CHEMICAL COMPONENTS OF THE RHIZOMES OF *Drynaria fortunei* (KUNZE) J. Sm. (POLYPODIACEAE) IN VIETNAM

Pham Thi Nhat TRINH[a], Nguyen Cong HAO[b1], Phan Thanh THAO[b2] and Le Tien DUNG[b3,*]

[a] *Department of Chemistry, Faculty of General Science, Tiengiang University, National Highway No.1, ChauThanh Dist. Tiengiang Province, Vietnam; e-mail: phamthinhattrinh1979@yahoo.com*

[b] *Institute of Chemical Technology, Vietnamese Academy of Science and Technology, 01 MacDinhChi Str., Dist.1, Ho Chi Minh City, Vietnam; e-mail: [1] nguyenconghao@yahoo.com, [2] ptthao@vast-hcm.ac.vn, [3] ltdung@vast-hcm.ac.vn*

Received August 2, 2010
Accepted May 19, 2011
Published online August 29, 2011

From the ethanol extract of *Drynaria fortunei* (KUNZE) J. Sm., a new phenylpropanoid glycoside, fortunamide (**1**), was isolated and characterized by spectroscopic methods. Together with a new glycoside, 9 known compounds, including three curcuminoids (**2**–**4**), two isoprenylated flavonoids (**5**, **6**), two flavonoids (**7**, **8**), one monoterpenoid (**9**) and one phenolic acid (**10**) were isolated and identified by spectral data analysis from the rhizomes of *Drynaria fortunei* (KUNZE) J. Sm. Eight of them were isolated from *Drynaria fortunei* (KUNZE) J. Sm. for the first time.

Keywords: *Drynaria fortunei* (Kunze) J. Sm.; Flavonoids; Fortunamide.

The rhizomes of *Drynaria fortunei* (KUNZE) J. Sm. (Polypodiaceae) have been used for treatment of osteoporosis, healing bone fractures in traditional Vietnamese and Chinese medicine[1–5]. Like most ferns, *D. fortunei* is abundant in triterpenoids, most of which are of the hopane and fernane skeletons, and in flavonoids. As a part of our continuing studies on *Drynaria* species in Vietnam[6–8], this paper describes the isolation and structural determination of ten secondary metabolites from the ethanolic extract of the rhizomes of *Drynaria fortunei* (KUNZE) J. Sm. One was a new compound and eight were reported for the first time from *D. fortunei*.

Collect. Czech. Chem. Commun. 2011, Vol. 76, No. 9, pp. 1133–1139

doi:10.1135/cccc2010098

EXPERIMENTAL

Abbreviations Used

ODS, octadecylsilyl silica gel; SPE, solid phase extraction.

Plant Material

Rhizomes of *D. fortunei* were collected in Vietnam in December 2007 and authenticated by the centre of medicinal plants and ginseng in Ho Chi Minh city (National Institute of Medicinal Material – Vietnam).

Equipment

NMR spectra (δ, ppm; *J*, Hz) were recorded on a Bruker Avance 500 MHz using TMS as internal standard, ESI-MS and HR-ESI-MS data were recorded on a Agilent 1100 LC-MSD Trap of Institute of Chemistry (Vietnamese Academy of Science and Technology). TLC were performed on silica gel 60 F_{254} (Merck 1,05715), RP_{18} F_{254s} (Merck). The zones were detected using UV at 254 or 365 nm or solution of $FeCl_3$–EtOH or H_2SO_4–EtOH. Column chromatography was performed on silica gel (240–430 mesh) or ODS or Sephadex LH20. The purifications of some compounds (**1–6**, **9**, **10**) were carried out on preparative HPLC Agilent 1100 Series DAD with UV detector.

Extraction and Isolation

Dried rhizomes of *D. fortunei* (2 kg) were extracted with EtOH 96%. The extract was evaporated to dryness (240 g) under reduced pressure. The ethanol extract was eluted on a silica gel column sequentially with petrol ether, chloroform, ethyl acetate and methanol.

