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# CHEMICAL CONSTITUENTS FROM *POLYGONATUM KINGIANUM* COLL. & HEMSL.

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**Abstract.** Six compounds, including two homoisoflavanones 3-(2′-hydroxy-4′-methoxy-benzyl)-5,7-dihydroxy-8-methyl-chroman-4-one (**1**), disporopsin (**2**) along with 2-*O*-methyl-*α*-D-fructofuranose (**3**), (*E,E*)-9-oxooctadeca-10,12-dienoic acid (**4**), 1-palmitoylglycerol (**5**), 5*α*,8*α*-ergosterol peroxide (**6**) were isolated from the rhizomes of *Polygonatum kingianum* of Viet Nam. Their structures were determined by 1D- and 2D-NMR spectra and by comparison with the reported spectral data. Compounds **3**, **4** and **6** are first reported from the genus *Polygonatum*. Compound **1** and **5** are reported for the first time from *Polygonatum kingianum.*

*Keywords: Polygonatum kingianum*, homoisoflavanone, 2-*O*-methyl-*α*-D-fructofuranose, (*E,E*)-9-oxooctadeca-10,12-dienoic acid, 5*α*,8*α*-ergosterol peroxide.

*Classification numbers*: 1.1.1, 1.1.6.

## 1. INTRODUCTION

*Polygonatum kingianum* Coll. & Hemsl. belonging to the genus *Polygonatum* (Liliaceae), is originated in Asian temperate and subtropical regions. The species is distributed mainly in China, Laos, and Viet Nam. In traditional Vietnamese medicine, the rhizomes of *P. kingianum* has been used to treat some diseases such as tuberculosis, hemoptysis, angina, coronary artery disease, diabetes, hypotension, autonomic nervous system disorders [1]. On the other hand, *P. kingianum*is also is used as a tonic and a remedy to treat lung diseases, upset stomachs, hyperlipidemia and related metabolic syndrome, ringworm in China [2 - 4]. Some previous studies on the rhizomes of *P. kingianum* in the world have resulted in the isolation of steroidal saponins, flavonoids, alkaloids, phenolics, fructose derivatives, and phytosterols [3 - 6]. However, in Viet Nam, there have not been any publication on chemical constituents of *P. kingianum* so far. In the present paper, we report the isolation and structural identification of

six compounds including 3-(2′-hydroxy-4′-methoxy-benzyl)-5,7-dihydroxy-8-methyl-chroman-4-one (**1**), disporopsin (**2**), 2-*O*-methyl-*α*-D-fructofuranose (**3**), (*E,E*)-9-oxooctadeca-10,12-dienoic acid (**4**), 1-palmitoylglycerol (**5**), 5*α*,8*α*-ergosterol peroxide (**6**) from the rhizomes of *P. kingianum* of Viet Nam.

## 2. MATERIALS AND METHODS

### 2.1. Plant materials

The rhizomes of *Polygonatum kingianum* Coll. & Hemsl. were collected at Ha Giang, Viet Nam in September 2017, and identified by Dr. Nguyen Van Du, Institute of Ecology and Biological Resources, Vietnam Academy of Science and Technology (VAST). A voucher specimen (HTHĐ - 09.2017) has been deposited at Institute of Natural Products Chemistry, VAST.

### 2.2. General experimental procedures

The $^{1}$H-NMR (500 MHz) and $^{13}$C-NMR (125 MHz) spectra were recorded on a Bruker AM500 FT-NMR spectrometer and tetramethylsilane was used as an internal standard. ESI-MS spectra were obtained from an Agilent 1100 Series LC/MSD Trap SL. The optical rotation was conducted on Jasco-P2000 instrument. Column chromatography (CC) was performed using silica gel (0.040 - 0.063 mm) and YMC RP-18 resins (30 - 50 μm). Thin layer chromatography (TLC) used pre-coated silica gel 60 $F_{254}$ and RP-18 $F_{254S}$ plates. Compounds were visualized by UV light at 254 and 365 nm, and by spraying with the solution of 10 % $H_2SO_4$ in ethanol and heating for 1-3 minutes.

### 2.3. Extraction and isolation

The dried and powdered rhizomes of *P. kingianum* (3.0 kg) were extracted with hot methanol three times using bath sonicator to yield 350 g of dark crude residue, which was then suspended in water and successively partitioned with *n*-hexane, ethyl acetate (EtOAc) to obtain the corresponding extracts: *n*-hexane (25.0 g), EtOAc (45.0 g) and water layer.

