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Comparison Effectiveness of Antidiabetic Activity Extracts of Bay Leaves (*Syzygium polycephalum*) and Moringa Seeds (*Moringa oleifera* L.)

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Abstract.

The present study reports a comparative evaluation of the antidiabetic potential of ethanol extracts from Syzygium polyanthum (bay leaves) and Moringa oleifera L. (moringa seeds) based on their inhibitory activity against the α-glucosidase enzyme. Diabetes mellitus, a chronic metabolic disorder characterized by hyperglycemia due to impaired insulin secretion or action, can be managed through enzyme inhibition that delays carbohydrate hydrolysis. The investigation was conducted for five weeks using an in vitro experimental method, in which both plant materials were extracted via maceration with 70% ethanol. The α-glucosidase inhibition assay was performed spectrophotometrically at 410 nm, and the half-maximal inhibitory concentration (IC_{50}) was determined to compare the inhibitory capacities of both extracts. Phytochemical profiling revealed that bay leaf extract contains flavonoids, tannins, saponins, and steroids, while moringa seed extract contains flavonoids, alkaloids, and steroids. Results showed that bay leaf extract exhibited strong α-glucosidase inhibition with an IC_{50} value below 100 ppm, indicating a significant potential as a natural antidiabetic agent. In contrast, moringa seed extract demonstrated weaker activity with no substantial inhibition observed at the tested concentrations. Based on comparative analysis, bay leaf extract shows a higher inhibitory efficiency, suggesting its potential application in herbal antidiabetic formulations. Further studies are recommended to explore the optimal concentration range and bioactive constituents of moringa seeds.

Keywords: *Syzygium polyanthum; Moringa oleifera, α-glucosidase inhibition; antidiabetic activity and phytochemical analysis.*

I. INTRODUCTION

Diabetes mellitus (DM) has emerged as one of the most prevalent chronic metabolic disorders worldwide, posing a serious threat to global health. According to the World Health Organization, the number of people living with diabetes increased dramatically from 200 million in 1990 to approximately 830 million in 2022 [1]. China currently has the highest prevalence (140.9 million cases), followed by India (74.2 million), Pakistan (32.0 million), the United States (32.2 million), and Indonesia (19.5 million), making Indonesia one of the top five countries with the highest diabetes incidence globally [2]. Diabetes is characterized by abnormalities in the body's ability to produce or utilize insulin effectively, resulting in impaired glucose regulation. The polypeptide hormone insulin, secreted by pancreatic β-cells within the islets of Langerhans, plays a crucial role in maintaining glucose homeostasis and facilitating cellular metabolism. Insulin resistance, a condition in which body cells lose sensitivity to insulin, is a key feature in many diabetic patients, leading to chronic hyperglycemia and metabolic imbalance [3] [4].In Indonesia, diabetes ranks as the third leading cause of death, accounting for 6.7% of total mortality, after stroke (21.1%) and heart disease (12.9%). The Basic Health Research (Riskesdas) 2022 reported that approximately 19.46 million Indonesians aged 20–79 years, or 10.6% of adults, suffer from diabetes. Riskesdas 2023 further revealed that 2.2% of Indonesians aged 15 years and above were diagnosed with diabetes mellitus by a physician, with the highest prevalence observed in Jakarta (3.9%), followed by Yogyakarta (3.6%) and East Kalimantan (3.1%) [2] [5].

These figures indicate an alarming upward trend over the past decade.Diabetes mellitus is classified into four major types: type 1 diabetes (T1DM), type 2 diabetes (T2DM), gestational diabetes, and other specific types. Type 1 diabetes results from autoimmune destruction of pancreatic β-cells by T-lymphocytes

