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CONTENTS VOL. 31(5), 2026
(Pages 355 - 450)

Page	SCIENTIFIC RESEARCH
357	**Saponins from the Leaves of *Panax vietnamensis* var. *fuscidiscus* Collected in Lai Chau Province, Vietnam -** *Vu Thi Diep, Do Thi Ha, Le Thi Xoan, Tran Minh Ngoc, Nguyen Thi Thanh Thanh, Nguyen Le Thuy Duong,*
365	**Benzyl, Flavonoid, and Iridoid Constituents from the Leaves of *Psychotria serpens* with Nitric Oxide Inhibitory Activity** - *Pham The Chinh, Vu Quang Tung, Pham Thi Tham, Phan Van Kiem, Nguyen Phuong Thao*
375	**Benzyl and Megastigmane Glucosides from the Leaves of *Zanthoxylum rhetsa* (Roxb.) DC. and their Inhibitory Effects on Nitric Oxide Production -** *Bui Thi Mai Anh, Nguyen Thi Mai, Nguyen Phuong Thao*
383	**Investigation of Flavonoid Constituents and Antioxidant Activity of Leaf Extracts from *Coccoloba uvifera* (L.) L.** - *Nguyen Thu Anh, Pham Van Son, Huynh Loi, Vo Van Leo*
391	**Triterpenoids and Acylglucosylsterol from *Galphimia glauca* Cav. Collected in Vietnam** - *Nguyen Thi Hue, Nguyen Thi Thu Trang, Tran Minh Ngoc, Nguyen Thi Hue, Do Thi Ha, Nguyen Van Tai*
398	**Phytochemical Constituents of the Branches and Leaves of *Alangium salviifolium* (L.f.) Wangerin Collected in Quang Ngai, Vietnam** - *Phan Thi Trang, Tran Minh Ngoc, Pham Van Cong, Dang Viet Hau, Do Thi Ha, Nguyen Van Tai*
405	**Chemical Constituents of *Bauhinia bracteata* Benth. Leaves and Their Antioxidant Activity -** *Nguyen Thi Trang, Le Minh Tuan, Pham Thi Thuy Trang, Tran Thanh Ha, Pham Thi Nguyet Hang*
412	**Isolation and Cytotoxic Evaluation of Compounds from the Twigs of *Millettia leptobotrya* Dunn** - *Ngo Van Cuong, Trinh Thi Thanh Van, Phi Thi Dao, Le Tran Nguyen Vu, Pham Van Cuong, Nguyen Thuy Linh, Doan Thi Mai Huong*
419	**Chemical Composition Analysis and Quantification of Perillaldehyde in *Perilla frutescens* Leaf Essential Oil Collected in Vietnam** - *Pham Thi Hien, Nguyen Thi Hai Yen, Do Thi Xinh, Nguyen Thi Thu, Phan Van Truong, Nguyen Thi Hang, Do Thi Ha, Tran Minh Ngoc, Nguyen Minh Khoi, Nguyen Thi Ha Ly*
428	**Preliminary Research on Establishing the Quality Standards for Wine-Processed *Radix Angelicae sinensis* -** *Do Thi Thuy Linh, Nguyen Thi Ha Ly, Phan Thanh Thuy, Nguyen Phu Quang, Pham Anh Minh, Tran Huu Khanh Tan, Bui Ngoc Tan, Nguyen Tuan Hiep*
438	***In vitro* Screening of Cytotoxic Activity of Vietnamese Medicinal Plants -** *Nguyen Thi Thu, Nguyen Tra My, Do Thi Ha, Vu Thi Diep, Nguyen Thi Hang, Tran Thi Hien, Hoang Thi Dieu Huong, Tran Thuy Giang*
446	**Evaluation of Biocompatibility and Preliminary Hemostatic Efficacy of a Chitosan-Based Hemostatic Sponge (Field Hemostatic Sponge) in Experimental Models -** *Vu Quang Thai, Le Thi Xoan, Nguyen Hoang Ngan, Do Thi Thuy Trang*

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TRITERPENOIDS AND ACYLGLUCOSYLSTEROL FROM *GALPHIMIA GLAUCA* CAV. COLLECTED IN VIETNAM

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Summary

Five compounds (**1**–**5**) were isolated from the dichloromethane fraction of *G. glauca* Cav. methanol extract. Their chemical structures were elucidated through detailed analysis of 1D and 2D NMR spectroscopic data and by comparison with literature data to be friedelin (**1**), epifriedelanol (**2**), lupeol (**3**), *β*-amyrin (**4**), and 3-*O*-[(6′-*O*-palmitoyl)-*β*-D-glucopyranosyl] sitosterol (**5**). Compounds **1**–**3** were 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. glauca* Cav. in Vietnam.

