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Antioxidant Activity and Blood Glucose-Lowering Effect of Sweet Potato Leaf Biscuits in Alloxan-Induced Rats

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ABSTRACT

Sweet potato leaves are a potential source of natural antioxidants because they contain bioactive compounds such as flavonoids and anthocyanins. This study aimed to evaluate the antioxidant activity of sweet potato leaf biscuits and their effect on blood glucose levels in alloxan-induced male rats. Biscuits were formulated using sweet potato leaf simplicia at three concentrations, namely 30 g (F1), 40 g (F2), and 50 g (F3). A total of 30 experimental rats were divided into six groups: normal control, negative control, positive control, and three treatment groups receiving F1, F2, or F3 biscuits. The test preparations were administered orally once daily for 21 days. Organoleptic evaluation, proximate analysis, antioxidant activity using the DPPH method, and blood glucose measurements were performed. Blood glucose data were analyzed using one-way ANOVA followed by the LSD post hoc test. The results showed that all biscuit formulations met the proximate quality requirements according to SNI 01-2973-1992. Antioxidant testing demonstrated that F3 had the strongest antioxidant activity, as indicated by the lowest IC_{50} value among the tested formulations. F3 also produced the greatest reduction in blood glucose levels in alloxan-induced rats. These findings suggest that biscuits containing a higher proportion of sweet potato leaf simplicia may provide greater antioxidant activity and better glucose-lowering potential.

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ABSTRAK

Daun ubi jalar berpotensi sebagai sumber antioksidan alami karena mengandung senyawa bioaktif seperti flavonoid dan antosianin. Penelitian ini bertujuan untuk mengevaluasi aktivitas antioksidan biskuit daun ubi jalar serta pengaruhnya terhadap kadar glukosa darah pada tikus jantan yang diinduksi aloksan. Biskuit diformulasikan menggunakan simplisia daun ubi jalar dalam tiga konsentrasi, yaitu 30 g (F1), 40 g (F2), dan 50 g (F3). Sebanyak 30 ekor tikus percobaan dibagi menjadi enam kelompok, yaitu kontrol normal, kontrol negatif, kontrol positif, dan tiga kelompok perlakuan yang menerima biskuit F1, F2, atau F3. Sediaan uji diberikan secara oral sekali sehari selama 21 hari. Evaluasi organoleptik, analisis proksimat, pengujian aktivitas antioksidan dengan metode DPPH, dan pengukuran kadar glukosa darah dilakukan pada seluruh formula. Data kadar glukosa darah dianalisis menggunakan uji one-way ANOVA yang dilanjutkan dengan uji lanjut LSD. Hasil penelitian menunjukkan bahwa seluruh formula biskuit memenuhi persyaratan mutu proksimat menurut SNI 01-2973-1992. Uji antioksidan menunjukkan bahwa F3 memiliki aktivitas antioksidan paling kuat, yang ditunjukkan oleh nilai IC_{50} paling rendah di antara seluruh formula. F3 juga menunjukkan penurunan kadar glukosa darah paling besar pada tikus yang diinduksi aloksan. Temuan ini menunjukkan bahwa biskuit dengan proporsi simplisia daun ubi jalar yang lebih tinggi cenderung memiliki aktivitas antioksidan yang lebih baik serta potensi lebih besar dalam menurunkan kadar glukosa darah.

Kata Kunci:
Daun ubi jalar; Biskuit fungsional; DPPH; Kadar glukosa darah; Tikus yang diinduksi aloksan

1. Introduction

Free radicals are highly reactive molecular species that contain one or more unpaired electrons in their outer orbitals. They are generated from endogenous processes, such as normal cellular metabolism, as well as exogenous sources including ultraviolet radiation, cigarette smoke, pollutants, and radical-inducing substances in food [1]. When the production of free radicals exceeds the body's antioxidant defense capacity, oxidative stress occurs and may lead to damage of lipids, proteins, and DNA [2]. Oxidative stress has been recognized as an important contributor to the development and progression of diabetes mellitus. Chronic hyperglycemia increases the formation of reactive oxygen species through several pathways, including glucose autoxidation, activation of the polyol pathway, and the formation of advanced glycation end products, all of which contribute to pancreatic β-cell dysfunction and impaired insulin secretion [3]. In addition, oxidative stress disrupts insulin signaling pathways, promotes insulin resistance, and accelerates the progression of diabetic complications such as neuropathy, nephropathy, retinopathy, and cardiovascular disorders [4].

