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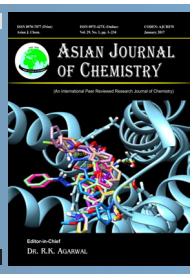

Synthesis of New Derivatives of Spiro[9H-xanthene-oxindole] under Solvent-Free Conditions

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In this paper, a simple and inexpensive method for the synthesis of a new series of spiro[9H-xanthene-oxindole] derivatives is described. The reaction proceeds in the presence of K_2CO_3 as a base and tetrabutyl ammonium bromide(TBAB), a low-cost and commercially available organic salt by conventional heating under solvent-free conditions. The structure of novel compounds were confirmed by IR, ^{1}H NMR, ^{13}C NMR and elemental analysis.

Keywords: Spiro[9H-xanthene-oxindole], Aza-Michael addition, Solvent-free conditions, α,β-Unsaturated esters, Alkyl halides.

INTRODUCTION

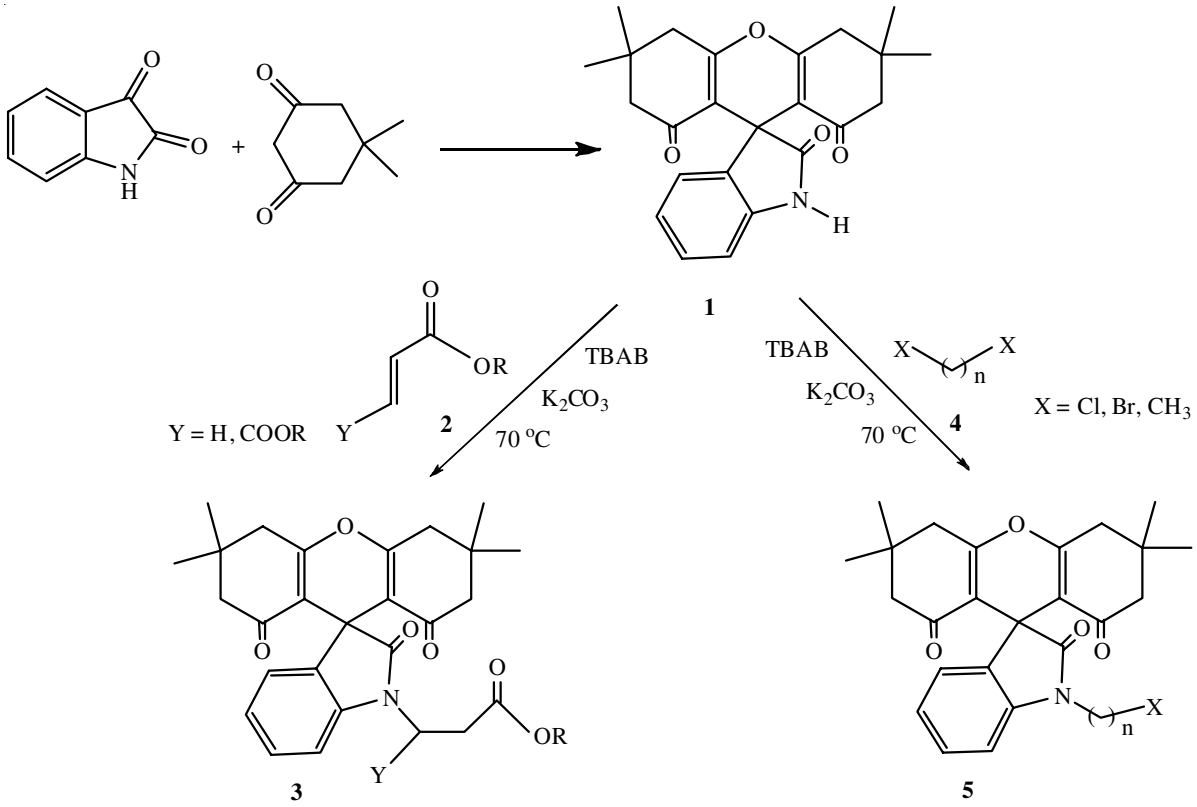
Xanthenes and related compounds have been of significant interest because of their broad spectrum of pharmaceutical importance such as analgesic [1], antibacterial [2], anti-inflammatory [3], antiviral [4] activities and can also be used as antagonists for the paralyzing action of zoxazolamine [5] and in photodynamic therapy (PDT) [6]. Furthermore, these heterocycles display useful spectroscopic properties and are used as dyes [7], in laser technologies [8] and as fluorescent materials for the visualization of biomolecules [9]. A number of xanthene dyes are extracted naturally from soil and plants [10]. The importance and utility of this family of compounds have led to the development of several strategies of accessing xanthene scaffolds [11-15].

