DOI: 10.17344/acsi.2025.9305 Acta Chim. Slov. 2025, 72, 672–678
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Scientific paper

Camellia yokdonensis leaves: Antioxidant, Potential Antidiabetic and *in vitro* Anti-inflammatory Activities

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Received: 05-05-2025

Abstract

This study investigated the phenolic content, antioxidant activity, α-amylase and α-glucosidase inhibitory effects, and albumin denaturation inhibitory activity of extracts from the leaves of *Camellia yokdonensis*, a plant species native to Vietnam. The results revealed epigallocatechin gallate as the dominant phenolic compound (33.76–191.95 mg/g). The methanolic extract showed the most potent antioxidant activity (ABTS IC_{50} = 135.01 ± 1.51 μg/mL, DPPH IC_{50} = 25.96 ± 0.11 μg/mL). The aqueous ethanolic extract exhibited the strongest inhibitory activity against albumin denaturation (IC_{50} = 320.20 ± 2.45 μg/mL). The aqueous methanolic extract possessed the highest α-glucosidase inhibition (IC_{50} = 382.80 ± 14.82 μg/mL), while the ethanolic extract displayed the strongest α-amylase inhibition (IC_{50} = 1105.96 ± 26.97 μg/mL). Pearson correlation analysis indicated positive correlations between total phenolic content and antioxidant activity, and albumin denaturation inhibition. These findings underscore *C. yokdonensis* leaves as a promising source of natural antioxidants and enzyme inhibitors for managing diabetes and inflammation.

Keywords: *Camellia yokdonensis*; HPLC; phenolics; catechins; bioactivities

1. Introduction

Plants have long been valued for their bioactive compounds, offering therapeutic potential for managing chronic diseases, such as diabetes and inflammation.[1–3] Among these, *Camellia* species, notably *Camellia sinensis*, are widely known for their rich phenolic content, particularly flavonoids, which contribute to antioxidant, antidiabetic, and anti-inflammatory properties.[4,5] Antioxidant activity, evaluated through free radical scavenging assays, is important for mitigating oxidative stress, a contributor to diabetes and inflammation.[6] In diabetes management, inhibition of carbohydrate hydrolyzing enzymes, α-amylase and α-glucosidase, helps reduce postprandial glucose spikes, offering a natural alternative to synthetic inhibitors, such as acarbose. Anti-inflammatory activity, measured via albumin denaturation inhibition, reflects the ability of phenolics to stabilize proteins, potentially alleviating inflammation-related disorders.

Research has shown that *Camellia* extracts may exert strong radical scavenging, enzyme inhibitory, and anti-inflammatory activities, attributed to their phenolic content.[7] *Camellia yokdonensis* Dung bis & Hakoda, a species native to Vietnam, has orange-red petals and 15–20 cm long large leaves.[8,9] To our knowledge, traditional use of its flowers and leaves has not been documented. Our previous research demonstrated an acetonic extract of *C. yokdonensis* leaves had potential to trap free radicals, inhibit α-amylase, and prevent albumin heat-induced denaturation.[10] A recent study has reported significant antioxidant and α-glucosidase inhibitory activities in *C. yokdonensis* flower extracts.[11] However, leaf extracts, which are more abundant and sustainable, warrant further investigation to elucidate their phenolic composition and bioactivity correlations.

This study aimed to investigate the phenolic content, antioxidant potential, α-amylase and α-glucosidase inhibitory effects, and albumin denaturation inhibitory activity of *C. yokdonensis* leaf extracts. By correlating total phenolic content with bioactivities and comparing solvent effects, we aimed to identify phytocompounds driving these properties and assess the potential of *C. yokdonensis* as a source of natural antidiabetic and anti-inflammatory agents. This work contributes to the growing body of research on *Ca-*

mellia species, offering insights into their phytochemical and pharmacological applications.

2. Experimental

2. 1. Sample Collection

Fresh leaves of *C. yokdonensis* were collected in December 2022 from Ea H'leo, Dak Lak province, Vietnam. Plant identification was authenticated by Dr. Nguyen Hoang Tuan (Faculty of Pharmacognosy and Traditional Medicine, Hanoi University of Pharmacy), with a voucher specimen (CY1222) deposited at Thu Dau Mot University, Ho Chi Minh City.[10] The collected leaves were carefully washed, then dried in a convection oven until the moisture content was below 8%. The dried leaves were subsequently ground into powder and stored refrigerated until further analysis.

