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Article

8-*O*-4'-Neolignans from Flower Buds of *Magnolia fargesii* and their Biological Activities

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Três novos derivados de 8-*O*-4'-neolignanas, fargesifenols A-C, juntamente com seis neolignanas conhecidas, foram isoladas de botões de flores de *Magnolia fargesii.* As estruturas foram elucidadas por métodos espectroscópicos, incluindo técnicas de RMN 1D e 2D. Os compostos foram também testados quanto à sua atividade anti-HIV-1 e quanto às citotoxicidades.

Three new 8-*O*-4'-neolignans, fargesiphenols A-C, together with six known neolignans, were isolated from the flower buds of *Magnolia fargesii*. The structures were elucidated by spectroscopic methods, including extensive 1D and 2D-NMR techniques. Compounds were also tested for their anti-HIV-1 activities and cytotoxicities.

Keywords: *Magnolia fargesii*, 8-*O*-4'-neolignans, anti-HIV-1 activity, cytotoxicity

Introduction

The genus of *Magnolia* (Magnoliaceae) has traditionally been used as herb medicine in China for a long time. Especially, Xinyi (dried flower buds of *Magnolia fargesii*), has been used for the treatment of inflammatory-related diseases such as nasal congestion, empyema, sinusitis, and allergic rhinitis.[1,2] Previous phytochemical investigations have reported that this species contains several secondary metabolites such as lignans,[3-5] neolignans,[6,7] sesquiterpenes,[2,8] and essential oils,[9] which show various biological activities.

To search for more new bioactive compounds from this plant, we reexamined the flower buds of *M. fargesii*, which led to the isolation of three new 8-*O*-4'-neolignans, named fargesiphenols A-C (**1**-**3**), along with six known compounds (**4**-**9**). In addition, the anti-HIV-1 activities and their cytotoxicities were evaluated. Their structure elucidation and biological activities are described in this paper.

Results and Discussion

A 70% aq. acetone extract prepared from the flower buds of *M. fargesii* was partitioned between EtOAc and H_2O. The EtOAc layer was subjected repeatedly to column chromatography on Si gel, Sephadex LH-20, RP-18 and preparative HPLC to afford compounds **1**-**9**, including three new 8-*O*-4'-neolignans named fargesiphenols A-C (**1**-**3**), together with six known neolignans, polysyphorin (**4**),[10] virolin (**5**),[11] 7*S*,8*S*-*threo*-4,7,9,9'-tetrahydroxy-3,3'-dimethoxy-8-*O*-4'-neolignan (**6**),[12] 7*S*,8*R*-*erythro*- 4,7,9,9'-tetrahydroxy-3,3'-dimethoxy-8-*O*-4'-neolignan (**7**),[12] (7*R*,8*S*)-1-(3,4-dimethoxyphenyl)-2-[4-(3-hydroxy-1-propenyl)-methoxy-phenoxy]-propane-1,3-diol (**8**),[13] and rhaphidecursinol A (**9**).[10] The structures of compounds **1**-**9** are shown in Figure 1, and the ^{1}H and ^{13}C NMR data of compounds **1**-**3** are listed in Table 1.

Compound **1** was obtained as pale yellow gum. Its molecular formula was determined as $C_{21}H_{26}O_6$ from the HRESIMS quasi-molecular ion peak $[M+Na]^+$ at *m/z* 397.1622 (calc. 397.1627). Its ^{1}H and ^{13}C NMR spectra showed signals of 26 hydrogens and 21 carbons, respectively, corresponding to two aromatic rings with five aromatic protons (δ_H 6.99, 7.34, 7.09, 7.15, 6.98), two methyl groups (δ_C 14.5, 18.4), three methoxyl groups (δ_C 55.9, 55.9, 60.4), two oxidated methine groups (δ_C 75.1, 80.9), one allyl group (δ_C 131.4, 124.1, 18.4; δ_H 6.38 d *J* 15.8, 6.10-6.17 m, 1.75 d *J* 6.5), and a phenolic hydroxyl group (δ_H 11.25). Strong absorption bands accounting for hydroxyl (3498 cm^{-1}) and aromatic groups

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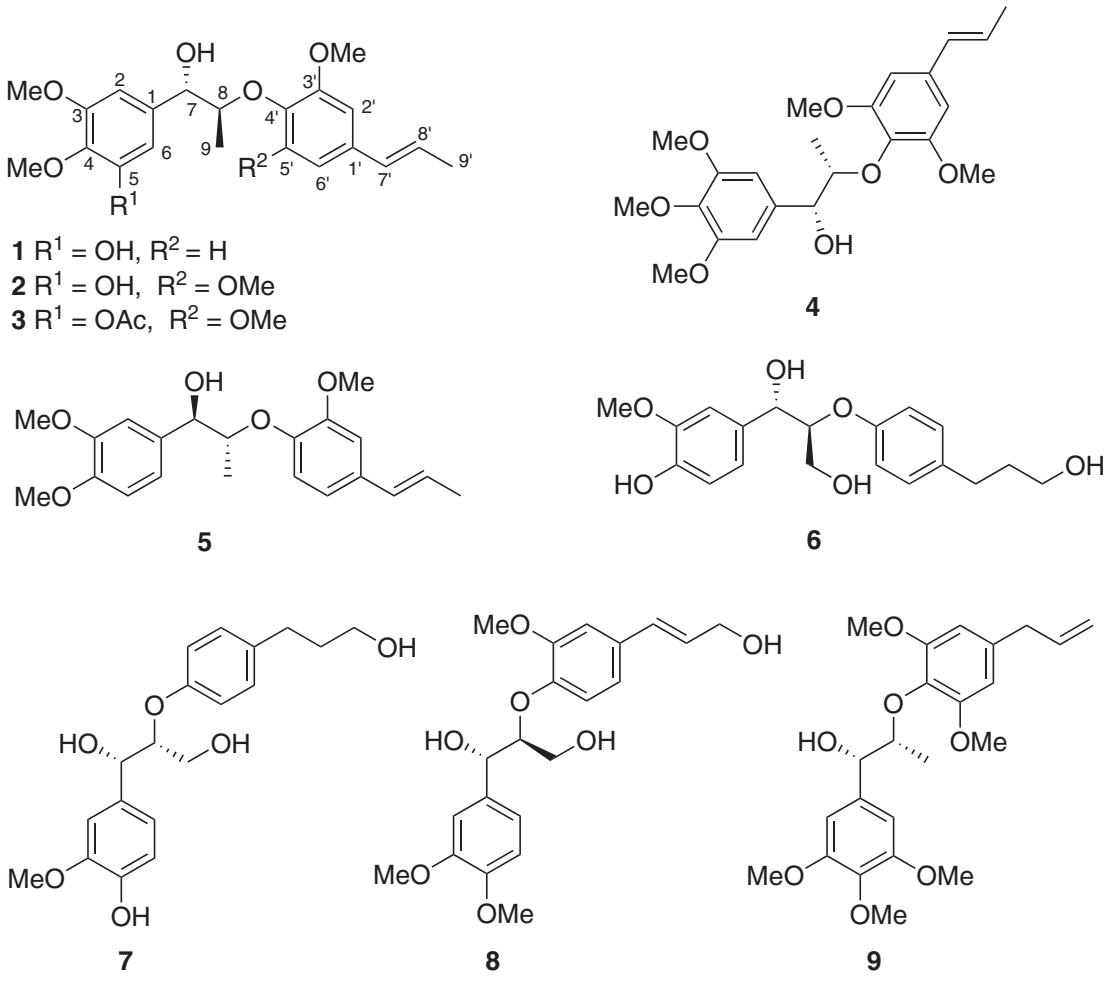

Figure 1. The structures of 8-*O*-4'-neolignans from *Magnolia fargesii*.

(1608, 1520, 1478 cm^{-1}) could also be observed in its IR spectrum. The UV spectrum of **1** showed absorption maxima at 285 and 210 nm, which confirmed the existence of the aromatic functions. The ^1H-^1H COSY correlations H-7/H-8/H-9, H-7'/H-8'/H-9', together with HMBC correlations (Figure 2) of H-7 (δ_H 5.38) with C-8 (δ_C 80.9), C-9 (δ_C 14.5), C-1 (δ_C 139.5), C-2 (δ_C 102.9) and C-6 (δ_C 109.0), of H-7' (δ_H 6.38) with C-2' (δ_C 110.7), C-1' (δ_C 132.6) and C-6' (δ_C 119.3), and H-8 (δ_C 4.88) with C-1 (δ_C 139.5) and C-4' (δ_C 147.4), suggested that **1** is a 8-*O*-4'-neolignan possessing three methoxyl groups and a phenolic hydroxyl group.[14]

Three methoxyl groups located at C-3, C-4, C-3' were assigned from the HMBC correlations of the methoxyl proton signals (δ_H 3.77, 3.88, 3.74) with C-3 (δ_C 153.9), C-4 (δ_C 136.7), and C-3' (δ_C 151.9), respectively. The presence of a phenolic hydroxyl group at C-5 was supported by the HMBC correlations of the phenolic hydroxyl proton signal (δ_H 11.25) with C-4 (δ_C 136.7), C-5 (δ_C 151.9), and C-6 (δ_C 109.0), respectively. Thus, the plain structure of **1** was established.

The configuration of the two chiral carbons (C-7 and C-8) was considered to be *threo* according to the coupling constant (*J* 7.2 Hz) between H-7 and H-8,[15] which is distinct from that of the *erythro* diastereoisomers.[16,17] The absolute configurations at C-7 and C-8 of **1** could be established on the basis of ROESY and CD spectroscopic evidence.[18] The CD spectrum of **1** gave a positive cotton effect at 237 nm, and clear ROESY correlations observed between H-7 and H-8, H-7 and H-2, H-7 and H_3-9 (Figure 3) indicated the 7*S*, 8*S*-configuration of **1**, which was named fargesiphenol A.

Compounds **2** and **3** (fargesiphenols B and C) were all obtained as yellow gums. HRESIMS analysis of **2** demonstrated that it has the molecular formula $C_{22}H_{28}O_7$ (*m/z* 427.1730, for $[M+Na]^+$, calc. 427.1733). The NMR spectra of **2**, when compared to those of **1**, displayed an additional methoxy group (δ_H 3.85; δ_C 55.6), which was located at C-5' from the HMBC cross-peak between this carbon (δ_C 152.3) and the methoxyl protons (δ_C 3.85).