As we know, aza-Michael addition reaction is one of the most famous methods for forming a carbon-nitrogen bond in organic synthesis [16]. Different Michael donors such as amines [17], amides [18] and imides [19] have been used in this reaction. To the best of our knowledge, it is surprising that there are no reports for Michael addition of spiro[9H-xanthene-oxindole] to α,β-unsaturated esters. Owing to our interest to use solvent-free conditions in aza-Michael addition of imides and amides to α,β-unsaturated esters [20-22], herein, we report the synthesis of a new series of spiro[9H-xanthene-oxindole] derivatives by aza-Michael addition reaction of this compound to α,β-unsaturated esters as well as direct alkylation by alkyl halides using a simple and expedient method under solvent-free conditions (**Scheme-I**).

EXPERIMENTAL

Spiro[9H-xanthene-oxindole] and α,β-unsaturated esters were synthesized in our laboratory according to the literature procedures [23,24]. Alkyl halides were purchased from Merck and used without further purification. Esters were transferred *via* syringe. Organic solvent were removed by rotary evaporator. Structures of compounds were confirmed by IR and ^{1}H NMR spectroscopy. The progress of the reactions was followed by TLC using silica gel SILIG/UV 254 plates. ^{1}H NMR (400 MHz) and ^{13}C NMR (100 MHz) spectra were recorded on a Bruker 400 MHz instrument. FT-IR spectra were recorded on a Perkin-Elmer RX-1 instrument. Mass spectra were recorded on a Shimadzu GC-MS-QP 1000PX. Elemental analysis for C, H and N were performed using a Heraeus CHN-O-Rapid analyzer. The melting points were determined in open capillaries with a Stuart Melting Point Apparatus and are uncorrected.

General procedure for addition of spiro[9H-xanthene-oxindole] to α,β-unsaturated esters and direct alkylation of this compound with alkyl halides: A mixture of spiro[9H-xanthene-oxindole] (**1**) (1.0 mmol), K_2CO_3 (1 mmol), tetrabutyl ammonium bromide (TBAB) (0.5 mmol) was placed in a flask. α,β-Unsaturated esters or alkyl halides (1.2 mmol) were added to this mixture and the flask was heated in the oil bath at 70 °C for the stipulated time (Tables 3 and 4) The progress of the reaction was monitored by TLC. After completion of reaction, the mixture was cooled to room temperature and dissolved in chloroform (20 mL). Tetrabutyl ammonium bromide (TBAB)



Scheme-I: Addition spiro[9H]-xanthene-oxindole] to α,β-unsaturated esters and alkyl halides

was recovered by the addition of water (3 × 15 mL), then collected and dried under vacuum. The chloroform layer was washed with water (3 × 15 mL). The organic layer was dried over anhydrous Na_2SO_4. The solvent was removed under reduced pressure and the resulting crude material was purified on short silica-gel column with ethyl acetate:*n*-hexane (4:6) as the eluent.

Ethyl 3-(3',3',6',6'-tetramethyl-1',2,8'-trioxo-1',2',3',4',5',6',7',8'-octahydrospiro[indoline-3,9'-xanthen]-1-yl)propanoate (3a): White solid, m.p.: 115-119 °C, IR (KBr, ν_{max}, cm^{-1}): 3055, 2958, 2872, 1716, 1674, 1610, 1490, 1465, 1371, 1346, 1311, 1219, 744. ^{1}H NMR (400 MHz, $CDCl_3$): δ ppm 1.01 (s, 6H), 1.10 (s, 6H), 1.26 (t, 3H, *J* = 6.8 Hz), 2.09 (d, 2H, *J* = 16 Hz), 2.22 (d, 2H, *J* = 16 Hz), 2.43 (d, 2H, *J* = 17.6 Hz), 2.55 (d, 2H, *J* = 17.6 Hz), 2.92 (t, 2H, *J* = 6.8 Hz), 4.10-4.18 (m, 4H), 6.88-6.91 (m, 3H), 7.20-7.27 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$): 15.3, 28.2, 30.2, 32.3, 33.1, 37.0, 42.3, 52.0, 61.6, 108.8, 114.7, 123.0, 123.4, 129.6, 134.2, 145.1, 164.6, 173.0, 196.3. Anal. calcd. for $C_{29}H_{33}NO_6$: C, 70.86; H, 6.77; N, 2.85. Found: C, 70.51; H, 6.48; N, 2.58.

