

PHENOLIC COMPOUNDS FROM LEAVES OF *Amesiodendron chinense* (Sapindaceae)

Ho Van Ban^{1,2,3*}, Vu Van Chien², Nguyen Thi Hue², Pham Thi Hang², Nguyen Le Tuan³,
Hoang Nu Thuy Lien³, Nguyen Quoc Vuong²

¹Graduate University of Science and Technology, Vietnam Academy of Science and Technology,
18 Hoang Quoc Viet St., Cau Giay, Hanoi, Vietnam

²Institute of Marine Biochemistry, Vietnam Academy of Science and Technology, 18 Hoang Quoc Viet St., Cau Giay,
Hanoi City, Vietnam

³Faculty of Natural Sciences, Quy Nhon University, 170 An Duong Vuong St., Quy Nhon City, Vietnam

* Correspondence to Ho Van Ban <hovanban@qnu.edu.vn>

(Received: 27 January 2021; Accepted: 7 April 2021)

Abstract. From the ethyl acetate extract of the leaves of *Amesiodendron chinense* (Merr.) Hu (Sapindaceae), we isolated three known phenolic compounds: 4-hydroxy-3-methoxybenzaldehyde (1), methyl 3,4-dihydroxybenzoate (2), and 3,4-dihydroxybenzoic acid (3). We elucidated their chemical structures from the spectral data and compared them with those reported in the literature.

Keywords: phenolic compounds, leaves, *Amesiodendron chinense*

1 Introduction

Phenolic compounds exist in various plant foods, such as fruits, vegetables, cereals, legumes, wine, tea, and coffee. The compounds have at least one aromatic ring with one hydroxy group [1-3]. They can be divided into two main class: flavonoids and nonflavonoids, according to their basic structure and specific substituent groups in basic structures [4, 5]. Nonflavonoids form a basic skeleton and are further classified into subheadings such as simple phenols, phenolic acids and derivatives, phenones, phenylacetic acid and derivatives, hydroxylable tannins, and stilbenes [6]. Phenolic compounds possess antioxidant activity [7-9] and reduce inflammatory and chronic diseases, such as cardiovascular diseases, arteriosclerosis, cancer, diabetes, cataract, disorders of cognitive function, and neurological diseases [10-12]. In this work, we isolate chemical constituents from the leaves of

Amesiodendron chinense (Merr.) Hu (Sapindaceae). This species is also called “Truong sang” in Vietnam [13, 14]. We report three known phenolic compounds: 4-hydroxy-3-methoxybenzaldehyde (1), methyl 3,4-dihydroxybenzoate (2), and 3,4-dihydroxybenzoic acid (3).

2 Material and methods

2.1 General experimental procedure

The structure of the compounds was studied by using ¹H-NMR, ¹³C-NMR spectra recorded on a Bruker AM500 FT-NMR spectrometer; IR spectra recorded on a Shimadzu Irtaffinity-1S FT-IR spectrometer; UV-Vis spectra recorded on a Shimadzu UV-1800 spectrometer. The ESI-MS was performed on an Agilent 1100 Series LC/MSD Trap SL. The compounds were separated with column chromatography (CC) on silica gel 60 (230–400 mesh, Merck) or Sephadex LH-20 (25–

100 μm , Sigma-Aldrich, USA) and thin-layer chromatography (TLC) on silica gel 60 F254 (Merck).

2.2 Plant material

The leaves of *A. chinense* (Sapindaceae) species were collected in June 2018 from Son Tra peninsula, Da Nang City. The plant's scientific name was identified at the Institute of Ecology and Biological Resources, Vietnam Academy of Science and Technology, with voucher PTH15032018.

2.3 Extraction and isolation

Dried leaves of *A. chinense* (7.0 kg) were powdered and extracted with MeOH 85% (5 \times 35 L, three times at 50 $^{\circ}\text{C}$ for 6 h). Then, the extracts were filtered, and the solvent was removed under reduced pressure to obtain a crude MeOH extract (2.5 L). The MeOH extract was suspended with H₂O (2.5 L) and then successively partitioned with hexane and ethyl acetate (EtOAc) to acquire hexane (ACH, 70 g) and EtOAc (ACE, 50 g) residues, and a water layer (ACW). The ACE fraction was separated in a silica gel column as follows: ACE with CH₂Cl₂/EtOAc (10:1, v/v) to give ACE1 (6 g), ACE2 (8 g), ACE3 (13 g), ACE4 (11 g), and ACE5 (7 g).

