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Mendeleev Commun., 2007, **17**, 247–248
Mendeleev Communications

Microwave-assisted synthesis of 14-aryl-14*H*-dibenzo[*a.j*]xanthenes catalysed by methanesulfonic acid under solvent-free conditions

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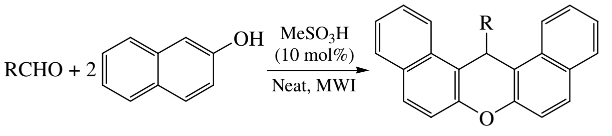
DOI: 10.1016/j.mencom.2007.06.023

The synthesis of 14-aryl-14*H*-dibenzo[*a.j*]xanthenes is described through a one-pot condensation of β-naphthol with aryl aldehydes in the presence of methanesulfonic acid as the catalyst under solvent-free conditions using microwave irradiation.

Xanthenes, especially benzoxanthenes, are of interest due to their antibacterial,[1] antiviral[2] and anti-inflammatory properties,[3] as well as use in photodynamic therapy[4] and for antagonism of the paralyzing action of zoxazolamine.[5] Furthermore, these compounds could also be used as dyes,[6] in laser technologies[7] and as pH-sensitive fluorescent materials for visualization of biomolecules.[8] Several procedures describe the synthesis of xanthenes and benzoxanthenes.[9] The reaction of β-naphthol with aldehydes or acetals under acidic conditions was reported.[10] However, many of these methodologies suffer from disadvantages such as prolonged reaction times, low yields, *etc*.

Methanesulfonic acid is useful for various transformations[11–13] as it is commercially available, environmentally benign, easy to handle and readily biodegradable.[14,15] Here, we report an efficient, convenient and facile method for the condensation of aldehydes with β-naphthol to corresponding benzoxanthenes catalysed by methanesulfonic acid under solvent-free conditions using microwave irradiation. Thus, the reaction of an aldehyde (1.0 mmol), β-naphthol (2.0 mmol) and methanesulfonic acid (10 mol%) under microwave irradiation furnished the corresponding benzoxanthene in good to excellent yield (Scheme 1).[†]



1 **2** **3**

Scheme 1

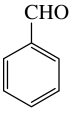
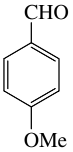
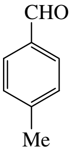
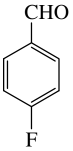
In order to establish the generality of the present reaction, several structurally diverse aldehydes (Table 1) were subjected to condensation with β-naphthol under the catalytic influence of methanesulfonic acid under solvent-free conditions, and 14-aryl-14*H*-dibenzo[*a.j*]xanthenes were obtained in high yields. The generality and the scope of the reagent could be easily gauged from the comparison of the data in Table 2. The comparison for some model substrates was made with respect to yields, reaction time and mol% of the catalyst used. Note that 4-fluorobenzaldehyde and 4-tolylbenzaldehyde provide the desired product within 1 min with higher yield than the earlier reported methods.

Table 1 Methanesulfonic acid catalysed synthesis of 14-aryl-14*H*-dibenzo-[*a.j*]xanthenes.[a]

Entry	Aldehyde **1**	Product	t/min	Yield[b] (%)	Mp/°C	References
1	PhCHO	**3a**	2	86	184–185	10(*d*),(*f*),(*g*)
2	3-$MeOC_6H_4CHO$	**3b**	3	88	180–181	—
3	4-$MeOC_6H_4CHO$	**3c**	4	72	204–205	10(*d*)
4	4-MeC_6H_4CHO	**3d**	1	94	229–230	10(*d*),(*f*),(*g*)
5	3-MeO-4-HO-C_6H_3CHO	**3e**	2	65	208–210	10(*c*)
6	3-ClC_6H_4CHO	**3f**	2	70	183–185	—
7	4-FC_6H_4CHO	**3g**	1	95	239–240	10(*d*)

[a] All products were characterised by spectral data and also by comparison with published data. [b] Yields refer to pure isolated products.