Butyl 3-(3',3',6',6'-tetramethyl-1',2,8'-trioxo-1',2',3',4',5',6',7',8'-octahydrospiro[indoline-3,9'-xanthen]-1-yl)propanoate (3b): White crystal, m.p.: 114-117 °C, IR (KBr, ν_{max}, cm^{-1}): 3055, 2956, 2870, 1732, 1712, 1666, 1616, 1490, 1465, 1371, 1346, 1311, 1222, 906, 744. ^{1}H NMR (400 MHz, $CDCl_3$): δ ppm 0.92 (t, 3H, *J* = 7.2 Hz), 1.01 (s, 6H), 1.11 (s, 6H), 1.26-1.41 (m, 2H), 1.57-1.63 (m, 2H), 2.09 (d, 2H, *J* = 16 Hz), 2.22 (d, 2H, *J* = 16 Hz), 2.43 (d, 2H, *J* = 17.6 Hz), 2.55 (d, 2H, *J* = 17.6 Hz), 2.92 (t, 2H, *J* = 6.4 Hz), 4.12-4.14 (m, 4H), 6.87-6.91 (m, 3H), 7.23-7.27 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$): 14.8, 20.2, 28.2, 30.2, 31.7, 32.3, 33.1, 37.0, 42.3, 52.1, 65.5, 108.8, 114.8, 123.0, 123.4, 129.7, 134.2, 145.1, 164.4, 172.8, 196.3. Anal. calcd. for $C_{31}H_{37}NO_6$: C, 71.65; H, 7.18; N, 2.70. Found: C, 71.32; H, 7.38; N, 2.38.

Hexyl 3-(3',3',6',6'-tetramethyl-1',2,8'-trioxo-1',2',3',4',5',6',7',8'-octahydrospiro[indoline-3,9'-xanthen]-1-yl)propanoate (3c): White solid, m.p.: 102-107 °C, IR (KBr, ν_{max}, cm^{-1}): 3057, 2954, 2870, 1730, 1710, 1664, 1614, 1490, 1463, 1371, 1346, 1311, 1224, 906, 742. ^{1}H NMR (400 MHz, $CDCl_3$): δ ppm 0.89 (t, 3H, *J* = 7.2 Hz), 1.01 (s, 6H), 1.11 (s, 6H), 1.26-1.30 (m, 8H), 2.09 (d, 2H, *J* = 16.4 Hz), 2.23 (d, 2H, *J* = 16.4 Hz), 2.43 (d, 2H, *J* = 18 Hz), 2.56 (d, 2H, *J* = 18 Hz), 2.91 (t, 2H, *J* = 6.8 Hz), 4.10-4.11 (m, 4H), 6.88-6.91 (m, 3H), 7.21-7.27 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$): 15.1, 23.6, 26.7, 28.2, 29.7, 30.2, 32.3, 32.6, 33.1, 37.0, 42.3, 52.1, 65.8, 108.8, 114.8, 122.9, 123.4, 129.7, 145.1, 146.3, 164.6, 173.1, 196.3. Anal. calcd. for $C_{33}H_{41}NO_6$: C, 72.37; H, 7.55; N, 2.56. Found: C, 72.83; H, 7.21; N, 2.79.

2-Ethylhexyl 3-(3',3',6',6'-tetramethyl-1',2,8'-trioxo-1',2',3',4',5',6',7',8'-octahydrospiro[indoline-3,9'-xanthen]-1-yl)propanoate (3d): White soapy, IR (KBr, ν_{max}, cm^{-1}): 3055, 2958, 2872, 1728, 1710, 1674, 1610, 1490, 1465, 1348, 1311, 1288, 906, 744. ^{1}H NMR (400 MHz, $CDCl_3$): δ ppm 0.92 (t, 6H, *J* = 7.2 Hz), 1.01 (s, 6H), 1.11 (s, 6H), 1.29- 1.43 (m, 9H), 2.09 (d, 2H, *J* = 16 Hz), 2.23 (d, 2H, *J* = 16 Hz), 2.43 (d, 2H, *J* = 17.6 Hz), 2.56 (d, 2H, *J* = 17.6 Hz), 2.92 (t, 2H, *J* = 6.4 Hz), 4.04-4.22 (m, 4H), 6.89-6.91 (m, 3H), 7.22-7.27 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$): 12.1, 15.1, 24.1, 24.8, 24.8, 28.2, 30.0, 30.2, 31.4, 32.3, 33.1, 39.8, 42.3, 52.0, 69.2, 108.8, 114.8, 123.0, 123.4, 129.9, 132.0, 145.0, 164.6, 173.2, 196.3. Anal. calcd. for $C_{35}H_{45}NO_6$: C, 73.02; H, 7.88; N, 2.43. Found: C, 73.27; H, 7.63; N, 2.67.

