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**PHENOLIC CONSTITUENTS FROM THE ETHYL ACETATE EXTRACT
OF *CAMELLIA FLAVA* FLOWERS (THEACEAE)
COLLECTED IN PHU THO PROVINCE**

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Summary

Camellia flava (Pitard) Sealy is one of the yellow camellia species belonging to the genus *Camellia* (family Theaceae), which is widely distributed in Vietnam. Phytochemical investigation of the ethyl acetate extract of *C. flava* flowers collected in Phu Tho province led to the identification of eight phenolic compounds, including 3,3',4'-tri-*O*-methyl ellagic acid (1), pinoresinol (2), quercetin (3), kaempferol (4), tyrosol (5), caffeic acid (6), protocatechuic acid (7), and gallic acid (8). The structures of the isolated compounds were determined by NMR and MS spectroscopic analyses and comparison with the reported data. This study represents the first report of compounds (1–8) from the flowers of *C. flava*.

Keywords: *Camellia flava*; *Camellia cucphuongensis*; Flavonoid; Lignan; Phenolic.

1. Introduction

Yellow Camellias, belonging to the genus *Camellia* L. (family Theaceae), represent a distinct group of plants characterized by their unique yellow flowers. Unlike the traditional green tea *Camellia sinensis*, yellow Camellias have remained poorly studied until recent decades, when their exceptional ornamental value and potential medicinal properties began attracting scientific attention [1]. The genus *Camellia* comprises approximately 300 accepted species, with about 97 species distributed in China and 95 species and 2 varieties recorded in Vietnam. Among these, around 69 yellow *Camellia* species have been described, of which over 50 species are found in Vietnam [2]. In recent years, phytochemical studies have revealed that yellow Camellias contain diverse classes of bioactive compounds comparable to those found in *C. sinensis*, including flavonoids, phenolic compounds, saponins, triterpenoids, phytosterols, essential oils, polysaccharides, and amino acids [1]. However, chemical investigations have focused primarily on a few species like *C. nitidissima*, *C. chrysantha*, and *C. bugiamapensis*, with *C. nitidissima* receiving the most intensive research attention [1],[3]. These studies have demonstrated that extracts and isolated compounds from yellow Camellias

possess a wide spectrum of biological activities, including antioxidant, anticancer, hypolipidemic, hypoglycemic, hepatoprotective, neuroprotective, and antidepressant effects [3].

Camellia flava (Pitard) Sealy (synonym: *Camellia cucphuongensis* Ninh & Rosmann), one of the yellow *Camellia* species, is mainly distributed in Ninh Binh and Phu Tho provinces. However, research on this species remains limited. Nguyen et al. have studied the anti-diabetic and hypolipidemic effects of *C. flava* flower and leaves extracts [4],[5],[6],[7]. The high concentration of polyphenols, total flavonoids, and antioxidant capacity of *C. flava* leaves were also reported by this group [8]. However, only one isolation study of *C. flava* leaves has been reported by Do et al., which identified phenolic compounds including kaempferol, gallic acid, astragalin, and vanillin [9]. As part of our efforts to discover bioactive compounds from medicinal plants, in this current study, we aimed to isolate and structurally elucidate chemical constituents from the ethyl acetate extract of unexplored *C. flava* flowers collected in Phu Tho province.

2. Materials and Methods

2.1. Materials

Flowers of *Camellia flava* (Pitard) Sealy (Theaceae) were provided by Biopharm Hoa

Binh Joint Stock Company in Hoa Binh ward, Phu Tho province, in October 2024. The plant material was identified by Prof. Tran The Bach, Institute of Biology, Vietnam Academy of Science and Technology (VAST). The voucher specimen (Cong21102024) was deposited at the Institute of Biology (VAST).

2.2. General experimental procedures

Solvents and chemicals used for extraction and isolation were of analytical grade. The stationary phases for column chromatography included *silica gel* (240–430 mesh, Merck), reversed-phase *silica gel* (RP-18 YMC), and Sephadex LH-20 (Sigma). Thin-layer chromatography was performed on pre-coated *silica gel* plates (Merck 60 F₂₅₄). Visualization was carried out under a UV lamp at 254 nm or by spraying with 10% sulfuric acid reagent followed by heating. Nuclear magnetic resonance (NMR) spectra were recorded on Bruker 600 MHz and Bruker AM500 FT-NMR spectrometers. Mass spectra (ESI-MS) were measured using an Agilent 1260 LC/MS system.