The NMR spectra of **3**, when compared to those of **2**, displayed the characteristic signals of an acetoxy group (δ_H 2.19, δ_C 21.1 and δ_C 169.9). Its ^{13}C NMR spectrum

Table 1. ^{1}H and ^{13}C NMR Data (in C_5D_5N) of compounds **1**-**3**

position	**1**		**2**		**3**	
	δ_C (m)	δ_H (m, *J*/Hz)	δ_C (m)	δ_H (m, *J*/Hz)	δ_C (m)	δ_H (m, *J*/Hz)
1	139.5 (s)		139.4 (s)		138.5 (s)	
2	102.9 (d)	6.99 (s)	102.8 (d)	6.91 (s)	107.2 (d)	7.03 (s)
3	153.9 (s)		153.5 (s)		152.7 (s)	
4	136.7 (s)		137.0 (s)		142.1 (s)	
5	151.9 (s)		151.2 (s)		144.8 (s)	
6	109.0 (d)	7.34 (s)	108.9 (d)	7.34 (s)	111.4 (d)	7.49 (s)
7	75.1 (d)	5.38 (d, *J* 7.2)	75.0 (d)	5.35 (d, *J* 7.2)	75.8 (d)	5.51 (d, *J* 7.2)
8	80.9 (d)	4.88 (m)	80.9 (d)	4.90 (m)	80.4 (d)	4.97 (m)
9	14.5 (q)	1.55 (d, *J* 5.9)	14.5 (q)	1.54 (d, *J* 5.9)	14.8 (q)	1.55 (d, *J* 5.8)
1'	132.6 (s)		133.3 (s)		133.8 (s)	
2'	110.7 (d)	7.09 (s)	104.2 (d)	6.59 (s)	103.4 (d)	6.56 (s)
3'	151.9 (s)		152.3 (s)		151.2 (s)	
4'	147.4 (s)		136.5 (s)		136.9 (s)	
5'	117.8 (d)	6.98 (d, *J* 8.2)	152.3 (s)		151.2 (s)	
6'	119.3 (d)	7.15 (d, *J* 8.2)	104.2 (d)	6.59 (s)	103.4 (d)	6.56 (s)
7'	131.4 (d)	6.38 (d, *J* 15.8)	131.6 (d)	6.34 (d, *J* 15.9)	133.1 (d)	6.41 (d, *J* 16.2)
8'	124.1 (d)	6.10-6.17 (m)	124.2 (d)	6.13-6.16 (m)	124.8 (d)	6.02-6.05 (m)
9'	18.4 (q)	1.75 (d, *J* 6.5)	18.5 (q)	1.74 (d, *J* 6.5)	18.7 (q)	1.80 (d, *J* 6.6)
OMe-3	55.9 (q)	3.77 (s)	55.9 (q)	3.80 (s)	55.9 (q)	3.82 (s)
OMe-4	60.4 (q)	3.88 (s)	60.8 (q)	3.81 (s)	60.9 (q)	3.85 (s)
OMe-2'	55.9 (q)	3.74 (s)	55.6 (q)	3.85 (s)	55.8 (q)	3.95 (s)
OMe-6'			55.6 (q)	3.85 (s)	55.8 (q)	3.95 (s)
-OAc					21.1 (q) 169.9 (s)	2.19 (s)

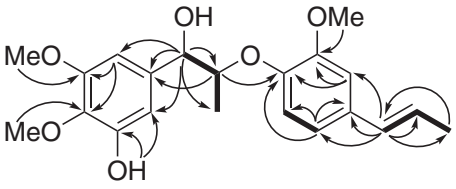

Figure 2. Selected HMBC (H→C) and ^{1}H-^{1}H COSY (**–**) correlations of **1**.

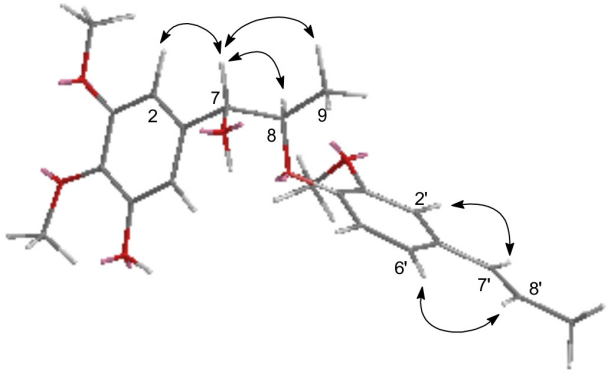

Figure 3. Key ROESY (↶) correlations of **1**.

showed downfield-shifted signals for C-4 (δ_C 142.1) and C-6 (δ_C 111.4), and an upfield-shifted signal for C-5 (δ_C 144.8), thus corroborating the placement of the acetoxy group at C-5. According to the observed ROESY correlations and comparison of ^{1}H and ^{13}C NMR data with those of **1** (Table 1), the relative configurations of **2** and **3** were established as being the same as that of **1**. The configuration of the two chiral carbons (C-7 and C-8) for **2** and **3** was considered to be *threo* according to the coupling constant (*J* 7.2 Hz) between H-7 and H-8, and a positive cotton effect at 237 nm for **2**, and 238 nm for **3** in their CD spectrum indicated a 7*S*,8*S*-configuration.[15]

Since some neolignans are reported to possess anti-HIV activities,[19,20] these have been tested for compounds **1**-**9**. The cytotoxicity assay against C8166 cells (CC_{50}), and anti-HIV-1 activity were evaluated by the inhibition assay for the cytopathic effects of HIV-1 (EC_{50}), using azidothymidine (AZT) as a positive control (EC_{50} = 0.034 μg mL^{-1} and CC_{50} = 200 μg mL^{-1}).[21] The results (Table 2) revealed significant activity for compounds **2**, **6**, **7**, and **8**, with therapeutic index (TI) values above 30. Compounds **1**, **4**, and **9** showed moderate activity with TI values above 10.

Some neolignans are also reported to possess cytotoxic activities,[22,23] which led us to evaluate compounds **1**-**9** for their cytotoxicities. The cytotoxicity tests were performed in triplicate using a previously reported procedure.[24] In the 3-(4,5-dimethylthiazol-2-yl)-2,5- diphenyltetrazolium bromide (MTT) assay, the IC_{50} was defined as the concentration of the tested compound resulting in a 50%

Table 2. Anti-HIV activities of the compounds **1**-**9**

Compound	CC_{50}/(μg mL^{-1})	EC_{50}/(μg mL^{-1})	TI[a]
1	63.5	3.62	17.5
2	≥ 200	4.86	≥ 41.2
3	28.6	3.11	9.20
4	22.6	2.16	10.5
5	61.5	6.87	8.95
6	135.6	3.87	35.0
7	185.4	5.54	33.5
8	≥ 200	2.08	≥ 96.2
9	87.9	3.09	28.4

[a]TI = EC_{50}/CC_{50}.

reduction of absorbance compared with untreated cells. The cytotoxic activities against HL-60, Hep-G2, KB, and MDA-MB-231 tumor cell lines by MTT-assay (with camptothecin as the positive control) are shown in Table 3. Compound **2** revealed high cytotoxic activity to HL-60 and MDA-MB-231 cells, whereas compound **8** showed high cytotoxic activity to KB cells, both with IC_{50} values close to those of positive control. The other compounds displayed moderate or weak cytotoxic activity.

Table 3. Cytotoxicities of compounds **1**-**9**

Compounds	Cell lines			
	HL-60	HepG2	KB	MDA-MB-231
	IC_{50}/(μmol L^{-1})			
1	12.0	6.08	9.21	6.48
2	1.69	3.50	2.05	2.19
3	10.3	6.50	8.55	7.19
4	5.28	11.4	14.4	6.25
5	7.01	6.42	15.7	6.15
6	11.0	8.58	9.59	8.23
7	8.17	6.29	7.51	10.3
8	16.2	7.50	1.76	4.02
9	12.3	9.23	6.08	18.1
Camptothecin	1.95	0.98	1.69	2.27

For a compound to be deemed effective, an IC_{50} value < 100 μmol L^{-1} is required. Camptothecin was used as positive control. HL-60, human acute promyelocytic leukemia; Hep-G2, human hepatocellular carcinoma; KB, human oropharyngeal epidermoid carcinoma; MDA-MB-231, human breast cancer cells.

Experimental

General experimental procedures

Optical rotations were measured with a Horiba SEPA-300 polarimeter. UV spectra were obtained using a Shimadzu UV-2401A spectrophotometer. A Tenor 27 spectrophotometer was used for scanning IR spectra with KBr pellets. CD spectra were measured on a JASCO J-810 spectropolarimeter. 1D and 2D NMR spectra were recorded on DRX-500 spectrometers with TMS as internal standard. HRESIMS was performed on an API QSTAR time-of-flight spectrometer and a VG Autospec-3000 spectrometer, respectively. Preparative HPLC was performed on a Shimadzu LC-8A preparative liquid chromatograph with a ZORBAX PrepHT GF (21.2 mm × 25 cm, 7 μm) column or a Venusil MP C_{18} (20 mm × 25 cm, 5 μm) column. Column chromatography was performed with Si gel (200-300 mesh, Qing-dao Marine Chemical, Inc., Qingdao, China), Lichroprep RP-18 gel (40-63 μm, Merck, Darmstadt, Germany) and MCI gel (75-150 μm, Mitsubishi Chemical Corporation, Tokyo, Japan). The fractions were monitored by TLC, and spots were visualized by heating Si gel plates sprayed with 5% H_2SO_4 in EtOH.

Plant material

The flower buds of *M. fargesii*, indigenous to Nanzhao country, Henang province, were purchased from Kunming Herb Medicine Market in September 2010. A voucher specimen (YNNI-10-9-28) has been deposited in our laboratory.

