Highly Brominated Mono- and Bis-phenols from the Marine Red Alga *Symphyocladia latiuscula* with Radical-Scavenging Activity

Xiao-Juan Duan,[†,‡] Xiao-Ming Li,[†] and Bin-Gui Wang*[,†]

Key Laboratory of Experimental Marine Biology, Institute of Oceanology, Chinese Academy of Sciences, Nanhai Road 7, Qingdao 266071, People's Republic of China, and Graduate School of Chinese Academy of Sciences, Beijing 100039, People's Republic of China

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Four new highly brominated and fully substituted mono- and bis-phenols, 1-(2,3,6-tribromo-4,5-dihydroxybenzyl)-pyrrolidin-2-one (**1**), 1,2-bis(2,3,6-tribromo-4,5-dihydroxyphenyl)ethane (**2**), 6-(2,3,6-tribromo-4,5-dihydroxybenzyl)-2,5-dibromo-3,4-dihydroxybenzyl methyl ether (**3**), and 2,3,6-tribromo-4,5-dihydroxybenzyl methyl sulfone (**4**), were characterized from the marine red alga *Symphyocladia latiuscula*. In addition, five known bromophenols, bis(2,3,6-tribromo-4,5-dihydroxyphenyl)methane (**5**), bis(2,3,6-tribromo-4,5-dihydroxybenzyl) ether (**6**), 2,3,6-tribromo-4,5-dihydroxybenzyl methyl ether (**7**), 2,3,6-tribromo-4,5-dihydroxymethylbenzene (**8**), and 2,3,6-tribromo-4,5-dihydroxybenzaldehyde (**9**), were also isolated and identified. The structures of these compounds were elucidated by spectroscopic methods including 1D and 2D NMR as well as by low- and high-resolution mass spectrometric analysis. Structurally, all of these compounds are highly brominated and fully substituted, and contain one or two 2,3,6-tribromo-4,5-dihydroxyphenyl unit(s) in each of the molecules. In addition, compound **4** possesses a unique sulfone structural feature. Each of the isolated compounds was evaluated for α,α-diphenyl-β-picrylhydrazyl (DPPH) radical-scavenging activity and all were found to be potent, with IC_{50} values ranging from 8.1 to 24.7 μM, compared to the known positive control butylated hydroxytoluene (BHT), with an IC_{50} of 81.8 μM.

Symphyocladia latiuscula (Harvey) Yamada (family Rhodomelaceae, order Ceramiales) is a marine red algal species that is mainly distributed in Korea, Japan, and the north part of the Chinese coastline.[1] Previous chemical studies of this species have resulted in the characterization of bromophenols.[2−5] Some of these bromophenols showed significant aldose reductase inhibitory activity,[5] antibacterial activity,[2] and free-radical-scavenging activity.[4] Free radicals attack biological molecules, leading to cell or tissue injury associated with aging, atherosclerosis, and carcinogenesis.[6−8] In the course of our search for biologically active constituents of marine algae from Chinese coastal waters, the organic extract and semipurified fractions of *S. latiuscula* were found to possess the strongest α,α-diphenyl-β-picrylhydrazyl (DPPH) radical-scavenging activity among the 28 tested samples, and the activity was comparable to the positive control, butylated hydroxytoluene (BHT).[9] Therefore, this species was selected for further chemical investigation, which resulted in the isolation and identification of nine compounds including four new bromophenols, 1-(2,3,6-tribromo-4,5-dihydroxybenzyl)pyrrolidin-2-one (**1**), 1,2-bis(2,3,6-tribromo-4,5-dihydroxyphenyl)ethane (**2**), 6-(2,3,6-tribromo-4,5-dihydroxybenzyl)-2,5-dibromo-3,4-dihydroxybenzyl methyl ether (**3**), and 2,3,6-tribromo-4,5-dihydroxybenzyl methyl sulfone (**4**), and five known bromophenols, bis(2,3,6-tribromo-4,5-dihydroxyphenyl)methane (**5**),[5] bis(2,3,6-tribromo-4,5-dihydroxybenzyl) ether (**6**),[2] 2,3,6-tribromo-4,5-dihydroxybenzyl methyl ether (**7**),[10] 2,3,6-tribromo-4,5-dihydroxymethylbenzene (**8**),[5] and 2,3,6-tribromo-4,5-dihydroxybenzaldehyde (**9**).[5] All of these nine compounds are highly brominated and fully substituted, and contain one or two 2,3,6-tribromo-4,5-dihydroxyphenyl unit(s) in each of the molecules. In addition, compound **4** possesses a unique sulfone structural feature. Each of the isolated compounds was evaluated for the DPPH radical-scavenging activity, and all of them exhibited potent activities, with IC_{50} values ranging from 8.1 to 24.7 μM. This paper describes the isolation, structural elucidation, and DPPH radical-scavenging activity of compounds **1**−**9**.

