

ALPHA GLUCOSIDASE INHIBITORY AND ANTIOXIDANT ACTIVITY OF EXTRACTS AND COMPOUNDS FROM ZINGIBER ZERUMBET LINN RHIZOMES

Ngo Xuan Luong¹, Le Thi Thuy Loan²

Received: 27 October 2025/ Accepted: 20 July 2026/ Published: 30 July 2026

<https://doi.org/10.70117/hdujs.E11.7.2026.1050>

Abstract: Extraction and isolation of ethyl acetate extract from the stem and root of ginger (*Zingiber zerumbet* Linn) and study of antioxidant and alpha glucosidase inhibitory properties of this extract. The results showed that the substances from the ethyl acetate extract inhibited α -glucosidase more effectively than the positive control acarbose, with an IC_{50} value of 95.7 μ g/mL, but the DPPH antioxidant activity was weaker than that of the positive control Trolox, with an IC_{50} value of 76.2 μ g/mL. Syringic acid (1) and Kaempferol-3-O-(4-O-acetyl)- α -L-rhamnopyranoside (2) were isolated from the ethyl acetate extract. In which, compound 2 showed strong α -glucosidase inhibitory activity with the corresponding IC_{50} value of 98.63 μ M, twice lower than that of acarbose (IC_{50} 214.1 μ M). The α -glucosidase inhibitory activity of substances from the stem and root of ginger (*Zingiber zerumbet* Linn) was demonstrated, which is a good anti-diabetic plant.

Keywords: *Zingiber zerumbet*, chloroform extract, α -glucosidase, aromadendrin, naringenin.

1. Introduction

The Ginger family (*Zingiberaceae*), is the family with the largest number of species in Vietnam, including perennial herbs with rhizomes that creep horizontally or form tubers, growing in moist places, under the canopy of large trees or forest canopy. Including 47 genera and nearly 1,000 species distributed in tropical and subtropical regions, mainly in South and Southeast Asia, with the most important species being ginger, turmeric, galangal, cardamom and cardamom [1-3]. Ginger has many uses, the stem and root are often used as a food spice or appetizer in the cuisine of many countries. In traditional medicine, active ingredients extracted from the rhizome are used to treat swelling, loss of appetite, back pain, diabetes, inflammation, chest pain, rheumatism, bronchitis, indigestion and sore throat [4-6].

Wild ginger, also known as wild galangal, green mugwort, sun mugwort, this plant belongs to the genus *Ginger* and grows wild in the northern mountainous provinces of our country, in humid places or along dense streams [7]. The important part of *Ginger* is the rhizome, which has many medicinal uses. According to oriental medicine, the plant has a bitter taste, neutral and spicy properties, and has the effect of clearing heat, eliminating wind, relieving pain, treating blood stasis, treating strokes, abdominal pain, and swelling. In addition, this plant is also used as a tonic, clearing heat, stimulating appetite, and

¹ Hong Duc Primary, Secondary and High School University; Email: ngoxuanluong@hdu.edu.vn

² Tay Nguyen University

nourishing the body for postpartum women [8]. Pharmacologically, *Z. zerumbet* has been studied to inhibit colon and lung carcinogenesis in mice [9], CXCL12-induced breast and pancreatic cancer cell invasion [10], apoptosis in liver cancer [11], inhibition of the expression of multiple scavenger receptor genes induced by phorbol esters in THP-1 human monocytes and Epstein-Barr virus activation [12-13]. Many studies on the chemical composition of *Z. zerumbet* have shown many different bioactive compounds such as: zerumbone, borneol, α -pinene, β -pinene, camphor, linalool, limonene, α -curcumene, α -humulene, humulene monoxide, humulene dioxide, β -caryophyllene, camphene, cineole [14] and sesquiterpenoids such as humulene epoxide I, humulene epoxide II, humulene epoxide III, humulenol I, humulenol II and caryophyllene oxide were found in the essential oil of the rhizome of *Z. zerumbet* India [14-16]. In addition, some new compounds were also identified in the essential oil of *Z. zerumbet* including: *cis*-nerolidol, α -phellandrene, terpinolene, *p*-cymene, caryophyllene oxide, δ -cardinene, fenchone and bornyl acetate [17]. Several phenolic compounds and glycosides have also been found such as: zerumbone, 3-O-methyl kaempferol, kaempferol-3-O-(2,4-di-O-acetyl- α -L-rhamnopyranoside), and kaempferol-3-O-(3,4-di-O-acetyl- α -L-rhamnopyranoside) from the rhizome [18]. Zerumbone is a compound isolated from *Ginger*, which has been extensively studied because it exhibits many valuable biological activities such as analgesic [19], anti-inflammatory [20-23] and antiplatelet aggregation [24] *in vivo*. Among the plants used as medicine, ginger (*Z. zerumbet*) is a familiar plant in life and contains many active ingredients that can inhibit the enzyme α -glucosidase and are of interest. In this article, the research process on ginger (*Z. zerumbet*) collected in Dak Lak province, from the rhizome extract, isolation and identification of substances from the ethyl acetate extract. And testing the ability to inhibit the enzyme α -glucosidase and antioxidant of the extract and isolated compounds.