2. 2. Chemicals

Acarbose, epigallocatechin gallate (EGCG), ferulic acid, and gallic acid (purity ≥ 99%) were obtained from Sigma-Aldrich (St. Louis, Missouri, USA). Catechin, epicatechin, kaempferol, quercetin and rutin (purity > 98.5%), were purchased from Chengdu Biopurify Phytochemicals Ltd (Sichuan, China). Diclofenac sodium (purity > 99.8%) was procured from the National Institute of Drug and Quality Control (Hanoi, Vietnam). ABTS (2,2'-azino-bis (3-ethylbenzothiazoline-6-sulfonic acid)) and DPPH (2,2-diphenyl-1-picrylhydrazyl) (purity ≥ 95%) were purchased from Thermo Fisher Scientific (Massachusetts, USA).

2. 3. Phenolics and Bioactivities

Determination of phenolics was performed using HPLC-DAD and colorimetric methods (Sections S1–S2, Supplemental data). The antioxidant activity of the extracts was evaluated using ABTS and DPPH radical scavenging assays. Inhibitory effects of the extracts on α-amylase, α-glucosidase, and bovine albumin denaturation were also assessed. All the bioassays and statistical analysis were provided in Supplemental data (Sections S3–S7).

3. Results and Discussion

3. 1. Phenolics

In this study, we analyzed nine phenolic compounds in the extracts from *C. yokdonensis* leaves (Table 1). Four solvent extracts were analyzed: ME (100% methanol), ME50 (50% aqueous methanol), ET (100% ethanol), and ET50 (50% aqueous ethanol). The extracts were evaluated for their concentrations of individual phenolic compounds (measured in mg/g) and total phenolic content (TPC, measured in mg GAE/g). The phenolic composition of *Camellia yokdonensis* leaf extracts varied significantly depending on the solvent used for extraction. Among the individual phenolic compounds, epigallocatechin gallate (EGCG) stood out as the most abundant across all extracts. Its average concentration ranged from 33.76 mg/g in ME50 to 191.95 mg/g in ME. The ET50 extract also showed a high EGCG level at 139.08 ± 1.10 mg/g, while ET and ME50 had lower values of 36.47 ± 0.57 mg/g and 33.76 ± 0.27 mg/g, respectively. The preference of EGCG for ME and ET50 may be linked to its solubility properties in these solvents. Other phenolic compounds displayed distinct extraction patterns depending on the solvent. Pure solvents like methanol and ethanol were particularly effective for extracting catechin (3.91 ± 0.04 mg/g in ME and 4.27 ± 0.25 mg/g in ET, respectively) and ferulic acid (0.11 ± 0.01 mg/g in ME), indicating that less polar phenolics favor 100% methanol or ethanol. In contrast, aqueous mixtures such as ME50 and ET50 excelled at extracting more polar

Table 1. Phenolic content in the *Camellia yokdonensis* leaf extracts

Phenolics	Concentrations, mg/g			
	ME	**ME50**	**ET**	**ET50**
Gallic acid	0.43 ± 0.01^{b}	1.95 ± 0.04^{a}	n.d.	0.44 ± 0.01^{b}
Chlorogenic acid	0.16 ± 0.00	0.13 ± 0.02	0.12 ± 0.01	0.12 ± 0.07
Ferulic acid	0.11 ± 0.01^{a}	0.03 ± 0.01^{b}	0.02 ± 0.00^{b}	0.03 ± 0.00^{b}
Catechin	3.91 ± 0.04^{a}	1.27 ± 0.45^{c}	4.27 ± 0.25^{a}	2.31 ± 0.0 ^{b}
Epicatechin	3.51 ± 0.38	2.25 ± 0.94	2.75 ± 0.65	2.81 ± 0.09
EGCG	191.95 ± 2.94^{a}	33.76 ± 0.2^{c}	36.47 ± 0.57^{c}	139.08 ± 1.10^{b}
Rutin	0.86 ± 0.01^{a}	0.49 ± 0.13^{b}	0.45 ± 0.06^{b}	0.90 ± 0.02^{a}
Quercetin	0.47 ± 0.00^{b}	0.50 ± 0.15 ^{ab}	0.31 ± 0.10^{b}	0.72 ± 0.02^{a}
Kaempferol	0.54 ± 0.00^{b}	0.54 ± 0.13^{b}	0.41 ± 0.06^{b}	0.80 ± 0.02^{a}
TPC (mg GAE/g)	255.80 ± 1.26^{a}	258.55 ± 1.53^{a}	170.73 ± 1.33^{c}	237.68 ± 1.53^{b}

