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FLAVONOIDS FROM FLOWERS OF *AMESIODENDRON CHINENSE*

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Abstract. From the flowers of *Amesiodendron chinense* (Merr.) Hu, six known flavonoids, (−)-catechin (**1**), (−)-*epi*-catechin (**2**), chrysoeriol (**3**), kaempferide 3-*O*-*β*-D-glucopyranoside (**4**), astragalin (**5**), quercetin 3-*O*-*β*-D-glucopyranoside (**6**) were isolated. Their chemical structures were elucidated by analysis of the physicochemical parameters, the NMR and mass spectral data, and comparison with those reported in the literatures.

Keyword: flavonoids, flowers, *Amesiodendron chinense*.

Classification numbers: 1.1.1, 1.1.6.

1. INTRODUCTION

Flavonoids are small molecular weight phenolic compounds found in all plant parts such as flowers, branches, leaves, seeds, bark, and fruit. They form a class of specific substances in plants and are divided into subheadings such as flavones, flavonols, flavanones, flavanonols, flavanols or catechins, anthocyanins, and chalcones [1]. Due to possessing antioxidant, anti-inflammatory, anti-mutagenic and anti-cancer activities, flavonoids were used for the improvement of human's health and they are indispensable ingredients in the productions of pellets, cosmetics and medicines. Hence, the search and discovery of natural source flavonoids are received great interest today [1 - 3]. In our project, *Amesiodendron chinense* (Merr.) Hu, also is called "Truong sang" in Viet Nam [4, 5], was studied on its chemical constituents. Herein, we present the isolation and chemical structural elucidation of six known flavonoids from the flowers of *A. chinense*, including two flavan-3-ols, (−)-catechin (**1**) and (−)-*epi*-catechin (**2**); one flavone, chrysoeriol (**3**); and three flavonols, kaempferide 3-*O*-*β*-D-glucopyranoside (**4**), astragalin (**5**) and quercetin 3-*O*-*β*-D-glucopyranoside (**6**).

2. MATERIALS AND METHODS

2.1. General experimental procedures

The ^{1}H-NMR, ^{13}C-NMR and 2D-NMR spectra were recorded on a Bruker AM500 FT-NMR spectrometer. Optical rotations were recorded on a JASCO P-2000 Polarimeter. The ESI-MS were measured on an Agilent 1100 Series LC/MSD Trap SL. Column chromatography (CC) was performed using a silica gel 60 (230 - 400 mesh, Merck) or RP-18 resins (30 - 50 μm, Fuji Silysia Chemical Ltd, Aichi, Japan). Thin layer chromatography (TLC) used percolated silica gel 60 F254 (Merck) and RP-18 F254S plates (Merck).

2.2. Plant material

The flowers of *Amesiodendron chinense* (Merr.) Hu (Sapindaceae) species were collected in May 2019 from Son Tra District, Da Nang City, and the scientific name was identified by Dr. Do Van Hai, Institute of Ecology and Biological Resources, Vietnam Academy of Science and Technology. A voucher specimen (PTH15032018) was deposited at the Institute of Ecology and Biological Resources, Vietnam Academy of Science and Technology.

2.3. Extraction and isolation

The dried flowers of the plant (2.3 kg) were pulverized then extracted with 85% MeOH (10L × 4) by sonification at 50 °C (each time 2 h). The extracts were collected and solvent were removed in reduced pressure to give a crude MeOH extract (1 L). The MeOH extract was suspended with water (1 L) and successively partitioned with *n*-hexane and ethyl acetate (EtOAc) to give *n*-hexane (AFH, 20.0 g) and ethyl acetate (AFE, 70.0 g) residues and a water layer (AFW, 1.5 L).

The AFE residue was applied on a silica gel CC eluting with EtOAc to give five fractions (fr. AFE1–AFE5).