The air-dried and ground marine red alga *S. latiuscula* was extracted using 95% EtOH, and the concentrated extract was suspended in water and successively partitioned with petroleum ether, EtOAc, and *n*-BuOH. The EtOAc extract was chromatographed over Si gel eluting with $CHCl_3$−MeOH. The subsequent fractions were further purified by a combination of Si gel and Sephadex LH-20 column chromatography as well as by RP semipreparative HPLC procedures, to yield four new and five known bromophenols, **1**−**9**.

Compound **1** was obtained as a yellowish, amorphous solid. The IR spectrum showed an absorption band for hydroxyl groups at 3452 cm^{-1} as well as the characteristic absorption bands for an aromatic ring at 1561 and 1452 cm^{-1}. The positive ESIMS spectrum exhibited a characteristic tribrominated quasi-molecular ion peak cluster at *m*/*z* 442/444/446/448 (1:3:3:1) $[M + H]^+$, and the molecular formula was determined as $C_{11}H_{10}Br_3O_3N$ by positive HRESIMS at *m*/*z* 441.8299 (calcd for $C_{11}H_{11}{}^{79}Br_3O_3N$, 441.8289). The ^1H NMR spectrum of **1** in acetone-d_6 showed only the presence of four signals attributed to four methylene groups including one singlet at δ 4.88 (2H, s, H-7′), two triplets at δ 3.15 (2H, t, $J = 7.0$ Hz, H-5) and 2.39 (2H, t, $J = 8.0$ Hz, H-3), and one multiplet at δ 1.96 (2H, m, H-4). The ^{13}C NMR and DEPT spectra revealed the presence of 11 signals attributed to one amide carbonary carbon at δ 176.8 (qC, C-2), six aromatic quaternary carbons at δ 126.9 (qC, C-1′), 118.7 (qC, C-2′), 114.5 (qC, C-3′), 146.5 (qC, C-4′), 145.1 (qC, C-5′), and 114.4 (qC, C-6′), and four methylene carbons at δ 49.9 (CH_2, C-7′), 31.8 (CH_2, C-3), 18.8 (CH_2, C-4), and 46.9 (CH_2, C-5). The oxygenated and brominated quaternary carbons were recognized by their chemical shifts at lower (δ > 140 ppm) and higher (δ < 120 ppm) fields, respectively. Detailed comparison of the above NMR data (Experimental Section) with that of **7** in the literature[10] clearly indicated the presence of a fully substituted benzyl unit, 2,3,6-tribromo-4,5-dihydroxybenzyl, in **1**. This was confirmed by the observed long-range correlations between H_2-7′ and C-1′, C-2′, and C-6′ in the HMBC spectrum (Figure 1). With consideration of the molecular composition and chemical shift values, the remaining signals of **1** suggested the presence of a pyrrolidin-2-one unit in the molecule. This was confirmed by the only spin system observed in the $^1H-^1H$ COSY spectrum including the correlations between H_2-3 and H_2-4 and between H_2-4 and H_2-5

* To whom correspondence should be addressed. Tel: 0086-532-82898553. Fax: 0086-532-82880645. E-mail: wangbg@ms.qdio.ac.cn.
† Institute of Oceanology.
‡ Graduate School of Chinese Academy of Sciences.

