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Phytochemical Constituents and Hypoglycemic Effects of Bhee Fruit (*Melastoma malabathricum* L.) Extract in Diabetic Mice

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Abstrak: Diabetes merupakan penyakit yang tidak dapat disembuhkan, namun dapat dikendalikan melalui agen hipoglikemik sintetik maupun herbal. Tanaman herbal dengan kandungan fitokimia berperan sebagai alternatif antidiabetes karena efek samping yang lebih rendah. Buah bhee (*Melastoma malabathricum* L) kaya antioksidan dan berpotensi sebagai agen hipoglikemik. Penelitian ini bertujuan mengidentifikasi kandungan fitokimia secara kualitatif dan kuantitatif serta menguji efek ekstrak buah bhee terhadap kadar glukosa darah pada model mencit diabetes. Identifikasi kualitatif menggunakan pelarut air, etanol, dan metanol. Analisis kuantitatif dilakukan dengan spektrofotometri UV-Vis dan gravimetri. Uji *in vivo* melibatkan 24 mencit yang dibagi menjadi enam kelompok: kontrol normal, kontrol metformin, kontrol diabetes, dan tiga kelompok perlakuan dengan dosis ekstrak 100, 200, dan 400 mg/kgBB selama 28 hari. Hasil menunjukkan bahwa pelarut air mengekstraksi komponen bioaktif paling banyak, meliputi steroid, terpenoid, saponin, flavonoid, fenol, dan tanin. Pemberian ekstrak air buah bhee secara signifikan menurunkan kadar glukosa darah mencit diabetes, dengan penurunan tertinggi pada dosis 400 mg/kgBB ($p<0,05$). Simpulan: ekstrak air buah bhee efektif sebagai agen hipoglikemik pada mencit diabetes.

Kata kunci: Aloksan; Antioksidan; Hiperglikemia; Metabolit Sekunder.

Abstract: Diabetes is a chronic condition that cannot be cured, but it can be managed using synthetic or herbal hypoglycaemic agents. Herbal plants containing phytochemicals serve as an alternative treatment for diabetes due to their lower incidence of side effects. Bhee fruit (*Melastoma malabathricum* L.) is rich in antioxidants and has potential as a hypoglycaemic agent. This study aims to identify the phytochemical content qualitatively and quantitatively, and to test the effect of bhee fruit extract on blood glucose levels in a diabetic mice model. Qualitative identification was carried out using water, ethanol and methanol as solvents. Quantitative analysis was performed using UV-Vis spectrophotometry and gravimetry. The *in vivo* test involved 24 mice divided into six groups: normal control, metformin control,

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diabetic control, and three treatment groups with extract doses of 100, 200, and 400 mg/kg body weight over 28 days. The results showed that the aqueous solvent extracted the highest amount of bioactive components, including steroids, terpenoids, saponins, flavonoids, phenols and tannin. Furthermore, administration of the aqueous extract significantly reduced blood glucose levels in diabetic mice, with the highest reduction at 400 mg/kg body weight ($p<0.05$). In conclusion, the aqueous extract of bhee fruit is effective as a hypoglycaemic agent in diabetic mice.
Keyword: Antioxidants; Alloxan; Hyperglycemia; Secondary metabolites.

1. Introduction

Diabetes mellitus is a chronic disease defined by disruptions in metabolic processes, especially those involving carbohydrate metabolism. It is marked by persistently elevated blood glucose levels, a condition known as hyperglycemia. Diabetes results from disruptions in the production or function of insulin, a hormone synthesized by pancreatic beta cells. Insulin facilitates the uptake of glucose into cells to provide energy. During hyperglycemia, beta cells are expected to increase insulin secretion [1]. Controlling glucose levels in people with diabetes aims to prevent sudden spikes in glucose levels. Untreated or poorly managed diabetes may progress to severe complications, including cardiovascular injury, microvascular damage, blindness, nephropathy, neuropathy, permanent disability, and fatality [2].

Controlling blood glucose levels in people with diabetes can be done through oral hypoglycemic medication or insulin injections, depending on the indication and type of diabetes. In addition to medical therapy, the use of herbal plants as alternative medicine is also becoming increasingly popular. This is due to the perception that medicinal plants are easily obtained from the environment, are affordable, and have fewer side effects on the body. [3]. Plants are used as herbal medicine because they contain secondary metabolites. Various studies have demonstrated that secondary metabolites can treat various diseases, including diabetes, with antidiabetic potential shown through both in vivo and in vitro approaches [4] [5]. A global registry

maintained by the *World Health Organization* (WHO) identifies 21,000 plants with medicinal properties, and 400 species within this group are noted for their potential in managing diabetes. [6].