The fraction AFE1 was chromatographed on a silica gel column eluting with *n*-hexane/EtOAc (1/1) to give five sub-fractions (AFE1.1–AFE1.5). The sub-fraction AFE1.2 was subjected to a silica gel CC eluting with CH_2Cl_2/acetone (10/1) to afford four fractions (AFE1.2.1–AFE1.2.4). The fraction AFE1.2.3 was further purified by sephadex LH-20 CC eluting with MeOH to give compound **1** (80 mg). The fraction AFE1.3 was separated by RP-18 CC eluting with MeOH/H_2O (1/2) to yield compounds **2** (50 mg) and **3** (70 mg).

The fraction AFE4 was chromatographed on a silica gel column eluting with CH_2Cl_2/EtOAc/MeOH (4/2/1) to give six sub-fractions (AFE4.1–AFE4.6). The fraction AFE4.2 was subjected to a silica gel CC eluting with CH_2Cl_2/MeOH (8/1) to afford five fractions (AFE4.2.1–AFE4.2.5). The fraction AFE4.2.3 was chromatographed on a silica gel RP-18 column eluting with MeOH/H_2O (1/1) to give compound **4** (30 mg). The fraction AFE4.4 (2.5 g) was separated by a silica gel RP-18 CC eluting with MeOH/H_2O (1/1) to yield four fractions (AFE4.4.1–AFE4.4.4). The fraction AFE4.4.1 was purified further by a Sephadex LH-20 CC eluting with MeOH to give compound **5** (25 mg). The fraction AFE4.4.3 was subjected to a silica gel RP-18 CC eluting with MeOH/H_2O (1/1) to give three fractions (AFE4.4.3.1–AFE4.4.3.3). The fraction AFE4.4.3.3 was purified further by a Sephadex LH-20 CC eluting with MeOH to give compound **6** (15 mg).

(−)-Catechin (**1**): yellow solid, $[\alpha]_D^{25}$ −54 (*c* 0.1, MeOH). Negative ESI-MS: *m/z* 290 $[M]^-$. ^{1}H-NMR (CD_3OD, 500 MHz) and ^{13}C-NMR (CD_3OD,125 MHz) see Table 1.

(−)-*Epi*-catechin (**2**): yellow solid, $[\alpha]_D^{25}$ −19 (*c* 0.1, MeOH). Negative ESI-MS: *m/z* 290 $[M]^-$. ^{1}H-NMR (CD_3OD, 500 MHz) and ^{13}C-NMR (CD_3OD, 125 MHz) see Table 1.

Chrysoeriol (**3**): yellow solid, $[\alpha]_D^{25}$−23 (*c* 0.1, MeOH). Positive ESI-MS: *m/z* 301 $[M+H]^+$; ^{1}H-NMR (acetone-d_6, 500 MHz) and ^{13}C-NMR (acetone-d_6, 125MHz) see Table 1.

Kaempferide 3-*O*-*β*-D-glucopyranoside (**4**): yellow solid, $[\alpha]_D^{25}$ −16 (*c* 0.1, MeOH). Negative ESI-MS: *m/z* 461 $[M-H]^-$. ^{1}H-NMR (CD_3OD, 500 MHz) and ^{13}C-NMR (CD_3OD, 125 MHz) see Table 2.

Astragalin (**5**): yellow solid, $[\alpha]_D^{25}$−28(*c* 0.1, MeOH). Negative ESI-MS: *m/z* 448 $[M]^-$. ^{1}H-NMR (CD_3OD, 500 MHz) and ^{13}C-NMR (CD_3OD, 125 MHz) see Table 2.

Quercetin 3-*O*-*β*-D-glucopyranoside (**6**), yellow solid, $[\alpha]_D^{25}$−10 (*c* 0.1, MeOH). Negative ESI-MS: *m/z* 463$[M-H]^-$.^{1}H-NMR (DMSO-d_6, 500 MHz): ^{13}C-NMR (DMSO-d_6, 125 MHz) see Table 2.

