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Glycemic Response to Karamunting Leaves Tea in Healthy Adults: Does a Family History of Diabetes Matter?

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ABSTRACT: Herbal tea is tea that does not come from *Camelia sinensis* tea leaves. Research using animal models has shown that herbal tea made from Karamunting leaves (*Melastoma malabathricum*) exhibits antidiabetic properties, acting as an antioxidant and antihyperglycemic agent. However, its efficacy in lowering blood glucose levels in healthy individuals is unproven. Therefore, this study aims to obtain the blood glucose response of healthy respondents without and with a hereditary history of diabetes mellitus after administering a glucose load and herbal tea from Karamunting leaves (KHT). This study was conducted on two groups of respondents aged 30-35 years with normal fasting blood glucose levels (70-110mg/dL). The KHT was administered shortly after the respondent was given glucose (75g). According to the findings, the KHT may reduce glucose levels to normal in respondents without a family history of diabetes at the 150th minute, as well as in respondents with a family history of diabetes at the 180th minute. The KHT efficiently prevents the increase in blood glucose levels in individuals without genetic diabetes mellitus and lowers blood glucose levels for individuals with hereditary diabetic mellitus. Adding spices or additional ingredients to karamunting leaf tea may enhance its antihyperglycemic abilities.

1. INTRODUCTION

Karamunting leaves (*Melastoma malabathricum*) have been trusted by the public to be used as a cure for diabetes mellitus sufferers. Several previous studies have confirmed this, including those utilizing tea. Its functional effect as an antihyperglycemic is manifested in addition to operating on the exocrine system, especially by reducing the activity of the alpha amylase and alpha glucosidase enzymes; it may also reduce blood glucose levels by means of its role as an insulin-mimetic [1]. Its capacity as an antioxidant through the donation of hydrogen and electrons is another functional benefit that meets the demands of individuals with diabetes mellitus [1,2]. In addition to in vitro testing, an in vivo test of its antihyperglycemic efficacy is conducted. The infusion approach indicates that the optimal dose is 0.4g/mL [3]. Other capabilities of extracts using organic solvent are anti-inflammation and analgesic [4], gastroprotection [5], antibacterial [6,7], antifungal [8], chemo preventive [9], anti-elastase [10], and anti-coagulant [11].

Antihyperglycemic activity refers to the ability to maintain blood glucose levels within the normal range (70–110 mg/dL). This can be achieved in two ways: by inhibiting carbohydrate digestion and by keeping blood glucose levels within normal limits. Carbohydrate digestion can be inhibited by suppressing the enzymes responsible for digesting carbohydrates, such as alpha-amylase and alpha-glucosidase. Alpha-amylase is a starch-hydrolyzing enzyme found in saliva (in the mouth) and pancreatic juice (in the intestine). It hydrolyzes starch into disaccharides (maltose), linear oligosaccharides, or dextrins (oligosaccharides

containing alpha-1,6 and alpha-1,4 linkages). Alpha-glucosidase, in turn, hydrolyzes the products of alpha-amylase into glucose. Inhibiting these two enzymes may slow carbohydrate digestion. It also reduces the amount of glucose, the end product of carbohydrate digestion, that is available for absorption into the bloodstream. This may prevent rapid spikes in blood glucose levels, thereby easing the workload of the pancreas, which produces insulin to keep blood glucose within the normal range. As a result, this mechanism may help prevent diabetes mellitus. Brewed Karamunting leaves have been shown to exhibit anti-alpha-amylase activity owing to the presence of isoquercitrin, malic acid, myricetin, myricitrin, and kaempferol, as well as anti-alpha-glucosidase activity attributed to rutin, shikimic acid, epicatechin, quercetin, quercitrin, and citric acid [1].