The petrol ether extract (50 g) was fractionated by column chromatography on a silica gel column using a petroleum ether–chloroform gradient to afford four fractions. Fraction 1 was further passed over sephadex LH-20 column using MeOH–$CHCl_3$ (50:50) as the eluent to give three subfractions, referred to as subfractions 1-1 to 1-3. Subfraction 1-2 was further purified by ODS preparative HPLC (MeCN–H_2O 70:30) to yield **9** (22.5 mg). Fraction 3 was subjected to column chromatography on silica gel with elution by hexane–chloroform gradients (4:1 to 0:100) to afford three subfractions, referred to as 3-1 to 3-3. Subfraction 3-3 was also passed over sephadex LH-20 column and eluted with $CHCl_3$–MeOH (50:50) to give three subfractions (3-3a to 3-3c). Subfraction 3-3c was further purified by ODS preparative HPLC (MeOH–H_2O 70:30) to afford **5** (25.5 mg).

The chloroform fraction (24.2 g) was rechromatographed on a silica gel column using a chloroform–methanol gradient to yield 2 fractions (C1 and C2). Fraction C2 was filtered on a sephadex LH20 column ($CHCl_3$–MeOH 50:50 as eluent) to give three subfractions (C2-1 to C2-3). Subfraction C2-3 was purified by ODS preparative HPLC (MeOH–H_2O 70:30) to give **6** (15 mg). Subfraction C2-2 was rechromatographed on a silica gel column and eluted with $CHCl_3$–MeOH gradient (100:1) to yield eight subfractions, named subfraction C2-2A to C2-2H, which were further purified by ODS preparative HPLC (MeCN–H_2O 45:55) to give **2** (137 mg), **3** (12.4 mg), **4** (12.5 mg).

The ethyl acetate fraction (20 g) was chromatographed on a silica gel column using a chloroform–methanol gradient to yield seven fractions (A1 to A7). Fraction A2 was filtered

through sephadex LH 20 and purified by preparative HPLC (MeOH–H_2O 30:70) to give **10** (60 mg).

The methanolic fraction (143 g) was chromatographed on a standard silica gel column with chloroform–methanol gradient to give seven fractions. Fraction 4 was repeatedly chromatographed ($CHCl_3$–MeOH 0–100%) on sephadex LH 20 with MeOH–$CHCl_3$ (50:50) and by ODS column chromatography using MeOH–H_2O (30:70→50:50) to give **7** (60.5 mg) and **8** (7.5 mg). Fraction 5 was chromatographed on silica gel with chloroform–methanol (0–100%), followed by purification on sephadex LH 20 with MeOH, SPE with ACN–MeOH–H_2O (1:1:20) and then subjected to final purification by ODS preparative HPLC with MeCN–MeOH–H_2O (1:1:40), to give **1** (60 mg).

Fortunamide **1**: white powder. IR (KBr, cm^{-1}): 3447 (–OH), 1654 (C=O), 1503 (C=C), 1026 (C–O–). ESI-MS, *m/z*: 365.0 $[M + Na]^+$. HR-ESI-MS, *m/z*: 341.21877 $[M]^+$ ($C_{15}H_{19}NO_8$). ^1H NMR (500 MHz, DMSO-d_6): 7.11 s, 1 H (H-2); 7.10 d, 1 H, *J* = 8.5 (H-5); 7.04 d, 1 H, *J* = 8.5 (H-6); 7.41 d, 1 H, *J* = 15.5 (H-7); 6.29 d, 1 H, *J* = 15.5 (H-8); 4.75 d, 1 H, *J* = 7 (H-1′); 3.70 m, 1 H (H-6′a); 3.45 m, 1 H (H-6′b); 3.32 m, 1 H (H-3′); 3.25 m, 1 H (H-5′); 3.29 m, 1 H (H-2′); 3.15 m, 1 H (H-4′). ^{13}C NMR (125 MHz, DMSO-d_6): 129.0 (C-1); 114.7 (C-2); 146.8 (C-3); 147.1 (C-4); 116.1 (C-5); 120.4 (C-6); 143.3 (C-7); 117.8 (C-8); 167.9 (C-9).

