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HPTLC Screening and Alpha-Glucosidase Inhibitory Activity of Ethanolic Extract of Marang *(Artocarpus odoratissimus)* Core Waste Fruit

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ABSTRACT

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Marang (Artocarpus odoratissimus) is a native Philippine tree commonly found in Southeast Asia, used to treat various ailments. To provide a scientific basis for such a claim, this study evaluated the potential of marang, focusing on the core waste fruit, as a natural treatment for diabetes that aligns with the Sustainable Development Goals and the circular economy by reducing resource waste and minimizing environmental impact. This study utilized a quantitative, descriptive, comparative, and experimental design to analyze data on the phytochemical constituents and alpha-glucosidase inhibitory activity. For the evaluation of glucosidase inhibition activity, in vitro methods, and statistical such as mean, standard deviation, One-Way ANOVA, Regression and Post Hoc were applied. HPTLC screening revealed the presence of primary metabolites, including proteins, suggesting possible medicinal properties. Results showed a statistically significant difference ($p<0.05$) at the 95% confidence level between acarbose and marang core waste fruit extract. The IC_{50} of the extract of marang core waste fruit shows (203±4.15µg/mL), demonstrating a significant difference to acarbose (125±0.48 µg/mL). Overall, the findings showed that the marang core waste fruit is a potential alternative herbal medicine as an alpha-glucosidase inhibitor for diabetes.

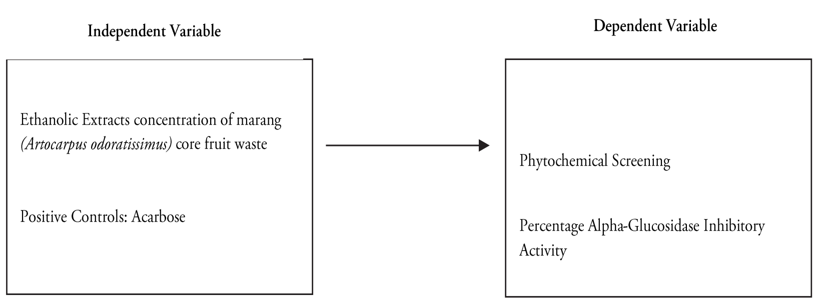
INTRODUCTION

Diabetes Mellitus (DM) remains one of the most pressing global health concerns today, contributing significantly to both mortality and morbidity worldwide (Hossain et al., 2024). It is a metabolic imbalance caused by glucose dysregulation, characterized by elevated blood glucose levels due to inadequate insulin production and insulin dependence (Gaur et al., 2024). Type 1 diabetes is a metabolic disorder that develops in children, adolescents, and young adults, in which T-cells destroy pancreatic beta-cells responsible for insulin production or insulin-dependent diabetes mellitus (IIDM) (Dirir et al., 2021). On the other hand, Type 2 diabetes is noninsulin-dependent diabetes milletus (NIDDM), which the body is inability of insulin-sensitive tissues to respond to insulin (Atkinson et al, 2025). A study by Abed et al. (2022) revealed that diabetes has become the third deadliest health concern, following cancer and cardiovascular diseases. The International Diabetes Federation (IDF) reported that approximately 537 million people are currently affected and projected to rise to 643 million by 2030 and 783 million by 2045 (Ulambayar et al., 2023). Globally, diabetes remains a major public health problem, affecting both developed and developing countries, particularly in China, India, the United States, Indonesia, Japan, Pakistan, Russia, Brazil, Italy, and Bangladesh (Tran et al., 2020).

In Asia, China recorded the highest number of diabetes cases, with over 118 million individuals, accounting for 22% of global cases (Xu et al., 2024). Similarly, the Philippines had a high number of diabetes cases, with a national rate of 7.5%, placing it among the top five Asian countries with the most diabetes mellitus cases (Cando et al. 2024). According to a study by Giron and De la Vega (2022), the National Capital Region (NCR) had the highest diabetes rates in the Philippines, followed by Central Luzon and Calabarzon. In Mindanao, specifically in the Davao region, the marang (Artocarpus Odoratissimus) tree is commonly cultivated. The fruit was usually sold in the local market (Estudillo & Tolentino, 2024). However, the study conducted by Alvarado (2023) found that Marang (Artocarpus odoratissimus) fruit produced about 43.5 metric tons from 2018 to 2020, with approximately 60% of the waste comprising the husk, seeds, and core, resulting in 26 metric tons per year. Consequently, poor management of these wastes can caused severe ecological issues such as eutrophication, greenhouse gas release, global warming, soil and water contamination (Jayasoorya& Kumar, 2024).

