

Phytochemical and In-vitro Antidiabetic Analysis of Ethanol extract of *Solenostemon monostachyus* Leaves

Authors:

Ohakwe DN^{1*}, Nwachukwu MO¹, Onuh FO², Akalazu CN³ and Alo CE⁴

¹Department of Biology, Federal University of Technology Owerri, Imo State, Nigeria.

²Department of Public Health, Federal University of Technology Owerri, Imo State, Nigeria.

³Basic Science Unit, Eko University of Medicine and Health Sciences, Ijanikin, Lagos State, Nigeria.

⁴Department of Pharmaceutical Technology, Federal Polytechnic Owerri, Nigeria.

*Corresponding Author:

Ohakwe DN, Department of Biology, Federal University of Technology Owerri, Imo State, Nigeria.

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ABSTRACT

Diabetes mellitus is a metabolic disorder characterized by persistent elevation of blood glucose and is associated with various health complications. This study investigated the phytochemical composition and in-vitro antidiabetic activity of ethanol extract of *Solenostemon monostachyus* leaves. The leaves were collected and authenticated at the botanical garden of the Federal University of Technology, Owerri, Imo State, Nigeria. The leaves were air-dried at room temperature until completely dry, pulverized using a blender and sieved through a 0.25 mm mesh to obtain a uniform particle-size powder. Extraction was done using ethanol by cold maceration. Qualitative phytochemical screening was carried out to determine the presence of selected secondary metabolites. The in-vitro antidiabetic activity of the extract was evaluated using α -amylase and α -glucosidase inhibition assays, with acarbose used as the reference standard. The phytochemical screening revealed the presence of phenols, saponins and tannins, while alkaloids and flavonoids were not detected. The ethanol extract inhibited α -amylase at 40, 60 and 80 mg/mL, producing inhibition values of $31.44 \pm 0.45\%$, $37.34 \pm 0.76\%$ and $42.30 \pm 0.43\%$, respectively. For α -glucosidase, the extract produced inhibition values of $36.21 \pm 0.27\%$, $34.16 \pm 0.26\%$ and $45.10 \pm 0.66\%$ at 40, 60 and 80 mg/mL, respectively. Acarbose produced higher inhibitory activity against both enzymes at the tested concentrations. The study demonstrates that ethanol extract of *S. monostachyus* leaves contains selected bioactive phytochemicals and possesses measurable in-vitro inhibitory activity against α -amylase and α -glucosidase.

Keywords: *Phytochemical; antidiabetic; ethanol extract; Solenostemon monostachyus*

INTRODUCTION

Diabetes mellitus is a chronic metabolic disorder characterized by elevated blood glucose levels resulting from inadequate insulin secretion, impaired insulin action, or a combination of both. It is one of the major health challenges worldwide, with its prevalence continuing to increase in both developed and developing countries. Persistent hyperglycaemia associated with diabetes can cause progressive damage to vital organs and tissues, including the kidneys, eyes, nerves, heart and blood vessels. The increasing prevalence of diabetes has created a need for effective, affordable and accessible approaches to its prevention and management, particularly in developing countries where healthcare resources may be limited (World Health Organization (WHO), 2024).

Type 2 diabetes mellitus is the most common form of diabetes and is characterized mainly by insulin resistance and progressive impairment of pancreatic β -cell function. One important biochemical consequence of carbohydrate-rich food consumption is an increase in blood glucose following the digestion and absorption of carbohydrates. Dietary starch is hydrolysed initially by the enzyme α -amylase into smaller oligosaccharides and subsequently converted into glucose by α -glucosidase enzymes. Inhibition of these enzymes can delay carbohydrate digestion and reduce the rate at which glucose enters the bloodstream. Consequently, α -amylase and α -glucosidase are important targets in the search for substances capable of controlling postprandial blood glucose levels (Dirir et al., 2021; Kaur et al., 2021).