Keywords: *Galphimia glauca* Cav.*; Triterpenoid; Acylglucosylsterol.*

1. Introduction

Galphimia glauca, a member of the Malpighiaceae family, has long been used in traditional Mexican medicine for the treatment of various conditions, including allergies, bronchial asthma, depression, gastric ulcers, rheumatism, and inflammatory disorders [1]. Modern pharmacological studies have demonstrated that this species possesses a wide range of biological activities, notably sedative, anti-inflammatory, antimicrobial, and anticancer effects. In particular, its anti-inflammatory activity has been confirmed in *in vivo* models, where it exhibits a strong capacity to inhibit inflammatory responses and oxidative stress [2],[5]. The extracts of *G. glauca* were reported to exhibit anti-asthmatic, anti-allergic, and anti-inflammatory activities in both preclinical and clinical studies [1],[2],[4]. In particular, the dichloromethane fraction was found to be rich in low-polarity terpenoids and triterpenoids, especially galphimine derivatives associated with the anxiolytic and sedative activities of the species [5],[6]. Phytochemical investigations revealed that *G. glauca* is a rich source of structurally diverse secondary metabolites, particularly nor-secofriedelane triterpenoids, which are considered characteristic constituents of the species, including galphimines A–J, galphins A–C, and galphimidin [6],[7],[8]. In addition, several phenolic compounds and flavonoids such as tetragalloylquinic acid, gallic acid derivatives, quercetin derivatives, and anticomplementary flavonoids have also been isolated from methanolic and ethyl acetate extracts [2],[3],[9]. Among the reported constituents, galphimine B has been identified as the major anxiolytic compound and has exhibited significant activity in both animal models and clinical studies [10]. However, most previous studies were conducted in the Americas, whereas phytochemical investigations of *G. glau*ca collected in Vietnam remain limited. Therefore, the present study aimed to investigate the chemical constituents of the dichloromethane fraction obtained from the methanol extract of the stems and leaves of *G. glauca* collected in Vietnam.

2. Materials and Methods

2.1. Plant materials

The stems and leaves of *Galphimia glauca* Cav. (Malpighiaceae) were collected from Xuan Phuong Commune, Hanoi City, Vietnam, in May 2025, and identified by MSc. Nguyen Van Hieu, Center of Medicinal Material Resources, National Institute of Medicinal Materials (NIMM). A voucher specimen (NIMM 0029146 was deposited at the Center of Medicinal Material Resources, 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, Fuji Silysia 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

Eight kilograms of the stems and leaves of *G. glauca* were successively extracted with 100% methanol (64 L × 3, 24 h each) at room temperature. The combined methanol extracts were concentrated under reduced pressure to afford a crude residue (750 g). This residue was suspended in distilled water (0.5 L) and successively partitioned with *n*-hexane (5 × 1 L), dichloromethane (DCM, 4 × 1 L), and ethyl acetate (EtOAc, 4 × 1 L). Each organic fraction was concentrated under reduced pressure to yield *n*-hexane (78 g), DCM (26 g), EtOAc (22 g), and aqueous fractions, respectively.

Preliminary TLC analysis indicated that the DCM fraction was enriched in low- to medium-polarity terpenoid constituents, whereas the more polar ethyl acetate and aqueous fractions mainly contained phenolic compounds and flavonoids that have been extensively reported from *G. glauca* [1],[8]. In addition, previous studies demonstrated that the DCM fraction of *G. glauca* contains triterpenoids and galphimine-related constituents associated with anxiolytic, sedative, and central nervous system depressant activities [6],[8]. Therefore, the present work prioritized the investigation of this fraction in order to further clarify the terpenoid profile of *G. glauca* collected in Vietnam.