Another antihyperglycemic approach is to help lower blood glucose levels, one route being the facilitation of glucose transport from the blood into cells. Several mechanisms are involved, namely insulin-mimetic action, activation of Adenosine Monophosphate-activated Protein Kinase (AMPK), and beta-cell regeneration [12]. In the insulin-mimetic mechanism, compounds such as epicatechin and citric acid in brewed Karamunting leaves bind to the insulin receptor, thereby substituting for insulin in enabling glucose to enter cells [1]. Conversely, cinnamaldehyde from cinnamon activates Transient Receptor Potential Ankyrin 1 (TRPA1), increasing Ca^{2+} influx and basal insulin release independently of K-ATP channel closure, thereby enhancing insulin secretion [13]. Berberine activates AMPK, which increases glucose uptake from the blood into muscle and adipose cells and suppresses hepatic gluconeogenesis (the synthesis of glucose from non-carbohydrate precursors) [14]. A reduction in beta-cell mass has been observed in patients with type 1 and type 2 diabetes. Beta-cell regeneration may therefore be supported by antioxidant activity that suppresses the oxidative stress these patients experience [15]. Accordingly, antioxidant capacity is also needed by individuals with diabetes mellitus. Brewed Karamunting leaves have been shown to possess antioxidant activity, mainly due to secondary metabolites such as isoquercitrin, epicatechin, citric acid, quercitrin, and quercetin [1].

Children with a positive family history of type 2 diabetes should be screened for type 2 diabetes risk [16]. This is because such children are at risk of type 2 diabetes, as indicated by weight gain, which is sometimes accompanied by the risk of other obesity-related comorbidities [17]. A family history of diabetes has also been associated with dysglycemia, detected through abnormal fasting insulin and fasting glucose levels [18]. The antihyperglycemic activity of brewed Karamunting leaves has been explored in *in vivo* studies at high concentrations; however, clinical studies at a concentration comparable to that of tea bags (2 g/100 mL) remain limited. Therefore, this study presents an innovative approach to evaluating the antihyperglycemic properties of Karamunting leaves prepared in the same way as brewed tea. This approach is expected to support the development of Karamunting leaves into a functional herbal tea or beverage. In this study, the antihyperglycemic activity of Karamunting herbal tea (KHT) was evaluated by measuring the blood glucose response of participants with and without a family history of diabetes after they were given a glucose load together with KHT. Accordingly, this study aims to determine blood glucose levels in healthy participants with and without a family history of diabetes after consuming KHT.

2. MATERIALS AND METHODS

2.1 Study Material

The main material used in this study was the top six leaves of karamunting after the shoots were picked in May 2025. The leaves were soaked in heated water (40°C for 2 minutes) and then cold water (15°C for 2 minutes) before being allowed to air dry until the water content was less than 12% [1]. The leaves were packaged using closed plastic before being used. Other materials used were D-glucose or dextrose monohydrate (Haulat Brand), blood glucose strips (Sinocare), alcohol swabs (onemed), and blood lancets (Sinocare). A blood glucose meter was utilized (Sinoheart Safe Accu). This study had passed ethical review (Ethical-Clearance) issued by the medical faculty of Tanjungpura University with the number 7458/UN22.9/PG/2025.

2.2 Sample Collection

Karamunting leaves were obtained from West Kalimantan and identified by the Herbarium Bogoriense, Research Center for Botany, Indonesian Institute of Sciences (No. 841/IPH.1.01/If.07/VIII/2020).

2.3 Extraction Procedure

The Herbal Tea of Karamunting leaves (KHT) was produced by assigning the Karamunting leaves shoots (<18 mesh) in a tea bag of 2g. The KHT was produced by dipping for five minutes in 100mL of hot water (90±2°C). The KHT was always prepared immediately before being used [1].

2.4 Analytical Methods

The respondents were volunteers who met the inclusion criteria: a normal BMI (18.5-24.9), no diet or medication consumption, and no smoking. Fasting blood glucose levels greater than 110 mg/dL were used as an exclusion criterion. Twenty respondents were separated into two groups: those with and without hereditary illness. This study is a Phase 1 clinical trial following up on dose testing in animal models at a Human Equivalent Dose (HED) of 125 mL [1]. Based on FDA guidelines for that phase, the minimum number of respondents required is twenty [19].