Conventional drugs such as acarbose, miglitol and voglibose act partly by inhibiting carbohydrate-digesting enzymes. Although these drugs can be useful in the management of postprandial hyperglycaemia, their use may be associated with gastrointestinal adverse effects. This has encouraged interest in medicinal plants as potential sources of compounds that may possess antidiabetic activities with fewer undesirable effects. Plants contain numerous secondary metabolites, including flavonoids, phenolic compounds, alkaloids, tannins, saponins and terpenoids, which have been investigated for their ability to influence carbohydrate metabolism and inhibit enzymes involved in glucose production and absorption (Dirir et al., 2021; Papoutsis et al., 2021).

Phytochemicals are naturally occurring chemical compounds produced by plants and many of them possess pharmacological properties. Phenolic compounds and flavonoids, for example, have received considerable attention because of their antioxidant and enzyme-inhibitory activities. The presence and concentration of these constituents can vary according to plant species, geographical location, maturity, extraction solvent and extraction method. Ethanol is a commonly used solvent for extracting a broad range of polar and moderately non-polar phytochemicals from plant materials. Therefore, investigation of the phytochemical composition of an ethanol extract can provide useful information about the chemical constituents that may contribute to its biological activity. *Solenostemon monostachyus* P. Beauv. is a medicinal plant belonging to the family Lamiaceae and occurs in several parts of tropical Africa, including Nigeria. The plant has been used traditionally for different medicinal purposes, and its leaves have attracted scientific interest because of their phytochemical composition and reported biological activities. Investigations of the leaves have identified several classes of phytochemicals, including alkaloids, flavonoids, glycosides, saponins, steroids and tannins. Other investigations have also reported the presence of phenolic and flavonoid compounds such as catechin, quercetin, kaempferol, apigenin and luteolin in extracts of the plant (Afolabi et al., 2016; Odion et al., 2024). The increasing prevalence of diabetes and the need for affordable sources of biologically active compounds provide a basis for investigating medicinal plants with established traditional uses. *Solenostemon monostachyus* is available in tropical Africa and contains phytochemical constituents such as flavonoids, alkaloids, tannins, saponins and glycosides (Afolabi et al., 2016; Odion et al., 2024). Investigating its ethanol leaf extract against α -amylase and α -glucosidase may provide useful preliminary information about its ability to interfere with carbohydrate digestion. The study will also provide a scientific basis for further research involving isolation and characterization of active constituents and subsequent evaluation of their antidiabetic properties.

MATERIALS AND METHODS

Study Area

The plant material used for this study was collected from the botanical garden of the Federal University of Technology (FUTO) Owerri Imo State, Nigeria. Federal University of Technology Owerri lies between latitude 05° 21 and 05° 42 North and longitude 07° 48 and 06° 53 East. Owerri consists of tropical rainforest zone with average annual rainfall distribution of 2,250–2800mm. This region produces many agricultural products conditions that support the growth of various indigenous plants, including medicinal plant species. Fresh leaves of *Solenostemon monostachyus* were collected from the study area and transported to the laboratory for identification, processing, extraction and subsequent phytochemical and in-vitro antidiabetic analyses.

Research Design

This study employed an experimental laboratory-based research design to investigate the phytochemical composition and in-vitro antidiabetic activity of ethanol extract of *Solenostemon monostachyus* leaves. The study involved the collection, identification, processing and ethanol extraction of the plant leaves, followed by qualitative phytochemical screening of the crude extract. The in-vitro antidiabetic activity of the extract was evaluated using α -amylase and α -glucosidase inhibition assays. Different concentrations of the extract were tested to determine its concentration-dependent inhibitory activity against the selected carbohydrate-digesting enzymes. Acarbose was used as the reference standard for comparison. The use of these laboratory assays provided preliminary information on the phytochemical constituents and potential antidiabetic activity of *Solenostemon monostachyus* leaf extract under controlled experimental conditions.

Collection and Identification of Plant Material

Fresh and healthy leaves of *Solenostemon monostachyus* were collected from the botanical garden of the federal university of technology futo Owerri Imo State Nigeria. The leaves were carefully selected to exclude damaged, diseased or contaminated portions. The collected plant material was placed in a clean container and transported to the laboratory for further processing. The plant material was identified and authenticated by a Professor in the Department of Botany, federal University of technology Owerri imo state Nigeria. The authenticated plant material was subsequently used for the study.