2.3. Extraction and isolation

The dried flower powder (2.6 kg) was macerated with 70% EtOH at room temperature for 24 hours (13 L × 4 times). The combined EtOH extracts were concentrated under reduced pressure to afford an EtOH residue (1.167 kg). This residue was dissolved in 500 mL of distilled water and successively partitioned with *n*-hexane and ethyl acetate (EtOAc). Removal of the solvent from the EtOAc fraction yielded an EtOAc residue (98.5 g).

The EtOAc residue was subjected to *silica gel* column chromatography (CC), and eluted with a gradient of *n*-hexane–EtOAc (0–100%) to afford nine fractions E1–E9. Fraction E6 (269 mg) was separated by Sephadex LH-20 CC, eluted with MeOH, yielding 7 fractions (E6A–E6G). Fraction E6A (53 mg) was purified by reversed-phase *silica gel* CC eluting with acetone–water (3:1, v/v) to obtain **4** (5.5 mg). Fraction E6D (46 mg) was purified by reversed-phase *silica gel* CC and eluted with acetone–water (2:1, v/v) to obtain **5** (3.4 mg). Fraction E7 (1.45 g) was separated on a *silica gel* column, eluting with *n*-hexane–acetone (8:2, v/v) to afford 10 fractions (E7A–E7K). Fraction E7D (53 mg) was purified by reversed-phase *silica gel* CC, eluting with acetone–water (2:1, v/v) to give **7** (4.5 mg). Fraction E7K (112 mg) was chromatographed by reversed-phase *silica gel* CC using acetone–water (2:1, v/v) as eluent to afford **3** (3.4 mg). Fraction E7F (36 mg)

was separated by reversed-phase *silica gel* CC eluting with acetone–water (2:1, v/v) to yield **6** (2.4 mg).

Fraction E8 (1.69 g) was separated on a *silica gel* CC eluting with *n*-hexane–acetone (8:2, v/v) to afford 9 fractions (E8A–E8I). Compound **1** (5.6 mg) was obtained by recrystallization in MeOH from fraction E8A. Fraction E8G (245 mg) was purified by reversed-phase *silica gel* CC eluting with acetone–water (2:1, v/v) to obtain **2** (4.5 mg). Fraction E8I (123 mg) was purified by reversed-phase *silica gel* CC and eluted with MeOH–water (2:1, v/v) to give **8** (6.5 mg).

3,3',4'-Tri-O-methyl ellagic acid (1): White solid. ESI-MS *m/z* 345 [M+H]⁺. ¹H-NMR (600 MHz, DMSO-*d*₆) and ¹³C-NMR (125 MHz, DMSO-*d*₆): see Table 1.

Pinoresinol (2): White solid. ESI-MS *m/z* 357 [M-H][−]. ¹H-NMR (600 MHz, CD₃OD) and ¹³C-NMR (125 MHz, CD₃OD): See Table 1.

Quercetin (3): Pale yellow solid. ESI-MS *m/z* 303.1 [M+H]⁺. ¹H-NMR (600 MHz, CD₃OD) and ¹³C-NMR (125 MHz, CD₃OD): see Table 2.

Kaempferol (4): Pale yellow solid. ESI-MS *m/z* 287.1 [M+H]⁺. ¹H-NMR (600 MHz, CD₃OD) and ¹³C-NMR (125 MHz, CD₃OD): see Table 2.

Tyrosol (5): White solid. ¹H-NMR (600 MHz, DMSO-*d*₆) and ¹³C-NMR (125 MHz, DMSO-*d*₆): see Table 3.

Caffeic acid (6): Pale yellow solid. ESI-MS *m/z* 179.1 [M-H][−]. ¹H-NMR (500 MHz, CD₃OD) and ¹³C-NMR (125 MHz, CD₃OD): See Table 3.

