

RESEARCH ARTICLE

Two New Prunasinoids From the Leaves of *Elaeocarpus bachmaensis* and Their Antidiabetic Activity

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ABSTRACT

Two new prunasines, 6'-*O-p-trans*-coumaroyl prunasin (**1**) and 6'-*O-p-cis*-coumaroyl prunasin (**2**), together with six known compounds, afzelin (**3**), tamarixetin 3-*O*-rhamnoside (**4**), mearnsitrin (**5**), *cis*-linalool-3,6-oxide β -D-glucopyranoside (**6**), *n*-hexyl-*O*- β -D-glucoside (**7**), and cucurbitacin F (**8**), were isolated from the leaves of *Elaeocarpus bachmaensis* collected in Bach Ma National Park, Vietnam. Their chemical structures were elucidated by one-dimensional nuclear magnetic resonance (1D-NMR), 2D-NMR, and high-resolution mass spectrometry spectra. Bioassays revealed that compound **6** inhibited α -amylase significantly with a half-maximal inhibitory concentration (IC₅₀) value of $137.3 \pm 14.4 \mu\text{M}$, whereas compounds **1–5** inhibited α -glucosidase significantly with IC₅₀ values ranging from 82.4 ± 10.4 to $160.0 \pm 19.9 \mu\text{M}$. These findings suggest that *E. bachmaensis* may serve as a promising natural source for the development of antidiabetic agents. This is the first report on the chemical composition and bioactivity of the *E. bachmaensis* species.

1 | Introduction

The genus *Elaeocarpus* comprises over 350 species, primarily distributed across Southeast Asia, East Asia, the Southwestern Pacific, and Oceania, with approximately 40 species recorded in Vietnam [1, 2]. Phytochemical and biological studies on *Elaeocarpus* species have revealed the presence of flavonoids [3], alkaloids [4–6], triterpenoids [2, 7–13], ellagic acid derivatives [13, 14], cyanogenic glycosides [15], and megastigmanoids [16], which exhibit significant bioactivities such as anticancer [8, 10, 12, 13], antidiabetic [11, 12], anti-Alzheimer [6], antiviral [17], antifungal [18], and antioxidant activities [19]. *E. bachmaensis* is a native species of both China and Vietnam [20]. According to local ethnobotanical knowledge, the fruits of *E. bachmaensis* are edible and traditionally used to reduce fever. However, no studies have been published to date on the chemical constituents and

biological activities of this species. As part of an ongoing project to identify new antidiabetic compounds from native Vietnamese plants, the present study reports the isolation and structural elucidation of two new prunasinoid compounds from the leaves of *E. bachmaensis* collected in Bach Ma National Park, Vietnam, and evaluates their α -amylase and α -glucosidase inhibitory activities.

2 | Results and Discussion

Compound **1** was obtained as a white amorphous powder. The infrared (IR) spectrum of **1** indicated typical vibrations corresponding to hydroxyl (3476 cm^{-1}), cyano (2376 cm^{-1}), carbonyl (1694 cm^{-1}), and ether (1082 cm^{-1}) functional groups. The high-resolution electrospray ionization mass spectrometry (HRESIMS) showed an $[\text{M} + \text{H}]^+$ quasi-molecular ion peak at m/z 442.1515,

TABLE 1 | ^1H (600 MHz) and ^{13}C nuclear magnetic resonance (NMR) (150 MHz) data of **1**, **2** in CD_3OD [δ (ppm), J (Hz)].

Position	1		2	
	δ_{C}	δ_{H}	δ_{C}	δ_{H}
1	134.9	—	134.7	—
2, 6	128.9	7.59 m	129.0	7.56 m
4	131.2	7.45 m	131.0	7.45 m
3, 5	130.1	7.45 m	130.1	7.45 m
7	69.2	5.79 s	69.0	5.69 s
8	119.2	—	119.1	—
1'	102.7	4.38 brd (7.2)	102.4	4.29 brd (7.8)
2'	74.7	3.33 m	74.7	3.32 m
3'	77.8	3.34 m	77.8	3.31 m
4'	71.6	3.40 m	71.5	3.33 m
5'	75.9	3.52 ddd (9.6, 6.0, 2.4)	75.7	3.45 ddd (9.6, 6.0, 2.4)
6'	64.6	4.40 dd (12.0, 2.4)	64.4	4.55 dd (12.0, 2.4)
		4.35 dd (12.0, 6.0)		4.30 dd (12.0, 6.0)
1''	127.2	—	127.6	—
2''	131.2	7.50 d (8.4)	133.8	7.68 d (9.0)
3''	116.9	6.84 d (8.4)	115.9	6.79 d (9.0)
4''	161.4	—	160.1	—
5''	116.9	6.84 d (8.4)	115.9	6.79 d (9.0)
6''	131.2	7.50 d (8.4)	133.8	7.68 d (9.0)
7''	146.9	7.73 d (16.2)	145.3	6.94 d (12.6)
8''	115.0	6.43 d (16.2)	116.4	5.89 d (12.6)
9''	169.1	—	168.2	—