The DCM fraction (26 g) was subjected to *silica gel* CC and eluted with a gradient of DCM–MeOH (0–100% MeOH) to give five fractions (D1–D5). Fraction D2 (2.3 g) was further separated by *silica gel* CC using *n*-hexane–DCM (3:1, v/v) as the eluent to afford six subfractions (D2A–D2F). Compound **1** (12 mg) was obtained from subfraction D2A (0.2 g) by crystallization from *n*-hexane–DCM (3:1, v/v). Subfraction D2C (0.3 g) was subjected to open *silica gel* column chromatography (CC) using *n*-hexane–EtOAc (100:1, v/v) as the eluent to afford compound **2** (11 mg). Subfraction D2E (0.6 g) was purified by reversed-phase C_{18} CC using a gradient of H_2O–acetone (50–100% acetone) to afford compounds **3** (11 mg) and **4** (10 mg). Fraction D4 (1.2 g) was further separated by *silica gel* CC using *n*-hexane–acetone (5:1, v/v) as the eluent to obtain three subfractions (D4A–D4C). Subfraction D4C (0.4 g) was purified by open *silica gel* CC, eluting with DCM–EtOAc (100:1, v/v), to yield compound **5** (10 mg).

Friedelin (1): White solid, ESI-MS: *m/z* 427.75 $[M+H]^+$; ^{1}H-NMR (600 MHz, $CDCl_3$): δ_H 1.69 (1H, m, H_a-1), 1.97 (1H, m, H_b-1), 2.31 (1H, m, H_a-2), 2.39 (1H, m, H_b-2), 2.25 (1H, m, H-4), 0.88 (3H, d, *J* = 6.6 Hz, H-23), 0.73 (3H, s, H-24), 0.87 (3H, s, H-25), 1.01 (3H, s, H-26), 1.05 (3H, s, H-27), 0.96 (3H, s, H-29), 1.00 (3H, s, H-30), 1.18 (3H, s, H-28); ^{13}C-NMR (150 MHz, $CDCl_3$): see Table 1.

Epifriedelanol (2): White solid, ESI-MS: *m/z* 429.45 $[M+H]^+$; ^{1}H-NMR (600 MHz, $CDCl_3$): δ_H 3.73 (1H, d, *J* = 2.4 Hz, H-3), 0.93 (3H, d, *J* = 6.0 Hz, H-23), 0.96 (3H, s, H-24), 0.86 (3H, s, H-25), 1.00 (3H, s, H-26), 0.98 (3H, s, H-27), 0.94 (3H, s, H-29), 1.17 (3H, s, H-30), 0.99 (3H, s, H-28); ^{13}C-NMR (150 MHz, $CDCl_3$): see Table 1.

Lupeol (3): White solid, ESI-MS: *m/z* 427.80 $[M+H]^+$; ^{1}H-NMR (600 MHz, $CDCl_3$): δ_H 3.18 (1H, dd, *J* = 4.2, 11.4 Hz, H-3), 2.37 (1H, m, H-19), 0.96 (3H, s, H-23), 0.76 (3H, s, H-24), 0.83 (3H, s, H-25), 1.03 (3H, s, H-26), 0.94 (3H, s, H-27), 4.68 (1H, d, *J* = 2.4 Hz, H_b-29), 4.56 (1H, dd, *J* = 2.4 Hz, 1.2 Hz, H_a-29), 1.68 (3H, s, H-30), 0.79 (3H, s, H-28); ^{13}C-NMR (150 MHz, $CDCl_3$): see Table 1.

***β*-Amyrin (4):** White solid, ESI-MS: *m/z* 427.70 $[M+H]^+$; ^{1}H-NMR (600 MHz, $CDCl_3$): δ_H 3.22 (1H, dd, *J* = 10.8, 4.2 Hz, H-3), 5.18 (1H, t, *J* = 3.6 Hz, H-12), 0.79 (3H, s, H-23), 0.99 (3H, s, H-24), 0.94 (3H, s, H-25), 0.96 (3H, s, H-26), 1.13 (3H, s, H-27), 0.87 (3H, s, H-29), 0.87 (3H, s, H-30), 0.83 (3H, s, H-28), ^{13}C-NMR (150 MHz, $CDCl_3$): see Table 1.