Curcumine (**2**): yellow powder. ESI-MS, *m/z*: 369.1 $[M + H]^+$; 367.1 $[M - H]^-$. ^1H NMR (500 MHz, acetone-d_6): 5.97 s, 1 H (H-1); 6.68 d, 1 H, *J* = 15.5 (H-3); 7.58 d, 1 H, *J* = 15.5 (H-4); 7.16 dd, 1 H, *J* = 1.5 and 8 (H-6); 6.87 d, 1 H, *J* = 8 (H-7); 7.32 d, 1 H, *J* = 1.5 (H-10); 6.68 d, 1 H, *J* = 15.5 (H-3′); 7.58 d, 1 H, *J* = 15.5 (H4′); 7.16 dd, 1 H, *J* = 1.5 and 8 (H-6′); 6.87 d, 1 H, *J* = 8 (H-7′); 7.32 d, 1 H, *J* = 1.5 (H-10′); 3.90 s, 3 H (9-OMe); 3.91 s, 3 H (9′-OMe). ^{13}C NMR (125 MHz, acetone-d_6): 101.6 (C-1); 184.4 (C-2); 122.3 (C-3); 141.3 (C-4); 128.1 (C-5); 123.7 (C-6); 116.2 (C-7); 150.0 (C-8); 148.7 (C-9); 111.6 (C-10); 184.4 (C-2′); 122.3 (C-3′); 141.3 (C-4′); 128.1 (C-5′); 123.7 (C-6′); 116.2 (C-7′); 150.0 (C-8′); 148.7 (C-9′); 111.6 (C-10′); 56.3 (9/9′-OMe).

Demethoxycurcumine (**3**): yellow powder. ESI-MS, *m/z*: 361.1 $[M + Na]^+$. ^1H NMR (500 MHz, acetone-d_6): 5.97 s, 1 H (H-1); 6.63 d, 1 H, *J* = 15.5 (H-3); 7.58 d, 1 H, *J* = 15.5 (H-4); 7.33 s, 1 H (H-6); 6.87 d, 1 H, *J* = 8.5 (H-9); 7.16 d, 1 H, *J* = 8.5 (H-10); 6.69 d, 1 H, *J* = 15.5 (H-3′); 7.59 d, 1 H, *J* = 15.5 (H-4′); 7.54 d, 1 H, *J* = 8.5 (H-6′); 6.89 d, 1 H, *J* = 8.5 (H-7′); 6.89 d, 1 H, *J* = 9 (H-9′); 7.54 d, 1 H, *J* = 9 (H-10′); 3.92 s, 3 H (9-OMe). ^{13}C NMR (125 MHz, acetone-d_6): 101.6 (C-1); 184.4 (C-2); 121.9 (C-3); 141.3 (C-4); 127.6 (C-5); 123.8 (C-6); 148.8 (C-7); 150.1 (C-8); 116.8 (C-9); 111.5 (C-10); 184.5 (C-2′); 122.2 (C-3′); 141.0 (C-4′); 128.1 (C-5′); 130.9 (C-6′); 116.2 (C-7′); 160.6 (C-8′); 116.2 (C-9′); 130.9 (C-10′); 56.3 (9-OMe).

Bisdemethoxycurcumine (**4**): yellow powder. ESI-MS, *m/z*: 309.1 $[M + H]^+$; 307.1 $[M - H]^-$. ^1H NMR (500 MHz, acetone-d_6): 5.98 s, 1 H (H-1); 6.65 d, 2 H, *J* = 15.5 (H-3/H-3′); 7.59 d, 2 H, *J* = 15.5 (H-4/H-4′); 7.55 d, 2 H, *J* = 9 (H-6/H-6′); 6.89 d, 2 H, *J* = 8.5 (H-7/H-7′); 6.89 d, 2 H, *J* = 8.5 (H-9/H-9′); 7.55 d, 2 H, *J* = 8.5 (H-10/H-10′). ^{13}C NMR (125 MHz, acetone-d_6): 101.6 (C-1); 184.5 (C-2/C-2′); 122.0 (C-3/C-3′); 141.5 (C-4/C-4′); 127.7 (C-5/C-5′); 130.9 (C-6/C-6′); 116.7 (C-7/C-7′); 160.5 (C-8/C-8′); 116.7 (C-9/C-9′); 130.9 (C-10/C-10′).

