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Original Article

Saponins from the Leaves of *Eclipta prostrata*

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Abstract: *Eclipta prostrata* (L.) is a traditional herbal medicine belonging to the *Eclipta* genus in the Asteraceae family. This plant is widely distributed in tropical and subtropical regions such as South America and Asia. According to the traditional medicine of some Asian countries (China, India, Thailand), *E. prostrata* is used to treat hepatic and renal diseases, diabetes, skin diseases, respiratory disorders, cool blood, and stanch bleeding. Besides, it also shows antioxidant, anti-inflammatory, antibacterial, and antimicrobial activities. In Vietnam, the plant grows naturally in moist soil and is distributed from mountainous areas to plains. It is used to treat coughs and burns, respiratory infections, and boils. In this research, four saponins including eclalbasaponin I-II and eclalbasaponin IV-V, were isolated from the methanol extract of *Eclipta prostrata* using various modern chromatography methods such as TLC, CC, and HPLC. Their chemical structures were identified by analysis of 1D, 2D-NMR, and ESI-MS spectra data and by comparison of the spectral data in the literature. Eclalbasaponin IV and V were first reported from *Eclipta prostrata* cultivated in Vietnam.

Keywords: Eclipta prostrata, saponin, echinocystic acid, Asteraceae

1. Introduction

Eclipta prostrata (L.) is a traditional herbal medicine belonging to the *Eclipta* genus in the Asteraceae family. This plant is widely distributed in tropical and subtropical regions such as South America and Asia [1]. According to the traditional medicine of some Asian countries (China, India, Thailand), *E. prostrata* is used to treat hepatic and renal diseases, diabetes, skin diseases, respiratory disorders, cool blood, and stanch bleeding [2-4]. Besides, it also shows antioxidant, anti-inflammatory, antibacterial, and antimicrobial activities [5-7]. In Vietnam, the plant grows naturally in moist soil and is distributed from mountainous areas to plains. It is used to treat coughs and burns,

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respiratory infections, and boils [8-10]. Many secondary metabolites have been isolated and identified from *E. prostrata* as triterpenoids, flavonoids, alkaloids, and steroids [2], of these saponins oleanane-type glycosides are the principal constituents of the *Eclipta* genus. We reported herein the isolation and structure elucidation of four saponins from the methanol extract of the leaves of *E. prostrata*.

2. Methodology

2.1. Plant Materials

The leaves of *Eclipta prostrata* (L.) were collected at Vinh Phuc, Vietnam, in September 2021 and identified by Dr. Nguyen The Cuong, Institute of Ecology and Biological Resources, VAST. A voucher specimen (NCCT-EP01) was deposited at the Institute of Ecology and Biological Resources, VAST.

2.2. General Experimental Procedures

All NMR spectra, including ^{1}H-NMR (600 MHz), ^{13}C (150 MHz), HSQC, and HMBC, were recorded on a Bruker AM600 FT-NMR spectrometer, and TMS was used as an internal standard. Optical rotations were determined on a Jasco DIP-370 automatic polarimeter. Column chromatography (CC) was performed using silica gel (Kieselgel 60, 70-230 mesh, and 230-400 mesh, Merck) or RP-18 resins (30-50 µm, Fuji Silysia Chemical Ltd.). Thin layer chromatography (TLC) was done using pre-coated silica gel 60 F_{254} (0.25 mm, Merck) and RP-18 F_{254S} plates (0.25 mm, Merck). HPLC was carried out via an Agilent 1100 HPLC system using a J'sphere H-80 column (250x20 mm) at a flow rate of 3.0 ml/min and a DAD detector.