1-Butyl-3',3',6',6'-tetramethyl-3',4',6',7'-tetrahydrospiro[indoline-3,9'-xanthene]-1',2,8'(2'H,5'H)-trione (5a): Yellow solid, m.p.: 151-155 °C, IR (KBr, ν_{max}, cm^{-1}): 3055, 2933, 2359, 170.6, 1667, 1608, 1486, 1347, 1338, 1218, 1129, 983.5. ^{1}H NMR (400 MHz, $CDCl_3$): δ ppm 0.90 (t, 3H, *J* = 6.8 Hz), 1.03 (s, 6H), 1.13 (s,6H), 1.48-1.58 (m, 2H), 1.82-1.90 (m, 2H), 2.11 (d, 2H, *J* = 16.4 Hz), 2.25 (d, 2H, *J* = 16.4 Hz), 2.45 (d, 2H, *J* = 17.6Hz), 2.58 (d, 2H, *J* = 17.6 Hz), 3.79 (t, 2H, *J* = 7.6 Hz), 6.85-6.89 (m, 3H), 7.19-7.25 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$): 13.9, 20.5, 27.0, 28.8, 29.1, 31.9, 40.4, 41.2, 51.0, 107.8, 113.7, 121.5, 122.0, 128.4, 133.2, 144.8, 163.4, 177.2, 195.2. Anal. calcd. for $C_{28}H_{33}NO_4$: C, 75.14; H, 7.43; N, 3.13. Found: C, 75.42; H, 7.80; N, 3.62.

1-Hexyl-3',3',6',6'-tetramethyl-3',4',6',7'-tetrahydrospiro[indoline-3,9'-xanthene]-1',2,8'(2'H,5'H)-trione (5c): Orange solid, m.p.: 113-118 °C, IR (KBr, ν_{max}, cm^{-1}): 3048, 2903, 1715, 1670, 1607, 1493, 1340, 1326, 1211, 1123, 981.4. ^{1}H NMR (400 MHz, $CDCl_3$): δ ppm 0.92 (t, 3H, *J* = 7.2 Hz), 1.03 (s, 6H), 1.13 (s, 6H), 1.28-1.53 (m, 6H), 1.83-1.91 (m, 2H), 2.11 (d, 2H, *J* = 16 Hz), 2.25 (d, 2H, *J* = 16 Hz) 2.45 (d, 2H, *J* = 17.6 Hz), 2.58 (d, 2H, *J* = 17.6 Hz), 3.78 (t, 2H, *J* = 8.0 Hz), 6.84-6.89 (m, 3H), 7.20-7.24 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$): 14.1, 22.6, 26.6, 26.9, 27.1, 29.1, 31.5, 31.9, 40.7, 41.3, 51.0, 107.8, 113.7, 121.5, 122.0, 128.4, 133.2, 144.8, 163.4, 177.1, 195.1. Anal. calcd. for $C_{30}H_{37}NO_4$: C, 75.76; H, 7.84; N, 2.94. Found: C, 75.38; H, 7.51; N, 3.22.

1-(2-Bromoethyl)-3',3',6',6'-tetramethyl-3',4',6',7'-tetrahydrospiro[indoline-3,9'-xanthene]-1',2,8'(2'H,5'H)-trione (5e): Yellow solid, m.p.: 179-181 °C, IR (KBr, ν_{max}, cm^{-1}): 3055, 2953, 2873, 1724, 1674, 1620, 1489, 1463, 1371, 1348, 1220, 902, 754, 553. ^{1}H NMR (400 MHz, $CDCl_3$): δ ppm 1.01 (s, 6H), 1.11 (s, 6H), 2.09 (d, 2H, *J* = 16 Hz), 2.23 (d, 2H, *J* = 16 Hz), 2.44 (d, 2H, *J* = 17.6 Hz), 2.56 (d, 2H, *J* = 17.6 Hz), 3.67 (t, 2H, *J* = 7.2Hz), 4.19 (t, 2H, *J* = 7.6 Hz), 6.89-6.91 (m, 3H), 7.21-7.28 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$): 28.0, 28.2, 30.2, 33.1, 39.8, 42.3, 52.0, 108.7, 114.7, 123.3, 123.6, 129.8, 133.9, 144.7, 165.4, 178.3, 196.3. Anal. calcd. for $C_{26}H_{28}BrNO_4$: C, 62.66; H, 16.03; N, 2.81. Found: C, 62.92; H, 5.35; N, 3.11.

1-(2-Chloroethyl)-3',3',6',6'-tetramethyl-3',4',6',7'-tetrahydrospiro[indoline-3,9'-xanthene]-1',2,8'(2'H,5'H)-trione (5f): Orange viscous oil, IR (KBr, ν_{max}, cm^{-1}): 3053, 2960, 2873, 1722, 1672, 1610, 1489, 1465, 1369, 1346, 1220, 744. ^{1}H NMR (400 MHz, $CDCl_3$): δ ppm 1.00 (s, 6H), 1.10 (s, 6H), 2.09 (d, 2H, *J* = 16 Hz), 2.22 (d, 2H, *J* = 16 Hz), 2.44 (d, 2H, *J* = 17.6 Hz), 2.56 (d, 2H, *J* = 17.6 Hz), 3.85 (t, 2H, *J* = 7.2 Hz), 4.13 (t, 2H, *J* = 6.8 Hz), 6.89-6.92 (m, 3H), 7.22-7.27 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$): 27.0, 28.9, 31.9, 39.4, 41.1, 42.0, 50.8, 107.7, 113.4, 122.3, 122.4, 128.6, 132.8, 143.7, 163.8, 177.7, 195.6. Anal. calcd. for $C_{26}H_{28}ClNO_4$: C, 68.79; H, 6.22; N, 3.09. Found: C, 68.71; H, 6.52; N, 3.21.