Extraction and isolation

The air-dried and powdered flower buds of *Magnolia fargesii* (4.5 kg) were extracted four times with 70% aqueous acetone (4 × 3 L) at room temperature, filtered, and the filtrate evaporated under reduced pressure and partitioned with EtOAc (4 × 3 L). The EtOAc phase (212 g) was applied to silica gel (200-300 mesh) column chromatography, eluting with a $CHCl_3$-MeOH gradient system (20:1, 9:1, 8:2, 7:3, 6:4, 5:5), to give six fractions A-F. Further separation of fraction B (35.8 g) by silica gel column chromatography, eluted with $CHCl_3$-acetone (9:1-2:1), yielded mixtures B1-B6. Fraction B2 (8:2, 4.8 g) was subjected to silica gel column chromatography using petroleum ether-acetone, and semi-preparative HPLC (55% MeOH-H_2O, flow rate 12 mL min^{-1}) to give **3** (22.6 mg), **4** (18.9 mg), **5** (22.7 mg) and **9** (28.5 mg). Fraction B3 (7:3, 5.47 g) was subjected to silica gel column chromatography using $CHCl_3$-acetone, and semi-preparative HPLC (48% MeOH-H_2O, flow rate 12 mL min^{-1}) to give **1** (11.6 mg) and **2** (28.9 mg). Fraction B4 (7:3, 3.28 g) was subjected to silica gel column chromatography using $CHCl_3$-acetone, and semi-preparative HPLC (40% MeOH-H_2O, flow rate 12 mL min^{-1}) to give **3** (14.2 mg), **6** (22.5 mg), and **7** (18.2 mg).

Anti-HIV-1 assay

The cytotoxicity assay against C8166 cells (CC_{50}) was assessed using the MTT method, and anti-HIV-1 activity was evaluated by the inhibition assay for the cytopathic effects of HIV-1 (EC_{50}).[21]

Cytotoxicity assay

The cytotoxicity tests for these compounds were performed against HL-60, Hep-G2, KB, and MDA-MB-231 tumor cell lines by the MTT-assay using camptothecin as positive control.[24]

Fargesiphenol A (**1**)

Pale yellow gum; $[\alpha]_D^{24.2}$ +38.5 (*c* 0.20, MeOH); CD (*c* 0.05, MeOH): $\Delta\varepsilon_{220\ nm}$ +0.36, $\Delta\varepsilon_{237\ nm}$ +7.18, $\Delta\varepsilon_{280\ nm}$ -0.97, $\Delta\varepsilon_{320\ nm}$ -0.21; UV (MeOH) λ_{max} (log ε) 320 (2.82), 285 (3.78), 210 (4.27) nm; IR (KBr) ν_{max}/cm^{-1}: 3498, 2957, 2874, 1608, 1520, 1478, 1440, 1265, 958; ^{1}H NMR (500 MHz) and ^{13}C NMR (125 MHz) data, Table 1; positive ESIMS *m/z* 397 $[M+Na]^+$; HRESIMS *m/z* 397.1622 $[M+Na]^+$ (calc. $C_{21}H_{26}NaO_6$ for 397.1627).

Fargesiphenol B (**2**)

Yellow gum; $[\alpha]_D^{24.0}$ +41.2 (*c* 0.22, MeOH); CD (*c* 0.05, MeOH): $\Delta\varepsilon_{220\ nm}$ +1.28, $\Delta\varepsilon_{237\ nm}$ +14.6, $\Delta\varepsilon_{280\ nm}$ –2.18, $\Delta\varepsilon_{320\ nm}$ –0.96; UV (MeOH) λ_{max} (log ε) 320 (2.88), 282 (3.82), 210 (4.23) nm; IR (KBr) ν_{max}/cm^{-1}: 3495, 2959, 2873, 1608, 1524, 1486, 1437, 1263, 954; ^{1}H NMR (500 MHz) and ^{13}C NMR (125 MHz) data, Table 1; positive ESIMS *m/z* 427 $[M+Na]^+$; HRESIMS *m/z* 427.1730 $[M+Na]^+$ (calc. $C_{22}H_{28}NaO_7$ for 427.1733).

Fargesiphenol C (**3**)

Yellow gum; $[\alpha]_D^{24.5}$ +42.5 (*c* 0.22, MeOH); CD (*c* 0.05, MeOH): $\Delta\varepsilon_{220\ nm}$ +0.47, $\Delta\varepsilon_{238\ nm}$ +6.52, $\Delta\varepsilon_{280\ nm}$ –0.83, $\Delta\varepsilon_{320\ nm}$ –0.49; UV (MeOH) λ_{max} (log ε) 318 (2.89), 280 (3.86), 210 (4.20) nm; IR (KBr) ν_{max}/cm^{-1}: 3493, 2950, 2876, 1614, 1529, 1482, 1442, 1260, 959; ^{1}H NMR (500 MHz) and ^{13}C NMR (125 MHz) data, Table 1; positive ESIMS *m/z* 469 $[M+Na]^+$; HRESIMS *m/z* 469.1833 $[M+Na]^+$ (calc. $C_{24}H_{30}NaO_8$ for 469.1838).

Supplementary Information

^{13}C NMR, DEPT, ^{1}H NMR, HSQC, HMBC, ^{1}H-^{1}H COSY, ROESY, CD, and HRESIMS spectra of fargesiphenol A; ^{13}C NMR, DEPT, ^{1}H NMR, HSQC, HMBC, and CD spectra of fargesiphenol B and C, are available free of charge at http://jbcs.sbq.org.br as PDF file.

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References

1. Miyazawa, M.; Kasahara, H.; Kameoka, H.; *Phytochemistry* **1992**, *31*, 3666.
2. Lee, Y. J.; Lee, Y. M.; Lee, C. K.; Jung, J. K.; Han, S. B.; Hong, J. T.; *Pharmacol. Ther.* **2011**, *130*, 157.
3. Huang, Y. L.; Chen, C. C.; Chen, Y. P.; Hsu, H. Y.; Kuo, Y. H.; *Planta Med.* **1990**, *56*, 237.
4. Miyazawa, M.; Ishikawa, Y.; Kasahara, H.; Yamanaka, J.; Kameoka, H.; *Phytochemistry* **1994**, *35*, 611.
5. Lee, J.; Lee, D.; Jang, D. S.; Nam, J. W.; Kim, J. P.; Park, K. H.; Yang, M. S.; Seo, E. K.; *Chem. Pharm. Bull*. **2007**, *55*, 137.
6. Lee, J.; Seo, E. K.; Jang, D. S.; Ha, T. J.; Kim, J. P.; Nam, J. W.; Bae, G.; Kim, J. S.; *Chem. Pharm. Bull*. **2009**, *57*, 298.
7. Kelm, M. A.; Nair, M. G.; *Stud. Nat. Prod. Chem*. **2000**, *24*, 845.
8. Jung, K. Y.; Kim, D. S.; Park, S. H.; Lee, I. S.; Oh, S. R.; Lee, J. J.; Kim, E. H.; Lee, H. K.; *Phytochemistry* **1998**, *48*, 1383.
9. Fang, J. Y.; Tsai, T. H.; Hung, C. F.; Wong, W. W.; *J. Pharm. Pharmacol.* **2004**, *56*, 1493.
10. Zhang, H. J.; Tamez, P. A.; Vu, D. H.; Ghee, T. T.; Nguyen, V. H.; Le, T. X.; Le, M. H.; Nguyen. M. C.; Do, T. T.; Soejarto, D. D.; Fong, H. H.; Pezzuto, J. M.; *J. Nat. Prod*. **2001**, *64*, 772.
11. Barata, L. E.; Santos, L. S.; Ferri, P. H.; Phillipson, J. D.; Paine, A.; Croft, S. L.; *Phytochemistry* **2000**, *55*, 589.
12. Matsuda, N.; Kikuchi, M.; *Chem. Pharm. Bull*. **1996**, *44*, 1676.
13. Lee, J.; Seo, E. K.; Jang, D. S.; Ha, T. J.; Kim, J. P.; Nam, J. W.; Bae, G.; Lee, Y. M.; Yang, M. S.; Kim, J. S.; *Chem. Pharm. Bull*. **2009**, *57*, 298.
14. Barata, L. E.; Baker, P. M.; Gottlieb, O. R.; Rùveda, E. A.; *Phytochemistry* **1978**, *17*, 783.
15. Cavalcante, S. H.; Yoshida, M.; Gottlieb, O. R.; *Phytochemistry* **1985**, *24*, 1051.
16. Fukagawa, N.; Ishizu, A.; *J. Wood Chem. Technol.* **1991**, *11*, 263.
17. Yoshikawa, M.; Morikawa, T.; Xu, F.; Ando, S.; Matsuda, H.; *Heterocycles* **2003**, *60*, 1787.
18. Matsuda, N.; Kikuchi, M.; *Chem. Pharm. Bull*. **1996**, *44*, 1676.
19. Zhang, X. J.; Yang, G. Y.; Wang, R. R.; Pu, J. X.; Sun, H. D.; Xiao, W. L.; Zheng, Y. T.; *Chem. Biodiversity* **2010**, *7*, 2692.
20. Pu, J. X.; Yang, L. M.; Xiao, W. L.; Li, R. T.; Lei, C.; Gao, X. M.; Huang, S. X.; Li, S. H.; Zheng, Y. T.; Huang, H.; Sun, H. D.; *Phytochemistry* **2008**, *69*, 1266.
21. Darke, P. L.; Huff, J. R.; *Adv. Pharmacol*. **1994**, *25*, 399.

22. Hahm, J. C.; Lee, I. K.; Kang, W. K.; Kim, S. U.; Ahn, Y. J.; *Planta Med.* **2005**, *71*, 464.
23. Amblard, F.; Govindarajan, B.; Lefkove, B.; Rapp, K. L.; Detorio, M.; Arbiser, J. L.; Schinazi, R. F.; *Bioorg. Med. Chem. Lett.* **2007**, *17*, 4428.
24. Mosmann, T.; *J. Immunol. Methods* **1983**, *65*, 55.

