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Research Article

In Vitro α-Glucosidase Inhibitory Activity of Ethanol Extract from Ficus elastica Leaves

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Abstract:

Diabetes mellitus is a chronic metabolic disorder characterized by elevated blood glucose levels and may lead to multiple complications. One strategy for controlling postprandial hyperglycemia is inhibition of the α-glucosidase enzyme. Although synthetic inhibitors such as acarbose are effective, they are frequently associated with gastrointestinal adverse effects, highlighting the need for alternatives derived from natural products. This study aimed to determine the in vitro α-glucosidase inhibitory activity of an ethanol extract of Ficus elastica leaves. The assay was performed spectrophotometrically using p-nitrophenyl-α-D-glucopyranoside (pNPG) as the substrate, and absorbance was measured at 405 nm with a microplate reader. Acarbose was used as the positive control. The ethanol extract showed concentration-dependent α-glucosidase inhibition. The highest inhibition was 71.437% at 400 µg/mL. The extract had an IC_{50} value of 264.694 µg/mL, whereas acarbose had an IC_{50} of 0.589 µg/mL. Although the inhibitory potency of the extract was substantially lower than that of acarbose, these findings indicate that Ficus elastica leaves may serve as a natural source of α-glucosidase inhibitors and support further investigation of their potential as a plant-based antidiabetic candidate.

Keywords: Ficus Elastica; A-Glucosidase Inhibition; Ethanol Extract; IC_{50}; Antidiabetic Activity.

Introduction:

Diabetes mellitus is a chronic metabolic disease characterized by persistent hyperglycemia resulting from impaired insulin secretion, impaired insulin action, or both. In type 2 diabetes, postprandial glycemic control is a major therapeutic target because intestinal α-glucosidase catalyzes the terminal hydrolysis of dietary carbohydrates into absorbable monosaccharides; consequently, inhibiting this enzyme can attenuate postprandial glucose excursions (1). Plant-derived α-glucosidase inhibitors have therefore attracted substantial interest as potential complementary candidates for type 2 diabetes management (2).

Acarbose is widely used as a reference standard in in vitro screening of plant-derived α-glucosidase inhibitors, although methodological factors can substantially affect comparisons between extracts and the reference drug (3). Flavonoid structure has been shown to influence selective inhibition of α-amylase and α-glucosidase (4). Consistent with this, isolated flavonoid derivatives from Bouea macrophylla have been evaluated for α-glucosidase inhibition using combined in vitro and in silico approaches (5). Phenolic composition has also been directly associated with α-glucosidase inhibition in plant leaves (6), while ethanolic plant extracts characterized by mass spectrometry have demonstrated antidiabetic potential (7).

Within the genus Ficus, recent studies provide growing evidence of antidiabetic and α-glucosidase-related activity. Metabolomic profiling of Ficus deltoidea varieties has been correlated with α-glucosidase inhibition (8). Chemical constituents from Ficus carica leaves have also been evaluated for direct α-glucosidase inhibitory activity (9). Extracts and semi-purified fractions of Ficus benghalensis have shown antidiabetic potential (10), while Ficus tikoua has been investigated in both in vitro and in vivo antidiabetic models (11). Phytochemical profiling of Ficus vasta further demonstrates the chemically diverse and biologically active nature of the genus (12).

Despite this broader evidence within Ficus, direct experimental evidence for α-glucosidase inhibition by Ficus elastica leaf ethanol extract remains limited. The magnitude of plant-enzyme inhibition can depend on extraction solvent, as shown in solvent-based comparative evaluation of leaf extracts (13). Extraction technique can likewise alter recovery of polyphenols and the resulting α-glucosidase inhibitory activity (14). In vitro screening of leaf and twig extracts has been used to characterize α-glucosidase inhibition in other medicinal plants (15), and phytochemical analysis combined with enzyme inhibition testing has provided a complementary strategy for linking plant chemistry with bioactivity (16).

Accordingly, this study was conducted to provide quantitative data on the α-glucosidase inhibitory activity of Ficus elastica leaf ethanol extract, expressed as percentage inhibition across several concentrations and as the IC_{50} value. The findings are expected to provide a basis for subsequent studies involving extraction optimization, fraction testing, and identification of active compounds responsible for the observed activity.

Method:

Study design and location

This laboratory experimental study was conducted from September 2025 until completion at the Research and Testing Laboratory, Faculty of Pharmacy, Universitas Muslim Indonesia. Ficus elastica leaves were collected from Gowa Regency, South Sulawesi, Indonesia.