3. RESULTS AND DISCUSSION

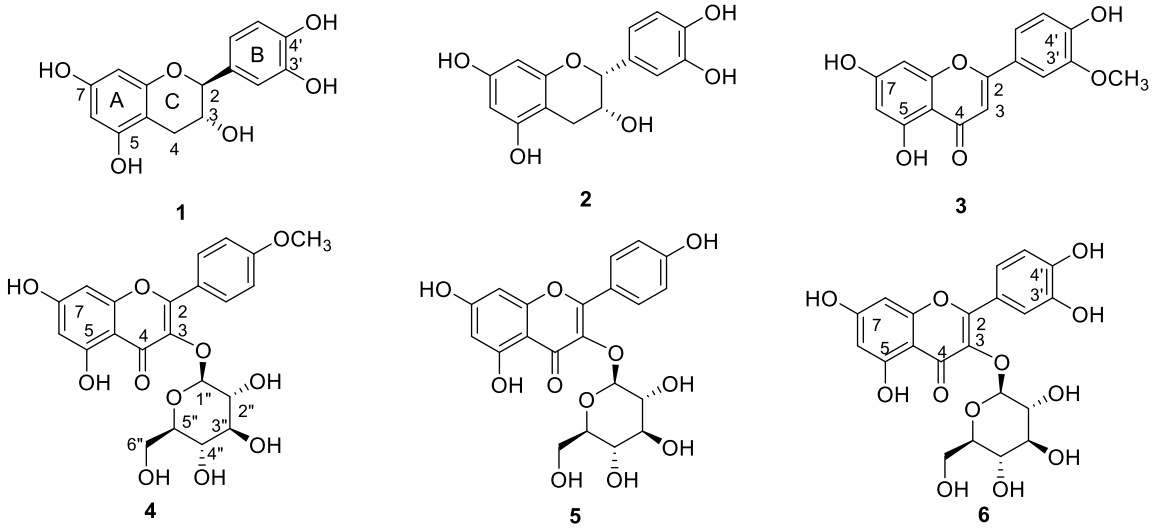

Figure 1. The chemical structure of compounds **1**–**6**.

Compound **1** was isolated as a yellow amorphous powder. The ESI-MS spectrum gave a negative *quasi*-molecular ion peak at *m/z* 290 $[M]^-$ ($C_{15}H_{14}O_6^-$) and ^{13}CNMR spectrum of **1** indicated a molecular formula of $C_{15}H_{14}O_6$ (M = 290). 1D and 2D NMR spectra of **1** revealed recognizable signals to a flavanol with 3 rings A, B and C (C_6-C_3-C_6). The ^{1}H-NMR spectrum of **1** (Table 1) displayed signals for ABX system aromatic protons of ring B at δ_H 6.86 (d, *J* = 2.0 Hz, H-2′), 6.79 (d, *J* = 8.0 Hz, H-5′), and 6.74 (dd, *J* = 8.0, 2.0 Hz, H-6′); two meta coupling aromatic protons of the ring A at δ_H5.96 (d, *J* = 2.0 Hz, H-6) and δ_H 5.89 (d, *J* = 2.0 Hz, H-8); and signals of C ring including two protons of two oxymethine groups at δ_H 4.59 (d, *J* = 7.5 Hz, H-2) and 4.00 (ddd, *J* = 8.0, 7.5, 5.5 Hz, H-3), and two protons of a methylene group at δ_H2.87 (dd, *J* = 16.0, 5.5Hz, H-4eq) and 2.54 (dd,*J* = 16.0, 8.0Hz, H-4ax). The ^{13}C-NMR (Table 1) and