Preparation of Plant Material

The freshly collected leaves of *Solenostemon monostachyus* were sorted to remove damaged leaves, extraneous materials and other foreign matter. The leaves were thoroughly washed with clean water to

remove adhering dirt and contaminants. The cleaned leaves were spread evenly and allowed to air-dry under shade at room temperature until completely dried. Shade drying was employed to minimize excessive exposure to direct sunlight, which may cause degradation or alteration of some phytochemical constituents. After drying, the leaves were pulverized into powder using a clean blender and sieved through a 0.25mm mesh to obtain uniform particle size which is similar with the procedure followed by Araya(2018), Nnodim, et al (2003) and Ohakwe et al (2025)The powdered plant material was stored in a clean, dry and properly labelled airtight container until extraction.

Preparation of *Solenostemon monostachyus* Leaf Extract by Cold Maceration

The ethanol extract of *Solenostemon monostachyus* leaves was prepared using the cold maceration method. Approximately 100 g of the powdered leaf material was accurately weighed and transferred into a clean glass container. The powdered material was soaked in 1,000 mL of ethanol and thoroughly mixed to ensure adequate contact between the plant material and extraction solvent. The container was tightly covered and the mixture was allowed to stand at room temperature for 72 hours with intermittent shaking to facilitate the extraction of ethanol-soluble constituents. At the end of the extraction period, the mixture was filtered initially using clean muslin cloth and subsequently through Whatman No. 1 filter paper to obtain a clear filtrate. The filtrate was concentrated by evaporation using a water bath maintained at approximately 40°C until a concentrated crude extract was obtained. The resulting extract was transferred into a clean, properly labelled airtight container and stored under appropriate conditions until required for phytochemical screening and in-vitro antidiabetic analyses.

Determination of Percentage Extract Yield

The concentrated crude extract obtained after evaporation of the solvent was weighed. The percentage extract yield was calculated by comparing the weight of the crude extract obtained with the initial weight of the powdered plant material used for extraction.

The percentage extract yield was calculated using the formula:

Percentage Extract Yield (%) = (Weight of Crude Extract / Weight of Powdered Plant Material) × 100

The calculated percentage yield represented the proportion of crude ethanol-soluble constituents recovered from the *Solenostemon monostachyus* leaves.

Qualitative Phytochemical Screening

The ethanol extract of *Solenostemon monostachyus* leaves was subjected to qualitative phytochemical screening to determine the presence of selected

secondary metabolites. The phytochemical groups investigated were alkaloids, flavonoids, tannins, saponins and phenolic compounds. Standard qualitative procedures based on characteristic colour changes, precipitate formation and frothing reactions were used for the preliminary identification of the phytochemical constituents.

Test for Alkaloids

The presence of alkaloids in the ethanol extract was determined using Dragendorff's reagent test. Approximately 2 mL of the ethanol extract was transferred into a clean test tube and diluted with a small quantity of distilled water. A few drops of dilute hydrochloric acid were added and the mixture was shaken thoroughly. The mixture was then filtered where necessary. A few drops of freshly prepared Dragendorff's reagent were added to the filtrate. The formation of an orange or reddish-brown precipitate indicated the presence of alkaloids.

Test for Flavonoids

The presence of flavonoids was determined using the Shinoda test. Approximately 2 mL of the ethanol extract was placed in a clean test tube, followed by the addition of a small quantity of magnesium turnings. About 1 mL of concentrated hydrochloric acid was then added carefully. The mixture was allowed to stand for a few minutes. The development of an orange, pink, red or reddish colour indicated the presence of flavonoids.

Test for Tannins

The presence of tannins was determined using the ferric chloride test. Approximately 2 mL of the ethanol extract was transferred into a clean test tube and diluted with distilled water. A few drops of 5% ferric chloride solution were added to the extract and the mixture was observed for a colour change. The development of a blue-black, greenish-black or dark green colour indicated the presence of tannins.