The oral glucose tolerance test, or OGTT, was used to assess blood glucose level responses [20]. OGTT measurements were conducted in the morning, commencing at 07:00 AM. The respondents should fast for at least 8 hours, and the results would be the 0-minute of measurement. Furthermore, the respondents were given a glucose of 75g, in which it was dissolved in 125mL KHT (drinking water was used in treatments without KHT), and to neutralize the flavor, up to 120 mL of drinking water was administered. The administration was determined by the treatment, namely without Hereditary (NH) and provided KHT (NH+T), and with Hereditary (WH) and given KHT (WH+T). The next measurement of blood glucose level was conducted every 30 minutes (counted from the end of consumption) till the 180th minute. The blood glucose levels were presented on a graph, with the x-axis representing the minutes of blood collection (0, 30, 60, 90, 120, 150, and 180) and the y-axis showing the blood glucose levels. To compute Area Under Curve (AUC), the researchers employed either the trapezoid method or the total area formula for a right triangle and a trapezoid.

2.5 Statistical Analysis

This analysis was carried out by means of SPSS 26, in which the one-way ANOVA was conducted, and it was followed by Duncan's further test at the 1% confidence level (α 0.01). Furthermore, multivariate data analysis was performed using SIMCA 14.0 to obtain treatment categories from measurements of each respondent's blood glucose level responses after treatment with Principal Component Analysis (PCA) followed by Orthogonal Partial Least Squares Discriminant Analysis (OPLS-DA) [21]. Additionally, Pearson Correlation analysis was carried out to discover the correlation between blood glucose level response per minute (0, 30, 60, 90, 120, 150, 180) and AUC.

3. RESULTS AND DISCUSSION

3.1 Respondent Characteristics

The responders were 20 people, 10 with non-hereditary and 10 with hereditary, aged 30 to 35 years, with a normal BMI (19.02 to 23.11). The respondent characteristics are presented in Table 1. Among the female responders with hereditary diabetes, 37.5% had a father with diabetes, whereas 12.5% had a mother. Among the male responders with hereditary diabetes, 12.5% had a father with diabetes, whereas 37.5% had a mother.

The respondents meet the inclusion criteria. The number of responders with an inherited diabetes mellitus from both mothers and fathers is equal. Data collection is crucial since the mother with diabetes mellitus poses a higher risk for children suffering from diabetes mellitus [22]. Consequently, it is intriguing to know the response of blood glucose levels after administering a glucose load to respondents without and with an inherited condition (Hereditary).

Table 1. Font Respondent Characteristic

Respondent	Gender	Age (years)	Body Mass Index (BMI)	Diabetic offspring from
Not Hereditary	Woman, n=6 Man, n=4	30 - 35	20.77 $\pm$ 1.48	-
With Hereditary	Woman, n=5 Man, n=5	30 - 35	22.22 $\pm$ 0.70	Mother, n=5 Father, n=5

3.2 Respondents' blood glucose levels

All responders had blood glucose levels within the normal range of 70 to 110 mg/dL (Table 2). The administration of Herbal Tea from Karamunting leaves (KHT) had a significant influence ($P<0.01$) on the response of blood glucose levels from 0 to 180 minutes, as well as the Area Under Curve. The respondents' blood glucose levels with Hereditary tended to be higher than without Hereditary. The results indicated that there was a similar blood glucose level response pattern in respondents without and with Hereditary before and after the administration Herbal Tea from Karamunting leaves (KHT) in the 60th, 90th, and 120th minutes, specifically the highest to lowest order of respondents without Hereditary (NH), which was not significantly different from respondents without Hereditary plus KHT (NH+T), respondents with Hereditary plus KHT (WH+T), and respondents with Hereditary without KHT (WH). The blood glucose level reaction in the 150th and 180th minutes, from lowest to highest, was NH+T, NH, which was not substantially different from WH+T and WH.