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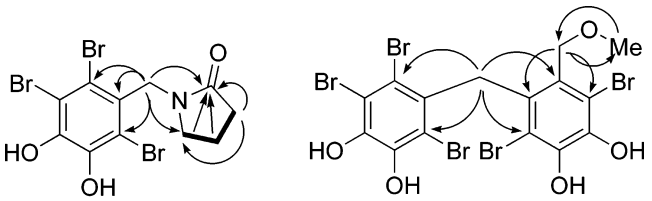
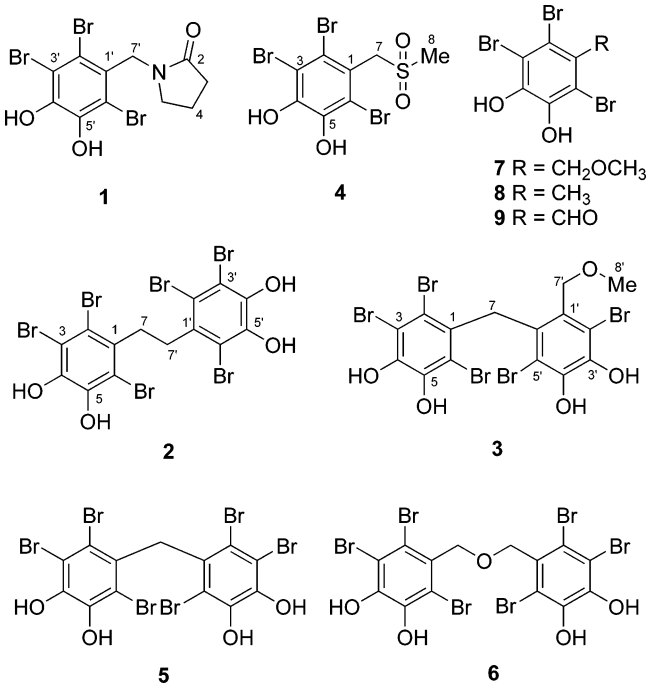


1 **3**

Figure 1. Key HMBC (arrow) and $^1H-^1H$ COSY (—) correlations of **1** and **3**.



1 **4** **7** $R = CH_2OCH_3$ **8** $R = CH_3$ **9** R = CHO

2 **3**

5 **6**

and was also confirmed by the observed HMBC correlations from H_2-3, H_2-4, and H_2-5 to the quaternary amide carbon C-2 (Figure 1). Furthermore, the strong HMBC correlations from H_2-7′ to C-2 and C-5 established that the 2,3,6-tribromo-4,5-dihydroxybenzyl moiety was connected to the nitrogen atom of the pyrrolidin-2-one moiety. Therefore, the structure of **1** was determined as 1-(2,3,6-tribromo-4,5-dihydroxybenzyl)pyrrolidin-2-one. A similar compound containing a pyrrolidin-2-one moiety was recently isolated from *Rhodomela confervoides*, a marine red alga also belonging to the family Rhodomelaceae.[11]

Compound **2** was also obtained as a yellowish, amorphous solid. Its EIMS spectrum gave a characteristic hexabrominated molecular ion peak cluster at *m*/*z* 714/716/718/720/722/724/726 (1:6:15:20:15:6:1) $[M]^+$. The molecular formula $C_{14}H_8Br_6O_4$ was determined by positive HRFABMS at *m*/*z* 719.5485 (calcd for $C_{14}H_8{}^{79}Br_3{}^{81}Br_3O_4$, 719.5461), which indicated the presence of 14 carbon atoms and eight proton atoms in the molecule. However, the NMR spectra of **2** showed only half the number of signals as deduced from its molecular formula. The ^1H NMR spectrum in acetone-d_6 exhibited a two-proton singlet attributed to a methylene at δ 3.42 (2H, s, H-7) and a two-proton broad singlet for the phenolic hydroxyls at δ 8.63 (2H, br s, OH). The ^{13}C NMR and DEPT data (Experimental Section) showed seven carbons including one benzylic methylene carbon at δ 37.5 (C-7) and six sp^2 carbons including one nonoxygenated quaternary carbon at δ 132.8 (C-1), two oxygenated quaternary carbons at δ 144.0 (C-4) and 143.9 (C-5), and three brominated quaternary carbons at δ 118.2 (C-2) and 113.9 (C-3 and C-6). Similar to compound **1**, the above NMR data as well as the observed HMBC correlations from H-7 to C-1, C-2, and C-6 also indicated the presence of a 2,3,6-tribromo-4,5-dihydroxybenzyl moiety in **2**. This deduction was confirmed by the strong fragment ion cluster at *m*/*z* 357/359/361/363 (1:3:3:1) in the EI mass spectrum. However, both the ^1H and ^{13}C NMR spectra of **2** showed simpler patterns than expected from its molecular formula, which indicated its symmetrical nature. Therefore, the structure of **2** was determined to be 1,2-bis(2,3,6-tribromo-4,5-dihydroxyphenyl)-ethane.

