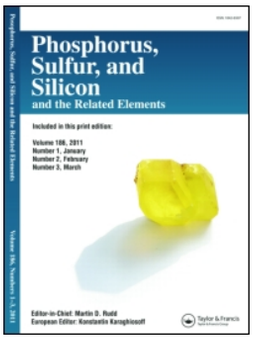

Phosphorus, Sulfur, and Silicon and the Related Elements

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A FACILE SYNTHESIS OF 7,8-DI ARYL COUMARINO AND FLAVANO BENZO-THIOPHENES

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(Received April 10 2001.)

*The key step for the synthesis of 7-hydroxy 2,3-diarylsubstituted benzothiophenes **5a–f**, by starting from substituted 2-aryl-2-((2-methoxy phenyl)thio)acetophenones **3a–f** as an intermediate, consists of a Friedel-Crafts cyclization followed by demethylation by Lewis acids like BF_3OEt_2 and $AlCl_3$ in DCM.*

Keywords: Benzopyranones; benzothiophenes; condensation; demethylation; Friedel crafts cyclization

Substituted benzothiophenes are of interest in many pharmaceutical areas. They exhibit a variety of biological properties such as antiallergic[1] and occular hypotensive activities.[2] In addition, they also to serve as bioisosters of indoles.[3] Recently Reloxifene (Ly 139481 HCl)[4,**] a polysubstituted-2-aryl benzothiophene was approved for the prevention of osteoporosis in postmenopausal women. Substituted Coumarino benzothiophenes were known to exhibit antiinflammatory,[5] analgesic,[6] and antipyretic activities.[7] There are relatively few methods[8,9] for the preparation of 3-aryl benzothiophenes reported in literature. In this communication, we report a convenient procedure for the preparation of 7-hydroxy-2,3-diaryl benzothiophenes **5a–f** by condensation and demethylation of substituted 2-aryl-2-{{2-methoxyphenyl}thio}acetophenones **3a–f** with Lewis acids like borontrifloride-etherate and aluminium chloride at room temperature.

Initially, we attempted the cyclization of **3a–f** with alcoholic KOH refluxed for 14–15 h which gave 7-methoxy-2,3-diarylbenzothiophenes

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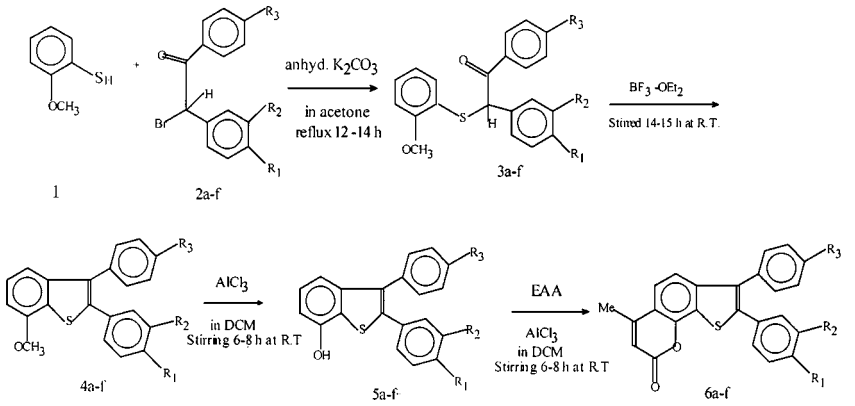
**Raloxifene was approved by the FDA in Jan. 1998, and is marketed as Evista by Eli Lilley.

4a–f with low yield (20–25%). Then followed by demethylation by a known procedure[10] gave the corresponding compounds **5a–f** with lower yields. These compounds were later condensed with ethylacetoacetate in the presence of polyposphoric acid[11] to produce the corresponding coumarino benzothiophenes **6a–f** about 30% yield.

Finally, after some experimentation, we synthesised the compounds **5a–f** and **6a–f** by a convenient route by using a Lewis acid. The closure of the benzothiophene ring was accomplished by treatment of **3a–f** with borontrifluoride-etherate (BF_3OEt_2) at room temperature, which afforded 7-methoxy-2,3-diarylbenzothiophenes **4a–f** in considerable yield. By the reaction of **4a–f** with aluminium chloride in the presence of DCM at room temperature, demethylation[12] took place producing the corresponding 7-hydroxy2,3-diarylbenzothiophenes **5a–f** in acceptable to good yields when these compounds were condensed with etylacetoacetate in the presence of $AlCl_3$, in DCM at room temperature the corresponding coumarino benzothiophenes **6a–f** were obtained.