Test for Saponins

The presence of saponins was determined using the frothing test. Approximately 5 mL of distilled water was added to about 2 mL of the ethanol extract in a test tube. The mixture was vigorously shaken for approximately 30 seconds and allowed to stand for about 10–15 minutes. The formation of a persistent froth or stable foam that remained for several minutes indicated the presence of saponins.

Test for Phenolic Compounds

The presence of phenolic compounds was determined using the ferric chloride test. Approximately 2 mL of the ethanol extract was transferred into a clean test tube and a few drops of 5% ferric chloride solution were added. The mixture was observed for the development of a characteristic colour. The formation

of a deep blue, green, purple or bluish-green colour indicated the presence of phenolic compounds.

Preparation of Extract Concentrations

An appropriate quantity of the concentrated ethanol extract of *Solenostemon monostachyus* leaves was dissolved in a suitable solvent to prepare a stock solution. Serial dilutions were subsequently prepared to obtain the concentrations required for the antidiabetic assays. For the α -amylase inhibition assay, extract concentrations of 0, 40, 60 and 80 mg/mL were prepared. For the α -glucosidase inhibition assay, extract concentrations of 40, 60 and 80 mg/mL were prepared. The zero concentration represented the control condition without the plant extract where applicable. Acarbose was prepared at appropriate concentrations and used as the reference standard for comparison in the α -amylase and α -glucosidase inhibition assays.

In-Vitro Antidiabetic Assays

The in-vitro antidiabetic activity of the ethanol extract of *Solenostemon monostachyus* leaves was evaluated using α -amylase and α -glucosidase inhibition assays. These assays were selected because α -amylase and α -glucosidase are important enzymes involved in the digestion of dietary carbohydrates. Inhibition of these enzymes may reduce the rate of carbohydrate breakdown and consequently reduce the rapid availability of glucose following carbohydrate consumption.

Determination of α -Amylase Inhibitory Activity

The α -amylase inhibitory activity of *Solenostemon monostachyus* leaf extract was determined according to the method described by Paun et al. (2020), with slight modifications. A solution of porcine pancreatic α -amylase at a concentration of 0.5 mg/mL was prepared. Different concentrations of the ethanol extract, namely 0, 40, 60 and 80 mg/mL, were prepared. The appropriate concentration of the extract was mixed with the α -amylase solution and pre-incubated at 37°C for 20 minutes. Following pre-incubation, 1% starch solution was added as the substrate, and the reaction mixture was incubated at 37°C for 30 minutes. The enzymatic reaction was terminated by adding dinitrosalicylic acid (DNS) reagent. The reaction mixture was subsequently processed according to the assay procedure, and the absorbance was measured using a UV-visible spectrophotometer at 540 nm.

A control containing the enzyme and substrate without the plant extract was prepared simultaneously. Acarbose was used as the positive reference standard. The percentage inhibition of α -amylase activity was calculated using the formula:

$$\% \alpha\text{-Amylase Inhibition} = [(Ac - As) / Ac] \times 100$$

Where:

Ac = absorbance of the control

As = absorbance of the sample containing the plant extract.

The assay was performed in triplicate, and the results were expressed as mean $\pm$ standard deviation.

Determination of α -Glucosidase Inhibitory Activity

The α -glucosidase inhibitory activity of *Solenostemon monostachyus* leaf extract was determined using the method described by Paun et al. (2020), with slight modifications. A reaction mixture containing 50 μ L of the extract solution, 125 μ L of α -glucosidase enzyme from *Saccharomyces cerevisiae* at a concentration of 0.5 U/mL, and 700 μ L of phosphate buffer at pH 6.9 was prepared. The reaction mixture was pre-incubated at 37°C for 15 minutes. Following pre-incubation, 125 μ L of 5 mM p-nitrophenyl glucopyranoside was added as the substrate. The mixture was incubated at 37°C for 30 minutes. The enzymatic reaction was terminated by adding 1,000 μ L of 0.2 M sodium carbonate (Na_2CO_3). The absorbance was measured using a UV-visible spectrophotometer at 405 nm. A control containing the enzyme and substrate without the plant extract was prepared simultaneously, while acarbose was used as the positive reference standard.