2.3. Extraction and Isolation

The dried leaves of *E. prostrata* (9.0 kg) were ground into a fine powder and exhaustively extracted with methanol (3 times x 30 L) in an ultrasonic extractor for 2 h each. The crude extract was then concentrated under reduced pressure to give the MeOH residue (270 g). Distilled water was added to dissolve this extract and then successively partitioned with *n*-hexane, dichloromethane, and ethyl acetate to obtain the *n*-hexane (EPH, 150.0 g), dichloromethane (EPD, 6.0 g), ethyl acetate (EPE, 2.0 g) and aqueous (EPW) extracts after evaporating solvents in *vacuo*. The EPW fraction was treated with Diaion HP-20 column chromatography to remove sugar with water and eluted with gradually increasing the concentration of MeOH solvent in water (MeOH:H_2O–25:75 → 100:0) to yield four fractions EPW1→4. The fraction EPW2 was separated on a silica gel column eluting with a CH_2Cl_2 – MeOH (20/1 – 1/1, v/v) stepwise gradient to give four fractions (EPW2A→D). The fraction EPW2B (8.1 g) was subjected to an RP-18 column using MeOH/H_2O (1/1.1, v/v) to give three fractions $EPW2B_{1\rightarrow3}$. The $EPW2B_1$ fraction was then purified by HPLC 50% ACN to give compound eclalbasaponin II (**2**, 8.1 mg). The fraction EPW2C (8.5 g) was runned on a silica gel RP-18 column using MeOH/H_2O (1/1.1, v/v) to obtain three fractions $EPW2C_{1\rightarrow3}$. The $EPW2C_2$ fraction was further chromatographed on a silica gel column and eluted with dichloromethane/acetone/water (1/2/0.1, v/v/v) to give compound eclalbasaponin V (**4**, 8.1 mg). The fraction EPW2D (14.0 g) was separated on an RP-18 column using MeOH – H_2O (1/1.1, v/v) to give three fractions $EPW2D_{1\rightarrow3}$. The $EPW2D_1$ fraction was continuously purified by HPLC 41% ACN to obtain compound eclalbasaponin I (**1**, 21.1 mg) and compound eclalbasaponin IV (**3**, 9.1 mg).

Eclalbasaponin I (1): $[\alpha]_D^{25} + 6.2° \ (c = 0.1, \ MeOH)$; colorless needles powder; ESI-MS *m/z* 795 $[M-H]^-$, $C_{42}H_{68}O_{14}$; ^{1}H- and ^{13}C-NMR (CD_3OD): see Table 1.

Eclalbasaponin II (2): $[\alpha]_D^{25} + 11.8° \ (c = 0.1, \ MeOH)$; amorphous powder; ESI-MS *m/z* 633 $[M-H]^-$, $C_{36}H_{58}O_9$; ^{1}H- and ^{13}C-NMR (CD_3OD): see Table 1.

Eclalbasaponin IV (3): $[\alpha]_D^{25} + 8.9° \ (c = 0.1, \ MeOH)$; amorphous

powder; ESI-MS *m/z* 795 $[M-H]^-$, $C_{42}H_{68}O_{14}$; ^{1}H- and ^{13}C-NMR (CD_3OD): see Table 1.

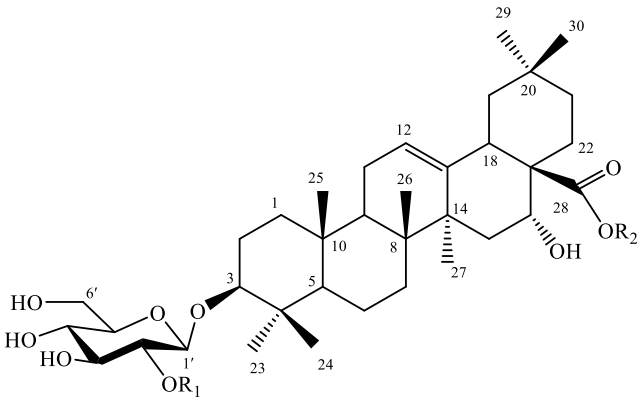
Eclalbasaponin V (4): $[\alpha]_D^{25} - 12.3° (c = 0.1, MeOH)$; amorphous powder; ESI-MS *m/z* 713 $[M-H]^-$, $C_{36}H_{58}O_{12}S$; ^{1}H- and ^{13}C-NMR (CD_3OD): see Table 1.