2. Materials and Methods

2.1. General

Column chromatography (CC) was conducted on silica gel 60 (Merck, 15-40 μ m, 40-63 μ m and 63-200 μ m). Thin layer chromatography (TLC) was carried out on precoated plates of silica gel 60 F254 (Merck) and spots were visualised using UV light (254 and 365 nm) or staining with vanilin-H₂SO₄ 10% solution and heating for 2-3 min. The UV spectra were recorded on a V-630 UV-VIS spectrophotometer (Jasco, Japan). NMR spectra were measured on a Bruker Avance 500 MHz NMR spectrometer, operating at 500 MHz (¹H) and 125 MHz (¹³C) with TMS as an internal standard. Chemical shifts were recorded in parts per million δ (ppm).

2.2. Plant materials

Z. zerumbet was collected in Dak Lak province, Vietnam in May 2023 and scientifically identified by Dr. Nguyen Quoc Binh, Vietnam Museum of Nature, Vietnam Academy of Science and Technology (VAST). The specimen (GG-AG-01) is kept at the Faculty of Natural Sciences and Technology, Tay Nguyen University, Dak Lak province, Vietnam.

2.3. Extraction and isolation

The stems and roots were washed, chopped, dried at 40°C for 3 days to obtain 5.2 kg of dry matter. The sample was extracted with methanol (MeOH) (3 liters x 3) at room temperature using conventional ultrasound-assisted techniques. The extract was obtained and concentrated under reduced pressure to obtain 608.3 g of methanol residue. The methanol residue was distributed in the solvents in order of increasing polarity: n-hexane, chloroform, ethyl acetate (each solvent 3 liters x 3). Solvent recovery yielded the following residues: n-hexane (145.0 g), chloroform (54.0 g), ethyl acetate (18.2 g) and methanol (374.0 g). The ethyl acetate residue was applied to a silica gel chromatography column (CC) and eluted with a chloroform: methanol gradient solvent system (ratio 100:0 to 0:100, v/v) to obtain 7 fractions A-G. Fraction D was further isolated by (CC) on silica gel, eluted with a n-hexane-ethyl acetate gradient solvent system (ratio 70:1 to 0:100, v/v) to obtain 10 fractions D1-D10. Fraction D4 was separated by silica gel CC column with gradient solvent n-hexane:ethyl acetate (ratio 100:0 to 0:100, v/v) combined with preparative thin layer chromatography (PTLC) with chloroform:methanol system (45:55, v/v) to obtain compound 1 (4.6 mg). Fraction D7 was separated by silica gel CC column with gradient solvent n-chloroform:ethyl acetate (ratio 100:0 to 0:100, v/v) to obtain 6 fractions D7.1- D7.6. Fraction D7.3 was separated by silica gel CC column with chloroform:ethyl acetate gradient solvent (ratio 100:0 to 0:100, v/v) combined with preparative thin layer chromatography (PTLC) with chloroform:ethyl acetate system (65:35, v/v) to obtain compound 2 (7.1 mg).

2.4. Inhibition of α -glucosidase assay

α -glucosidase inhibition was performed according to the method [25] where the extracts and compounds were dissolved in DMSO and diluted with phosphate buffer (pH 6.8) at different concentrations of 250, 100, 50, 25 and 10 μ g/ml. In a 96-well plate, the reaction mixture containing 100 μ L of phosphate buffer (100 mM, pH 6.8), 40 μ L of extracts or compounds, 20 μ L of α -glucosidase (0.4 U/mL, CAS No. 9001-42-7, Sigma) was incubated for 15 min at 37 °C. was stopped with 100 μ L of Na₂CO₃ (0.1 M) for each well after 20 min of incubation. Without the test compound, the reaction was performed as a blank control and acarbose was used as a positive control. The experiments were performed in triplicate. The absorbance of the released p-nitrophenol was measured at 405 nm using a microplate reader. The inhibition results were calculated using the following formula:

$$\text{Inhibition (\%)} = [(\text{OD control} - \text{OD sample}) / \text{OD control}] \times 100$$

The IC₅₀ value showed the concentration of compound inhibiting 50% of α -glucosidase activity. The IC₅₀ value was calculated using TableCurve software.

2.5. Antioxidant Assay

The antioxidant capacity of *B. variegata* essential oil was evaluated based on its DPPH free radical scavenging activity, following a modified method of Nguyen and Eun [26]. Briefly, 1 mL of the essential oil sample was transferred into a test tube, followed by the addition of 5 mL of DPPH solution. The mixture was shaken thoroughly and kept in the dark at room temperature for 30 min. Absorbance was then measured at 517 nm using a UV-VIS spectrophotometer (Janway 6305, UK). A control sample containing methanol was prepared in parallel. The antioxidant activity was calculated using Eq. (1).

$$\text{Antioxidant (\%)} = \frac{AB - AA}{AB} \times 100\% \quad (1)$$

where AB and AA are the absorbance of the control sample (sample containing only methanol) and the absorbance of the reaction solution containing essential oil, respectively. The antioxidant activity of essential oils was determined by half-maximal inhibitory concentration (IC₅₀).