corresponding to a molecular formula of $\text{C}_{23}\text{H}_{23}\text{NO}_8$ (calcd. for $[\text{C}_{23}\text{H}_{24}\text{NO}_8]^+$: 442.1518). The ^1H nuclear magnetic resonance (NMR) data (Table 1) of compound **1** indicated two sets of aromatic protons with one monosubstituted aromatic ring [δ_{H} 7.45 (3H, m, H-3, H-4, and H-5), δ_{H} 7.59 (2H, m, H-2 and H-6)] and one 1,4-disubstituted aromatic ring [δ_{H} 7.50 (2H, d, $J = 8.4$ Hz, H-2'' and H-6'') and δ_{H} 6.84 (2H, d, $J = 8.4$ Hz, H-3'' and H-5'')]. Additionally, one *trans*-olefin [δ_{H} 7.73 (1H, d, $J = 16.2$ Hz, H-7'') and δ_{H} 6.43 (1H, d, $J = 16.2$ Hz, H-8'')], one oxymethine [δ_{H} 5.79 (1H, s, H-7)], and one sugar anomeric proton [δ_{H} 4.38 (1H, brd, $J = 7.2$ Hz, H-1')] were also detected, alongside signals attributed to other hydrogens of a sugar moiety (δ_{H} 4.40–3.33) in the ^1H NMR spectrum. The ^{13}C NMR and heteronuclear single quantum coherence (HSQC) spectrum of **1** showed 23 carbon signals corresponding to the two aromatic rings (δ_{C} 116.9–161.4) and one sugar moiety (δ_{C} 102.7–64.6). The remaining five carbon signals were assigned to one ester carbonyl (δ_{C} 169.1), one *trans*-olefin (δ_{C} 146.9 and 115.0), one oxymethine (δ_{C} 69.2), and one non-protonated carbon (δ_{C} 119.2), which is appropriately situated for a nitrile function. Analysis of the 1D NMR data of **1** (Table 1) indicated similarities to those of prunasine [21]. The main difference was the additional presence of a *p*-coumaroyl moiety in **1**. Furthermore, the heteronuclear multiple bond correlation (HMBC) correlations of H-6' [δ_{H} 4.40

(dd, $J = 12.0, 2.4$ Hz, $\text{H}_{\text{a}}\text{-6}'$) and δ_{H} 4.35 (dd, $J = 12.0, 6.0$ Hz, $\text{H}_{\text{b}}\text{-6}'$) with C-9'' (δ_{C} 169.1, $\text{C}=\text{O}$) indicate that C-6' and C-9'' were connected through an oxygen atom. The planar structure of **1** was determined by 2D NMR (correlated spectroscopy, HSQC, and HMBC) spectroscopic analysis (Table 1 and Figure 1). The coupling constant of the anomeric proton at δ_{H} 4.38 (1H, brd, $J = 7.2$ Hz, H-1') confirmed it as β -glucopyranose. The acid hydrolysis of **1** yielded D-glucopyranose, which was identified by co-TLC analysis and comparison with an authentic sample (D-glucose, Sigma-Aldrich) as well as the positive sign of the optical rotation [22, 23]. As has long been noted, the anomeric proton signals of cyanogenic glycosides with the (*S*)-configuration typically appear as clean doublets, whereas those of the (*R*)-configuration are observed as complex higher-order multiplets [21]. Accordingly, the relative configuration at C-7 in compound **1** was assigned as 7*R** based on the characteristic resonance of the anomeric proton at δ_{H} 4.38 (brd, $J = 7.2$ Hz, H-1'). Consequently, compound **1** was determined to be 6'-*O-p-trans*-coumaroyl prunasin.