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Supplementary Information

8-*O*-4'-Neolignans from Flower Buds of *Magnolia fargesii* and their Biological Activities

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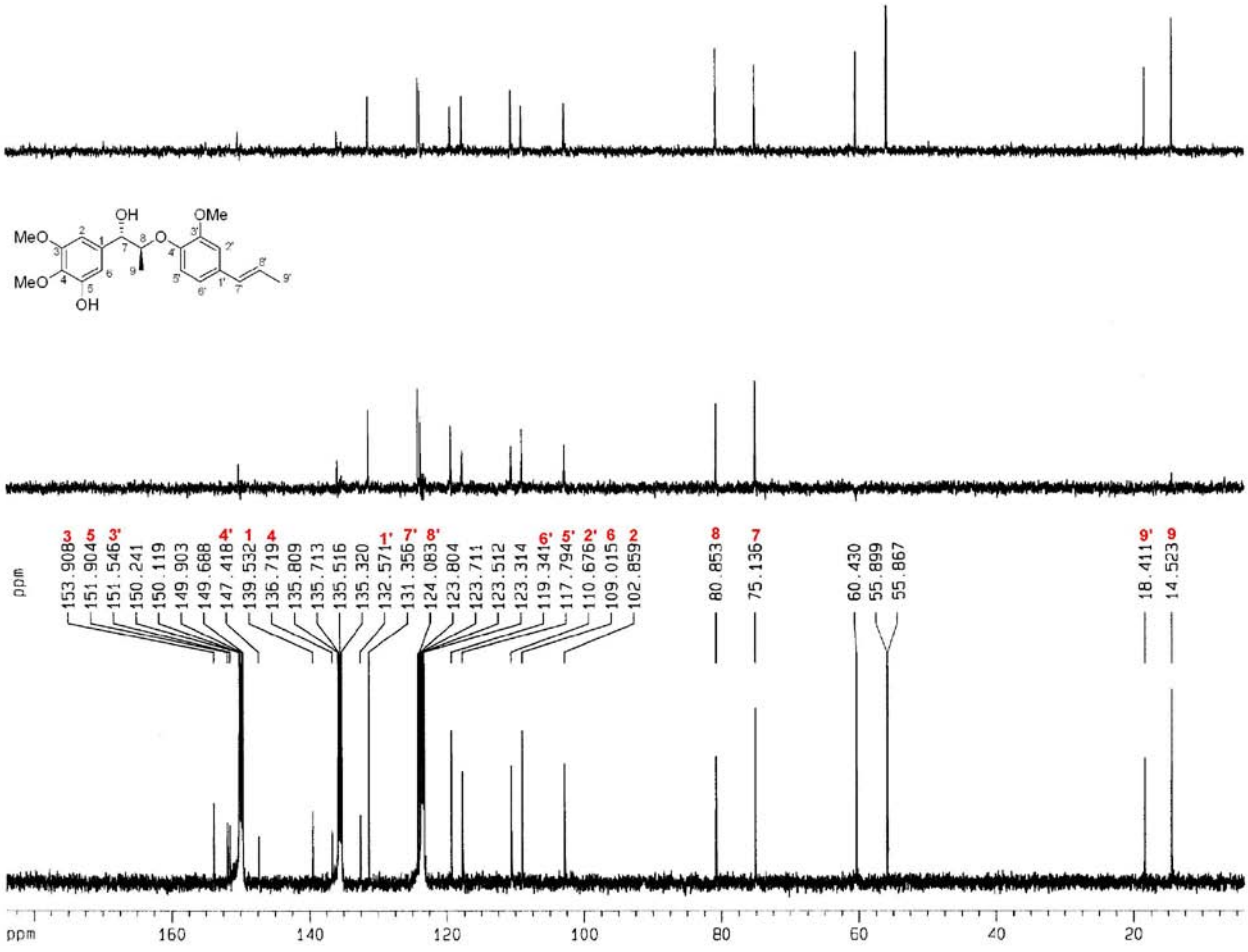

Figure S1. ^{13}C NMR and DEPT spectra of fargesiphenol A (**1**).

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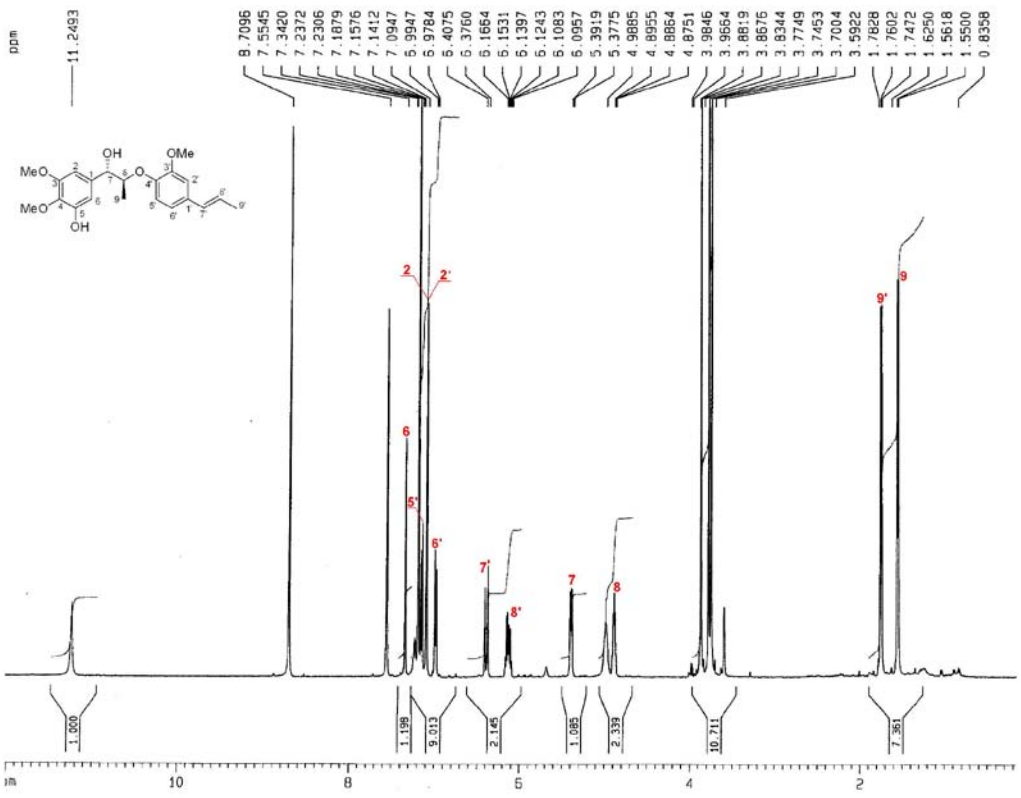

Figure S2. ^{1}H NMR spectra of fargesiphenol A (**1**).

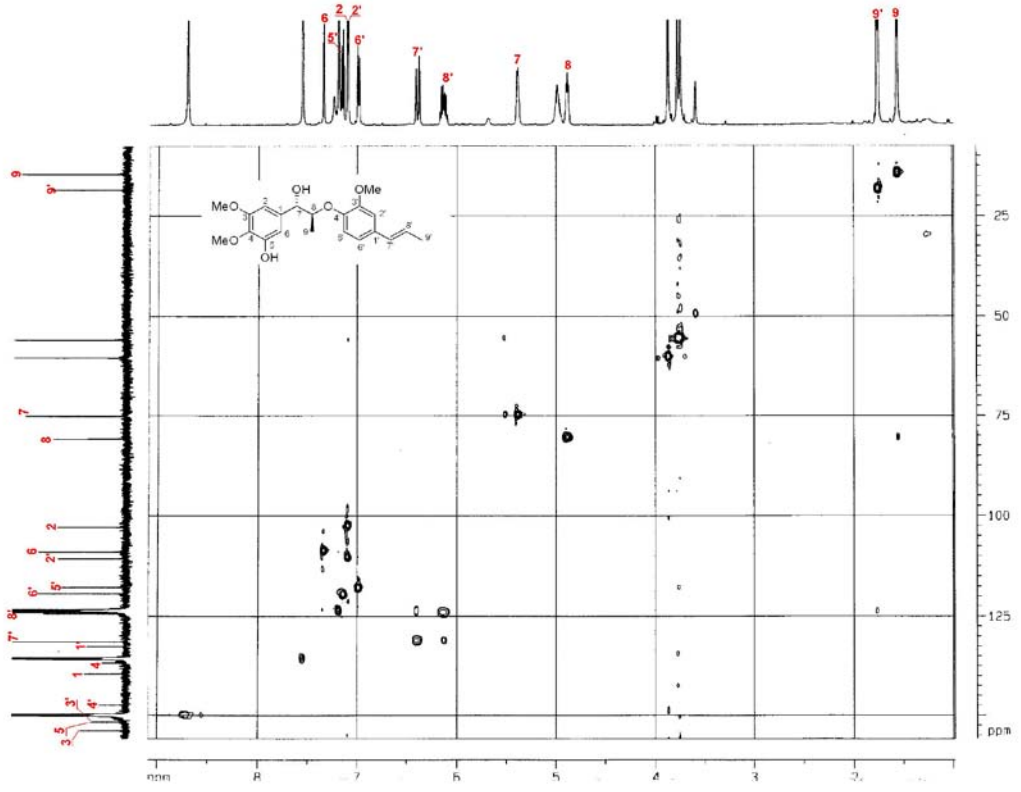

Figure S3. HSQC spectra of fargesiphenol A (**1**).