The inventory of herbal plants used as raw materials for antidiabetic drugs remains limited in Aceh, particularly in West Aceh. Bhee fruit *(Melastoma malabathricum* L.) is one example with potential as an antidiabetic agent, though it is not widely utilized. Administration of bhee fruit ethanol extract reduced blood glucose levels in alloxan-induced zebrafish [7] and diabetic mice. However, information on its antidiabetic properties is still scarce [8]. Although initial research and ethnopharmacological evidence are promising, further comprehensive studies are required to empirically establish the efficacy, safety, optimal dosage, and mechanism of action of each herbal plant before recommending them as therapies.

The selection of extraction solvent dictates the type of phytochemicals obtained: polar solvents (water, ethanol, methanol) extract polar compounds, whereas non-polar solvents (ether, chloroform, n-hexane) isolate non-polar ones [9]. This study assessed the extraction efficiency of water, ethanol, and methanol for metabolites from bhee fruit simplisia, followed by qualitative and quantitative analyses, and in vivo evaluation in diabetic mice at varying dosages

2. Research Method

Phytochemical evaluation of Bhee fruit *(Melastoma malabathricum* L.) was conducted at the MIPA Biological Laboratory, Syiah Kuala University (qualitative and quantitative analyses), and *in vivo* testing on diabetic mice at the IPB UPHL Laboratory.

Preparation of Bhee Fruit Simplisia Powder

Bhee fruit sourced from West Aceh had its stem and petals manually removed prior to further processing, dried for 4 days in an oven at 40-50°C, ground using a blender, and stored in a dark container for testing. The plant specimen was identified as *Melastoma malabathricum* L. at the Laboratory of the Department of Biology, Faculty of Mathematics and Natural Sciences

(FMIPA), Universitas Syiah Kuala (USK). The simplisia powder was subsequently extracted using water as the solvent by the maceration method, at a material-to-solvent ratio of 1:10 (w/v), for 48–72 hours at room temperature.

Qualitative Test

Phytochemical screening was performed on bhee fruit extracts using water, ethanol, and methanol as solvents. Compound identification was based on color changes, precipitate formation, or foam using specific reagents Flavonoids were detected with 2N HCl and Mg powder; tannins with 1% $FeCl_3$; saponins by a foam test that remained stable for at least 30 seconds; alkaloids with Wagner's, Mayer's, and Dragendorff's reagents; and terpenoids and steroids with Liebermann-Burchard reagent, following the procedure described by Khafid et al [10].

Quantitative Testing

Total flavonoids, tannins, phenolics, and steroids were quantified using a UV-Vis spectrophotometer (Shimadzu) [11]. Saponin and terpenoid contents were determined gravimetrically due to the unavailability of appropriate standards [12].

Preparation of diabetic test animals

A total of 24 mice (weighing 18–20 g) were obtained from UPHL IPB and acclimatized for 7 days. Diabetes was induced by intraperitoneal injection of alloxan at a dose of 120 mg/kg body weight; diabetes was confirmed when blood glucose levels reached ≥200 mg/dL after 48 hours [13] Mice were randomly divided into six groups (n=4): KN (normal control), KO (metformin HCl 1.3 mg/20 g BW [14], KD (diabetic control without treatment), and P1, P2, and P3 (bhee fruit extract at doses of 100, 200, and 400 mg/kg BW). Treatments were administered for 28 days. Blood glucose levels were measured before alloxan induction, after induction, and on days 14 and 28. This study was approved by the Animal Research Ethics Committee (No. 366/XI/2023).

Data Analysis

Data were analyzed using one-way analysis of variance (ANOVA). Normality was assessed using the *Shapiro Wilk* test as a prerequisite for ANOVA. When ANOVA results were statistically significant, post hoc comparisons between treatment groups were performed using Duncan's Multiple Range Test (DMRT) at a 5% significance level. All data are expressed as mean ± standard error of the mean (SEM).

3. Results and Discussion

Phytochemical Content of Bhee Fruit Extract (*Melastoma malabathricum* L).

a. Qualitative Test

The results of qualitative phytochemical screening of Bhee fruit using three solvents are presented in Table 1.