Bavachinine (**5**): orange powder. ESI-MS, *m/z*: 361.1 $[M + Na]^+$. ^1H NMR (500 MHz, acetone-d_6): 5.43 dd, 1 H, *J* = 13 and 3 (H-2); 2.66 dd, 1 H, *J* = 3 and 16.5 (H-3a); 3.00 dd, 1 H, *J* = 13 and 16.5 (H-3b); 7.57 s, 1 H (H-5); 6.53 s, 1 H (H-8); 7.39 d, 1 H, *J* = 8.5 (H-2′); 6.89 d, 1 H, *J* = 8.5 (H-3′); 6.89 d, 1 H, *J* = 8.5 (H-5′); 7.39 d, 1 H, *J* = 8.5 (H-6′); 3.23 d, 2 H, *J* = 7 (H-11); 5.26 m, 1 H (H-12); 1.70 s, 3 H (H-14); 1.72 s, 3 H (H-15). ^{13}C NMR (125 MHz, acetone-d_6): 80.6 (C-2); 44.6 (C-3); 190.6 (C-4); 127.3 (C-5); 124.8 (C-6); 164.6 (C-7); 99.8

(C-8); 163.2 (C-9); 114.9 (C-10); 131.3 (C-1′); 128.9 (C-2′); 116.1 (C-3′); 158.5 (C-4′); 116.1 (C-5′); 128.9 (C-6′); 29.3 (C-11); 123.0 (C-12); 133.0 (C-13); 17.7 (C-14); 25.8 (C-15).

Isobavachalcone (**6**): orange powder. ESI-MS, *m/z*: 324.2 $[M + H]^+$. ^{1}H NMR (500 MHz, acetone-d_6): 6.54 d, 1 H, *J* = 8.5 (H-5); 7.97 d, 1 H, *J* = 9 (H-6); 3.38 d, 2 H, *J* = 7 (H-7); 5.27 m, 1 H (H-8); 1.64 s, 3 H (H-10); 1.77 s, 3 H (H-11); 7.73 d, 2 H, *J* = 8.5 (H-2′/H-6′); 6.93 d, 2 H, *J* = 8.5 (H-3′/H-5′); 7,76 d, 1 H, *J* = 15.5 (H-α); 7,85 d, 1 H, *J* = 15.5 (H-β). ^{13}C NMR (125 MHz, acetone-d_6): 114.4 (C-1); 165.1 (C-2); 116.1 (C-3); 162.7 (C-4); 108.0 (C-5); 130.2 (C-6); 22.1 (C-7); 123.3 (C-8); 131.4 (C-9); 25.8 (C-10); 17.8 (C-11); 127.6 (C-1′); 131.6 (C-2′/C-6′); 116.7 (C-3′/C-5′); 160.9 (C-4′); 118.5 (C-α); 144.9 (C-β); 193.0 (C=O).

(–)-*Epicatechine* (**7**): white powder. ESI-MS, *m/z*: 313.0 $[M + Na]^+$. ^{1}H NMR (500 MHz, DMSO-d_6): 4.73 s, 1 H (H-2); 4.01 s, 1 H (H-3); 2.46 dd, 1 H, *J* = 3.5 and 16.5 (H-4a); 2.66 dd, 1 H, *J* = 4 and 16.5 (H-4b); 5.89 d, 1 H, *J* = 2 (H-6); 5.72 d, 1 H, *J* = 2 (H-8); 6.89 s, 1 H (H-2′); 6.64 d, 1 H, *J* = 9 (H-6′); 6.66 d, 1 H, *J* = 8.5 (H-5′). ^{13}C NMR (125 MHz, DMSO-d_6): 78.0 (C-2); 64.9 (C-3); 28.1 (C-4); 156.4 (C-5); 95.1 (C-6); 156.2 (C-7); 94.1 (C-8); 155.7 (C-9); 98.5 (C-10); 130.6 (C-1′); 114.8 (C-2′); 144.4 (C-3′); 144.4 (C-4′); 114.7 (C-5′); 117.9 (C-6′).

