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3B QUANG TRUNG - CUA NAM - HANOI - VIETNAM
TEL: (+84-24) 38247058 FAX: (+84-24) 39348740
Email: tapchiduoclieu@nimm.org.vn; tapchiduoclieu@gmail.com

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PHENOLICS FROM *GLECHOMA HEDERACEA* L. IN VIETNAM

Nguyen Thi Hue, Pham Van Cong, Nguyen Thi Thu Trang, Phan Thi Trang, Pham Ngoc Khanh, Do Thi Ha, Nguyen Van Tai *

National Institute of Medical Materials (NIMM), Hanoi 11018, Vietnam

*Corresponding author: nguyenvantai1111@gmail.com

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Summary

Glechoma hederacea L., commonly known as ground ivy, is traditionally used for the treatment of hepatitis, cholecystitis, and edema. This study aimed to isolate and identify the chemical constituents of the ethyl acetate fraction from the 70% ethanol extract of *G. hederacea* collected in Vietnam. Five compounds (**1–5**) were isolated from the ethyl acetate fraction of *G. hederacea* L. 70% ethanol extract. Their chemical structures were elucidated through detailed analysis of 1D and 2D NMR spectroscopic data and by comparison with literature data to be rosmarinic acid (**1**), apigenin-7-*O*-*β*-D-glucopyranoside (**2**), luteolin-7-*O*-*β*-D-glucopyranoside (**3**), apigenin (**4**), and luteolin (**5**). Compound **2** was isolated from this plant for the first time. To the best of our knowledge, this is the first study on the chemical constituents of *G. hederacea* L. in Vietnam.

Keywords: *Glechoma hederacea* L.; *Rosmarinic acid; Flavonoids; Flavonoid glycosides.*

1. Introduction

The genus *Glechoma* L. comprises eight species worldwide, primarily distributed in warm temperate, subtropical, and high-altitude tropical regions. In Vietnam, only one species, *Glechoma hederacea* L., has been recorded [1]. In traditional medicine, *G. hederacea* has been widely used in both Asia and Europe to treat gastritis, bronchitis, tinnitus, diarrhoea… [2]. Recent studies on the biological activity of *G. hederacea* have demonstrated its anti-inflammatory, analgesic, anticomplement, antimicrobial, antioxidant, depigmenting, anticancer, and antiviral activities [3]. The pharmacological effects are most often attributed to the presence of phenolic compounds, such as phenolic acids and flavonoids, which are found in significant amounts from this plant species [4]. Additionally, studies on the aerial parts of *G. hederacea* have revealed the presence of triterpenes and diterpenes, essential oils, alkaloids, fatty acids, and tannins [3]. As part of the project entitled "Conservation of Traditional Medicinal Plants and Indigenous Knowledge in 2022" conducted by Dr. Nguyen Van Khiem, the species *G. hederacea* was recorded in Ta Van Giay 2 village, Ta Van commune, Lao Cai province. Based on the traditional uses and previously reported bioactivities of *G. hederacea*, the present study focuses on the ethyl acetate fraction of the 70% ethanol extract of the whole plant collected in Vietnam.

2. Materials and methods

2.1. Plant materials

The whole plant of *G. hederacea* L. was collected from Sa Pa ward, Lao Cai province, Vietnam, in May 2024, and identified by MSc. Nguyen Quynh Nga, Center of Medicinal Material Resources, National Institute of Medicinal Materials (NIMM). A voucher specimen (NIMM 20130) was deposited at NIMM.

2.2. General experimental procedures

All NMR spectra were recorded on a Bruker 600 MHz spectrometer operating at 150 MHz for ^{13}C NMR, and at 600 MHz for ^{1}H-NMR. Mass spectrometry data were analyzed using an LC-MS/MS system equipped with a DAD detector

(Shimadzu, Japan). Column chromatography (CC) was performed on *silica gel* (40-60 μm, Merck), YMC RP-18 (30-50 μm, FuJisilisa Chemical Ltd), and Sephadex LH-20 (GE healthcare Life). For thin layer chromatography (TLC), pre-coated *silica gel* 60 F_{254} (0.25 mm, Merck) plates were used.