1 2a-f 3a-f 4a-f 5a-f 6a-f

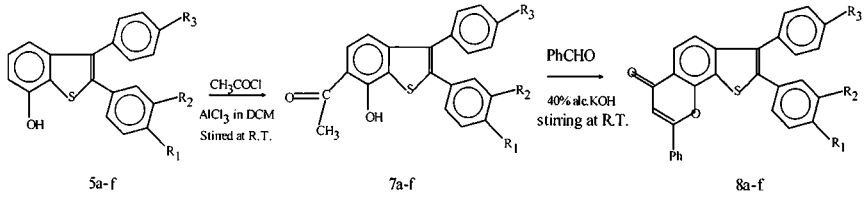
2a : $R_1 = R_2 = R_3 = H$ 2b : $R_1 = R_2 = H : R_3 = Br$

2c : $R_1 = R_2 = H: R_3 = CH_3$ 2d : $R_1 = R_2 = F : R_3 = H$

2e : $R_1 = R_2 = F : R_3 = Br$ 2f : $R_1 = R_2 = F : R_3 = CH_3$

SCHEME 1

Substituted 7-hydroxybenzothiophenes **5a–f** were acetylated with acetyl chloride in the presence the of $AlCl_3$ in dry DCM. The acyl compounds **7a–f** were later condensed with benzaldehyde in the presence of alcoholic KOH(40%) to give rise to the corresponding flavano benzothiophenes **8a–f**.



SCHEME 2

In conclusion, a convergent procedure for the preparation of Pharmacologically valuable 7,8-diarylcoumarinobenzothiophenes **6a–f** via a common intermediate **3a–f** has been developed. These intermediates may also provide a synthetic entry to a variety of flavano benzothiophenes **8a–f**.

EXPERIMENTAL

All melting points were uncorrected. The elementary analysis was carried out by CARLO ERBA STUMENTAZOINE, Itali Model 1108 and IR spectra (νcm^{-1}) were recorded on Perkin Elmer-282 instrument.

The ^1H NMR spectra were recorded on a varian 200MHz spectrometer using tetramethyl silane as internal standard. Chemical shift values are expressed in δ ppm. Mass spectra were scanned on a Jeol-JMS-300 spectrometer at 70 eV. The purity of compound were monitered by TLC performed on a silicagel plates (merck) using ethylacetate and pet.ether.

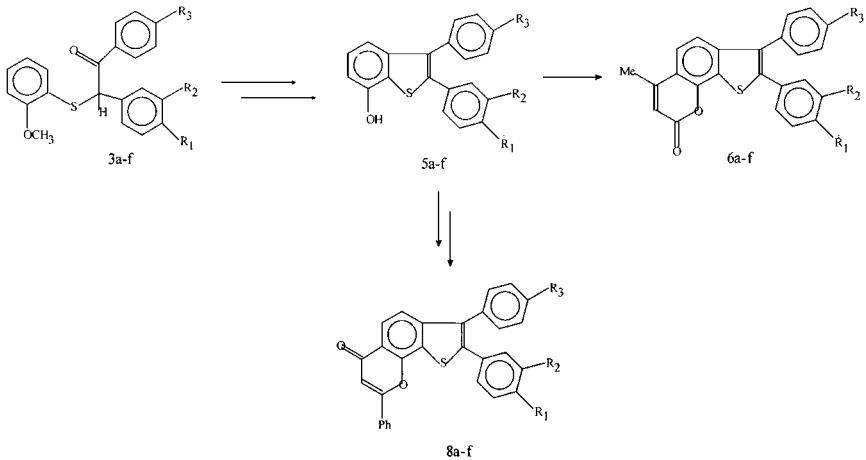


FIGURE 1 A facile synthesis of 7,8-di aryl coumarino and flavano benzothiophenes.