Protocatechuic acid (7): Brown solid. ¹H-NMR (600 MHz, CD₃OD) δ (ppm): 7.44 (1H, br s, H-2), 7.42 (1H, d, *J* = 8.4 Hz, H-6), 6.79 (1H, d, *J* = 8.4 Hz, H-5). ¹³C-NMR (125 MHz, CD₃OD) δ (ppm): 169.5 (COOH), 149.7 (C-4), 144.0 (C-3), 123.3 (C-1), 121.6 (C-6), 116.5 (C-5), 114.6 (C-2).

Gallic acid (8): Yellow solid. ¹H-NMR (600 MHz, CD₃OD) δ (ppm): 7.07 (2H, s, H-2, H-6). ¹³C-NMR (125 MHz, CD₃OD) δ (ppm): 170.3 (COOH), 146.3 (C-4), 139.6 (C-3, C-5), 110.3 (C-2, C-6), 121.9 (C-1).

3. Results and Discussion

Compound **1** was isolated as a white solid. The ¹H-NMR spectrum showed two signals in the aromatic region at δ_{H} 7.49 (s, H-5) and 7.57 (s, H-5'); 3 methoxy group signals at δ_{H} 4.05 (3H, s), 4.03 (3H, s), and 3.98 (3H, s). The ¹³C-NMR spectrum revealed the signals of 17 carbons, including two carboxyl carbon signals at δ_{C} 158.5 (C-7') and 158.4 (C-7); 12 aromatic carbons at δ_{C} 153.8, 152.9, 141.9, 141.0, 140.8,

140.3, 113.4, 112.5, 111.8, 111.8, 111.0, and 107.5 and 3 methoxy group signals at δ_C 61.3, 61.0, and 56.7. The ESI-MS spectrum exhibited a molecular ion at m/z 345 $[M+H]^+$,

so the molecular formula of **1** was determined as $C_{17}H_{12}O_8$. From NMR and MS data, compound **1** was determined as 3,3',4'-tri-*O*-methyl ellagic acid [10].