2.3. Extraction and isolation

Five kilograms of the whole plant of *G. hederacea* L. were successively extracted with 70% ethanol (20 L × 3 times × 2 h each) at 70 °C. The combined extracts were concentrated under reduced pressure to yield 700 g of residue. This residue was suspended in distilled water (1.0 L) and partitioned successively with *n*-hexane (H, 3 times × 1 L), dichloromethane (DCM, 4 times × 1 L), and ethyl acetate (EtOAc, 4 times × 1 L). Each fraction was concentrated under reduced pressure to afford *n*-hexane (H, 197 g), dichloromethane (DCM, 15 g), ethyl acetate (EtOAc, 60 g), and aqueous (W) fractions, respectively.

The EtOAc extract (60 g) was subjected to *silica gel* CC and eluted with a gradient of DCM-MeOH (0% – 100% MeOH), yielding ten fractions (E1–E10). Fraction E1 (12.5 g) was further separated by *silica gel* CC using DCM-MeOH (50:1, v/v) as the eluent to obtain eight subfractions (E1A–E1H). Fraction E1E (1.2 g) was chromatographed on a Sephadex LH-20 column with MeOH-DCM (9:1, v/v) to yield three subfractions (E1E1–E1E3). E1E3 (0.19 g) was further purified by *silica gel* CC using DCM-EtOAc (4:1, v/v) to yield compounds **4** (6.7 mg) and **5** (9 mg). Fraction E1H (0.9 g) was purified by C_{18} reversed-phase *silica gel* CC using H_2O-acetone (3.5:1, v/v), followed by Sephadex LH-20 chromatography with MeOH-DCM (9:1, v/v), to afford compound **1** (8.0 mg). Fraction E6 (1.3 g) was subjected to Sephadex LH-20 CC using 100% MeOH, affording five subfractions (E6A–E6E). Subfraction E6E (0.24 g) was purified by C_{18} reversed-phase *silica gel* CC with a gradient of H_2O-MeOH (0 – 100% MeOH) to obtain compound **2** (6.9 mg). Fraction E8 (0.9 g) was also subjected to C_{18} reversed-phase *silica gel* CC, eluted with a gradient of H_2O-acetone (0 – 100% acetone), yielding three subfractions (E8A–E8C). Subfraction E8C (0.2 g) was further separated by *silica gel* CC using DCM-MeOH (2:0.3, v/v) to yield compound **3** (11 mg).

Rosmarinic acid (1): yellowish-brown powder; $[\alpha]^{20}_D$ +22.04 (c 0.14, MeOH); ESI-MS: *m/z* 359.15 $[M-H]^-$; ^{1}H-NMR (CD_3OD, 600 MHz) δ_H (ppm): 7.52 (1H, d, *J* = 16.2 Hz, H-7'), 7.04 (1H, d, *J* = 1.8 Hz, H-2'), 6.93 (1H, dd, *J* = 8.4, 1.8 Hz, H-6'), 6.78 (1H, dd, *J* =1.8 Hz, H-2), 6.77 (1H, d, *J* = 8.4 Hz, H-5'), 6.68 (1H, d, *J* = 7.8 Hz, H-5), 6.64 (1H, dd, *J* = 7.8, 1.8 Hz, H-6), 6.27 (1H, d, *J* = 16.2 Hz, H-8'), 5.11 (1H, dd, *J* = 9.6, 3.6 Hz, H-8), 3.12 (1H, dd, *J* = 14.4, 3.6 Hz, H-7a), 2.95 (1H, dd, *J* = 14.4, 9.6 Hz, H-7b); ^{13}C-NMR (150 MHz, CD_3OD) (see Table 1).

Apigenin-7-*O*-*β*-D-glucopyranoside (2): Yellow powder, ESI-MS: *m/z* 431.20 $[M-H]^-$; ^{1}H-NMR (600 MHz, DMSO-d_6) δ_H (ppm): 12.96 (1H, s, OH-5), 7.95 (2H, d, *J* = 9.0 Hz, H-2', H-6'), 6.94 (2H, d, *J* = 9.0 Hz, H-3', H-5'), 6.86 (1H, s, H-3), 6.82 (1H, d, *J* = 2.4 Hz, H-8), 6.45 (1H, d, *J* = 2.4 Hz, H-6), 5.06 (1H, d, *J* = 7.2 Hz, H-1″), 3.19–3.50 (5H, m, H-2″ to H_b-6″), 3.72 (1H, d, *J* = 10.2 Hz, H_a-6″); ^{13}C-NMR (150 MHz, DMSO-d_6) (see Table 1).