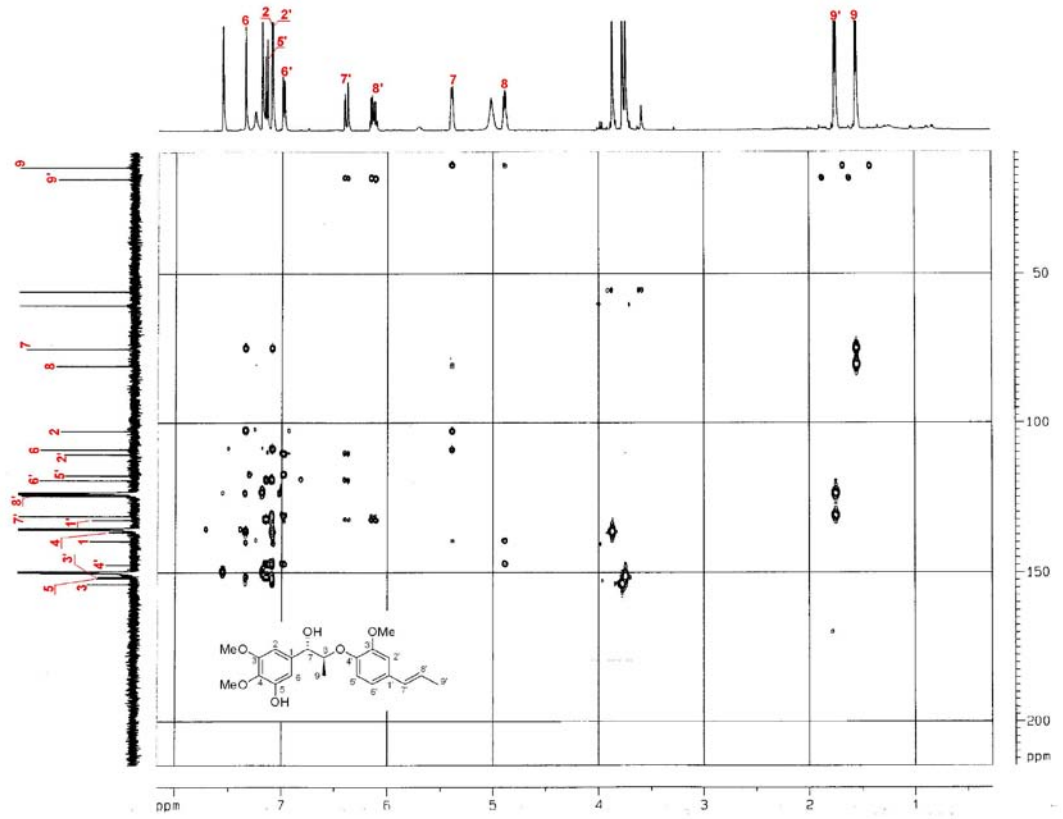

Figure S4. HMBC spectra of fargesiphenol A (**1**).

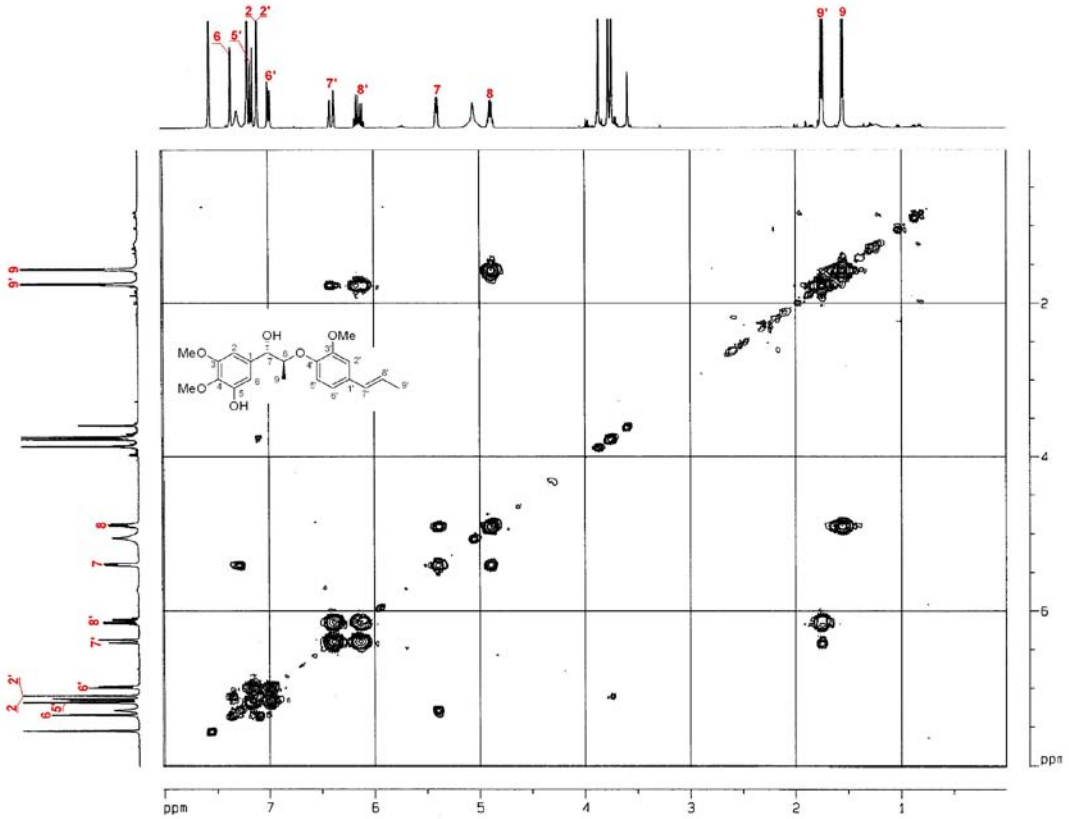

Figure S5. ^{1}H-^{1}H COSY spectra of fargesiphenol A (**1**).

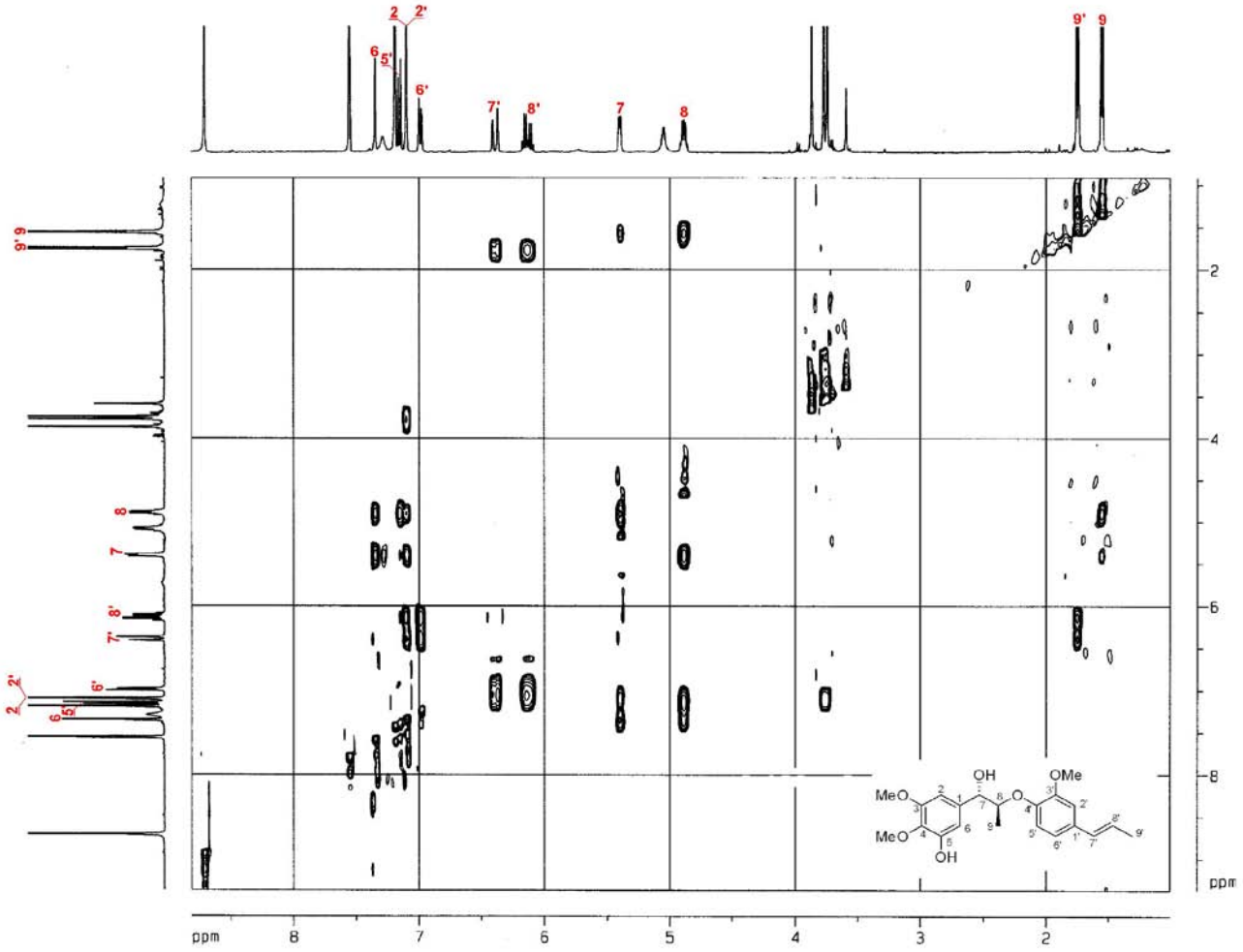

Figure S6. ROESY spectra of fargesiphenol A (**1**).

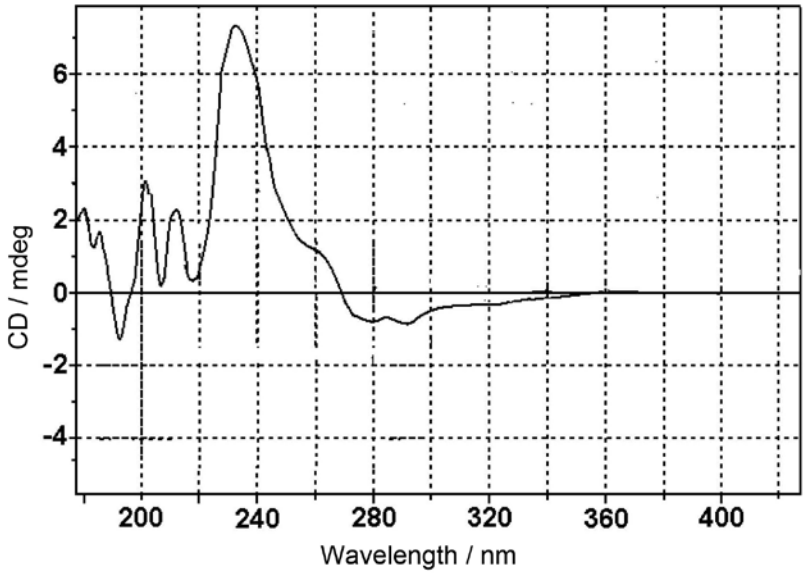

Figure S7. CD spectra of fargesiphenol A (**1**).