3. Results and Discussion

3.1. Chemical composition

From the ethyl acetate extract, using thin layer chromatography (CC) with silica gel as the adsorbent, thin layer chromatography (TLC) and fractional crystallization obtained 2 substances 1 and 2

Compound **1** was obtained as white powder, soluble in acetone solvent. The ¹H NMR of compound **1** shows that at low field, there are signals of 2 aromatic protons located at meta positions at δ_H 7.41 (2H, s, H-2/6) corresponding to a benzene ring with 4 substituents at positions 1,3,4,5; together with 2 methoxyl groups at high field at δ_H 3.96 (6H, s; 3/5-OCH₃). The ¹³CNMR of compound **1** indicated the presence of 9 carbons, including 1 carbonyl carbon of the acid group at δ_C 167.7 (C-7); 3 quaternary aromatic carbons attached to oxygen at δ_C 148.5 (C-3), δ_C 141.7 (C-4) and δ_C 148.7 (C-5); 1 quaternary aromatic carbon at δ_C 121.8 (C-1), 2 tertiary aromatic carbons at δ_C 108.4 (C-2) and δ_C 108.4 (C-6); and 2 methoxyl carbons at δ_C 56.8 (C-3/5). Above NMR spectra of **1** (Table 1 and Figure 2) shown that compound **1** has a structure of a polyphenolic acid. A search of reference documents combined with a comparison of the spectral data of compound **1** and syringic acid [26] shows similarities. Therefore, compound **1** is concluded to be syringic acid (Figure 1).

Table 1. ¹H and ¹³C NMR data of **1** and Syringic acid [26] (δ ppm, CD₃COCD₃)

	Compound 1 (CD ₃ COCD ₃)		Syringic acid [26] (CD ₃ COCD ₃)	
	δ_H (ppm), J (Hz)	δ_C (ppm)	δ_H (ppm), J (Hz)	δ_C (ppm)
2	-	121.8	-	121.9
1	7.41 s	108.4	7.33 s	108.4
2/6	-	148.5	-	148.9
3/5	-	141.7	-	141.8
4	-	167.7	-	170.0
7	56.8	3.88 s	56.8	
3,5-OCH ₃	3.96 s	56.8	3.88 s	56.8

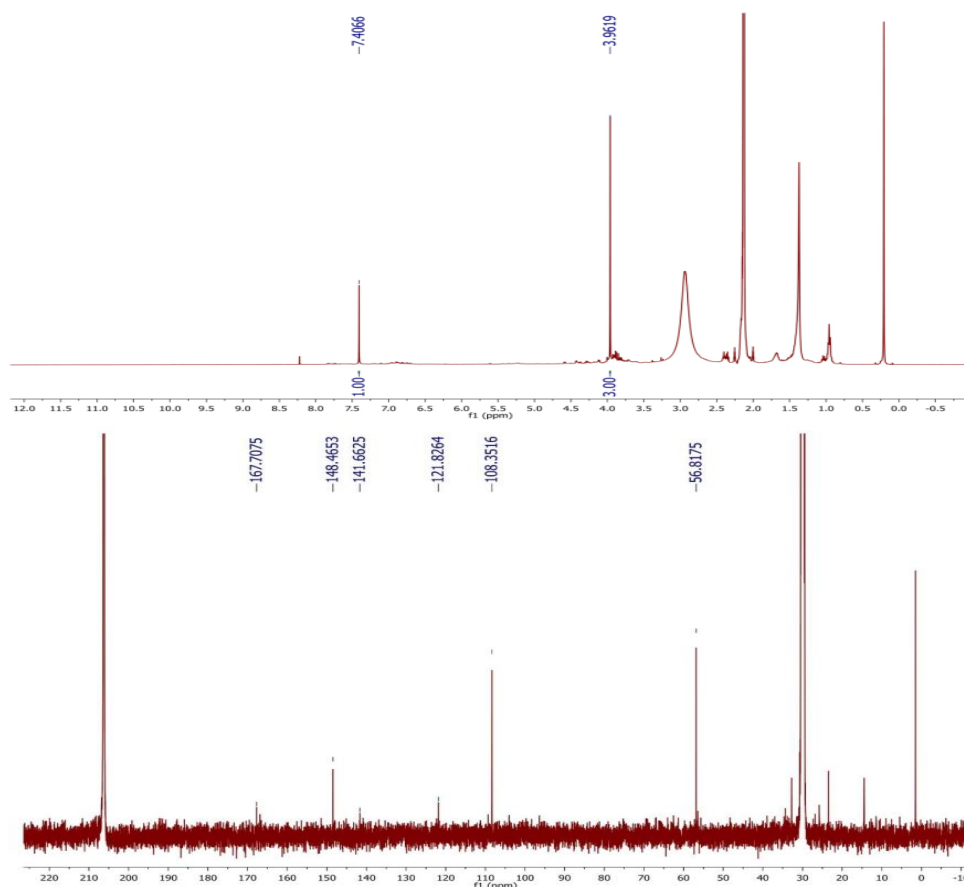


Figure 2. ^1H and ^{13}C NMR spectra data of compound 1

Compound 2 was obtained as pale yellow powder. The ^1H -NMR of compound 2 showed the presence of 2 pairs of ortho-coupled aromatic proton signals at δ_{H} 7.84 (2H; d; $J = 8.7$ Hz; H-2', H-6'), δ_{H} 7.04 (2H; d; $J = 8.7$ Hz; H-3', H-5') corresponding to a benzene ring with 2 substituents at para position; 2 meta-coupled aromatic proton signals at δ_{H} 6.27 (1H; d; $J = 2.1$ Hz; H-6'), δ_{H} 6.47 (1H; d; $J = 2.1$ Hz; H-8) corresponding to a benzene ring with 4 substituents at positions 1, 2, 3, 5 and 1 proton signal of alkyl hydroxyl group at δ_{H} 12.67 (1H; s; 5-OH). In addition, the ^1H -NMR of compound 2 also showed additional signals of the sugar moiety: 1 anomer proton at δ_{H} 5.53 (1H; d; $J = 2.1$ Hz; H-1''); 4 oxymethine protons at δ_{H} 4.24 (1H; dd; $J = 3.1$ Hz, 1.2; H-2''), δ_{H} 3.86 (1H; dd; $J = 9.7$ Hz, 3.3; H-3''), δ_{H} 4.83 (1H; t; $J = 9.7$ Hz; H-4''), δ_{H} 3.41 (1H; dq; $J = 9.9$, 6.3 Hz; H-5''); 2 methyl groups at δ_{H} 0.78 (3H; d; $J = 6.2$ Hz; H-6''), δ_{H} 1.98 (3H; s; 4''-COCH₃).