The percentage inhibition of α -glucosidase activity was calculated using the formula:

$$\% \alpha\text{-Glucosidase Inhibition} = [(A_0 - A_1) / A_0] \times 100$$

Where:

A_0 = absorbance of the control

A_1 = absorbance of the reaction mixture containing the sample.

The assay was performed using extract concentrations of 40, 60 and 80 mg/mL and was carried out in triplicate.

Determination of IC_{50}

The concentration-dependent inhibitory activity of the ethanol extract of *Solenostemon monostachyus* leaves against α -amylase and α -glucosidase was used to estimate the IC_{50} where the experimental data permitted reliable dose-response modelling. The percentage inhibition obtained at each extract concentration was plotted against the corresponding extract concentration. The concentration required to inhibit 50% of the enzyme activity was estimated from the resulting concentration-response relationship. The IC_{50} value was used as an indicator of the inhibitory potency of the extract under the experimental conditions.

Statistical Analysis

The data obtained from the α -amylase and α -glucosidase inhibition assays were organized and subjected to statistical analysis. Results were expressed as mean $\pm$ standard deviation of triplicate determinations. The effects of extract concentration and treatment group on enzyme inhibition were analysed using analysis of variance (ANOVA). Where significant differences were observed, Duncan's

Multiple Range Test (DMRT) was used as the post-hoc test to determine differences among the treatment means. Statistical significance was accepted at $p < 0.05$. The statistical analysis was performed using an appropriate statistical software package.

RESULTS

Table 1 shows the qualitative phytochemical screening of the ethanol extract of *Solenostemon monostachyus* leaves revealed the presence of phenols, saponins and tannins, while alkaloids and flavonoids were not detected in the extract under the conditions of the tests performed.

Table 2 presents the α -amylase inhibitory activity of the ethanol extract of *Solenostemon monostachyus* leaves and acarbose at different concentrations. The extract demonstrated α -amylase inhibitory activity across the concentrations evaluated. At 0 mg/mL, the extract produced no α -amylase inhibition (0.00%), while inhibition increased to $31.44 \pm 0.45\%$ at 40 mg/mL. The inhibitory activity increased further to $37.34 \pm 0.76\%$ at 60 mg/mL and reached $42.30 \pm 0.43\%$ at 80 mg/mL. Acarbose demonstrated higher α -amylase inhibitory activity than the plant extract at all

corresponding concentrations. Its inhibitory activity increased from $60.21 \pm 0.27\%$ at 0 mg/mL to $79.71 \pm 0.25\%$ at 40 mg/mL, $80.31 \pm 0.12\%$ at 60 mg/mL and $83.62 \pm 0.21\%$ at 80 mg/mL. The results indicate that the ethanol extract exhibited measurable α -amylase inhibitory activity, although the activity was lower than that observed for acarbose under the experimental conditions.

Table 3 shows the α -glucosidase inhibitory activity of the ethanol extract of *Solenostemon monostachyus* leaves and acarbose at different concentrations. The extract exhibited α -glucosidase inhibitory activity at all concentrations tested. The inhibition was $36.21 \pm 0.27\%$ at 40 mg/mL and decreased slightly to $34.16 \pm 0.26\%$ at 60 mg/mL. At 80 mg/mL, the extract produced a higher inhibition of $45.10 \pm 0.66\%$. Acarbose showed considerably higher α -glucosidase inhibitory activity than the extract at all concentrations. Its inhibition increased from $78.46 \pm 0.79\%$ at 40 mg/mL to $80.15 \pm 0.79\%$ at 60 mg/mL and $81.27 \pm 0.00\%$ at 80 mg/mL. The ethanol extract therefore demonstrated inhibitory activity against α -glucosidase, although its activity was lower than that of the reference standard.

Table 1: Qualitative Phytochemical Composition of Ethanol Extract of *Solenostemon monostachyus* Leaves

Phytochemical constituent	Result
Alkaloids	—
Flavonoids	—
Phenols	+
Saponins	+
Tannins	+

Key: + = Present; — = Not detected.