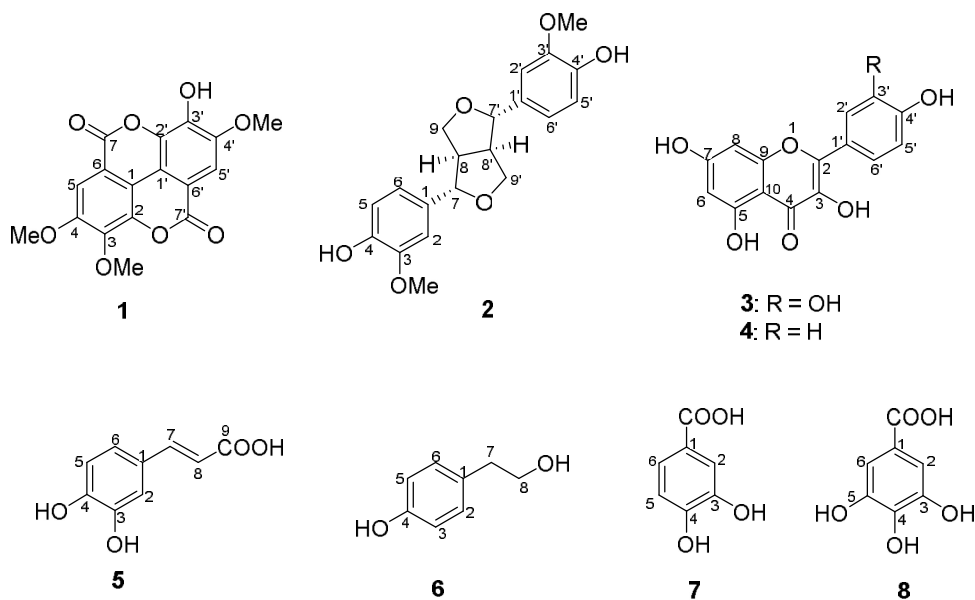


Fig. 1. Chemical structures of isolated compounds **1–8**

Compound **2** was obtained as a white powder. The negative ESI-MS spectrum displayed an ion m/z 357 $[M-H]^-$, which combined with the NMR data, suggested the molecular formula $C_{20}H_{22}O_6$. The molecular formula indicated that **1** has a symmetrical structure with the duplication of NMR signals. The 1H -NMR spectrum showed the presence of 22 protons, including six protons belonging to two ABX aromatic ring systems at δ_H 6.98 (2H, d, $J = 1.8$ Hz, H-2, H-2'), 6.83 (2H, dd, $J = 8.4$, 1.8 Hz, H-6, H-6'), and 6.78 (2H, d, $J = 8.0$ Hz, H-5, H-5'); two oxymethine protons at δ_H 4.67 (2H, d, $J = 4.2$ Hz, H-7, H-7'); four protons of two oxymethylene groups at δ_H 4.20 (2H, m,

Ha-9, Ha-9') and 3.80 (2H, m, Hb-9, Hb-9'); two methoxy groups at δ_H 3.84 (6H, s, 3-OMe, 3'-OMe); and two methine protons at δ_H 3.08 (2H, m, H-8, H-8'). The ^{13}C -NMR spectrum exhibited 10 signals for 20 carbons, including 12 aromatic carbon signals at δ_C 133.8 (C-1, C-1'), 111.0 (C-2, C-2'), 149.1 (C-3, C-3'), 147.3 (C-4, C-4'), 116.1 (C-5, C-5'), and 120.1 (C-6, C-6'); two oxymethine carbons at δ_C 87.5 (C-7, C-7'); two oxymethylene carbons at δ_C 72.6 (C-9, C-9'); two methoxy carbons at δ_C 56.5 (3-OMe, 3'-OMe); and two methine carbons at δ_C 55.3 (C-8, C-8'). Based on the above spectral data and comparison with the reported literature [11], **2** was identified as pinoresinol.

Table 1. 1H - and ^{13}C -NMR data of compounds **1** and **2**

Pos.	1			Pos.	2		
	$\delta_H^{a,b}$ mult. (J in Hz)	$\delta_C^{a,c}$	$\delta_C^{a,d}$ [10]		$\delta_H^{c,b}$ mult. (J in Hz)	$\delta_C^{e,c}$	$\delta_C^{e,e}$ [11]
1		111.0	111.2	1, 1'		133.8	133.8
2		141.0	140.9	2, 2'	6.98, d (1.8)	111.0	111.9
3		140.3	140.2	3, 3'		149.1	149.1
4		152.9	152.6	4, 4'		147.3	147.2
5	7.49, s	111.8	111.6	5, 5'	6.78, d (8.4)	116.1	116.1
6		112.5	112.5	6, 6'	6.83, dd (8.4, 1.8)	120.1	120.0
7		158.4	158.3	7, 7'	4.73, d, (4.2)	87.5	87.4
1'		111.8	111.9	8, 8'	3.16, m	55.3	55.3
2'		141.4	141.5	9, 9'	4.25, m/3.85, m	72.6	72.6
3'		140.8	140.8				

Pos.	1			Pos.	2		
	$\delta_{\text{H}}^{\text{a,b}}$ mult. (J in Hz)	$\delta_{\text{C}}^{\text{a,c}}$	$\delta_{\text{C}}^{\text{a,d}}$ [10]		$\delta_{\text{H}}^{\text{c,b}}$ mult. (J in Hz)	$\delta_{\text{C}}^{\text{e,c}}$	$\delta_{\text{C}}^{\text{e,e}}$ [11]
4'		153.8	153.8	3-OMe	3.87, s	56.5	56.4
5'	7.57, s	107.5	107.5				
6'		113.4	113.4				
7'		158.7	158.4				
3-OMe	4.05, s	61.0	61.0				
3'-OMe	4.03, s	61.3	61.3				
4'-OMe	3.98, s	56.7	56.7				

^a: DMSO-*d*₆; ^b: 600 MHz; ^c: 125 MHz; ^d: 100 MHz; ^e: CD₃OD;