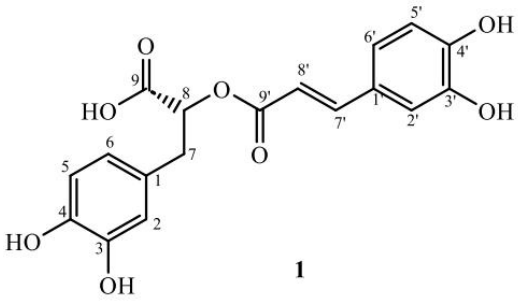
Luteolin-7-*O*-*β*-D-glucopyranoside (3): Yellow powder, ESI-MS: *m/z* 447.25 $[M-H]^-$; ^{1}H-NMR (600 MHz, DMSO-d_6) δ_H (ppm): 12.98 (1H, s, OH-5), 7.45 (1H, dd, *J* = 8.4, 1.8 Hz, H-6'), 7.42 (1H, d, *J* = 1.8 Hz, H-2'), 6.90 (1H, d, *J* = 8.4 Hz, H-5'), 6.74 (1H, s, H-3), 6.79 (1H, d, *J* = 1.8 Hz, H-8), 6.45 (1H, d, *J* = 1.8 Hz, H-6), 5.08 (1H, d, *J* = 7.8 Hz, H-1″), 3.19–3.48 (5H, m, H-2″ to H_b-6″), 3.71 (1H, d, *J* = 10.8 Hz, H_a-6″); ^{13}C-NMR (150 MHz, DMSO-d_6) (see Table 1).

Apigenin (4): Yellow powder, ESI-MS: *m/z* 269.15 $[M-H]^-$; ^{1}H-NMR (600 MHz, DMSO-d_6) δ_H (ppm): 12.96 (1H, s, OH-5), 7.92 (2H, d, *J* =

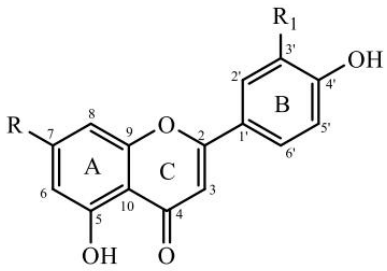
9.0 Hz, H-2', H-6'), 6.92 (2H, d, J = 9.0 Hz, H-3', H-5'), 6.78 (1H, s, H-3), 6.48 (1H, d, J = 2.4 Hz, H-8), 6.19 (1H, d, J = 2.4 Hz, H-6); ^{13}C-NMR (150 MHz, DMSO-d_6) (see Table 1).

Luteolin (5): Yellow powder, ESI-MS: *m/z* 285.15 [M-H]$^-$; ^{1}H-NMR (600 MHz, DMSO-d_6) δ_H (ppm): 12.97 (1H, s, OH-5), 7.42 (1H, dd, J = 8.4, 2.4 Hz, H-6'), 7.39 (1H, d, J = 2.4 Hz, H-2'), 6.90 (2H, d, J = 8.4 Hz, H-5'), 6.66 (1H, s, H-3), 6.44 (1H, d, J = 1.8 Hz, H-8), 6.19 (1H, d, J = 1.8 Hz, H-6); ^{13}C-NMR (150 MHz, DMSO-d_6) (see Table 1).