($CD4^+$ and $CD8^+$) and macrophages, whereas type 2 diabetes arises from insulin resistance and pancreatic β-cell dysfunction, leading to insufficient insulin production. Gestational diabetes typically develops during the second or third trimester of pregnancy due to placental factors that interfere with insulin function, and about 30–40% of affected women may later develop type 2 diabetes [6] [7].Current treatment approaches for diabetes include insulin therapy and oral hypoglycemic agents, which primarily act by reducing glucose absorption or enhancing insulin sensitivity. One pharmacological strategy involves the inhibition of α-glucosidase, an enzyme responsible for carbohydrate hydrolysis in the intestinal mucosa[1]. Inhibiting this enzyme delays glucose absorption, thereby controlling postprandial blood glucose levels [8] [9]. However, the long-term use of synthetic antidiabetic drugs often leads to adverse effects, including hypoglycemia, hepatotoxicity, cardiovascular complications, and gastrointestinal discomfort. Hence, there is rowing interest in exploring natural products as safer alternatives for diabetes management [10] [11][12]. Medicinal plants have gained significant attention as potential sources of antidiabetic compounds.

Among them, Syzygium polyanthum (bay leaf) and Moringa oleifera L. (moringa seed) are two promising candidates. Bay leaves contain bioactive components such as flavonoids, tannins, saponins, steroids, and phenolics, which exhibit antioxidant, anti-inflammatory, and hypoglycemic properties [13] [14]. Previous studies demonstrated that ethanol extracts of bay leaves significantly reduced blood glucose levels in diabetic rats. Likewise, Moringa oleifera is known for its diverse pharmacological activities, including antioxidant, antihypertensive, hepatoprotective, and antidiabetic effects. Its seeds and leaves are rich in flavonoids, terpenoids, vitamins A, C, and E, and essential minerals that enhance glucose metabolism and insulin secretion [15] [16].According to Sulastri et al. (2024), ethanol extracts of Syzygium polyanthum at concentrations of 70% and 96% exhibited IC_{50} values of 86.29 ppm and 51.54 ppm, respectively, indicating potent α-glucosidase inhibitory activity [17] [18]. Nonetheless, limited comparative studies have been conducted to evaluate the antidiabetic potential of Moringa oleifera seeds relative to Syzygium polyanthum leaves. Therefore, this study aims to investigate and compare the α-glucosidase inhibitory activities of ethanol extracts from both plants. The findings are expected to contribute to the development of safer, plant-based antidiabetic agents and to support the utilization of Indonesian medicinal plants in modern therapeutic applications [19][15].

Taxonomic classification of Moringa oleifera L.

- Kingdom: Plantae
- Division: Magnoliophyta
- Class: Magnoliopsida
- Order: Brassicales
- Family: Moringaceae
- Genus: Moringa
- Species: Moringa oleifera

Taxonomic classification of Syzygium polyanthum (Wight.)

- Kingdom: Plantae
- Division: Magnoliophyta
- Class: Magnoliopsida
- Order: Myrtales
- Family: Myrtaceae
- Genus: Syzygium
- Species: Syzygium polyanthum (Wight.) Walp.

II. METHODS

This study employed an in vitro experimental design to compare the antidiabetic activity of ethanol extracts from *Syzygium polycephalum* (bay leaves) and *Moringa oleifera* L. (moringa seeds) based on their α-glucosidase enzyme inhibition [20]. Acarbose was used as a positive control, while a buffer–substrate

20 mixture without enzyme served as a negative control. The research was conducted from October 2024 to
January 2025 at the Medical Laboratory of Universitas Kristen Indonesia and the Faculty of Agriculture,
Bogor. Dried moringa seeds from Yogyakarta and bay leaves from Universitas Kristen Indonesia were
extracted by maceration using 70% ethanol. Each 500 g of powdered material was soaked in 1 L of solvent
28 for three consecutive 24-hour periods, filtered, and concentrated with a rotary evaporator to obtain viscous
29 crude extracts[21].The α-glucosidase inhibitory assay was performed spectrophotometrically at 410 nm using
p-nitrophenyl-α-D-glucopyranoside (pNPG) as substrate. The reaction mixture consisted of phosphate buffer,
enzyme solution, substrate, and test samples at concentrations of 100–300 ppm, incubated at 37°C for 30
minutes and terminated with 0.2 M sodium carbonate. The percentage inhibition was calculated as %
inhibition = (B − S)/B × 100, and IC_{50} values were determined by linear regression (y = a + bx). Qualitative
phytochemical screening was conducted to identify alkaloids, flavonoids, phenolics, saponins, triterpenoids,
21 and steroids using standard reagents. All tests were performed in triplicate, and results were expressed as
mean ± SD. Lower IC_{50} values indicated stronger α-glucosidase inhibition and higher antidiabetic potential
of the extracts [22].