Table 2: α -Amylase Inhibitory Activity of Ethanol Extract of *Solenostemon monostachyus* Leaves and Acarbose

Concentration (mg/mL)	Extract (% Inhibition)	Acarbose (% Inhibition)
0	0.00	60.21 ± 0.27
40	31.44 ± 0.45	79.71 ± 0.25
60	37.34 ± 0.76	80.31 ± 0.12
80	42.30 ± 0.43	83.62 ± 0.21

Values are expressed as Mean $\pm$ Standard Deviation ($n = 3$).

Table 3: α -Glucosidase Inhibitory Activity of Ethanol Extract of *Solenostemon monostachyus* Leaves and Acarbose

Concentration (mg/mL)	Extract (% Inhibition)	Acarbose (% Inhibition)
40	36.21 ± 0.27	78.46 ± 0.79
60	34.16 ± 0.26	80.15 ± 0.79
80	45.10 ± 0.66	81.27 ± 0.00

Values are expressed as Mean $\pm$ Standard Deviation ($n = 3$).

DISCUSSION

The present study demonstrated that the ethanol leaf extract of *Solenostemon monostachyus* contained phenols, saponins and tannins, while alkaloids and flavonoids were not detected. The presence of these phytochemicals provides a possible biochemical basis for the enzyme inhibitory activity observed in the

study. Plants contain several secondary metabolites capable of interacting with carbohydrate-digesting enzymes, and phenolic compounds, tannins and saponins have been reported to possess α -amylase and α -glucosidase inhibitory properties (Papoutsis et al., 2021; Kashtoh & Baek, 2022). The phytochemical profile obtained in this study is also consistent with previous reports showing that *S. monostachyus*

contains several bioactive constituents. Afolabi et al. (2016) reported the presence of important bioactive compounds in the leaves, including phenolic and flavonoid-related compounds, while Afolabi et al. (2021) reported appreciable levels of saponins, tannins and polyphenolic constituents in the plant. Differences in the phytochemical profile between studies may result from differences in geographical location, plant maturity, extraction solvent, extraction conditions and analytical methods (Papoutsis et al., 2021).

The ethanol extract exhibited α -amylase inhibitory activity at the concentrations investigated. The inhibition increased from $31.44 \pm 0.45\%$ at 40 mg/mL to $37.34 \pm 0.76\%$ at 60 mg/mL and $42.30 \pm 0.43\%$ at 80 mg/mL. This pattern suggests that increasing the concentration of the extract generally increased its ability to inhibit α -amylase. α -Amylase is responsible for the initial breakdown of dietary starch into smaller carbohydrate molecules, and its inhibition can reduce the rate at which glucose becomes available for absorption after carbohydrate consumption (Kaur et al., 2021). The observed activity therefore suggests that constituents present in the extract may interfere with starch digestion. Plant-derived α -amylase inhibitors have attracted considerable research interest because phenolic compounds and other secondary metabolites can interact with the enzyme and reduce its catalytic activity (Kaur et al., 2021; Jiang et al., 2021). Polyphenols may interact with α -amylase through hydrogen bonding and other non-covalent interactions that can alter enzyme structure or interfere with access to the catalytic region (Xiao et al., 2020).

The extract also inhibited α -glucosidase, with inhibition values of $36.21 \pm 0.27\%$, $34.16 \pm 0.26\%$ and $45.10 \pm 0.66\%$ at 40, 60 and 80 mg/mL, respectively. The highest inhibition occurred at 80 mg/mL, although the response was not strictly concentration-dependent because inhibition decreased slightly at 60 mg/mL before increasing at 80 mg/mL. This variation may be associated with differences in the interaction of individual extract constituents with the enzyme or with the complexity of crude plant extracts. α -Glucosidase catalyses the final stages of carbohydrate digestion, and inhibition of the enzyme can delay the release and absorption of glucose, thereby helping to reduce postprandial glucose elevation (Dirir et al., 2021; Kashtoh & Baek, 2022). The activity recorded in this study agrees with reports that plant phenolics, tannins, saponins and other secondary metabolites can inhibit α -glucosidase (Papoutsis et al., 2021; Cisneros-Yupanqui et al., 2023). Phenolic acids have also been shown to interact with both α -amylase and α -glucosidase, although their inhibitory effects can vary according to their chemical structure and experimental conditions (Aleixandre et al., 2022).