Table 2 Comparison of methanesulfonic acid with other catalysts for the synthesis of 14-aryl-14*H*-dibenzo[*a.j*]xanthenes.

Substrate	Catalyst	Catalyst (mol%)	Reaction time	Yield[a] (%)
	Selectfluor®	10	8 h	93[10(*b*)]
	Iodine	10	2.5 h	90[10(*c*)]
	p-TSA	2	4 h	89[10(*d*)]
	LiBr/MW	15	4 min	83[10(*f*)]
	Methanesulfonic acid/ MW	10	2 min	86
	Selectfluor®	10	10 h	92[10(*b*)]
	Iodine	10	4 h	89[10(*c*)]
	p-TSA	2	6 h	80[10(*d*)]
	LiBr/MW	15	4.5 min	82[10(*f*)]
	Methanesulfonic acid/ MW	10	3 min	88
	Selectfluor®	10	11 h	92[10(*b*)]
	Iodine	10	3 h	88[10(*c*)]
	p-TSA	2	3 h	92[10(*d*)]
	LiBr/MW	15	3 min	82[10(*f*)]
	Methanesulfonic acid/ MW	10	1 min	94
	Selectfluor®	10	6 h	93[10(*b*)]
	Iodine	10	2.5 h	93[10(*c*)]
	p-TSA	2	3 h	90[10(*d*)]
	Methanesulfonic acid/ MW	10	1 min	95

[a] References for earlier methods.

In conclusion, methanesulfonic acid is a highly efficient acid catalyst for the synthesis of 14-aryl-14*H*-dibenzo[*a.j*]xanthenes by the one-pot condensation of aldehydes and β-naphthol under microwave irradiation. The main advantages of this method are mild, clean and solvent-free reaction conditions, good to excellent yields and an environmentally benign catalyst. This reaction system not only provides a novel method for the synthesis of biologically important 14-aryl-14*H*-dibenzo[*a.j*]xanthenes but also is an environmentally friendly chemical process.

AKB is grateful to the Director, NCL, Pune for financial support (MLP008626) and to Dr. Mukund K. Gurjar, Head, Division of Organic Chemistry and Prof. Krishna N. Ganesh, J. C. Bose Fellow and Director, IISER, Pune for constant encouragement and support. KCR is grateful to the Council of Scientific and Industrial Research (CSIR), New Delhi for a research fellowship.

References

1 T. Hideo, *Jpn. Tokkyo Koho JP 56005480*, 1981 (*Chem. Abstr.*, 1981, **95**, 80922b).

2 R. W. Lambert, J. A. Martin, J. H. Merrett, K. E. B. Parkes and G. J. Thomas, *PCT Int. Appl. WO 9706178*, 1997 (*Chem. Abstr.* 1997, **126**, p212377y).

3 J. P. Poupelin, G. Saint-Rut, O. Foussard-Blanpin, G. Narcisse, G. Uchida-Ernouf and R. Lacroix, *Eur. J. Med. Chem.*, 1978, **13**, 67.

4 (*a*) R. M. Ion, *Prog. Catal.*, 1997, **2**, 55; (*b*) R. M. Ion, D. Frackowiak, A. Planner and K. Wiktorowicz, *Acta Biochim. Pol.*, 1998, **45**, 833.

5 (*a*) G. Saint-Ruf, A. De and H. T. Hieu, *Bull. Chim. Ther.*, 1972, **7**, 83; (*b*) G. Saint-Ruf, H. T. Hieu and J. P. Poupelin, *Naturwissenschaften*, 1975, **62**, 584.

6 (*a*) S. M. Menchen, S. C. Benson, J. Y. L. Lam, W. Zhen, D. Sun, B. B. Rosenblum, S. H. Khan and M. Taing, *US Patent 6583168*, 2003 (*Chem. Abstr.*, 2003, **139**, p54287f); (*b*) A. Banerjee and A. K. Mukherjee, *Stain Technol.*, 1981, **56**, 83; (*c*) G. A. Reynolds, S. A. Tuccio, O. G. Peterson and D. P. Specht, *Ger. Offen. DE 2109040*, 1971 (*Chem. Abstr.*, 1971, **71**, p81334c).