1-(3-Bromopropyl)-3',3',6',6'-tetramethyl-3',4',6',7'-tetrahydrospiro[indoline-3,9'-xanthene]-1',2,8'(2'H,5'H)-trione (5g): Orange viscous oil. IR (KBr, ν_{max}, cm^{-1}): 3010, 2958, 2872, 1716, 1670, 1610, 1489, 1465, 1367, 1348, 1222, 756, 565. ^{1}H NMR (400 MHz, $CDCl_3$): δ ppm 1.01 (s, 6H), 1.10 (s, 6H), 1.45-1.49 (m, 2H), 2.09 (d, 2H, *J* = 16 Hz), 2.23 (d, 2H, *J* = 16 Hz), 2.44 (d, 2H, *J* = 17.6 Hz), 2.56 (d, 2H, *J* = 17.6 Hz), 3.66 (t, 2H, *J* = 6.4 Hz), 3.97 (t, 2H, *J* = 6.4 Hz), 6.88-6.98 (m, 3H), 7.22-7.28 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$): 27.1, 29.0, 30.5, 31.9, 38.9, 41.2, 45.3, 50.9, 107.7, 113.5, 121.9, 122.2, 128.6, 133.0, 144.6, 163.7, 177.8, 195.4. Anal. calcd. for $C_{27}H_{30}BrNO_4$: C, 63.28; H, 5.90; N, 2.73. Found: C, 63.82; H, 5.57; N, 2.47.

1-(5-Bromopentyl)-3',3',6',6'-tetramethyl-3',4',6',7'-tetrahydrospiro[indoline-3,9'-xanthene]-1',2,8'(2'H,5'H)-trione (5h): Yellow viscous oil, IR (KBr, ν_{max}, cm^{-1}): 3005, 2958, 2864, 1716, 1672, 1610, 1456, 1436, 1346, 1222, 731, 561. ^{1}H NMR (400 MHz, $CDCl_3$): δ ppm 1.01 (s, 6H), 1.10 (s, 6H), 1.63-1.70 (m, 2H), 1.82-1.87 (m, 2H), 1.92-1.97 (m, 2H), 2.09 (d, 2H, *J* = 16 Hz), 2.23 (d, 2H, *J* = 16 Hz), 2.43 (d, 2H, *J* = 17 Hz), 2.56 (d, 2H, *J* = 17 Hz), 3.45 (t, 2H, *J* = 6.4 Hz), 3.78 (t, 2H, *J* = 6.8 Hz), 6.83-6.88 (m, 3H), 7.21-7.26 (m,1H). ^{13}C NMR (100 MHz, $CDCl_3$): 26.0, 27.1, 29.0, 31.9, 32.5, 33.9, 40.3, 41.2, 45.4, 50.9, 107.7, 113.5, 121.7, 122.1, 128.4, 133.2, 144.6, 163.6, 177.4, 195.3. Anal. calcd. for $C_{29}H_{34}BrNO_4$: C, 64.44; H, 6.34; N, 2.59. Found: C, 64.87; H, 6.74; N, 2.29.

1-(6-Bromohexyl)-3',3',6',6'-tetramethyl-3',4',6',7'-tetrahydrospiro[indoline-3,9'-xanthene]-1',2,8'(2'H,5'H)-trione (5i): Yellow viscous oil, IR (KBr, ν_{max}, cm^{-1}): 3005, 2958, 2856, 1718, 1674, 1610, 1436, 1348, 1247, 727, 561. ^{1}H NMR (400 MHz, $CDCl_3$): δ ppm 1.01 (s, 6H), 1.11 (s, 6H), 1.48-1.53 (m, 6H), 1.80-1.98 (m, 2H), 2.09 (d, 2H, *J* = 16 Hz), 2.23 (d, 2H, *J* = 16 Hz), 2.43 (d, 2H, *J* = 16 Hz), 2.56 (d, 2H, *J* = 16 Hz), 3.42 (t, 2H, *J* = 2.8 Hz), 3.78 (t, 2H, *J* = 2.8 Hz), 6.84-6.87 (m, 3H), 7.20-7.27 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$): 26.6, 27.1, 27.8, 29.0, 31.9, 32.7, 34.0, 40.4, 41.2, 45.4, 51.0, 107.7, 113.6, 121.6, 122.1, 128.4, 133.2, 144.8, 163.4, 177.3, 195.2. Anal. calcd. for $C_{30}H_{36}BrNO_4$: C, 64.98; H, 6.54; N, 2.53. Found: C, 65.12; H, 6.72; N, 2.83.