The *n*-hexane extract (25.0 g) was applied to silica gel CC eluting with a gradient of *n*-hexane : EtOAc (50:1, 20:1, 5:1,1:1, 0:1; v:v) to provide five fractions (H1 to H5). Fraction H1 (3.2 g) was fractionated on silica gel CC using the mobile phase of *n*-hexane : EtOAc (25:1; v:v) to give three smaller fractions (H1.1 to H1.3). Fraction H1.2 (0.8 g) was further purified by silica gel CC eluting with *n*-hexane : acetone (15:1; v:v) to afford compound **5** (12.0 mg). Fraction H2 (1.5 g) was firstly subjected to silica gel CC with the eluent of *n*-hexane : EtOAc (10:1; v:v) and then recrystallized in *n*-hexane : acetone (4:1; v:v) to yield compound **6** (15.0 mg). Fraction H3 (2.0 g) was separated into four smaller fractions (H3.1 to H3.4) by silica gel CC using *n*-hexane : EtOAc (15:1; v:v) as eluent. Compound **4** (10.0 mg) was obtained from fraction H3.2 using silica gel CC and the eluent of dichloromethane : EtOAc (40:1; v:v).

The EtOAc extract (45.0 g) was subjected to silica gel CC eluting with a gradient of *n*-hexane : EtOAc (10:1, 4:1, 1:1,1:2, 0:1; v:v) to produce five fractions (E1 to E5). Fraction E1 (5.7 g) was subsequently separated using silica gel CC and *n*-hexane : acetone (15:1; v:v) to give four smaller fractions (E1.1 to E1.4). Fraction E1.1 (1.2 g) was passed through silica gel CC using the mobile phase of dichloromethane : EtOAc (10:1; v:v) to yield five sub-fractions

(E1.1.1 to E1.1.5). Purification of sub-fraction E1.1.3 on YMC RP-18 CC with the solvent system of methanol : water (1:3, v:v) gave compound **1** (12.0 mg). Fraction E1.2 (0.9 g) was chromatographed on silica gel CC with dichloromethane : acetone (15:1; v:v) and then on silica gel CC with the solvent mixture of chloroform : methanol : water (8:1:0.05; v:v:v) to achieve compound **2** (9.0 mg). Fraction E5 (2.8 g) was separated into four smaller fractions (E5.1 to E5.4) by silica gel CC using the solvent mixture of chloroform : methanol : water (7:1:0.1; v:v:v). Fraction E5.3 (0.6 g) was purified by YMC RP-18 CC using methanol : water (2:1, v:v) to afford compound **3** (11.0 mg).

**3-(2′-hydroxy-4′-methoxy-benzyl)-5,7-dihydroxy-8-methyl-chroman-4-one (1)**: yellow powder. ESI-MS: *m/z* 331.1 $[M+H]^+$, $C_{18}H_{18}O_6$. $[\alpha]_D^{25}$ = – 12.5 (*c* 0.2, MeOH). $^1$H-NMR (500 MHz, $CD_3OD$), δ (ppm): 1.94 (3H, s, $CH_3$); 2.63 (1H, dd, *J* = 13.5, 5.0 Hz, Ha-9); 2.97 (1H, m, H-3); 3.20 (1H, dd, *J* = 13.5, 5.0 Hz, Hb-9); 3.76 (3H, s, $OCH_3$); 4.15 (1H, dd, *J* = 11.5, 7.5 Hz, Ha-2); 4.30 (1H, dd, *J* = 11.5, 7.5 Hz, Hb-2); 5.94 (1H, s, H-6); 6.38 (1H, dd, *J* = 8.5, 2.5 Hz, H-5′); 6.40 (1H, d, *J* = 2.5 Hz, H-3′); 7.00 (1H, d, *J* = 8.5 Hz, H-6′). $^{13}$C-NMR (125 MHz, MeOD), δ (ppm): 7.4($CH_3$); 28.2(C-9); 46.4(C-3); 55.6 ($OCH_3$); 70.7 (C-2); 96.2(C-6); 102.4 (C-3′); 102.9(C-4a); 104.2 (C-8); 105.7 (C-5′); 118.3 (C-1′); 132.6 (C-6′); 157.6 (C-2′); 161.2 (C-4′); 161.7 (C-8a); 163.3 (C-5); 166.0 (C-7); 200.5 (C-4).