ME, ME50, ET, and ET50 stand for the leaf extracts obtained with methanol (100%), aqueous methanol (50%, v/v), ethanol (100%), and aqueous ethanol (50%).
Data are shown as mean ± standard deviation of three independent replicates.
Uppercase letters $^{(a, b, c)}$ indicate significant differences in the means at $p < 0.05$ within the row.
n.d.: not detected

compounds. For instance, gallic acid reached 1.95 ± 0.04 mg/g in ME50, while rutin (0.90 ± 0.02 mg/g), quercetin (0.72 ± 0.02 mg/g), and kaempferol (0.80 ± 0.02 mg/g) are highest in ET50. Meanwhile, compounds like chlorogenic acid and epicatechin showed relatively stable concentrations across all extracts, suggesting their solubility is less dependent on solvent polarity. These findings have practical implications for optimizing extraction methods and understanding the potential applications of *Camellia yokdonensis* extracts.

While individual phenolic profiling reveals specific compounds, total phenolic content (TPC) provides an overview of the overall phenolic abundance in the extracts. The results demonstrated notable variation in TPC across the extracts. Methanol-based extracts, ME and ME50, exhibited the highest TPC values at 255.80 ± 1.26 mg GAE/g and 258.55 ± 1.53 mg GAE/g, respectively. In comparison, ET50 yielded a TPC of 237.68 ± 1.53 mg GAE/g, while ET has the lowest at 170.73 ± 1.33 mg GAE/g. This suggests that methanol, especially when combined with water in ME50, is highly effective at extracting a wide range of phenolic compounds. The addition of water in aqueous mixtures likely enhances the solubility of more polar phenolics, contributing to the elevated TPC in ME50.

Although HPLC-DAD is a widely accepted method for the analysis of phenolic compounds, it has limitations when applied to complex plant extracts, where overlapping peaks and co-eluting compounds can reduce accuracy of identification. Pre-treatment steps such as solvent partitioning, column chromatography, or solid-phase extraction can improve resolution, but they do not fully eliminate the possibility of misidentification. Complementary techniques such as LC-MS offer higher sensitivity and structural resolution, limited access to such facilities constrained our analysis in the present study. Nevertheless, the HPLC-DAD results reported here provide meaningful comparative information across extracts, which can serve as an important basis for future LC-MS based investigations and in vivo validation.

The presence of phenolics, particularly catechins, in *Camellia* species underscores their importance for plant survival and potential human health benefits. For example, *C. sinensis, C. quephongensis,* and *C. nitidissima* exhibited a variety of phenolics with antioxidant, antidiabetic, and anti-inflammatory effects.[12–14] The presence of these compounds in *C. yokdonensis* further confirms their widespread occurrence across the genus. Catechins, the dominant phenolics in tea leaves (*C. sinensis*) known for their health-promoting and antioxidant effects, are also abundant in other *Camellia* species. Ecologically, catechins in *Camellia* contribute to plant defense by deterring herbivores and pathogens.[15,16] Physiologically, they may enhance cold tolerance by protecting cells from damage. These combined functions highlight the ecological significance of catechins in plant adaptation and their potential value in nutraceutical and pharmacological applications.

3. 2. Antioxidant Activity

This study evaluated the antioxidant activity of *C. yokdonensis* leaf extracts using ABTS and DPPH radical scavenging assays. The results are shown in Figures 1 and 2 and Table 2. The extracts exhibited concentration-dependent radical scavenging, with increased concentrations correlating with enhanced free radical neutralization. The methanolic extract (ME) demonstrated the highest ABTS scavenging activity (IC_{50} = 135.01 ± 1.51 µg/mL), followed by the 50% methanolic extract (ME50, IC_{50} = 170.68 ± 1.89 µg/mL). The ethanolic extracts (ET and ET50) displayed significantly lower activity, as indicated by higher IC_{50} values. For DPPH scavenging, the extracts followed the potency order: ME > ET50 > ME50 > ET. Compared to ascorbic acid, all the extracts exerted lower scavenging capacities. These findings are consistent with previous research on *Camellia* species. For example, an ethanolic extract of *C. nitidissima* leaves presented potent ABTS and DPPH scavenging activities (IC_{50} = 29.8 and 17.4 µg/mL, respectively),[4] comparable to ascorbic acid. Similarly, *C. quephongensis* leaf extracts showed an ABTS IC_{50} value of 57.88 µg/mL.[12] In contrast, *C. fascicularis* extracts demonstrated lower scavenging potential than ascorbic acid.[17] Our prior study on acetonic extracts of *C. yokdonensis* reported weaker ABTS and DPPH scavenging activities (IC_{50} = 244.44 and 78.95 µg/mL, respectively).[10]