TABLE I Spectroscopic Data of Substituted Coumarino Benzothiophenes **6a–f**

Product	% yield	m.p.°C	Spectroscopic data
6a	60	216–217	IR (cm^{-1}): 3100, 2900 (CH), 1710 (Lactone,C═O), 1600 (C═C), 750 (C—S) ^{1}HNMR (200 MHz, $CDCl_3$), δ (ppm) 2.44 (s, 3H, CH_3), 6.52 (s, 1H, coumarino-H), 6.76–6.89 (m, 5H, Ar—H), 7.00–7.16 (m, 5H, Ar—H), 7.45–7.52 (dd, 2H, Ar—H), mass (m/z): M^+ 367, 341
6b	52	212–213	IR (cm^{-1}): 3098, 2905(CH), 1712 (Lactone, C═O), 1605 (C═C), 750 (C—S) ^{1}HNMR (200 MHz, $CDCl_3$), δ (ppm) 2.38 (s, 3H, CH_3), 6.50 (s, 1H, coumarino-H), 6.9–7.2 (dd, 4H, Ph—CH_3), 6.80–6.95 (m, 5H, Ar—H), 7.04–7.26 (dd, 2H, Ar—H), mass (m/z): M^+ 446, 381
6c	55	207–208	IR (cm^{-1}): 3105, 2905 (C—H), 1712 (Lactone, C═O), 1608 (C═C), 750 (C—S) ^{1}HNMR (200 MHz, $CDCl_3$), δ (ppm) 2.42 (s, 6H, 2 × CH_3), 6.54 (s, 1H, coumarino-H), 6.78–6.91 (dd, 4H, Ar—CH_3), 7.13–7.34 (m, 5H, Ar—H), 7.61–7.91 (dd, 2H, Ar—H), mass (m/z): M^+ 381, 366, 338
6d	59	237–238	IR (cm^{-1}): 3105, 2905 (CH), 1710 (Lactone, C═O), 1605 (C═C), 750 (C—S) ^{1}HNMR (200 MHz, $CDCl_3$), δ (ppm) 2.40 (s, 3H, CH_3), 6.45 (s, 1H, coumarino-H), 6.70–7.0 (m, 5H, Ar—H), 7.63–7.54 (dd, 2H, Ar—H), 7.7–7.8 (s, 1H, Ar—H), 7.84–7.9 (dd, 2H, Ar—H), mass (m/z): M^+ 443, 415
6e	54	242–243	IR (cm^{-1}): 3100, 2910 (CH), 1710 (Lactone, C═O), 1605 (C═C), 750(C—S) ^{1}HNMR (200 MHz, $CDCl_3$), δ (ppm) 2.42 (s, 3H, CH_3), 6.52 (s, 1H, coumarino-H), 7.1–7.2 (s, 1H, Ar—H), 7.3–7.5 (dd, 2H, Ar—H), 7.6–7.9 (dd, 4H, Ar—Br), 7.92–8.2 (dd, 2H, Ar—H), mass (m/z): M^+ 481, 453, 372
6f	57	222–223	IR (cm^{-1}): 3105, 2900 (C—H), 1708 (Lactone, C═O), 1605 (C═C), 750 (C—S) ^{1}HNMR (200 MHz, $CDCl_3$), δ (ppm) 2.44 (s, 6H, 2 × CH_3), 6.58 (s, 1H, coumarino-H), 6.9–7.0 (s, 1H, Ar—H), 7.2–7.3 (dd, 2H, Ar—H), 7.44–7.72 (dd, 4H, Ar—CH_3), 7.89–7.92 (dd, 2H, Ar—H), mass (m/z): M^+ 417, 389, 374