The ^{13}C -NMR of compound 2 indicated the presence of 23 carbons, in which there is 1 carbonyl carbon of the connecting ketone group at δ_{C} 179.2 (C-4); 1 carbonyl carbon of the ester group at δ_{C} 170.1 (4''); 4 aromatic carbons carrying oxygen at δ_{C} 163.3 (C-5), δ_{C} 165.1 (C-7), δ_{C} 158.1 (C-9), δ_{C} 161.0 (C-4''); 2 olefin carbons carrying oxygen at δ_{C} 158.7 (C-2), δ_{C} 135.6 (C-3); 2 aromatic carbons at δ_{C} 105.8 (C-10), δ_{C} 122.5 (C-1'); 6 aromatic carbons at δ_{C} 99.6 (C-6), δ_{C} 94.6 (C-8), δ_{C} 131.7 (C-2', C-6'), δ_{C} 116.3 (C-3', C-5'); 1 carbon anomer at δ_{C} 102.3 (C-1''); 4 carbon oxymethine at δ_{C} 71.5 (C-2''), δ_{C} 74.5 (C-4''), δ_{C} 69.8 (C-3''), δ_{C} 69.0 (C-5''); 2 carbon methyl at δ_{C} 17.6 (C-6''), δ_{C} 20.9 (4'').

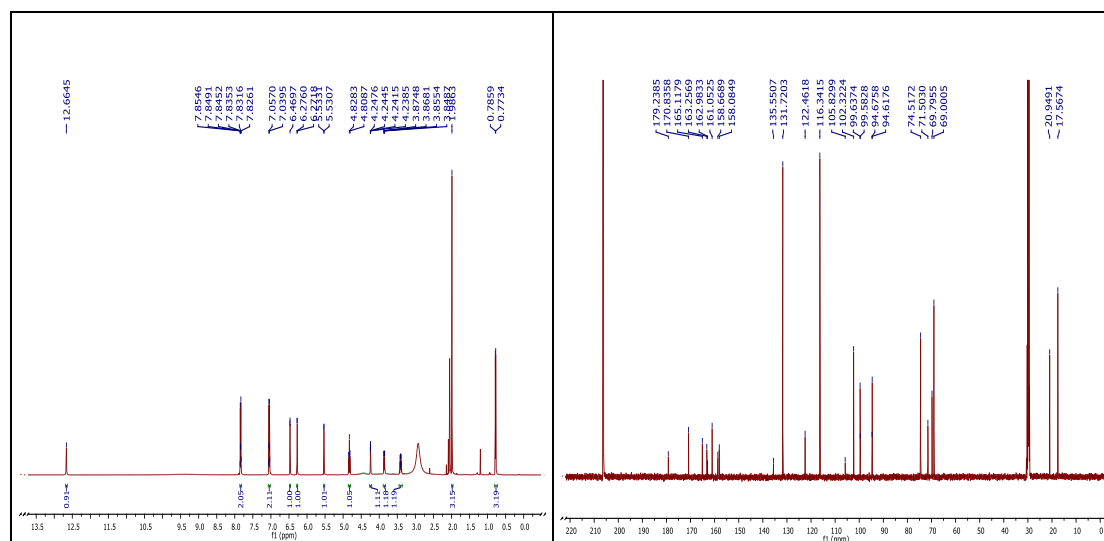


Figure 3. ^1H and ^{13}C NMR spectra data of compound **2**

Table 2. ^1H and ^{13}C NMR data of **2** and kaempferol-3-O-(4-O-acetyl)- α -L-rhamnopyranoside [27] (δ ppm, CD_3COCD_3)

Compound 2 (CD_3COCD_3)		Kaempferol-3-O-(4-O-acetyl)- α -L-rhamnopyranoside [27] (CD_3COCD_3)	
δ_{H} (ppm), J (Hz)	δ_{C} (ppm)	δ_{H} (ppm), J (Hz)	δ_{C} (ppm)
2	158.7		158.2
3	135.6		135.4
4	179.2		179.1
5	163.3		163.2
6	6.27 (1H; d ; $J = 2.1$)	6.27 (1H, <i>brs</i>)	100.0
7			166.3
8	6.47 (1H; d ; $J = 2.1$)	6.47 (1H, <i>brs</i>)	94.8
9			158.4
10			105.4
1'	122.5		122.4
2', 6'	7.84 (2H; d ; $J = 8.7$)	7.82 (2H; d ; $J = 8.6$)	131.7
3', 5'	7.04 (2H; d ; $J = 8.7$)	7.05 (2H; d ; $J = 8.6$)	116.4
4'			161.2
1''	5.53 (1H; d ; $J = 1.2$)	5.54 (1H, <i>brs</i>)	102.3
2''	4.24 (1H; dd ; $J = 3.1, 1.2$)	4.25 (1H, <i>brs</i>)	71.5
3''	3.86 (1H; dd ; $J = 9.7, 3.3$)	3.87 (1H; dd ; $J = 9.8, 3.4$)	69.8
4''	4.83 (1H; t ; $J = 9.7$)	4.83 (1H; t ; $J = 9.8$)	74.5
5''	3.41 (1H; dq ; $J = 9.9, 6.3$)	3.42 (1H; dq ; $J = 10.0, 6.2$)	69.0
6''	0.78 (3H; d ; $J = 6.2$)	0.78 (3H; d ; $J = 6.1$)	17.6
4''			170.1
(>C=O)			170.8
4''			
(-CH ₃)	1.98 (3H; <i>s</i>)	1.98 (3H; <i>s</i>)	20.9

