

# Superoxide Mediated New, Convenient Multicomponent Synthesis of Xanthene and 4*H*-benzochromene Derivatives Using Tetraethylammonium Bromide as Phase Transfer Catalyst

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**ABSTRACT:** A new, convenient one-pot multicomponent synthesis of xanthene and 4*H*-benzochromene derivatives has been achieved in the presence of superoxide ion using tetraethylammonium bromide as phase transfer catalyst. The three-component reaction of various aromatic aldehydes,  $\beta$ -naphthol and dimedone / malononitrile yielded Xanthene and 4*H*-benzochromene derivatives under the mild reaction conditions at room temperature. The present report demonstrates the applicability of tetraethylammonium bromide as a phase transfer catalyst for efficient superoxide studies.

**KEYWORDS:** Xanthene, heterocyclic compounds, multicomponent synthesis, PTC, superoxide ion, TEAB.

## I. INTRODUCTION

Multicomponent reactions (MCRs) by their convergence, productivity, high yields and ease of execution have recently recognised as a worthless synthetic route in current organic synthesis [1]. MCRs usually benefit from other aspects such as atom economy, the use of readily available starting materials, resource effectiveness and bond-forming efficiency, which renders these reactions green and environmentally friendly, given greener perspective [2-4]. Also, because MCRs are one-pot processes with milder experimental conditions that do not require the isolation of intermediates, they are perfect candidates for combinatorial, automated synthesis and drug discovery. The chemistry of superoxide ion has come to the forefront of current interdisciplinary research owing to its demonstrated biochemical implications and as a species of relatively unexplored chemical reactivity [5, 6]. From the standpoint of synthetic considerations, the ability of superoxide ion to function as a multipotent reagent has made the chemistry of this radical anion quite enigmatic [7-9]. In spite of some progress prepared in the understating of the chemistry of superoxide ion, an important aspect involving the use of superoxide radical ion in multicomponent organic synthesis remains untouched and warrants its study in the synthesis of biologically active unit's direction [10-15].

Xanthene and 4*H*-benzochromene derivatives are a central class of oxygen-containing heterocyclic compounds that are known to partake important biological and pharmacological activities such as anti-inflammatory [16-18] anti-bacterial [19] anti-viral [20] and also provide efficacy in photodynamic therapy [21, 22]. They are also used as pH sensitive fluorescent materials [23, 24] dyes and also in laser technologies [25, 26]. Therefore, the syntheses of xanthene derivatives due to a broad range of applications have always been a fascinating field in organic synthesis. Three component reactions of aldehydes,  $\beta$ -naphthol and dimedone/malononitrile compounds are one of the most attractive

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

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Vol. 6, Issue 7, July 2017

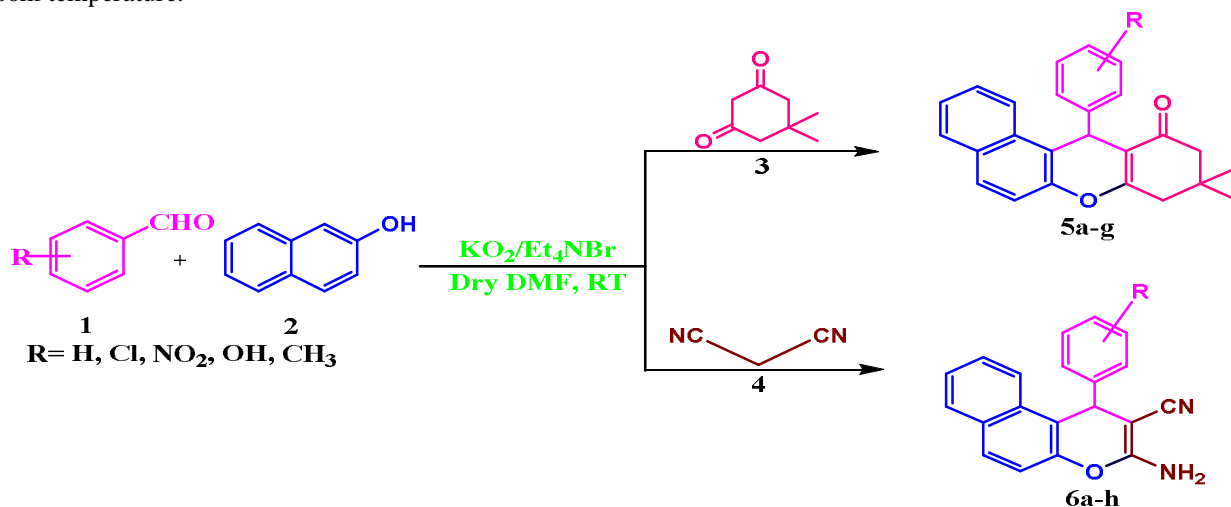
methodologies for the synthesis of xanthene and 4*H*-benzochromene[27-33]. A few catalysts have been used to stimulate this transformation, as well as Co/Mn supported on nanoZnO[34], TiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub> and Fe<sub>3</sub>O<sub>4</sub> nanoparticles[35], KHSO<sub>4</sub>[36], PEG-400[37], Fe<sub>3</sub>O<sub>4</sub>[38], titanium dodecyl amino phosphate[39], trityl Chloride[40], imidazole and isoquinoline[41], H<sub>4</sub>SiW<sub>12</sub>O<sub>40</sub>[42], Ce(SO<sub>4</sub>)<sub>2</sub>·4H<sub>2</sub>O[43], ionic liquid DDPA[HSO<sub>4</sub>][44], [Pyridine-SO<sub>3</sub>H]Cl[45], silica sulfuric acid(SSA)[46], *p*-dodecylbenzenesulfonic acid[47], TTAB[48], guanidine hydrochloride[49], Fe<sub>3</sub>O<sub>4</sub>@MCM-41-SO<sub>3</sub>H@[HMIIm][HSO<sub>4</sub>][50], ammonium oxalate[51], grinding and CSA[52], nano-TiCl<sub>4</sub>/SiO<sub>2</sub>[53], InCl<sub>3</sub> and P<sub>2</sub>O<sub>5</sub>[54], *p*-toluene sulfonic acid (*p*-TSA)/ ionic liquid[55], silicasulfamic acid[56], NaHSO<sub>4</sub>-SiO<sub>2</sub> under reflux halogenated solvents[57], Cu/SiO<sub>2</sub>[58], ruthenium chloride[59], iodine[60], phenyl boronic acid[61], K<sub>5</sub>CoW<sub>12</sub>O<sub>40</sub>·3H<sub>2</sub>O[62], LiBr[63], KAl(SO<sub>4</sub>)<sub>2</sub>·12H<sub>2</sub>O[64] and Yb(OTf)<sub>3</sub>[65]. Respectively of these methods has its own merit, but some of these methods are plagued by poor yields, difficult workup, and effluent pollution. Thus there is a need for further enlargement in the synthesis of xanthene derivative. To investigating the behavior of the superoxide ion in multicomponent organic synthesis, which is of significance in itself and further to assess its synthetic scope, the reaction of this novel reagent was studied.