The increasing number of diabetes cases in the Philippines and the concurrent rise in agricultural waste present an opportunity to explore sustainable, plant-based therapeutic alternatives. Several studies have shown that the parts of the marang (Artocarpus odoratissimus) fruit contain phytochemicals, including primary and secondary metabolites, with therapeutic properties that can benefit both the environment and the economy (Kshirsagar et al., 2019; Kumari et al., 2024). This gap further emphasized by Cortez (2024), who revealed that inadequate waste segregation in Davao City has resulted in landfill overcapacity, with approximately 23.79% of the total waste. This issue provides the Davaoeños an opportunity to transform the core waste product of the marang into a plant-based alternative therapeutic medicine to manage diabetes mellitus while minimizing environmental impact. However, there remains limited scientific validation of the phytochemical constituents and antidiabetic activity, particularly of the primary and secondary metabolites and alpha-glucosidase activity. Therefore, this study is distinct in its focus on the vitro evaluation of marang (Artocarpus odoratissimus) core waste fruit as a plant-based alternative therapeutic agent for diabetes milletus, addressing both public health and environmental sustainability concerns.

FRAMEWORK



The diagram shows the independent variable which is the ethanolic extracts concentration of marang (*Artocarpus odoratissimus*) core waste fruit and acarbose as the positive control and evaluates two dependent variables through phytochemical screening and alpha-glucosidase enzyme inhibition percentage.

OBJECTIVES OF THE STUDY

The study aimed to identify the phytochemical constituents of marang (*Artocarpus odoratissimus*) core fruit waste, specifically focusing on primary and secondary metabolites. It also determinethe percentage of alpha-glucosidase inhibition of the ethanolic extract of marang (*Artocarpus odoratissimus*) core fruit waste and positive control to assess its potential as a plant-based alternative for managing diabetes.

METHODOLOGY

Research Design

A quantitative, descriptive, comparative, and experimental research design was used in conducting this study. The researcher used a quantitative design in the study to obtain accurate data for determining percentage inhibition, IC_{50} values, and HPTLC metabolite profiles. In this approach, the researcher can effectively evaluate the potential antidiabetic properties of the ethanolic extract from the core waste fruit of marang (Artocarpus odoratissimus). Additionally, the researcher used a descriptive study to measure alpha-glucosidase assay inhibition as a percentage at different concentrations, which was used to determine the IC_{50} value. Moreover, the study applied a comparative research design to examine differences between two variables using quantitative methods (Iranifard et al., 2022). This design compares the plant extract and the positive control (acarbose) to determine which has the lower IC_{50} value.

Lastly, the researcher employed an experimental design to structure the study scientifically, with two sets of variables (Salmons., 2021). The context of this design is the extraction of plant material using ethanol solvent, followed by HPTLC screening to detect primary and secondary metabolites. The marang (Artocarpus odoratissimus) core waste fruit was collected in the main local establishments in Davao City: Local Food Delicacies Vendors, Magsaysay Fruit Vendors Association, Bankerohan Fruit Vendors, and the Pasalubong Center. The collection of the waste material was selected using purposive sampling. These areas were strategically selected due to their waste generation, providing a sustainable and accessible raw material source for the study. This aligns with a study by Cortez (2024), which found that in Davao City, inadequate waste segregation has led to overcapacity in landfills, with approximately 23.79% of total waste consisting of fruit and vegetable waste.

Instrumentation

The HPTLC (Camag TLC plate) instrument was utilized for the identification of primary and secondary metabolites. The analytical-grade reagents and chemicals used in the study included ethanol, alpha-glucosidase assay, ferric chloride, sodium hydroxide, hydrochloric acid, sulfuric acid, chloroform, and nitric acid for extract concentration. A rotary evaporator (Yamato Scientific RE210) was also used for the concentration of the ethanolic extract, and an analytical balance (SHIMADZU AX200) was used. Additionally, the researcher used a UV-Vis spectrophotometer to determine the percentage of alpha-glucosidase inhibitory activity.

Ethical Considerations

Standardized and validated laboratory procedures were followed to ensure the reliability and validity of results. Ethical standards and laboratory safety protocols set by the University of the Immaculate Conception Research Ethics Committee were strictly observed. The researcher utilized complete personal protective equipment and complied with institutional biosafety and chemical safety regulations. Chemical wastes were properly segregated and disposed of in accordance with DENR-EMB guidelines (DENR Administrative Order No. 29, Series of 1992).