Table 2. Respondents' Blood Glucose Levels and Area Under The Curve (AUC)

Treatment	Minute 0	30 th Minute	60 th Minute	90 th Minute	120 th Minute	150 th Minute	180 th Minute	AUC
NH	83±6a	161±11b	150±5a	143±12a	129±11a	118±7b	107±4b	22661±1200a
WH	91±7ab	160±10b	201±9c	187±8c	176±8c	148±8c	116±6c	27896±1124c
NH+T	94±4b	148±4a	159±7a	135±10a	125±6a	108±4a	85±7a	21540±855a
WH+T	88±7ab	160±6b	184±5b	172±8b	152±6b	123±6b	100±5b	25260±722b

Numbers followed by different letters indicate a significant difference ($P<0.01$). Treatment code NH=Not Hereditary, WH=With Hereditary, NH+T=Not Hereditary given KHT (*Karamunting* Herbal Tea), WH+T=With Hereditary given KHT

A different pattern of respondents' blood glucose levels was found in the 30th minute, especially among non-hereditary respondents. The highest blood glucose level for NH appeared at the 30th minute, while NH+T had reached the 60th minute (Figure 1). Figure 1 also performs that the NH+T reaches the normal blood glucose level (70-110mg/dL) at the 150th minute, NH and WH+T reach the 180th minute; meanwhile, till the 180th minute, WH's blood glucose level remains over average. The Area Under Curve (AUC) indicates that the greatest to lowest order is NH+T, which is not substantially different from NH, WH+T, and WH (Table 1). Respondents with and without genetic KHT provision are more sloped than those without KHT, as seen in the curve of Figure 1.

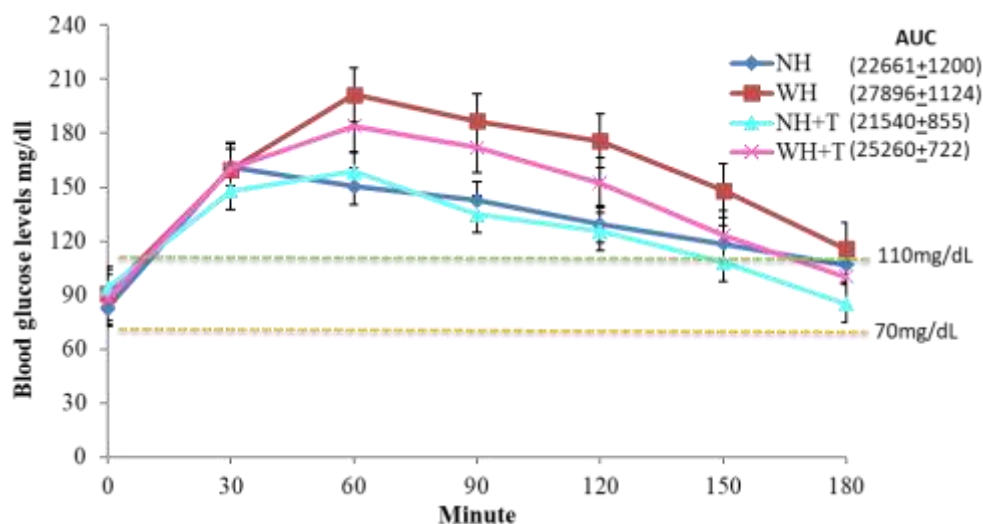


Figure 1. Changes in Blood Glucose Levels of Respondents After The Administration of KHT. Treatment Code: NH=Not Hereditary, WH=With Hereditary, NH+T=Not Hereditary Given KHT (*Karamunting* Herbal Tea), WH+T=With Hereditary Given KHT.

The Karamunting leaf herbal tea offers antihyperglycemic ability. This study proved that, for respondents without Hereditary KHT, it can reduce the growth in blood glucose levels, as seen by a shift in the highest peak point of blood glucose levels from the 30th minute (without KHT) to the 60th minute (with KHT) (Figure 1). This indicates that the administration of KHT can accelerate the absorption of glucose into cells. Thus, at all times of measurement, blood glucose levels are not greater than before the KHT treatment. This occurs in other experiments involving the administration of black tea and cinnamon tea [23]. However, both black tea and cinnamon tea cause a drop in blood glucose levels at each measurement point, with a peak appearing at the 30th minute.