Liquiritine (**8**): yellow powder. ESI-MS, *m/z*: 441.1 $[M + Na]^+$. ^{1}H NMR (500 MHz, DMSO-d_6): 5.48 dd, 1 H, *J* = 2.5 and 12 (H-2); 2.64 dd, 1 H, *J* = 2.5 and 17 (H-3a); 3.05 dd, 1 H, *J* = 12.5 and 17 (H-3b); 7.61 d, 1 H, *J* = 8.5 (H-5); 6.45 d, 1 H, *J* = 8.5 (H-6); 6.28 s, 1 H (H-8); 7.06 d, 2 H, *J* = 8.5 (H-3′/H-5′); 7.43 d, 2 H, *J* = 8.5 (H-2′/H-6′); 4.87 d, 1 H, *J* = 7.5 (H-1″); 3.15 m, 1 H (H-2″); 3.23 m, 1 H (H-3″); 3.05 m, 1 H (H-4″); 3.26 m, 1 H (H-5″); 3.31 m, 1 H (H-6a); 3.69 m, 1 H (H-6b). ^{13}C NMR (125 MHz, DMSO-d_6): 78.4 (C-2); 43.1 (C-3); 189.3 (C-4); 128.1 (C-5); 111.1 (C-6); 163.8 (C-7); 102.5 (C-8); 163.0 (C-9); 112.5 (C-10); 132.4 (C-1′); 116.1 (C-3′/C-5′); 127.7 (C-2′/C-6′); 157.3 (C-4′); 100.3 (C-1″); 73.1 (C-2″); 76.5 (C-3″); 69.7 (C-4″); 76.9 (C-5″); 60.6 (C-6″).

Bakuchiol (**9**): yellow oil. ESI-MS, *m/z*: 279.3 $[M + Na]^+$. ^{1}H NMR (500 MHz, acetone-d_6): 7.25 d, 1 H, *J* = 8.5 (H-2); 6.77 d, 1 H, *J* = 9 (H-3); 6.77 d, 1 H, *J* = 9 (H-5); 7.25 d, 1 H, *J* = 8.5 (H-6); 6.27 d, 1 H, *J* = 16.5 (H-7); 6.08 d, 1 H, *J* = 16 (H-8); 1.48 m, 2 H (H-10); 1.95 m, 2 H (H-11); 5.11 m, 1 H (H-12); 1.65 s, 3 H (H-14); 1.57 s, 3 H (H-15); 1.19 s, 3 H (H-16); 5.89 m, 1 H (H-17); 4.99 m, 2 H (H-18). ^{13}C NMR (125 MHz, acetone-d_6): 130.3 (C-1); 128.0 (C-2); 116.1 (C-3); 157.5 (C-4); 116.1 (C-5); 128.0 (C-6); 127.8 (C-7); 135.3 (C-8); 43.1 (C-9); 42.1 (C-10); 23.9 (C-11); 125.7 (C-12); 131.4 (C-13); 25.7 (C-14); 17.6 (C-15); 23.7 (C-16); 147.0 (C-17); 112.0 (C-18).

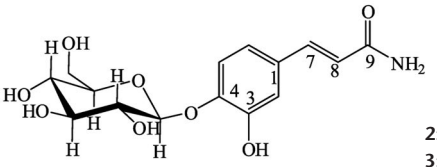
Protocatechuic acid (**10**): white powder. ESI-MS, *m/z*: 177.1 $[M + Na]^+$; 153.0 $[M - H]^-$. ^{1}H NMR (500 MHz, acetone-d_6): 7.54 s, 1 H (H-2); 6.89 d, 1 H, *J* = 7.5 (H-5); 7.48 d, 1 H, *J* = 7.5 (H-6). ^{13}C NMR (125 MHz, acetone-d_6): 168.1 (COOH); 122.9 (C-1); 117.4 (C-2); 145.5 (C-3); 150.7 (C-4); 115.6 (C-5); 123.7 (C-6).

RESULTS AND DISCUSSION

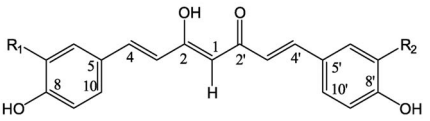
The ethanol extract of *D. fortunei* was partitioned successively with petroleum ether, chloroform, ethyl acetate and methanol. After column chromatography on silica gel (normal and reverse phase), sephadex LH-20 as adsorbent, the ethyl acetate, petroleum ether and chloroform fractions yielded 1, 2 and 4 known compounds, respectively. Separation of the methanol extract by repeated chromatography on silica gel and sephadex LH-20,

followed by purification on a preparative HPLC afforded 3 compounds, one of which is a new glycoside (**1**), together with two known compounds. The spectral data of the above nine known compounds (**2**–**10**) were in good agreement with those published in the literatures. The compounds were thus identified as curcumine[9], demethoxycurcumine[9], bisdemethoxycurcumine[9], bavachinine[10], isobavachalcone[10], (–)epicatechine[11], liquiritine[12], bakuchiol[13], protocatechuic acid[14].