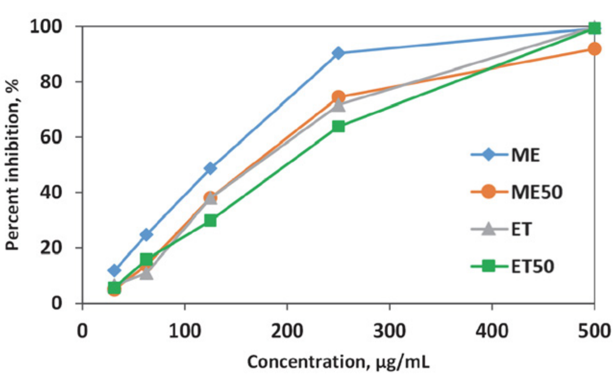

Figure 1. ABTS radical scavenging activity (percent inhibition, %) of the *C. yokdonensis* leaf extracts.

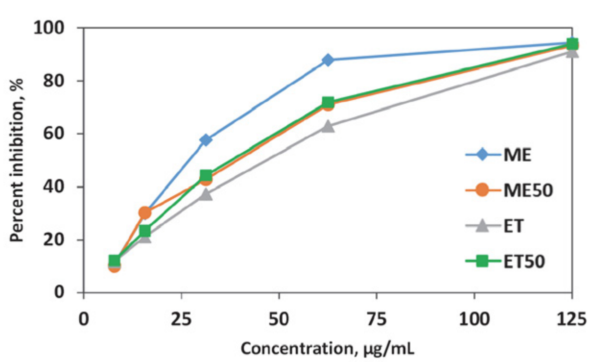

Figure 2. DPPH radical scavenging activity (percent inhibition, %) of the *C. yokdonensis* leaf extracts.

The observed antioxidant activity is primarily attributed to catechins, a class of phenolic compounds with potent radical scavenging properties. As shown in Table 2, catechins exhibited significantly strong abilities to counteract ABTS and DPPH free radicals, contributing to the highest antioxidant activity of ME. Catechins are prevalent in green tea, walnuts, and berries, where they underpin high antioxidant activity.[18–20] This bioactivity is associated with antiaging, anti-inflammatory and anticarcinogenic properties, highlighting its significance in biological systems.

Table 2. ABTS and DPPH radical scavenging activities (IC_{50}, μg/mL) of the *C. yokdonensis* leaf extracts and reference standard solutions

Samples	ABTS	DPPH
ME	135.01 ± 1.51^{d}	25.96 ± 0.11^{d}
ME50	170.68 ± 1.89^{c}	37.40 ± 0.31^{b}
ET	219.96 ± 0.44^{b}	58.11 ± 0.25^{a}
ET50	231.66 ± 1.11^{a}	32.19 ± 0.13^{c}
Ascorbic acid	65.91 ± 1.60^{e}	10.14 ± 0.43^{e}
Catechin*	28.75 ± 1.01	6.48 ± 0.04
Epicatechin*	23.65 ± 0.26	5.46 ± 0.04
EGCG*	44.25 ± 8.87	13.47 ± 0.10

Data are shown as mean ± standard deviation of three independent replicates.
Uppercase letters $^{(a, b, c, d, e, f, g)}$ indicate significant differences in the means at $p < 0.05$ within the column.
*: data from Ref. 12