Extraction

The leaves were washed, subjected to wet sorting, dried in a drying cabinet, dry-sorted, and ground into powdered crude drug material. A total of 50 g of powdered material was macerated with 750 mL of 96% ethanol for 3 × 24 h. The filtrate was collected, and remaceration was performed three times using fresh solvent. All filtrates were combined and concentrated using a rotary vacuum evaporator to obtain a viscous extract.

Materials and test solutions

The main materials were α-glucosidase enzyme, p-nitrophenyl-α-D-glucopyranoside (pNPG), acarbose, phosphate buffer pH 7, Na_2CO_3, 96% ethanol, distilled water, and Ficus elastica leaf extract. Na_2CO_3 was prepared at 200 mM. Acarbose solutions were prepared at 0.2, 0.4, 0.6, 0.8, and 1.0 µg/mL. The extract was initially prepared as a 1000 µg/mL stock solution and diluted to 100, 175, 250, 325, and 400 µg/mL. The pNPG substrate concentration was 5 mM, and the enzyme solution was 0.25 U/mL.

α-Glucosidase inhibition assay

Blank reaction

Phosphate buffer (36 µL, pH 7) and 17 µL of 5 mM pNPG were added to a microplate well and incubated for 5 min at 37 °C. Subsequently, 17 µL of α-glucosidase enzyme was added and the mixture was incubated for 15 min at 37 °C. The reaction was stopped with 100 µL of 200 mM Na_2CO_3, and absorbance was measured at 405 nm using a microplate reader.

Positive control test (acarbose)

Phosphate buffer (36 µL, pH 7) was added to each well, followed by 30 µL of acarbose solution at one of five concentrations (0.2, 0.4, 0.6, 0.8, or 1.0 µg/mL). Next, 17 µL of 5 mM pNPG was added and the plate was incubated for 5 min at 37 °C. α-Glucosidase enzyme (17 µL) was then added to each well, followed by a second incubation for 15 min at 37 °C. The reaction was terminated by adding 100 µL of 200 mM Na_2CO_3, and absorbance was measured at 405 nm using a microplate reader.

Test sample (Ficus elastica leaf ethanol extract)

Phosphate buffer (36 µL, pH 7) was added to each well, followed by 30 µL of Ficus elastica leaf ethanol extract at one of five concentrations (100, 175, 250, 325, or 400 µg/mL). Then, 17 µL of 5 mM pNPG was added and the plate was incubated for 5 min at 37 °C. After incubation, 17 µL of α-glucosidase enzyme was added to each well and the plate was incubated again for 15 min at 37 °C. Finally, 100 µL of 200 mM Na_2CO_3 was added to stop the reaction, and absorbance was measured at 405 nm using a microplate reader.

Results:

The Ficus elastica leaf ethanol extract showed a concentration-dependent increase in α-glucosidase inhibition. At 100 µg/mL, inhibition was 26.031%, increasing to 71.437% at 400 µg/mL. Linear regression yielded an IC_{50} of 264.694 µg/mL. For the positive control, acarbose produced 35.689–65.018% inhibition over the concentration range of 0.2–1.0 µg/mL, with an IC_{50} of 0.589 µg/mL.

Table 1. α-glucosidase inhibition by ficus elastica leaf ethanol extract

Concentration (µg/mL)	Blank (B1)	Blank control (B0)	Sample (S1)	Sample control (S0)	Inhibition (%)	IC_{50} (µg/mL)
100	1.764	0.066	1.371	0.115	26.031	
175	1.764	0.066	1.260	0.183	36.572	
250	1.764	0.066	1.101	0.214	47.762	264.694
325	1.764	0.066	0.979	0.254	57.303	
400	1.764	0.066	0.824	0.339	71.437	

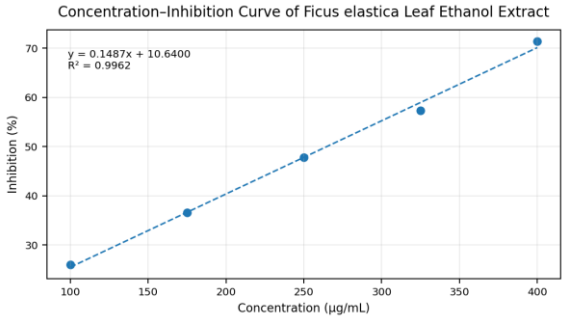

Figure 1. Concentration-dependent α-glucosidase inhibition by Ficus elastica leaf ethanol extract