3-*O*-[(6′-*O*-Palmitoyl)-*β*-D-glucopyranosyl] sitosterol (5): Colorless oil, ESI-MS: *m/z* 837.95 $[M+Na]^+$; ^{1}H-NMR (600 MHz, $CDCl_3$) δ_H (ppm): 5.35 (1H, m, H-6), 4.43 (1H, dd, *J* = 5.4, 12.0 Hz, H_a-6'), 4.38 (1H, d, *J* = 7.8 Hz, H-1'), 4.28 (1H, d, *J* = 12.0 Hz, H_b-6'), 2.33 (2H, t, *J* = 7.2 Hz, H-2"), 1.25 methylenes (26H, brs), 1.00 (3H, s, H-19), 0.91 (3H, d, *J* = 6.6 Hz, H-21), 0.87 (3H, d, *J* = 7.2 Hz, H-26), 0.84 (3H, t, *J* = 7.2 Hz, H-29), 0.81 (3H, d, *J* = 6.6 Hz, H-27), 0.68 (3H, s, H-18), 0.88 (3H, t, *J* = 7.2 Hz, H-16"); ^{13}C-NMR (150 MHz, $CDCl_3$): see Table 1.

3. Results and Discussion

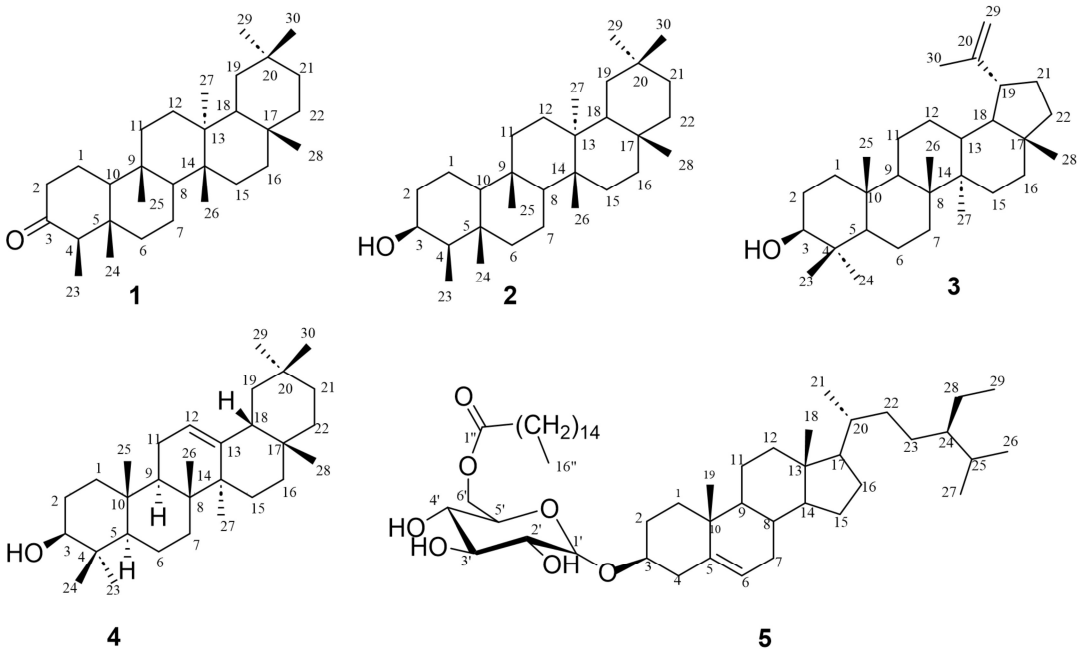


Fig. 1. Chemical structures of compounds **1-5**

Compound **1** was isolated as a white solid. The molecular ion peak $[M+H]^+$ was observed at *m/z* 427.75 in the ESI-MS spectrum, consistent with the molecular formula $C_{30}H_{50}O$. The ^{1}H-NMR spectrum exhibited signals corresponding to eight methyl groups, including seven singlets and one doublet, observed at δ_H [0.73 (3H, s, H-24), 0.87 (3H, s, H-25), 1.01 (3H, s, H-26), 1.05 (3H, s, H-27), 0.96 (3H, s, H-29), 1.00 (3H, s, H-30), 1.18 (3H, s, H-28), and 0.88 (3H, d, J = 6.6 Hz, H-23)]. In addition, the spectrum showed multiple overlapping signals corresponding to aliphatic methylene and methine protons of the triterpenoid skeleton. The ^{13}C-NMR spectrum of compound **1** revealed a total of 30 carbon signals, which were classified into eight methyl carbons, four sp^3 methine carbons, eleven methylene carbons, six quaternary carbons, and one carbonyl carbon resonating at δ_C 213.2 (C-3). The presence of a ketone carbonyl group is characteristic of a friedelane-type pentacyclic triterpenoid. On the basis of the above spectroscopic features, compound **1** was assigned to the class of pentacyclic triterpenoids. Further detailed analysis of the NMR spectroscopic data and comparison with reported literature values [11] allowed compound **1** to be unambiguously identified as friedelin (Fig. 1). Friedelin exhibited strong antibacterial activity against MRSA, inhibited virulence gene expression, and reduced biofilm formation. In infected mice, friedelin decreased bacterial load and wound size, enhanced angiogenesis markers, and accelerated wound healing through bactericidal and anti-inflammatory effects [12].