DEPT spectra showed corresponding signals to fifteen carbons including seven non-protonated carbons at δ_C 157.5 (C-5), 157.8 (C-7), 156.9 (C-9), 146.2 (C-3′, C-4′), 100.9 (C-10) and 132.2 (C-1′); five methines at δ_C96.3 (C-6), 95.4 (C-8), 115.3 (C-2′), 116.1 (C-5′) and 120.0 (C-6′); two oxygenated aliphatic methines at δ_C 82.8 (C-2) and 68.8 (C-3); and one aliphatic methylene at δ_C 28.4 (C-4). The HMBC correlations between H-2 and C-4/C-3/C-1′/C-9/C-2′/C-6′; H-3 and C-1′/C-10; H-4ax and C-3/C-2/C-10/C-9/C-5, H-4eq and C-3/C-2/C-10 confirmed that these protons located at C-2, C-3, and C-4, respectively. Moreover, the HMBC correlations between H-6 and C-5/C-8, H-8 and C-6/C-9/C-10, indicated that two protons located at C-6 and C-8, respectively. Above 1D, 2D NMR spectra analysis established compound **1** to be catechin having the 2,3-*trans*configuration by the large coupling constant (J = 7.5 Hz) of H-2 (δ_H 4.59) with H-3 and the resonance position of C-2 at δ_C 82.8 ppm. The optical rotation of **1** was determined to be $[\alpha]_D^{25}$−54 (*c* 0.1, MeOH), establishing **1** to be (−)-catechin [6, 7].

Compound **2** was isolated as a yellow amorphous powder. Its ESI-MS spectrum gave a negative *quasi*-molecular ion peak at *m/z* 290 $[M]^-$ ($C_{15}H_{14}O_6^-$) and ^{13}C-NMR spectrum of **2** indicated a molecular formula of $C_{15}H_{14}O_6$ (M = 290). The NMR spectra of **2** (Table 1) is almost identical with those of **1** except for the following signals: C-2 resonated at δ_C79.9 and H-2 at δ_H 4.83 (overlap by signal of HOD) identified base on analysis of COSY and HSQC, HMBC spectra. The chemical shift H-2 and C-2 suggested that **2** possesses the *cis*-2,3 stereochemistry, this was supported by the small value for the coupling constant (J < 1 Hz) between the H-2 and H-3 protons, which appeared as a broad singlet at H-3(δ_H 4.20) [6, 7].Thus, **2** was assigned to be *epi*-catechin, its $[\alpha]_D^{25}$ was determined to be −19 (*c* 0.1, MeOH), establishing **2** as (−)-*epi*-catechin.

Compound **3** was isolated as a yellow amorphous powder, $[\alpha]_D^{25}$−23(*c* 0.1, MeOH). The ESI-MS gave a positive *quasi*-molecular ion peak at *m/z* 301$[M+H]^+$ ($C_{16}H_{13}O_6^+$) and ^{13}C-NMR spectrum of **3** indicated a molecular formula of $C_{16}H_{12}O_6$ (M = 300). ^{1}H-NMR spectrum of compound **3** revealed recognizable signals to a flavon one, its molecule includes three ABX coupling protons of B ring at δ_H 7.62 (d, J = 2.0 Hz, H-2′), 7.59 (dd, J = 8.0, 2.0 Hz, H-6′) and 7.00 (d, J = 8.0 Hz, H-5′); two meta coupling protons of A ring at δ_H 6.54 (d, J = 2.0 Hz, H-8) and δ_H 6.25 (d, J = 2.0 Hz, H-6); and one methine proton of C ring at δ_H6.69(s, H-3). ^{13}C-NMR and DEPT spectra showed corresponding carbons to fifteen carbons including one carbonyl at δ_C 183.1 (C-4); eight non-protonated carbons at 163.3 (C-5), 165.1 (C-7), 158.8 (C-9), 148.9 (C-3′), 151.5 (C-4′),165.0 (C-2), 105.3 (C-10) and 123.5 (C-1′); and six methines at δ_H 99.7 (C-6), 94.8 (C-8), 110.6 (C-2′), 116.4 (C-5′), 121.3 (C-6′) and 104.4 (C-3). In addition, the HMBC correlations between H-3 and C-1′/C-2/C-4/C-10 and between H-8 and C-6/C-7/C-9/C-10 confirmed two protons at C-3 and C-8, respectively; between H-6′ and C-2′/C-4′/C-2 and between protons of $OCH_3$and C-3′(δ_C 148.9) revealed the methoxy group attaching on position C-3′of B ring. The analysis of NMR spectra indicated the structure of **3** was similar to those of chrysoeriol, which were reported in literature (Table 1) [8, 9]. Thus, **3** was confirmed as chrysoeriol (3′-methoxy-4′,5,7-trihydroxyflavone).