- ACE3 fraction with CH₂Cl₂/EtOAc (2:1, v/v) to obtain five sub-fractions (ACE3.1–ACE3.5).
- ACE3.1 with hexane/EtOAc (2:1, v/v) to provide five smaller fractions (ACE3.1.1–ACE3.1.5).
- ACE3.1.1 with hexane/EtOAc (2:1, v/v) to give three sub-fractions (ACE3.1.1.1–ACE3.1.1.3).
- ACE3.1.1.2 with CH₂Cl₂/EtOAc (2:0.5, v/v) to give compound **1** (8 mg).
- ACE5 fraction (7 g) with EtOAc/Acetone (1:1, v/v) to obtain five sub-fractions (ACE5.1–ACE5.5).
- ACE5.1 with EtOAc/Acetone (2:1, v/v) to give three smaller fractions (ACE5.1.1–ACE5.1.3).
- ACE5.1.3 with EtOAc/Acetone (2:0.5, v/v) to obtain two smaller fractions (ACE5.1.3.1–ACE5.1.3.2).
- ACE5.1.3.1 with EtOAc/Acetone (2:0.4, v/v) to provide compound **2** (7 mg).

The ACE5.1.3.2 fraction was purified on the Sephadex LH-20 column to give compound **3** (12 mg).

4-Hydroxy-3-methoxybenzaldehyde (**1**) is a white solid. IR (KBr) ν : 3450, 2918, 1732, and 1595 cm^{-1} ; UV-Vis (MeOH) λ_{max} : 275.0, 306.0 nm; positive ESI-MS: m/z 137 [M-CH₃]⁺; ¹H NMR (CDCl₃, 500 MHz): 9.83 (–CHO), 7.43 (1H, d, J = 8.5 Hz, H-6), 7.42 (1H, s, H-2), 7.04 (1H, d, J = 8.5 Hz, H-5), 6.17 (s, 4-OH), 3.97 (3H, s, –OCH₃); ¹³C NMR (CDCl₃, 125 MHz): 190.8 (C=O), 151.7 (C-4), 147.2 (C-3), 129.9 (C-1), 127.5 (C-6), 114.4 (C-2), 108.8 (C-5), 56.2 (–OCH₃).

Methyl 3,4-dihydroxybenzoate (**2**) is a yellow solid. IR (KBr) ν : 3450, 2929, 1686, 1535 cm^{-1} , UV-Vis (MeOH) λ_{max} : 261.2, 296.0 nm; negative ESI-MS: m/z 167 [M-H][–]; ¹H NMR (MeOD, 500 MHz): 7.43 (1H, dd, J = 2, 8 Hz, H-6), 7.42 (1H, d, J = 2 Hz, H-2), 6.82 (1H, d, J = 8 Hz, H-5), 3.85 (3H, s, –OCH₃); ¹³C NMR (MeOD, 125 MHz): 168.9 (C=O), 151.7 (C-4), 146.2 (C-3), 123.6 (C-6), 122.6 (C-1), 117.4 (C-5), 115.9 (C-2), 52.2 (–OCH₃).

3,4-Dihydroxybenzoic acid (**3**) is a white solid. IR (KBr) ν : 3450, 1641, 1535 cm^{-1} ; UV-Vis (MeOH) λ_{max} : 259.4, 295.4 nm; positive ESI-MS: m/z 155 [M+H]⁺; ¹H NMR (MeOD, 500 MHz): 7.46 (1H, dd, J = 3.5, 8 Hz, H-6), 7.44 (1H, d, J = 3.5 Hz, H-2), 6.82 (1H, d, J = 8 Hz, H-5); ¹³C NMR (MeOD,

125 MHz): 170.3 (C=O), 151.5 (C-4), 146.1 (C-3), 123.9 (C-1), 123.2 (C-6), 117.8 (C-2), 115.8 (C-5).

3 Results and discussion

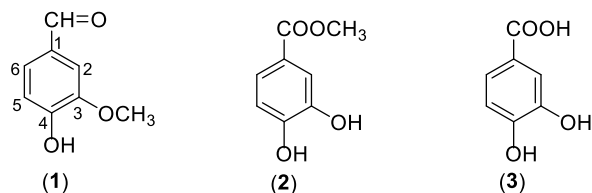


Fig. 1. Chemical structure of compounds 1–3

Compound **1** is a white amorphous solid. Its ESI-MS spectrum gives a positive *quasi*-molecular ion peak at m/z 137 $[M-CH_3]^+$. The ^{13}C -NMR indicates a molecular formula of $C_8H_8O_3$ ($M = 152$). The IR spectrum shows absorptions at 3450, 2918, and 1732 cm^{-1} , corresponding to the vibration of OH, C–H (CH_3), and C=O groups and 1595 and 1512 cm^{-1} for aromatic C=C. The UV spectrum absorption bands at 275.0 and 306.0 nm suggest the $\pi \rightarrow \pi^*$ transition in the benzene ring. The 1H -NMR spectrum shows signals at δ_H 9.83 (–CHO), 6.17 (s, 4-OH), and 3.97 (3H, s, –OCH₃). The signals of the aromatic system include δ_H 7.42 (1H, s, H-2), and two doublet signals at δ_H 7.04 (1H, d, $J = 8.5$ Hz, H-5) and 7.43 (1H, d, $J = 8.5$ Hz, H-6). The ^{13}C -NMR and DEPT spectra show signals of eight carbons: three methine carbons at δ_C 108.8 (C-5), 114.4 (C-2), and 127.5 (C-6); four quaternary carbons at δ_C 129.9 (C-1), 147.2 (C-3), 151.7 (C-4), and 190.8 (C=O), and a last value of methyl group at δ_C 56.2 (–OCH₃). According to the spectral data published in the literature [15], compound **1** is 4-hydroxy-3-methoxybenzaldehyde (vanillin).