TABLE II Spectroscopic Data of Substituted Flavano Benzothiophenes **8a–f**

Product	% yield	m.p.°C	Spectroscopic data
8a	61	106–108	IR (cm^{-1}): 3110, 2910 (C—H), 1695 (C═O), 1610 (C═C), 750(C—S) ^{1}HNMR (200 MHz, $CDCl_3$), δ (ppm) 7.12 (s, 1H, flavano-H), 7.15–7.24 (m, 5H, Ar—H), 7.28–7.36 (m, 5H, Ar—H), 7.50–7.60 (m, 2H, Ar—H), 7.72–7.91 (m, 5H, Ph—H), mass (m/z): M^+ 429, 401, 326
8b	60	120–122	IR (cm^{-1}): 3109, 2905 (C—H), 1697 (C═O), 1612 (C═C), 750 (C—S) ^{1}HNMR (200 MHz, $CDCl_3$), δ (ppm) 7.14 (s, 1H, flavano-H), 7.18–7.21 (m, 4H, Ph—Br), 7.26–7.31 (m, 5H, Ar—H), 7.40–7.52 (m, 2H, Ar—H), 7.75–7.82 (m, 5H, Ph—H), mass (m/z): M^+ 508, 480, 403
8c	58	113–115	IR (cm^{-1}): 3112, 2910 (C—H), 1698 (C═O), 1612 (C═C), 750 (C—S) ^{1}HNMR (200 MHz, $CDCl_3$), δ (ppm) 2.42 (s, 3H, CH_3), 7.2 (s, 1H, flavano-H), 7.25–7.34 (m, 4H, Ph—CH_3), 7.36–7.45 (m, 5H, Ar—H), 7.47–7.55 (m, 2H, Ar—H), 7.9–8.1 (m, 5H, Ph—H), mass (m/z): M^+ 437, 410, 333
8d	57	109–111	IR (cm^{-1}): 3114, 2910 (C—H), 1698 (C═O), 1615 (C═C), 750 (C—S) ^{1}HNMR (200 MHz, $CDCl_3$), δ (ppm) 7.23 (s, 1H, flavano-H), 7.26–7.32 (m, 5H, Ar—H), 7.41–7.50 (dd, 2H, Ar—H), 7.52–7.53 (s, 1H, Ar—H), 7.61–7.72 (m, 2H, Ar—H), 7.8–7.94 (m, 5H, Ar—H), mass (m/z): M^+ 493, 465, 388
8e	55	125–127	IR (cm^{-1}): 3109, 2908 (C—H), 1698 (C═O), 1614 (C═C), 750 (C—S) ^{1}HNMR (200 MHz, $CDCl_3$), δ (ppm) 7.22 (s, 1H, flavano-H), 7.30–7.41 (m, 4H, Ph—Br), 7.44–7.51 (dd, 2H, Ar—H), 7.52–7.54 (s, 1H, Ar—H), 7.64–7.78 (m, 2H, Ar—H), 7.81–7.92 (m, 5H, Ar—H), mass (m/z): M^+ 573, 545, 468, 387
8f	59	117–119	IR (cm^{-1}): 3112, 2909 (C—H), 1698 (C═O), 1615 (C═C), 750 (C—S) ^{1}HNMR (200 MHz, $CDCl_3$), δ (ppm) 2.45 (s, 3H, CH_3), 7.25 (s, 1H, flavano-H), 7.36–7.42 (m, 4H, Ph—CH_3), 7.43–7.51 (dd, 2H, Ar—H), 7.52–7.54 (s, 1H, Ar—H), 7.64–7.81 (m, 2H, Ar—H), 7.88–8.1 (m, 5H, Ar—H), mass (m/z): M^+ 497, 469, 392

TABLE III Analytical Data of **6a–f**

Compound	R_1	R_2	R_3	Elemental analysis-calcd (found)					
				C	H	O	S	Br	F
6a	H	H	H	78.24 (78.20)	4.38 (4.35)	8.68 (8.66)	8.70 (8.69)	—	—
6b	H	H	Br	64.44 (64.41)	3.38 (3.35)	7.15 (7.12)	7.17 (7.10)	17.86 (17.81)	—
6c	H	H	CH_3	78.51 (78.39)	4.74 (4.70)	8.37 (8.34)	8.38 (8.36)	—	—
6d	F	F	H	71.28 (71.26)	3.49 (3.48)	7.91 (7.80)	7.93 (7.88)	—	9.39 (9.35)
6e	F	F	Br	59.64 (59.62)	2.71 (2.68)	6.62 (6.60)	6.63 (6.61)	16.53 (16.51)	7.86 (7.82)
6f	F	F	CH_3	71.76 (71.63)	3.85 (3.81)	7.65 (7.63)	7.66 (7.64)	—	9.08 (9.02)