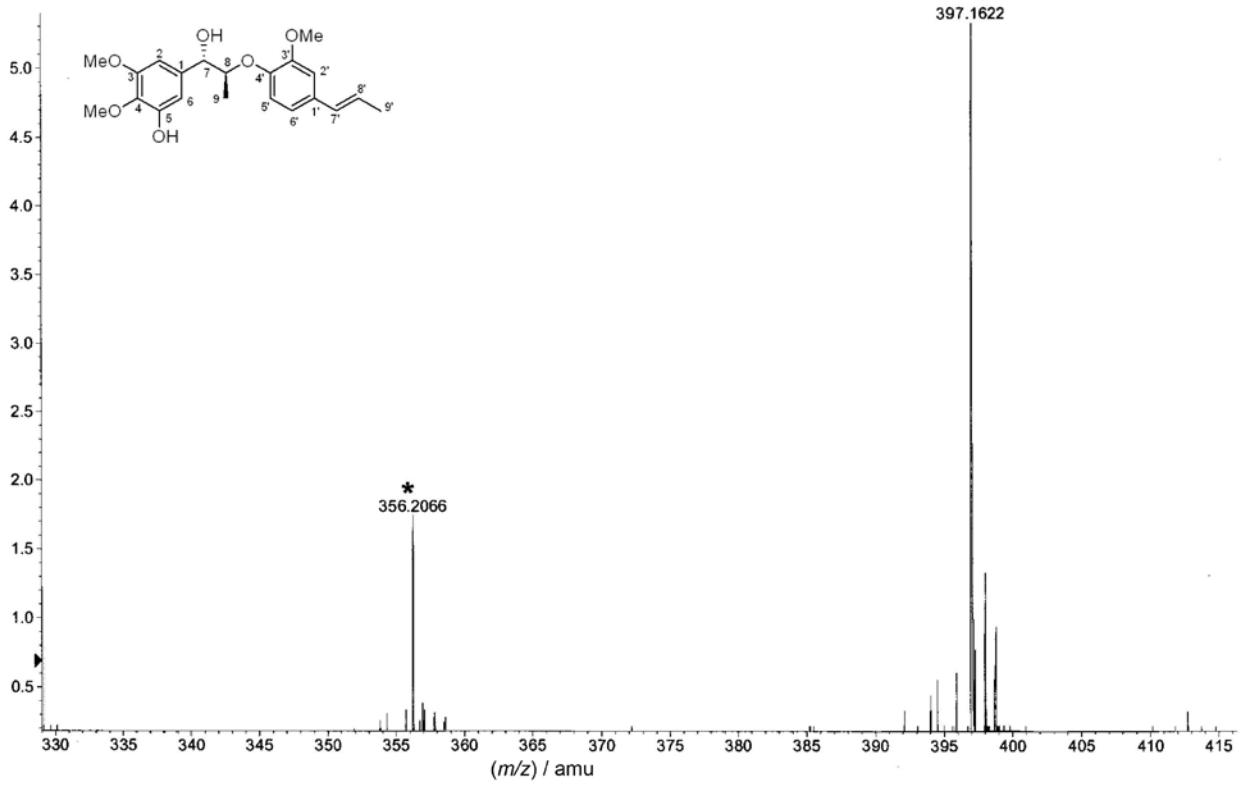

Figure S8. HRESIMS spectra of fargesiphenol A (**1**).

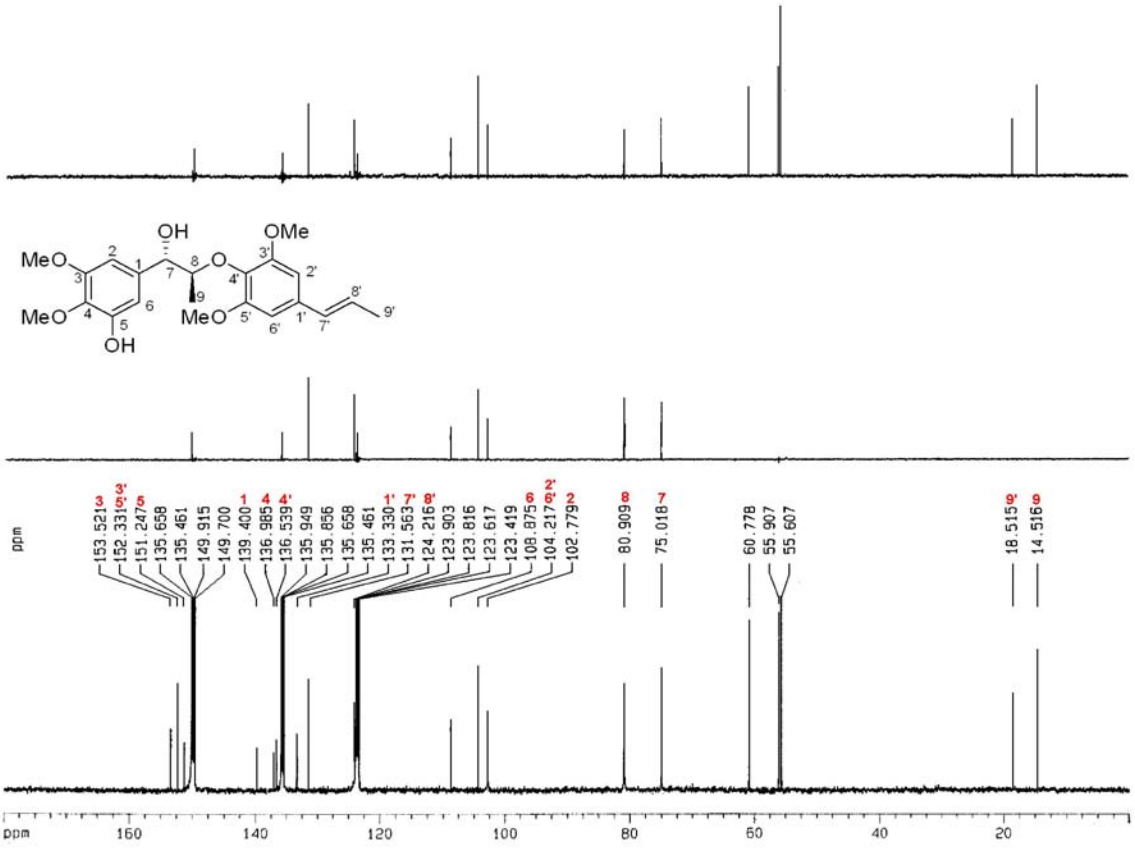

Figure S9. ^{13}C NMR and and DEPT spectra of fargesiphenol B (**2**).

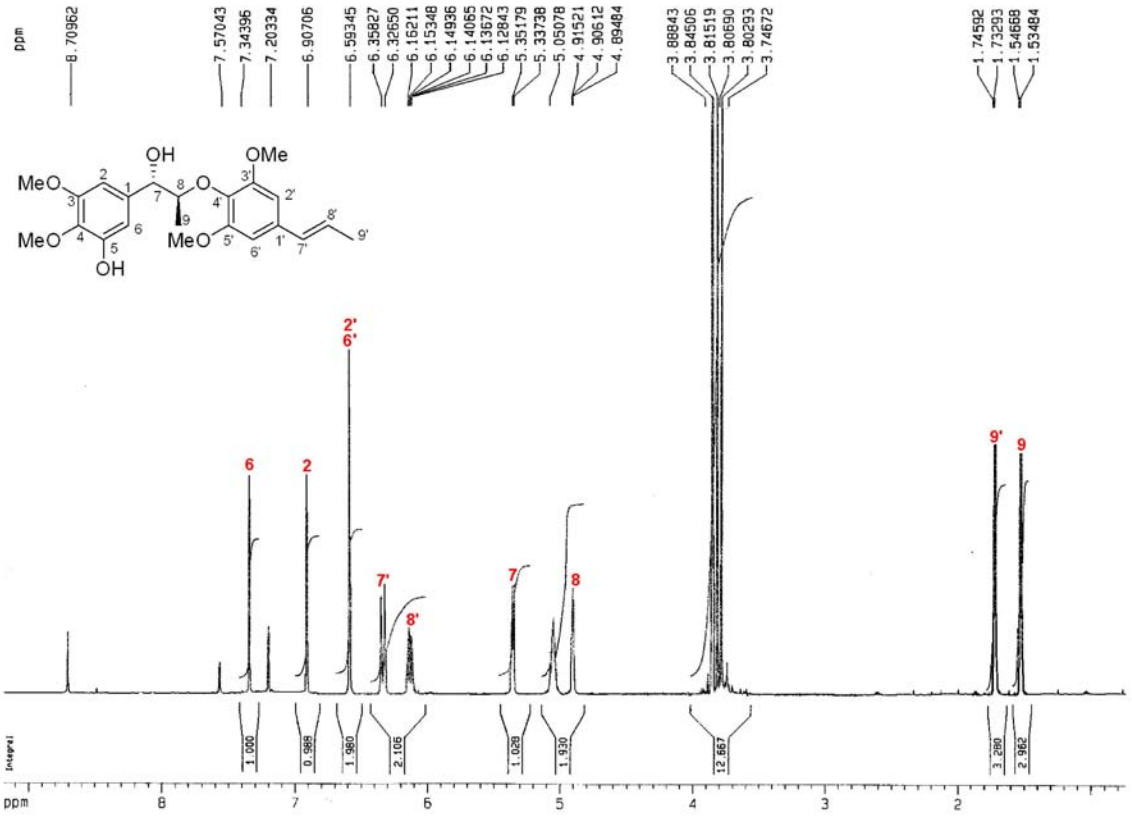

Figure S10. ^{1}H NMR spectra of fargesiphenol B (**2**).