Previous research has shown that karamunting leaves can act as an insulin-mimetic due to the epicatechin and citric acid in them, which allow them to bind to insulin receptors. Other contents that have a negative correlation with AUC include quercitrin, kaemferol-3-rhamnoside, myricetin 3-O-beta-D-galactopyranoside, and myricetin 3-galactoside [1]. Following the administration of KHT, it is believed that the insulin-mimetic ability can lower blood glucose levels. Furthermore, quercitrin is known to have antihyperglycemic activity, in which it has an ability to interact with SIRT1 protein (Sirtuin 1) that is closely associated with increased insulin sensitivity in skeletal muscle [24]. Quercetin, the aglycone of quercitrin, has another antihyperglycemic mechanism: it increases the activity of monophosphate-activated protein kinase (AMPK), stimulating the translocation of glucose transporters (GLUT 4) to the plasma membrane to bring glucose into cells and reducing glucose production by down-regulating the enzymes phosphoenolpyruvate carboxylase (PEPCK) and glucose-6-phosphate [25]. However, based on the bioavailability between quercitrin and its aglycone, the quercitrin with O-Glucoside bonds has a higher bioavailability [26]. Hence, the quercitrin has been suggested to play a greater role in decreasing the blood glucose level since it is more easily absorbed by the body than quercetin.

Following the KHT administration, the blood glucose response of respondents without and with hereditary diabetes is reduced; however, WH+T respondents have a larger AUC value than the NH and NH+T. People with genetic diabetes can develop diabetes mellitus, are insulin-independent, and have a low kidney glucose tolerance [27]. This indicates that individuals with genetic conditions may have low insulin sensitivity or insulin resistance. Consequently, the presumption explained before, the bioactive compounds contained in Karamunting leaves have an antihyperglycemic ability, which can assist respondents with Hereditary conditions to reduce their blood glucose levels. Yet, respondents with Hereditary may require a greater dose to attain the same AUC as NH. The AUC reduction after the KHT treatment for the respondents with Hereditary is 14.98%. The results are similar to other studies, which show that the distribution of black tea can decrease the AUC value by 14.18% [28], and kratom tea is 14.9% [29]. The reduction of AUC in KHT distribution is higher than the green tea, which is around 9.26% [30]. However, it is not higher than the cinnamon tea that can decrease the AUC by 26.32% [31].

3.3 Mapping of respondents before and after KHT administration based on blood glucose level and AUC responses

The results of multivariate analysis in Figure 2a showed the formation of 4 groups, namely group 1 of NH (light blue), group 2 of NH+T (dark blue), group 3 of WH (red), and group 4 of WH+T (pink). It indicated that there was a difference in the blood glucose level response with and without heredity. The biplot of Figure 2 also presented that the WH had the highest respondents' blood glucose level (at the 60th, 90th, 120th, and 150th minutes) and AUC. The point of differentiation of glucose response due to the treatment that is considered important is blood glucose levels at 180th, 30th, and 0th minutes, as indicated by a Variable Importance in Projection value (VIP) greater than 1 (Figure 2b). This explains that the initial blood glucose level (minute 0) can determine blood glucose levels in subsequent minutes. The 180-minute glucose level indicates the final time when blood glucose levels fall within the normal range (70-110 mg/dL). Meanwhile, the 30th minute level becomes a significant difference, especially in respondents without hereditary factors, where the peak glucose level shifts from the 30th minute (without KHT) to the 60th minute (with KHT) (Figure 1). This suggests that KHT administration to respondents without hereditary factors can slow glucose absorption into the blood. This also applies to green tea supplementation, which has a blood glucose-lowering effect [32].

Multivariate analysis results showed that KHT administration was particularly effective in reducing blood glucose levels at 60th, 90th, 120th, and 150th minutes and AUC (Figure 2a), especially in respondents with hereditary diabetes. Meanwhile, for respondents without hereditary who were given KHT, there was a significant difference in blood glucose levels at 30th and 180th minutes, which were lower than those without KHT administration. However, there was no difference in terms of AUC values. This was similar to the administration of green tea in DM animal models, which showed a decrease in AUC, but not in normal animal models [33].