Compound **5** was also isolated as a yellow amorphous powder. The ESI-MS spectrum gave a negative *quasi*-molecular ion peak at *m/z* 448$[M]^-$ ($C_{21}H_{21}O_{11}^-$) and ^{13}C-NMR spectrum of **5** indicated a molecular formula of $C_{21}H_{21}O_{11}$ (M = 448). The ^{1}H, ^{13}C-NMR spectrum of **5** revealed the signals to a flavonol glucoside. The ^{1}H-NMR spectrum showed four aromatic protons of B ring at δ_H 8.07 (d, J = 9.0 Hz, H-2′ and H-6′) and 6.91 (d, J = 9.0, H-3′ and H-5′), two meta coupling proton of A ring at δ_H 6.40 (d, J = 2.0 Hz, H-8) and 6.21 (br s, H-6), assigned to flavonol aglycone; otherwhile, one anomeric proton at δ_H 5.25 (d, J= 7.5 Hz, H-1″); four methine protons at δ_H3.47 (dd, J= 9.0, 7.5 Hz, H-2″), 3.45 (t,J= 9.0 Hz, H-3″), 3.33 (overlapped,

H-4″), and at δ_H3.23 (m, H-5″); and two protons of methylene at δ_H3.71 (dd, *J*= 12.0, 2.5Hz, Ha-6″) and 3.55 (dd, *J*= 12.0, 5.5 Hz, Hb-6″); assigned to *O*-glucosyl moiety.

Table 1. The NMR spectroscopic data for compounds **1**–**3**.

No.	**1**			**2**			**3**		
	δ_C [#]	δ_C [a,b]	δ_H [a,c] (mult., *J* in Hz)	δ_C [##]	δ_C [a,b]	δ_H [a,c] (mult., *J* in Hz)	δ_C [###]	δ_C [a,b]	δ_H [a,c] (mult., *J* in Hz)
2	82.8	82.8	4.59 (d, 7.5)	79.5	79.9	4.83 (ovl.)	164.9	165.0	
3	68.3	68.8	4.00 (ddd, 8.0, 7.5, 5.5)	67.0	67.5	4.20 (brs)	104.5	104.4	6.69 (s)
4	28.8	28.4	2.87Heq (dd, 16.0, 5.5)	29.0	29.3	2.88 Heq (dd, 16.5, 5.0)	182.9	183.1	-
			2.54 Hax (dd, 16.0, 8.0)			2.76 Hax (dd, 16.5, 3.0)			-
5	157.2	157.5	-	157.6	157.4	-	163.3	163.3	-
6	96.1	96.3	5.96 (d, 2.0)	96.2	96.4	5.96 (d, 2.0)	99.7	99.7	6.25 (d, 2.0)
7	157.7	157.8	-	157.6	158.0	-	165.0	165.1	-
8	95.3	95.4	5.89 (d, 2.0)	95.7	95.9	5.94 (d, 2.0)	94.7	94.8	6.54 (d, 2.0)
9	156.9	156.9	-	157.2	157.7	-	158.7	158.8	-
10	100.6	100.9	-	100.0	100.1	-	105.2	105.3	-
1′	131.8	132.2	-	132.3	132.3	-	123.6	123.5	-
2′	115.2	115.3	6.86 (d, 2.0)	115.3	115.4	7.00 (d, 2.0)	110.7	110.6	7.62 (d, 2.0)
3′	146.1	146.2	-	145.4	146.0	-	148.8	148.9	-
4′	146.0	146.2	-	145.3	145.8	-	151.3	151.5	-
5′	115.7	116.1	6.79 (d, 8.0)	115.5	115.9	6.78 (d, 8.0)	116.4	116.4	7.00 (d, 8.0)
6′	118.8	120.0	6.74 (dd, 8.0, 2.0)	119.4	119.4	6.82 (dd, 8.0, 2.0)	121.4	121.3	7.59 (dd, 8.0, 2.0)
3′-OCH_3-	-		-	-	-	-	56.6	56.6	4.00 (s)