5-OH 12.67 (1H; s)

^1H -NMR and ^{13}C -NMR spectral data show that compound 4 has the structure of a flavonol skeleton with 3 hydroxyl groups, 1 sugar molecule and 1 acetyl group (Table 2 and Figure 3). Combined analysis of HSQC spectral data and HMBC (Figure 4) also shows that the sugar molecule has typical substituents of rhamnopyranoside sugars including: 1 anomer group, 4 oxymethine groups, 1 methyl group and this sugar molecule is attached to the C-3 position of the flavonol skeleton through HMBC correlation of the anomer group's H-1" proton with C-3. The acetoxy group is attached to the sugar molecule at the C-4" position through HMBC correlation of the acetyl group proton and the oxymethine H-4" proton of the sugar molecule with the carbonyl carbon of the acetoxy group (Figure 5). Comparison of the spectral data of compound 4 with that of kaempferol-3-O-(4-O-acetyl)- α -L-rhamnopyranoside showed compatibility.

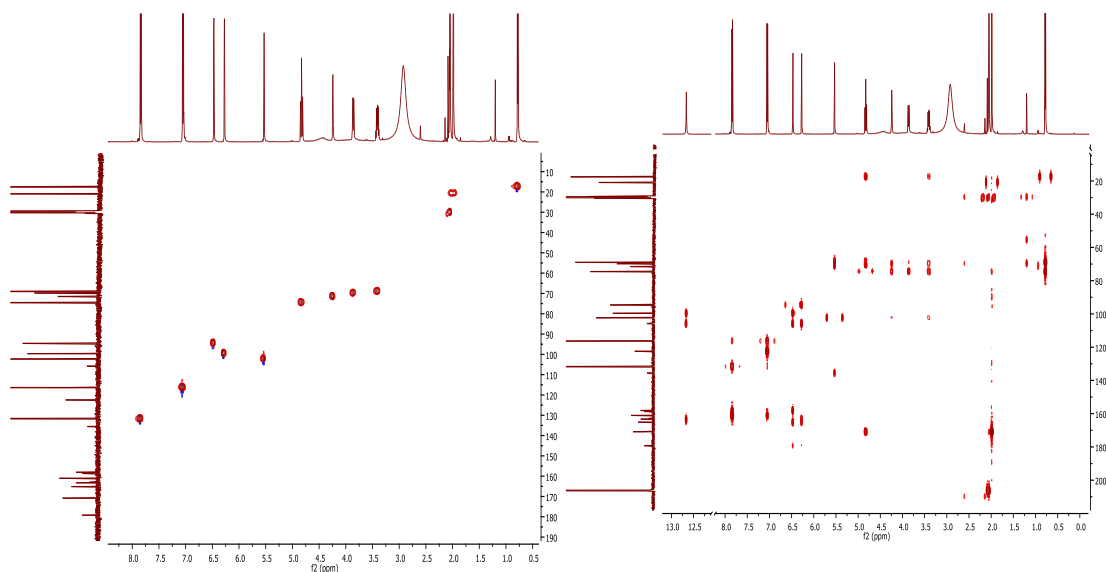


Figure 4. HSQC and HMBC spectra data of compound 2

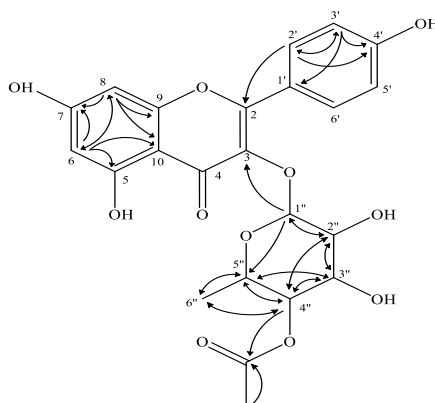


Figure 5. HMBC correlation of compound 2

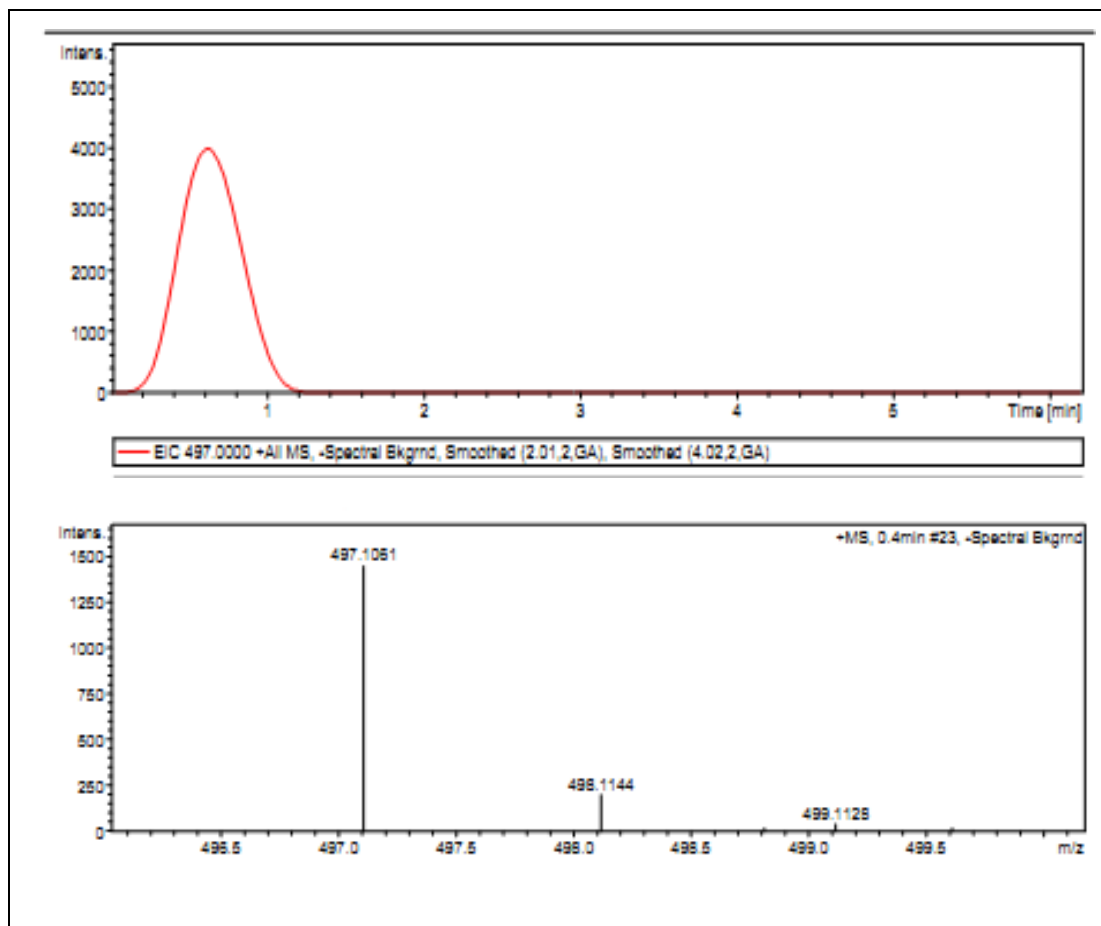
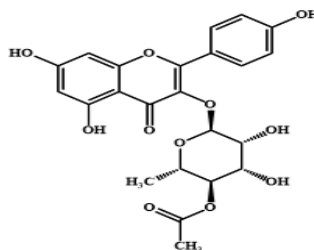
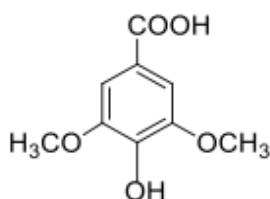


Figure 6. HR-ESI-MS spectrum of compound 2

The high-resolution HR-ESI-MS mass spectrum (Figure 6) gave a pseudo-molecular ion peak at m/z 497.1061, corresponding to the molecular formula $C_{23}H_{22}O_{11}$. The theoretically calculated value for $[C_{27}H_{26}O_{13}+2Na-H]^+$ was 497.1060 m/z , with a theoretical error of 1 mmass compared to the experimental one. Therefore, the proposed structure of compound 2 was kaempferol-3-O-(4-O-acetyl)- α -L-rhamnopyranoside (Figure 1). From the above argument and comparison of their spectral data with published works allowed to confirm their structures (Figure 1).