Acarbose produced higher inhibition of both enzymes than the *S. monostachyus* extract at the tested concentrations. This is expected because acarbose is a clinically used carbohydrate-digesting enzyme

inhibitor and has been specifically developed to reduce postprandial glucose elevation (Dirir et al., 2021). The lower activity of the crude extract does not necessarily indicate an absence of antidiabetic potential because crude extracts contain mixtures of compounds with different biological activities and concentrations. The activity may also be influenced by extraction solvent and plant source. Recent reviews have emphasized that the inhibitory activity of plant extracts depends on factors such as solvent selection, extraction procedure, plant maturity and chemical composition (Papoutsis et al., 2021; Dang et al., 2023).

The presence of phenols, saponins and tannins in the extract is particularly relevant to the enzyme inhibition observed. Phenolic compounds can interact directly with digestive enzymes, while saponins have also been reported to inhibit α -amylase and α -glucosidase through interactions influenced by their chemical structure (El-Haddad et al., 2026). Tannins may interact with proteins through hydrogen bonding and hydrophobic interactions, potentially reducing enzyme activity. However, the present qualitative phytochemical analysis cannot establish which individual compound was responsible for the observed activity. The results therefore provide preliminary evidence that ethanol extract of *S. monostachyus* leaves possesses in-vitro inhibitory activity against α -amylase and α -glucosidase, supporting further investigation using quantitative phytochemical analysis, compound identification and in-vivo studies. Since diabetes remains an important metabolic disorder associated with persistent hyperglycaemia and serious complications, continued investigation of plant-derived enzyme inhibitors may contribute to the search for additional sources of antidiabetic bioactive compounds (WHO, 2024).

Strengths of the Study

The study evaluates the in-vitro antidiabetic potential of the ethanol extract of *Solenostemon monostachyus* leaves using α -amylase and α -glucosidase inhibition assays. It also provides preliminary information on the phytochemical constituents of the extract and compares its enzyme inhibitory activity with acarbose as a reference standard.

Limitations of the Study

The study was limited to qualitative phytochemical screening and in-vitro enzyme inhibition assays. Quantitative determination and characterization of individual bioactive compounds were not performed. The study did not include in-vivo experiments or clinical evaluation to establish the antidiabetic efficacy and safety of the extract. Furthermore, the IC_{50} values were not reported, and the α -glucosidase inhibitory response was not consistently concentration-dependent.

Future Directions

Future studies should include quantitative phytochemical analysis, chromatographic profiling, and isolation and characterization of the active constituents of *Solenostemon monostachyus*. Further research should evaluate the dose-response relationship, determine reliable IC₅₀ values, investigate the safety and toxicity of the extract, and assess its antidiabetic potential through appropriate in-vivo studies.

CONCLUSION

The study concludes that ethanol extract of *Solenostemon monostachyus* leaves contains bioactive phytochemicals, particularly phenols, saponins and tannins, and demonstrates in-vitro inhibitory activity against α -amylase and α -glucosidase. The observed enzyme inhibition suggests that the plant may contain constituents capable of interfering with carbohydrate-digesting enzymes, which provides a basis for further investigation of its potential antidiabetic properties. However, the extract showed lower inhibitory activity than acarbose, and the α -glucosidase response was not consistently concentration-dependent. Since the study was conducted using in-vitro enzyme assays, the results cannot be directly interpreted as evidence of antidiabetic effectiveness in humans.

DECLARATIONS

Ethical Approval and Consent to Participate

Not applicable, as the study involved plant material and in-vitro laboratory assays and did not involve human participants or live vertebrate animals.

Consent for Publication

Not applicable

Funding

Nil.

Conflicts of Interest

The authors declare no conflicts of interest.

Author Contributions

All authors contributed to the research and preparation of the manuscript according to their respective roles.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request, subject to the availability of the original research data.

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Nil.

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