Compound **2** was isolated as a white amorphous powder with the same molecular formula as **1** ($\text{C}_{23}\text{H}_{23}\text{NO}_8$), which was determined from its (+)-HRESIMS [found m/z 464.1924 [$\text{M} + \text{Na}$] $^+$ (calcd. for $[\text{C}_{23}\text{H}_{23}\text{NNaO}_8]^+$: 464.1927)] and ^{13}C NMR data. The ^1H and ^{13}C NMR and HSQC data were strikingly similar (Table 1). The

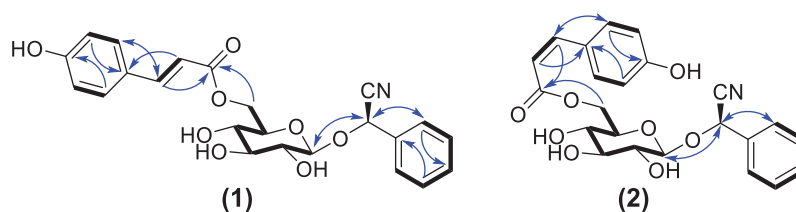


FIGURE 1 | Key heteronuclear multiple bond correlation (HMBC) ($^1\text{H} \rightarrow ^{13}\text{C}$, arrows) and correlated spectroscopy (COSY) (bold lines) correlations of compounds **1** and **2**.

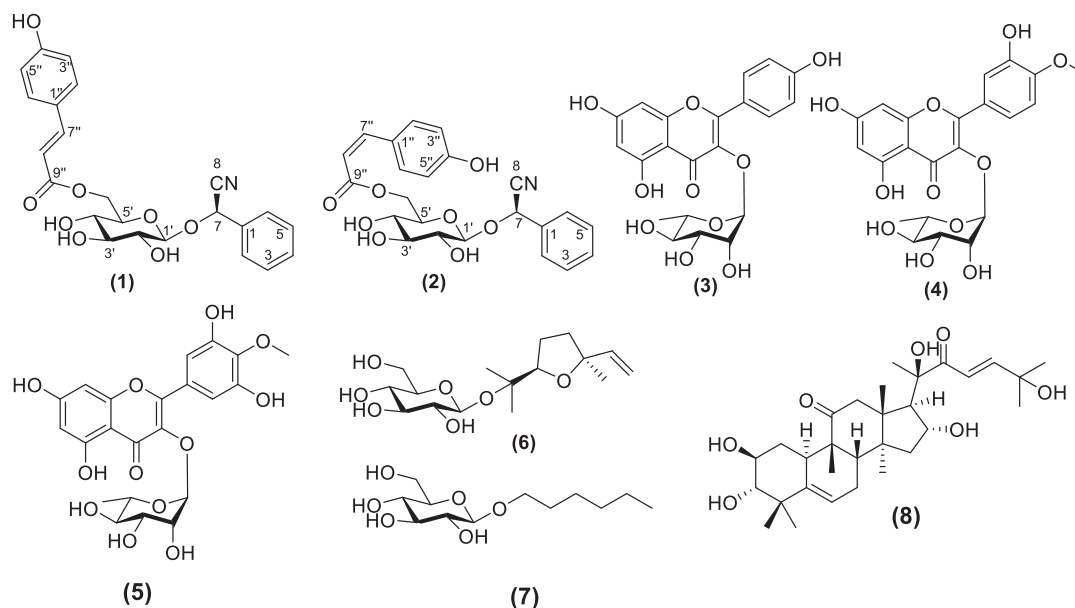


FIGURE 2 | Chemical structures of compounds **1**–**8** isolated from the leaves of *E. bachmaensis*.

most notable differences were the coupling constants of H-7'' and H-8'' in **2**. The $\Delta^{7''(8'')}$ olefinic bond was *Z*-configured, as indicated by the small coupling constants of H-7'' and H-8'' ($^3J = 12.6$ Hz) and the ROESY correlation of H-7''/H-8''. These observations indicated that compound **2** is an isomer of **1**, supporting the conclusion that the double bond has a *cis*-geometry [25, 26]. Based on these data, the structure of **2** was defined to be 6'-*O*-*p*-*cis*-coumaroyl prunasin.

In addition, six other known compounds were isolated and identified as afzelin (**3**) [27], tamarixetin 3-*O*-rhamnoside (**4**) [28], mearnsitrin (**5**) [29], *cis*-linalool-3,6-oxide β -D-glucopyranoside (**6**) [30], *n*-hexyl-*O*- β -D-glucoside (**7**) [31], and cucurbitacin F (**8**) [32] by comparison of their NMR spectroscopic data with literature (Figure 2 and Supporting information).