Compound **2** is a yellow amorphous solid. The ESI-MS spectrum gives a negative *quasi*-molecular

ion peak at m/z 167 $[M-H]^-$, and the ^{13}C -NMR indicates a molecular formula of $C_8H_8O_4$ ($M = 168$). The IR spectrum shows absorptions at 3450, 2929, 1686, 1535 cm^{-1} , assigning to the OH, C–H (CH_3), C=O, and aromatic C=C bonds. The UV absorption bands at 261.2 and 296.0 nm suggest $\pi \rightarrow \pi^*$ transition in the benzene ring. Similar to **1**, the 1H -NMR spectrum also shows the signals of an ABX aromatic system at δ_H 7.43 (1H, dd, $J = 2$; 8 Hz, H-6), 7.42 (1H, d, $J = 2$ Hz, H-2), 6.82 (1H, d, $J = 8$ Hz, H-5) and a signal of the methoxy group at δ_H 3.85 (s, 3H, –OCH₃). The ^{13}C -NMR and DEPT spectra show the signals of eight carbons: three methine carbons at δ_C 115.9 (C-2), 117.4 (C-5), and 123.6 (C-6); four quaternary carbons at δ_C 122.6 (C-1), 146.2 (C-3), 151.7 (C-4), and 168.9 (C=O), and a carbon of the methoxy group at δ_C 52.2 (–OCH₃). According to the spectral data published in the literature [16], compound **2** is methyl 3,4-dihydroxybenzoate.

Compound **3** is a white amorphous solid. The ESI-MS spectrum gives a positive *quasi*-molecular ion peak at m/z 155 $[M+H]^+$, and the ^{13}C -NMR indicates a molecular formula of $C_7H_6O_4$ ($M = 154$). The 1H -NMR and ^{13}C -NMR spectra of **3** are similar to those of **2**, without the methoxy group. The 1H -NMR spectrum shows signals at δ_H 7.46 (1H, dd, $J = 3.5$; 8 Hz, H-6), 7.44 (1H, d, $J = 3.5$ Hz, H-2), and 6.82 (1H, d, $J = 8$ Hz, H-5). The ^{13}C -NMR spectrum shows the signals of seven carbons: four quaternary carbons at δ_C 170.3 (C=O), 151.5 (C-4), 146.1 (C-3), and 123.9 (C-1); three methine carbons at δ_C 123.2 (C-6), 117.8 (C-2), and 115.8 (C-5). According to the spectral data published in the literature [17], compound **3** is 3,4-dihydroxybenzoic acid.

Table 1. NMR spectroscopic data for compounds 1–3

Position	(1)			(2)			(3)		
	$\delta_{\text{C}}^{\#}$	$\delta_{\text{C}}^{a,b}$	$\delta_{\text{H}}^{a,c}$ (mult., <i>J</i> in Hz)	$\delta_{\text{C}}^{\#\#}$	$\delta_{\text{C}}^{d,e}$	$\delta_{\text{H}}^{d,f}$ (mult., <i>J</i> in Hz)	$\delta_{\text{C}}^{\#\#\#}$	$\delta_{\text{C}}^{d,g}$	$\delta_{\text{H}}^{d,h}$ (mult., <i>J</i> in Hz)
1	129.9	129.9	–	122.7	122.6	–	123.9	123.9	–
2	114.4	114.4	7.42(s)	115.9	115.9	7.42 (d, 2)	117.9	117.8	7.44 (d, 3.5)
3	147.1	147.2	–	146.3	146.2	–	146.2	146.1	–
4	151.6	151.7	–	151.8	151.7	–	151.5	151.5	–
5	108.7	108.8	7.04 (d, 8.5)	117.5	117.4	6.82 (d, 8)	115.8	115.8	6.82 (d, 8)
6	127.5	127.5	7.43 (d, 8.5)	123.7	123.6	7.43 (dd, 2; 8)	123.8	123.2	7.46 (dd, 3.5; 8)
C=O	190.6	190.8	9.83 (s, CHO)	168.9	168.9	–	171.0	170.3	–
OH	–	–	6.17 (s, OH)	–	–	–	–	–	–
(–OCH ₃)	56.1	56.2	3.97 (s, 3H)	52.3	52.2	3.85 (s, 3H)	–	–	–

Note: ^arecorded in CDCl₃, ^b125 MHz, ^c500 MHz, ^drecorded in MeOD, ^{e,g}125 MHz, ^{f,h}500 MHz, [#] δ_{C} of 4-hydroxy-3-methoxybenzaldehyde [15] (in CDCl₃ at 100MHz) and ^{\#\#} δ_{C} , ^{\#\#\#} δ_{C} of methyl 3,4-dihydroxybenzoate [16], 3,4-dihydroxybenzoic acid [17] (in MeOD at 125 MHz).