## II. MATERIALS AND METHODS

All chemicals were obtained from Aldrich, the USA, and E. Merck, Germany and used without further purification. TLC was carried out on the SiO<sub>2</sub> gel (HF254, 200 mesh). The solvent system employed was ethyl acetate: n-hexane (2: 1) and the spots were identified by Iodine chamber. IR spectra were taken on a PerkinElmer FT/IR version 10.03.05 spectrometer. NMR spectra were run on a Bruker Advance 500 MHz FT-NMR at 500 MHz spectrometers; chemical shifts are given in δppm, relative to TMS as an internal standard. An open capillaries were used for measuring melting points and are uncorrected.

## III. RESULTS AND DISCUSSION

In continuation of our ongoing program of superoxide research, it is our current endeavor to extend the applicability of Et<sub>4</sub>NO<sub>2</sub> for the one-pot synthesis of multi-substituted xanthene and 4*H*-benzochromene derivatives by the reaction of aromatic aldehydes, β-naphthol and dimedone/malononitrile (Scheme 1). Tetraethylammonium superoxide was generated in situ by phase transfer reaction of potassium superoxide and tetraethylammonium bromide in dry DMF at room temperature.



Scheme 1

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In order to achieve the optimum yield of the products, the effect of many parameters such as the effect of solvent and molar proportion of the reactants were investigated in detail. The multicomponent reaction of benzaldehydes,  $\beta$ -naphthol and dimedone/malononitrile was taken as reference reaction. A perusal of the table clearly indicates that the best result was obtained using benzaldehydes,  $\beta$ -naphthol, dimedone/malononitrile,  $\text{KO}_2$  and  $\text{Et}_4\text{NBr}$  in the molar proportion 1: 1: 1: 4: 2 at room temperature in dry DMF in 4 h (Entry 5, Table 1).

**Table 1:** Effect of molar ratio on the % yield of compound **5a/6a**.

Entry	Reactants molar ratio				%Yield, <b>5a/6a</b>	
	Benzaldehydes	$\beta$ -naphthol	Dimedone	$\text{KO}_2$	$\text{Et}_4\text{NBr}$	
1	1.0	1.0	1.0	1.0	1.0	38
2	1.0	1.0	1.0	1.0	0.5	37
3	1.0	1.0	1.0	1.0	0.25	25
4	1.0	1.0	1.0	2.5	1.25	68
5	<b>1.0</b>	<b>1.0</b>	<b>1.0</b>	<b>4.0</b>	<b>2.00</b>	<b>90</b>
6	1.0	1.0	1.0	6.0	3.00	90

To investigate the effect of solvents, the multicomponent reaction of benzaldehydes,  $\beta$ -naphthol and dimedone/malononitrile, as carried out in different aprotic solvents. The results obtained were clearly indicate that dimethylformamide (DMF) was the best solvent among all investigated solvents in the terms of product yield and the reaction time (Table 2, Entry 5).

**Table 2:** Effect of solvents on the yield of the product **5a/6a**

Entry	Solvents	Time	% Yield
1	Dichloromethane	12h	trace
2	Acetonitrile	8h	69
3	Tetrahydrofuran	14h	45
4	Dimethylsulfoxide	20h	trace
5	<b>Dimethylformamide</b>	<b>4h</b>	<b>90</b>

Under the optimized set of reaction condition, various aromatic aldehydes **1** were made to undergo smooth coupling with  $\beta$ -naphthol **2** and dimedone/malononitrile **3&4** in the presence of tetraethylammonium superoxide ( $\text{Et}_4\text{NO}_2$ ) at room temperature to afford naphthopyranderivatives in good to excellent yield **5a-g/6a-h** (Table 1).

Based on product isolation and current literature on the chemistry of superoxide ion in aprotic media, the following mechanism may be hypothesized (Scheme 2). In these processes, superoxide ion plays an important role in accelerating the reaction. Superoxide is assumed to initiate the reaction by proton abstraction from the substrate

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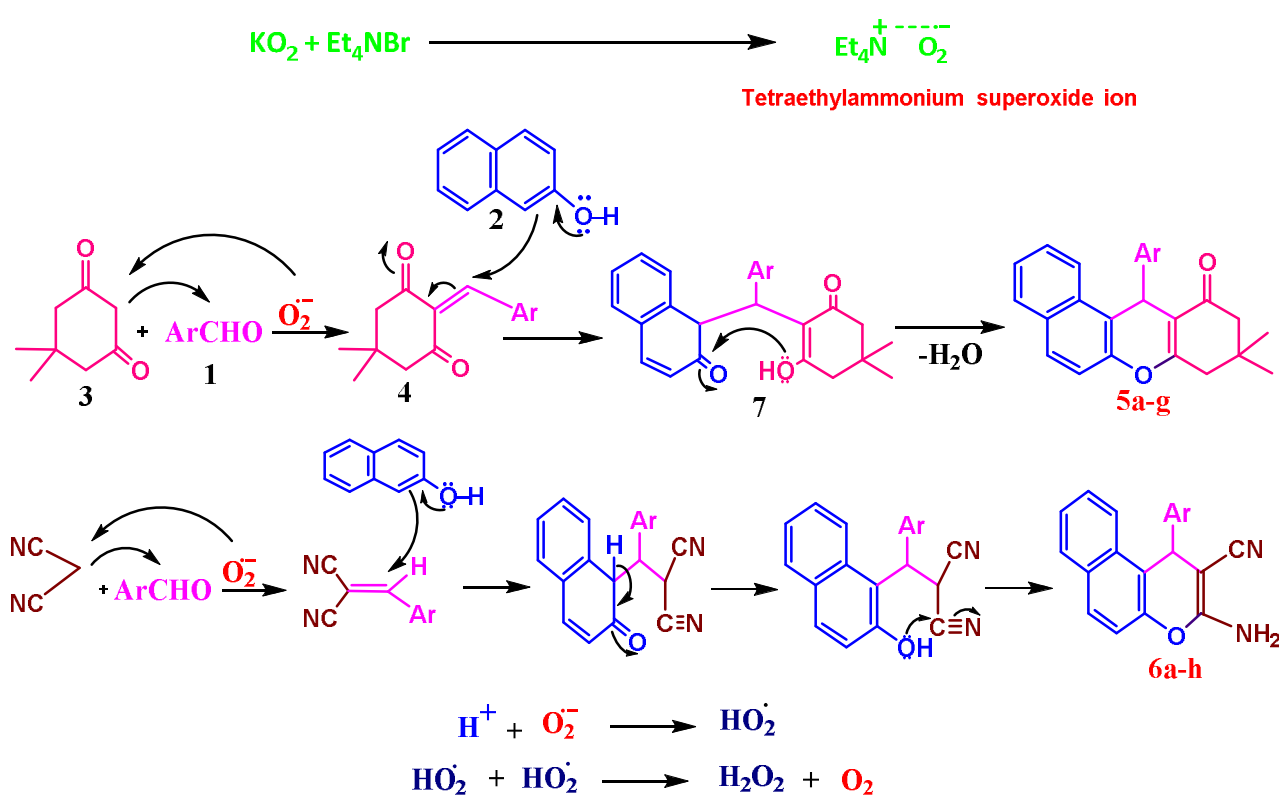
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dimedone followed by anucleophilic attack on aldehyde and subsequently, by dehydration, theolefin4is formed. The subsequentMichael-type addition of  $\beta$ -naphthol2to the olefin andproduces7, which tautomerizes and cyclized to give the corresponding products 5a-g.