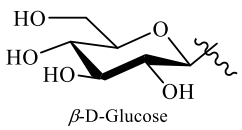
3. Results and Discussion

Compound **1** was obtained as an amorphous powder. Its molecular formula was predicted to be $C_{42}H_{68}O_{14}$ based on a quasi-molecular ion peak at *m/z* 795 $[M-H]^-$ in the ESI-MS and ^{13}C-NMR data. The ^{1}H-NMR spectrum showed seven angular methyl groups at δ_H 0.81, 0.87, 0.91, 0.98, 0.99, 1.08, and 1.37, and a typical signal for axial proton attached to a hydroxylated carbon at δ_H 4.55 (br s). Further features were vinylic proton signal at δ_H 5.32 (1H, br s) and sugar proton signals between δ_H 3.21 and δ_H 5.37. In the ^{13}C-NMR data of **1**, the presence of 42 carbons was indicated, the signals due to seven methyl carbons, two olefinic carbons at δ_C 123.6 and 144.6, and a carboxyl carbon at δ_C 177.2 combined with the information from the ^{1}H-NMR spectrum, indicated that **1** was a triterpene glycoside with a triterpene moiety of oleanane skeleton. The deshielded position of the axial methyl group at C-14 (Me-27, δ_H 1.37) and the presence of a broad singlet proton signal at δ_H 4.55 (H-16) in the ^{1}H-NMR spectrum of **1** suggested the hydroxy group at C-16. The assignments of the proton and the carbon signals of the triterpene moiety were established by the combined use of HSQC and HMBC experiments, which allowed the identification of the triterpene moiety as echinocystic acid, a common triterpene of triterpene glycosides. The characteristic signals of two glucopyranosyl units were observed at δ_H 4.34 (1H, d, J = 7.8 Hz) and δ_H 5.37 (1H, d, J = 7.8 Hz), two hydroxymethylenes at [δ_H 3.68 (dd, J = 5.4, 12.0 Hz) and 3.84 (dd, J = 1.8, 12.0 Hz)], and [δ_H 3.70 (dd, J = 5.4, 12.0 Hz) and 3.87 (dd, J = 2.4, 12.0 Hz)], and the corresponding carbon anomeric at δ_C 106.7 and 95.7 ppm. Due to naturally occurring and thus more abundant *D*-glucose, as well as all glucose sugar in triterpene saponins found in *E. prostrata* to be *D* notation [4], both glucopyranosyl units were therefore proposed as *D*-glucopyranose. The *β*-configuration of both anomeric protons was determined from the large coupling constant J = 7.8 Hz of H-1' (δ_H 4.34) and J = 7.8 Hz of H-1" (δ_H 5.37). The HMBC correlations from H-1' (δ_H 4.34, d, J = 7.8 Hz) to C-3 (δ_C 90.8) and from H-1" (δ_H 5.37, d, J = 7.8 Hz) to C-28 (δ_C 177.3), as shown in Figure 2, suggested the location of the two glucopyranosyl residues at C-3 and C-28 of the aglycone triterpene echinocystic acid. From the above evidence, the structure of compound **1** was thus determined as eclalbasaponin I, an oleane glycoside previously isolated from *Eclipta alba* [11]. Its NMR data have been found to match entirely with those published in the literature [11].

Compound **2** was obtained as a colorless needle powder. The molecular formula of **2** was deduced as $C_{36}H_{58}O_9$ based on ESI-MS (*m/z*: 633, $[M-H]^-$) and is consistent with ^{13}C-NMR data. The ^{1}H-NMR spectrum showed seven angular methyl groups at δ_H 0.83, 0.87, 0.90, 0.98, 0.99, 1.08, 1.39, and the corresponding methyl carbons at δ_C 16.1, 17.0, 17.8, 25.0, 27.3, 28.6, 33.4. In addition, an olefinic proton at δ_H 5.32 (br s) and carbons olefin at δ_C 123.4, 145.1, and six carbons of a sugar moiety were also observed. The signals of *D*-glucopyranoside were proved based on the appearance of the characteristic signals on the ^{1}H-NMR spectrum at δ_H 4.34 (1H, d, J = 7.8 Hz), hydroxymethylene at δ_H 3.69 (dd, J = 5.4, 12.0 Hz) and 3.86 (dd, J = 2.4, 12.0 Hz), and the ^{13}C-NMR spectra at δ_C 106.7, 78.3, 77.7, 75.7, 71.7, and 62.8 ppm. The *β*-configuration of the anomeric proton of *D*-glucose was determined from the large coupling constant J = 7.8 Hz of H-1' (δ_H 4.34). The ^{1}H- and ^{13}C-NMR data of **2** were quite similar to those of **1** except for the absence of one *D*-glucose unit in compound **2** compared to compound **1**. These implied that **2** had the aglycone as echinocystic acid and one *D*-glucopyranosyl residue. The location of the sugar unit was determined at C-3 of

echinocystic acid aglycone by the HMBC correlations observed between H-1' (δ_H 4.34, d, J = 7.8 Hz) and C-3 (δ_C 90.8). In addition, the ^{1}H- and ^{13}C-NMR data of **2** were identical to those of eclalbasaponin II, a compound also previously isolated from *Eclipta alba* [11] (Table 1) and found to match well. Thus, the structure of **2** was characterized.