Table 2. α-glucosidase inhibition by acarbose (positive control)

Concentration (µg/mL)	Blank (B1)	Blank control (B0)	Sample (S1)	Sample control (S0)	Inhibition (%)	IC_{50} (µg/mL)
0.2	1.764	0.066	1.176	0.084	35.689	
0.4	1.764	0.066	1.055	0.089	43.110	
0.6	1.764	0.066	0.947	0.093	49.706	0.589
0.8	1.764	0.066	0.824	0.118	58.422	
1.0	1.764	0.066	0.739	0.145	65.018	

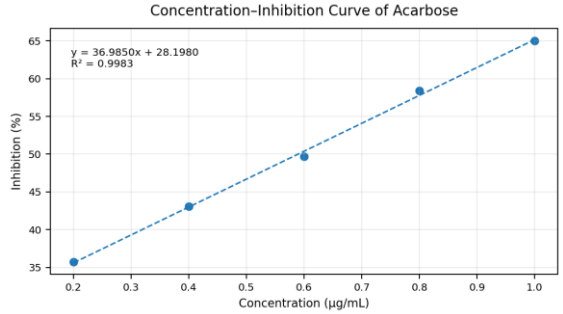

Figure 2. Concentration-dependent α-glucosidase inhibition by acarbose

Discussion:

The results demonstrate that Ficus elastica leaf ethanol extract inhibited α-glucosidase activity in vitro. Inhibition increased from 26.031% at 100 µg/mL to 71.437% at 400 µg/mL, indicating a clear concentration-dependent response. Comparable α-glucosidase inhibitory activity has been reported in leaf-derived tea and kombucha prepared from Rhizophora mucronata (17).

Based on the study findings, the Ficus elastica leaf ethanol extract had an IC_{50} above 250 µg/mL and was therefore categorized in the source study as having weak α-glucosidase inhibitory activity, whereas acarbose, with an IC_{50} below 50 µg/mL, was categorized as a very strong inhibitor. Differences in inhibitory potency among botanical extracts are consistent with comparative studies showing substantial variation in polyphenolic profiles and antidiabetic potential across ethnomedicinal plants (18). Mechanistic work on flavonoids further indicates that α-glucosidase inhibition is influenced by molecular structure and compound interactions (19). Likewise, mechanistic screening of a polyphenol-rich sugarcane extract supports the importance of the qualitative composition of polyphenols, rather than extract concentration alone, in determining inhibitory performance (20). These observations may help explain why the crude Ficus elastica extract showed measurable but substantially lower potency than acarbose.

The observed activity may be related to secondary metabolites present in Ficus elastica leaves, including flavonoids, tannins, saponins, polyphenols, and terpenoids. Bioactivity-guided phytochemical investigation of medicinal plants has demonstrated the value of fractionation and compound-level characterization for identifying α-glucosidase inhibitors (21). Isolated phenolic compounds from Caesalpinia decapetala var. japonica have also been evaluated directly for α-glucosidase inhibitory activity (22). LC-MS-assisted characterization combined with molecular docking has identified candidate α-glucosidase inhibitors in Trigonella stellata extracts (23). Within Ficus, compounds isolated from Ficus esquiroliana leaves have likewise been examined for α-glucosidase inhibitory activity (24). Polyphenol profiling of Cistus × incanus further supports the relevance of phenolic composition to α-glucosidase inhibition (25). Together, these findings strengthen the rationale for fractionating Ficus elastica extract and identifying the compounds responsible for its activity.

Previous research on the anti-inflammatory activity of Ficus elastica showed that its ethanol extract exhibited biological activity with an IC_{50} of 31.24 µg/mL in a protein-denaturation assay. This value cannot be directly equated with α-glucosidase inhibition because the biological target and assay mechanism differ; nevertheless, it supports the view that Ficus elastica leaves contain bioactive constituents worthy of further investigation. The present results therefore extend the pharmacological evidence for this species by demonstrating a distinct in vitro α-glucosidase inhibitory effect.

This study is limited by its in vitro design and by the absence of identification of the specific compounds responsible for α-glucosidase inhibition. The inhibition mechanism, whether competitive, noncompetitive, or mixed, was also not determined kinetically. Future research should therefore combine fractionation, chromatographic characterization, enzyme kinetic analysis, and in vivo evaluation to clarify the active constituents, mechanism, efficacy, and safety of Ficus elastica as a potential plant-based antidiabetic candidate.