TABLE IV Analytical Data of **8a–f**

Compound	R_1	R_2	R_3	Elemental analysis-calcd (found)					
				C	H	O	S	Br	F
8a	H	H	H	80.91 (80.88)	4.21 (4.20)	7.43 (7.41)	7.45 (7.43)	—	—
8b	H	H	Br	68.38 (68.36)	3.36 (3.35)	6.28 (6.26)	6.29 (6.27)	15.69 (15.66)	—
8c	H	H	CH_3	81.05 (81.03)	4.53 (4.51)	7.20 (7.17)	7.21 (7.19)	—	—
8d	F	F	H	74.67 (74.65)	3.46 (3.42)	6.86 (6.84)	6.87 (6.85)	—	8.14 (8.10)
8e	F	F	Br	63.86 (63.84)	2.77 (2.74)	5.87 (5.85)	5.88 (5.86)	14.65 (14.62)	6.97 (6.94)
8f	F	F	CH_3	74.99 (74.97)	3.78 (3.74)	6.66 (6.63)	6.67 (6.65)	—	7.91 (7.88)

TABLE V Spectral Data of Compounds **3a–f**, **4a–f**, **5a–f**, and **7a–f**

Compound	% Yield	b.p.(°C)	Spectroscopic data
3a	50	104–105	IR (cm^{-1}): 3100, 2890 (C—H), 1689 (C=O), 1610 (C=C), 750 (C—S) ^1H NMR (δ ppm): 6.92–7.10 (5H, m, Ar—H), 7.24–7.52 (5H, m, Ar—H), 7.55–7.91 (4H, m, Ph—OCH_3), 4.62 (1H, s, S—CH), 3.92 (3H, s, —OCH_3), mass (m/z): 334 (M^{+1})
3b	55	116–117	IR (cm^{-1}): 3105, 2895 (C—H), 1690 (C=O), 1610 (C=C), 750 (C—S) ^1H NMR (δ ppm): 6.96–7.12 (4H, dd, Ph—Br), 7.21–7.52 (5H, m, Ar—H), 7.59–7.90 (4H, m, Ph—OCH_3), 4.60 (1H, s, S—CH), 3.93 (3H, s, —OCH_3), mass (m/z): 413 (M^{+1})
3c	50	125–127	IR (cm^{-1}): 3105, 2890 (C—H), 1692 (C=O), 1610 (C=C), 750 (C—S) ^1H NMR (δ ppm): 6.8–6.91 (4H, dd, Ph—CH_3), 7.1–7.3 (5H, m, Ar—H), 7.37–7.95 (4H, m, Ph—OCH_3), 4,62 (1H, s, —S—CH), 3.92 (3H, s, —OCH_3), 2.49 (3H, s, CH_3), mass (m/z): 348 (M^{+1})
3d	52	108–110	IR (cm^{-1}): 3100, 2895 (C—H), 1690 (C=O), 1610 (C=C), 750 (C—S) ^1H NMR (δ ppm): 6.92–7.14 (5H, m, Ar—H), 7.26–7.34 (2H, dd, Ar—H), 7.38–7.42 (1H, s, Ar—H), 7.52–7.94 (4H, m, Ph—OCH_3), 4.61 (1H, s, —S—CH), 3.90 (3H, s, —OCH_3), mass (m/z): 378 (M^{+1})
3e	60	122–123	IR (cm^{-1}): 3095, 2892 (C—H), 1698 (C=O), 1612 (C=C), 750 (C—S) ^1H NMR (δ ppm): 6.98–7.14 (4H, dd, Ph—Br), 7.36–7.46 (2H, dd, Ar—H), 7.49—7.52 (1H, s, Ar—H), 7.55–7.93 (4H, m, Ph—OCH_3), 4.62 (1H, s, —S—CH), 3.90 (3H, s, OCH_3), mass (m/z): 489 (M^{+1})
3f	57	119–121	IR (cm^{-1}): 3100, 2900 (C—H), 1697 (C=O), 1610 (C=C), 750 (C—S) ^1H NMR (δ ppm): 7.04–7.13 (4H, dd, Ph—CH_3), 7.26–7.32 (2H, dd, Ar—H), 7.36–7.41 (1H, s, Ar—H), 7.53–7.92 (4H, m, Ph—OCH_3), 4.61 (1H, s, —S—CH), 3.93 (3H, s, OCH_3), 2.49 (3H, s, CH_3), mass (m/z): 424 (M^{+1})
4a	66	115–116	IR (cm^{-1}): 3105, 2890 (C—H), 1610 (C=C), 750 (C—S) ^1H NMR (δ ppm): 6.80–7.08 (5H, m, Ar—H), 7.12–7.28 (5H, m, Ar—H), 7.24–7.51 (3H, m, Ph—OCH_3), 3.92 (3H, s, —OCH_3), mass (m/z): 316 (M^{+1})
4b	65	125–127	IR (cm^{-1}): 3107, 2895 (C—H), 1610 (C=C), 750 (C—S) ^1H NMR (δ ppm): 6.79–7.02 (4H, dd, Ph—Br), 7.04–7.15 (5H, m, Ar—H), 7.29–7.53 (3H, m, Ph—CH_3), 3.93 (3H, s, —OCH_3), mass (m/z): 395 (M^{+1})