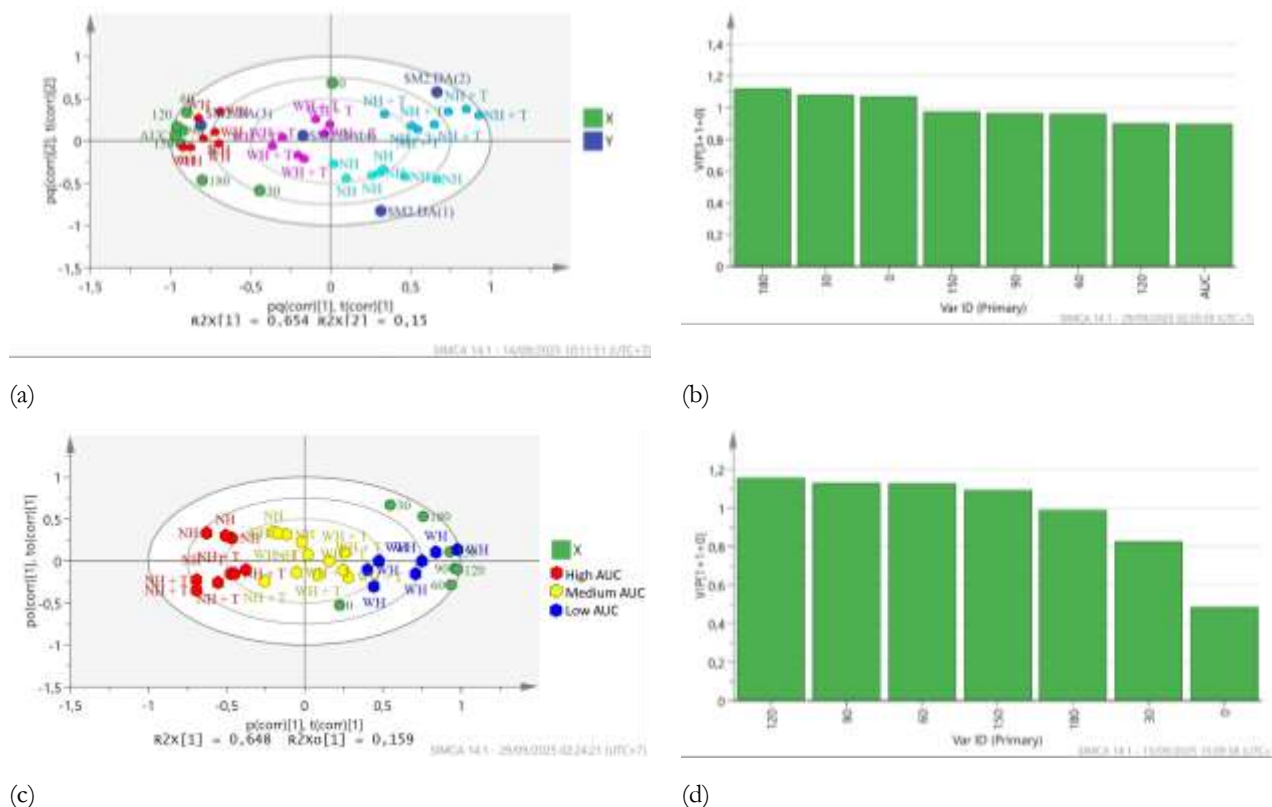


Figure 2. Biplot of Treatment Grouping Based on Blood Glucose Level Response Before and After KHT Administration (a), Variable Importance in Projection (VIP) (b) Value with OPLS-DA (R^2X 0.971, R^2Y 0.789, and Q^2 0.789), and Biplot of Treatment Grouping due to AUC (c) and Variable Importance in Projection (VIP) (d) Value with OPLS-DA (R^2X 0.785, R^2Y 0.789, and Q^2 0.727). Four Groups were Created by The Grouping: WH (3/Red), NH (1/Light Blue), NH+T (2/Dark Blue), and WH+T (4/Pink). NH+T=Not Hereditary given KHT (Karamunting Herbal Tea), WH+T=With Hereditary Given KHT, and NH=Not Hereditary Given KHT were the Treatment Codes.