*Mechanism of the reaction has described in the Scheme 2.*



Scheme 2

## IV. EXPERIMENTAL

### A. General procedure for synthesis of compounds 5a-g/6a-h

Potassium superoxide (1.42 g, 0.02mol) and tetraethylammonium bromide (2.10 g, 0.01mol) were weighed under nitrogen atmosphere using an atmosbag and were transferred into a three-necked R. B. flask, dry DMF (20 mL) was added to it and the mixture was agitated magnetically for 15 min to facilitate the formation of tetraethylammoniumsuperoxide. To the stirred reaction mixture, were added dimedone /malononitrile3/4(0.01 mol). After 10 min, the various aromatic aldehydes 1 (0.01 mol) and  $\beta$ -naphthol 2(0.01mol) were introduced, and the stirring was continued 4-6h. After the reaction was over as indicated by TLC, themixturewas treated with cold brine solution (2 mL) followed by saturated sodium hydrogen carbonate solution (2 mL) to decompose the unreacted  $\text{KO}_2$ . The mixture was then extracted with dichloromethane (3 $\times$  15 mL), and the combined organic phase was dried over anhydrous  $\text{Na}_2\text{SO}_4$ , then filtered, and evaporated to give the products 5a-g/6a-h, which was purified by column chromatography.

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### B.Characterization data for synthesized compounds of xanthene derivatives:

**9,9-Dimethyl-12-phenyl-9,10-dihydro-8H-benzo[a]xanthen-11(12H)-one(5a):** mp:150–152<sup>0</sup>C. IR (KBr, cm<sup>-1</sup>): 3053, 2950, 2885, 1650, 1373, 1230, 1176, 1077, 813.<sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>): δ(ppm) 7.94-7.90 (d, J = 8.4, 1H), 7.72-7.68 (t, J = 7.4, 2H), 7.39-7.24 (m, 5H), 7.12-7.08 (t, J = 7.8, 2H), 7.05-7.03 (t, J = 7.4, 1H), 5.64 (s, 1H), 2.54 (s, 2H), 2.34-2.26 (m, 2H), 1.07 (s, 3H), 0.93 (s, 3H), <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>): δ (ppm) 196.2, 164.1, 147.4, 145.1, 131.2, 131.0, 129.3, 129.1, 128.4, 128.4, 127.6, 126.5, 125.3, 123.4, 117.5, 117.3, 113.2, 50.1, 40.6, 34.1, 32.1, 29.2, 26.2.

**9,9-dimethyl-12-(3-Chlorophenyl)-9,10-dihydro-8H-benzo[a]xanthen-11(12H)-one(5b):** mp:178–180<sup>0</sup>C. IR(KBr, cm<sup>-1</sup>): 3073, 2932, 1646, 1371, 1225, 1175, 1030, 748.<sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>): δ (ppm) 7.90-7.84 (d, J = 8.4, 1H), 7.76-7.73 (m, 2H), 7.43-7.22 (m, 5H), 7.18-7.05 (t, J = 7.8, 1H), 7.01-7.00 (d, J = 8.8, 1H), 5.64 (s, 1H), 2.54 (s, 2H), 2.29-2.20 (m, 2H), 1.10 (s, 3H), 0.95 (s, 3H), <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>): δ (ppm) 196.6, 165.0, 148.05, 148.03, 133.3, 131.8, 131.2, 130.8, 130.2, 129.3, 128.7, 128.2, 127.5, 127.3, 125.7, 124.0, 118.0, 117.2, 113.5, 50.8, 41.1, 34.6, 32.5, 29.5, 27.0.

**9,9-Dimethyl-12-(3-nitrophenyl)-9,10-dihydro-8H-benzo[a]xanthen-11(12H)-one(5c) :** mp:232–234<sup>0</sup>C. IR(KBr, cm<sup>-1</sup>): 3062, 2950, 2889, 1650, 1593, 1372.<sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>): δ (ppm) 7.93–8.09 (2H, m, Ar.), 7.79–7.84 (4H, m, Ar.), 7.35–7.46 (4H, m, Ar.), 5.84 (1H, s, CH), 2.66–2.82 (2H, m, CH<sub>2</sub>), 2.33–2.45 (2H, m, CH<sub>2</sub>), 1.93–2.12 (2H, m, CH<sub>2</sub>), <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>): δ (ppm) 197.0, 147.6, 146.6, 135.7, 134.7, 131.4, 129.0, 128.4, 127.1, 125.0, 123.1, 123.0, 122.3, , 121.4, 117.0, 116.0, 114.2, 36.0, 34.5, 27.3, 20.2.

**9,9-Dimethyl-12-(4-nitrophenyl)-9,10-dihydro-8H-benzo[a]xanthen-11(12H)-one (5d) :** mp:234–236<sup>0</sup>C. IR(KBr, cm<sup>-1</sup>): 3104, 3064, 2944, 2883, 1653, 1591, 1453.<sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>): δ (ppm) 7.78–7.81 (3H, m, Ar.), 7.34–7.50 (5H, m, Ar.), 5.83 (1H, s, CH), 2.63–2.80 (2H, m, CH<sub>2</sub>), 2.33–2.50 (2H, m, CH<sub>2</sub>), 1.91–2.13 (2H, m, CH<sub>2</sub>), <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>): δ (ppm) 196.7, 151.9, 147.5, 143.1, 131.5, 131.0, 129.3, 129.1, 128.3, 127.4, 125.0, 123.3, 123.1, 123.0, 117.1, 116.0, 114.0, 36.7, 34.6, 27.5, 20.1.