Conclusion:

Ficus elastica leaf ethanol extract demonstrated in vitro inhibitory activity against α-glucosidase. The inhibition increased from 26.031% at 100 µg/mL to 71.437% at 400 µg/mL, with an IC_{50} of 264.694 µg/mL. This inhibitory potency was markedly lower than that of acarbose, which had an IC_{50} of 0.589 µg/mL. These findings support the preliminary potential of Ficus elastica as a natural source of α-glucosidase inhibitors. Further work is required to optimize extraction and to fractionate, isolate, and identify the active compounds responsible for the activity.

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References:

1. Dirir AM. A review of alpha-glucosidase inhibitors from plants as potential candidates for the treatment of type-2 diabetes [Internet]. Vol. 21, Phytochemistry Reviews. 2022. p. 1049–79. Available from: https://www.scopus.com/inward/record.uri?partnerID=HzOxMe3b&scp=85112552266&origin=inward
2. Ha KN. Alpha-glucosidase inhibitors from Nervilia concolor, Tecoma stans, and Bouea macrophylla. Saudi J Biol Sci [Internet]. 2022;29(2):1029–42. Available from: https://api.elsevier.com/content/article/eid/1-s2.0-S1319562X21008731
3. Miller N. Critical Assessment of in Vitro Screening of α -Glucosidase Inhibitors from Plants with Acarbose as a Reference Standard [Internet]. Vol. 88, Planta Medica. 2022. p. 1078–91. Available from: https://www.scopus.com/inward/record.uri?partnerID=HzOxMe3b&scp=85118151275&origin=inward
4. Lim J. Structural requirements of flavonoids for the selective inhibition of α-amylase versus α-glucosidase. Food Chem [Internet]. 2022;370. Available from: https://api.elsevier.com/content/article/eid/1-s2.0-S0308814621019877
5. Nguyen NH. α-Glucosidase inhibitory activities of flavonoid derivatives isolated from Bouea macrophylla: in vitro and in silico studies. Rsc Adv [Internet]. 2023;13(12):8190–201. Available from: https://www.scopus.com/inward/record.uri?partnerID=HzOxMe3b&scp=85150619874&origin=inward
6. Alarcón-Espósito J. Phenolic Composition and α-Glucosidase Inhibition of Leaves from Chilean Bean Landraces. Plant Foods Hum Nutr [Internet]. 2022;77(1):135–40. Available from: https://www.scopus.com/inward/record.uri?partnerID=HzOxMe3b&scp=85124844184&origin=inward
7. Okaiyeto K. UPLC-ESI-QTOF-MS phenolic compounds identification and quantification from ethanolic extract of Myrtus communis 'Variegatha': In vitro antioxidant and antidiabetic potentials. Arab J Chem [Internet]. 2023;16(2). Available from: https://api.elsevier.com/content/article/eid/1-s2.0-S1878535222007638
8. Kasim N. Correlation of chemical profiles obtained from 1H-NMR and LC–MS metabolomics with α-glucosidase inhibition activity for varietal selections of Ficus deltoidea. Phytochem Anal [Internet]. 2022;33(8):1235–45. Available from: https://www.scopus.com/inward/record.uri?partnerID=HzOxMe3b&scp=85139235225&origin=inward
9. Guo M. Chemical Components and Their α-Glucosidase Inhibitory Activity from the Leaves of Ficus carica Linn. Rec Nat Prod [Internet]. 2024;18(1):165–70. Available from: https://www.scopus.com/inward/record.uri?partnerID=HzOxMe3b&scp=85185324793&origin=inward
10. Rauf A. Anti-Diabetic, Anti-Cholinesterase, and Anti-Inflammatory Potential of Plant Derived Extracts and Column Semi-Purified Fractions of Ficus benghalensis. Front Biosci Landmark [Internet]. 2024;29(5). Available from: https://www.scopus.com/inward/record.uri?partnerID=HzOxMe3b&scp=85194381860&origin=inward
11. Wang H. In Vitro and In Vivo Evaluation of Antidiabetic Properties and Mechanisms of Ficus tikoua Bur. Nutrients [Internet]. 2022;14(20). Available from: https://www.scopus.com/inward/record.uri?partnerID=HzOxMe3b&scp=85140915728&origin=inward
12. Aati HY. Phytochemical Profiling, In Vitro Biological Activities, and In-Silico Studies of Ficus vasta Forssk.: An Unexplored Plant. Antibiotics [Internet]. 2022;11(9). Available from: https://api.elsevier.com/content/article/eid/1-s2.0-S2079638222016995
13. Singdam P. Phytochemical Screening, Antioxidant Potential, and α-Glucosidase Inhibition of Causonis trifolia Leaf Extracts: A Solvent-Based Comparative Study. Pharmacogn J [Internet]. 2025;17(2):164–70. Available from: https://www.scopus.com/inward/record.uri?partnerID=HzOxMe3b&scp=105004846973&origin=inward
14. Mondal SC. Ultrasonic extraction of reducing sugar and polyphenols from burdock (Arctium lappa L.) root waste and evaluation of antioxidants and α-glucosidase inhibition activity. Biomass Convers Biorefinery [Internet]. 2024;14(16):18619–36. Available from: https://www.scopus.com/inward/record.uri?partnerID=HzOxMe3b&scp=85149475476&origin=inward
15. Rosa D. In Vitro and In Silico Screening Analysis of Artabotrys sumatranus Leaf and Twig Extracts for α-Glucosidase Inhibition Activity and Its Relationship with Antioxidant Activity. Sci Pharm [Internet]. 2023;91(1). Available from: https://www.scopus.com/inward/record.uri?partnerID=HzOxMe3b&scp=85151090092&origin=inward