**Disporopsin (2):** white powder. ESI-MS: *m/z* 303.4 $[M+H]^+$, $C_{18}H_{14}O_6$. $[\alpha]_D^{25}$ = – 24.5 (*c* 0.1, MeOH). $^1$H-NMR (500 MHz, $CD_3OD$), δ (ppm): 2.59 (1H, d, *J* = 14.0 Hz, Ha-9); 3.15 (1H, d, *J* = 14.0 Hz, Hb-9); 4.09 (1H, d, *J* = 11.5 Hz, Ha-2); 4.23 (1H, d, *J* = 11.0 Hz, Hb-2); 5.80 (1H, d, *J* = 2.0 Hz, H-8); 5.83 (1H, d, *J* = 2.0 Hz, H-6); 6.26 (1H, dd, *J* = 8.0, 2.5 Hz, H-5′); 6.32 (1H, d, *J* = 2.5 Hz, H-3′); 6.89 (1H, d, *J* = 8.0 Hz, H-6′). $^{13}$C-NMR (125 MHz, MeOD), δ (ppm): 28.3 (C-9); 46.1 (C-3); 70.5 (C-2); 96.6 (C-8); 97.8 (C-6); 102.2 (C-4a); 103.6 (C-3′); 107.5 (C-5′); 117.0 (C-1′); 132.6 (C-6′); 157.6 (C-2′); 158.3 (C-4′); 164.8 (C-8a); 165.8 (C-5); 170.5 (C-7); 199.6 (C-4).

**2-*O*-methyl-*α*-D-fructofuranose (3):** pale yellow oil. ESI-MS: *m/z* 195.2 $[M+H]^+$, $C_7H_{14}O_6$. $[\alpha]_D^{25}$ = + 27.0 (*c* 0.15, MeOH). $^1$H-NMR (500 MHz, $CD_3OD$), δ (ppm): 3.30 (3H, s, $OCH_3$); 3.65 (1H, d, *J* = 12.0 Hz, Ha-1); 3.66 (1H, dd, *J* = 3.0, 12.0 Hz, Ha-6); 3.73 (1H, d, *J* = 12.0 Hz, Hb-1); 3.77 (1H, dd, *J* = 3.0, 12.0 Hz, Hb-6); 3.87 (1H, m, H-5); 3.92 (1H, m, H-4); 4.05 (1H, d, *J* = 4.5 Hz, H-3).$^{13}$C-NMR (125 MHz, MeOD), δ (ppm): 49.0 ($OCH_3$); 60.5 (C-1); 62.8 (C-6); 78.9 (C-4); 82.5 (C-3); 84.6 (C-5); 109.2 (C-2).

**(*E,E*)-9-oxooctadeca-10,12-dienoic acid (4)**: colorless oil. ESI-MS: *m/z* 295.2 $[M+H]^+$, $C_{18}H_{30}O_3$. $^1$H-NMR (500 MHz, $CDCl_3$), δ (ppm): 0.88 (3H, t, *J* = 6.5 Hz, H-18); 1.27 – 1.33 (10H, H-4, H-5, H-6, H16, H17); 1.43 (2H, m, H-15); 1.61 (2H, m, H-7); 1.63 (2H, m, H-3); 2.18 (2H, m, H-14); 2.34 (2H, t, *J* = 7.5 Hz, H-2); 2.53 (2H, t, *J* = 7.5 Hz, H-8); 6.07 (1H, d, *J* = 15.0 Hz, H-10); 6.16 (1H, m, H-13); 6.17 (1H, m, H-12); 7.13 (1H, dm, *J* = 15.0 Hz, H-11). $^{13}$C-NMR (125 MHz, $CDCl_3$), δ (ppm):14.0 (C-18); 22.5 (C-17); 24.4 (C-7); 24.6 (C-3); 28.4 (C-15); 28.9-29.1 (C-4 to C-6); 31.4 (C-16); 33.1 (C-14); 33.8 (C-2); 40.5 (C-8); 127.9 (C-10); 128.9 (C-12); 143.1 (C-11); 145.8 (C-13); 178.6 (C-1); 201.1 (C-9).