**9,9-dimethyl-12-(2-Hydroxyphenyl)-9,10-dihydro-8H-benzo[a]xanthen-11(12H)-one (5e) :** mp:220–222<sup>0</sup>C. IR(KBr, cm<sup>-1</sup>): 3351, 3054, 3022, 2948, 2872, 1651, 1593, 1466, 1369.<sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>): δ (ppm) 9.23 (s, 1H), 7.75-7.71 (m, 2H), 7.63-7.61 (d, J = 8, 1H), 7.38-7.27 (m, 3H), 7.00-6.96 (m, 2H), 6.60-6.54 (m, 2H), 5.72 (s, 1H), 2.54 (s, 2H), 2.40-2.30 (m, 2H), 1.10 (s, 3H), 0.97 (s, 3H), <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>): δ (ppm) 197.2, 162.0, 153.9, 147.1, 135.9, 131.1, 128.9, 128.3, 128.1, 126.3, 124.4, 123.9, 117.3, 117.0, 115.2, 114.0, 109.0, 50.4, 41.0, 33.3, 29.4, 27.1.

**9,9-dimethyl-12-(3-Hydroxyphenyl)-9,10-dihydro-8H-benzo[a]xanthen-11(12H)-one(5f) :** mp:240–242<sup>0</sup>C. IR(KBr, cm<sup>-1</sup>): 3410, 3052, 2951, 1640, 1589, 1373, 1222, 1170, 1023.<sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>): δ (ppm) 9.23 (s, 1H), 7.75-7.71 (m, 2H), 7.63-7.61 (d, J = 8, 1H), 7.38-7.27 (m, 3H), 7.00-6.95 (m, 2H), 6.60-6.54 (m, 2H), 5.72 (s, 1H), 2.52 (s, 2H), 2.40-2.30 (m, 2H), 1.13 (s, 3H), 0.93 (s, 3H), <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>): δ (ppm) 196.7, 164.5, 157.9, 148.0, 147.0, 131.9, 131.6, 129.8, 129.3, 127.9, 125.8, 124.1, 119.8, 118.0, 115.9, 114.1, 51.0, 41.1, 34.8, 32.7, 29.6, 27.1.

**9,9-dimethyl-12-(4-Hydroxyphenyl)-9,10-dihydro-8H-benzo[a]xanthen-11(12H)-one (5g) :** mp:210–212<sup>0</sup>C. IR(KBr, cm<sup>-1</sup>): 3356, 3057, 3024, 2950, 2871, 1650, 1592, 1468, 1371.<sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>): δ (ppm) 7.98–7.67 (3H, m, Ar.), 7.45–7.30 (3H, m, Ar.), 7.20–7.13 (2H, m, Ar.), 6.66–6.60 (2H, m, Ar.), 5.64 (1H, s, CH), 4.81 (1H, s, OH), 2.57 (2H, s, CH<sub>2</sub>), 2.34–2.20 (2H, m, CH<sub>2</sub>), 1.11 (3H, s, CH<sub>3</sub>), 0.97 (3H, s, CH<sub>3</sub>), <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>): δ (ppm) 197.5, 162.1, 154.0, 147.3, 136.8, 131.3, 129.2, 128.5, 128.1, 126.7, 124.7, 123.5, 117.5, 117.0, 115.0, 114.2, 109.2, 50.8, 41.2, 33.6, 29.0, 27.0.

**3-Amino-1-(phenyl)-1H-benzo[f]chromene-2-carbonitrile (6a):** mp: 288-290 <sup>0</sup>C. IR (KBr, cm<sup>-1</sup>): 3448, 3346, 2179, 1641, 1578, 1420. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>): δ (ppm) 7.64 (d, 1H, J = 8.4, Ar), 7.40 (d, 1H, J = 8.4, Ar), 7.60-7.56 (m, 3H, Ar), 7.17-7.12 (m, 5H, Ar), 6.80 (d, 1H, Ar), 6.59 (brs, 2H, NH<sub>2</sub>), 4.69 (s, 1H, CH). <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>): δ (ppm) 177.6, 161.6, 140.2, 136.9, 126.4, 124.2, 124.1, 123.3, 123.1, 122.4, 122.3, 122.1, 119.6, 119.3, 118.3, 60.1, 29.1.

**3-Amino-1-(4-chlorophenyl)-1H-benzo[f]chromene-2-carbonitrile (6b):** mp: 206–208<sup>0</sup>C. IR (KBr, cm<sup>-1</sup>): 3408, 3320, 3029, 2224, 1630, 1585. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>): δ (ppm) 7.82 (d, 2H, Ar), 7.74-7.60 (m, 4H, Ar), 7.50 (d, 2H, Ar), 7.43-7.40 (m, 1H, Ar), 7.30-7.27 (m, 1H, Ar), 7.13 (brs, 2H, NH<sub>2</sub>), 5.01 (s, 1H, CH). <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>): δ (ppm) 210.1, 145.4, 141.9, 134.4, 131.2, 131.0, 129.4, 128.2, 127.4, 126.1, 125.3, 124.4, 122.9, 121.2, 118.9, 118.5, 60.2, 40.4.

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**3-Amino-1-(3-chlorophenyl)-1H-benzo[f]chromene-2-carbonitrile (6c):** mp: 202–204<sup>0</sup>C. IR (KBr, cm<sup>-1</sup>): 3430, 3329, 2180, 1648, 1590. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>): δ (ppm) 7.96–7.86 (m, 2H, Ar), 7.45–7.41 (m, 2H, Ar), 7.35–7.18 (m, 5H, Ar), 6.36 (brs, 2H, NH<sub>2</sub>), 5.34 (s, 1H, CH). <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>): δ (ppm) 159.9, 147.5, 145.6, 143.0, 137.1, 134.2, 127.1, 126.5, 126.3, 126.1, 123.9, 123.5, 120.9, 120.8, 119.5, 118.5, 115.0, 111.2, 59.1.

**3-Amino-1-(2-chlorophenyl)-1H-benzo[f]chromene-2-carbonitrile (6d):** mp: 268–270<sup>0</sup>C. IR (KBr, cm<sup>-1</sup>): 3342, 3264, 2192, 1636, 1543. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>): δ (ppm) 7.15–7.12 (1H, d, Ar), 7.76–7.73 (1H, d, Ar), 7.03–7.00 (1H, d, Ar), 7.08 (4H, s, Ar), 7.55–7.44 (3H, m, Ar), 6.53 (brs, 2H, NH<sub>2</sub>), 4.00 (s, 1H, CH). <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>): δ (ppm) 178.5, 175.4, 151.9, 145.5, 145.3, 132.9, 132.4, 129.1, 128.9, 128.3, 128.1, 127.8, 127.2, 126.5, 119.6, 118.1, 58.9, 17.9.