Compound **3** was isolated as a pale yellow solid. The ¹H-NMR spectrum displayed two *meta*-coupled aromatic proton signals at δ_{H} 6.41 (1H, d, *J* = 2.4 Hz, H-8) and 6.19 (1H, d, *J* = 2.4 Hz, H-6); 3 signals corresponding to an ABX spin system of an aromatic ring at δ_{H} 7.68 (1H, d, *J* = 2.4 Hz, H-2'), 7.55 (1H, dd, *J* = 2.4, 8.4 Hz, H-6'), and 6.89 (1H, d, *J* = 8.4 Hz, H-5'). The ¹³C-NMR spectrum showed 15 carbon signals of a flavonoid skeleton, including a carbonyl carbon at δ_{C} 175.4 (C-4), oxygenated aromatic carbons at δ_{C} 164.1 (C-7), 160.7 (C-5), 156.2 (C-9), 147.7 (C-4'), 146.8 (C-2), 145.1 (C-3'), and 135.7 (C-3), methine carbons at δ_{C} 120.0 (C-6'), 115.6 (C-5'), 115.0 (C-2'), 98.2 (C-6), and 93.4 (C-8), and non-protonated aromatic carbons at δ_{C} 121.9 (C-1') and 102.9 (C-10). The ESI-MS of compound **3** displayed a protonated peak at *m/z* 303.1 [M+H]⁺, in combination with the NMR data,

suggested the molecular formula of **3** as C₁₅H₁₀O₇. Compound **3** was identified as quercetin based on comparison of its spectral data with previous literature [12].

Compound **4** was obtained as a pale yellow solid. The ¹H-NMR spectrum of **4** also showed characteristic signals of a flavonoid, with two *meta*-aromatic proton signals at δ_{H} 6.40 (1H, d, *J* = 2.0 Hz, H-8) and 6.20 (1H, d, *J* = 2.0 Hz, H-6); and signals of a 1,4-disubstituted benzene ring at δ_{H} 8.01 (2H, d, *J* = 8.5 Hz, H-2', H-6') and 6.92 (2H, d, *J* = 8.5 Hz, H-3', H-5'). The ¹³C-NMR spectrum of **4** showed signals for 15 carbons of a flavonoid skeleton. The ESI-MS of **4** exhibited an ion at *m/z* 287.1 [M+H]⁺, which suggested the molecular formula C₁₅H₁₀O₆. Compound **4** was determined as kaempferol (Fig. 1) based on the agreement with the reported spectral data [13].

Table 2. ¹H- and ¹³C-NMR data of compounds **3** and **4**

Pos.	3			4		
	$\delta_{\text{H}}^{\text{a,b}}$, mult. (J in Hz)	$\delta_{\text{C}}^{\text{a,c}}$	$\delta_{\text{C}}^{\text{a,c}}$ [12]	$\delta_{\text{H}}^{\text{d,e}}$, mult. (J in Hz)	$\delta_{\text{C}}^{\text{d,e}}$	δ_{C} [13]
2	-	146.8	146.8	-	148.0	148.0
3	-	135.7	135.6	-	137.1	137.1
4	-	175.8	175.9	-	177.3	177.3
5	-	160.7	160.8	-	162.5	162.5
6	6.19, d (2.4)	98.2	98.3	6.20, d (2.0)	99.3	99.3
7	-	164.1	164.2	-	165.5	165.6
8	6.41, d (2.4)	93.4	93.4	6.40, d (2.0)	94.5	94.4
9	-	156.2	156.2	-	158.2	158.2
10	-	102.9	102.0	-	104.5	104.5
1'	-	121.9	122.1	-	123.7	123.7
2'	7.68, d (2.4)	115.0	115.0	8.01, d (8.5)	130.7	130.7
3'	-	145.1	145.1	6.92, d (8.5)	116.3	116.3
4'	-	147.7	147.8	-	160.5	160.5
5'	6.89, d (8.4)	115.6	115.7	6.92, d (8.5)	116.3	116.3
6'	7.55, dd (2.4, 8.4)	120.0	120.0	8.01, d (8.5)	130.7	130.7
5-OH	12.48, s					

^a: DMSO-*d*₆; ^b: 600 MHz; ^c: 125 MHz; ^d: CD₃OD; ^e: 500 MHz.