RESULTS AND DISCUSSION

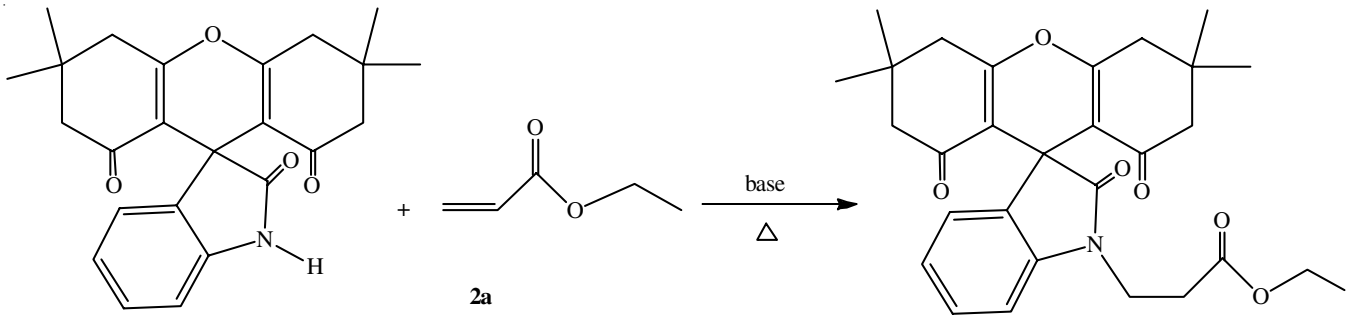
We have extended our work [25,26] concerning the synthesis of novel derivatives of isatin because of its biological and pharmaceutical properties by applying the solvent-free conditions. Therefore, aza-Michael addition reaction of spiro[9H-xanthene-oxindole] **1** to ethyl acrylate **2a** (**Scheme-II**), as a model reaction, was investigated in the presence of TBAB and various organic and inorganic bases to evaluate their capabilities (Table-1).

This study showed that the best results were obtained when K_2CO_3 was applied as a base in the presence of tetrabutyl

TABLE-1
MICHAEL REACTION OF SPIRO[9H-XANTHENE-OXINDOLE] TO ETHYL ACRYLATE IN THE PRESENCE OF DIFFERENT BASES AND TBAB UNDER SOLVENT-FREE CONDITIONS

Entry	Base[c]	Time (base)	Yield (%)
1	Na_2CO_3[a,b]	18	–
2	K_2CO_3[b]	2	93
3	DABCO[b]	2	70
5	KOH[b]	2	10
6	CaO[b]	2	60
7	PPh_3[a,b]	18	–
8	NEt_3[a,b]	18	–
9	Pyridine[a]	18	10

[a]Room temperature; [b]70 °C; [c]The reactions were carried out with spiro[9H-xanthene-oxindole] (1.0 mmol), base (1.0 mmol), TBAB (0.5 mmol) and ethyl acrylate (1.2 mmol).



1 **3a**

Scheme-II: Michael addition spiro[9H-xanthene-oxindole] to ethyl acrylate (as model reaction)

ammonium bromide (TBAB) under solvent-free conditions at 70 °C (Table-1, entry 2). Using bases such as Na_2CO_3, PPh_3, NEt_3 was not successful at room temperature and 70 °C (Table-1, entries 1, 7, 8). Also, in the absence of TBAB and in the presence of variety solvents, in the reaction media (Table-2), considerable progressing wasn't observed for model reaction. Although moderate to good yields were afforded in CH_3CN, CH_3COCH_3, THF solvents (Table-2, entries 3, 6, 7), but they are avoided to use because of their disadvantages. These disadvantages are lack of compatibility with the environment and economics (save money on solvent), need to avoid solvent, *etc*. Therefore, this reaction is more efficient in the presence of K_2CO_3 and organic salt TBAB is a suitable media for this transformation.

TABLE-2
EFFECT OF DIFFERENT SOLVENTS ON THE MICHAEL REACTION SPIRO[9H-XANTHENE-OXINDOLE] WITH ETHYL ACRYLATE ESTER

Entry	Solvent[a]	Time (min)	Yields[b] (%)
1	DMSO	30	–
2	DMF	30	–
3	CH_3CN	30	80
4	CH_2Cl_2	30	30
5	CH_3COOEt	30	50
6	CH_3COCH_3	30	70
7	THF	30	60
8	Toluene	30	10
9	Dioxane	30	50
10	TBAB	30	95

[a]The reactions were carried out with spiro[9H-xanthene-oxindole] (1 mmol), K_2CO_3 (1 mmol) and ethyl acrylate (1.2 mmol) in TBAB (1 mmol) or 5 mL solvent at room temperature; [b]Isolated yield.