3. 3. Inhibition of Albumin Denaturation

Bovine albumin denaturation serves as an *in vitro* model for protein denaturation, a process linked to inflammation-related disorders. This study assessed the anti-inflammatory potential of *C. yokdonensis* leaf extracts by measuring their inhibition of bovine albumin denaturation, with results presented in Figure 3 and Table 3. ET50 exhibited the highest inhibitory activity (IC_{50} = 320.20 ± 2.45 μg/mL), followed by ME (IC_{50} = 338.54 ± 3.83 μg/mL). With IC_{50} = 411.39 ± 7.97 μg/mL), ET showed the lowest potency. Compared to diclofenac (IC_{50} = 87.31 ± 5.11 μg/mL), all the extracts demonstrated significantly lower inhibitory activity. The potency order (ET50 > ME > ME50 > ET) reflects differences in phytochemical profiles, particularly phenolic compounds like catechins, which contribute to anti-inflammatory effects. Solvent polarity primarily governed these variations by influencing the extraction of bioactive phenolics, thereby determining anti-inflammatory activity of the extracts.[21]

Camellia plants are known for their anti-inflammatory properties, including the inhibition of albumin denaturation. This inhibitory capacity varies among species and is influenced by extraction method. An aqueous methanolic extract from *C. quephongensis*, for instance, was found to be a potent inhibitor of albumin denaturation, surpassing diclofenac.[12] Research on *C. sinensis* also indicated that aqueous extracts at various concentrations effectively inhibited this process. Interestingly, our findings for *C. yokdonensis* reveal a contrast: while an earlier study using an acetonic extract reported weak inhibition of albumin denaturation,[10] Table 3 indicates that extracts prepared with other solvents used in the present study demonstrate considerably stronger inhibitory effects. It is likely that the acetone extracted a different profile or lower concentration of these specific bioactive compounds compared to methanol and ethanol, leading to a weaker inhibitory effect on albumin denaturation. The exact mechanism for how these plant extracts inhibit heat-induced albumin denaturation remains an area requiring further study. It is thought that certain constituents, such as flavonoids, phenolic acids and tannins, interact with albumin, potentially at aliphatic sites near lysine residues, which could protect the protein from heat damage.[22] However, more research is necessary to fully understand the mechanisms of this denaturation inhibition by plant compounds.

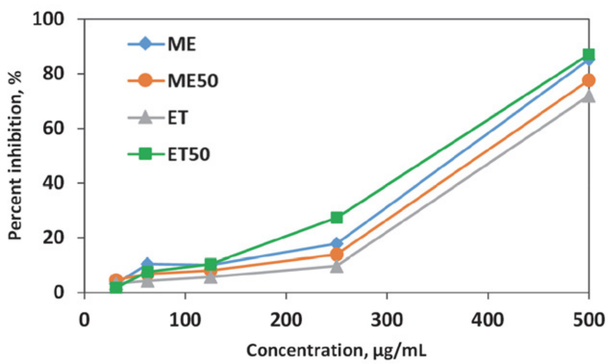

Figure 3. The inhibitory effect of the *C. yokdonensis* leaf extracts on albumin denaturation.

3. 4. Inhibition of α-Amylase

Figure 4 and Table 3 present the results of the experiment investigating the inhibitory effects of various extracts from *C. yokdonensis* leaves on α-amylase. Among the extracts, ET showed the highest inhibitory activity as its IC_{50} value (1105.96 ± 26.97 μg/mL) was significantly lower than the other extracts, followed by ME. Both aqueous extracts (ME50 and ET50) had significantly higher IC_{50} values (2774.89 ± 11.94 μg/mL and 2659.07 ± 28.68 μg/mL, respectively), indicating the weakest inhibitory effects. Compared to the standard inhibitor acarbose, all the tested *C. yokdonensis* leaf extracts exhibited considerably weaker inhibitory activity against α-amylase. These findings are consistent with recent reports; for example, ethanol and methanol leaf extracts of *C. quephongensis* were shown to possess very low α-amylase inhibitory activity (IC_{50} > 2000 μg/mL).[12] Similarly, another study demonstrated that aqueous methanolic extracts from various *Camellia* species collected in the Central Highlands of Vietnam exerted minimal inhibition of this enzyme.[5] The weak inhibitory effect of *Camellia* extracts on α-amylase could be due to high levels of catechins which are less effective against α-amylase.[23] There is also evidence to show that *Camellia* extracts tend to bind to starch substrates rather than directly blocking α-amylase.[13] The higher binding percentage of *Camellia* extracts to substrate resulted in lower inhibition rates.