Compound 1

Compound 2

Figure 1. Structures of compounds isolated from *Zingiber zerumbet***3.2. Biological activity****3.2.1. α -glucosidase inhibitory activity**

The total methanol extract, n-hexane extract, chloroform extract, ethyl acetate extract and two isolated compounds from the rhizome of *Z. zerumbet* were evaluated for α -glucosidase inhibitory activity. As shown in Table 3, the remaining methanol extract showed weak inhibitory activity against α -glucosidase while the n-hexane extract showed no inhibitory activity. Both chloroform and ethyl acetate extracts showed good inhibitory activity, however, the ethyl acetate extract showed better inhibitory activity, so we selected this extract for the isolation of the compounds.

Table 3. α -glucosidase inhibitory activity of extracts from *Z. zerumbet* rhizomes

Extracts	Inhibition (I, %)					IC ₅₀ (μ g/mL)
	250 μ g/mL	100 μ g/mL	50 μ g/mL	25 μ g/mL	10 μ g/mL	
Total MeOH residue	88.6 $\pm$ 1.5	27.5 $\pm$ 2.6	2.3 $\pm$ 2.6	–	–	155.2
n-Hexane extract	79.1 $\pm$ 2.8	18.6 $\pm$ 1.4	–	–	–	177.7
Chloroform extract	94.8 $\pm$ 1.5	40.2 $\pm$ 2.9	6.4 $\pm$ 1.8	–	–	126.9
Ethyl acetate extract	72.1 $\pm$ 2.2	52.0 $\pm$ 3.2	28.54 $\pm$ 0.61	7.3 $\pm$ 1.4	–	95.7
Acarbose						214.1

*: I > 100 %; –: I < 1 %

Two compounds isolated from ethyl acetate extract of *Z. zerumbet* rhizomes were evaluated for α -glucosidase inhibitory activity. The results are shown in Table 4.