Diabetes mellitus is a chronic metabolic disorder characterized by elevated blood glucose levels resulting from impaired insulin secretion, insulin resistance, or both [5]. The global burden of diabetes continues to increase and is accompanied by substantial health and economic consequences. Although pharmacological agents such as insulin and oral antidiabetic drugs remain the mainstay of treatment, their long-term use may be associated with reduced effectiveness and undesirable side effects. For this reason, the exploration of natural products with antioxidant and antihyperglycemic potential has attracted increasing attention as a complementary strategy for diabetes management [5].

One potential natural source of antioxidants is the sweet potato plant (*Ipomoea batatas*), particularly its leaves. Sweet potato leaves are often underutilized and commonly regarded as agricultural waste or animal feed, despite being rich in bioactive compounds such as flavonoids, polyphenols, carotenoids, and anthocyanins [6],[7]. These compounds have been reported to possess various biological activities, including antioxidant and antidiabetic effects. Natural antioxidants derived from plant materials may help reduce oxidative stress, protect pancreatic β-cells, and support glycemic control, thereby offering potential benefits in the management of diabetes [7].

In addition to their bioactive potential, sweet potato leaves may also be developed into functional food products. Functional foods are foods that provide nutritional value while also delivering physiological benefits due to the presence of bioactive compounds [8]. One practical application is the incorporation of sweet potato leaf simplicia into biscuit formulations. Biscuits are widely consumed snack products because they are ready to eat, relatively affordable, have a longer shelf life than many other baked products, and can serve as suitable carriers for functional ingredients [9],[10]. Incorporating sweet potato leaf simplicia into biscuits may therefore represent an innovative approach to developing a functional food with antioxidant activity and potential blood glucose-lowering effects.

Despite the recognized antioxidant and antidiabetic potential of sweet potato leaves, studies evaluating their incorporation into biscuit formulations and examining both antioxidant activity and blood glucose-lowering effects in experimental animals remain limited. Therefore, this study aimed to evaluate the antioxidant activity of sweet potato leaf biscuits and their effectiveness in reducing blood glucose levels in alloxan-induced rats.

2. Methods

Tools and Materials

This study used an analytical balance, containers, spoons, baking trays, parchment paper, a blender, sieves, a mixer, an oven, and standard laboratory glassware for analysis. The main raw material was sweet potato leaf simplicia (*Ipomoea batatas*), collected from Manikliyu Village, Kintamani District, Bangli Regency, Bali Province. Additional ingredients included wheat flour, baking soda, margarine, powdered vanilla, egg yolks, stevia sugar, and skim milk. The chemicals used for analysis were methanol p.a., DPPH reagent, distilled water, alloxan, 1% Na CMC, and glibenclamide.

Preparation of Sweet Potato Leaf Simplicia

Fresh sweet potato leaves were cleaned to remove adhering impurities and washed under running water. The leaves were then dried in an oven at 50 °C until completely dehydrated and subsequently ground into powder to obtain sweet potato leaf simplicia [11].

Biscuit Formulation and Preparation

Three biscuit formulations were prepared by varying the amount of sweet potato leaf simplicia, while the amounts of the other ingredients were kept constant. The formulations used in this study are presented in **Table 1**. F1 contained 30 g of sweet potato leaf simplicia, F2 contained 40 g, and F3 contained 50 g. These variations were designed to evaluate the effect of increasing sweet potato leaf content on the physicochemical characteristics, antioxidant activity, and blood glucose-lowering potential of the biscuits.