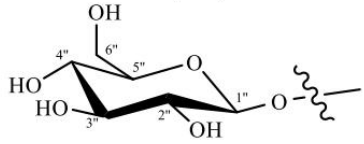
3. Results and discussion



1



Compounds	R_1	R
2	H	O-[Glc]
3	OH	O-[Glc]
4	H	OH
5	OH	OH



O-[Glc]

Fig. 1. Chemical structures of compounds **1**-**5**

Compound **1** was obtained as a yellowish-brown amorphous powder. The molecular ion peak [M-H]$^-$ was observed at *m/z* 359.15 in the ESI-MS spectrum, consistent with the molecular formula $C_{18}H_{16}O_8$. The ^{1}H-NMR spectrum of the compound **1** showed two ABX systems [δ_H 6.64 (1H, dd, J = 7.8, 1.8 Hz, H-6), 6.68 (1H, d, J = 7.8 Hz, H-5), 6.78 (1H, d, J = 1.8 Hz, H-2) and 6.77 (1H, d, J = 8.4 Hz, H-5'), 6.93 (1H, dd, J = 8.4, 1.8 Hz, H-6'), 7.04 (1H, d, J = 1.8 Hz, H-2')], two *trans*-olefinic protons [δ_H 6.27 (1H, d, J = 16.2 Hz, H-8') and 7.52 (1H, d, J = 16.2 Hz, H-7')], a methine proton [δ_H 5.11 (1H, dd, J = 3.0, 9.6 Hz, H-8), and two methylene protons [δ_H 2.95 (1H, dd, J = 9.6, 14.4 Hz, H-7b) and 3.12 (1H, dd, J = 3.6, 14.4 Hz, H-7a)].

The ^{13}C-NMR and HSQC spectrum showed 18 carbon signals, including twelve aromatic carbon signals, two olefinic carbons resonated at δ_C 146.6 (C-7') and 115.7 (C-8'), one methylene group at δ_C 38.9 (C-7), an oxymethine group at δ_C 77.8 (C-8), a carboxylic acid carbon at δ_C 177.7 (C-9), and a carboxylate carbon at δ_C 169.1 (C-9′). In the HMBC spectrum, long-range correlations from H-7′ and H-8′ to C-1′ and C-9′ confirmed the presence of a 3,4-dihydroxy-*E*-cinnamoyl moiety (Fig. 2). Additionally, HMBC correlations from H-7 (δ_H 3.12/2.95) to C-2 (δ_C 117.5) and C-6 (δ_C 121.7), and from H-8 (δ_H 5.11) to C-1 (δ_C 131.4), indicated that the remaining portion of the molecule corresponds to 3-(3,4-dihydroxyphenyl)-2-hydroxypropanoic acid. Furthermore, the HMBC correlation between H-8 and the carboxylate carbon at δ_C 169.1 confirmed that the 3,4-dihydroxy-*E*-cinnamoyl moiety is esterified at the C-8 position (Fig. 2). Based on the foregoing observations and a comparison of the data with the literature [5], compound **1** was

determined to be rosmarinic acid (Fig. 1). Rosmarinic acid was first isolated in 1958 from *Rosmarinus officinalis* by Scarpati and Oriente [4]. In *G. hederacea* L., it has been identified as the major compound (1.39%) [6]. Rosmarinic acid exhibits potent anti-inflammatory and antioxidant activities; it inhibits IL-6, ADAMTS-4/5, COX-2, and IL-1β, improves inflammation scores and leukocyte infiltration in mouse joint and colon tissues, while reducing ROS and MDA levels and increasing SOD, GSH-Px, and catalase activities, thereby protecting multiple organs from oxidative stress [7].