1. R_1 = H, R_2 = β-D-Glucose
2. R_1 = H, R_2 = H
3. R_1 = β-D-Glucose, R_2 = H
4. R_1 = HSO_3, R_2 = H

Figure 1. Chemical structures of compounds **1**-**4** from *E. prostrata*.

Table 1. The ^{1}H- and ^{13}C-NMR data for compounds **1-4**

C	**1**		**2**		**3**		**4**	
	δ_C[a, b]	δ_H[a, c] mult. (J in Hz)	δ_C [a, b]	δ_H[a, c] mult. (J in Hz)	δ_C[a, b]	δ_H[a, c] mult. (J in Hz)	δ_C[a, b]	δ_H[a, c] mult. (J in Hz)
1	39.9	1.02 (m) 1.65 (m)	39.9	1.02 (m) 1.65 (m)	39.9	1.05 (m) 1.65 (m)	39.9	1.02 (m) 1.64 (m)
2	27.0	1.70 (m) 1.95 (m)	27.0	1.70 (m) 1.95 (m)	27.1	1.74 (m) 1.98 (m)	27.0	1.73 (m) 1.93 (m)
3	90.8	3.20 (m)	90.8	3.20 (m)	91.5	3.22 (m)	91.5	3.18 (dd, 4.2, 12.0)
4	40.2	-	40.2	-	40.4	-	40.2	-
5	57.2	0.80*	57.1	0.81 (br s)	57.1	0.80*	57.1	0.80*
6	19.3	1.40 (m) 1.57 (m)	19.3	1.41 (m) 1.57 (m)	19.3	1.41 (m) 1.58 (m)	19.3	1.39 (m) 1.58 (m)
7	34.2	1.37 (m) 1.54 (m)	34.3	1.36 (m) 1.56 (m)	34.3	1.36 (m) 1.55 (m)	34.3	1.35 (m) 1.56 (m)
8	40.8	-	40.7	-	40.7	-	40.7	-
9	48.2	1.65 (m)	48.2	1.67 (m)	48.2	1.66 (m)	48.2	1.66 (m)
10	37.9	-	37.9	-	37.9	-	37.9	-
11	24.5	1.91 (m)	24.5	1.71 (m)	24.5	1.91 (m)	24.5	1.91 (m)
12	123.6	5.34 (t, 3.6)	123.4	5.32 (br s)	123.3	5.32 (br s)	123.4	5.32 (br s)
13	144.6	-	145.1	-	145.2	-	145.2	-
14	42.7	-	42.7	-	42.7	-	42.7	-
15	36.3	1.38 (m) 1.87 (m)	36.2	1.35 (m) 1.87 (m)	36.2	1.35* 1.88 (m)	36.2	1.39 (m) 1.91 (m)
16	74.9	4.55 (br s)	75.4	4.48 (br s)	75.2**	4.46 (br s)	75.4	4.48 (br s)