Compound **3** was obtained as a yellowish oil. The EIMS spectrum did not give the molecular ion peak; instead, it gave a characteristic pentabrominated fragment ion peak cluster at *m*/*z* 634/636/638/640/642/644 (1:5:10:10:5:1) $[M - MeOH]^+$. The molecular formula $C_{15}H_{11}Br_5O_5$ was established by positive HRFABMS at *m*/*z* 640.6279 $[M - MeOH]^+$ (calcd for $C_{14}H_8{}^{79}Br_2{}^{81}Br_3O_4$, 640.6278). The ^1H NMR spectrum of **3** in acetone-d_6 showed four singlets at δ 8.51 (4H, br s, OH), 4.72 (2H, s, H-7), 4.48 (2H, s, H-7′), and 3.10 (3H, s, OCH_3) attributed to phenolic hydroxyl protons and protons of two benzylic methylenes and one methoxyl, respectively. The ^{13}C NMR and DEPT spectra (Experimental Section) displayed 15 carbon signals consisting of one methoxyl at δ 57.9 (C-8′), two methylene carbons with one oxygenated at δ 72.5 (C-7′) and one nonoxygenated at δ 43.3 (C-7), and 12 sp^2 carbons including three nonoxygenated quaternary carbons at δ 133.0 (C-1), 132.6 (C-1′), and 129.7 (C-6′), four oxygenated quaternary carbons at δ 144.2 (C-4), 144.0 (C-4′), 143.9 (C-5), and 142.7 (C-3′), and five brominated quaternary carbons at δ 118.5 (C-2), 115.4 (C-2′), 114.7 (C-6), 114.4 (C-5′), and 114.3 (C-3). The protonated carbons were assigned by the HMQC experiment. All of the above data revealed that **3** is a dibenzyl pentabromophenol consisting of two fully substituted benzyl moieties. The substitution and connectivity of the two benzyl moieties were determined by HMQC and HMBC experiments. The HMBC correlations (Figure 1) from H-7 to C-2 and C-6 demonstrated that one of the benzyl moieties is 2,3,6-tribromo-4,5-dihydroxybenzyl, while correlations from H-7′ to C-1′, C-2′, C-6′, and C-8′ (the methoxyl carbon) and from the methoxy protons to C-7′ indicated that the second benzyl moiety is 2′,5′-dibromo-3′,4′-dihydroxybenzyl methyl ether. In addition, the HMBC correlations from H-7 to C-1′, C-5′, and C-6′ unequivocally revealed that the two moieties were connected through a carbon bond between C-7 and C-6′. Therefore, the structure of **3** was determined as 6-(2,3,6-tribromo-4,5-dihydroxybenzyl)-2,5-dibromo-3,4-dihydroxybenzyl methyl ether.

Compound **4** was obtained as a yellowish, amorphous solid. The EIMS spectrum exhibited a characteristic molecular ion peak cluster at *m*/*z* 436/438/440/442 (1:3:3:1) $[M]^+$, suggesting the presence of three bromine atoms in **4**. The molecular formula was determined as $C_8H_7Br_3O_4S$ by positive HRFABMS at *m*/*z* 438.7660 (calcd for $C_8H_8{}^{79}Br_2{}^{81}BrO_4S$, 438.7673). The ^1H NMR spectrum of **4** showed only the presence of a methyl singlet at δ 3.05 (3H, s, H-8) and a methylene singlet at δ 4.98 (2H, s, H-7). The ^{13}C NMR and DEPT spectra of **4** displayed eight carbon signals attributed to a hexasubstituted benzene ring, a methyl, and a methylene. A strong fragment ion cluster at *m*/*z* 357/359/361/363 (1:3:3:1) in the EIMS of **4** as well as the similarity with the NMR data of **7** suggested the presence of a 2,3,6-tribromo-4,5-dihydroxybenzyl moiety in **4**.[10] This was confirmed by long-range correlations from H_2-7 to C-1, C-2, and C-6 in the HMBC spectrum. In combination with the chemical shift values of the methyl group (δ 3.05 and 43.4) and the molecular composition of **4**, the strong HMBC correlation from the methyl protons to the methylene carbon (C-7) revealed that the methyl was connected with the 2,3,6-tribromo-4,5-dihydroxybenzyl moiety through a sulfone group. Therefore, the structure of **4** was determined as 2,3,6-tribromo-4,5-dihydroxybenzyl methyl sulfone. A similar compound containing a methyl sulfoxide moiety was recently isolated from the marine red alga *Rhodomela confervoides*.[12]