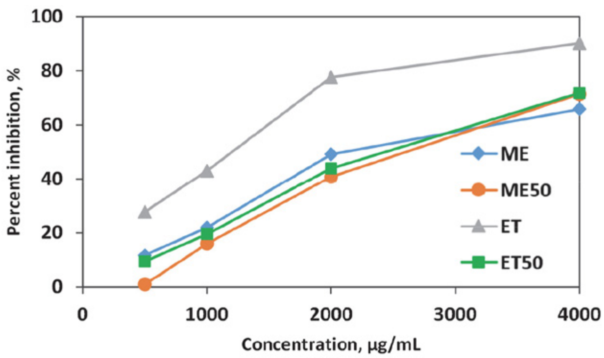

Figure 4. The inhibitory effect of the *C. yokdonensis* leaf extracts on α-amylase.

Table 3. Inhibitory effects (IC_{50}, µg/mL) of the *C. yokdonensis* leaf extracts and reference standards on albumin denaturation, α-amylase and α-glucosidase

Samples	Albumin denaturation	α-Amylase	α-Glucosidase
ME	338.54 ± 3.83^{c}	2294.12 ± 96.35^{b}	705.03 ± 10.52^{a}
ME50	375.08 ± 2.63^{b}	2774.89 ± 11.94^{a}	382.80 ± 14.82^{c}
ET	411.39 ± 7.97^{a}	1105.96 ± 26.97^{c}	658.91 ± 18.42^{a}
ET50	320.20 ± 2.45^{d}	2659.07 ± 28.68^{a}	519.79 ± 62.84^{b}
Acarbose	n.a.	98.61 ± 1.03^{d}	94.12 ± 1.98^{d}
Diclofenac	87.31 ± 5.11^{e}	n.a.	n.a.

n.a.: not available. Uppercase letters $^{(a, b, c, d, e)}$ indicate significant differences in the means at $p < 0.05$ within the column.

3. 5. Inhibition of α-Glucosidase

Figure 5 and Table 3 show the inhibitory effects of *C. yokdonensis* leaf extracts on α-glucosidase, measured as IC_{50} values (µg/mL). The results revealed that ME50 with the lowest IC_{50} (382.80 ± 14.82 µg/mL) could exert the highest inhibitory activity among the extracts, followed by ET50 (519.79 ± 62.84 µg/mL). No significant difference in the inhibitory effect between ME and ET was noted. In comparison with acarbose, all the examined *C. yokdonensis* leaf extracts displayed significantly weaker inhibitory activity against α-glucosidase. Previous research has demonstrated potent α-glucosidase inhibitory activity in *Camellia* species, with *C. yokdonensis* flower extracts showing an IC_{50} of 94.52 µg/mL.[11] Other *Camellia* species exhibited even stronger inhibition, with IC_{50} values ranging from 5.36 to 25.24 µg/mL.[5] Notably, various *C. sinensis* tea extracts displayed significant inhibitory effects, with IC_{50} values between 42.00 and 71.60 µg/mL.[24] Catechins, abundant in *Camellia* extracts, are key contributors to this activity, often surpassing the potency of acarbose by binding to α-glucosidase and altering its conformation.[23] Molecular simulations have revealed that catechins interact with critical amino acid residues (Lys156, Ser157, Arg315, Asp352) in the enzyme's active site, potentially blocking substrate access and reducing activity.[25] Other inhibitors include flavonoid glycosides in *C. hirsuta*, oleanane triterpene saponins in *C. petelotii*, and polysaccharides in *C. sinensis* var. *kitamura*.[26–28] Therefore, further investigation is required to characterize the chemical composition of *C. yokdonensis* and to identify the key compounds responsible for inhibiting these enzymes.

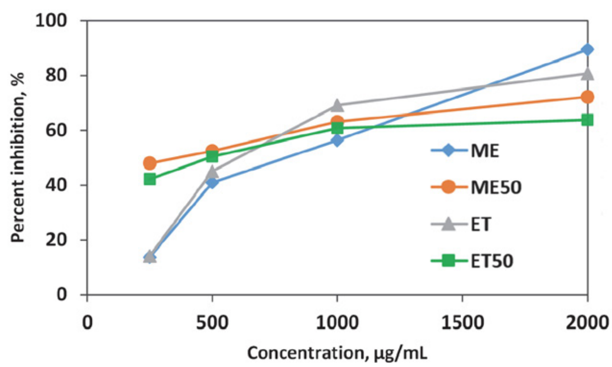

Figure 5. The inhibitory effect of the *C. yokdonensis* leaf extracts on α-glucosidase.