Statistical Tools

The collected data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 20. The mean and standard deviation were used in this study to determine the average percentage of alpha-glucosidase inhibition activity and the extent of variation. Data were analyzed using one-way ANOVA to determine significant differences in the percentage of alpha-glucosidase inhibitory activity of the extracts from marang (Artocarpus odoratissimus) fruit cores, compared with core waste controls, at different concentrations. In addition, a post hoc test was performed to determine the highest concentration and the level of inhibition. The purpose of this statistical analysis was to evaluate the efficacy of the plant extract as a potential antidiabetic by comparing its inhibitory effect with that of the positive control. Lastly the regression analysis was applied to establish the relationship between the concentration of the ethanolic extract and the percentage of alpha-glucosidase inhibition. This method was also used to determine the IC_{50} value, which represents the concentration required to inhibit 50% of enzyme activity and indicates the potency of the extract.

RESULTS AND DISCUSSION

Table 1

Preliminary Pytochemical Screening of Marang (Artocarpus odoratissimus) Core Waste Marang Extracts

Test Parameters	Results
Glycoside	-
Tannin	-
Flavonoid	-
Phenol	-
Saponin	-
Terpenoid	-
Protein	+
Alkaloid	-
Phytosterol	-
Reducing Sugar	-

(+) - indicates presence of phytochemical constituents

(-) - indicates absence of phytochemical constituents

The quantitative photochemical profile of marang (*Artocarpus odoratissimus*) core waste extract was determined by phytochemical screening using HPTLC to identify the primary and secondary metabolites. Table 1 shows that proteins are present in the ethanolic extract of marang (*Artocarpus odoratissimus*) core waste. These findings support the study conducted by Alvarado (2023), which resulted in (1.31±1.51g) proteins found in marang (*Artocarpus odoratissimus*) fruit flesh. Previous studies have revealed that proteins in marang (*Artocarpus odoratissimus*) fruit have the potential to enhance, demonstrating their potential as natural antidiabetic agents (Jonatas et al., 2020). Similarly, the study by Zahoor et al., (2025) confirmed that the proteins present in the plant extract contain phytochemical constituents that may play an essential role in metabolic processes, particularly in maintaining blood glucose levels. Moreover, these findings are consistent with those of the present study, suggesting that proteins in the marang (*Artocarpus odoratissimus*) core waste extract may have significant value, particularly as a plant-based alternative for managing diabetes.

Table 2
Percent alpha-glucosidase inhibitory activity of Marang (Artocarpus odoratissimus) Core Waste Fruit and Acarbose

Extract	Concentration ppm	Results (%)			Mean (%)	SD	RSD
		Trial 1	Trial 2	Trial 3			
Plant Extract	50	17.7	17.6	17.0	17.4	0.36	2.06
	100	25.9	27.3	25.9	26.3	0.82	3.10
	150	36.2	36.1	37.2	36.4	0.62	1.70
	200	48.3	48.4	48.7	48.4	0.24	0.49
	250	60.8	64.5	61.6	62.4	2.11	3.38
Acarbose (Positive Control)	50	30.0	30.0	29.8	29.9	0.11	0.37
	100	42.9	43.6	43.2	43.2	0.34	0.78
	150	57.7	58.2	57.7	57.8	0.28	0.48
	200	68.4	65.8	67.1	67.1	1.29	1.92
	250	86.4	86.7	85.5	86.2	0.63	0.73

