

THE ONE-POT SYNTHESIS OF 14-ARYL-14H-DIBENZO[A,J]XANTHENE DERIVATIVES USING BARIUM HYDROXIDE UNDER SOLVENT FREE CONDITIONS



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ABSTRACT

A simple, efficient, greener method for the synthesis of biological active 14-aryl-14H-dibenzo[a,j]xanthenes derivatives has been achieved by one-pot condensation of aryl aldehydes and β -naphthol under solvent free condition using Barium Hydroxide as a heterogeneous base with excellent yields in a very short span of time.

KEYWORDS

14-Aryl-14H-dibenzo[a,j]xanthenes derivatives, Aldehyde, β -naphthol, One-pot reaction, Solvent free, Green synthesis.

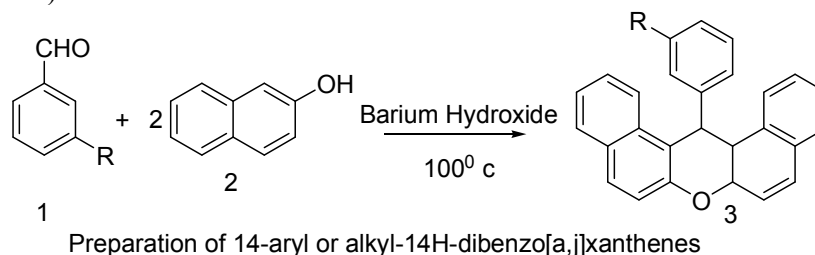
INTRODUCTION

For synthesis point of view xanthenes are very important in organic synthesis due to their wide biological and pharmacological properties, such as anti-inflammatory [1], agricultural bactericide activity [2], and antiviral activity [3]. They have also been used for photodynamic therapy [4], used as dyes [5], and in laser technologies [6]. In the literature there are many methods for the synthesis of xanthenes derivatives have been reported, including reaction of aryloxymagnesium halides with triethylorthoformate [7], cyclodehydration[8], trapping of benzyne by phenols [9], and using sulphonic acid functionalized silica under solvent free condition[10]. Many of these methods suffer from disadvantages such as low yields, harsh reaction condition, long reaction time, lack of easy availability of starting material and the use of toxic solvents. So it is important to develop more convenient and simple method for the preparation of Xanthene derivatives.

Keeping in view of increasing demand for clean and efficient chemical reactions result in solvent free reaction condition along with high yield, also economy and environmental concerns encourage the application of heterogeneous catalysts to carry out various organic transformations due to easy handling and removing from reaction mixture to become experimental procedure very simple and ecofriendly. Therefore, performing an organic synthesis using a simple and efficient catalyst would be an ideal methodology by using solvent free condition. Recently Barium Hydroxide as a heterogeneous solid catalyst in so many one pot synthesis of different biologically active compounds [11]. In continuation of our studies on the application of solvent free condition we had the opportunity to explore the catalytic activity of Barium Hydroxide towards the synthesis of 14-aryl or alkyl-14H-dibenzo[a,j]xanthenes derivatives under solvent free conditions.

RESULT AND DISCUSSION

In this paper, the preparation of 14-aryl or alkyl-14H-dibenzo[a,j]xanthenes have been studied by condensation of β -naphthol and various aldehydes in presence of heterogeneous base catalyst (Scheme 1).



Scheme 1

First of all we investigated the catalytic activity of barium hydroxide in synthesis of dibenzoxanthenes under different reaction conditions using different solvents by condensation of benzaldehyde and β -naphthol in presence of heterogeneous base. Among the solvents such as methanol, ethanol, CH_3CN , 1,2-dichloroethane, CHCl_3 and a solvent-free system, the best method was obtained by barium hydroxide with high yield (89%) in solvent free condition. Therefore, the all reaction with different aldehydes are summarized in Table 1. The reaction takes 10-20 minutes by simple grinding, and yields dibenzoxanthenes and progress of reaction is checked by TLC.

Table 1. Synthesis of 14-substituted-14H-dibenzo[a,j]xanthenes under solvent-free condition.