17	50.0	-	49.4	-	49.3	-	48.2	-
18	42.1	3.01 (dd, 4.8, 16.8)	42.2	3.04 (dd, 3.0, 13.8)	42.2	3.05 (br d, 13.2)	42.2	3.04 (br d, 12.0)
19	47.8	1.09* 2.30 (t, 16.8)	47.7	1.03 (d, 3.0) 2.29 (t, 13.8)	47.8	1.05 (m) 2.29 (t, 13.2)	47.8	1.04 (m) 2.29 (t, 13.2)
20	31.3	-	31.4	-	31.4	-	31.2	-
21	36.4	1.18 (m) 1.95 (m)	36.6	1.16 (m) 1.94 (m)	36.6	1.17 (m) 1.95 (m)	36.6	1.16 (m) 1.92 (m)
22	31.6	1.79 (m) 1.96 (m)	32.6	1.78 (m) 1.91 (m)	32.5	1.79 (m) 1.91 (m)	32.5	1.77 (m) 1.92 (m)
23	28.6	1.08 (s)	28.6	1.08 (s)	28.5	1.10 (s)	28.6	1.12 (s)
24	17.0	0.87 (s)	17.0	0.87 (s)	16.9	0.88 (s)	17.0	0.88 (s)
25	16.1	0.98 (s)	16.1	0.98 (s)	16.1	0.98 (s)	16.1	0.98 (s)
26	17.8	0.81 (s)	17.8	0.83 (s)	17.8	0.82 (s)	17.8	0.82 (s)
27	27.3	1.37*	27.3	1.39 (s)	27.3	1.38*	27.3	1.39 (s)
28	177.2	-	Nd		nd		nd	
29	33.3	0.91 (s)	33.4	0.90 (s)	33.5	0.90 (s)	33.4	0.90 (s)
30	25.1	0.99 (s)	25.0	0.99 (s)	25.1	0.99 (s)	25.1	0.99 (s)
3-*O*-Glc								
1'	106.7	4.34 (d, 7.8)	106.7	4.34 (d, 7.8)	104.5	4.70 (d, 7.8)	104.3	4.50 (d, 7.8)
2'	75.7	3.21 (m)	75.7	3.20 (m)	81.1	3.59 (m)	81.8	4.07 (dd, 7.8, 9.0)
3'	78.7	3.35 (m)	78.3	3.35 (m)	78.5	3.57 (m)	77.8	3.68 (m)
4'	71.6	3.31 (m)	71.7	3.30 (m)	71.9	3.23 (m)	71.5	3.41 (t, 9.0)
5'	78.3	3.30 (m)	77.7	3.28 (m)	78.3	3.28 (m)	77.3	3.30 (m)
6'	62.7	3.68 (m) 3.84 (dd, 1.2, 12.0)	62.8	3.69 (dd, 5.4, 12.0) 3.86 (dd, 2.4, 12.0)	63.1	3.64 (dd, 6.0, 12.0) 3.85 (dd, 1.8, 12.0)	62.7	3.69 (dd, 5.4, 12.0) 3.86 (dd, 1.8, 12.0)
28-*O*-Glc								
1"	95.7	5.37 (d, 7.8)			105.4	4.46 (d, 7.8)		
2"	74.0	3.32 (m)			76.3	3.25 (m)		
3"	78.3	3.41 (m)			77.9	3.29 (m)		
4"	71.1	3.36 (m)			71.6	3.31 (m)		
5"	77.6	3.28 (m)			77.7	3.30 (m)		
6"	62.4	3.70 (m) 3.87 (dd, 2.4, 12.0)			62.8	3.68 (dd, 5.4, 12.0) 3.87 (dd, 1.8, 12.0)		

Recorded in [a)]CD_3OD, [b)]150 MHz, [c)]600 MHz, *overlap signals, **see in HMBC, nd: not detected.