Table 1. Detection of phytochemical content in bhee fruit (*Melastoma malabathricum* L.) using water, ethanol, and methanol solvents

Metabolite Content	Reagen	Water Extract	Ethanol Extract	Methanol Extract
Alkaloid	Mayer	-	-	-
	Wagner	-	-	-
	Dragendorff	-	-	-
Steroid	Liebermann-Burchard test	+	-	-
Terpenoid	Liebermann-Burchard test	+	+	+
Saponin	Shake	+	+	+
Flavonoid	HCL and Mg Metal	+	+	+
Fenol	$FeCl_3$	+	+	+
Tannin	Gelatin+H_2SO_4	+	-	-

Screening for secondary metabolites in Bhee fruit using water, ethanol, and methanol as solvents yielded distinct metabolite profiles. Water extracts contained steroids, terpenoids, saponins, flavonoids, phenols, and tannins, while ethanol and methanol extracts included terpenoids, saponins, flavonoids, and phenols. The extraction efficiency of these solvents is determined by their polarity. Since secondary metabolites are generally polar, solvents with higher polarity extract these compounds more effectively [15].

The findings indicate that water extracts a broader spectrum of secondary metabolites from Bhee fruit compared to ethanol or methanol. This

result is attributed to the higher polarity of water, which enhances its efficiency in extracting polar secondary metabolites. Both ethanol and methanol extracts yielded the same types of secondary metabolites. Although both ethanol and methanol yielded the same metabolite types, ethanol is considered a more efficient extractant due to its higher polarity and stability compared to methanol [16].

Alkaloids were not detected in any of the water, ethanol, or methanol extracts. Given that alkaloids are semi polar [17], their absence may be due to the use of polar solvents, or possibly a low concentration of alkaloids in the Bhee fruit sample. Steroids were detected only in water extracts, while ethanol and methanol extracts tested negative. This finding contrasts with the theoretical classification of steroids as non-polar compounds, which is complicated by the presence of an OH group [18]. Similarly, tannins were detected exclusively in water extracts. Due to their high polarity and abundance of OH groups, tannins exhibit greater solubility in water [19].

b. Quantitative Test

Quantitative analysis was subsequently performed on the water extract, which demonstrated the highest metabolite diversity in the qualitative screening. Quantitative analysis of flavonoid, tannin, phenolic, and steroid content in the water extract by UV-vis spectrophotometry is presented in Table 2:

Table 2. Results of Quantitative Testing of Bhee Fruit Water Extract by UV-Vis Spectrophotometry

Sample	Types of Secondary Metabolites (mg/g Extract)			
	Flavonoid	**Tannin**	**Fenolik**	**Steroid**
Bhee Fruit Water Extract	0.576 mgQE/g Extract	0.298 mgTAE/g Extract	0.443 mgQE/g Extract	0.953 mgCE/g Extract

According to the data presented above, the total steroid content measured by spectrophotometry was the highest, reaching 0.953 mgCE/g extract. The flavonoid content exceeded the phenolic content, with percentages of 0.576 mgQE/g extract and 0.443 mgQE/g extract, respectively.

The total tannin content was the lowest, at 0.298 mgTAE/g extract. The relatively moderate flavonoid and phenolic contents in this study may be attributed to the use of ripe fruit, as previous studies report higher flavonoid and phenolic levels in unripe *Melastoma malabathricum* L. fruit. Gravimetric quantification of saponin and terpenoid content is shown in Table 3.

Table 3. Results of Gravimetric Quantitative Testing of Bhee Fruit Water Extract

Sample	Types of Secondary Metabolites (mg/g Extract)	
	Saponin	**Terpenoid**
Bhee Fruit Water Extract	0.78 mgQE/g Extract	0.89 mgTAE/g Extract

Gravimetric analysis revealed that terpenoid content (0.89%) was higher than saponin content (0.78%), indicating a strong affinity of terpenoid compounds for the aqueous extract of Bhee fruit [20].

Blood Glucose Levels

Alloxan Induction

Blood glucose levels before and after alloxan induction across all groups are presented in Table 4:

Table 4. Blood glucose levels before and after alloxan induction

Groups	KGD (Mean±SEM)	
	KGD0 (Mean±SEM)	**KGD Alloxan (Mean±SEM)**
KN	161.00±8.37^{ab}	162.75±5.90^{a}
KO	156.50±2.36^{ab}	244.00±2.48^{bc}
KD	170.00±5.06^{b}	245.25±10.78^{bc}
P1	162.75±6.15^{ab}	239.00±7.93^{b}
P2	170.50±8.14^{b}	265.75±6.66^{cd}
P3	149.25±5.15^{a}	270.75±8.20^{cd}

Different superscript letters (a, b, c, and d) in each column indicate significant differences at $p < 0.05$. Values are presented as means ± SEM.