Each of the isolated compounds was evaluated for the DPPH radical-scavenging activity by using a previously reported proce-

Table 1. DPPH Radical-Scavenging Activity of Compounds **1**−**9**

compound	IC_{50} (μM)	compound	IC_{50} (μM)
1	18.5	**6**	8.5
2	10.2	**7**	15.5
3	10.5	**8**	14.0
4	24.0	**9**	24.7
5	8.1	BHT[a]	81.8

[a] BHT = butylated hydroxytoluene.

dure.[9] Compounds **1**−**9** showed strong activities (Table 1), with IC_{50} values ranging from 8.1 to 24.7 μM. These radical-scavenging activities were 3.3- to 10-fold more potent than that of a known synthetic antioxidant, butylated hydroxytoluene (IC_{50} = 81.8 μM). Structurally, the DPPH radical-scavenging activities of the bis-phenols, **2**, **3**, **5**, and **6**, are stronger than those of the mono-phenols, **1**, **4**, and **7**−**9**. This result is in good agreement with the observation that free-radical-scavenging activity increased significantly with the number of hydroxyl groups in related molecules.[13]

Experimental Section

General Experimental Procedures. Melting points were determined by a SGW X-4 micromelting apparatus (uncorrected). IR spectra were performed on a Nicolet NEXUE 470 infrared spectrophotometer. UV spectra were measured on a PuXi TU-1810 UV−visible spectrophotometer. 1D and 2D NMR were recorded on a Bruker Avance 500 MHz spectrometer with TMS as internal standard. Mass spectra were performed on a VG Autospec 3000 mass spectrometer. HPLC analysis was carried out on a Dionex HPLC system (P680 HPLC pump, UVD 340U UV−visible detector) using a C18 column (5 μm, 8.0 × 250 mm). Si gel (200−300 and 300−400 mesh, Qingdao Haiyang Chemical Co., Qingdao, China) and RP-18 reversed-phase Si gel and Sephadex LH-20 (Merck, Darmstadt, Germany) were used for open CC. TLC was carried out with a glass plate precoated with Si gel GF_{254}, and spots were visualized under UV light and detected by spraying with a solution composed of 1% potassium ferricyanide and 1% ferric chloride.

Algal Material. The marine red alga *Symphyocladia latiuscula* (Harvey) Yamada was collected at the coast of Qingdao, China, in May 2004 and identified by Prof. B.-M. Xia at the Institute of Oceanology, Chinese Academy of Sciences (IOCAS). A voucher specimen (no. HZ03121) was deposited in the Herbarium of Marine Organisms at IOCAS.

Extraction and Isolation. The air-dried and ground *S. latiuscula* (2.52 kg) was extracted with 95% EtOH at room temperature for 3 × 72 h. After the solvent was removed under reduced pressure at <40 °C, a brown residue was obtained. The residue was suspended in H_2O and then partitioned with petroleum ether, EtOAc, and *n*-butanol, successively. The EtOAc extract (108 g) was chromatographed over Si gel (220 g) eluting with a gradient of increasing MeOH (0−100%) in $CHCl_3$ and separated into nine fractions (I−IX) on the basis of TLC analyses. Fraction III (9.6 g) was further fractionated by CC on Si gel with a gradient of increasing acetone (10−100%) in petroleum ether to yield seven subfractions. The third and sixth subfractions were further chromatographed over Sephadex LH-20 eluting with $CHCl_3$−MeOH (1:1) to yield compounds **8** (18.7 mg) and **7** (17.2 mg), respectively. Fraction IV (7.1 g) was further chromatographed over Si gel eluting with a gradient of increasing EtOAc (20−100%) in petroleum ether to yield five subfractions, and the second and third subfractions were further purified by CC on Sephadex LH-20 using MeOH to give compounds **2** (11.0 mg) and **9** (16.8 mg), respectively. Fraction V (4.0 g) was chromatographed over Sephadex LH-20 eluting with acetone to yield compounds **5** (14.8 mg) and **6** (51.5 mg). Fraction VI (6.6 g) was separated by RP-18 column chromatography eluting with MeOH−H_2O (4:1) to give compound **4** (27.5 mg). Fraction VII (18.5 g) was chromatographed over Si gel eluting with a gradient of increasing EtOAc (40−100%) in petroleum ether and separated into six subfractions; the third subfraction was further purified by RP semipreparative HPLC using MeOH−H_2O (55:45) as the mobile phase to yield compounds **1** (17.4 mg) and **3** (11 mg).