Table 1. ^{13}C-NMR data of compounds **1 – 5** and references

Carbon	1		2		3		4		5	
	δ_C [b]	δ_C [a]	δ_C [d]	δ_C [c]	δ_C [e]	δ_C [c]	δ_C [f]	δ_C [c]	δ_C [g]	δ_C [c]
1	131.2	131.4	-	-	-	-	-	-	-	-
2	117.6	117.5	164.2	164.2	164.3	164.4	164.1	164.1	163.9	163.9
3	146.0	146.0	103.0	103.1	103.0	103.1	102.8	102.8	102.9	102.8
4	144.9	144.8	181.7	181.9	181.8	181.8	181.8	181.7	181.7	181.6
5	116.3	116.1	161.5	161.3	161.0	161.1	161.1	161.1	161.4	161.4
6	121.8	121.7	99.4	99.5	99.4	99.5	98.8	98.8	98.9	98.8
7	38.9	38.9	162.8	162.9	162.8	162.9	163.8	163.7	164.1	164.1
8	77.7	77.8	94.9	94.8	94.6	94.7	94.0	93.9	93.9	93.8
9	177.6	177.7	156.8	156.9	156.8	156.9	157.3	157.3	157.3	157.3
10	-	-	105.4	105.3	105.2	105.3	103.7	103.6	103.8	103.7
1'	128.1	127.8	120.9	120.9	121.2	121.3	121.3	121.1	121.6	121.5
2'	115.2	114.9	128.3	128.6	113.4	113.5	128.4	128.4	113.4	113.3
3'	146.8	146.6	115.9	115.9	145.7	145.8	116.0	115.9	145.8	145.7
4'	149.5	149.9	161.0	161.1	149.8	150.0	161.5	161.4	149.7	149.7
5'	116.6	116.5	115.9	115.9	115.8	115.9	116.0	115.9	116.1	116.0
6'	123.4	122.9	128.3	128.6	119.0	119.1	128.4	128.4	119.0	118.9
7'	146.7	146.7	-	-	-	-	-	-	-	-
8'	115.7	115.6	-	-	-	-	-	-	-	-
9'	169.2	169.1	-	-	-	-	-	-	-	-
1″	-	-	100.1	99.9	99.7	99.9	-	-	-	-
2″	-	-	73.1	73.1	73.0	73.1	-	-	-	-
3″	-	-	76.5	76.4	76.3	76.4	-	-	-	-
4″	-	-	69.9	69.5	69.4	69.5	-	-	-	-
5″	-	-	77.2	77.1	77.0	77.1	-	-	-	-
6″	-	-	60.8	60.6	60.5	60.6	-	-	-	-

[a]: recorded in CD_3OD at 150 MHz; [c]: recorded in DMSO-d_6 at 150 MHz; [b]: recorded in CD_3OD at 125 MHz [5] ; [d]: recorded in DMSO-d_6 at 150 MHz [9] ; [e]: recorded in DMSO-d_6 at 75 MHz [11]; [f]: recorded in DMSO-d_6 at 125 MHz [12]; [g]: recorded in DMSO-d_6 at 100 MHz [13]