[a]recorded in CD_3OD, [b]125 MHz, [c]500 MHz, [#]δ_C of (−)-catechin and [##]δ_C of (−)-*epi*-catechin (in acetone-d_6 at 125 MHz) [6], [###]δ_C of chrysoeriol (in acetone-d_6 at 150 MHz) [8], ovl. means overlapped.

The ^{13}C-NMR and DEPT spectra showed signals of corresponding carbons including one carbonyl at δ_C 179.5; eight non-protonated carbons at δ_C 158.5 (C-2), 135.5 (C-3), 163.1 (C-5),166.4 (C-7), 159.1 (C-9), 161.6 (C-4′),105.6 (C-10) and 122.8 (C-1′); and six methines at δ_C100.1 (C-6), 94.9 (C-8), 132.3 (C-2′ and C-6′) and 116.1 (C-3′ and C-5′); revealed the flavonol aglycone as kaempferol. The glucose moiety includes one anomeric carbon at δ_C 104.2 (C-1″); four oxygenated methines at δ_C 75.7 (C-2″), 78.4 (C-3″), 71.4 (C-4″) and78.1 (C-5″); and one oxygenated methylene at δ_C 62.7 (C-6″). The HMBC correlation between H-1″ and C-3, and between H-2″ and C-1″, showed sugar moiety linked to aglycone at C-3. The large coupling constant between H-1″ and H-2″, H-2″ and H-3″, H-3″ and H-4″, confirmed their *axial* orientation and the sugar moiety was identified as a glucose and connected to kaempferol

through *β*-linkage. The analysis of NMR spectra indicated the structure of **5** was similar to those of kaempferol 3-*O*-*β*-D-glucopyranoside reported in literature (Table 2) [11]. Thus, the compound **5** was confirmed as kaempferol 3-*O*-*β*-D-glucopyranoside or astragalin.

Table 2. The NMR spectroscopic data for compounds **4**–**6**.