Table 1. Biscuit Formulations Containing Sweet Potato Leaf Simplicia

Ingredient	F1 (g)	F2 (g)	F3 (g)
Sweet potato leaf powder	30	40	50
Wheat flour	70	70	70
Egg yolk	32	32	32
Margarine	24	24	24
Vanilla	2.4	2.4	2.4
Baking soda	0.6	0.6	0.6
Skim milk	4.8	4.8	4.8
Stevia sugar	14.3	14.3	14.3

The biscuit dough was prepared in three stages. First, margarine, skim milk, and stevia sugar were mixed using a mixer for 5 min. Second, egg yolk and vanilla were added to the mixture and mixed again for 10 min. Third, wheat flour, sweet potato leaf simplicia, and baking soda were mixed separately until homogeneous, then added to the first mixture and blended until a uniform dough was formed. The dough was shaped and baked in an oven at 125 °C for 20–30 min until the biscuits were fully cooked.

Organoleptic Evaluation

Organoleptic evaluation was performed using 30 untrained panelists consisting of 15 men and 15 women aged 20–40 years who agreed to participate and had no known allergies to the biscuit ingredients. The evaluated attributes included color, taste, aroma, and texture. Acceptability was assessed using a 5-point hedonic scale, namely 1 = very dislike, 2 = dislike, 3 = neutral, 4 = like, and 5 = very like [12].

Proximate Analysis

Proximate analysis was carried out to determine the moisture, ash, fat, protein, and carbohydrate contents of the biscuits using standard proximate analytical procedures [16]. The results were then compared with the requirements of SNI 01-2973-1992 for biscuit products.

Antioxidant Activity Assay

Antioxidant activity was evaluated using the DPPH method [17]. For sample preparation, 0.1 g of each biscuit sample was extracted with 5 mL of 99.9% methanol. The mixture was homogenized and centrifuged at 3000 rpm for 15 min. The resulting supernatant was filtered, and the filtrate was adjusted to a final volume of 5 mL, giving a sample concentration of 20 mg/mL.

For absorbance measurement, 0.5 mL of the sample solution was mixed with 3.5 mL of 0.1 mM DPPH solution and incubated for 30 min. The absorbance was then measured at 517 nm. Antioxidant activity was expressed as percentage inhibition of DPPH radicals using the following formula:

$$\%\ \text{inhibition} = \frac{A_{blank} - A_{sample}}{A_{blank}} \times 100$$

where A_{blank} is the absorbance of the blank solution and A_{sample} is the absorbance of the sample solution. The IC_{50} value of each formulation was determined from the linear regression between sample concentration and percentage inhibition. Lower IC_{50} values indicated stronger antioxidant activity.

Blood Glucose Test in Experimental Rats

This study used 30 male white rats aged 2–3 months with body weights of 150–200 g. The animals were divided into six groups, each consisting of five rats: normal control, negative control, positive control, and three treatment groups receiving F1, F2, and F3 biscuits, respectively. Hyperglycemia was induced by intraperitoneal administration of alloxan at a dose of 150 mg/kg body weight [23],[24].

Before induction, the rats were fasted for 24 h and baseline blood glucose levels were measured. Blood glucose levels were measured again 24 h after alloxan administration to confirm hyperglycemia. Rats with blood glucose levels above 200 mg/dL were considered hyperglycemic. The normal control group received distilled water, the negative control group received 1% Na CMC, the positive control group received glibenclamide, and the treatment groups received F1, F2, or F3 biscuits. All treatments were administered orally once daily for 21 days. Blood glucose levels were measured at three time points: before induction, after alloxan induction, and on day 21 after treatment. This study received ethical approval from Poltekkes Kemenkes Denpasar with approval number DP.04.02/F.XXXII.25/0927/2024.

Statistical Analysis

Blood glucose data were tested for normality using the Shapiro–Wilk test and for homogeneity using Levene's test. Differences among groups were analyzed using one-way ANOVA, followed by the LSD post hoc test to determine pairwise differences. Statistical significance was set at $p < 0.05$.

3. Results and Discussion

Organoleptic Characteristics of Sweet Potato Leaf Biscuits

The organoleptic characteristics of the sweet potato leaf biscuits are shown in **Figure 1** and **Figure 2**. **Figure 1** presents the physical appearance of the three biscuit formulations, whereas **Figure 2** shows the organoleptic profiles of F1, F2, and F3 based on panelists' assessments of color, taste, aroma, and texture. Organoleptic evaluation was conducted to assess the acceptability of the biscuits as a functional food product, because sensory attributes are important determinants of consumer preference and product acceptance [12].