Table 4 shows that prior to alloxan induction, all groups had comparable baseline blood glucose levels ($p=0.185$). Following intraperitoneal injection of alloxan at 120 mg/kgBW, blood glucose levels in the diabetic groups increased significantly to ≥200 mg/dL ($p<0.001$), confirming successful establishment of the diabetic animal model. Normality testing (Shapiro-Wilk, $p\geq0.05$) confirmed data were suitable for ANOVA analysis, which demonstrated a significant difference in post-induction glucose levels among groups ($p<0.001$). Changes in

blood glucose levels before and after alloxan induction are shown in the figure below:

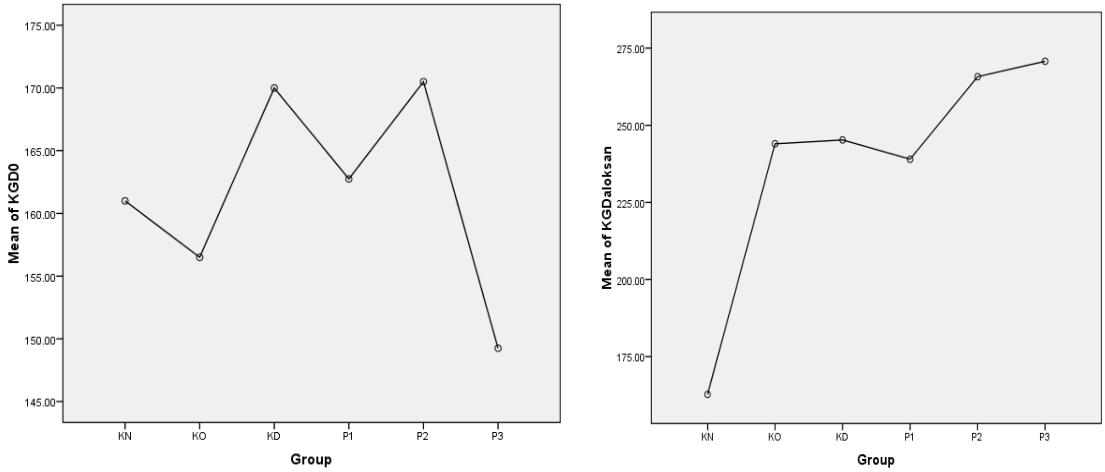


Figure 1. Graph showing blood glucose levels KGD0 (before alloxan induction) KGD alloxan (after alloxan induction)

Figure 1 illustrates that baseline blood glucose levels across all groups were within the normal range prior to alloxan induction, confirming homogeneity among groups before treatment. Following alloxan injection, a marked elevation in blood glucose was observed exclusively in the diabetic groups, while the KN group remained stable, validating the selectivity of alloxan-induced β-cell damage as a diabetic model.

Extract Treatment

Following extract administration, blood glucose levels in all treatment groups showed a declining trend compared to the diabetic control (Table 5):

Table 5. Blood glucose levels after administration of the extract on days 14 and 28

Groups	KGD (Mean±SEM)		
	KGDaloksan (Mean±SEM)	**KGD14 (Mean±SEM)**	**KGD28 (Mean±SEM)**
KN	162.75±5.90^{a}	159.75±4.49^{a}	163.75±7.79^{b}
KO	244.00±2.48^{bc}	193.75±9.33^{b}	131.25±5.35^{a}
KD	245.25±10.78^{bc}	246.25±9.87^{d}	258.00±7.35^{d}
P1	239.00±7.93^{b}	187.25±9.74^{ab}	193.75±10.71^{c}
P2	265.75±6.66^{cd}	214.50±11.21^{bc}	182.50±10.31^{bc}
P3	270.75±8.20^{cd}	229.00±9.67^{cd}	175.50±10.01^{bc}

Different superscript letters (a, b, c, and d) in each column indicate significant differences at $p < 0.05$. Values are presented as means ± SEM.