Compound **5** was obtained as a white solid. The ¹H-NMR spectrum showed signals of an A₂B₂ system of an aromatic ring at δ_{H} 6.78 (2H, d,

J = 8.4 Hz, H-3, H-5), 7.08 (2H, d, *J* = 8.4 Hz, H-2, H-6), and two methylene groups at δ_{H} 2.80 (2H, t, *J* = 6.6 Hz, H-7), 3.82 (2H, t, *J* = 6.6 Hz, H-8).

The ^{13}C -NMR spectrum showed signals for 8 carbons, with 6 signals for the aromatic ring at δ_{C} 131.0 (C-1), 130.9 (C-2, C-6), 116.1 (C-3, C-5), and 156.78 (C-4), an oxymethylene group at δ_{C} 64.8 (C-8), and a methylene group at δ_{C} 39.4 (C-7). Compound **5** was identified as tyrosol based on comparison of its spectral data with the reference literature [14].

Compound **6** was isolated as a pale yellow powder. The ^1H -NMR spectrum of **6** showed the presence of an ABX system with three protons at δ_{H} 7.05 (1H, d, $J = 2.0$ Hz, H-2), 6.94 (1H, dd, $J = 2.0, 8.5$ Hz, H-6), and 6.79 (1H, d, $J = 8.5$ Hz, H-5). In addition, there were two *trans* olefinic protons at δ_{H} 7.53

(1H, d, $J = 15.5$ Hz, H-7) and 6.25 (1H, d, $J = 15.5$ Hz, H-8). The ^{13}C -NMR spectrum of **6** showed signals for 9 carbons, with 6 signals for an aromatic ring at δ_{C} 149.4 (C-3), 146.8 (C-4), 127.9 (C-1), 122.8 (C-6), 115.9 (C-2), and 115.1 (C-5), two olefinic carbons at δ_{C} 146.8 (C-7) and 116.5 (C-8), and one carboxylic acid group at δ_{C} 171.3 (COOH). Based on the above spectral data and comparison with reference literature, **6** was identified as caffeic acid [15].

Compounds **7** and **8** were identified as protocatechuic acid [16] and gallic acid [9], respectively, based on the comparison of NMR data with those in the previous literature.

Table 3. ^1H - and ^{13}C -NMR data of compounds **5** and **6**

Pos.	5		$\delta_{\text{C}}^{\text{a,c}}$ [14]	6		$\delta_{\text{C}}^{\text{a,c}}$ [15]
	$\delta_{\text{H}}^{\text{a,b}}$, mult. (J in Hz)	$\delta_{\text{C}}^{\text{a,c}}$		$\delta_{\text{H}}^{\text{a,d}}$, mult. (J in Hz)	$\delta_{\text{C}}^{\text{a,c}}$	
1		131.0	131.0		127.9	126.4
2	7.08, d (8.4)	130.9	130.9	7.05, d (2.0)	115.9	113.7
3	6.78, d (8.4)	116.1	116.1		149.4	145.6
4		156.8	156.8		146.8	145.4
5	6.78, d (8.4)	116.1	116.1	6.79, d (8.5)	115.1	115.1
6	7.08, d (8.4)	130.9	130.9	6.94, dd (2.0, 8.5)	122.8	121.4
7	2.80, t (6.6)	39.4	39.4	7.53, d (15.5)	146.8	148.1
8	3.82, t (6.6)	64.8	64.6	6.25, d (15.5)	116.5	114.8
9				-	171.3	169.6

^a: CD_3OD ; ^b: 600 MHz; ^c: 125 MHz; ^d: 500 MHz.

Our work represents the first isolation study of *C. flava* flowers. Several ellagic acids have already been found from *Camellia* sp [1], but 3,3',4'-tri-*O*-methyl ellagic acid (**1**) was identified in the genus *Camellia* for the first time. Lignan pinoresinol was isolated from *C. olifera* [17]. Flavonoids quercetin (**3**), kaempferol (**4**), and phenolic acids **5–7** were identified from flowers and leaves of many *Camellia* species like *C. chrysantha* [18], *C. flava* [9], *C. olifera* [19], *C. sinensis* [20], and *C. japonica* [21]. Tyrosol (**5**) was reported from *C. olifera* [22] and *C. japonica* [23]. Our chemical study suggested that *C. flava* possibly has a close chemotaxonomic relationship with *C. olifera* and *C. japonica*. These phenolic constituents displayed various

pharmacological activities such as antioxidant, anti-diabetic, and neuroprotective activities [19],[21],[23],[24],[25].