7 (*a*) O. Sirkeeioglu, N. Talinli and A. Akar, *J. Chem. Res. (S)*, 1995, 502; (*b*) M. Ahmad, T. A. King, Do-K. Ko, B. H. Cha and J. Lee, *J. Phys. D: Appl. Phys.*, 2002, **35**, 1473.

8 C. G. Knight and T. Stephens, *Biochem. J.*, 1989, **258**, 683.

9 (*a*) D. W. Knight and P. B. Little, *Synlett.*, 1998, 1141; (*b*) D. W. Knight and P. B. Little, *J. Chem. Soc., Perkin Trans. 1*, 2001, 1771; (*c*) A. Bekaert, J. Andrieux and M. Plat, *Tetrahedron Lett.*, 1992, **33**, 2805; (*d*) C. A. Buehler, D. E. Cooper and E. O. Scrudder, *J. Org. Chem.*, 1943, **8**, 316; (*e*) R. Vazquez, M. C. de la Fuente, L. Castedo and D. Dominguez, *Synlett.*, 1994, 433; (*f*) H. Ishibashi, K. Takagaki, N. Imada and M. Ikeda, *Synlett.*, 1994, 49; (*g*) A. Jha and J. Beal, *Tetrahedron Lett.*, 2004, **45**, 8999; (*h*) C.-W. Kuo and J.-M. Fang, *Synth. Commun.*, 2001, **31**, 877.

10 (*a*) S. B. Patil, R. P. Bhat and S. D. Samant, *Synth. Commun.*, 2006, **36**, 2163; (*b*) P. S. Kumar, B. S. Kumar, B. Rajitha, P. N. Reddy, N. Sreenivasalu and Y. T. Reddy, *Arkivoc*, 2006, 46; (*c*) B. Das, B. Ravikanth, R. Ramu, K. Laxminarayana and B. V. Rao, *J. Mol. Catal. A: Chem.*, 2006, **255**, 74; (*d*) A. R. Khosropour, M. M. Khodaei and H. Moghannian, *Synlett.*, 2005, 955; (*e*) B. Rajitha, B. S. Kumar, Y. T. Reddy, P. N. Reddy and N. Sreenivasulu, *Tetrahedron Lett.*, 2005, **46**, 8691; (*f*) A. Saini, S. Kumar and J. S. Sandhu, *Synlett.*, 2006, 1928; (*g*) R. J. Sarma and J. B. Baruah, *Dyes Pigm.*, 2005, **64**, 91.

11 (*a*) R. Namme, T. Mitsugi, H. Takahashi and S. Ikegami, *Tetrahedron Lett.*, 2005, **46**, 3033; (*b*) S. S. Bhar and M. M. V. Ramana, *J. Org. Chem.*, 2004, **69**, 8935; (*c*) U. Matteoli, A. Scrivanti and V. Beghetto, *J. Mol. Catal. A: Chem.*, 2004, **213**, 183.

12 (*a*) B. X. Luong, A. L. Petre, W. F. Hoelderich, A. Commaieu, J.-A. Laffitte, M. Espeillac and J. Souchet, *J. Org. Chem.*, 2004, **226**, 301; (*b*) O. Mouthtady, H. G. Iloughmane, N. Roques and C. L. Roux, *Tetrahedron Lett.*, 2003, **44**, 6379.

13 N. Suryakiran, T. S. Reddy, K. A. Latha, P. Prabhakar, K. Yadagiri and Y. Venkateswarlu, *J. Mol. Catal. A: Chem.*, 2006, **258**, 371.