Table 4. α -glucosidase inhibitory activity of compounds from *Z. zerumbet* rhizomes

Compound	Inhibition (I, %)					IC ₅₀ (μ M)
	250 μ g/mL	100 μ g/mL	50 μ g/mL	25 μ g/mL	10 μ g/mL	
Syringic acid (1)	86.5 $\pm$ 1.2	35.2 $\pm$ 1.5	19.0 $\pm$ 1.1	–	–	142.55
Kaempferol-3-O-(4-O-acetyl)- α -L-rhamnopyranoside (2)		50.48 $\pm$ 0.67	33.0 $\pm$ 1.1	6.1 $\pm$ 1.2	–	98.63
Acarbose						214.1

*: I > 100 %; –: I < 1 %

The results showed that both compounds had stronger inhibitory activity against α -glucosidase enzyme than the positive control, acarbose, with IC₅₀ values of Syringic acid

(1) and Kaempferol-3-O-(4-O-acetyl)- α -L-rhamnopyranoside (2) being 142.55 and 98.63, respectively, much smaller than that of acarbose (IC_{50} = 214.1 μ M). Among the two compounds, compound 1 showed stronger inhibitory activity against α -glucosidase enzyme, thus having potential use as an antidiabetic drug.

3.2.2. Antioxidant activity

DPPH free radical inhibitory activity test on total methanol residue, *n*-hexane extract, chloroform extract, ethyl acetate extract and two isolated compounds from the rhizomes of *Z. zerumbet*. The results are presented in the table 5

Table 5. Antioxidant activity of extracts from *Z. zerumbet* rhizomes

Extracts	Inhibition (I, %)				IC_{50} (μ g/mL)
	100 μ g/mL	50 μ g/mL	25 μ g/mL	10 μ g/mL	
Total MeOH residue	22.30 $\pm$ 1.70	7.43 $\pm$ 0.66	3.89 $\pm$ 0.85	0.07 $\pm$ 0.81	>100
<i>n</i> -Hexane extract	8.41 $\pm$ 1.10	4.34 $\pm$ 0.80	–	–	>100
Chloroform extract	49.86 $\pm$ 0.94	32.56 $\pm$ 0.85	19.94 $\pm$ 1.81	2.07 $\pm$ 0.70	~100
Ethyl acetate extract	62.64 $\pm$ 0.98	37.36 $\pm$ 0.66	20.45 $\pm$ 0.74	8.59 $\pm$ 0.55	76.2
Trolox*					2.73

The results of the DPPH free radical inhibitory activity test of *Z. zerumbet* rhizomes on crude extracts showed that most of the extracts had weak activity at 4 test concentrations. In the 5 active test extracts, 4 samples of *n*-hexane, chloroform, ethyl acetate and total methanol extracts had inhibitory activity at a concentration of 100 μ g/mL; in which ethyl acetate extract had an inhibition percentage greater than 50% at a concentration of 100 μ g/mL. In addition, *n*-hexane, chloroform, ethyl acetate and total methanol extracts all had inhibitory activity at a concentration of 50 μ g/mL; chloroform, ethyl acetate and total methanol extracts had inhibitory activity at concentrations of 25 μ g/mL and 10 μ g/mL. Ethyl acetate extract had the strongest DPPH free radical inhibitory activity with IC_{50} value = 76.2 μ g/mL. However, the activity of this sample was still weaker than that of the positive control trolox (IC_{50} = 2.2 μ g/mL).

4. Conclusions

Four extracts and two compounds from *Z. zerumbet* rhizomes were studied for their inhibitory activity against α -glucosidase and DPPH inhibitory antioxidant activity. The results showed that the ethyl acetate extract showed good activity with IC_{50} lower than the IC_{50} of acarbose. Both compounds had good inhibitory activity against α -glucosidase but Kaempferol-3-O-(4-O-acetyl)- α -L-rhamnopyranoside (2) isolated from the ethyl acetate extract showed strong activity with IC_{50} lower than the positive control, especially

Kaempferol-3-O-(4-O-acetyl)- α -L-rhamnopyranoside with IC_{50} value of 98.63 μ M compared to 214.1 μ M of acarbose. All extracts showed weak DPPH antioxidant activity compared to the positive control trolox. The potential α -glucosidase inhibitory activity of chloroform extract and compounds from *Z. zerumbet* rhizome provides a theoretical basis for its application in functional foods, drugs or healthcare products to support diabetes treatment.