3.4 Correlation between blood glucose level response (x) and AUC (y)

The relationship between blood glucose levels and AUC as a result of treatment, according to multivariate analysis, showed a skewing into three groups (Figure 2c). These groups were group 1 with high AUC (WH), group 2 with moderate AUC (WH+T and some NH), and group 3 with low AUC (some NH outside of group 2 and NH+T). These results explain that giving KHT to respondents with hereditary factors can reduce the AUC value, while in respondents without hereditary factors, some have a lowering effect and some do not. Respondents without hereditary conditions can be said to be in a normal condition where the body has the hormone insulin that can maintain normal blood sugar levels. Therefore, the lowering effect depends on the condition of blood glucose levels at the time of KHT administration.

Multivariate analysis also showed that blood glucose levels between the 60th and 150th minutes are important in determining the AUC value. This is indicated by an AUC value >1 (Figure 2c). It is known that the time between these minutes is an important indicator of whether people with diabetes are different from those without. People with type 2 diabetes mellitus tend to have blood glucose levels above 155 mg/dL 1 hour after eating [34]. This was demonstrated in respondents with hereditary conditions in this study.

Similar results were shown in multivariate analysis using Pearson correlation. The Pearson correlation depicts that the blood glucose level has a positive correlation with the AUC. The blood glucose levels at the 60th and 150th minutes provide a very high correlation ($r > 0.8$). The 150th minute (r 0.921863), 60th minute (r 0.939446), 90th minute (r 0.964144), and 120th minute (r 0.978935) are the blood glucose levels with the highest to lowest correlation values.

This study shows that key points are substantially associated with an increase in AUC, specifically blood glucose levels at the 60th, 90th, 120th, and 150th minutes (Figure 3). This is reinforced by the results of multivariate analysis that the WH with the highest AUC has high blood glucose levels at the 60th, 90th, 120th, and 150th minutes (Figure 2). Studies on the connection between AUC and blood glucose levels at each measurement period are limited. Other studies on the administration of green tea, however, reveal that blood glucose levels begin to drop between the 60th and 240th minutes [30]. This reveals comparable results, with the KHT treatment causing a drop in blood glucose levels from the 60th to the 150th minute (Table 1).

The study has limitations related to the use of a sample of healthy adults, a relatively narrow age range, the classification of family history, and a short observation period; furthermore, larger-scale controlled studies are needed to determine whether the observed responses offer tangible benefits for individuals with diabetes or those at high metabolic risk.

Additionally, formulations combining other herbs with potential as masking agents could be explored; examples include butterfly pea flowers, nutmeg mace, cinnamon, and honey. Butterfly pea flowers can provide attractive color and functional benefits, such as antihyperglycemic and antioxidant effects [35], as well as support for breast milk production [36]. Nutmeg mace demonstrates antidiabetic potential and acts as an antioxidant with a potency 4.9 times that of vitamin C and functions as an antihyperglycemic agent by inhibiting alpha-amylase enzyme activity 4.2 times more effectively than acarbose [37]. Cinnamon is known to exert antihyperglycemic and antioxidant effects [38]. Honey, aside from potentially enhancing product acceptability due to its sweet taste, also possesses antioxidant activity and inhibits alpha-amylase enzyme function [20].

4. CONCLUSION

The Karamunting Herbal Tea offers antihyperglycemic effects. It reduces the rise in blood glucose levels in people who do not have a genetic illness. Meanwhile, it enhances glucose absorption into cells among individuals with genetic illnesses, lowering the area under the curve (AUC).

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AUTHOR CONTRIBUTIONS

Oke Anandika Lestari: Conceptualization, Supervision, Writing—Review.

Sulha Rahmi Oktaviani: Methodology.

Dwi Gusmalawati: Data Curation.

Silvia: Laboratory Analysis.

Hasbullah: Raw materials & Methodology.

Uray Ulfah Nabilah: Formal Analysis.

Ifwarisan Defri: Laboratory Analysis & Editing.

CONFLICT OF INTEREST

Authors declare no conflict of interest to disclose.

ETHICS STATEMENT

This study had passed ethical review (Ethical- Clearance) issued by the medical faculty of Tanjungpura University with the number 7458/UN22.9/PG/2025.

DATA AVAILABILITY STATEMENT

Data supporting the findings of this study are available from the corresponding author upon reasonable request.

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