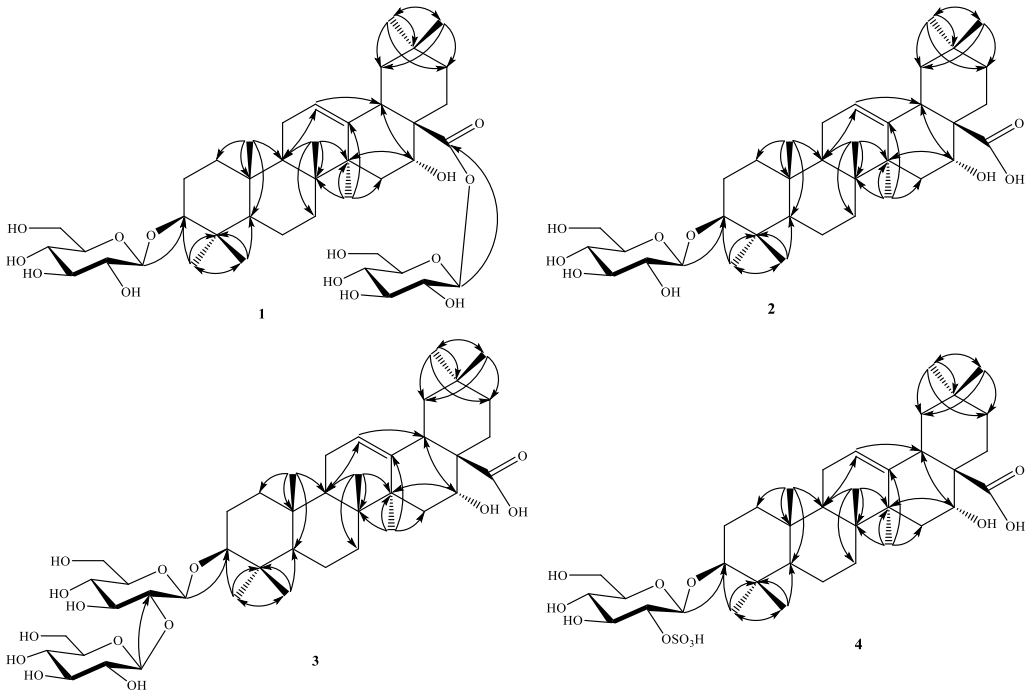


Figure 2. The key HMBC correlations of compounds **1**-**4**.

Compound **3** was obtained as an amorphous powder. It gave a molecular formula of $C_{42}H_{68}O_{14}$ at *m/z* 795 $[M-H]^-$ in the ESI-MS and ^{13}C-NMR data. The ^{1}H- and ^{13}C- NMR spectra of **3** also showed signals of seven angular methyl groups, one double bond, and two *β-D*-glucopyranosyl residues. The NMR spectra data of compound **3** were similar to those of compound **1** and had the same molecular formula, suggesting that **3** and **1** are isomers. These implied that the disaccharide chain should be located at C-3 of the echinocystic acid aglycone. The HMBC correlations from H-1' (δ_H 4.34, d, J = 7.8 Hz) to C-3 (δ_C 90.8) suggested the location of the one *β-D*-glucopyranosyl unit at C-3. The second hexose was attached to the first *β-D*-glucopyranosyl unit at C-2' due to the HMBC correlations between H-1" (δ_H 5.37, d, J = 7.8 Hz) to C-2' (δ_C 81.1) (Figure 2). Consequently, compound **3** was elucidated as eclalbasaponin IV, also isolated from *Eclipta alba* [11] (Figure 1). Its NMR data matched perfectly with those reported data in the literature [11].

Compound **4** was obtained as an amorphous powder. It had a quasi-molecular ion peak in the ESI-MS at *m/z* 713 [M-H]. The ^{1}H- and ^{13}C- NMR spectra of **4** also showed characteristic signals of the echinocystic acid aglycone and signals of one sugar unit. In addition, the NMR spectra data of compound **4** were very similar to compound **2** except for the signals belonging to the sugar unit. The characteristic of glucopyranose sulfate sugar was clearly observed at δ_H 4.50 (d, J = 7.8 Hz, H-1'), 4.07 (dd, J = 7.8, 9.0 Hz, H-2'), 3.68 (m, H-3'), 3.41 (t, J = 9.0 Hz, H-4'), 3.30 (m, H-5'), and hyroxymethylene at δ_H 3.69 (dd, J = 5.4, 12.0 Hz, H-6'a) and 3.86 (dd, J = 1.8, 12.0 Hz, H-6'b) and the corresponding carbon signals at δ_C 104.3, 81.8, 77.8, 71.5, 77.3 and 62.7, which were agreed with NMR data of glucopyranose sulfate in literature. Notably, a significant chemical shift toward the downfield of proton and carbon at C-2' of a sugar moiety (δ_H 4.07, δ_C 81.8) in compound **4** compared with (δ_H 3.20, δ_C 75.7) in compound **2**. This evidence suggested that the sulfate group should be located at C-2' of the glucopyranosyl unit.

Moreover, the ^{1}H- and ^{13}C-NMR data of **4** were close to the NMR data of eclalbasaponin V, a compound also isolated from *Eclipta alba* [11], and found to match. Therefore, the structure of **4** was characterized as eclalbasaponin V.

4. Conclusion

Four saponins, including eclalbasaponin I-II and eclalbasaponin IV-V, were isolated from the methanol extract of the leaves of *Eclipta prostrata* using combined chromatographic methods. To our best knowledge, eclalbasaponin IV and V were first reported from *Eclipta prostrata* cultivated in Vietnam [12].