No	**4**			**5**			**6**		
	$\delta_C^{\#}$	$\delta_C^{a,b}$	$\delta_H^{a,c}$ (mult., *J* in Hz)	$\delta_C^{\#\#}$	$\delta_C^{d,b}$	$\delta_H^{d,c}$ (mult., *J* in Hz)	$\delta_C^{\#\#\#}$	$\delta_C^{d,b}$	$\delta_H^{d,c}$ (mult., *J* in Hz)
2	156.9	156.4		158.0	158.5		158.6	158.4	
3	133.5	133.5		135.3	135.5		135.7	135.6	
4	177.6	177.4		179.2	179.5		179.5	179.4	-
5	161.4	161.2		162.7	163.1		163.0	162.9	-
6	98.8	98.8	6.20 (d, 2.0)	99.8	100.1	6.21 (brs)	100.2	99.9	6.20 (d, 2.0)
7	164.6	164.6		165.7	166.4		166.7	166.1	-
8	94.2	93.7	6.43 (d, 2.0)	94.8	94.9	6.40 (d, 2.0)	94.9	94.8	6.39 (d, 2.0)
9	156.7	155.7		158.8	159.1		159.0	159.0	-
10	103.9	104.1		105.6	105.6		105.5	105.6	-
1′	121.5	122.5		122.5	122.8		123.1	123.1	-
2′	131.4	130.7	8.13 (d, 9.0)	132.1	132.3	8.07 (d, 9.0)	116.0	116.0	7.73 (d, 2.0)
3′	116.7	113.7	7.07 (d, 9.0)	115.9	116.1	6.91 (d, 9.0)	146.0	145.8	-
4′	157.5	158.8		161.2	161.6		149.9	149.8	-
5′	116.7	113.7	6.91 (d, 9.0)	115.9	116.1	6.91 (d, 9.0)	117.6	117.6	6.89 (d, 8.5)
6′	131.4	130.7	8.13 (d, 9.0)	132.1	132.3	8.07 (d, 9.0)	123.2	123.2	7.59 (dd, 8.5, 2.0)
1″	101.5	100.8	5.47 (d, 7.5)	104.0	104.2	5.25 (d, 7.5)	104.5	104.4	5.25 (d, 7.5)
2″	74.3	74.2	3.2-3.6 (ovl.)	75.6	75.7	3.47 (dd, 9.0, 7.5)	75.8	75.7	3.51 (dd, 9.0, 7.5)
3″	76.5	76.4	3.2-3.6 (ovl.)	78.2	78.4	3.45 (t, 9.0)	78.4	78.1	3.46 (t, 9.0)
4″	70.3	69.9	3.2-3.6 (ovl.)	71.2	71.4	3.33 ovl.	71.3	71.2	3.38 (dd, 9.5, 9.0)
5″	76.0	77.5	3.2-3.6 (ovl.)	78.0	78.1	3.23 (m)	78.2	78.3	3.55 (ddd 9.5, 5.5, 2.5)
6″	62.2	60.8	3.2-3.6 (ovl.)	62.4	62.7	3.71 Ha (dd, 12.0, 2.5) 3.55 Hb (dd,12.0, 5.5)	62.6	62.6	3.74 (dd 12.0, 2.5) 3.60 (dd 12.0, 5.5)
3′-OCH_3	56.7	55.4	3.85 (s)	-	-	-	-	-	-

[a]recorded inDMSO-d_6, [b]125 MHz, [c]500 MHz,[d] recorded in CD_3OD,[#]δ_C of kaempferide3-*O*-*β*-D-glucopyranoside (recorded in DMSO-d_6 at 125 MHz) [10] and [##]δ_C of astragalin (recorded in CD_3OD at 100 MHz) [11], [###]δ_C of isoquercetin (inCD_3OD at 75.5 MHz) [12], ovl. means overlapped.

Compound **4** was also isolated as a yellow amorphous powder. The ESI-MS gave a negative *quasi*-molecular ion peak at *m/z* 461[M-H]$^-$ ($C_{22}H_{21}O_{11}^-$) and ^{13}C-NMRspectrum of **4** indicated a molecular formula of $C_{22}H_{22}O_{11}$ (M = 462). The ^{1}H- and ^{13}C-NMR spectral data of **4** resembled closely those of **5** (astragalin), including a flavonol aglycone as kaempferol bearing a

glucose, except for an additional methoxy group. The large coupling constant of anomeric proton between H-1″ and H-2″ (J = 7.5 Hz) confirmed the sugar moiety as a β-linkage. The HMBC correlation between H-1″ (δ_H 5.47) and C-3 (δ_C 133.5) showed sugar moiety linked to aglycone at C-3, and the HMBC correlation from the methoxy group (δ_H 3.85) to C-4′ (δ_C158.8) suggested the position of methoxy group at C-4′. In addition, the ^{1}H- and ^{13}C-NMR spectral data of **4** is very closed with those of kaempferide 3-*O*-β-D-glucopyranoside, which was also recorded in DMSO-d_6 (Table 2) [10], identified the compound **4** as kaempferide 3-*O*-β-D-glucopyranoside.