16. Ahda M. Phytochemical analysis, antioxidant, α-glucosidase inhibitory activity, and toxicity evaluation of Orthosiphon stamineus leaf extract. Sci Rep [Internet]. 2023;13(1). Available from: https://www.scopus.com/inward/record.uri?partnerID=HzOxMe3b&scp=85173713973&origin=inward
17. Puspitasari YE. α-Glucosidase Inhibitory Activity of Tea and Kombucha from Rhizophora mucronata Leaves. Beverages [Internet]. 2024;10(1). Available from: https://www.scopus.com/inward/record.uri?partnerID=HzOxMe3b&scp=85188804549&origin=inward
18. Kukavica B. Comparative polyphenolic profiling of five ethnomedicinal plants and their applicative potential in the treatment of type 2 diabetes. J Ethnopharmacol [Internet]. 2024;320. Available from: https://api.elsevier.com/content/article/eid/1-s2.0-S0378874123012473
19. Han X. α-Glucosidase Inhibition Mechanism and Anti-Hyperglycemic Effects of Flavonoids from Astragali Radix and Their Mixture Effects. Pharmaceuticals [Internet]. 2025;18(5). Available from: https://www.scopus.com/inward/record.uri?partnerID=HzOxMe3b&scp=105006695748&origin=inward
20. Yao M. α-Glucosidase inhibitory activity of polyphenol-rich sugarcane extract: screening and mechanistic insights based on biolayer interferometry-mass spectrometry. Front Nutr [Internet]. 2025;12. Available from: https://www.scopus.com/inward/record.uri?partnerID=HzOxMe3b&scp=105013129313&origin=inward
21. Duong TH. Bioactive-Guided Phytochemical Investigations, In Vitro and In Silico Alpha-Glucosidase Inhibition of Two Vietnamese Medicinal Plants Dicranopteris linearis and Psychotria adenophylla. Pharmaceuticals [Internet]. 2023;16(9). Available from: https://api.elsevier.com/content/article/eid/1-s2.0-S1424824723009870
22. Le TT. α-Glucosidase Inhibitory Activity of Phenolic Compounds Isolated from the Stems of Caesalpinia decapetala var. japonica. Nat Prod Sci [Internet]. 2022;28(3):143–52. Available from: https://www.scopus.com/inward/record.uri?partnerID=HzOxMe3b&scp=85140384371&origin=inward
23. Elwekeel A. Characterization of Possible α-Glucosidase Inhibitors from Trigonella stellata Extract Using LC–MS and In Silico Molecular Docking. Plants [Internet]. 2022;11(2). Available from: https://api.elsevier.com/content/article/eid/1-s2.0-S2223774722034849
24. Dai DC. Study on the compounds with α-glucosidase inhibitory activity from leaves of Ficus esquiroliana. Tianran Chanwu Yanjiu Yu Kaifa [Internet]. 2024;36(9):1518–37. Available from: https://www.scopus.com/inward/record.uri?partnerID=HzOxMe3b&scp=85205923787&origin=inward
25. Starzec A. Polyphenol Profile of Cistus × incanus L. and Its Relevance to Antioxidant Effect and α-Glucosidase Inhibition. Antioxidants [Internet]. 2023;12(3). Available from: https://api.elsevier.com/content/article/eid/1-s2.0-S2076392123017839