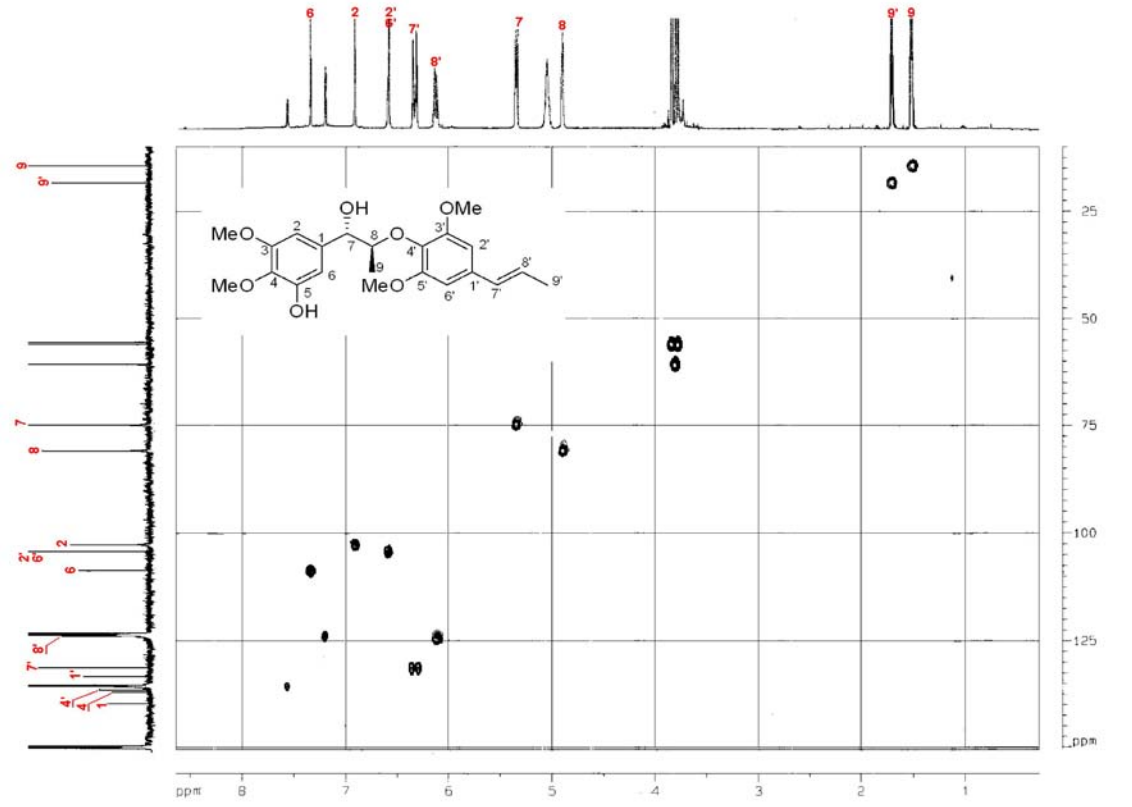

Figure S11. HSQC spectra of fargesiphenol B (**2**).

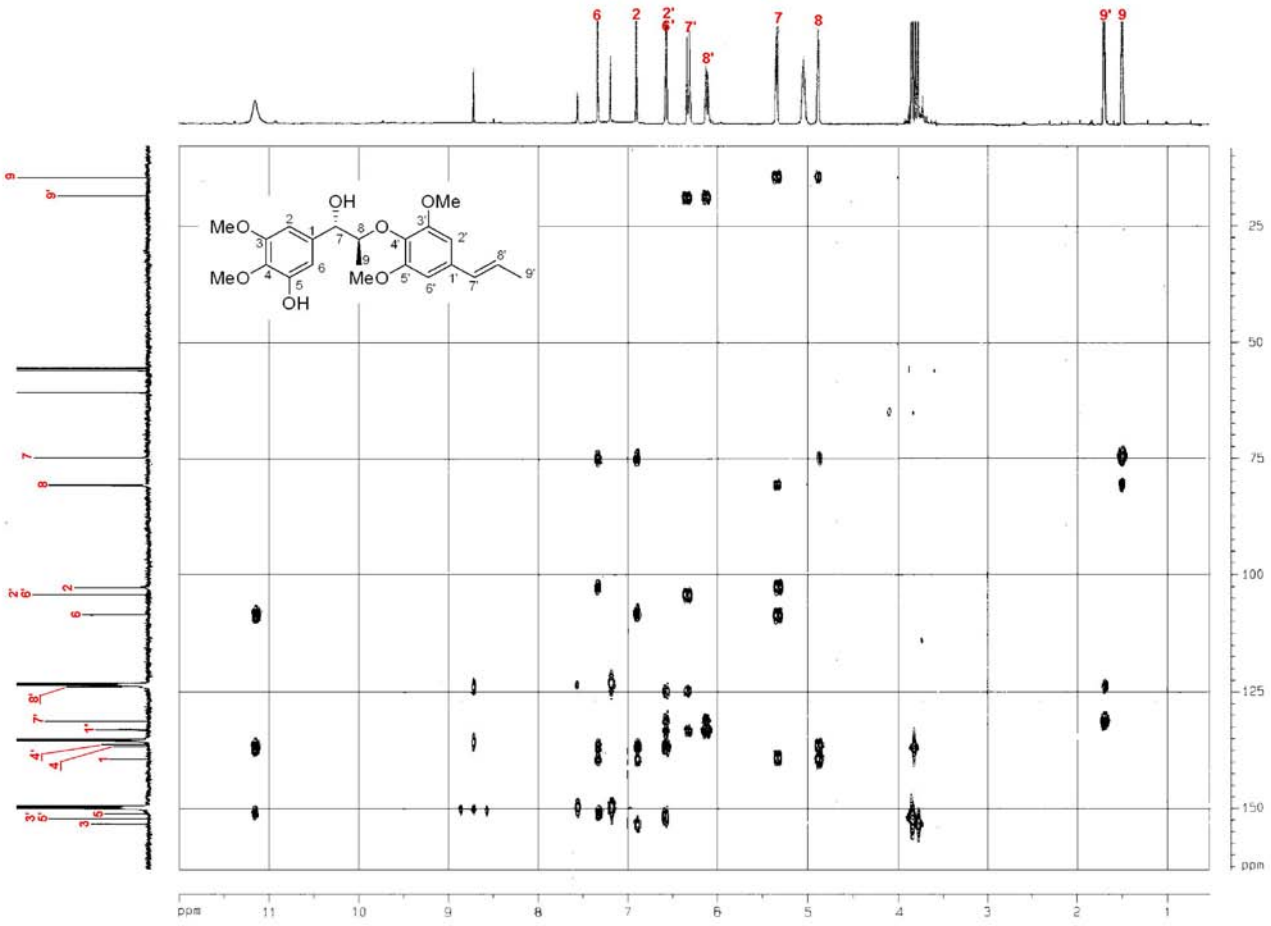

Figure S12. HMBC spectra of fargesiphenol B (**2**).

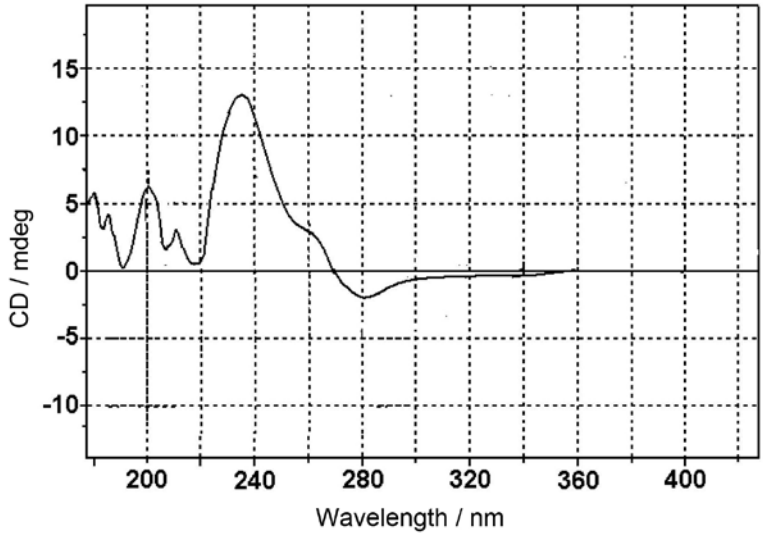

Figure S13. CD spectra of fargesiphenol B (**2**).

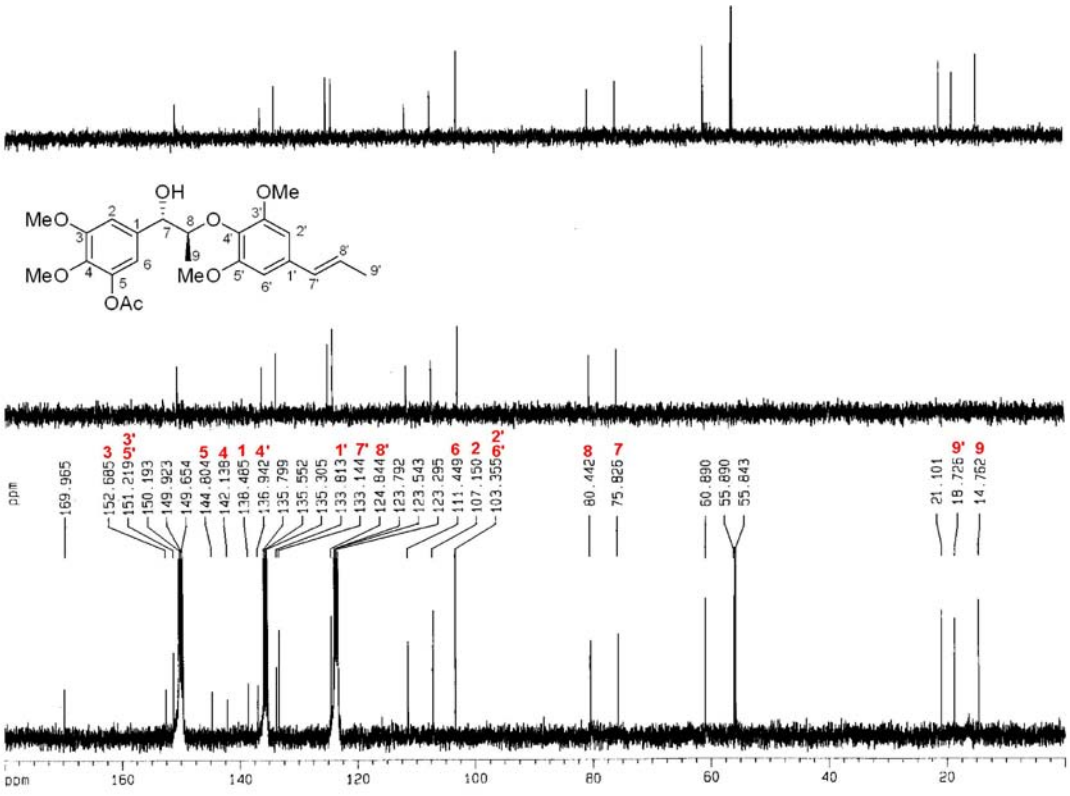

Figure S14. ^{13}C NMR and and DEPT spectra of fargesiphenol C (**3**).