In continuation of our research to optimize the reaction, we examined the model reaction in the presence of different molar ratio of K_2CO_3, TBAB, ethyl acrylate and spiro[9H-xanthene-oxindole] that the best results were obtained with molar ratio 1:0.5:1.2:1 of these compounds respectively.

Having this model reaction in hand, we examined the reaction with various types of α,β-unsaturated esters and results are summarized in Table-3. It is seen that the reactions with acrylic esters were very clean and the products were obtained in very good to excellent yields within 2 h (Table-3, entries 1-4). The reaction was not successful with methyl and butyl methacrylate (Table-3, entries 5, 6). It can be attributed to steric hindrance of methyl group at α-position of these esters. Also, this reaction was not successful with fumaric esters. Probably, the steric hindrance of RO_2C-groups at β-position prevent from attacking of Michael donor to this position (Table-2, entries 7-9).

These results encouraged us to study the N-alkylation of compound **1** with alkyl halides **4** under the above conditions. Herein, we proceeded the alkylation reaction of spiro[9H-xantheneoxindole] (**1**) with various alkyl halides in the presence of K_2CO_3 and TBAB at 70 °C. The synthetic products are depicted in Table-4.

In all cases, the reaction proceeded clean to give the desired products, in good yields (Table-4, entries 1-3, 5-9). The reaction was not successful with dibromomethane (Table-4, entry 4). This can be attributed to the fact that this substrate is not suitable for substitution reaction with spiro[9H-xanthene-oxindole].

Conclusion

In summary, we developed a new, expedient and environment friendly procedure for the addition of spiro[9H-xantheneoxindole] to acrylic esters and alkylation of this spiro compound with linear alkyl halides in the presence of TBAB as an ionic organic salt under solvent-free conditions. It was found that the suitable base for this reaction is K_2CO_3. It is considerable that the readily available catalyst, facile procedure and potentially valuable products would make method practical and useful to synthetic chemists.

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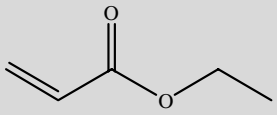
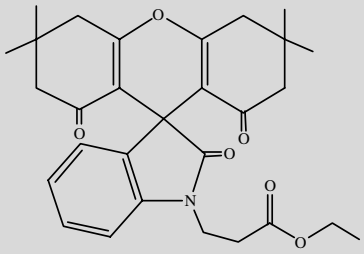
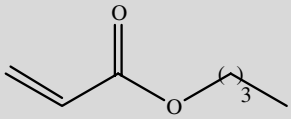
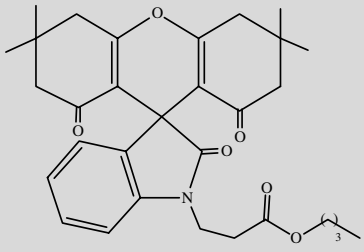
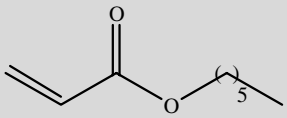
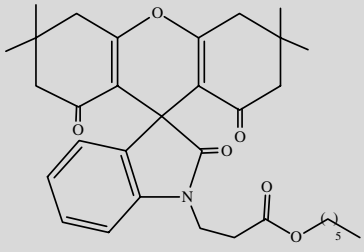
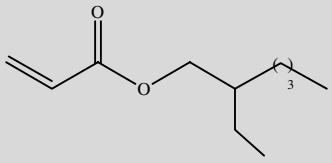
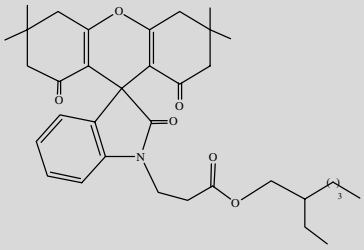
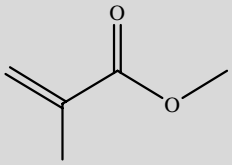
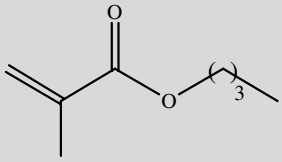
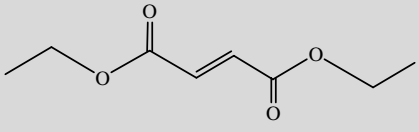
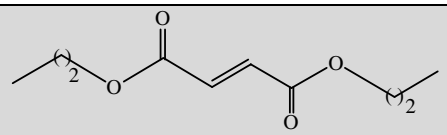
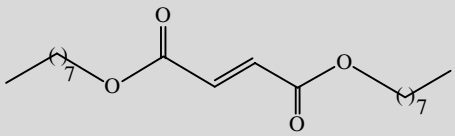
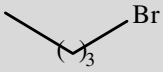
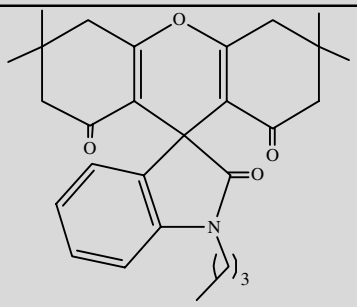
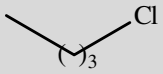
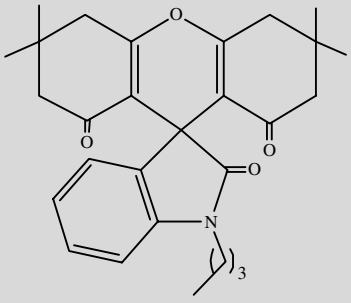
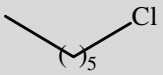
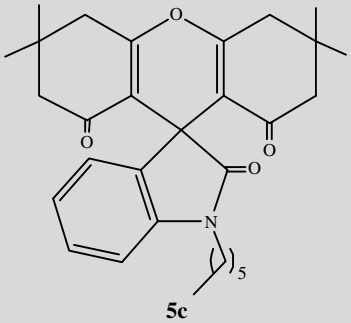
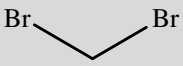
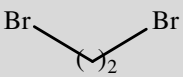
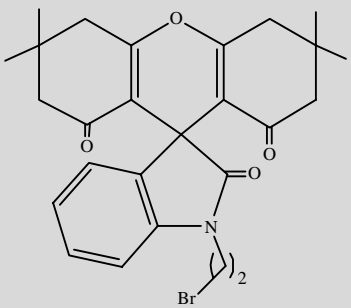
TABLE-3
AZA-MICHAEL ADDITION OF SPIRO[9H-XANTHENE-OXINDOLE] **1** TO α,β-UNSATURATED ESTERS **2** UNDER SOLVENT-FREE CONDITIONS