**1-palmitoylglycerol (5):** white powder. ESI-MS: *m/z* 331.3 $[M+H]^+$, $C_{19}H_{38}O_4$. $^1$H-NMR (500 MHz, $CDCl_3$), δ (ppm): 0.88 (3H, t, *J* = 7.0 Hz, H-16′); 1.26 (24H, H-4′ to H-15′); 1.60 (2H, m, H-3′); 2.35 (2H, t, *J* = 7.5 Hz, H-2′); 3.59 (1H, dd, *J* = 3.5, 11.5 Hz, Ha-3); 3.69 (1H, dd, *J* = 6.0, 11.5 Hz, Hb-3); 3.92 (1H, m, H-2); 4.17 (2H, m, H-1). $^{13}$C-NMR (125 MHz, $CDCl_3$), δ

(ppm): 14.1(C-16′); 22.7 (C-15′); 24.9 (C-3′); 29.1-29.7 (C-4′ to C-13′); 31.9 (C-14′); 34.2 (C-2′); 63.4 (C-3); 65.1 (C-1); 70.3 (C-2); 174.4 (C-1′).

**5*α*,8*α*-ergosterol peroxide (6):** white crystals. ESI-MS: *m/z* 429.2 $[M+H]^+$, $C_{28}H_{44}O_3$. $^1$H-NMR (500 MHz, $CDCl_3$), δ (ppm): 0.81 (3H, d, *J* = 7.0 Hz, H-26); 0.82 (3H, s, H-19); 0.83 (3H, d, *J* = 7.0 Hz, H-27); 0.88 (3H, s, H-18); 0.90 (3H, d, *J* = 7.0 Hz, H-28); 1.00 (3H, d, *J* = 6.5 Hz, H-21); 1.22 (2H, m, Ha-12, H-17); 1.23 (1H, m, Ha-11); 1.35 (1H, m, Ha-16); 1.41 (1H, m, Ha-15); 1.46 (1H, m, H-25); 1.49 (1H, m, H-9); 1.50 (1H, m, Hb-11); 1.53 (1H, m, Ha-2); 1.57 (1H, m, H-14); 1.59 (1H, m, Hb-15); 1.69 (1H, m, Ha-1); 1.75 (1H, m, Hb-16); 1.84 (2H, m, Hb-2, H-24); 1.90 (1H, m, Ha-4); 1.95 (2H, m, Hb-1, Hb-12); 2.01 (1H, m, H-20); 2.10 (1H, m, Hb-4); 3.96 (1H, m, H-3); 5.15 (1H, m, H-22); 5.23 (1H, m, H-23); 6.24 (1H, d, *J* = 8.5 Hz, H-6); 6.50 (1H, d, *J* = 8.5 Hz, H-7). $^{13}$C-NMR (125 MHz, $CDCl_3$), δ (ppm): 12.9 (C-19); 17.6 (C-28); 18.2 (C-18); 19.6 (C-26); 19.9 (C-27); 20.6 (C-15); 20.9 (C-21); 23.4 (C-11); 28.6 (C-16); 30.1 (C-2); 33.1 (C-25); 34.7 (C-1); 37.0 (C-4, C-10); 39.4 (C-12); 39.7 (C-20); 42.8 (C-24); 44.6 (C-13); 51.1 (C-9); 51.7 (C-14); 56.2 (C-17); 66.5 (C-3); 79.4 (C-8); 82.2 (C-5); 130.8 (C-7); 132.3 (C-23); 135.2 (C-22); 135.4 (C-6).