Bioassays demonstrated that most isolated compounds exhibited inhibitory activity against α -amylase and α -glucosidase, with half-maximal inhibitory concentration (IC_{50}) from 82.4 ± 10.4 to 663.8 ± 43.3 μM (Table 2). Notably, compound **6** inhibited significant α -amylase with an IC_{50} value of 137.3 ± 14.4 μM , whereas compounds **1**–**5** inhibited significant α -glucosidase with IC_{50} values ranging from 82.4 ± 10.4 to 160.0 ± 19.9 μM , outperforming the reference drug acarbose. To date, the antidiabetic potential of these compounds has been largely unreported in the literature, with the exception of compound **3**, which has previously demonstrated potent α -glucosidase inhibition with IC_{50} values ranging from

0.94 to 118 μM [33, 34]. These findings suggest that *E. bachmaensis* may serve as a promising natural source for the development of antidiabetic agents. However, cytotoxic assessments should be a key focus of further investigations, particularly for potentially toxic constituents such as the cyanogenic glycosides **1** and **2**, to ensure safety prior to further biological activity evaluations.

3 | Conclusions

Phytochemical investigation of the leaves of *E. bachmaensis* led to the isolation and identification of eight compounds, including two new prunasines (**1** and **2**) and six known compounds (**3**–**8**). Bioassays showed that **6** inhibited significant α -amylase with an IC_{50} value of 137.3 ± 14.4 μM , whereas compounds **1**–**5** inhibited significant α -glucosidase with IC_{50} values ranging from 82.4 ± 10.4 to 160.0 ± 19.9 μM . These findings suggest that *E. bachmaensis* is a potential source of antidiabetic agents.

4 | Experimental

4.1 | General

Column chromatography was performed using silica gel, reversed-phase C18, Sephadex LH-20, and Diaion HP-20 resins as the stationary phase. Analytical TLC was carried out on pre-

TABLE 2 | α -Amylase and α -glucosidase activity of the isolated compounds.

Compound	IC ₅₀ (μ M)	
	α -Amylase inhibition	α -Glucosidase inhibition
1	>1000	133.3 $\pm$ 12.2
2	>1000	167.5 $\pm$ 12.9
3	515.2 $\pm$ 41.1	82.4 $\pm$ 10.4
4	>1000	156.9 $\pm$ 11.3
5	>1000	160.0 $\pm$ 19.9
6	137.3 $\pm$ 14.4	663.8 $\pm$ 43.3
7	>1000	492.1 $\pm$ 42.0
8	528.0 $\pm$ 23.9	356.1 $\pm$ 38.2
Acarbose	173.6 $\pm$ 4.8	206.0 $\pm$ 6.8

coated silica gel 60 F₂₅₄ and RP-18 F_{254S} plates. The compounds were characterized using an Agilent 1260 system including a binary pump, autosampler, DAD detector, and semipreparative high-performance liquid chromatography (HPLC) column YMC J'sphere ODS-H80 (4 μ m, 20 $\times$ 250 mm), a Bruker Avance Neo 600 NMR spectroscopy (Bruker, MA, USA) with TMS as the internal reference, and Agilent 6530 Accurate-Mass spectrometers (Agilent, CA, USA). The optical rotations were measured on a Jasco P2000 polarimeter.

4.2 | Plant Material

The leaves of *Elaeocarpus bachmaensis* Gagnep. were collected in Bach Ma National Park, Vietnam, in March 2025, and were identified by Dr. Le Tuan Anh (Vietnam National Museum of Nature, VAST). The voucher specimens (MISR-NCXS-24) have been deposited at the herbarium of Mientrung Institute for Scientific Research, VNMN, VAST, Vietnam.