**3-Amino-1-(3-nitrophenyl)-1H-benzo[f]chromene-2-carbonitrile(6e):** mp: 240–242<sup>0</sup>C. IR (KBr, cm<sup>-1</sup>): 3465, 3356, 2193, 1659, 1590. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>): δ (ppm) 8.00 (m, 1H, Ar), 7.98 (d, J=6.5 Hz, 1H, Ar), 7.94–7.88 (m, 2H, Ar), 7.84 (d, J= 7.5 Hz, 1H, Ar), 7.63 (m, 1H, Ar), 7.57 (t, J= 7.5 Hz, 1H, Ar), 7.45–7.40 (m, 2H, Ar), 7.36 (d, J= 8.0 Hz, Ar), 7.16 (brs, 2H, NH<sub>2</sub>), 5.02 (s, 1H, CH). <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>): δ (ppm) 169.4, 158.4, 148.9, 147.8, 134.5, 131.9, 130.9, 130.5, 130.1, 129.4, 127.9, 125.1, 123.0, 122.9, 121.1, 120.0, 117.1, 115.1, 57.9.

**3-Amino-1-(4-nitrophenyl)-1H-benzo[f]chromene-2-carbonitrile (6f):** mp: 184–186<sup>0</sup>C. IR (KBr, cm<sup>-1</sup>): 3576, 3452, 2238, 1659, 1533. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>): δ (ppm) 7.98 (d, 1H, Ar), 7.79 (d, 1H, Ar), 7.66–7.60 (m, 3H, Ar), 7.61–7.50 (m, 2H, Ar), 7.37–7.32 (m, 2H, Ar), 7.19 (d, 1H, Ar), 6.96 (brs, 2H, NH<sub>2</sub>), 4.31 (s, 1H, CH). <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>): δ (ppm) 188.9, 167.2, 154.9, 146.1, 129.2, 128.3, 128.1, 127.9, 127.5, 126.9, 126.7, 125.9, 125.1, 124.4, 122.2, 119.3, 67.1, 34.7.

**3-Amino-1-(3-hydroxyphenyl)-1H-benzo[f]chromene-2-carbonitrile(6g):** mp: 280–282<sup>0</sup>C. IR (KBr, cm<sup>-1</sup>): 3419, 3325, 2186, 1642, 1586. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>): δ (ppm) 8.38 (brs, 1H), 7.89 (t, J= 8.5 Hz, 3H, Ar), 7.46–7.40 (m, 2H, Ar), 7.31 (d, 1H, Ar), 7.09 (t, J= 8.5 Hz, 1H, Ar), 6.69 (d, 1H, Ar), 6.64–6.60 (m, 2H, Ar), 6.56 (brs, 2H, NH<sub>2</sub>), 4.56 (s, 1H, CH). <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>): δ (ppm) 161.1, 159.8, 148.3, 147.1, 132.0, 130.9, 129.9, 129.7, 128.8, 126.8, 124.9, 123.9, 119.1, 118.9, 116.9, 115.1, 114.1, 113.0, 59.9.

**3-Amino-1-(4-methylphenyl)-1H-benzo[f]chromene-2-carbonitrile (6h):** mp: 268–270<sup>0</sup>C. IR (KBr, cm<sup>-1</sup>): 3482, 3368, 2190, 1638, 1571. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>): δ (ppm) 2.35 (s, 3H, CH<sub>3</sub>), 7.81 (d, 2H, Ar); 7.75–7.61 (m, 4H, Ar), 7.51 (d, 2H, Ar), 7.41–7.38 (m, 1H, Ar), 7.30–7.27 (m, 1H, Ar), 7.00 (s, 2H, NH<sub>2</sub>), 4.46 (s, 1H, CH). <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>): δ (ppm) 187.3, 174.9, 152.9, 144.9, 144.5, 143.1, 134.9, 132.7, 131.9, 129.5, 129.3, 129.0, 128.1, 127.3, 127.1, 59.1, 24.3, 17.9.

## V. CONCLUSION

A new alternative method for synthesis of some xanthene and 4H-benzochromene derivatives from three-component, one-pot condensation of an aldehyde, β-naphthol and dimedone / malononitrile under the mild reaction conditions at room temperature using tetraethylammonium superoxide is given. The development includes the use of tetraethylammonium bromide as a phase transfer catalyst. The advantages of this method over other existing methods are higher yields, mild reaction condition, easy purification and economic viability of the catalyst.

## ACKNOWLEDGEMENT

The authors wish to thank the UGC, New Delhi, India for the lab facilities and financial support for this work.

## REFERENCES

- [1] I.B. Afanas'ev, Superoxide ion: chemistry and biological implications, CRC press 1991.
- [2] M. Bagley, M. Lubinu, Microwave-assisted multicomponent reactions for the synthesis of heterocycles, Microwave-assisted synthesis of heterocycles, pp. 31–58, 2006.
- [3] S. Karamthulla, A. Jana, L.H. Choudhury, Synthesis of Novel 5, 6-Disubstituted Pyrrolo [2, 3-d] Pyrimidine-2, 4-Diones Via One-Pot Three-Component Reactions, ACS combinatorial science, 19, pp. 108–112, 2017.



# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 7, July 2017

- [4] N.Z. Kiss, E. Bálint, G. Keglevich, Microwave-Assisted Syntheses in Organic Chemistry, Milestones in Microwave Chemistry, Springer, pp. 11-45, 2016.
- [5] H. Eckert, Synergy Effects in the Chemical Synthesis and Extensions of Multicomponent Reactions (MCRs)—The Low Energy Way to Ultra-Short Syntheses of Tailor-Made Molecules, *Molecules*, 22, pp. 349, 2017.
- [6] S. Su, C. Li, X. Jia, J. Li, Isocyanide - Based Multicomponent Reactions: Concise Synthesis of Spirocyclic Oxindoles with Molecular Complexity by Using a [1, 5] - Hydrogen Shift as the Key Step, *Chemistry-A European Journal*, 20, pp. 5905-5909, 2014.
- [7] D. Maricle, W. Hodgson, Reduction of Oxygen to Superoxide Anion in Aprotic Solvents, *Analytical Chemistry*, 37, pp. 1562-1565, 1965.
- [8] R. Poupko, I. Rosenthal, Electron transfer interactions between superoxide ion and organic compounds, *The Journal of Physical Chemistry*, 77, pp. 1722-1724, 1973.
- [9] C.M. Collins, C. Sotiriou-Leventis, M.T. Canales, N. Leventis, A cyclic voltammetric study of the proton abstraction from selected aromatic ketones by superoxide, *Electrochimica acta*, 45, pp. 2049-2059, 2000.
- [10] Y. Fang, Z.-L. Zhu, P. Xu, S.-Y. Wang, S.-J. Ji, Aerobic radical-cascade cycloaddition of isocyanides, selenium and imidamides: facile access to 1, 2, 4-selenadiazoles under metal-free conditions, *Green Chemistry*, 19, pp. 1613-1618, 2017.
- [11] W. Wang, H. Huang, C. Yu, X. Li, Y. Zhang, Y. Zhang, X. Chen, P.S. Mariano, H. Xie, Synthesis of Aldehydes by Organocatalytic Formylation Reactions of Boronic Acids with Glyoxylic Acid, *Angewandte Chemie International Edition*, 2017.
- [12] Q. Liu, L.-Z. Wu, Recent advances in visible-light driven organic reactions, *National Science Review*, 2017.
- [13] N. Li, M. Wang, X. Gao, Z. Yu, W. Pan, H. Wang, B. Tang, A DNA Tetrahedron Nanoprobe with Controlled Distance of Dyes for Multiple Detection in Living Cells and In Vivo, *Analytical Chemistry*, 2017.
- [14] D. Sengupta, S. Ghosh, B. Basu, Advances and Prospects of Graphene Oxide (GO) as Heterogeneous Carbocatalyst, *Current Organic Chemistry*, 21, pp. 834-854, 2017.
- [15] S. Song, W. Xu, J. Zheng, L. Luo, M.H. Engelhard, M.E. Bowden, B. Liu, C.-M. Wang, J.-G. Zhang, Complete Decomposition of Li<sub>2</sub>CO<sub>3</sub> in Li-O<sub>2</sub> Batteries Using Ir/B<sub>4</sub>C as Noncarbon-Based Oxygen Electrode, *Nano Letters*, 17, pp. 1417-1424, 2017.
- [16] P. Zhao, K.-I. Chen, G.-I. Zhang, G.-r. Deng, J. Li, Pharmacological Basis for Use of Selaginella moellendorffii in Gouty Arthritis: Antihyperuricemic, Anti-Inflammatory, and Xanthine Oxidase Inhibition, *Evidence-Based Complementary and Alternative Medicine*, 2017, 2017.
- [17] J. Devaney, M. Tilbury, B. Higgins, R. MacLoughlin, J. Laffey, J.G. Wall, D. O'Toole, Recombinant SOD Protein Is Nebulisable By Aerogen Solo Nebuliser And Retains Anti-Inflammatory Properties, C54. CRITICAL CARE: TRANSLATIONAL INSIGHTS INTO ARDS AND SEPSIS-FROM BENCH TO BEDSIDE, *Am Thoracic Soc*, pp. A5830-A5830, 2017.
- [18] T.D. Nguyen, P.T. Thuong, I.H. Hwang, T.K.H. Hoang, M.K. Nguyen, H.A. Nguyen, M. Na, Anti-Hyperuricemic, Anti-Inflammatory and Analgesic Effects of Siegesbeckia orientalis L. Resulting from the Fraction with High Phenolic Content, *BMC complementary and alternative medicine*, 17, 191, 2017.
- [19] S. Naseem, M. Khalid, M.N. Tahir, M.A. Halim, A.A. Braga, M.M. Naseer, Z. Shafiq, Synthesis, structural, DFT studies, docking and antibacterial activity of a xanthene based hydrazone ligand, *Journal of Molecular Structure*, 1143, pp. 235-244, 2017.
- [20] G.L. Goud, S. Ramesh, D. Ashok, V.P. Reddy, P. Yogeeswari, D. Sriram, B. Saikrishna, V. Manga, Design, synthesis, molecular-docking and antimycobacterial evaluation of some novel 1, 2, 3-triazolyl xanthenones, *MedChemComm*, 8, pp. 559-570, 2017.
- [21] S.T. Buck, F. Bettanin, E. Orestes, P. Homem-de-Mello, H. Imasato, R.B. Viana, J.R. Perussi, A.B. da Silva, Photodynamic Efficiency of Xanthene Dyes and Their Phototoxicity against a Carcinoma Cell Line: A Computational and Experimental Study, *Journal of Chemistry*, 2017, 2017.
- [22] V. Pérez-Laguna, L. Pérez-Artiaga, V. Lampaya-Pérez, S.C. López, I. García-Luque, M.J. Revillo, S. Nonell, Y. Gilaberte, A. Rezusta, Comparative effect of photodynamic therapy on separated or mixed cultures of Streptococcus mutans and Streptococcus sanguinis, *Photodiagnosis and Photodynamic Therapy*, 2017.
- [23] S. Ma, Y. Wang, M. She, S. Wang, Z. Yang, P. Liu, S. Zhang, J. Li, Design strategies and progress on xanthene-based fluorescent probe for metal ions, *Reviews in Analytical Chemistry*, 2017.
- [24] K. Liu, Y. Yao, J. Wang, L. Zhu, M. Sun, B. Ren, L. Xie, Y. Luo, Q. Meng, X. Zhan, Spiro [fluorene-9, 9'-xanthene]-based hole transporting materials for efficient perovskite solar cells with enhanced stability, *Materials Chemistry Frontiers*, 1, pp. 100-110, 2017.
- [25] G. Harichandran, P. Parameswari, P. Shanmugam, An efficient solvent free Amberlite IRA-400 Cl resin mediated multicomponent synthesis and photophysical properties of fluorescent 4H-chromene derivatives, *Dyes and Pigments*, 139, pp. 541-548, 2017.
- [26] A. Nakhaei, S. Yadegarian, An efficient synthesis of 14-substituted-14H-dibenzo [a, j] xanthene derivatives promoted by a nanoisopolyoxomolybdate under thermal and solvent-free conditions.
- [27] B. Maleki, M. Baghayeri, S. Sheikh, S. Babae, S. Farhadi, One-pot synthesis of some 2-amino-4H-chromene derivatives using triethanolamine as a novel reusable organocatalyst under solvent-free conditions and its application in electrosynthesis of silver nanoparticles, *Russian Journal of General Chemistry*, 87, pp. 1064-1072, 2017.
- [28] N. Yu, J.M. Aramini, M.W. Germann, Z. Huang, Reactions of salicylaldehydes with alkyl cyanoacetates on the surface of solid catalysts: syntheses of 4H-chromene derivatives, *Tetrahedron Letters*, 41, pp. 6993-6996, 2000.
- [29] S. Akocak, B. Şen, N. Lolak, A. Şavk, M. Koca, S. Kuzu, F. Şen, One-pot three-component synthesis of 2-Amino-4H-Chromene derivatives by using monodisperse Pd nanomaterials anchored graphene oxide as highly efficient and recyclable catalyst, *Nano-Structures & Nano-Objects*, 11, pp. 25-31, 2017.
- [30] S.K. Salama, A.F. Darweesh, I.A. Abdelhamid, A.H. Elwahi, Microwave Assisted Green Multicomponent Synthesis of Novel bis (2 - Amino - tetrahydro - 4H - chromene - 3 - carbonitrile) Derivatives Using Chitosan as Eco - friendly Basic Catalyst, *Journal of Heterocyclic Chemistry*, 54, pp. 305-312, 2017.