Description: *F1 contained 30 g of sweet potato leaf simplicia, F2 contained 40 g, and F3 contained 50 g*

Figure 1. Physical appearance of sweet potato leaf biscuits in formulations F1, F2, and F3

In terms of appearance, the biscuits showed visible differences among formulations. F1 had a green color, F2 showed a darker green appearance, and F3 appeared black. This pattern indicates that increasing the proportion of sweet potato leaf simplicia intensified the color of the biscuits. Such variation is reasonable because color is one of the first sensory attributes perceived by consumers and strongly influences their initial acceptance of food products [13]. The darker appearance observed in F3 may reflect the higher concentration of plant material incorporated into the formulation.

Differences were also observed in taste. F1 was described as slightly bitter followed by sweetness, whereas F2 and F3 were described as bitter followed by sweetness. This finding suggests that a higher proportion of sweet potato leaf simplicia contributed to a stronger bitter taste in the final product. Taste is an important aspect of food evaluation because it directly affects palatability and overall acceptability [14]. In the present study, the increasing bitterness from F1 to F3 was consistent with the increasing concentration of sweet potato leaf simplicia in the biscuit formulations.

For aroma, the three formulations showed a similar characteristic scent of sweet potato leaf simplicia. This indicates that the aroma of the biscuits was primarily influenced by the plant material used in the formulation rather than by the variation in concentration alone. Aroma is an essential sensory attribute because it contributes to the overall perception and attractiveness of food products [12]. In this study, the aroma profile remained characteristic across F1, F2, and F3, although the intensity may have varied subjectively among panelists.

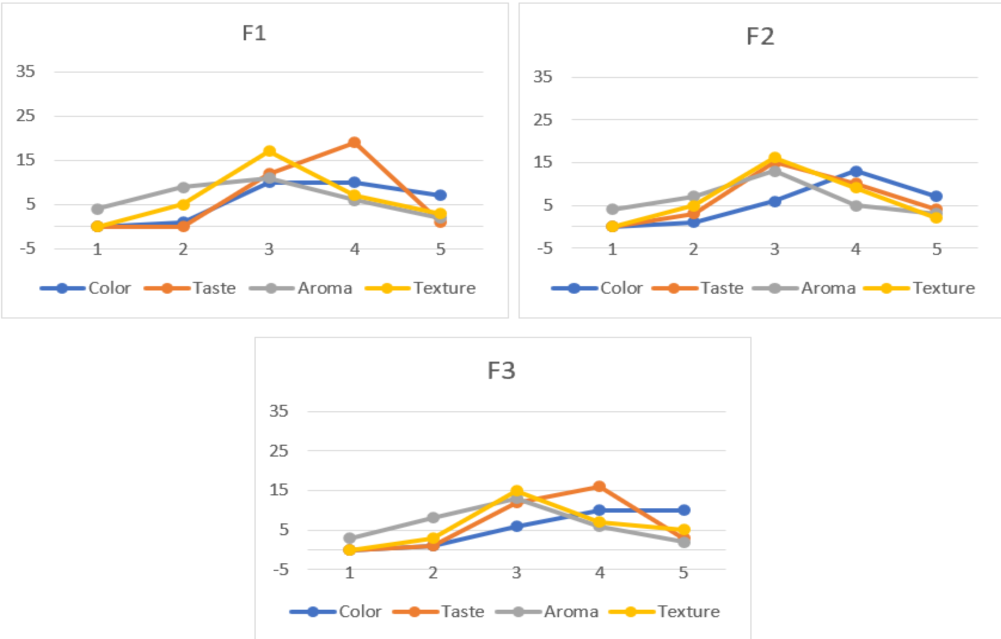

Figure 2. Organoleptic profiles of sweet potato leaf biscuits in formulations F1, F2, and F3 based on color, taste, aroma, and texture scores.