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

Carbon	1[a]	1[b]	2[a]	2[c]	3[a]	3[d]	4[a]	4[e]	5[a]	5[f]
1	22.3	22.3	15.8	15.7	38.8	38.7	38.7	38.7	37.3	37.3
2	41.5	41.5	35.2	35.1	27.5	27.8	27.3	27.3	29.6	29.6
3	213.2	213.2	72.8	72.7	79.0	79.0	79.1	79.0	79.6	79.6
4	58.2	58.2	49.2	49.1	38.9	38.8	38.8	38.8	38.9	38.9
5	42.1	42.1	37.1	37.1	55.3	55.3	55.3	55.3	140.3	140.3
6	41.3	41.3	41.8	41.7	18.4	18.7	18.4	18.5	122.2	122.1
7	18.2	18.2	17.6	17.5	34.3	34.3	32.8	32.8	32.0	31.9
8	53.1	53.1	53.2	53.1	40.9	40.8	39.9	38.8	32.0	31.9
9	37.4	37.4	38.4	38.3	50.5	50.4	47.7	47.7	50.2	50.2
10	59.5	59.4	61.4	61.3	37.2	37.2	37.2	37.6	36.2	36.2

11	35.6	35.6	35.4	35.3	21.2	21.2	23.7	23.6	21.1	21.1
12	30.5	30.5	30.7	30.6	25.2	25.2	121.8	121.8	39.8	39.8
13	39.7	39.7	37.9	37.8	38.1	38.1	145.2	145.1	42.4	42.3
14	38.3	38.3	39.7	39.6	42.9	42.8	41.8	41.8	56.8	56.8
15	32.4	32.4	32.4	32.3	27.4	27.4	26.2	26.2	24.3	24.3
16	36.0	36.0	36.1	36.0	35.6	35.6	27.0	27.0	28.3	28.2
17	30.0	30.0	30.0	30.0	43.0	43.0	32.5	32.5	56.1	56.1
18	42.8	42.8	42.8	42.7	48.0	48.0	47.3	47.4	11.9	11.8
19	35.3	35.3	35.6	35.5	48.3	48.3	46.9	46.9	19.4	19.4
20	28.1	28.1	28.2	28.1	150.9	150.9	31.1	31.1	36.8	36.7
21	32.8	32.7	32.8	32.8	29.9	29.9	34.8	34.8	19.1	19.0
22	39.2	39.2	39.3	39.2	40.0	40.0	37.2	37.2	34.0	34.0
23	6.8	6.8	11.6	11.6	28.0	28.0	28.1	28.2	29.2	29.2
24	14.6	14.6	16.4	16.4	15.3	15.3	15.5	15.5	45.9	45.9
25	17.9	17.9	18.3	18.2	16.1	16.1	15.6	15.6	26.2	26.1
26	20.2	20.2	18.7	18.6	16.0	16.0	16.9	16.9	18.8	18.8
27	18.6	18.6	20.1	20.1	14.5	14.5	26.0	26.0	19.8	19.8
28	32.1	32.1	31.8	31.7	18.0	18.3	28.4	28.4	23.1	23.1
29	35.0	35.0	35.0	35.0	109.3	109.3	33.3	33.3	12.0	12.0
30	31.8	31.8	32.1	32.0	19.3	19.3	23.6	23.7	-	-
1'	-	-	-	-	-	-	-	-	101.2	101.2
2'	-	-	-	-	-	-	-	-	73.6	73.6
3'	-	-	-	-	-	-	-	-	76.6	76.8
4'	-	-	-	-	-	-	-	-	70.2	70.1
5'	-	-	-	-	-	-	-	-	74.0	73.9
6'	-	-	-	-	-	-	-	-	63.3	63.2
1"	-	-	-	-	-	-	-	-	174.6	174.6
2"	-	-	-	-	-	-	-	-	34.3	34.3
3"	-	-	-	-	-	-	-	-	25.0	25.0
4"-14"	-	-	-	-	-	-	-	-	29.8	29.9
15"	-	-	-	-	-	-	-	-	22.7	22.7
16"	-	-	-	-	-	-	-	-	14.1	14.1