The Table 2 shows that the ethanolic extract of the marang core waste substantially inhibited the alpha-glucosidase enzyme at 250 ppm, with a mean inhibition of (62.40±2.11). However, the acarbose demonstrated a higher inhibitory activity at the same concentration, with a mean of (86.20±0.63). This indicates that the marang *(Artocarpus odoratissimus)* core waste extract has potential antidiabetic properties but exhibits a lower inhibitory effect than acarbose. This study contradicts the claims of Jonatas (2020), wherein it was found that marang fruit parts *(Artocarpus odoratissimus)* extracts exhibited the highest percentage of alpha-glucosidase inhibitory activity, with the seed (98.25±0.16), pulp (96.32±0.08), and husk (95.91±0.16) compared to acarbose with the lowest percent at (76.07±1.64). Based on their results, the marang extracts show stronger alpha-glucosidase inhibition than acarbose. In contrast, the present study demonstrated the opposite trend, with acarbose showing a higher alpha-glucosidase activity than marang fruit (*Artocarpus odoratissimus*) extracts. However, the ethanolic extract marang (*Artocarpus odoratissimus*) core waste study found a percentage decrease at 250 ppm with a mean of (62.40±2.11) alpha-glucosidase inhibitory activity compared to the positive control, acarbose, with a mean of (86.20±0.63). This can be related to the phytochemical results, where the presence of proteins was found without the presence of secondary metabolites. The study by Lu et al. (2023) supported these results, suggesting a positive relationship between higher levels of secondary and primary metabolites and a higher degree of alpha-glucosidase inhibition. This indicates the significance of the secondary metabolites like flavonoids, tannins, and phenolic compounds in enzyme inhibition. This also supported findings by Hieu et al. (2020) suggesting the importance of primary and secondary metabolites significantly involved in the inhibition of alpha-glucosidase. Thus, it can therefore be concluded that the lower percentage of the marang fruit (*Artocarpus odoratissimus*) core waste ethanolic extract's inhibitory activity can be related to their fewer phytochemical properties.

Table 3

Significant difference in the percentage alpha-glucosidase inhibitory activity between ethanolic extract of marang (Artocarpus odoratissimus) core waste fruit and acarbose

Test variables	F	P	Remarks
Plant Extract	3574.79	<0.001	Significant
Types of Treatments	3184.77	<0.001	Significant

The results revealed that the inhibitory activity plant extracts increased as the concentration increased, showing a clear concentration-dependent effect. The ANOVA results showed a highly significant difference ($p<0.001$) among the different extract concentrations and treatment types (plant extract vs. acarbose). The very high F-values for the plant extract ($F=3574.79$) and the treatment types ($F=3184.77$), indicated that the difference in enzyme inhibition were caused by real differences among the samples. This means that both concentration and treatment type had a significant effect on alpha-glucosidase inhibition. This result support on study conducted of Jonatas et al. (2020) on marang (*Artocarpus odoratissimus*), which showed a significant difference in inhibition across concentration of marang (*Artocarpus odoratissimus*) core waste fruit extracts showing a dose-dependent interaction between extract and concentration. Similarly, Othman et al (2024), found that marang (*Artocarpus odoratissimus)* core waste fruit exhibited a significant difference, this means that the plant extracts potential to inhibit alpha-glucosidase activity. The present study supports these previous findings, showing significant difference ($p<0.001$) between the ethanolic extract of marang (*Artocarpus odoratissimus*) core waste fruit and acarbose in their alpha-glucosidase inhibitory activity, further confirming the extract's strong and concentration-dependent inhibitory activity.

The post-hoc multiple mean comparison test further showed a significant difference ($p< 0.05$) in the level of alpha-glucosidase activity inhibition, indicates that the concentration with the highest value showed the strongest level of inhibition. This result indicated that the higher the concentration, the stronger the alpha-glucosidase inhibitory activity possessed by the extract. This revealed that there was a significant difference in the alpha-glucosidase inhibitory property between plant extracts and positive controls based on varying concentrations tested. The result supports other findings that marang (Artocarpus odoratissimus) core waste fruit has alpha- glucosidase inhibitory activity in a concentration-dependent manner (Ismail et al., 2023). This was in line with the result from Othman et al. (2024), who revealed that a higher concentration of the extract increases the level of inhibitory activity. This study was in support of findings from Alvarado (2023), who demonstrated that there was a difference in the level of inhibitory activity between acarbose and plant extracts based on concentration.

Table 4

Maximal Half-Concentration of Ethanolic Marang (Artocarpus odoratissimus) core waste fruit and acarbose

Test	Test Drug	N	IC_{50}(ppm)
Alpha-glucosidase	Ethanolic Marang (Artocarpus odoratissimus) Core Waste Fruit	3	203 ± 4.15
	Acarbose	3	125 ± 0.48