III. RESULT AND DISCUSSION

22 ***Phytochemical Test of Moringa Seed Extract***

Table 1. Phytochemical Test of Moringa Seed Extract

Sample	Phytochemical Type (Parameter)	Result	Analysis Technique
Moringa oleifera L Seed Extract	Flavonoid	Positive	Color Visualization
	Alkaloid (Wagner)	Positive	Color Visualization
	Alkaloid (Mayer)	Positive	Color Visualization
	Alkaloid (Dragendorff)	Positive	Color Visualization
	Tannin	Negative	Color Visualization
	Saponin	Negative	Color Visualization
	Quinone	Negative	Color Visualization
	Steroid	Positive	Color Visualization
	Triterpenoid	Negative	Color Visualization

The active components identified in the Moringa oleifera seed extract were flavonoids, alkaloids, and steroids, based on color visualization analysis techniques.

Phytochemical Test of Bay Leaf Extract

Table 2. Phytochemical Test of Bay Leaf Extract [26]

Sample	Phytochemical Type (Parameter)	Result	Analysis Technique
Bay Leaf Extract	Saponin	Positive	Color Visualization
	Tannin	Positive	Color Visualization
	Steroid	Positive	Color Visualization
	Alkaloid	Negative	Color Visualization
	Flavonoid	Positive	Color Visualization

The active components identified in the *Syzygium polycephalum* (bay leaf) extract include saponins, tannins, steroids, and flavonoids [26].

Extraction of Bay Leaf

Fig 1. Extraction of Bay Leaf

A total of 500 grams of *Syzygium polycephalum* (bay leaf) simplicia were extracted with 1 liter of 70% ethanol, producing a thick, paste-like extract with a dark black color.

Extraction of Moringa Seed

Fig 2. Extraction of Moringa Seed

A total of 500 grams of *Moringa oleifera* L. seed simplicia extracted with 1 liter of 70% ethanol produced a thick, paste-like extract with a dark brown color.

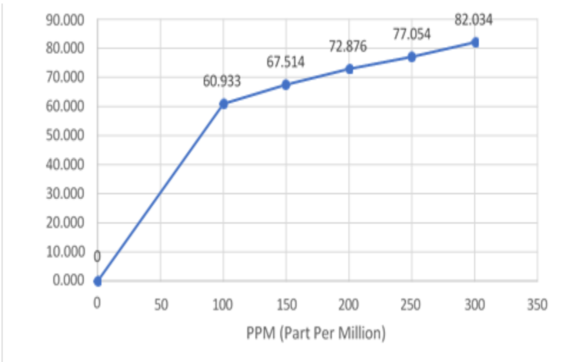
α-Glucosidase Enzyme Assay of Bay Leaf Extract

Table 3. α-Glucosidase Enzyme Assay of Bay Leaf Extract

	Bay Leaf Extract Absorbance				**Corrected Absorbance**			**% inhibisi**			
ppm	**U1**	**U2**	**U3**	**K-**	**U1**	**U2**	**U3**	**U1**	**U2**	**U3**	**Rata - rata % inhibisi**
300	0,258	0,255	0,255	0,084	0,174	0,171	0,171	81,875	82,094	82,132	82,033
250	0,296	0,3	0,3	0,079	0,217	0,221	0,221	77,396	76,859	76,907	77,054
200	0,343	0,337	0,336	0,079	0,264	0,258	0,257	72,5	72,984	73,145	72,876
150	0,411	0,408	0,414	0,1	0,311	0,308	0,314	67,604	67,749	67,189	67,514
100	0,444	0,442	0,44	0,068	0,376	0,374	0,372	60,833	60,838	61,129	60,933
0	1,023	1,018	1,02	0,063	0,96	0,955	0,957				

Based on this study, the bay leaf extract at a concentration of 300 ppm showed an average inhibition rate of 82%. The IC_{50} value obtained for the bay leaf extract was less than 100 ppm.