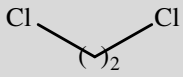
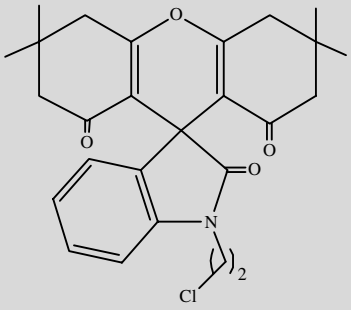
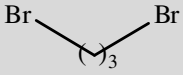
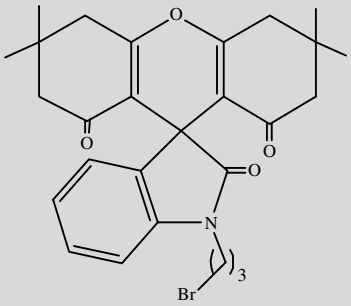
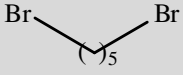
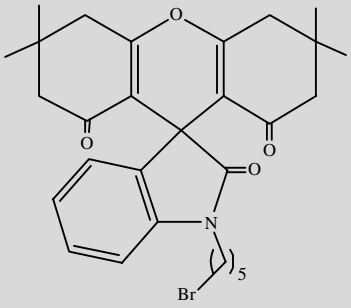
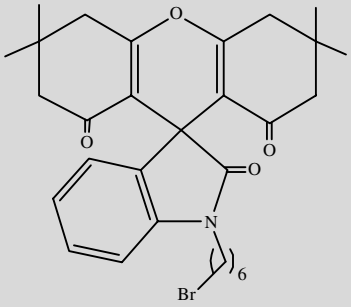
Entry	Ester	Product	Time (min)	Yield (%)[a]
1	 **2a**	 **3a**	2	93
2	 **2b**	 **3b**	2	85
3	 **2c**	 **3c**	2	85
4	 **2d**	 **3d**	2	75
5	 **2e**	–	24	–
6	 **2f**	–	24	–
7	 **2g**	–	36	–

8	 **2h**	–	36	–
9	 **2i**	–	36	–

[a]Isolated yields

TABLE-4
ADDITION OF SPIRO[9H-XANTHENE-OXINDOLE] **1** TO ALKYL HALIDES 4 UNDER SOLVENT-FREE CONDITIONS

Entry	Alkylhalide	Product	Time (min)	Yield (%)[a]
1	 **4a**	 **5a**	8	90
2	 **4b**	 **5a**	8	90
3	 **4c**	 **5c**	8	88
4	 **4d**	- **5d**	24	-
5	 **4e**	 **5e**	8	88

6	 **4f**	 **5f**	8	82
7	 **4g**	 **5g**	8	79
8	 **4h**	 **5h**	8	85
9	 **4i**	 **5i**	8	58

[a]Isolated yields

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