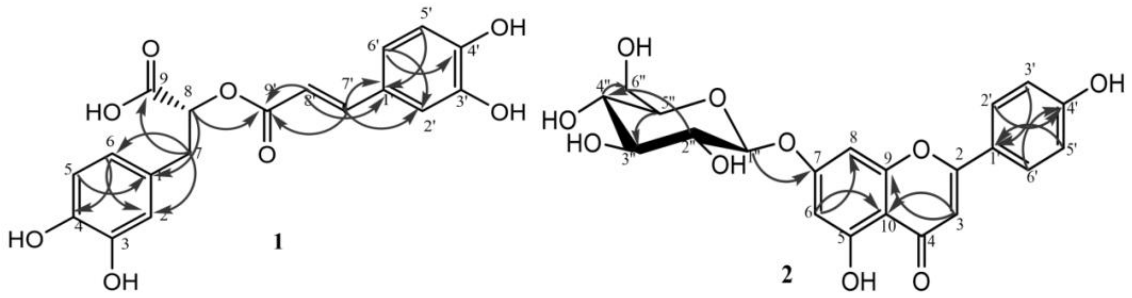


Fig. 2. HMBC interactions of compounds **1** and **2**

Compound **2** was obtained as a yellow amorphous powder**.** The ESI-MS spectrum exhibited a $[M-H]^-$ ion at *m/z* 431.20, consistent with the molecular formula $C_{21}H_{20}O_{10}$. The ^{1}H-NMR data revealed characteristic signals of both apigenin and glucose moieties [8]. The apigenin skeleton was identified by the presence of a hydroxyl proton at δ_H 12.96 (1H, s, OH-5), two *meta*-coupled doublets at δ_H 6.45 (1H, d, J = 2.4 Hz, H-6) and δ_H 6.82 (1H, d, J = 2.4 Hz, H-8) on the A-ring, and an A_2B_2-type aromatic system on the B-ring, with doublets at δ_H 7.95 (d, J = 9.0 Hz, H-2′, H-6′) and 6.94 (2H, d, J = 9.0 Hz, H-3′, H-5′). Additionally, an olefinic proton signal was observed at δ_H 6.86 (s, H-3), indicative of a flavone *C*-ring. Signals attributable to a *β*-glucopyranosyl unit were observed, including an anomeric proton at δ_H 5.06 (1H, d, J = 7.2 Hz, H-1″), a multiplet at δ_H 3.19–3.50 (5H, m, H-2″ to H_b-6″), and a doublet at δ_H 3.72 (1H, d, J = 10.2 Hz, H_a-6″). The ^{13}C-NMR and HSQC spectra showed 21 carbon resonances, including signals for a hexose moiety at δ_C (99.9, 73.1, 76.4, 69.5, 77.1, and 60.6), and 15 carbons assigned to the flavone skeleton. In the HMBC spectrum, a correlation between H-1″ and C-7 established the site of glycosylation at C-7 of the aglycone (Fig. 2). Based on detailed analysis of 1D and 2D NMR data and comparison with published literature [9], compound **2** was unambiguously identified as apigenin 7-*O*-*β*-D-glucopyranoside (Fig. 1).

Compound **3** exhibited a molecular ion peak at *m/z* 447.25 $[M-H]^-$ in the ESI-MS spectrum, corresponding to the molecular formula $C_{21}H_{20}O_{11}$. The ^{1}H-NMR spectrum displayed characteristic resonances consistent with the flavonoid skeleton of luteolin [10]. These included a downfield hydroxyl proton at δ_H 12.98 (1H, s, OH-5), a singlet at δ_H 6.74 (1H, s, H-3, ring C), and two *meta*-coupled doublets at δ_H 6.45 (1H, d, J = 1.8 Hz, H-6) and 6.79 (1H, d, J = 1.8 Hz, H-8) on ring A. Aromatic signals corresponding to a 1,3,4-trisubstituted B ring were observed at δ_H 7.42 (1H, d, J = 1.8 Hz, H-2′), 7.45 (1H, dd, J = 1.8, 8.4 Hz, H-6′), and 6.90 (1H, d, J = 8.4 Hz, H-5′). In addition, the ^{1}H-NMR spectrum showed resonances assignable to a *β*-glucopyranosyl moiety, including an anomeric proton at δ_H 5.08 (1H, d, J = 7.8 Hz, H-1″), a pair of geminal methylene protons at δ_H 3.71 (1H, d, J = 10.8 Hz, H_a-6″) and 3.48 (1H, m, H_b-6″), along with overlapped multiplets at δ_H 3.17–3.45 (4H, m, H-2″, H-3″, H-4″, H-5″). The ^{13}C-NMR spectrum revealed 21 carbon signals, consistent with a flavone glucoside. Signals corresponding to the B ring were observed at δ_C 121.3 (C-1′), 113.5 (C-2′), 145.8 (C-3′), 150.0 (C-4′), 115.9 (C-5′), and 119.1 (C-6′). Signals for ring A appeared at δ_C 161.1 (C-5), 99.5 (C-6), 162.9 (C-7), 94.8 (C-8), 156.9 (C-9), and 105.3 (C-10), while ring C carbons were assigned at δ_C 164.4 (C-2), 103.1 (C-3), and 181.8 (C-4, carbonyl carbon). The glucose unit showed

resonances at δ_C 99.9 (C-1″), 73.1 (C-2″), 76.4 (C-3″), 69.5 (C-4″), 77.1 (C-5″), and 60.6 (C-6″). The HMBC spectrum showed a long-range correlation between H-1″ (δ_H 5.08) and C-7 (δ_C 162.9), confirming that the glucose moiety is attached at C-7 of the luteolin aglycone. Based on the combined 1D and 2D NMR data, along with comparison to reported values in the literature [11], compound **3** was unequivocally identified as luteolin 7-*O*-*β*-D-glucopyranoside (Fig. 1).