4. Conclusions

Eight phenolic constituents, including 3,3',4'-tri-*O*-methyl ellagic acid (**1**), pinoresinol (**2**), quercetin (**3**), kaempferol (**4**), tyrosol (**5**), caffeic acid (**6**), protocatechuic acid (**7**), and gallic acid (**8**), were isolated and characterized from the ethyl acetate extract of *Camellia flava* flowers. Compounds **2**, **3**, and **5–7** were identified for the first time from this species, and compound **1** was first reported from the *Camellia* genus.

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References

1. Trinh T. D. (2022), Yellow camellias: a review of chemical constituents and biological activities, *Dalat University Journal of Science*, 12(3), 117-144.
2. Le N. H. N., Luong V. D., Nguyen V. C., Pham T. T. D., Luu T. T., Pham V. T. (2020), An updated checklist of Theaceae and a new species of *Polyspora* from Vietnam. *Taiwania*, 65(2), 216-227.

3. He D., Li X., Sai X., Wang L., Li S., Xu Y. (2018), *Camellia nitidissima* C.W. Chi: A review of botany, chemistry, and pharmacology. *Phytochemistry Reviews*, 17(2), 327-349.
4. Nhut T. M., My N. H. T., Tuan N. D., Thuy N. H. L. (2024), Chemical composition and potential cytotoxic mechanisms of *Camellia flava* (Pitard) Sealy leaves. *Pharmaceutical Sciences Asia*, 51(3), 282.
5. Nguyen Q. T., Nguyen H. L. T., Ha T. T. P., Khuu M. H., Truong M. N., Truong V. D., Mai H. N. (2023), Evaluate acute toxicity and hypoglycemic effect of Golden Camellia flower extract (*Camellia flava*) on alloxan-induced diabetic model. *Vietnam Medical Journal*, 527, 316-319.
6. Nguyen H. L., Thuy H., Phuong T. T., Nguyen N. P., Nguyen P., Linh N. H., Mai H. N. (2024), Effect of *Camellia flava* (Pitard) Sealy flower extract on the degeneration of Islets of Langerhans and insulin resistance in alloxan-induced hyperglycemia model on Swiss albino mice. *Pharmacia*, 71, 1-15.
7. Nguyen H. L. T., Khuu M. H., Nguyen H. K., Truong M. N., Nguyen T. B., Mai H. N. (2024), Evaluate the ameliorative effect of *Camellia flava* leaf and flower extract on high-fat diet-induced obesity on Swiss albino mice, *Vietnam Medical Journal*, 543, 212-216.
8. Truong M. N., Nguyen-Hoang T. M., Nguyen H. L. T. (2022), Identification, chemical determination and evaluation bioactivities of *Camellia flava* in Tay Nguyen. *Journal of Drug Quality Control*, 20, 12-18.
9. Pham T. T., Nguyen D. T., Nguyen T. H., Nguyen H. T., Do T. H. (2019), Các hợp chất phenolic từ lá Trà Hoa vàng Cúc Phương (*Camellia cucphuongensis*) [Phenolic compounds from the leaves of *Camellia cucphuongensis*]. *Tạp chí Nghiên cứu Dược và Thông tin thuốc*, 10(4+5+6), 16-20.
10. Ndukwe G. I., Zhao Y. (2007), Pharmacological activity of 2,3,8-tri-*O*-methyl ellagic acid isolated from the stem bark of *Irvingia gabonensis*, *African Journal of Biotechnology*, 6(16), 1910-1912.
11. Shao P., Dong S., Mu L. T., Han L., Lv C. N., Yuan J. Z., Lu J. C. (2024), Two new anti-inflammatory compounds from the roots and rhizomes of *Clematis terniflora* var. *manshurica* (Rupr.) Ohwi. *Natural Product Research*, 38(11), 1874-1881.