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 7, July 2017

- [31] A.H. Halawa, M.M. Elaasser, A.M. El Kerdawy, A.M.A. El-Hady, H.A. Emam, A.M. El-Agrody, Anticancer activities, molecular docking and structure-activity relationship of novel synthesized 4H-chromene, and 5H-chromeno [2, 3-d] pyrimidine candidates, Medicinal Chemistry Research, pp. 1-15, 2017.
- [32] R.M.N. Kalla, A. Varyambath, M.R. Kim, I. Kim, Amine-functionalized hyper-crosslinked polyphenanthrene as a metal-free catalyst for the synthesis of 2-amino-tetrahydro-4H-chromene and pyran derivatives, Applied Catalysis A: General, 538, pp.9-18, 2017.
- [33] T. Hajiashrafi, M. Karimi, A. Heydari, A.A. Tehrani, Erbium-Organic Framework as Heterogeneous Lewis Acid Catalysis for Hantzsch Coupling and Tetrahydro-4H-Chromene Synthesis, Catalysis Letters, 147, pp. 453-462, 2017.
- [34] S. Sadeghi, A. Farokhi, Z. Hamidi, F. Maleki, Synthesis of Co/Mn/Nano ZnO as an Efficient Supported Catalyst for Preparation of Tetrahydrobenzo[a]xanthene-11-one and Its Derivatives, Synthesis and Reactivity in Inorganic, Metal-Organic and Nano-Metal Chemistry, 46, pp. 77-82, 2016.
- [35] A. Davoodnia, S. Yadegarian, A. Nakhaei, N. Tavakoli-Hoseini, A comparative study of  $\text{TiO}_2$ ,  $\text{Al}_2\text{O}_3$ , and  $\text{Fe}_3\text{O}_4$  nanoparticles as reusable heterogeneous catalysts in the synthesis of tetrahydrobenzo[a]xanthene-11-ones, Russian Journal of General Chemistry, 86, pp. 2849-2854, 2016.
- [36] N.B. Reddy, K.U.M. Rao, C.S. Sundar, S.K. Nayak, C.S. Reddy, An efficient  $\text{KHSO}_4$  catalyzed synthesis of xanthenes, Heterocyclic Communications, 18, pp. 53-56, 2012.
- [37] N.V. Shitole, S.B. Sapkal, B.B. Shingate, M.S. Shingare, A simple and green synthesis of tetrahydrobenzo[a]xanthene-11-one using peg-400 as efficient and recyclable reaction media, Bull. Korean Chem. Soc., 32, pp. 35-36, 2011.
- [38] D. Habibi, S. Kaamyabi, H. Hazarkhani,  $\text{Fe}_3\text{O}_4$  nanoparticles as an efficient and reusable catalyst for the solvent-free synthesis of 9, 9-dimethyl-9, 10-dihydro-8H-benzo[a] xanthene-11(12H)-ones, CuihuaXuebao/Chinese Journal of Catalysis, 36, pp. 362-366, 2015.
- [39] A. Rajini, N. Venkathathi, Synthesis, characterization and catalytic activity of titanium dodecylamino phosphate for synthesis of tetrahydrobenzo[a]xanthene-11-ones, Indian Journal of Chemistry - Section A Inorganic, Physical, Theoretical and Analytical Chemistry, 54A, pp. 1044-1050, 2015.
- [40] A. Khazaei, M.A. Zolfigol, A.R. Moosavi-Zare, A. Zare, M. Khojasteh, Z. Asgari, V. Khakyzadeh, A. Khalafi-Nezhad, Organocatalyst trityl chloride efficiently promoted the solvent-free synthesis of 12-aryl-8,9,10,12-tetrahydrobenzo[a]xanthene-11-ones by in situ formation of carbocationic system in neutral media, Catalysis Communications, 20, pp. 54-57, 2012.
- [41] R. Heydari, F. Shahrekipour, One-pot synthesis of 12-aryl-8,9,10,12-tetrahydrobenzo[a]xanthene-11-ones by using of neutral and efficient organocatalysts under solvent-free conditions, Research on Chemical Intermediates, 41, pp. 4581-4586, 2015.
- [42] A. Hassankhani, E. Mosaddegh, S.Y. Ebrahimipour, H 4SiW 12O 40 Catalyzed one-pot synthesis of 12-Aryl-8,9,10,12-tetrahydrobenzo[a]xanthene-11-ones under solvent-free conditions, E-Journal of Chemistry, 9, pp. 786-790, 2012.
- [43] F. Taghavi-Khorasani, A. Davoodnia, A fast and green method for synthesis of tetrahydrobenzo[a]xanthene-11-ones using  $\text{Ce}(\text{SO}_4)_2 \cdot 4\text{H}_2\text{O}$  as a novel, reusable, heterogeneous catalyst, Research on Chemical Intermediates, 41, pp. 2415-2425, 2015.
- [44] D. Fang, J.M. Yang, Y.F. Cao, Synthesis of 12-aryl-8,9,10,12-tetrahydrobenzo[a]xanthene-11-ones catalyzed by biodegradable ionic liquid, Research on Chemical Intermediates, 39, pp. 1745-1751, 2013.
- [45] A.R. Moosavi-Zare, M.A. Zolfigol, M. Zarei, A. Zare, V. Khakyzadeh, Preparation, characterization and application of ionic liquid sulfonic acid functionalized pyridinium chloride as an efficient catalyst for the solvent-free synthesis of 12-aryl-8,9,10,12-tetrahydrobenzo[a]xanthene-11-ones, Journal of Molecular Liquids, 186, pp. 63-69, 2013.
- [46] Y.L. Song, Z.P. Lin, G.F. Chen, Q.L. Liu, J.T. Li, Synthesis of 12-aryl-8,9,10,12-tetrahydrobenzo[a]xanthene-11-one catalyzed by silica sulfuric acid under solvent free condition, Letters in Organic Chemistry, 9, pp. 145-149, 2012.
- [47] J.T. Li, Y.W. Li, Y.L. Song, Efficient synthesis of 12-aryl-8,9,10,12-tetrahydrobenzo[a]xanthene-11-one derivatives catalyzed by p-dodecylbenzenesulfonic acid in aqueous media under ultrasound irradiation, Synthetic Communications, 42, pp. 2161-2170, 2012.
- [48] P.V. Shinde, A.H. Kategaonkar, B.B. Shingate, M.S. Shingare, Surfactant catalyzed convenient and greener synthesis of tetrahydrobenzo[a]xanthene-11-ones at ambient temperature, Beilstein Journal of Organic Chemistry, 7, pp. 53-58, 2011.
- [49] M. Sadeghpour, A. Olyaei, M. Rezaei, Guanidine Hydrochloride: A Highly Efficient Organocatalyst for the Synthesis of 12-Aryl-8,9,10,12-tetrahydrobenzo[a]xanthene-11-ones under Solvent-Free Conditions, Journal of Heterocyclic Chemistry, 53, pp. 981-988, 2016.
- [50] H. Kefayati, S.J. Bazargard, P. Vejdansafat, S. Shariati, A.M. Kohankar,  $\text{Fe}_3\text{O}_4$ @MCM-41- $\text{SO}_3\text{H}$ [HMI][HSO $_4$ ]: An effective magnetically separable nanocatalyst for the synthesis of novel spiro[benzoxanthene-indoline]diones, Dyes and Pigments, 125, pp. 309-315, 2016.
- [51] H.R.M. Esfahani, N. Foroughifar, A. Mobinikhaledi, H. Moghanian, Ammonium oxalate as an efficient catalyst for one-pot synthesis of tetrahydrobenzo[a]xanthene-11-one derivatives under solvent-free conditions, Synthesis and Reactivity in Inorganic, Metal-Organic and Nano-Metal Chemistry, 43, pp. 752-755, 2013.
- [52] P.V. Shinde, B.B. Shingate, M.S. Shingare, An organocatalyzed expeditious synthetic route to tetrahydrobenzo[a] xanthene-11-ones via grinding technique, Letters in Organic Chemistry, 8, pp. 568-572, 2011.
- [53] B.B.F. Mirjalili, A. Bamoniri, L. Zamania, Nano-TiCl $_4$ /SiO $_2$ : An efficient and reusable catalyst for the synthesis of tetrahydrobenzo[a]xanthenes-11-ones, Letters in Organic Chemistry, 9, pp. 338-343, 2012.
- [54] G.C. Nandi, S. Samai, R. Kumar, M. Singh, An efficient one-pot synthesis of tetrahydrobenzo[a] xanthene-11-one and diazabenzo[a] anthracene-9, 11-dione derivatives under solvent free condition, Tetrahedron, 65, pp. 7129-7134, 2009.
- [55] J.M. Khurana, D. Magoo, pTSA-catalyzed one-pot synthesis of 12-aryl-8, 9, 10, 12-tetrahydrobenzo[a] xanthene-11-ones in ionic liquid and neat conditions, Tetrahedron Letters, 50, pp. 4777-4780, 2009.
- [56] M. Seyyedhamzeh, P. Mirzaei, A. Bazgir, Solvent-free synthesis of aryl-14H-dibenzo[a, j] xanthenes and 1, 8-dioxo-octahydro-xanthenes using silica sulfuric acid as catalyst, Dyes and Pigments, 76, pp. 836-839, 2008.



# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 7, July 2017

- [57] B. Das, K. Laxminarayana, M. Krishnaiah, Y. Srinivas, An efficient and convenient protocol for the synthesis of novel 12-aryl-or 12-alkyl-8, 9, 10, 12-tetrahydrobenzo [a] xanthen-11-one derivatives, *Synlett*, 2007, pp. 3107-3112, 2007.
- [58] H.A. Oskooie, M.M. Heravi, N. Karimi, G. Kohansal, Cu/SiO<sub>2</sub>-catalyzed one-pot synthesis of 12-aryl-8, 9, 10, 12-tetrahydrobenzo [a] xanthen-11-ones under solvent-free conditions, *Synthetic Communications*, 41, pp. 2763-2768, 2011.
- [59] K. Tabatabaeian, A. Khorshidi, M. Mamaghani, A. Dadashi, M.K. Jalali, One-pot synthesis of tetrahydrobenzo [a] xanthen-11-one derivatives catalyzed by ruthenium chloride hydrate as a homogeneous catalyst, *Canadian Journal of Chemistry*, 89, pp. 623-627, 2011.
- [60] R.-Z. Wang, L.-F. Zhang, Z.-S. Cui, Iodine-catalyzed synthesis of 12-aryl-8, 9, 10, 12-tetrahydro-benzo [a] xanthen-11-one derivatives via multicomponent reaction, *Synthetic Communications*, 39, pp. 2101-2107, 2009.
- [61] S. Goswami, P. Thorat, S. Dhone, S. Bhusare, Phenylboronic acid-catalyzed synthesis of 9, 9-dimethyl-12-phenyl-9, 10-dihydro-8H-benzo [a] xanthen-11 (12H)-one derivatives, *J. Chem. Pharm. Res.*, 3, pp. 632-635, 2011.
- [62] L. Nagarapu, S. Kantevari, V.C. Mahankhali, S. Apuri, Potassium dodecatungstocobaltatetratehydrate (K<sub>5</sub> CoW<sub>12</sub> O<sub>40</sub>• 3H<sub>2</sub> O): A mild and efficient reusable catalyst for the synthesis of aryl-14H-dibenzo [a, j] xanthenes under conventional heating and microwave irradiation, *Catalysis Communications*, 8, pp. 1173-1177, 2007.
- [63] A. Saini, S. Kumar, J.S. Sandhu, A new LiBr-catalyzed, facile and efficient method for the synthesis of 14-alkyl or aryl-14H-dibenzo [a, j] xanthenes and tetrahydrobenzo [b] pyrans under solvent-free conventional and microwave heating, *Synlett*, 2006, pp. 1928-1932, 2006.
- [64] M. Dabiri, M. Baghbanzadeh, M.S. Nikcheh, E. Arzroomchilar, Eco-friendly and efficient one-pot synthesis of alkyl-or aryl-14H-dibenzo [a, j] xanthenes in water, *Bioorganic & medicinal chemistry letters*, 18, pp. 436-438, 2008.
- [65] W. Su, D. Yang, C. Jin, B. Zhang, Yb (OTf)<sub>3</sub> catalyzed condensation reaction of β-naphthol and aldehyde in ionic liquids: a green synthesis of aryl-14H-dibenzo [a, j] xanthenes, *Tetrahedron Letters*, 49, pp. 3391-3394, 2008.

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