The half maximal inhibitory concentration (IC_{50}) is a measure of effectiveness for a given concentration, and it is calculated as the concentration which inhibits the biological process by 50%.The potency level of the antagonist drug is indicated by the IC_{50}, which is calculated based on the given concentration in inhibiting biological processes by 50%.The result of overall IC_{50} calculation is presented in table 4. The observation by Jonatas (2020) revealed that marang (Alpha odoratisissimus) pulp extracts have the highest percentages of inhibition (93.32±0.08), which is much higher than acarbose (76.07±1.64). These findings congruent to the present study showing the maximal inhibitory concentration (IC_{50}) values for ethanolic extract of marang (Artocarpus odoratissimus) core waste fruit, which revealed the IC_{50} values for the ethanolic marang (*Artocarpus odoratissimus) core* waste fruit were (203±4.15) which is higher than the positive control (acarbose) at (125±0.48). Thus, the lower IC_{50} value observed for positive control (acarbose) indicates that it is the more potent inhibitor of alpha-glucosidase. Moreover, the ANOVA results ($p<0.05$) also confirmed both treatment type and concentration, showing a dose dependent inhibition. This means that as the dose of the extract increases, its ability to inhibit the enzyme alpha-glucosidase also increases. Nevertheless, the higher IC_{50} value of the ethanolic extract compared to positive control (acarbose) suggests a lower inhibitory potency.

Table 5

Significant difference of Maximal Half-Concentration of ethanolic Marang (Artocarpus odoratissimus) core waste fruit and acarbose

Test	IC_{50}	t	P	Remarks
Plant Extract	203 ± 4.15	-5.096	<0.05	Significant
Acarbose	125 ± 0.48	-5.096	<0.05	Significant

Several studies evaluated the significant difference maximal half-concentration of plant extract and acarbose, showed that there was significant difference ($p<0.05$), indicating that the marang (*Artocarpus odoratissimus)* fruit parts such as seeds, peel, husks exhibited alpha-glucosidase activity (Kshirsagaret al., 2019). The present findings support these previous studies. As demonstrated in table 5, the mean IC_{50} value of the plant extract (203±4.15) was significantly higher than that of positive control (125±0.48). This means that the higher IC_{50} value indicates lower potency, meaning that a greater concentration of the plant extract is needed to inhibit 50% of alpha-glucosidase activity compared to acarbose. The t-value supports these findings, simply reflecting the direction of the difference between plant extract and positive control (acarbose). Combined with the associated p-value ($p<0.05$), 95% confidence. This indicated a 95%

certainty that the difference in IC_{50} values was not due to experimental error. This high t-value also confirmed the significance of the difference between IC_{50} values of plant extract and positive control (acarbose), therefore suggesting a strong evidence supporting the rejection of the null hypothesis. This study agreed with earlier researchers who clearly confirmed that acarbose was more potent compared with plant extracts, despite the later still exhibiting alpha-glucosidase activity. It confirmed the existence of a significant difference in potency between plant extract and positive control acarbose IC_{50} values.

CONCLUSIONS

The results of this study, indicates that the ethanolic extract of the marang (*Artocarpus odoratissimus)* core waste fruit contains proteins as the main phytochemical constituents. The extract was dose-dependent in inhibiting the alpha-glucosidase enzyme, indicating the potential use of the extract as an alternative alpha-glucosidase inhibitor. Moreover, the activity was clearly revealed that the positive control (acarbose) showed highly significant inhibitory activity which demonstrated significantly greater inhibitory effects confirming its superior potency compared to the plant extract. Statistical analysis also confirmed that there was a highly significant difference between the inhibitory activity of the ethanolic extract of the marang (*Artocarpus odoratissimus*) core waste fruit and the activity of the standard alpha- glucosidase inhibitor to the positive control (acarbose), confirming the relative low efficacy of the former when used as an alpha-glucosidase inhibitor. Thus, the ethanolic extract had a higher IC_{50} value than positive control (acarbose), thereby suggesting a higher amount or concentration to achieve 50% inhibition of alpha-glucosidase activity.

TRANSLATIONAL RESEARCH

This study could provide guidance to researchers and healthcare professionals, farmers, and students on finding practical applications for the utilization of waste fruits of marang (*Artocarpus odoratissimus*). Pytochemical analysis and enzyme inhibition assays, it is demonstrated that proteins extracted using ethanol exhibit dose-dependent alpha-glucosidase inhibitory activity, suggesting potential antidiabetic properties. These phytochemical properties support the feasibility of converting marang (*Artocarpus odoratissimus*) core waste fruit into value-added products, such as herbal supplements and functional food ingredients, following appropriate formulation, safety validation, and standardization processes. Moreover, the study may also provide insights for educators and curriculum developers in integrating activities concerned with sustainable practices and green chemistry principles into the instructional programs so that practical utilization of plant-based resources could be encouraged. This result serves as the basis for further studies on plant-derived therapeutics and valorization of agriculture by-products.

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