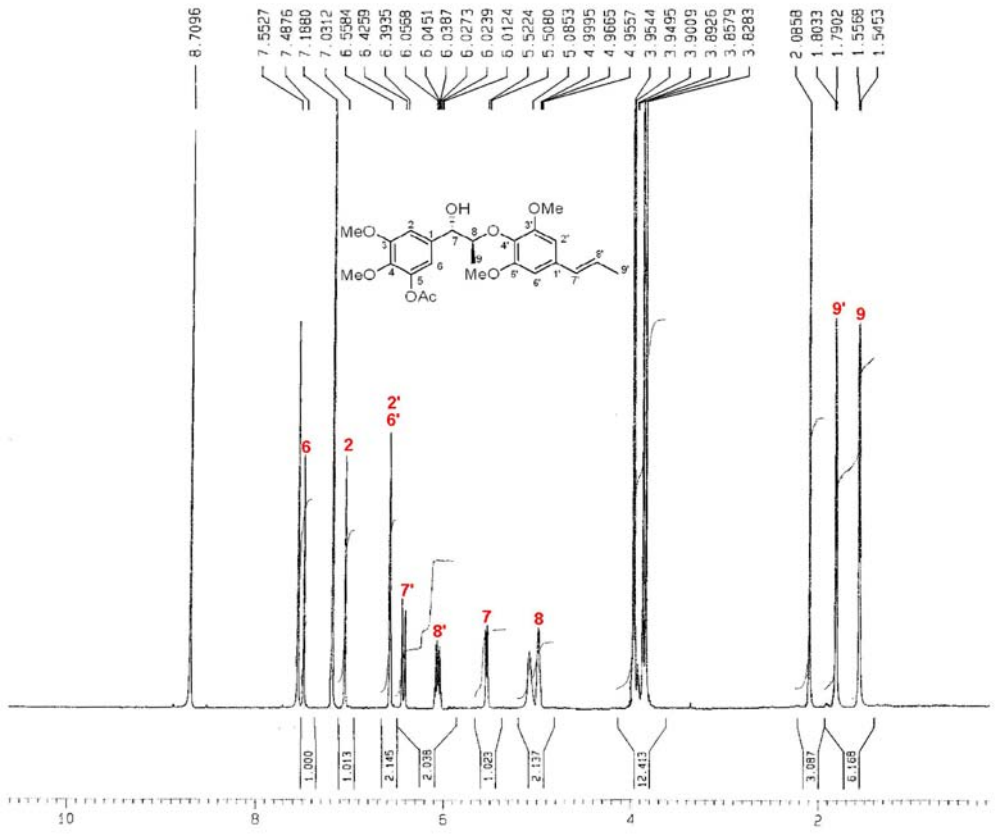

Figure S15. ^{1}H NMR spectra of fargesiphenol C (**3**).

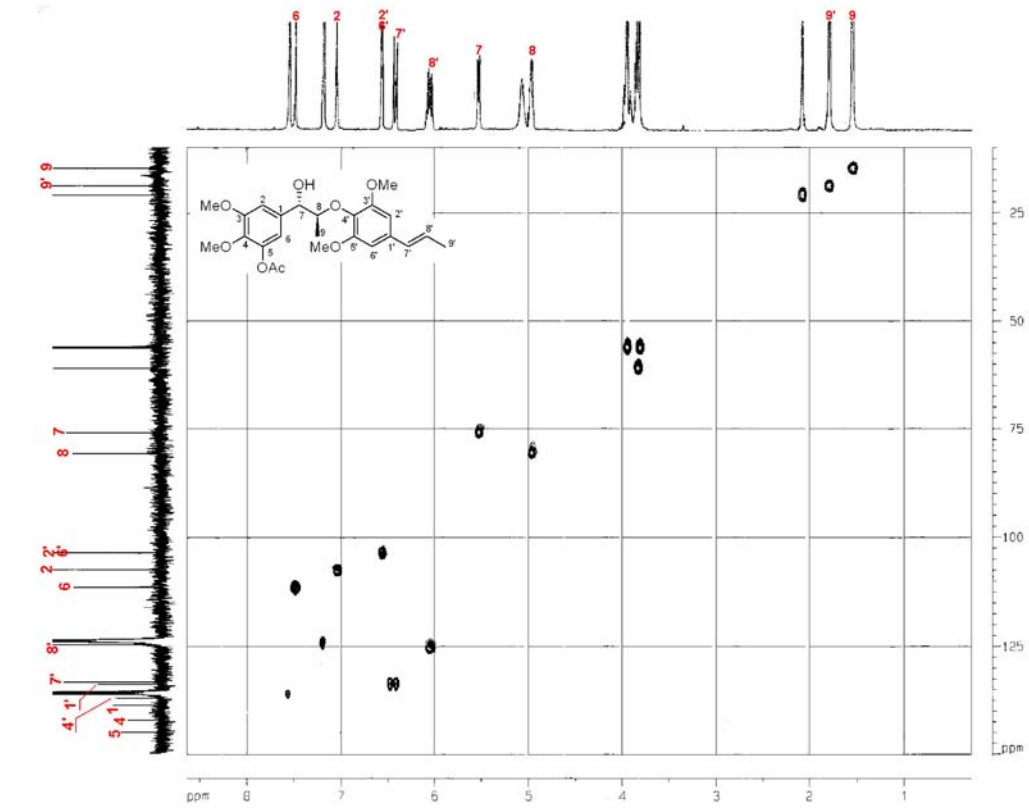

Figure S16. HSQC spectra of fargesiphenol C (**3**).

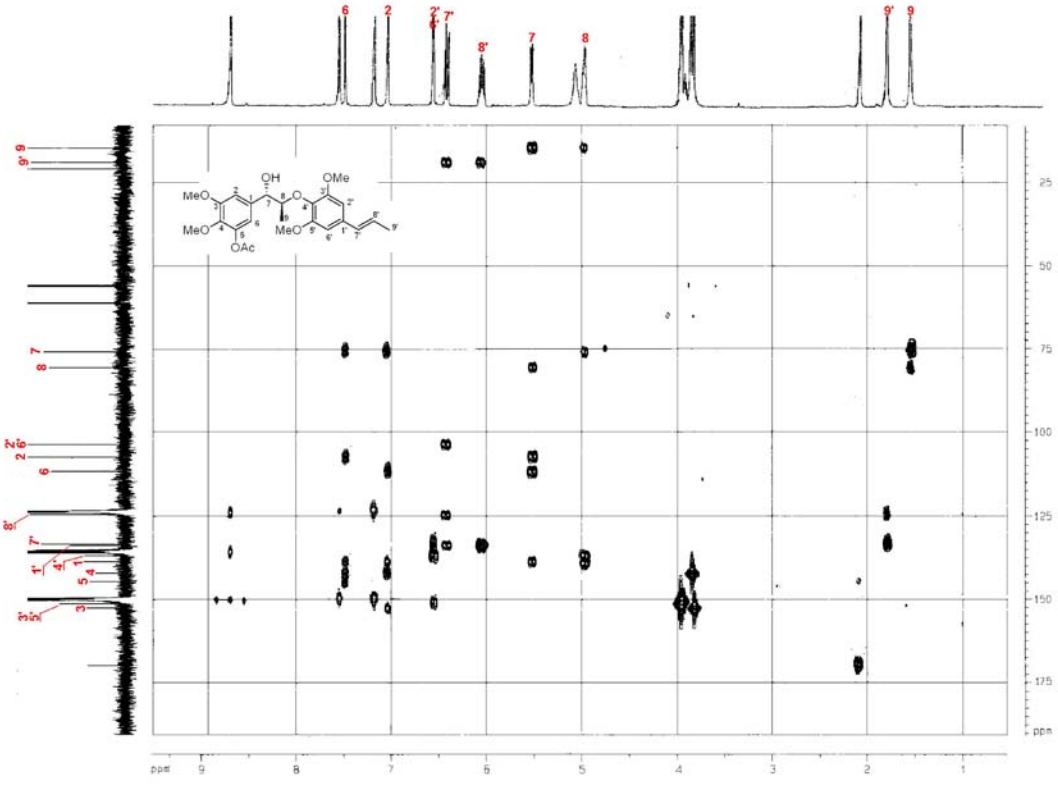

Figure S17. HMBC spectra of fargesiphenol C (**3**).

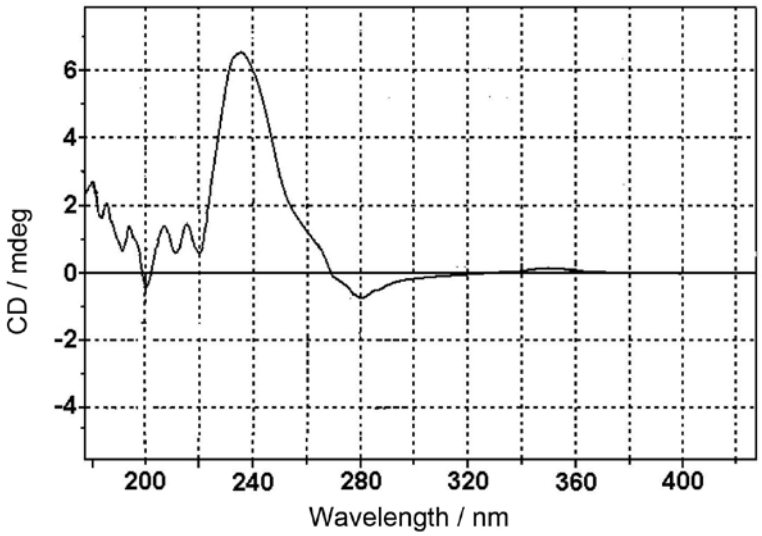

Figure S18. CD spectra of fargesiphenol C (**3**).