4c	68	108–109	IR (cm^{-1}): 3109, 2892 (C—H), 1612 (C═C), 750 (C—S) ^1H NMR (δ ppm): 6.78–6.84 (4H, dd, Ph—CH_3), 6.90–7.15 (5H, m, Ar—H), 7.26–7.60 (3H, m, Ph—CH_3), 3.90 (3H, s, —OCH_3), 2.45 (3H, s, CH_3), mass (m/z): 346 (M^{+1})
4d	72	119–120	IR(cm^{-1}): 3102, 2900 (C—H), 1610 (C═C), 750 (C—S) ^1H NMR (δ ppm): 7.10–7.24 (5H, m, Ar—H), 7.29–7.34 (2H, dd, Ar—H), 7.39—7.42 (1H, s, Ar—H), 7.49—7.85 (3H, m, Ph—OCH_3), 3.90 (3H, s, —OCH_3), mass (m/z): 392 (M^{+1})
4e	73	112–113	IR (cm^{-1}): 3108, 2902 (C—H), 1612 (C═C), 750 (C—S) ^1H NMR (δ ppm): 7.12–7.25 (4H, dd, Ph—Br), 7.30–7.39 (2H, dd, Ar—H), 7.40–7.43 (1H, s, Ar—H), 7.49—7.84 (3H, m, Ph—OCH_3), 3.92 (3H, s, OCH_3), mass (m/z): 471 (M^{+1})
4f	75	122–123	IR (cm^{-1}): 3115, 2904 (C—H), 1612 (C═C), 750 (C—S) ^1H NMR (δ ppm): 7.15–7.26 (4H, dd, Ph—CH_3), 7.29–7.35 (2H, dd, Ar—H), 7.39–7.42 (1H, s, Ar—H), 7.52–7.91 (3H, m, Ph—OCH_3), 3.91 (3H, s, OCH_3), 2.43 (3H, s, CH_3), mass (m/z): 422 (M^{+1})
5a	56	129–131	IR (cm^{-1}): 3452 (br, Ph—OH), 3050, 2900 (C—H), 1610 (C═C), 750 (C—S) ^1H NMR (δ ppm): 6.79–6.94 (5H, m, Ar—H), 7.02–7.31 (5H, m, Ar—H), 7.40–7.82 (3H, m, Ph—OH), 10.52 (1H, br, s, —OH), mass (m/z): 298 (M^{+1})
5b	57	114–115	IR (cm^{-1}): 3452 (br, Ph—OH), 3053, 2905 (C—H), 1610 (C═C), 750 (C—S) ^1H NMR (δ ppm): 6.77–6.92 (4H, dd, Ph—Br), 7.06–7.32 (5H, m, Ar—H), 7.43–7.84 (3H, m, Ph—OH), 10.53 (1H, br, s, OH), mass (m/z): 381 (M^{+1})
5c	60	110–112	IR (cm^{-1}): 3452 (br, Ph—OH), 3050, 2905 (C—H), 1612 (C═C), 750 (C—S) ^1H NMR (δ ppm): 6.78–6.92 (4H, dd, Ph—CH_3), 7.06–7.35 (5H, m, Ar—H), 7.49–7.85 (3H, m, Ph—OH), 10.52 (1H, br, s, OH), 2.45 (3H, s, CH_3), mass (m/z): 316 (M^{+1})
5d	62	124–125	IR (cm^{-1}): 3452 (br, Ph—OH), 3053, 2905 (C—H), 1613 (C═C), 750 (C—S) ^1H NMR (δ ppm): 7.10–7.26 (5H, m, Ar—H), 7.31–7.42 (2H, dd, Ar—H), 7.52–7.60 (1H, s, Ar—H), 7.69–7.93 (3H, m, Ph—OH), 10.52 (1H, br, s, OH), mass (m/z): 378 (M^{+1})
5e	65	131–132	IR (cm^{-1}): 3452 (br, Ph—OH), 3050, 2905 (C—H), 1612 (C═C), 750 (C—S) ^1H NMR (δ ppm): 7.12–7.24 (4H, dd, Ph—Br), 7.30–7.45 (2H, dd, Ar—H), 7.50—7.61 (1H, s, Ar—H), 7.69–7.92 (3H, m, Ph—OH), 10.52 (1H, br, s, OH), mass (m/z): 457 (M^{+1})