Acknowledgements

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References

[1] M. Sharma, M. Sharma, N. Bithel, M. Sharma, Ethnobotany, Phytochemistry, Pharmacology and Nutritional Potential of Medicinal Plants from Asteraceae Family, Journal of Mountain Research, Vol. 17, No. 2, 2022, pp. 67-83, https://doi.org/10.51220/jmr.v17i2.7.

[2] I. M. Chung, G. Rajakumar, J. H. Lee, S. H. Kim, M. Thiruvengadam, Ethnopharmacological Uses, Phytochemistry, Biological Activities, and Biotechnological Applications of *Eclipta prostrata*, Applied Microbiology Biotechnology, Vol. 101, 2017, pp. 5247-5257, https://doi.org/10.1007/s00253-017-8363-9.

[3] J. H. Park, H. Lee, W. M. Yang, The Effects of *Eclipta prostrata* L. (Ecliptae Herba) on Periodontitis Rats, The Journal of Korean Medicine, Vol. 39, No. 1, 2018, pp. 63-74, https://doi.org/10.13048/jkm.18007.

[4] L. Feng, Y. Y. Zhai, J. Xu, W. F. Yao, Y. D. Cao, F. F. Cheng, B. H. Bao, L. Zhang, A Review on Traditional Uses, Phytochemistry and Pharmacology of *Eclipta prostrata* (L.) L. Journal of Ethnopharmacology, Vol. 245, 2019, pp. 112109, https://doi.org/10.1016/j.jep.2019.112109.

[5] S. Tewtrakul, S. Subhadhirasakul, P. Tansakul, S. Cheenpracha, C. Karalai, Antiinflammatory Constituents from *Eclipta prostrata* Using RAW264.7 Macrophage Cells, Phytotherapy Research, Vol. 25, No. 9, 2011, pp. 1313-1316, https://doi.org/10.1002/ptr.338.

[6] D. I. Kim, Lee, S. H. Choi, J. H. Lillehoj, H. S. Yu, M. H. Lee, G. S. The Butanol Fraction of *Eclipta prostrata* (Linn) Effectively Reduces Serum Lipid Levels and Improves Antioxidant Activities in CD Rats, Nutrition Research, Vol. 28, No. 8, 2008, pp. 550-554, https://doi.org/10.1016/j.nutres.2008.05.003.

[7] M. S. Rahman, M. A. Rashid, Antimicrobial Activity and Cytotoxicity of *Eclipta prostrata*, Advances in Traditional Medicine, Vol. 8, No. 1, 2008, pp. 47-52, https://doi.org/10.3742/OPEM.2008.8.1.047.

[8] Acid and Eclalbasaponin II Isolated from *Eclipta Prostrata* L. (Asteraceae Family), Can Tho University Journal of Science, No. 11b, 2009, pp. 278-283 (in Vietnamese).

[9] D. H. Bich, D. Q. Trung, B. X. Chuong, N. T. Dong, D. T. Dam, P. V. Hien, V. N. Lo, P. D. Mai, P. K. Man, D. T. Nhu, N. Tap, T. Toan, Medicinal Plants and Animals in Vietnam, Science and Technology Publishing House, Vol. 2, 2006 (in Vietnamese).

[10] H. K. Dieu, L. T. L. Em, Assessment Pure Characteristic and Antibacteria of *Eclipta prostrata* and *Phyllanthus niruri* in Cuu Long River Delta, Can Tho University Journal of Science, No. 19a, 2011, pp. 149-155 (in Vietnamese).

[11] S. Yahara, N. Ding, T. Nohara, Oleanane Glycosides from *Eclipta alba*, Chemical Pharmaceutical Bulletin, Vol. 42, No. 6, 1994, pp. 1336-1338, https://doi.org/10.1248/cpb.42.1336.

[12] P. M. Giang, N. T. Thoi, N. V. Tai, P. T. Son, Study on Chemical Constituents of *Eclipta prostrata* L., Asteraceae in Vietnam, Vietnam Journal of Chemistry, Vol. 53, No. 1, 2015, pp. 56-61 (in Vietnamese). https://doi.org/10.15625/0866-7144.2015-0088.