Entry	Aldehydes	Product	Time(min)	Yield (%)	m.p ($^{\circ}\text{C}$)
1	Ph	3a	15	89	182-183
2	3- $\text{NO}_2\text{C}_6\text{H}_5$	3b	20	85	210-212
3	3- $\text{CH}_3\text{C}_6\text{H}_5$	3c	15	88	198-200
4	3- $\text{OCH}_3\text{C}_6\text{H}_5$	3d	20	89	174-176

Completion of the reaction was monitored by TLC, the crude product was dissolved in hot ethyl acetate, the heterogeneous solid catalyst was removed easily by simple filtration and after cooling and reduced solvent, the pure crystals of products were obtained. The new products were characterized by IR and NMR spectroscopy data. Melting points are compared with reported values in literature. The reaction of 4-chlorobenzaldehyde and β -naphthol has been studied with several catalysts in literature (Table 2). The present methodology provides several advantages, such as simple procedure, excellent yields, short reaction time, easy synthesis, simple work-up and greener condition in contrast with other existing methods.

Table 2. Comparison of efficiency of various catalysts in synthesis of 14-aryl-14H-dibenzo[a,j]xanthenes

Entry	Catalyst	Condition	Time (h)	Yield (%)
1	Sulphuric acid	AcOH/80 ⁰ C	73	60-90
2	p-Toluene sulfonic acid	ClCH ₂ CH ₂ Cl/reflux	15-24	83-95
3	I ₂	Solvent free	2.5-5	82-95
4	Cellulose sulphuric acid	Solvent free/100 ⁰ C	1.5-3	81-97
5	Barium Hydroxide	Solvent free	10-20 min.	85-89

CONCLUSION

In summary, a novel and highly efficient method for the synthesis of 14-aryl-14H-dibenzo[a,j]xanthenes derivatives has been achieved by simple condensation reaction of aromatic aldehydes and two mole of β -naphthol using barium hydroxide as a solid base under solvent free condition. The attractive feature of this method are simple procedure, excellent yields, short reaction time, easy synthesis, simple work-up, greener condition and non-chromatographic purification of products. This approach could make a valuable contribution to the existing process in the field of dibenzoxanthene derivatives synthesis.

EXPERIMENTAL SECTION

IR spectra were recorded from KBr disks using a FT-IR Bruker Tensor 27 instrument. Melting points were measured using the open capillary tube method with an electro thermal 9200 apparatus. ¹H-NMR (250 MHz) was run on a Bruker DPX, 250 MHz spectrometer.

General procedure for the preparation of 14-aryl-14H-dibenzo[a,j]xanthene derivatives

At first, the barium hydroxide was activated in a oven at 100⁰ C and then after cooling to room temperature, a mixture of 2-naphthol (1 mmol), and aldehyde (2 mmol) was added and grinding in a pastel motor for 10-20 min. The mixture was heated at 100⁰ C for 10 min. And progress of the reaction was monitored by TLC, after completion of reaction mixture was cooled to room temperature. The crude product was heated in ethyl acetate and the catalyst was removed by filtration and new compound was confirmed by melting point, IR and NMR data which already present in literature.

Spectral data of some representative compounds

14-phenyl-14H-dibenzo[a,j]xanthene **3a**: White solid, Melting point 182-183, IR (KBr, cm⁻¹): $\nu_{\max}$ =3074, 3020, 2924, 1623, 1590, 1512, 1454, 1400, 1251, 1077, 961, 826, 802, 742 cm⁻¹; ¹H NMR (250 MHz, CDCl₃): δ =6.48 (s, 1H, CH), 6.97(tt, j=7.5 1H, ArH), 7.13(tt, j=7.5 2H, ArH), 7.39 (t, j=7.5 2H, ArH), 7.45–7.59 (m, 6H, ArH), 7.79(t, j=8.5 4H, ArH), 8.40(d, j=8.5Hz, 2H, ArH) ppm.
 14-(3-nitrophenyl)-14H-dibenzo[a,j]xanthene **3b**. Yellow solid, Melting point 210-212, IR (KBr, cm⁻¹): $\nu_{\max}$ =3076, 2925, 1592, 1527, 1435, 1431, 1252, 812, 747 cm⁻¹; ¹H NMR (250 MHz, CDCl₃): δ =6.59 (s, 1H, CH), 7.25-7.86(m, 13H, ArH), 8.28(d, j=7.5Hz, 2H, ArH), 8.41(s, 1H, ArH) ppm.