[a]: recorded in $CDCl_3$ at 150 MHz; [b]: recorded in $CDCl_3$ at 100 MHz [11]; [c]: recorded in $CDCl_3$ at 125 MHz [13]; [d]: recorded in $CDCl_3$ at 150 MHz [15]; [e]: recorded in $CDCl_3$ at 125 MHz [16]; [f]: recorded in $CDCl_3$ at 125 MHz [19].

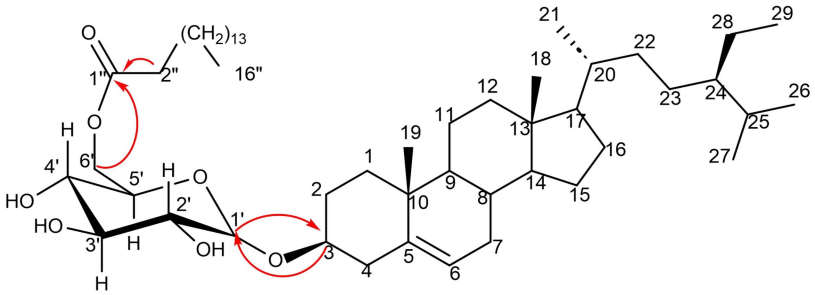


Fig. 2. Selected key HMBC correlations of compound **5**

Compound **2** was obtained as a white solid. The molecular ion peak $[M+H]^+$ was observed at *m/z* 429.45 in the ESI-MS spectrum, consistent with the molecular formula $C_{30}H_{52}O$. Compound **2** was structurally related to compound **1**. The only difference is the presence of the 3-hydroxy group instead of the 3-keto group. In the ^{1}H-NMR spectrum of **2**, signals due to eight methyls of the friedelane skeleton appeared as a doublet at δ_H 0.93 (J = 6.0 Hz, Me-23) and seven singlets in the region of δ_H (0.86 – 1.17). The 3-hydroxy group was an oxymethine proton signal at δ_H 3.73 (J = 2.4 Hz, H-3). The small coupling constant (J = 2.4 Hz) of H-3 further indicated its equatorial orientation, thereby confirming the β-configuration of the 3-hydroxyl group [13]. The

^{13}C-NMR spectrum showed the signal due to the oxygenated C-3 at δ_C 72.8. The carbon signal due to the methyl group at C-4, the most upfield signal, was observed at δ_C 11.6 (C-23). This signal was significantly more downfield than the corresponding signal in the ^{13}C-NMR spectrum of **1** owing to the different substituents at C-3. On the basis of these spectroscopic data and comparison with reported values in the literature [13], compound **2** was identified as epifriedelanol (Fig. 1). Epifriedelinol exhibits potent antiproliferative activity against prostate cancer cells by inducing apoptosis through modulation of BAX, P53, caspases, PARP, BCL-2, and NF-κB. *In vivo*, epifriedelanol reduces prostate enlargement and inflammatory markers while improving histopathological parameters [14].