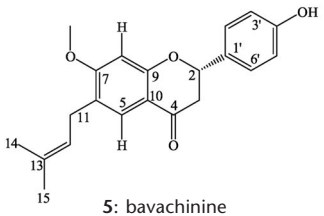
Compound **1** was obtained as a white powder, which gave a positive reaction with $FeCl_3$–EtOH indicating a phenolic compound. The IR spectrum of **1** showed the corresponding carbonyl absorption (ν 1654 cm^{-1}), hydroxyl



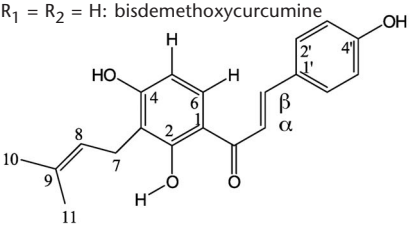
1: fortunamide



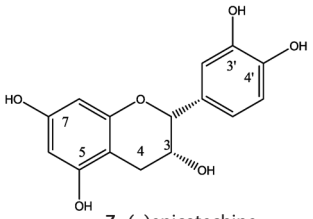
2: $R_1 = R_2 = OCH_3$: curcumine
3: $R_1 = OCH_3$; R_2 = H: demethoxycurcumine
4: $R_1 = R_2$ = H: bisdemethoxycurcumine



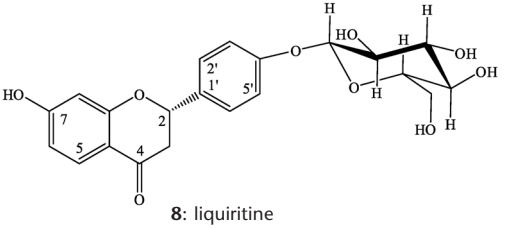
5: bavachinine



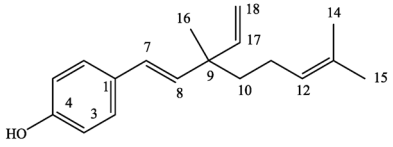
6: isobavachalcone



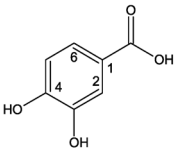
7: (–)epicatechine



8: liquiritine



9: bakuchiol



10: protocatechuic acid

(ν 3447 cm^{-1}), and aromatic ring (1503 cm^{-1}). The ^1H NMR (500 MHz, DMSO-d_6) spectrum of **1** showed signals of one trisubstituted aromatic δ_H [7.04 (1 H, d, J = 8.5 Hz, H-6); 7.10 (1 H, d, J = 8 Hz, H-5) and 7.11 (1 H, s, H-2)], two *trans* olefinic protons δ_H [6.29 (1 H, d, J = 16 Hz, H-8); 7.41 (1 H, d, J = 16 Hz, H-7)] and a β-glucose moiety δ_H [4.75 (1 H, d, J = 7 Hz, H-1′); 3.70 (1 H, H-6′a); 3.45 (1 H, m, H-6′b); 3.32 (1 H, H-3′); 3.25 (1 H, H-5′); 3.29 (1 H, H-2′) and 3.15 (1 H, H-4′)]. The ^{13}C NMR and DEPT spectra indicated that **1** possessed 15 carbons, which were sorted out into one carbonyl δ_C 167.9, two olefinic carbons δ_C [117.8; 143.3], six aromatic carbons including two oxygenated ones δ_C [114.7; 116.1; 120.4; 129.0; 146.8; 147.1] and a β-D-glucose moiety δ_C [60.7; 69.7; 73.2; 75.8; 77.3; 101.6].