Administration of *Melastoma malabathricum* L. fruit extract over 28 days resulted in reduced blood glucose levels in mice. Normality tests (P value ≥

0.05) confirmed the data were appropriate for ANOVA analysis. ANOVA results demonstrated a significant effect of the extract on blood glucose levels on days 14 and 28 (($p<0.001$)). The Duncan test indicated that, on day 14, blood glucose levels were significantly different between the KN group and the diabetic mouse group. On day 14, P1 showed the most notable reduction among treatment groups, with glucose levels not significantly different from the KO group (metformin). The KD group maintained significantly elevated glucose levels throughout the study period.

At day 28, glucose levels in the P2 and P3 groups were not significantly different from those in the KN group ($p>0.05$), demonstrating that doses of 200 and 400 mg/kg BW successfully restored near-normal glycemia. The dose-dependent decline in glucose levels across the P1–P3 groups indicates that higher doses exert more potent hypoglycemic effects. The accompanying graph illustrates these changes.:

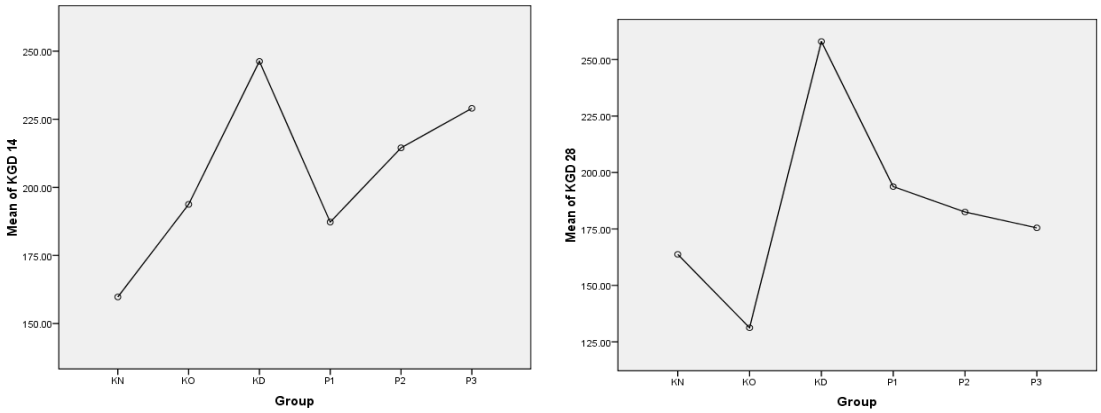


Figure 2. Graph showing blood glucose levels KGD14 (14 days of extract treatment) KGD28 (28 days of extract treatment).

Figure 2 demonstrates a progressive decline in blood glucose levels in groups P1, P2, and P3 from day 14 to day 28, indicating a time-dependent hypoglycemic response to Bhee fruit water extract. In contrast, the KD group exhibited a continuous upward trend, reinforcing that untreated hyperglycemia leads to progressive β cell dysfunctio, while the KO group showed the steepest decline consistent with metformin's established efficacy.

The hypoglycemic effect observed in the treatment groups is attributable to the synergistic action of bioactive compounds identified in the water extract of Bhee fruit, particularly flavonoids, steroids, tannins,

phenolics, saponins, and terpenoids. The results of in vivo tests show that administration of bhee fruit water extract for 28 days significantly affects blood glucose levels in diabetic mice, although not as significantly as metformin administration in the KO group. The decrease in blood glucose levels in groups P2 and P3 showed a consistent decrease and was statistically not significantly different from the KN group. Blood glucose levels in the KN group remained within the normal range, while in the KD group they continued to increase. The factor causing the increase in blood glucose levels in the KD group was due to the effects of alloxan induction without any intervention.

Alloxan damages pancreatic β cells inhibits the Keap1/Nrf2 signaling pathway, increases ROS production, and causes DNA damage [21] as a result of apoptosis in pancreatic cells [22]. When hyperglycemia occurs in the KD mouse group without therapeutic intervention, damage to pancreatic β cells will worsen and even become permanent. This condition results in the disruption or cessation of endogenous insulin production. Without insulin, glucose cannot enter target cells and remains in the bloodstream [23]. Each component of the bioactive compounds found in bhee fruit extract plays an important role in lowering blood glucose levels.

Steroids play an important role as anti-inflammatories and help lower blood glucose levels by stimulating insulin secretion from the pancreas [24]. certain steroid glycosides further enhance insulin sensitivity without altering basal insulin secretion [25].