Compound **3** was isolated as a white solid. Its molecular formula was determined to be $C_{30}H_{50}O$ based on the molecular ion peak at *m/z* 427.7 $[M+H]^+$. The ^{1}H-NMR spectrum exhibited characteristic resonances of a lupane-type triterpenoid, including six tertiary methyl groups at δ_H [0.96 (3H, s, H-23), 0.76 (3H, s, H-24), 0.83 (3H, s, H-25), 1.03 (3H, s, H-26), 0.94 (3H, s, H-27), and δ_H 0.79 (3H, s, H-28)] and one olefinic methyl group at δ_H 1.68 (3H, s, H-30). A characteristic multiplet at δ_H 2.37 (1H, m, H-19) was consistent with the lupane skeleton. The oxymethine proton H-3 appeared as a double doublet at δ_H 3.18 (1H, dd, J = 4.2, 11.4 Hz, H-3), while an exomethylene group was evidenced by two doublets at δ_H 4.68 and 4.56 (1H each), assigned to H_a-29 and H_b-29, respectively. The coupling pattern of H-3 (dd, J = 11.4, 4.2 Hz) was consistent with the characteristic coupling pattern of H-3 in 3*β*-hydroxylated lupane-type triterpenoids, supporting the assignment of the 3*β*-hydroxyl configuration. The ^{13}C-NMR spectrum showed 30 carbon signals, including a hydroxylated carbon at δ_C 79.0 (C-3), an exomethylene carbon at δ_C 109.3 (C-29), and an sp^2 quaternary carbon at δ_C 150.9 (C-20). On the basis of these spectroscopic data and comparison with reported values in the literature [15], compound **3** was identified as lupeol (Fig. 1).

Compound **4** was obtained as a white solid. The molecular ion peak $[M+H]^+$ was observed at *m/z* 427.70 in the ESI-MS spectrum, consistent with the molecular formula $C_{30}H_{50}O$. The ^{1}H-NMR spectrum exhibited characteristic signals of a triterpenoid skeleton, including one olefinic proton at δ_H 5.18 (t, J = 3.6 Hz, H-12), one oxymethine proton at δ_H 3.22 (dd, J = 10.8, 4.2 Hz, H-3), and eight methyl singlets at δ_H 0.79 (3H, s, H-23), 0.99 (3H, s, H-24), 0.94 (3H, s, H-25), 0.96 (3H, s, H-26), 1.13 (3H, s, H-27), 0.87 (3H, s, H-29), 0.87 (3H, s, H-30) and 0.83 (3H, s, H-28). The coupling pattern of H-3 (dd, J = 10.8, 4.2 Hz) was consistent with that reported for 3*β*-hydroxylated oleanane-type triterpenoids, supporting the assignment of the 3*β*-hydroxyl configuration. The ^{13}C-NMR spectrum showed 30 carbon signals, comprising one oxymethine carbon (δ_C 79.0), two olefinic carbons at δ_C 121.8 and δ_C 145.2, eight methyl carbons, ten methylene carbons, three methine carbons, and six quaternary carbons. On the basis of these spectroscopic data and comparison with reported values in the literature [16], compound **4** was identified as *β*-amyrin (Fig. 1).

Lupeol and *β*-amyrin are pentacyclic triterpenes widely distributed in medicinal plants and have been reported to possess notable anti-inflammatory activities. Lupeol has been shown to exert anti-inflammatory effects primarily through the inhibition of the NF-κB signaling pathway, leading to the downregulation of pro-inflammatory mediators such as TNF-α, IL-1β, IL-6, COX-2, and iNOS [17]. Similarly, *β*-amyrin suppresses the production of nitric oxide (NO) and pro-inflammatory cytokines, and also modulates the NF-κB pathway. These findings suggest that lupeol and *β*-amyrin may contribute to the anti-inflammatory effects of plant extracts [18].

