.58 (m, 2H, ArH), 7.86 (d, $J$ = 8.4 Hz, 2H, ArH); IR (KBr) *v*: 3440, 3074, 1673, 1614, 1565, 1509, 1453, 1350, 1309, 1254, 1216, 1181, 1091, 1035, 957, 905, 828, 767 $cm^{-1}$. Anal. calcd for $C_{26}H_{18}O_7$: C 70.58, H 4.10; found C 70.85, H 3.94%.

*3,3-(2',4'-dimethoxybenzylidene)bis(4-hydroxycoumarin)* (**3f**): $^1H$NMR (DMSO-$d_6$) δ: 3.55 (s, 3H, $CH_3O$), 3.72 (s, 3H, $CH_3O$), 6.15 (s, 1H, CH),

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6.39–6.42 (m, 1H, ArH), 6.46 (s, 1H, ArH), 7.03 (d, $J$ = 8.8 Hz, 1H, ArH), 7.29–7.35 (m, 4H, ArH), 7.55–7.59 (m, 2H, ArH), 7.88 (d, $J$ = 8.8 Hz, 2H, ArH); IR (KBr) $v$: 3448, 3083, 1662, 1608, 1564, 1501, 1453, 1344, 1306, 1263, 1209, 1182,1129, 1092, 1046, 1027, 823, 761 cm$^{-1}$. Anal. calcd for $C_{27}H_{20}O_8$: C 68.64, H 4.27; found C 68.83, H 4.19%.

*3,3-(3',4'-dimethylbenzylidene)bis(4-hydroxycoumarin)* (**3g**): $^1$H NMR (DMSO-$d_6$) δ: 2.11 (s, 3H, $CH_3$), 2.16 (s, 3H, $CH_3$), 6.28 (s, 1H, CH), 6.85–6.87 (m, 1H, ArH), 6.90 (s, 1H, ArH), 6.96–6.98 (m, 1H, ArH), 7.29–7.36 (m, 4H, ArH), 7.56–7.60 (m, 2H, ArH), 7.88–7.90 (m, 2H, ArH); IR (KBr) $v$: 3420, 3300, 1760, 1660, 1620, 1570, 1450, 1430, 1350, 1310, 1260, 1220,1180, 1110, 810, 760 cm$^{-1}$. Anal. calcd for $C_{27}H_{20}O_6$: C 73.63, H 4.58; found C 73.87, H 4.38%.

*3,3-(4'-chlorobenzylidene)bis(4-hydroxycoumarin)* (**3h**): $^1$H NMR (DMSO-$d_6$) δ: 6.26 (s, 1H, CH), 7.12 (d, $J$ = 7.6 Hz, 2H, ArH), 7.22–7.30 (m, 6H, ArH), 7.52–7.55 (m, 2H, ArH), 7.83 (d, $J$ = 7.6 Hz, 2H, ArH); IR (KBr) $v$: 3445, 3076, 1673, 1616, 1565, 1491, 1403, 1351, 1309, 1267, 1215, 1185, 1095, 958, 909, 822, 786, 766 cm$^{-1}$. Anal. calcd for $C_{25}H_{15}ClO_6$: C 67.20, H 3.38; found C 67.39, H 3.27%.

*3,3-(3',4'-dichlorobenzylidene)bis(4-hydroxycoumarin)* (**3i**): $^1$H NMR (DMSO-$d_6$) δ: 6.28 (s, 1H, CH), 7.27–7.33 (m, 4H, ArH), 7.11–7.14 (m, 2H, ArH), 7.44–7.46 (m, 1H, ArH), 7.54–7.59 (m, 2H, ArH), 7.86–7.88 (m, 2H, ArH); IR (KBr) $v$: 3430, 3300, 3080, 1650, 1630, 1610, 1600, 1560, 1490, 1480, 1450, 1350, 1310, 1260, 1220, 1100, 820, 760 cm$^{-1}$. Anal. calcd for $C_{25}H_{14}Cl_2O_6$: C 62.39, H 2.93; found C 62.58, H 2.75%.

*3,3-(4'-nitrobenzylidene)bis(4-hydroxycoumarin)* (**3j**): $^1$H NMR (DMSO-$d_6$) δ: 6.34 (1H, s), 7.22–7.27 (4H, m), 7.29–7.37 (2H, m), 7.05–7.54 (2H, m), 7.81 (2H, *d*, $J$ = 7.6 Hz), 8.06 (2H, *d*, $J$ = 8.4 Hz); IR (KBr) $v$: 3440, 3073, 1679, 1611, 1541, 1514, 1468, 1404, 1344, 1179, 1109, 1036, 1019, 944, 903, 850, 829, 761 cm$^{-1}$. Anal. calcd for $C_{25}H_{15}O_8$: C 65.65, H 3.31, N 3.06: found C 65.68, H 3.16, N 2.97%.

*3,3-(3',4'-dimethoxybenzylidene)bis(4-hydroxycoumarin)* (**3k**):$^1$H NMR (DMSO-$d_6$) δ: 3.74 (3H, s), 3.87 (3H, s), 6.08 (1H, s), 6.71 (1H, s), 6.76–6.83 (2H,m), 7.41–7.43 (4H, m), 7.62–7.66 (2H, m), 8.02–8.07 (2H, m), 11.30 (1H, s), 11.54 (1H, s); IR (KBr) $v$: 3447, 3080, 1664, 1615, 1565, 1515, 1352, 1312, 1265, 1246, 1143, 1097, 1028, 808, 767 cm$^{-1}$. Anal. calcd for $C_{27}H_{20}O_8$: C 68.64, H 4.27; found C 68.82, H 4.18%.

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## References

1 K.P. Link, *Fed. Proc.,* 1945, **4**, 176.
2 P. Sengupta, M. Sen and P. Karuri, *J. Ind. Chem. Soc.,* 1985, **62**, 916.
3 R.D.H. Murray, *Fortschr Chem. Org. Naturst*, 1991, **58**, 83.
4 L.A. Singer and N.P. Kong, *J. Am. Chem. Soc*., 1966, **88**, 5213.
5 A. Schonberg and N. Ltif, *J. Am. Chem. Soc*., 1954, **76**, 6208.
6 A. Mitra, S.K. Misra and A. Petra, *Synth. Commun*., 1980, **10**, 915.
7 V. Hauke, J.M. Trendel and P. Albrecht, *Tetrahedron Lett.,* 1994, **35**, 2227.
8 S. Chalais, P. Laszlo and A. Mathy *Tetrahedron Lett.*, 1986, **27**, 2627.
9 W.G. Dauben, J.M. Cogen and V. Behar, *Tetrahedron Lett.,* 1990, **31**, 3241.
10 A. Cornelis and P. Laszlo, *Synthesis*, 1980,849.
11 M.E.F. Braibante, H.S. Braibante, L. Missio and A. Andricopulo, *Synthesis*, 1994, 898.
12 D. Villemin and B. Martin, *J. Chem. Res. (S),* 1994, 146.
13 A. Cornelis, P. Laszlo and P. Pennetreau, *Bull. Soc. Chim. Belg.*, 1984, **93**, 961.
14 J. Cabral, P. Laszlo and L. Mahe, *Tetrahedron Lett.*, 1989, **30**, 3969.
15 Shi Daqing, Wang Xiangshan, Yao Changsheng and Mu Lailong, *J. Chem. Res. (S),* 2002, 344.
16 M.K. Khalid, I. Sajid and A.L. Muhammad, *et al. Bioorg. Med. Chem.,* 2004, **12**, 1963.