4 Conclusion

This is the first time, three known phenolic compounds, namely 4-hydroxy-3-methoxybenzaldehyde (1), methyl 3,4-dihydroxybenzoate (2), and 3,4-dihydroxybenzoic acid (3) are isolated from the ethyl acetate extract of the leaves of the Vietnamese *Amensiodendron chinese* (Merr.) Hu (Sapindaceae) species, collected from Son Tra peninsula, Da Nang City.

Funding statement

This research is funded by Quy Nhon University under grant No. T2020.663.11 and the Vietnam Academy of Science and Technology (VAST) under grant No. VAST 04.04/18-19.

References

1. Pridham JB. Low molecular weight phenols in higher plants, Annual Review of Plant Physiology. 1965;16(1):13-36.
2. Bruneton J. Pharmacognosy, phytochemistry, medicinal plants. 3rd ed. Hampshire: Intercept Ltd; 1999. 1119 p.
3. Manach C, Scalbert A, Morand C, Rémésy C, Jiménez L. Polyphenols: food sources and bioavailability. The American Journal of Clinical Nutrition. 2004;79(5):727-747.
4. Cheynier V. Polyphenols in foods are more complex than often thought. The American Journal of Clinical Nutrition. 2005;81(1):223S-229S.
5. De la Rosa LA, Alvarez-Parrilla E, González-Aguilar GA. Fruit and vegetable phytochemicals: chemistry, nutritional value and stability. Ames: Wiley-Blackwell; 2009. 384 p.
6. Kougan GB, Tabopda T, Kuete V, Verpoorte R. 6 - Simple Phenols, Phenolic Acids, and Related Esters from the Medicinal Plants of Africa. In: Kuete V, editor. Medicinal Plant Research in Africa. Oxford: Elsevier; 2013. p. 225-49.
7. Vijaya KRC, Sreeramulu D, Raghunath M. Antioxidant activity of fresh and dry fruits commonly consumed in India. Food Research International. 2010;43(1):285-288.
8. Sarawong C, Schoenlechner R, Sekiguchi K, Berghofer E, Ng PK. Effect of extrusion cooking on the physicochemical properties, resistant starch, phenolic content and antioxidant capacities of green banana flour. Food Chemistry. 2014;143:33-39.
9. Someya S, Yoshiki Y, Okubo K. Antioxidant compounds from bananas (*Musa Cavendish*). Food Chemistry. 2002;79(3):351-354.

10. Tanaka T, Shnimizu M, Moriwaki H. Cancer Chemoprevention by Carotenoids. *Molecules*. 2012 03;17(3):3202-3242.
11. Eliassen AH, Hendrickson SJ, Brinton LA, Buring JE, Campos H, Dai Q, et al. Circulating carotenoids and risk of breast cancer: pooled analysis of eight prospective studies. *JNCI: Journal of the National Cancer Institute*. 2012;104(24):1905-1916.
12. Pojer E, Mattivi F, Johnson D, Stockley CS. The case for anthocyanin consumption to promote human health: A review. *Comprehensive Reviews in Food Science and Food Safety*. 2013;12(5):483-508.
13. Ban NT. List of Vietnamese plant species. Hanoi: Agriculture Publishing House; 2003. 1016 p. Vietnamese
14. Ho PH. An illustrated flora of Vietnam. Ho Chi Minh City: Young Publisher; 2003. 326 p. Vietnamese
15. Ma W, Qin L. Chemical constituents of *arabidopsis thaliana*. *Chemistry of Natural Compounds*. 2014;50(4):776-777.
16. Megawati, Darmawan A, Fajriah S, Primahana G, Dewi RT, Minarti, et al. Antioxidant and α -glucosidase activities of benzoic acid derivates from the bark of *Myristica fatua* Houtt. *AIP Conference Proceedings*. 2017;1904(1):020027.
17. Nguyen D, Seo D, Kim K, Park R, Kim D, Han Y, et al. Nematicidal activity of 3,4-dihydroxybenzoic acid purified from *Terminalia nigrovenulosa* bark against *Meloidogyne incognita*. *Microbial Pathogenesis*. 2013;59-60:52-59.