12. Yang Z., Wang Y., Wang Y., Zhang Y. (2012), Bioassay-guided screening and isolation of α -glucosidase and tyrosinase inhibitors from leaves of *Morus alba*. *Food Chemistry*, 131(2), 617-625.
13. Li G., Liu Z., Xie J., Jin Y., Wang L., Yang H., He Y., Shen T. (2025), Chemical constituents of *Oxytropis ochrocephala*. *Molecules*, 30(12), 2489.
14. Tran A. T., Nguyen B. T., Ho H. T. C., Bui H. D. T., Nguyen M. T. T. (2011). Antioxidative activities and chemical constituents of the ethyl acetate extract from *Jasminum undulatum* Ker-Gawl. *VNUHCM Journal of Science and Technology Development*, 14(2), 50-57.
15. Zhou, X. J., Yan, L. L., Yin, P. P., Shi, L. L., Zhang, J. H., Liu, Y. J., Ma, C. (2014). Structural characterisation and antioxidant activity evaluation of phenolic compounds from cold-pressed *Perilla frutescens* var. *arguta* seed flour. *Food Chemistry*, 164, 150-157.
16. Li H. L., Peng C. Z., Zhan R., Liu Y., Chen Y. G. (2015), Phenolics and triterpenoids from *Pterospermum yunnanense*. *Chemistry of Natural Compounds*, 51(5), 972-974.
17. Yan Q. W., Zhong R. J., Zhou G. P., Fu H. Z., Zhang T. X. (2015), Chemical constituents from *Camellia olifera* stem. *Zhongyaocai (Journal of Chinese Medicinal Materials)*, 38(10), 2102-2104.
18. Van N. T. H., Bach P. C., Inh C. T., Phuong D. L., Thanh L. T., Toan T. Q., Long P. Q. (2019), Flavonoids isolated from the flowers of *Camellia chrysantha*. *Vietnam Journal of Science and Technology*, 57(3), 287-293.
19. Ye Y., Guo Y., Luo Y. T., Wang Y. F. (2012), Isolation and free radical scavenging activities of a novel biflavonoid from the shells of *Camellia oleifera* Abel. *Fitoterapia*, 83(8), 1585-1589.
20. Kingori S. M., Ochanda S. O., Koech R. K. (2021), Variation in levels of flavonols myricetin, quercetin and kaempferol in Kenyan tea (*Camellia sinensis* L.) with processed tea types and geographic location. *Open Journal of Applied Sciences*, 11(6), 736-749.
21. Lee H. H., Cho J. Y., Moon J. H., Park K. H. (2011), Isolation and identification of antioxidative phenolic acids and flavonoid glycosides from *Camellia japonica* flowers. *Horticulture, Environment, and Biotechnology*, 52(3), 270-277.
22. Lee C. P., Yen G. C. (2006), Antioxidant activity and bioactive compounds of tea seed (*Camellia oleifera* Abel.) oil. *Journal of Agricultural and Food Chemistry*, 54(3), 779-784.
23. Pereira A. G., Fraga-Corral M., Silva A., Barroso M. F., Grosso C., Carpena M., Garcia-Perez P., Perez-Gregorio R., Cassani L., Prieto M. A. (2024), Unraveling the bioactive potential of *Camellia japonica* edible flowers: profiling antioxidant substances and *in vitro* bioactivity assessment. *Pharmaceuticals*, 17(7), 946.
24. Feunaing R. T., Tamfu A. N., Gbaweng A. J. Y., Kucukaydin S., Tchamgoue J., Lannang A. M., Lenta B. N., Kuam S. F., Duru M. E., Dinica R. M. (2024), *In vitro* and molecular docking evaluation of the anticholinesterase and antidiabetic effects of compounds from *Terminalia macroptera* Guill. & Perr. (Combretaceae). *Molecules*, 29(11), 2456.
25. Plotnikov M. B., Plotnikova T. M. (2021), Tyrosol as a neuroprotector: strong effects of a “weak” antioxidant. *Current Neuropharmacology*, 19(4), 434-448.