Fig 3. Average α-Glucosidase Inhibition of Bay Leaf Extract Increases with Higher Concentrations



The average α-glucosidase inhibition of the bay leaf extract increased with higher concentrations; the greater the concentration used, the higher the percentage of inhibition obtained.

α-Glucosidase Enzyme Assay of Moringa Seed Extract

Table 4. α-Glucosidase Enzyme Assay of Moringa Seed Extract

	Moringa Seed Extract									
	Absorbance				**Corrected Absorbance**			**% inhibisi**		
ppm	**U1**	**U2**	**U3**	**K-**	**U1**	**U2**	**U3**	**U1**	**U2**	**U3**
300	1,269	1,267	1,265	0,109	1,16	1,158	1,156	-21,977	-21,767	-20,921
250	1,191	1,19	1,194	0,059	1,132	1,131	1,135	-19,033	-18,927	-18,724
200	1,145	1,144	1,144	0,066	1,079	1,078	1,078	-13,460	-13,354	-12,762
150	1,094	1,093	1,093	0,061	1,033	1,032	1,032	-8,623	-8,517	-7,950
100	1,058	1,061	1,061	0,062	0,996	0,999	0,999	-4,732	-5,047	-4,498
0	1,016	1,016	1,021	0,065	0,951	0,951	0,956			

Moringa Seed Extract	The IC50 value could not be determined

Acarbose was used as a positive control in the α-glucosidase enzyme assay, and the results showed an IC_{50} value of 0.16 ppm based on three replications using five different concentrations. The acarbose concentrations ranged from 0.1 ppm to 0.5 ppm, 1 ppm to 5 ppm, and 10 ppm.

Table 5. Results of the α-Glucosidase Enzyme Assay on Acarbose as a Positive Control

	Acarbose									
	Absorbance				**Corrected Absorbance**			**% inhibisi**		
ppm	**U1**	**U2**	**U3**	**K-**	**U1**	**U2**	**U3**	**U1**	**U2**	**U3**
10	0,076	0,079	0,076	0,056	0,02	0,023	0,02	97,468	97,092	97,459
5	0,123	0,124	0,123	0,056	0,067	0,068	0,067	91,519	91,403	91,487
1	0,285	0,289	0,29	0,057	0,228	0,232	0,233	71,139	70,670	70,394
0,5	0,344	0,346	0,344	0,059	0,285	0,287	0,285	63,924	63,717	63,787
0,1	0,502	0,503	0,504	0,059	0,443	0,444	0,445	43,924	43,869	43,456
0	0,852	0,853	0,849	0,062	0,79	0,791	0,787			

IC_{50} Acarbose	**0,16**	**ppm**

IV. CONCLUSION

The ethanol extracts of *Syzygium polycephalum* (bay leaf) and *Moringa oleifera* L. (moringa seed) were found to contain secondary metabolites such as flavonoids and steroids, which possess potential antidiabetic activity. This finding is supported by the results of the phytochemical and enzymatic analyses conducted in this study. The moringa seed extract contains flavonoids that are theoretically capable of inhibiting the α-glucosidase enzyme through hydroxylation and substitution on the β-ring; however, in practice, it showed no significant inhibitory effect under the tested conditions.In contrast, the ethanol extract of bay leaves exhibited strong α-glucosidase inhibitory activity, with the highest inhibition observed at a concentration of 300 ppm (82%) and an IC_{50} value below 100 ppm. These results indicate that bay leaf extract demonstrates potent enzyme inhibition and has strong potential as a natural antidiabetic agent, while moringa seed extract showed minimal or no inhibition at equivalent concentrations.In conclusion, the findings of this study provide scientific support for the traditional use of bay leaves in diabetes management and suggest further investigation into the optimization of moringa seed extract concentrations and bioactive compound isolation to enhance its therapeutic potential.

3

V. ACKNOWLEDGMENTS

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