4.3 | Extraction and Isolation

The dried powdered leaves of *E. bachmaensis* (4.0 kg) were extracted with methanol using an ultrasonic power of 600 W in three times (each for 15 L, 3 h, 40–50°C). The methanol extract was concentrated under reduced pressure to obtain a residue (EB, 390.0 g). This residue was suspended in warm water (2.0 L) and successively partitioned with *n*-hexane (3 $\times$ 2 L), dichloromethane (3 $\times$ 2 L), and ethyl acetate (3 $\times$ 2 L) to give: *n*-hexane (EBH, 162.4 g), dichloromethane (EBD, 95.0 g), ethyl acetate (EBE, 18.2 g), and a water layer after removal of the solvents (EBW, 114.4 g). The water layer (EBW, 114.4 g) was passed through a Diaion HP-20 column, washed with distilled water, and eluted with methanol/water in ratios of 25/75, 50/50, 75/25, and 100% methanol to give four fractions, EBW1–EBW4. Fraction EBW3 (3.8 g) was separated on a silica gel column using a gradient of dichloromethane/acetone solvent system (1:0 $\rightarrow$ 0:1) to get five fractions, EBW3.1–EBW3.5. Fraction EBW3.3 (922 mg) was separated on a silica gel column (dichloromethane/methanol, 20:1) to obtain three fractions, EBW3.3.1–EBW3.3.3. Chromatography of fraction EBW3.3.1 (207 mg) on an RP-18 column (methanol/water, 2:3) to get two subfractions, EBW3.3.1.1–EBW3.3.1.2. EBW3.3.1.2

(121 mg) was further purified on the HPLC (acetonitrile/water, 15:85) to yield compounds **1** (9.2 mg, t_R = 36.465 min) and **2** (6.5 mg, t_R = 47.517 min). Compounds **3** (13.0 mg, t_R = 36.116 min) and **4** (5.9 mg, t_R = 59.046 min) were isolated from EBW3.3.2 (119 mg) by HPLC (acetonitrile/water, 25:75). Compound **5** (8.8 mg, t_R = 25.464 min) were purified from EBW3.3.3 (98 mg) by HPLC (acetonitrile/water, 20:80). Fraction EBW3.4 (250 mg) was separated using a Sephadex LH-20 column (methanol/water, 1:2) to get a fraction, EBW3.4.1. Compounds **6** (20.6 mg) and **7** (10.0 mg) were obtained from EBW3.4.1 (118 mg) by separating on an RP-18 column (methanol/water, 1:3). Finally, chromatography of fraction EBW3.2 (350 mg) on a silica gel column (dichloromethane/methanol, 20:1), giving a fraction, EBW3.2.1. Compound **8** (20.0 mg, t_R = 37.399 min) was purified from EBW3.1.1 (83 mg) by HPLC (acetonitrile/water, 35:65).

6'-O-*p*-trans-coumaroyl prunasin (1): white amorphous powder; $[\alpha]_D^{25}$: -61.1 (*c* 0.10, MeOH); HRESIMS m/z 442.1515 $[M + H]^+$ (calcd. for $[C_{23}H_{24}NO_8]^+$: 442.1518); IR (KBr) ν_{max} cm⁻¹: 3476, 2376, 1694, 1082; ¹H (CD₃OD, 600 MHz) and ¹³C NMR (CD₃OD, 150 MHz) spectroscopic data are shown in Table 1.

6'-O-*p*-cis-coumaroyl prunasin (2): white amorphous powder; $[\alpha]_D^{25}$: -42.7 (*c* 0.15, MeOH); HRESIMS m/z 464.1329 $[M + Na]^+$ (calcd. for $[C_{23}H_{23}NNaO_8]^+$: 464.1331); IR (KBr) ν_{max} cm⁻¹: 3476, 2374, 1691, 1090; ¹H (CD₃OD, 600 MHz) and ¹³C NMR (CD₃OD, 150 MHz) spectroscopic data are shown in Table 1.

4.3.1 | Acid Hydrolysis and Monosaccharide Identification of Compounds 1 and 2

Acid hydrolysis of compounds **1** and **2** was the same as exhibited in previous literature [23], as referred to in the [Supporting Information](#).

4.3.2 | α -Amylase and α -glucosidase Inhibitory Assays

α -Amylase and α -glucosidase inhibitory assays were performed according to the protocols described by Dat [35], referred to in the [Supporting Information](#).

Author Contributions

Le Canh Viet Cuong, Ton That Huu Dat, and Phan Thi Diem Tran designed experiments, elucidated chemical structures, and wrote the paper. **Tran Phuong Ha** and **Le Trung Hieu** assisted with the isolation experiments. **Vu Thi Thanh Tam** performed the α -amylase and α -glucosidase assays.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The authors have nothing to report.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.

Supporting File 1: cbdv70876-sup-0001-SupMat.doc