References

- [1] NT.Ban (2005), *Checklist of plant species of Vietna*, Vol. 3. Agriculture Publishing House, Hanoi.
- [2] Christenhusz M. J. M.; Byng J. W. (2016), *The number of known plants species in the world and its annual increase*, *Phytotaxa*, 261(3):201–217.
- [3] Bhuiyan M. N. I., Chowdhury J. U., Begum J. (2009), *Chemical investigation of the leaf and rhizome essential oils of Zingiber zerumbet (L.) Smith from Bangladesh*. *Bangladesh J Pharmacol*, 4(1):9-12.
- [4] Zakaria Z. A., Mohamad A. S., Chear C. T., Wong Y. Y., Israf D. A., Sulaiman M. R.(2010), *Antiinflammatory and antinociceptive activities of Zingiber zerumbet methanol extract in experimental model systems*, *Med Princ Pract*, 19(4):287-294.
- [5] Zakaria Z. A., Mohamad A. S., Ahmad M. S., Mokhtar A. F., Israf D. A., Lajis N. H., et al.(2011), *Preliminary analysis of the anti-inflammatory activity of essential oils of Zingiber zerumbet*. *Biol Res Nurs*,13(4):425-432.
- [6] Sulaiman M. R., Tengku Mohamad T. A. S., Shaik Mossadeq W. M., Moin S., Yusof M., Mokhtar A. F., et al.(2010), *Antinociceptive activity of the essential oil of Zingiber zerumbet*. *Planta Med*, 76(2):107-112.
- [7] Do Tat Loi (2004), *Vietnamese medicinal plants and herbs*. Medical Publisher, Hanoi, Vietnam.
- [8] Kim M., Miyamoto S., Yasui Y., Oyama T., Murakami A., Tanaka T.(2009), *Zerumbone, a tropical ginger sesquiterpene, inhibits colon and lung carcinogenesis in mice*. *Int J Cancer*, 124:264-271.
- [9] Sung B., Jhurani S., Ahn K. S., Mastuo Y., Yi T., Guha S., et al. (2008), *Zerumbone down-regulates chemokine receptor CXCR4 expression leading to inhibition of CXCL12-induced invasion of breast and pancreatic tumor cells*. *Cancer Res*, 68:8938-8944.
- [10] Sakinah S. A. S., Handayani S. T., Hawariah L. P. A.(2007), *Zerumbone induced apoptosis in liver cancer, HepG2 cells via modulation of Bax/ Bcl-2 ratio*. *Cancer Cell Int*, 7:4.
- [11] Vimala S., Norhanom A. W., Yadav M.(1999), *Anti-tumour promoter activity in Malaysian ginger rhizobia used in traditional medicine*. *Br J Cancer*, 80:110-116.
- [12] I. C. Nigam, L. Levi.(1963), *Column and gas chromatographic analysis of oil of wild ginger. Identification and estimation of some new constituents*. *Can. J. Chem*, 41: 1726-1730
- [13] N. P. Damodaran, S. Dev.(1968), *Studies in sesquiterpenes - XXXVIII, Structure of humulene epoxide-I and humulene epoxide-II*. *Tetrahedron*, 24:4123-4132.
- [14] N. P. Damodaran, S. Dev. (1968), *Studies in sesquiterpenes– XXXVIII, Sesquiterpenoids from the essential oil of Zingiber zerumbet Smith*. *Tetrahedron*, 24:4113-4122.

- [15] N. P. Damodaran, S. Dev.(1968), *Studies in sesquiterpenes–XXXVIII, Structure of humulenols*. Tetrahedron, 24:4133-4142.
- [16] C. M. Jimmy, V. Robert, C. J. Claude.(2003), *Chemical composition of the essential oil from rhizomes, leaves and flowers of Zingiber zerumbet Smith from Reunion Island*. Journal of Essential Oil Research, 15(3):202-205.
- [17] T. Y. Chen, L. G. Chen, C. J. Lee, F. Y. Lee, C. C. Wang.(2008), *Anti-inflammatory constituents of Zingiber zerumbet*. Food Chem, 110:584-589.
- [18] Sulaiman M. R., Perimal E. K., Zakaria Z. A., Mokhtar F., Akhtar M. N., Lajis N. H., et al.(2009), *Preliminary analysis of the antinociceptive activity of zerumbone*. Fitoterapia, 80(4):230-232.
- [19] Murakami A, Takahashi M, Jiwajinda S, Koshimizu K, Ohigashi H. (1999), *Identification of zerumbone in Zingiber zerumbet Smith as a potent inhibitor of 12-O-tetradecanoylphorbol-13-acetateinduced Epstein-Barr virus activation*. Biosci Biotechnol Biochem, 63:1811-1812.
- [20] Sulaiman MR, Perimal EK, Akhtar MN, Mohamad AS, Khalid MH, Tasrip NA, et al.(2010), *Anti-inflammatory effect of zerumbone on acute and chronic inflammation models in mice*. Fitoterapia, 81:855-858.
- [21] Chaung HC, Ho CT, Huang TC. (2008), *Anti-hypersensitive and antiinflammatory activities of water extract of Zingiber zerumbet (L.) Smith*. Food Agric Immunol, 19 (2):117-129.
- [22] Chien T. Y., Chen L. G., Lee C. J., Lee F. Y., Wang C. C. (2008), *Anti-inflammatory constituents of Zingiber zerumbet*. Food Chem, 110(3):584-589.
- [23] Jantan I, Raweh SM, Sirat HM, Jamil S, Mohd Yasin YH, Jalil J, et al. (2008), *Inhibitory effect of compounds from Zingiberaceae species on human platelet aggregation*. Phytomedicine, 15(4):306-309.
- [24] Abdullah NH, Salim F, Ahmad R. (2016), *Chemical Constituents of Malaysian U. cordata var. ferruginea and their in vitro α -glucosidase inhibitory activities*. Molecules 21(5):525.
- [25] Nguyen QV, Eun JB. (2013), *Antioxidant activity of solvent extracts from Vietnamese medicinal plants*. J Med Plans Res, 5(13):2798-2811.
- [26] Silva A.R.J., Pinto C.A.R.M.C., Pinheiro B.L.M., Tamborini E.C.C.M. (1998), *Triterpen esters from Himatanthus sucuuba (Spruce) woodson*. Quimica nova, 21(6):702-704.
- [27] T. Y. Chien, L. G. Chen, C. J. Lee, F. Y. Lee, C. C. Wang (2008), *Anti-inflammatory constituents of Zingiber zerumbet*, Food Chemistry, 110(3):584-589.