## 3. RESULTS AND DISCUSSION

Compound **1** was obtained as a yellow powder. The molecular ion peak at *m/z* 331.1 $[M+H]^+$ from ESI-MS spectrum of **1** suggested its molecular formula $C_{18}H_{18}O_6$. Detailed analysis of the $^1$H-NMR and HSQC spectra of **1** revealed four aromatic protons [5.94 (1H, s, H-6), 6.38 (1H, dd, *J* = 8.5, 2.5 Hz, H-5′), 6.40 (1H, d, *J* = 2.5 Hz, H-3′), 7.00 (1H, d, *J* = 8.5 Hz, H-6′)], a singlet methyl signal ($\delta_H$ 1.94), a methoxy group ($\delta_H$ 3.76), two methylene groups and a methine proton. The $^{13}$C-NMR spectrum of **1** showed 18 carbon signals. Twelve of them were assigned to two aromatic rings ($\delta_C$ from 96.2 to 166.0 ppm). Besides, the presence of a carbonyl group ($\delta_C$ 200.5), a methylene ($\delta_C$ 28.2), an oxygenated methylene ($\delta_C$ 70.7), and a methine ($\delta_C$ 46.4) suggested compound **1** was a homoisoflavanone [7]. The HMBC cross-peaks from the methyl group ($\delta_H$ 1.94) to C-7 ($\delta_C$ 166.0), C-8 ($\delta_C$ 104.2), C-8a ($\delta_C$ 161.7) and from the methoxy group ($\delta_H$ 3.76) to C-4′ ($\delta_C$ 161.2) established the methyl and methoxy groups were attached to C-8 and C-4′, respectively. According to the analysis, specific rotation value and comparison with the published data [8], compound **1** was determined to be 3-(2′-hydroxy-4′-methoxy-benzyl)-5,7-dihydroxy-8-methyl-chroman-4-one, which was isolated from *P. kingianum* for the first time.

Compound **2** was obtained as a white powder. The molecular ion peak at *m/z* 303.4 $[M+H]^+$ from ESI-MS spectrum of **2** suggested its molecular formula $C_{18}H_{14}O_6$. The $^{13}$C-NMR spectrum of **2** showed the presence of 16 carbon signals typical of a homoisoflavanone skeleton [28.3(C-9); 46.1 (C-3); 70.5 (C-2), 199.6 (C-4), the others from $\delta_C$ 96.6 to 170.5 ppm] [7]. The $^1$H-NMR spectrum of **2** exhibited five aromatic protons at $\delta_H$ 5.80 (1H, d, *J* = 2.0 Hz, H-8), 5.83 (1H, d, *J* = 2.0 Hz, H-6), 6.26 (1H, dd, *J* = 8.0, 2.5 Hz, H-5′), 6.32 (1H, d, *J* = 2.5 Hz, H-3′), 6.89 (1H, d, *J* = 8.0 Hz, H-6′). Based on the spectroscopic evidence and specific rotation value, the structure of compound **2** was identified as disporopsin by comparison with the published data [9]. Disporopsin was previously isolated from the rhizomes of *P. kingianum* [10] and found to be cytotoxic against a series of human cancer cell lines (HCT15, T24S, MCF7, Bowes) [9].

Compound **3** was obtained as pale yellow oil. The molecular ion peak at *m/z* 195.2 $[M+H]^+$ from ESI-MS spectrum of **3** suggested its molecular formula $C_7H_{14}O_6$. Detailed analysis of the

$^{1}$H-, $^{13}$C-NMR and HSQC spectra of **3** displayed signals of three oxygenated methines [3.87 (1H, m, H-5)/ 84.6 (C-5), 3.92 (1H, m, H-4)/ 78.9 (C-4), 4.05 (1H, d, *J* = 4.5 Hz, H-3)/ 82.5 (C-3)], two oxygenated methylenes [3.65 (1H, d, *J* = 12.0 Hz, Ha-1), 3.73 (1H, d, *J* = 12.0 Hz, Hb-1)/ 60.5 (C-1) and 3.66 (1H, dd, *J* = 3.0, 12.0 Hz, Ha-6), 3.77 (1H, dd, *J* = 3.0, 12.0 Hz, Hb-6)/ 62.8 (C-6)], a dioxygenated non-protonated carbon [109.2 (C-2)]. The above evidence suggested the presence of a fructofuranose moiety, which was supported by correlations observed from the COSY and HMBC spectra. Furthermore, a singlet signal at $\delta_H$ 3.30 (3H, s) was assigned to a methoxy group. The location of the methoxy group at C-2 was deduced by the HMBC cross-peak between $\delta_H$ 3.30 and $\delta_C$ 109.2 (C-2). The NOESY correlation of the methoxy protons with H-3 suggested *α* configuration at C-2 [11]. The prediction was further confirmed by the positive optical rotation value of **3** as $[\alpha]_D^{25}$ = + 27.0 (*c* 0.15, MeOH) [11]. Therefore, the structure of **3** was determined as 2-*O*-methyl-*α*-D-fructofuranose by comparison with the published literature [11]. This is the first report on the isolation of 2-*O*-methyl-*α*-D-fructofuranose from the genus *Polygonatum.*