Flavonoids affect blood glucose levels through intra and extra pancreatic mechanisms. Intrapancreatic action works by repairing pancreatic β cells, while extrapancreatic action protects the pancreas from damage. Flavonoids can act as anti-inflammatories in two ways: by inhibiting arachidonic acid, increasing gastric mucosal prostaglandin hormones, and suppressing the release of pro-inflammatory cytokines [26].

The type of flavonoid contained in Bhee fruit is anthocyanin [27]. Anthocyanins act as anti-inflammatories and increase insulin secretion

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through increased regulation of the GLUT4 gene, activation of protein kinase, and decreased regulation of retinol-binding protein 4 (RBP4) expression, thereby increasing glucose uptake and protecting pancreatic cells from necrosis [28].

The tannins contained in Bhee fruit inhibit the absorption of nutrients, preventing glucose levels from rising rapidly due to the astringent properties of tannins [4]. The role of phenolics as antioxidants will prevent the formation of free radicals and reduce oxidative stress in the pancreas. In addition, phenolics can also reduce carbohydrate absorption in the digestive process because they contain α-amylase and α-glucosidase inhibitors [29].

Saponins work through several main pathways: activating pancreatic β cells, regulating important signaling networks such as IRS-1/PI3K/Akt and AMPK [30] and increase liver insulin resistance [31]. In addition, saponins can block GLUT-1, thereby reducing glucose absorption [32]. Saponins exert hypoglycemic effects by activating pancreatic β-cells, regulating the IRS-1/PI3K/Akt and AMPK signaling pathways and blocking GLUT-1 to reduce intestinal glucose absorption.

Terpenoids work as antidiabetics through their mechanism of increasing insulin secretion from pancreatic β cells and inhibiting the enzyme α glucosidase. Terpenoids exert antidiabetic effects by stimulating insulin secretion from pancreatic β-cells and inhibiting α-glucosidase activity, thereby reducing postprandial glucose absorption [33].

This study has several limitations. First, the specific bioactive compounds responsible for the hypoglycemic effect were not identified. Second, only one extraction method (maceration) and three solvents were evaluated; other extraction parameters (time, temperature, ratio) were not optimized. Third, the study duration was limited to 28 days, and long-term safety was not assessed. Therefore, further studies are warranted to elucidate the specific active compounds, optimal extraction parameters, and long term safety profile of Bhee fruit extract as a potential antidiabetic agent

4. Conclusion

The water extract of Bhee fruit (*Melastoma malabathricum* L.) yielded the broadest phytochemical profile, detecting six compound groups (steroids, terpenoids, saponins, flavonoids, phenolics, and tannins), whereas ethanol and methanol extracts yielded only four (terpenoids, saponins, flavonoids, and phenolics). Steroids were the most abundant compounds, followed by terpenoids, saponins, flavonoids, phenolics, and tannins. Oral administration for 28 days significantly reduced blood glucose in alloxan-induced diabetic mice at all doses tested (100, 200, and 400 mg/kg BW), with the 200 and 400 mg/kg doses achieving normoglycemia comparable to the normal control. These findings support Bhee fruit water extract as a promising natural antidiabetic agent and warrant further studies on its active constituents, optimal dosing, and safety.

5. Reference

[1] O. A. Ojo, H. S. Ibrahim, D. E. Rotimi, A. D. Ogunlakin, and A. B. Ojo, "Diabetes mellitus: From molecular mechanism to pathophysiology and pharmacology," *Med. Nov. Technol. Devices*, vol. 19, pp. 1–8, Sep. 2023, doi: 10.1016/j.medntd.2023.100247.

[2] O. S. Datu, J. S. Lebang, E. J. Suoth, and P. Farmasi, "Efek Pemberian Ekstrak Buah Salak (Salacca zalacca) dalam Menurunkan Kadar Glukosa Darah Pada Tikus Model Diabetes MelitusL.)," *J. MIPA*, vol. 12(1), pp. 30–33, Jan. 2023, doi: https://doi.org/10.35799.

[3] T. C. Widiastuti *et al.*, "Pemanfaatan Tanaman Obat untuk Mengatasi Penyakit Diabetes Melitus Di Kota Kebumen," *J. Farm. Klin. Dan Sains*, vol. 2, no. 1, p. 87, Jun. 2022, doi: 10.26753/jfks.v2i1.776.