Compound **4** was isolated as a yellow amorphous powder. The ESI-MS spectrum showed a molecular ion peak at *m/z* 269.15 $[M-H]^-$, consistent with the molecular formula $C_{15}H_{10}O_5$. The ^{1}H-NMR spectrum revealed a downfield hydroxyl proton at δ_H 12.96 (1H, s, OH-5), a singlet at δ_H 6.77 (1H, s, H-3, ring C), and aromatic proton signals corresponding to the B ring at δ_H 7.92 (2H, d, J = 9.0 Hz, H-2′, H-6′) and 6.92 (2H, d, J = 9.0 Hz, H-3′, H-5′), indicative of a *para*-substituted phenyl group. Two *meta*-coupled aromatic protons of ring A were observed at δ_H [6.19 (1H, d, J = 2.4 Hz, H-6) and 6.48 (1H, d, J = 2.4 Hz, H-8)]. The ^{13}C-NMR spectrum exhibited 15 carbon signals, including one carbonyl carbon at δ_C 181.7 (C-4); five oxygenated quaternary aromatic carbons at δ_C 157.3 (C-9), 161.1 (C-5), 161.4 (C-7), 163.7 (C-2), and 164.1 (C-4′); two quaternary aromatic carbons at δ_C 103.7 (C-10) and 121.3 (C-1′); and seven sp^2 methine carbons at δ_C 93.9 (C-8), 98.8 (C-6), 102.8 (C-3), 128.4 (C-2′, C-6′), and 115.9 (C-3′, C-5′). Based on the spectroscopic data and comparison with previously reported literature values [12], compound **4** was identified as apigenin (Fig. 1).

Compound **5** was isolated as a yellow amorphous powder. The ESI-MS spectrum exhibited a molecular ion peak at *m/z* 285.15 $[M-H]^-$, corresponding to the molecular formula $C_{15}H_{10}O_6$. The ^{1}H-NMR spectrum displayed characteristic resonances of a flavone skeleton [10]. A strongly deshielded hydrogen-bonded hydroxyl signal was observed at δ_H 12.97 (1H, s, OH-5), alongside two *meta*-coupled aromatic protons at δ_H [6.44 (1H, d, J = 1.8 Hz, H-8) and 6.19 (1H, d, J = 1.8 Hz, H-6)], corresponding to ring A. The aromatic region of the B ring exhibited three distinct proton signals at δ_H 7.42 (1H, dd, J = 7.8, 1.8 Hz, H-6′), 7.39 (1H, d, J = 2.4 Hz, H-2′), and 6.89 (1H, d, J = 8.4 Hz, H-5′), consistent with a 1,3,4-trisubstituted phenyl ring. In addition, a singlet at δ_H 6.66 (1H, s, H-3) indicated the presence of an olefinic proton on ring C. The ^{13}C-NMR spectrum revealed 15 carbon signals, including one conjugated carbonyl carbon at δ_C 181.6 (C-4); B ring signals at δ_C [121.5 (C-1′), 113.3 (C-2′), 145.7 (C-3′), 149.7 (C-4′), 116.0 (C-5′), and 118.9 (C-6′)]; A ring signals at δ_C [161.4 (C-5), 98.8 (C-6), 164.1 (C-7), 93.8 (C-8), 157.3 (C-9), and 103.7 (C-10)]; and C ring signals at δ_C [163.9 (C-2) and 102.8 (C-3)]. Based on these spectroscopic data and by comparison with reported values in the literature [13], compound **5** was identified as luteolin (Fig. 1).

Compounds luteolin-7-*O*-*β*-D-glucopyranoside (**3**), apigenin (**4**), and luteolin (**5**) were isolated from *G. hederacea* in 2007 and 2005 by Yang, Yamauchi, and colleagues, while compound **2** was reported for the first time from this species. These compounds are also found in considerable amounts in *Matricaria chamomilla* (0.1–1.1%) and exhibit important biological activities, particularly antioxidant and anti-inflammatory effects [14],[15],[16].

4. Conclusion

The investigation of the chemical composition of ethyl acetate extract from *G. hederacea* led to the isolation of five compounds, including rosmarinic acid (**1**), apigenin-7-*O*-*β*-D-glucopyranoside (**2**), luteolin-7-*O*-*β*-D-glucopyranoside (**3**), apigenin (**4**), and luteolin (**5**). To the best of our knowledge, compound **2** was reported from this

plant for the first time. This study provides additional information on the chemical constituents of *G. hederacea* L.

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