Compound **5** was isolated as a colorless oil. On the basis of the ^{1}H-NMR and ^{13}C-NMR spectroscopic data, compound **5** was identified as a sterol acylglycoside. The ^{1}H-NMR spectrum exhibited six characteristic methyl signals of the sterol nucleus at δ_H 0.68 (3H, s, H-18), 1.04 (3H, s, H-19), 0.92 (3H, d, J = 6.6 Hz, H-21), 0.87 (3H, d, J = 7.2 Hz, H-26), 0.81 (3H, d, J = 6.6 Hz, H-27), and 0.84 (3H, t, J = 7.2 Hz, H-29). An olefinic proton resonance was observed at δ_H 5.35 (1H, m, H-6), together with an oxymethine proton at δ_H 3.57 (1H, m, H-3). The chemical shift of H-3 was consistent with those reported for 3β-hydroxysterols [13], supporting the assignment of a 3β-hydroxyl group. The presence of a β-glucose unit was confirmed by an anomeric proton signal at δ_H 4.38 (1H, d, J = 7.8 Hz, H-1′), four oxymethine protons at δ_H [3.57–3.34 (H-2′–H-5′)], and two oxymethylene protons at δ_H [4.43 (1H, dd, J = 5.4, 12.0 Hz, H_a-6′) and 4.28 (1H, d, J = 12.0 Hz, H_b-6′)]. Signals attributable to a fatty acid chain were evidenced by a methylene α-carbonyl at δ_H 2.33 (2H, t, J = 7.2 Hz, H-2″), a terminal methyl group at δ_H 0.88 (3H, t, J = 7.2 Hz, H-16″), and a series of overlapping methylene resonances at δ_H 1.25. The ^{13}C-NMR and HSQC spectra displayed carbon resonances consistent with a sterol glucoside ester. The sterol moiety showed six methyl carbons at δ_C 19.1 (C-21), 18.8 (C-26), 19.8 (C-27), 11.8 (C-18), 12.0 (C-29), and 19.4 (C-19), an oxymethine carbon at δ_C 79.6 (C-3), and two olefinic carbons at δ_C 140.3 (C-5) and 122.2 (C-6). The glucose unit exhibited characteristic carbon signals at δ_C 101.2 (C-1′), 73.6 (C-2′), 76.6 (C-3′), 70.2 (C-4′), 74.0 (C-5′), and 63.3 (C-6′). The acyl moiety was identified by the presence of an ester carbonyl carbon at δ_C 174.2 (C-1″), methylene carbons at δ_C 34.3 (C-2″), 25.0 (C-3″), and 22.7 (C-15″), a series of long-chain methylene carbons at δ_C (29.4–29.9) (C-4″– C-14″), and a terminal methyl carbon at δ_C 14.1 (C-16″). HMBC spectra correlations between the anomeric proton H-1′ (δ_H 4.38) and C-3 (δ_C 79.6) established the glycosidic linkage at C-3 of the sterol nucleus. Additional HMBC correlations from the ester carbonyl carbon C-1″ (δ_C 174.2) to the oxymethylene protons H_a-6′ (δ_H 4.43) and H_b-6′ (δ_H 4.28) confirmed that the fatty acid moiety was esterified at C-6′ of the glucose unit (Fig. 2). The ESI-MS spectrum showed a pseudomolecular ion peak at m/z 837.95 $[M+Na]^+$, consistent with the molecular formula $C_{51}H_{90}O_7$. On the basis of the above spectroscopic evidence and comparison with literature data [19],[20],[21], compound **5** was identified as 3-*O*-[(6′-*O*-palmitoyl)-β-D-glucopyranosyl] sitosterol (Fig. 1). 3-*O*-[(6′-*O*-Palmitoyl)-β-D-glucopyranosyl] sitosterol exhibited significant anti-inflammatory activity in the TPA-induced mouse ear edema model, showing a concentration-dependent effect. The compound suppressed the production of pro-inflammatory cytokines (IL-1β, IL-6, and TNF-α) while enhancing anti-inflammatory cytokines (IL-4 and IL-10) [22].

The present study provides preliminary information on the chemical constituents of the dichloromethane fraction of *G. glauca* collected in Vietnam, leading to the isolation of several pentacyclic triterpenoids and a sterol acylglycoside. While previous studies on the dichloromethane fraction of *G. glauca* collected in the Americas mainly reported characteristic galphimine derivatives, the difference in phytochemical composition observed here may be associated with geographical and climatic conditions between Vietnam and the native regions of the species. As the present study was limited to the isolation and structural elucidation of chemical constituents of this fraction, further studies on the phytochemical profiles and biological activities of other fractions are necessary to clarify the medicinal value and potential applications of *G. glauca* in Vietnam.

4. Conclusion

The investigation of the chemical composition of dichloromethane extract from *G. glauca* led to the isolation of five compounds, including friedelin (**1**), epifriedelanol (**2**), lupeol (**3**), β-amyrin (**4**), and 3-*O*-[(6′-*O*-Palmitoyl)-β-D-

glucopyranosyl] sitosterol (**5**). To the best of our knowledge, compounds **1-3** were reported from this plant for the first time. This study provides additional information on the chemical constituents of *G. glauca*.

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