14 A. Commarieu, W. Hooelderich, J. A. Laffite and M.-P. Dupont, *J. Mol. Catal. A: Chem.*, 2002, **182**, 137.

15 S. C. Baker, *Nature*, 1991, **350**, 627.

Received: 15th January 2007; Com. 07/2860

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† *General experimental procedure*. To a mixture of an aldehyde (1 mmol) and 2-naphthol (2 mmol), methanesulfonic acid (10 mol%) was added, and the mixture was microwaved (Kenstar Model No. OM-9918C; 2450 MHz, 2350 W) for a specified period (Table 1) in an open vessel. After completion (TLC), the reaction mass was cooled to room temperature, water was added and extracted with dichloromethane (3×50 ml). The combined extracts were dried (anhydrous Na_2SO_4) and evaporated to dryness. The crude was subjected to column chromatography (SiO_2, 230–400 mesh, EtOAc–hexane) to furnish pure compounds. All the products were characterised by spectral data and comparison with authentic samples.

*14-Phenyl-14*H*-dibenzo[*a,j*]xanthene* **3a**: ^{1}H NMR (200 MHz, $CDCl_3$) δ: 6.48 (s, 1H), 6.93–7.13 (m, 3H), 7.36–7.61 (m, 8H), 7.76–7.83 (m, 4H), 8.38 (d, 2H, *J* 8.8 Hz). ^{13}C NMR (50 MHz, $CDCl_3$) δ: 38.1, 117.4, 118.1, 122.7, 124.3, 126.4, 126.8, 128.3, 128.5, 128.8, 128.9, 131.1, 131.5, 145.1, 148.8. IR ($CHCl_3$, ν/cm^{-1}): 2923, 1591, 1461, 1377, 1249. Found (%): C, 90.30; H, 4.98. Calc. for $C_{27}H_{18}O$ (%): C, 90.47; H, 5.06.

*14-(3-Methoxyphenyl)-14*H*-dibenzo[*a,j*]xanthene* **3b**: ^{1}H NMR (200 MHz, $CDCl_3$) δ: 3.61 (s, 3H), 6.41 (s, 1H), 6.48–6.53 (m, 1H), 7.01–7.13 (m, 3H), 7.34–7.60 (m, 6H), 7.74–7.82 (m, 4H), 8.38 (d, 2H, *J* 8.4 Hz). ^{13}C NMR (50 MHz, $CDCl_3$) δ: 38.0, 55.1, 111.0, 115.0, 117.2, 118.0, 120.8, 122.8, 124.3, 126.8, 128.8, 128.9, 129.3, 131.1, 131.5, 146.6, 148.8, 159.6. IR ($CHCl_3$, ν/cm^{-1}): 3018, 2958, 2933, 1593, 1487, 1458, 1431, 1400, 1251. Found (%): C, 86.45; H, 5.06. Calc. for $C_{28}H_{20}O_2$ (%): C, 86.57; H, 5.19.

*14-(4-Methoxyphenyl)-14*H*-dibenzo[*a,j*]xanthene* **3c**: ^{1}H NMR (200 MHz, $CDCl_3$) δ: 3.57 (s, 3H), 6.41 (s, 1H), 6.64 (d, 2H, *J* 8.5 Hz), 7.33–7.58 (m, 8H), 7.72–7.81 (m, 4H), 8.35 (d, 2H, *J* 8.5 Hz). ^{13}C NMR (50 MHz, $CDCl_3$) δ: 37.1, 55.1, 113.9, 117.5, 118.0, 122.7, 124.2, 126.8, 128.8, 128.8, 129.2, 131.1, 131.4, 137.4, 148.7, 157.8. IR ($CHCl_3$, ν/cm^{-1}): 3018, 2399, 1602, 1508, 1423, 1215. Found (%): C, 86.46; H, 5.13. Calc. for $C_{28}H_{20}O_2$ (%):C, 86.57; H, 5.19.