(Continued on next page)

TABLE V Spectral Data of Compounds **3a–f**, **4a–f**, **5a–f**, and **7a–f** *(Continued)*

Compound	% Yield	b. p.(°C)	Spectroscopic data
5f	64	119–120	IR (cm^{-1}): 3450 (br,Ph—OH), 3052, 2900 (C—H), 1610 (C=C), 750 (C—S) ^1H NMR (δ ppm): 7.13–7.28 (4H, dd, Ph—CH_3), 7.31–7.44 (2H, dd, Ar—H), 7.49–7.62 (1H, s, Ar—H), 7.72–7.95 (3H, m, Ph—OH), 10.50 (1H, br, s, OH), 2.43 (3H, s, CH_3), mass (m/z): 392 (M^{+1})
7a	50	125–126	IR (cm^{-1}): 3450 (br, Ph—OH), 3050, 2900 (C—H), 1685 (C=O), 1610 (C=C), 750 (C—S) ^1H NMR (δ ppm): 6.92–7.13 (5H, m, Ar—H), 7.21–7.32 (5H, m, Ar—H), 7.39–7.45 (2H, m, Ph—OH), 10.53 (1H, br, s ,—OH), 2.41 (3H, s, —CH_3), mass (m/z): 346 (M^{+1})
7b	55	137–138	IR (cm^{-1}): 3452 (br, Ph—OH), 3052, 2905 (C—H), 1688 (C=O), 1610 (C=C), 750 (C—S) ^1H NMR (δ ppm): 6.90–7.12 (4H, dd, Ph—Br), 7.22–7.35 (5H, m, Ar—H), 7.37–7.45 (2H, m, Ph—OH), 10.52 (1H, br, s, OH), 2.41 (3H, s, —CH_3), mass (m/z): 425(M^{+1})
7c	60	153–155	IR (cm^{-1}): 3450 (br, Ph—OH), 3053, 2900 (C—H), 1690 (C=O), 1610 (C=C), 750 (C—S) ^1H NMR (δ ppm): 6.92–7.14 (4H, dd, Ph—CH_3), 7.19–7.31 (5H, m, Ar—H), 7.39–7.47 (2H, m, Ph—OH), 10.52 (1H, br, s, OH), 2.41 (3H, s, CH_3), 2.45 (3H, s, CH_3), mass (m/z): 358 (M^{+1})
7d	62	144–146	IR (cm^{-1}): 3452 (br, Ph—OH), 3050, 2905 (C—H), 1688 (C=O), 1610 (C=C), 750 (C—S) ^1H NMR (δ ppm): 7.12–7.21 (5H, m, Ar—H), 7.25–7.32 (2H, dd, Ar—H), 7.39–7.43 (1H, s, Ar—H), 7.46–7.53 (2H, m, Ph—OH), 10.52 (1H, br, s, OH), 2.41 (3H, s, CH_3), mass (m/z): 422 (M^{+1})
7e	59	165–166	IR (cm^{-1}): 3450 (br, Ph—OH), 3054, 2902 (C—H), 1690 (C=O), 1612 (C=C), 750 (C—S) ^1H NMR (δ ppm): 7.14–7.27 (4H, dd, Ph—Br), 7.31–7.42 (2H, dd, Ar—H), 7.49–7.52 (1H, s, Ar—H), 7.58–7.62 (2H, m, Ph—OH), 10.52 (1H, br, s, OH), 2.41 (3H, s, CH_3), mass (m/z): 501 (M^{+1})
7f	53	140–141	IR (cm^{-1}): 3450 (br, Ph—OH), 3050, 2905 (C—H), 1692 (C=O), 1612 (C=C), 750 (C—S) ^1H NMR (δ ppm): 7.12–7.24 (4H, dd, Ph—CH_3), 7.30–7.45 (2H, dd, Ar—H), 7.48–7.53 (1H, s, Ar—H), 7.59–7.68 (2H, m, Ph—OH), 10.52 (1H, br, s, OH), 2.41 (3H, s, CH_3), 2.45 (3H, s, CH_3), mass (m/z): 434 (M^{+1})