14-(3-methylphenyl)-14H-dibenzo[a,j]xanthene **3c**: White solid, Melting point 198-200, IR (KBr, cm⁻¹): $\nu_{\max}$ =3018, 2921, 1623, 1591, 1512, 1457, 1400, 1249, 960, 826, 806, 802, 743 cm⁻¹; ¹H NMR (250 MHz, CDCl₃): δ =2.14(s, 3H, CH), δ =6.42 (s, 1H, CH), 6.96(d, j=7.5 1H, ArH), 7.03(t, j=7.5 1H, ArH), 7.22-7.40 (m, 4H, ArH), 7.44(d, j=8.75Hz, 2H, ArH), 7.55(t, j=7.5 2H, ArH), 7.74(t, j=10Hz, 4H, ArH), 8.36(d, j=7.5Hz, 2H, ArH) ppm.

14-(3-methoxyphenyl)-14H-dibenzo[a,j]xanthene **3d**: Pale pink solid, Melting point 174-176, IR (KBr, cm^{-1}): ν_{max} =3068, 3011, 2932, 1583, 1454, 1430, 1399, 1248, 1048, 961, 808, 743 cm^{-1} ; ^1H NMR (250 MHz, CDCl_3): δ =3.61(s, 3H, OCH_3), δ =6.45 (s, 1H, CH), 6.51(dd, j =7.5 1H, ArH), 7.01-7.47 (m, 6H, ArH), 7.55(t, j =7.5Hz, 2H, ArH), 7.78(t, j =7.5 4H, ArH), 8.39(d, j =7.5Hz, 2H, ArH) ppm.

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REFERENCE

- [1] J. M. Jamison, K. Krabill, A. Hatwalkar, Potentiation of the antiviral activity by xanthene dyes, *Cell. Biol. Int. Rep.*, 14 (1990), pp. 1075–1084
- [2] T. Hideu Benzopyrano[2,3-b]xanthene derivatives *Chem. Abstr.*, 95 (1981), pp. 80922b
- [3] R.M. Ion, D. Frackowiak, K. Wiktorowicz, The incorporation of various porphyrins into blood cells measured via flow cytometry, absorption and emission spectroscopy *Acta. Biochim. Pol.*, 45 (1998), pp. 833–845
- [4] J. P. Poupelin, G. Saint-Ruf, O. Foussard-Blanpin, G. Narcisse, G. Uchida-Emouf, R. Lacroix, Synthesis and antiinflammatory properties of bis(2-hydroxy-1-naphthyl) methane derivatives, *Eur. J. Med. Chem.*, 13 (1978), pp. 67–71
- [5] B. B. Bhowmik, P. Ganguly, Photophysics of xanthene dyes in surfactant solution, *Spectrochim. Acta A*, 61 (2005), pp. 1997–2003
- [6] O. Sirkecioglu, N. Talinli, A. Akar, Synthesis of 14-alkyl-14H-dibenzo[a,j]xanthenes *J. Chem. Res. (S)* (1995), pp. 502–506
- [7] G. Casiraghi, G. Casnati, M. Catellam, M. Cornia, Regiospecific reactions of phenol salts: reaction-pathways of alkylphenoxy-magnesiumhalides with triethylorthoformate, *Tetrahedron Lett.*, 14 (1973), pp. 679–682
- [8] A. Bekaert, J. Andrieux, M. Plat, New total synthesis of bikaverin, *Tetrahedron Lett.*, 33 (1992), pp. 2805–2806
- [9] D.W. Knight, P.B. Little, The first high-yielding benzyne cyclisation using a phenolic nucleophilic, *Synlett.*, 10 (1998), pp. 1141–1143
- [10] G. M. Ziarani, A.R. Badiei, M. Azizi, The one-pot synthesis of 14-aryl-14H-dibenzo[a,j]xanthene derivatives using sulfonic acid functionalized silica under solvent free conditions, *Scientia Iranica.*, 18 (2011), pp. 453-457