Texture also differed among formulations. F1 was described as crunchy, F2 as somewhat crunchy, and F3 as not crunchy. This trend was consistent with the increasing moisture content observed in the proximate analysis, where F3 had the highest moisture content among the three formulations. Texture is a major determinant of product quality and acceptability, particularly for biscuit products, which are generally expected to have a crisp structure [15]. Therefore, the softer texture observed in F3 may be associated with its higher moisture retention and higher proportion of sweet potato leaf simplicia.

Overall, the organoleptic findings suggest that increasing the amount of sweet potato leaf simplicia influenced the sensory characteristics of the biscuits, particularly color, taste, and texture. F1 showed the most acceptable appearance in terms of lighter color and crisp texture, whereas F3 exhibited the strongest visual and taste changes associated with the highest concentration of sweet potato leaf simplicia. These results indicate that formulation differences affected the sensory profile of the biscuits and should be considered in the development of sweet potato leaf biscuits as a functional food product.

Proximate Composition of Sweet Potato Leaf Biscuits

The proximate composition of sweet potato leaf biscuits is presented in **Table 2**. The analysis included moisture, ash, fat, protein, and carbohydrate contents for formulations F1, F2, and F3. Overall, all biscuit formulations met the proximate quality requirements for biscuits according to SNI 01-2973-1992, indicating that the products were acceptable from a nutritional and physicochemical standpoint. Proximate analysis is an important parameter in biscuit evaluation because it provides basic information on nutritional composition, product quality, and storage stability [16]. In addition, the physicochemical characteristics of biscuits may be influenced by the type and proportion of functional ingredients incorporated into the formulation [9],[10],[17].

Table 2. Proximate Composition of Sweet Potato Leaf Biscuits and Comparison with SNI 01-2973-1992

Parameter	F1 (%)	F2 (%)	F3 (%)	SNI 01-2973-1992 Requirement	Compliance
Moisture content	1.4993	1.9304	2.0234	Max. 5%	All complied
Ash content	0.7968	0.8159	0.8232	Max. 1.5%	All complied
Fat content	9.6424	9.7489	9.9741	Min. 9.5%	All complied
Protein content	13.3781	13.1849	13.2638	Min. 9%	All complied
Carbohydrate content	74.6834	74.3200	73.9154	Min. 70%	All complied

The moisture content of the three formulations ranged from 1.4993% to 2.0234%, which was well below the maximum limit of 5% required by SNI 01-2973-1992. Among the tested formulations, F3 had the highest moisture content, followed by F2 and F1. This pattern suggests that increasing the proportion of sweet potato leaf simplicia may contribute to slightly greater water retention in the biscuit matrix. Nevertheless, all values remained within the acceptable range, indicating that the biscuits retained the low-moisture characteristic expected of biscuit products and may therefore have good storage stability.

The ash content ranged from 0.7968% to 0.8232%, which was also below the maximum SNI limit of 1.5%. This indicates that all formulations met the mineral residue requirement for biscuits. Similarly, the fat content ranged from 9.6424% to 9.9741%, exceeding the minimum SNI requirement of 9.5% in all formulations. Although F3 showed the highest fat content, this difference should not be attributed to wheat flour concentration, because the amount of wheat flour was kept constant at 70 g in all formulations. Therefore, the variation in fat content is more reasonably interpreted as a result of formulation interactions and analytical variation rather than flour concentration alone.

Protein content ranged from 13.1849% to 13.3781%, which was higher than the minimum SNI requirement of 9% for biscuits. The protein values among F1, F2, and F3 were relatively similar, indicating that increasing the amount of sweet potato leaf simplicia did not produce major differences in protein composition under the present formulation conditions. Carbohydrate content ranged from 73.9154% to 74.6834%, exceeding the minimum SNI requirement of 70% in all formulations. Although slight differences were observed among formulations, the carbohydrate content remained consistently high across all biscuit types, which is expected in baked products containing flour-based ingredients.

Taken together, these results indicate that incorporation of sweet potato leaf simplicia into biscuit formulations produced products with acceptable proximate composition according to national biscuit standards. While minor variations were observed among F1, F2, and F3, the overall nutritional profiles remained within the expected range for biscuit products. The most notable change was the slightly higher moisture content in F3, whereas the other proximate components remained relatively stable across formulations.