Substituted 2-aryl-2-((2-methoxy phenyl)thio) Acetophenones 3a–f

To a suspension of anhydrous K_2CO_3 (13.8 g, 0.1 mol) in 100 ml of dry acetone, a solution of 2-methoxy benzene thiol (0.01 mol) was added. Later a solution of desyl bromide[13,14] (0.01 mol) in 5 ml of dry acetone was also added slowly. The resulting mixture was refluxed for 12–14 h, cooled, poured into 100 ml ice water, and extracted with EtOAc. The organic layer was washed with brine and dried over Na_2SO_4. The solvent was removed in vacuo, and the resulting oil was purified by column chromatography (EtOAc\pet.ether 1:9) to give **3a–f** (50–60%).

Substituted 7-methoxy-2,3-diaryl Benzo(b)thiophenes 4a–f

A solution of **3a–f** (0.01 mol) and BF_3OEt_2[15] (10 ml) was stirred at room temperature under N_2 atmosphere for 14–15 h. The resulting mixture was poured into $NaHCO_3$ stirred for 10 min, and extracted with DCM. The organic layer was washed with brine (2 × 50 ml) and dried over Na_2SO_4. The solvent was removed under vacuum. The residue was purified by column chromatography (EtOAc\pet.ether 2:8) to result in the formation of **4a–f** (65–75%).

Substituted 7-Hydroxy-2,3-diaryl Benzo(b)thiophenes 5a–f

A finely powdered anhydrous $AlCl_3$(13.0 g, 0.1 mol) in 5 ml of dry DCM was added at room temperature to a solution of **4a–f** (0.01 mol) in 10 ml of dry DCM under N_2 atmosphere. The resulting mixture was stirred at room temperature for 4–5 h, poured into 100 ml ice water, acidified, and extracted with DCM. The organic layer was washed with brine (2 × 50 ml) and dried over Na_2SO_4. The solvent was removed in vacuo, and residue was 7-hydroxy-2,3-diaryl benzo(b)thiophenes **5a–f**: purified by column chromatography (EtOAc\pet.ether 1:9) to give **5a–f** (55–65%).

7,8-Diaryl-4-methyl Coumarino Benzo(b)thiophenes 6a–f

A mixture of **5a–f** (0.01 mol) and ethylacetoacetate (1.18 g, 0.01 mol) in 20 ml of dry DCM was added to a solution of anhydrous $AlCl_3$ in 5 ml of dry DCM, at room temperature under N_2 atmosphere. The solution was then stirred at room temperature for 6–8 h. This solution was acidified

and extracted with DCM. The organic layer was washed with brine (2 × 15 ml) and dried over Na_2SO_4. The solution was concentrated in vacuo and the compound was purified by Column chromatography (EtOAc\pet.ether 1:9) to produce compounds **6a–f** (52–60%).

7,8-Diaryl Flavano Benzo(b)thiophenes 8a–f

Compounds **4a–f** (0.01 mol) were acylated with acetyl chloride in the presence of $AlCl_3$ in dry DCM to produce the corresponding compounds **7a–f**.

A mixture of **7a–f** (0.01 mol) and benzaldehyde (0.01 mol) was taken in a solution of ethanol and 40% KOH. The solution was stirred at room temperature for 5 h, then left at room temperature. The resulting mixture was acidified with conc. H_2SO_4 and extracted with DCM (2 × 50 ml). The solvent was concentrated in vacuo, the precipitate was filtered, then purified by recrystallization from methanol to give **8a–f** (56–61%).

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