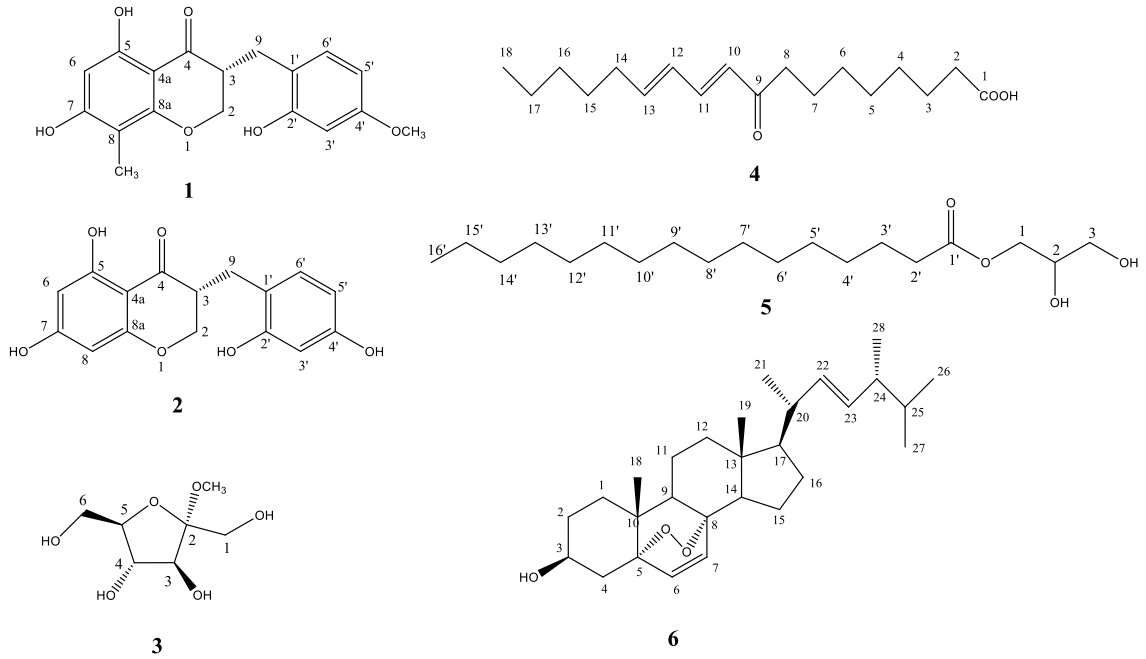


*Figure 1.* Chemical structures of isolated compounds (**1**-**6**).

Compound **4** was obtained as a colorless oil. The molecular ion peak at *m/z* 295.2 $[M+H]^+$ from ESI-MS spectrum of **4** suggested its molecular formula $C_{18}H_{30}O_3$. The $^{1}$H-NMR data of **4** revealed four olefinic protons [6.07 (1H, d, *J* = 15.0 Hz, H-10); 6.16 (1H, m, H-13); 6.17 (1H, m, H-12); 7.13 (1H, dd, *J* = 15.5, 9.5Hz, H-11)], a triplet methyl signal [0.88 (3H, t, *J* = 6.5 Hz, H-18)], and an overlap signal at $\delta_H$ from 1.27 to 1.33 (10H, m). The $^{13}$C-NMR and HSQC spectra of **4** showed 18 carbon signals including two carbonyl group [178.6 (C-1), 201.1 (C-9)], four olefinic methines [127.9 (C-10), 128.9 (C-12), 143.1 (C-11), 145.8 (C-13)], a methyl group [14.0 (C-18)] and eleven methylenes from at $\delta_C$ 22.5 to 40.5. The above spectroscopic data suggested **4** was an oxooctadecadienoic acid [12]. The spectroscopic data of **4** was identical to those of (*E*,*E*)-9-oxooctadeca-10,12-dienoic acid [13]. The cross-peaks obtained from HMBC and COSY spectra of **4** further confirmed the identified structure. Therefore, the structure of **4**

was deduced to be (*E,E*)- 9-oxooctadeca-10,12-dienoic acid, which was first reported from the genus *Polygonatum*. Compound **4** was previously reported to show acetyl-CoA carboxylase inhibitory activity thus retard fat accumulation and avoid obesity which is a risk factor of many chronic diseases [12].