1-(2,3,6-Tribromo-4,5-dihydroxybenzyl)pyrrolidin-2-one (1): yellowish, amorphous solid; mp 166−168 °C; UV λ_{max} (MeOH) (log ϵ) 216 (3.86), 259 (2.90), 295 (2.70) nm; IR (KBr) ν_{max} 3452, 2936, 2563, 2357, 1627, 1561, 1452, 1394, 1239, 1181, 1014, 901, 497 cm^{-1}; ^1H NMR (acetone-d_6, 500 MHz) δ 4.88 (2H, s, H-7′), 3.15 (2H, t, J = 7.0 Hz, H-5), 2.39 (2H, t, J = 8.0 Hz, H-3), 1.96 (2H, m, H-4); ^{13}C NMR (acetone-d_6, 125 MHz) δ 176.8 (qC, C-2), 146.5 (qC, C-4′ or C-5′), 145.1 (qC, C-5′ or C-4′), 126.9 (qC, C-1′), 118.7 (qC, C-2′), 114.5 (qC, C-3′), 114.4 (qC, C-6′), 49.9 (CH_2, C-7′), 46.9 (CH_2, C-5), 31.8 (CH_2, C-3), 18.8 (CH_2, C-4); ESIMS *m*/*z* 470 (21), 468 (61), 466 (84), 464 (26) $[M + Na]^+$, 448 (36), 446 (99), 444 (100), 442 (33) $[M + H]^+$, 404 (15), 402 (28), 400 (21), 361 (16), 318 (11), 302 (17), 274 (50), 218 (14), 124 (14), 102 (10); HRESIMS *m*/*z* 441.8299 $[M + H]^+$ (calcd for $C_{11}H_{11}{}^{79}Br_3O_3N$, 441.8289).

1,2-Bis(2,3,6-tribromo-4,5-dihydroxyphenyl)ethane (2): yellowish, amorphous solid; mp 230−232 °C; UV λ_{max} (MeOH) (log ϵ) 212 (4.51), 297 (3.27) nm; IR (KBr) ν_{max} 3487, 3289, 2963, 2847, 1681, 1553, 1460, 1390, 1289, 1254, 1157, 1017, 703 cm^{-1}; ^1H NMR (acetone-d_6, 500 MHz) δ 8.63 (4H, br s, OH), 3.42 (4H, s, H-7, 7′); ^{13}C NMR (acetone-d_6, 125 MHz) δ 144.0 (qC, C-4/C-4′ or C-5/C-5′), 143.9 (qC, C-5/C-5′ or C-4/C-4′), 132.8 (qC, C-1/C-1′), 118.2 (qC, C-2/C-2′), 113.9 (qC, C-3/C-3′, C-6/C-6′), 37.5 (CH_2, C-7/C-7′); EIMS *m*/*z* (%) 726 (<1), 724 (<1), 722 (1.6), 720 (2.4), 718 (1.6), 716 (<1), 714 (<1) $[M]^+$, 564 (1), 562 (4), 560 (6), 558 (3.5), 556 (1) $[M - 2Br]^+$, 481 (6), 480 (10), 478 (7), 402 (6), 400 (13), 398 (7), 363 (31), 361 (96), 359 (100), 357 (35), 281 (23), 279 (20), 201 (11), 199 (13), 131 (23), 91 (22), 82 (84), 80 (88), 79 (35), 63 (25); HRFABMS *m*/*z* 719.5485 $[M + H]^+$ (calcd for $C_{14}H_8{}^{79}Br_3{}^{81}Br_3O_4$, 719.5461).

