Molecular iodine catalyzed synthesis of aryl-14H-dibenzo[a,j]xanthenes under solvent-free condition

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Abstract—Molecular iodine efficiently catalyzes the reaction of β-naphthol and araldehydes on a preheated hot plate at 90–95°C to give biologically active aryl-14H-dibenzo[a,j]xanthenes under solvent-free condition. The yields are excellent and the reactions go to completion within 15–20 min.

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Aryl-14H-dibenzo[a,j]xanthenene functionality is a key structural element of many biologically active compounds such as antibacterials,1 antivirals2 and anti-inflammatory agents3 and in photodynamic therapy.4 Xanthene-based compounds have also been investigated for agricultural bactericide activity and some other benzoxanthenes find application in industries such as dyes in laser technology and fluorescent materials for visualization of biomolecules.6 Xanthene dyes are extracted naturally from soil and plants such as Indigofera longiracemosa.7 Chemical synthesis of xanthenes has been documented by a variety of methods such as reactions including palladium catalyzed cyclisation of polycyclic aryltriflate esters,8 intermolecular trapping of benzenes by phenols,9 reaction of aryloxymagnesium halides with triethylorthoformate10 and using conc. HCl/CH3COOH or H3PO4 from β-naphthol and araldehydes or acetals.11a,1b Some of the methods involve tedious experimental procedures such as heating the contents at 125°C for 6–12 h,12a give a mixture of products12b and the yields of some of the products are low.13 Further, Rajitha et al.12a and Ahmad et al.13 carried out the synthesis of 14H-dibenzo[a,j]xanthenes from araldehydes and β-naphthol in presence of sulfamic acid and p-toluene sulfonic acid, respectively, under microwave irradiation, where the chemistry community fails to carryout reactions on a large-scale.

Khosropour et al.14 reported the synthesis of alkyl-14H or aryl-14H-dibenzo[a,j]xanthenes from aldehydes, β-naphthol and p-toluenesulfonic acid in 1,2-dichloroethane as solvent and under solvent-free condition. The yields of some of the products were not satisfactory; the reactions require extended time as long as 2.5–24 h. Therefore, practical methods of obtaining aryl-14H-dibenzo[a,j]xanthenes are of great interest in the lead optimization process of drug discovery. To avoid the limitations, we started search for new catalysts, with high catalytic activity, easy availability and short reaction time involving simple work-up procedure, and molecular iodine attracted our attention because molecular iodine is known to catalyze a number of organic transformations.15a Recently, we have reported the synthesis of N,N′-disubstituted ureas/thioureas catalyzed by molecular iodine15b and α-iodoacetates from alkenes/ammonium acetate/I2.15c

Results and discussion: In continuation with the search for simple non-hazardous methods for the transformations in organic synthesis using iodine, herein we report a highly versatile and efficient synthesis of aryl-14H-dibenzo[a,j]xanthenes 3 (Scheme 1) from araldehydes 1, β-naphthol 2 and catalytic amounts of iodine. In a typical reaction, a mixture of 1 and 2 (1:2) equivalents, respectively, and iodine (cat.) was taken in a 50 mL flat-bottomed flask and heated for 15–20 min on a hot plate at 90–95°C under solvent-free condition to get 3 in excellent yield, the results are summarized in Table 1. These conditions were applied to a series of substituted araldehydes with β-naphthol.16

Keywords: β-Naphthol; Araldehydes; Aryl-14H-dibenzo[a,j]xanthenes; Solvent-free condition.

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To demonstrate the protocol, we selected p-anisaldehyde as the model substrate and treated with β-naphthol in the presence of catalytic iodine at 90–95°C for 15 min to get 14-(4-methoxyphenyl)-14H-dibenzo[a,j]xanthene in 92% yield (Table 1, entry 2). The interesting feature of the present method of synthesis of aryl-14H-dibenzo[a,j]xanthenes is that the substituents OCH₃, Cl, Br, F and NO₂ are unaffected under the reaction condition.

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### Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.bmcl.2006.11.009.

### References and notes


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presence of ZnCl$_2$ on heating at 190 °C requires more than 4 h for completion, and gives a mixture of products.


16. Typical procedure for the synthesis of aryl-14H-dibenzo[a,j]xanthenes: p-anisaldehyde (1.36 g, 10 mmol), β-naphthol (2.88 g, 20 mmol) and iodine (0.063 g, 0.25 mmol) were ground well and transferred to a 50 mL flat-bottomed flask and heated on a hot plate at 90–95 °C for 15 min. After complete conversion (monitored on TLC), the system was cooled to room temperature, the mixture was washed with 10% Na$_2$S$_2$O$_3$ solution and the separated precipitate was purified by recrystallization from aqueous ethanol to afford 14-(4′-methoxyphenyl)-14H-dibenzo[a,j]xanthene 3b (3.68 g, 92%); mp: 205–207 °C; IR (KBr) : 3042, 2924, 1620, 1591, 1253, 841, 800 cm$^{-1}$; $^1$H NMR (200 MHz, CDCl$_3$): $\delta$ = 3.64 (s, 3H), 6.56 (s, 1H), 6.75 (d, $J$ = 9.3 Hz, 2H), 7.38–7.95 (m, 14H), 8.40 (d, $J$ = 9.5 Hz, 2H); $^{13}$C NMR (200 MHz, CDCl$_3$): $\delta$ = 37.7, 54.0, 114.5, 118.2, 118.6, 124.0, 124.8, 127.3, 130.1, 131.5, 1334.0, 137.9, 149.3, 158.5; Anal. Calcd for C$_{28}$H$_{20}$O$_2$: C, 86.57; H, 5.20; Found: C, 86.60; H, 5.19; MS: $m/z$ = 403 (M$^+$)].