*14-(4-Methylphenyl)-14*H*-dibenzo[*a,j*]xanthene* **3d**: ^{1}H NMR (200 MHz, $CDCl_3$) δ: 2.12 (s, 3H), 6.45 (s, 1H), 6.94 (d, 2H, *J* 8.1 Hz), 7.35–7.61 (m, 8H), 7.75–7.83 (m, 4H), 8.38 (d, 2H, *J* 8.4 Hz). ^{13}C NMR (50 MHz, $CDCl_3$) δ: 21.0, 37.7, 117.5, 118.1, 122.8, 124.3, 126.9, 128.2, 128.9, 129.3, 131.2, 131.6, 136.0, 142.2, 148.8. IR ($CHCl_3$, ν/cm^{-1}): 2943, 2852, 2362, 1591, 1461, 1377, 1242. Found (%): C, 90.12; H, 5.36. Calc. for $C_{28}H_{20}O$ (%): C, 90.29; H, 5.41.

*14-(4-Hydroxy-3-methoxyphenyl)-14*H*-dibenzo[*a,j*]xanthene* **3e**: ^{1}H NMR (200 MHz, $CDCl_3$) δ: 3.64 (s, 3H). 5.32 (s, 1H), 6.42 (s, 1H), 6.71 (d, 1H, *J* 8.0 Hz), 6.82 (d, 1H, *J* 2.14 Hz), 7.12–7.16 (m, 1H), 7.37–7.58 (m, 6H), 7.76–7.84 (m, 4H), 8.39 (d, 2H, *J* 8.30 Hz). ^{13}C NMR (50 MHz, $CDCl_3$) δ: 40.8, 58.9, 114.6, 117.5, 120.8, 121.1, 124.2, 126.0, 127.5, 129.9, 132.0, 134.3, 134.7, 140.2, 147.5, 150.5, 151.9. IR ($CHCl_3$, ν/cm^{-1}): 3020, 2399, 1593, 1508, 1431, 1215. Found (%): C, 83.02; H, 4.88. Calc. for $C_{28}H_{20}O_3$ (%): C, 83.15; H, 4.98.

*14-(3-Chlorophenyl)-14*H*-dibenzo[*a,j*]xanthene* **3f**: ^{1}H NMR (200 MHz, $CDCl_3$) δ: 6.46 (s, 1H), 6.94–7.12 (m, 2H), 7.39–7.64 (m, 8H), 7.79–7.86 (m, 4H), 8.32 (d, 2H, *J* 8.4 Hz). ^{13}C NMR (50 MHz, $CDCl_3$): 37.8, 116.6, 118.1, 122.5, 124.4, 126.5, 126.8, 127.0, 128.4, 129.0, 129.2, 129.7, 131.1, 131.3, 134.4, 147.0, 148.8. IR ($CHCl_3$, ν/cm^{-1}): 2918, 2852, 2362, 2335, 1596, 1458, 1377, 1251. Found (%): C, 82.26; H, 4.18. Calc. for $C_{27}H_{17}ClO$ (%): C, 82.54; H, 4.36.

*14-(4-Flourophenyl)-14*H*-dibenzo[*a,j*]xanthene* **3g**: ^{1}H NMR (200 MHz, $CDCl_3$) δ: 6.48 (s, 1H), 6.77–7.86 (m, 2H), 7.38–7.62 (m, 8H), 7.78–7.86 (m, 4H), 8.34 (d, 2H, *J* 8.2 Hz). ^{13}C NMR (50 MHz, $CDCl_3$): 37.2, 115.1, 115.6, 117.1, 118.0, 122.5, 124.4, 126.9, 128.9, 129.0, 129.6, 129.7, 131.1, 131.3, 140.8, 140.8, 148.7. IR ($CHCl_3$, ν/cm^{-1}): 2952, 2852, 2362, 2331, 1591, 1458, 1377, 1247, 1213. Found (%): C, 86.02; H, 4.28. Calc. for $C_{27}H_{17}FO$ (%): C, 86.15; H, 4.55.

The English language edited by Valentin V. Makhlyarchuk, Moscow
Typeset by Sergei I. Ososkov, Moscow
Printed in the United Kingdom by Alden Press