Compound **6** was isolated as a yellow amorphous powder, $[\alpha]_D^{25}$= - 10^o(c 0.1, MeOH). The ESI-MS gave a pseudomolecular negative ion peak at *m/z* 463[M-H]$^-$ ($C_{21}H_{19}O_{12}^-$) and ^{13}C-NMR spectrum of **6** indicated a molecular formula of $C_{21}H_{20}O_{12}$ (M = 464). ^{1}H, ^{13}C-NMR spectra of compound **6** revealed recognizable signals of a flavonol bearing a sugar moiety. The signals of the flavonol aglycone includes three ABX coupling protons of B ring at δ_H 7.73 (d, J = 2.0 Hz, H-2′), 7.59 (dd, J = 8.5, 2.0 Hz, H-6′) and 6.89 (d, J = 8.5 Hz, H-5′); two meta coupling protons of A ring at δ_H 6.39 (d, J = 2.0 Hz, H-8) and δ_H 6.20 (d, J = 2.0 Hz, H-6). The corresponding carbons to the flavonol moiety include one carbonyl carbon at δ_C 179.4 (C-4); nine non-protonated carbons at δ_C 158.4 (C-2), 135.6 (C-3), 162.9 (C-5), 166.1 (C-7), 159.0 (C-9), 145.8 (C-3′), 149.8 (C-4′), 105.6 (C-10) and 123.1 (C-1′); five methine carbons at δ_C 99.9 (C-6), 94.8 (C-8), 116.0 (C-2′), 117.6 (C-5′) and 123.2 (C-6′). The signals of glucosyl moiety include one anomeric proton at δ_H 5.25 (d, J = 7.5 Hz); four oxygenated methine protons at δ_H 3.51 (dd, J = 9.0, 7.5 Hz, H-2″), 3.46 (t, J = 9.0 Hz, H-3″), 3.38 (dd, J = 9.5, 9.0 Hz, H-4″) and 3.55 (ddd, J = 9.5, 5.5, 2.5 Hz, H-5″); and two methylene protons at δ_H 3.74 (dd, J = 12.0, 2.5 Hz, Ha-6″) and 3.60 (dd, J = 12.0, 5.5 Hz, Hb-6″). The HMBC correlation between H-1″ (δ_H5.25) and C-3 (δ_C 135.6) showed sugar moiety linked to aglycone at C-3, the large coupling constant between H-1″ and H-2″ (J = 7.5 Hz) confirmed the presence of β-glycosidic linkage. The NMR spectroscopic analysis of **6** to those of quercetin 3-*O*-β-D-glucopyranoside reported in literature (Table 2) [12], confirmed compound **6** as quercetin 3-*O*-β-D-glucopyranoside or isoquercetin.

The six obtained compounds (**1**–**6**), as known, possess high antioxidant activity used for the prevention and treatment of a number of chronic diseases as cardiovascular, diabetic and cancers (catechins, astragalin) [13, 14, 15], osteoporosis (chrysoeriol) [9, 16]; On the other hand, compounds **3**–**5** exhibited potent antimicrobial and anti-inflammatory activities [10, 17, 18].

4. CONCLUSION

From the flowers of *Amesiodendron chinense*, six known flavonoids were isolated as (−)-catechin (**1**), (−)-*epi*-catechin (**2**),chrysoeriol (**3**), kaempferide 3-*O*-β-D-glucopyranoside (**4**), astragalin (**5**), and quercetin 3-*O*-β-D-glucopyranoside(**6**). Their structures were elucidated by spectroscopic analysis including MS, 1D, 2D-NMR spectra, physical properties as well as by the comparison with reported data in literatures. This is the first time the study on the chemical constituents of the flowers of *Amesiodendron chinense* (Merr.) Hu was performed. Biological activities and medicinal properties of the obtained compounds suggested the flowers of *Amesiodendron chinense*as a potential candidate for preparing a functional food to prevent and treat cardiovascular, diabetes, and cancer diseases.

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