3. 6. Correlation Analysis

Table 4 displays Pearson correlation coefficients that assess the linear relationships between TPC of the extracts and the measured bioactivities (i.e., ABTS and DPPH antioxidant activities, α-amylase and α-glucosidase inhibitory effects, and albumin denaturation inhibitory activity). The results showed varying degrees of correlation between TPC and the tested bioactivities. The strong positive correlation between TPC and DPPH activity (r = 0.818) suggests that phenolics, likely catechins and flavonoids, are primary contributors to free radical scavenging, as higher phenolic content enhances electron donation to neutralize DPPH radicals. The moderate correlation between TPC and ABTS (r = 0.609) was perhaps due to ABTS's sensitivity to both hydrophilic and lipophilic phenolics, requiring a broader compound range. The moderate correlation with albumin denaturation inhibitory activity (r = 0.648) reflects phenolics' ability to stabilize proteins as stated earlier. Conversely, a very strong negative correlation with α-amylase inhibitory activity (r = -0.960) and a weak, non-significant correlation with α-glucosidase inhibitory activity (r = 0.452) were observed. In other words, phenolics in this case are unlikely to be the main contributors to the observed enzyme inhibition. Instead, the inhibitory activity could be attributed to specific non-phenolic compounds or interactions among metabolites. It may also suggest potential antagonistic interactions, where high levels of certain phenolics interfere with the enzyme inhibition process.

Table 4. Correlation coefficients showing the relationships between phenolic contents and bioactivities of the extracts

Bioactivities	TPC
ABTS	**0.609**
DPPH	**0.818**
α-Amylase inhibitory activity	−0.960
α-Glucosidase inhibitory activity	0.452
Albumin denaturation inhibitory activity	**0.648**

Values in bold are different from 0 with a significance level p = 0.05

4. Conclusions

This study demonstrated that *C. yokdonensis* leaf extracts were rich in phenolics and possessed significant bioactivities, with varying antioxidant, α-amylase, α-glucosidase, and albumin denaturation inhibitory effects affected by solvent polarity. Methanolic extracts had the highest total phenolic content, with EGCG as the predominant compound. Phenolics significantly contributed to potent antioxidant activities. The aqueous methanolic extract showed superior α-glucosidase inhibition, while ethanolic extract (ET) was most effective against α-amylase. The aqueous ethanolic extract outperformed the other extracts in protecting against albumin denaturation. Correlation analysis revealed that phenolics significantly contributed to antioxidant and anti-inflammatory activities but had limited or negative associations with enzyme inhibition, suggesting specific compounds or matrix effects governed these properties. These results suggest *C. yokdonensis* is a valuable source of natural bioactive compounds, with potential applications in diabetes and inflammation management. Future research should employ advanced metabolomic profiling to identify key inhibitors and explore fractionation techniques to enhance bioactivity.

Conflict of interest

All authors report no conflicts of interest relevant to this article.

5. References

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Povzetek

Ta študija je raziskovala vsebnost fenolov, antioksidativno aktivnost, zaviralne učinke na α-amilazo in α-glukozidazo ter zaviralno aktivnost denaturacije albumina pri izvlečkih iz listov *Camellia yokdonensis*, rastlinske vrste, ki izvira iz Vietnama. Rezultati so pokazali, da je epigalokatehin galat prevladujoča fenolna spojina (33,76–191,95 mg/g). Metanolni izvleček je izkazal najmočnejšo antioksidativno aktivnost (ABTS IC_{50} = 135,01 ± 1,51 μg/mL, DPPH IC_{50} = 25,96 ± 0,11 μg/mL). Vodno-etanolni izvleček je pokazal najmočnejšo zaviralno aktivnost proti denaturaciji albumina (IC_{50} = 320,20 ± 2,45 μg/mL). Vodno-metanolni izvleček je imel najvišjo zaviralno aktivnost α-glukozidaze (IC_{50} = 382,80 ± 14,82 μg/mL), medtem ko je etanolni izvleček pokazal najmočnejšo inhibicijo α-amilaze (IC_{50} = 1105,96 ± 26,97 μg/mL). Pearsonova korelacijska analiza je pokazala pozitivne povezave med celotno vsebnostjo fenolov ter antioksidativno aktivnostjo in inhibicijo denaturacije albumina. Ti izsledki izpostavljajo liste *C. yokdonensis* kot obetaven vir naravnih antioksidantov in zaviralcev encimov za obvladovanje sladkorne bolezni in vnetij.

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