In the HMBC spectrum of **1**, two signals of olefinic protons showed long range correlations to the carbonyl and a quaternary aromatic carbon indicating that the double bond was attached to the aromatic ring at C-1 (δ_C 129.0). Because of the resonance effect of the carbonyl group, the chemical shifts of H-7 and H-8 were δ_H 7.41 and 6.29, respectively. Two hydroxy groups could have been attached to the aromatic ring at C-3/C-4 or C-2/C-4.

In addition, H-7 showed correlations with two aromatic carbons δ_C [114.7; 120.4], which confirmed that these two carbons were C-2 and C-6, respectively. Consequently, C-3 and C-4 bear the two hydroxy groups. Proton at δ_H 7.04 (1 H, d, J = 8.5 Hz) gave HMBC correlations with C-7 and an oxygenated aromatic carbon. This result suggests that the proton was H-6. Consequently, two protons H-5 and H-2 had chemical shifts at δ_H [7.10 (1 H, d, J = 8 Hz)] and [7.11 (1 H, s)], respectively. The HMBC spectrum showed that the signal of the oxygenated carbon at δ_C 147.1 gave correlations just with H-6 and the anomeric proton proving that the signal at δ_C 147.1 was C-4 and suggesting C-4 as the location of the glucose moiety. The coupling constant of the anomeric proton J = 7 Hz attested to the β-conformation of the glucose unit.

The signal of the carbonyl at δ_C 167.9 indicated that **1** could have a carboxy or amide group. However, the IR spectrum of **1** did not reveal the presence of the carboxy group, and ESI-MS gave molecular peak of 342 amu consistent with the molecular formula of $C_{15}H_{19}NO_8$. The HR-ESI-MS gave the molecular peak at *m/z* 341.21877 amu and the result of element analysis confirmed the above molecular formula of $C_{15}H_{19}NO_8$.

Based on these spectral features of **1**, we have assigned the structure of 4-*O*-β-D-glucopyranosyl caffeic acid amide to this natural compound. Amide **1** appears to be a new natural product, for which we suggested the trivial name fortunamide.

Except for (–)-epicatechine (**7**), all compounds were isolated from *Drynaria fortunei* for the first time.

REFERENCES

1. Loi D. T.: *Medicinal Plants and Remedy of Vietnam*, p. 491. Publisher of Medicine, Hanoi 2004.
2. Ho P. H.: *Vietnamese Plants*, Vol. 1, p. 83. Publisher of Young, Hanoi 2002.
3. Songqing L., Zhuoyin X., Rui F.: *Phytochemistry* **1994**, *35*, 1595.
4. Xin-Luan W., Nai-Li W., Yan Z., Hao G., Wai-Yin P., Man-Sau W., Ge Z., Ling Q., Xin-Sheng Y.: *Chem. Pharm. Bull.* **2008**, *56*, 46.
5. Ramesh N., Viswanathan M. B., Saraswathy A., Balakrishna K., Brindha P., Lakshmanaperumalsamy P.: *Fitoterapia* **2001**, *72*, 934.
6. Nhat Trinh Pham T., Hao Nguyen C., Thao Phan T.: *Vietnamese J. Chem.* **2009**, *47*, 463.
7. Nhat Trinh Pham T., Hao Nguyen C., Thao Phan T.: *Vietnamese J. Chem.* **2009**, *47*, 468.
8. Nhat Trinh Pham T., Dung Le T., Hao Nguyen C., Thao Phan T.: *J. Med. Mater.-Hanoi* **2009**, *14*, 272.
9. Peret-Almeida L., Cherubino A. P. F., Alves R. J., Dufosse L., Gloria M. B. A.: *Food Res. Int.* **2005**, *38*, 1039.
10. Guodong X., Guowen L., Liang C., Zijia Z., Jun-Jie Y., Tao W., Zhihong C., Xiaohui W., Zhengtao W.: *J. Chromatogr., A* **2010**, *1217*, 5470.
11. Lai Yeap F.: *Phytochemistry* **1987**, *26*, 2825.
12. Tsutomu N., Aiura I., Kazuico K., Kaisuke Y.: *Phytochemistry* **1985**, *24*, 339.
13. Labbé C., Faini F., Coll J., Connolly J. D.: *Phytochemistry* **1996**, *42*, 1299.
14. Sang S., Lapsley K., Rosen R. T., Ho C.-T.: *J. Agric. Food Chem.* **2002**, *50*, 607.