Compound **5** was obtained as a white powder. The molecular ion peak at *m/z* 331.3 $[M+H]^+$ from ESI-MS spectrum of **5** suggested its molecular formula $C_{19}H_{38}O_4$. The $^1$H-NMR spectrum of **5** showed a triplet methyl signal [0.88 (3H, t, *J* = 7.0 Hz, H-16′)] and an overlap signal [1.26 (24H, H-4′ to H-15′)], suggesting the presence of a long chain aliphatic moiety. Besides, five protons [3.59 (1H, dd, *J* = 3.5, 11.5 Hz, Ha-3), 3.69 (1H, dd, *J* = 6.0, 11.5 Hz, Hb-3), 3.92 (1H, m, H-2), 4.17 (2H, m, H-1)] were assigned to a glycerol moiety. The $^{13}$C-NMR spectrum of **5** exhibited a carbonyl group [174.4 (C-1′)] along with three carbon of a glycerol moiety [63.4 (C-3), 65.1 (C-1), 70.3 (C-2)] and the others belonging to a long chain aliphatic moiety [14.1 (C-16′), 22.7 (C-15′), 24.9 (C-3′), 29.1-29.8 (C-4′ to C-13′), 31.9 (C-14′), 34.2(C-2′)]. These predictions are completely based on the data obtained from the HSQC, HMBC and COSY spectra of **5**. Based on the spectroscopic evidence and by comparison with the published data [14], compound **5** was identified as 1-palmitoylglycerol, which was obtained from *P. kingianum* for the first time.

Compound **6** was obtained as white crystals. The molecular ion peak at *m/z* 429.2 $[M+H]^+$ from ESI-MS spectrum of **6** suggested its molecular formula $C_{28}H_{44}O_3$. The $^1$H-NMR spectrum of **6** displayed the presence of four olefinic protons [6.24 (1H, d, *J* = 8.5 Hz, H-6), 6.50 (1H, d, *J* = 8.5 Hz, H-7), 5.15 (1H, m, H-22), 5.23 (1H, m, H-23)], an oxygenated methine proton [3.96 (H-3)] and six methyl groups [0.81 (3H, d, *J* = 7.0 Hz, H-26), 0.82 (3H, s, H-19), 0.83 (3H, d, *J* = 7.0 Hz, H-27), 0.88 (3H, s, H-18), 0.90 (3H, d, *J* = 7.0 Hz, H-28), 1.00 (3H, d, *J* = 6.5 Hz, H-21)]. The $^{13}$C-NMR and DEPT spectra of **6** showed signals of 28 carbons (6 x $CH_3$, 7 x $CH_2$, 11x CH, 4 x non-protonated C). Four olefinic carbons [130.8 (C-7), 132.3 (C-23), 135.2 (C-22), 135.4 (C-6)] and three oxygenated carbons [79.4 (C-8), 82.2 (C-5), 66.5 (C-3)] are characteristic for a 5*α*,8*α*-epidioxy sterol skeleton [15]. Detailed analysis of HSQC, HMBC and COSY spectra of **6** further confirmed the predicted structure. Based on the above evidence and literature [16], compound **6** was identified to be 5*α*,8*α*-ergosterol peroxide, which was reported to have antibacterial, anti-inflammatory, antiviral, antioxidant, antitumor and immunosuppressive properties [17]. 5*α*,8*α*-Ergosterol peroxide is a known compound obtained from a variety of fungi, lichens, sponges, and marine organisms [18] but this is the first time this compound was isolated from the genus *Polygonatum*.

## 4. CONCLUSION

From the *n*-hexane and EtOAc extracts of the rhizomes of *P. kingianum* (Liliaceae), six compounds were isolated and identified of structures including 3-(2′-hydroxy-4′-methoxy-benzyl)-5,7-dihydroxy-8-methyl-chroman-4-one (**1**), disporopsin (**2**), 2-*O*-methyl-*α*-D-fructofuranose (**3**), (*E,E*)-9-oxooctadeca-10,12-dienoic acid (**4**), 1-palmitoylglycerol (**5**), and 5*α*,8*α*-ergosterolperoxide (**6**). Among them, compound **1** and **5** were isolated from *P. kingianum* for the first time, compounds **3**, **4** and **6** were first reported from the genus *Polygonatum*. To date, this is the first phytochemical investigation of *P. kingianum* of Viet Nam.

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