6-(2,3,6-Tribromo-4,5-dihydroxybenzyl)-2,5-dibromo-3,4-dihydroxybenzyl methyl ether (3): yellow oil; UV λ_{max} (MeOH) (log ϵ) 215 (3.98), 296 (2.81) nm; IR (KBr) ν_{max} 3441, 2924, 1697, 1553, 1460, 1425, 1390, 1278, 1165, 1095, 936, 691 cm^{-1}; ^1H NMR (acetone-d_6, 500 MHz) δ 8.51 (4H, br s, OH), 4.72 (2H, s, H-7), 4.48 (2H, s, H-7′), 3.10 (3H, s, H-8′); ^{13}C NMR (acetone-d_6, 125 MHz) δ 144.2 (qC, C-4 or C-5), 144.0 (qC, C-4′ or C-3′), 143.9 (qC, C-5 or C-4), 142.7 (qC, C-3′ or C-4′), 133.0 (qC, C-1), 132.6 (qC, C-1′), 129.7 (qC, C-6′), 118.5 (qC, C-2), 115.4 (qC, C-2′), 114.7 (qC, C-6), 114.4 (qC, C-5′), 114.3 (qC, C-3), 72.5 (CH_2, C-7′), 57.9 (CH_3, C-8′), 43.3 (CH_2, C-7); EIMS *m*/*z* (%) 644 (0.04), 642 (0.21), 640 (0.42), 638 (0.42), 636 (0.20), 634 (0.04) $[M - MeOH]^+$, 563 (1.2), 561 (3.8), 559 (6), 557 (4.2), 555 (1) $[M - MeOH - Br]^+$, 482 (5.2), 480 (14), 478 (15), 476 (5) $[M - MeOH - 2Br]^+$, 402 (4), 400 (8), 398 (5) $[M - MeOH - 3Br + H]^+$, 373 (4), 358 (4), 330 (4), 294 (4), 240 (13), 200 (8), 131 (9), 82 (92), 80 (100), 79 (41); HRFABMS *m*/*z* 640.6279 $[M - MeOH]^+$ (calcd for $C_{14}H_8{}^{79}Br_2{}^{81}Br_3O_4$, 640.6278).

2,3,6-Tribromo-4,5-dihydroxybenzyl methyl sulfone (4): yellowish, amorphous solid, mp 134−136 °C; UV λ_{max} (MeOH) (log ϵ) 220 (4.20), 267 (3.35) nm; IR (KBr) ν_{max} 3437, 3223, 3006, 2536, 2361, 1550, 1456, 1390, 1285, 1169, 1115, 975, 878, 489 cm^{-1}; ^1H NMR (acetone-d_6, 500 MHz) δ 4.98 (2H, s, H-7), 3.05 (3H, s, H-8); ^{13}C NMR (acetone-d_6, 125 MHz) δ 146.5 (qC, C-4 or C-5), 144.7 (qC, C-5 or C-4), 122.9 (qC, C-1), 119.3 (qC, C-2), 114.6 (qC, C-6), 114.2 (qC, C-3), 63.7 (CH_2, C-7), 43.4 (CH_3, C-8); EIMS *m*/*z* (%) 442 (0.7), 440 (2), 438 (2), 436 (0.6) $[M]^+$, 363 (27), 361 (85), 359 (89), 357 (32) $[M - CH_3SO_2]^+$, 334 (10), 332 (35), 330 (33), 328 (14), 281 (31), 279 (33), 242 (68), 223 (24), 199 (20), 171 (22), 143 (45), 133 (67), 129 (40), 118 (39), 98 (37), 91 (58), 80 (87), 69 (50), 65 (100), 63 (81), 57 (63); HRFABMS *m*/*z* 438.7660 $[M + H]^+$ (calcd for $C_8H_8{}^{79}Br_2{}^{81}BrO_4S$, 438.7673).

Determination of the DPPH Radical-Scavenging Activity. DPPH radical-scavenging activity of compounds **1**−**9** was evaluated as previously reported.[9] Briefly, a 2.0 mL aliquot of test sample (in acetone) was added to 2.0 mL of a 0.16 mM methanolic solution of DPPH. The mixture was vortexed for 1 min and then left to stand at room temperature for 30 min in the dark, and its absorbance was determined at 517 nm. Each sample was tested at six concentrations from 0.5 to 50 μg/mL, and every concentration had three replicates. A synthetic antioxidant (BHT) was used as the positive control. The IC_{50} values were calculated by the software program SigmaPlot 8.0.

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Supporting Information Available: ^{1}H and ^{13}C NMR, DEPT, and selected 2D NMR spectra of compounds **1**−**4**. This material is available free of charge via the Internet at http://pubs.acs.org.

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