Antioxidant Activity of Sweet Potato Leaf Biscuits

The antioxidant activity of sweet potato leaf biscuits was evaluated using the DPPH method, and the results are presented in **Table 3**. Based on the IC_{50} values obtained, antioxidant activity increased from F1 to F3. Among the three formulations, F3 showed the strongest antioxidant activity, as indicated by the lowest IC_{50} value (79.729 ppm), followed by F2 (95.2626 ppm) and F1 (107.4993 ppm). According to the current classification used in the manuscript, F1 was categorized as having moderate antioxidant activity, whereas F2 and F3 were categorized as strong. These findings indicate that increasing the proportion of sweet potato leaf simplicia in the biscuit formulation was associated with stronger free radical scavenging activity.

Table 3. Antioxidant Activity of Sweet Potato Leaf Biscuits

Formula	Linear Regression Equation	R^2	IC_{50} (ppm)	Antioxidant Activity
F1	y = 471.91x + 0.73	0.9754	107.4993	Moderate
F2	y = 529.00x + 0.3939	0.9724	95.2626	Strong
F3	y = 0.0775x + 56.179	0.9768	79.7290	Strong

Note: *Lower IC_{50} values indicate stronger antioxidant activity. The regression equations shown above should be rechecked for consistency before final submission.*

The trend observed in this study is biologically plausible because sweet potato leaves are known to contain antioxidant-related phytochemicals, particularly flavonoids and tannins, which may contribute to radical scavenging activity and may also support antihyperglycemic effects [18]–[22]. Flavonoids have been reported to exert antidiabetic effects through multiple pathways, including antioxidant activity, inhibition of carbohydrate-hydrolyzing enzymes, and modulation of glucose uptake mechanisms [18]–[20]. Tannins may also contribute by acting as free radical scavengers and by supporting antioxidant defense systems [21],[22]. Therefore, the stronger antioxidant activity observed in F3 may be related to the higher proportion of sweet potato leaf simplicia incorporated into the formulation.

However, the regression model shown in **Table 3** should be interpreted cautiously. Although the reported R^2 values were high for all three formulations, the regression slopes of F1 and F2 differed markedly from that of F3, which may indicate inconsistency in the regression model, unit definition, or the relationship between concentration and measured response. Accordingly, the reported IC_{50} values may still be used descriptively in the present draft, but the regression equations and underlying calculations should be rechecked before final submission to ensure mathematical consistency and correct interpretation of antioxidant strength.

Taken together, the current data suggest that sweet potato leaf biscuits possess measurable antioxidant activity, with F3 showing the most favorable profile among the tested formulations. Nevertheless, because the regression outputs still require verification, the antioxidant findings should be presented cautiously as preliminary quantitative evidence rather than as final definitive values until the regression analysis has been fully confirmed.

Blood Glucose-Lowering Effect in Alloxan-Induced Rats

The blood glucose-lowering effect of sweet potato leaf biscuits in alloxan-induced rats is presented in **Table 4**. Before induction, blood glucose levels were relatively similar among all groups, ranging from 93.2 ± 8.10 mg/dL to 104.4 ± 10.92 mg/dL, indicating comparable baseline conditions. After alloxan induction, blood glucose levels increased markedly in all induced groups, ranging from 292.4 ± 16.12 mg/dL to 339.4 ± 24.98 mg/dL, whereas the normal control group remained within the normal range (97.8 ± 8.25 mg/dL). These findings indicate that alloxan successfully induced hyperglycemic conditions in the experimental rats, which is consistent with its established diabetogenic effect through pancreatic β-cell damage [23],[24].

Table 4. Blood Glucose Levels of Experimental Rats Before Induction, After Alloxan Induction, and on Day 21

Group	Before Induction (mg/dL)	After Alloxan Induction (mg/dL)	Day 21 (mg/dL)
Normal control	95.8 ± 4.76	97.8 ± 8.25	95.4 ± 7.11
Negative control	99.6 ± 9.58	296.8 ± 22.19	347.2 ± 7.13
Positive control	93.2 ± 8.10	329.8 ± 20.45	110.0 ± 6.32
F1	104.0 ± 5.87	292.4 ± 16.12	142.2 ± 6.32
F2	104.4 ± 10.92	316.4 ± 42.78	123.2 ± 2.46
F3	99.60 ± 7.66	339.4 ± 24.98	111.6 ± 2.21

After 21 days of treatment, clear differences were observed among the groups. The negative control group showed the highest blood glucose level (347.2 ± 7.13 mg/dL), indicating persistent hyperglycemia in the absence of active treatment. In contrast, the positive control group treated with glibenclamide showed a marked reduction in blood glucose to 110.0 ± 6.32 mg/dL, confirming the expected antihyperglycemic effect of the standard drug [25]. Among the biscuit-treated groups, F3 showed the lowest blood glucose level on day 21 (111.6 ± 2.21 mg/dL), followed by F2 (123.2 ± 2.46 mg/dL) and F1 (142.2 ± 6.32 mg/dL). Thus, among the biscuit formulations, F3 showed the greatest reduction in blood glucose level.

The statistical analysis indicated that the assumptions for parametric testing were met, as the data were reported to be normally distributed based on the Shapiro–Wilk test and homogeneous based on Levene's test. One-way ANOVA showed a significant difference in blood glucose levels among groups ($p < 0.05$), and the LSD post hoc test indicated that the negative control group had the highest glucose level compared with the other groups. The positive control group showed a significant reduction in blood glucose level, and the biscuit-treated groups also demonstrated lower glucose levels than the negative control. Among the biscuit formulations, F3 showed the most favorable glucose-lowering profile. Because exact pairwise p-values were not reported in the current draft, the interpretation should remain focused on the observed overall pattern and the reported significance from the ANOVA and post hoc analyses.

The superiority of F3 in lowering blood glucose levels is consistent with its stronger antioxidant activity, as F3 also showed the lowest IC_{50} value among the tested biscuit formulations. This relationship is biologically plausible because flavonoids and tannins from sweet potato leaves have been associated with antioxidant and antihyperglycemic effects, including protection against oxidative stress, improvement of glucose uptake, and modulation of carbohydrate-hydrolyzing enzymes [18]–[22]. However, this association should be interpreted cautiously, and the current findings should not be presented as definitive proof of a direct causal mechanism. Rather, the glucose-lowering effect observed in F3 may be related to its higher sweet potato leaf content and stronger antioxidant profile.

Study Limitations

This study has several limitations that should be considered when interpreting the findings. First, the organoleptic evaluation was still relatively simple and mainly descriptive, although it involved panelists and hedonic assessment. Second, the antioxidant activity analysis was based on the DPPH method only, and the regression equations used to derive the IC_{50} values should be rechecked to ensure mathematical consistency and accurate interpretation. Third, the antihyperglycemic evaluation was limited to blood glucose measurements before induction, after alloxan induction, and on day 21, without additional biochemical or histopathological markers to clarify the underlying mechanism. Fourth, the study did not include identification or quantification of the specific bioactive compounds responsible for the observed antioxidant and glucose-lowering effects. Finally, because the experiment was conducted in an alloxan-induced rat model, the findings cannot yet be directly generalized to humans. Therefore, further studies involving validated antioxidant modeling, phytochemical characterization, broader metabolic parameters, and longer-term in vivo evaluation are needed to strengthen the evidence for sweet potato leaf biscuits as a functional food with potential antihyperglycemic benefits.

4. Conclusion

Sweet potato leaf biscuits demonstrated measurable antioxidant activity and blood glucose-lowering effects in alloxan-induced rats. All formulations met the proximate quality requirements according to SNI 01-2973-1992, while F3 showed the most favorable profile, with the lowest IC_{50} value and the greatest reduction in blood glucose levels among the tested formulations. These findings suggest that increasing the proportion of sweet potato leaf simplicia in the biscuit formulation may enhance antioxidant activity and support glucose-lowering potential. However, further studies are needed to verify the antioxidant modeling, identify the active compounds involved, and clarify the mechanisms underlying the observed antihyperglycemic effect.

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Conflict of Interest:

The authors declare no conflict of interest related to this study.

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