[4] N. K. Y. Pratiwi and I. W. M. Santika, "Mekanisme Aktivitas Anti-Diabetes Dari Kandungan Senyawa Tanaman Kersen (Muntingia calabura L.): Systematic Review," *Pros. Workshop Dan Semin. Nas. Farm.*, vol. 2, pp. 100–112, Nov. 2023, doi: 10.24843/WSNF.2022.v02.p08.

[5] E. Elfahmi, W. Santoso, and K. Anggardiredja, "Uji Aktivitas Antidiabetes Produk Obat Herbal yang Mengandung Ekstrak Bratawali (Tinospora crispa (L.) Miers ex Hoff.f & Thoms.)," *J. Sains Farm. Klin.*, vol. 6, no. 3, p. 213, Dec. 2019, doi: 10.25077/jsfk.6.3.213-219.2019.

[6] P. Dey, J. Singh, J. K. Suluvoy, K. J. Dilip, and J. Nayak, "Utilization of Swertia chirayita Plant Extracts for Management of Diabetes and Associated Disorders: Present Status, Future Prospects and

Limitations," *Nat. Prod. Bioprospecting*, vol. 10, no. 6, pp. 431–443, Dec. 2020, doi: 10.1007/s13659-020-00277-7.

[7] A. Novitalia and I. Miladiyah, "Aktivitas Hipoglikemik Snedds Ekstrak Etanol Buah Harendong (Melastoma Affine D.Don) Pada Ikan Zebra (Danio Rerio) Yang Diinduksi Aloksan," *J. Tumbuh. Obat Indones.*, vol. 15, no. 1, pp. 48–56, Jul. 2022, doi: 10.22435/jtoi.v15i1.5313.

[8] R. Rinawati *et al.*, "Phytochemical Screening and Blood Glucose Level Effects of Bhee Fruit Extract (Melastoma sp) on Diabetic Mice," *J-Kesmas J. Fak. Kesehat. Masy. Indones. J. Public Health*, vol. 10, no. 1, p. 15, Apr. 2023, doi: 10.35308/j-kesmas.v10i1.7366.

[9] N. Ramadhani, A. G. Samudra, W. Syahidah, C. D. Utami, and S. Rahmawati, "Kadar Flavonoid Total Daun Rhizopora Apiculata Blume dengan Variasi Pelarut," *LUMBUNG Farm. J. Ilmu Kefarmasian*, vol. 3, no. 2, pp. 291–297, Jul. 2022, doi: https://doi.org/10.31764/lf.v3i2.9328.

[10] A. Khafid *et al.*, "UJi Kualitatif Metabolit Sekunder pada Beberapa Tanaman yang Berkhasiat sebagai Obat Tradisional," *Bul. Anat. Dan Fisiol.*, vol. 8, no. 1, pp. 61–70, May 2023, doi: 10.14710/baf.8.1.2023.61-70.

[11] L. Listiana, P. Wahlanto, S. S. Ramadhani, and R. Ismail, "Penetapan Kadar Tanin Dalam Daun Mangkokan (Nothopanax scutellarium Merr) Perasan Dan Rebusan Dengan Spektrofotometer UV-Vis," *Pharm. Genius*, vol. 1, no. 1, pp. 62–73, Oct. 2022, doi: 10.56359/pharmgen.v1i01.152.

[12] S. K. Malik, "Qualtitative And Quantitative Estimation Of Terpenoid Contents In Some Important Plants Of Punjab, Pakistan," *Pak. J. Sci.*, vol. 69, no. 2, pp. 150–154, Jan. 2023, doi: 10.57041/pjs.v69i2.364.

[13] D. Daoudi *et al.*, "Exploring the relationships of Metabolic Syndrome with sociodemographic factors, weight status, dietary and lifestyle behaviors in Moroccan adults," *Clin. Epidemiol. Glob. Health*, vol. 34, p. 102058, Jul. 2025, doi: 10.1016/j.cegh.2025.102058.

[14] M. Li, A. Sharma, C. Yin, X. Tan, and Y. Xiao, "Metformin ameliorates hepatic steatosis and improves the induction of autophagy in HFD-induced obese mice," *Mol. Med. Rep.*, vol. 16, no. 1, pp. 680–686, Jan. 2017, doi: 10.3892/mmr.2017.6637.

[15] S. Poncowati, N. Soenardjo, N. Taufiq-Spj, and M. T. Sibero, "Profil Senyawa Metabolit Sekunder Ekstrak Daun Mangrove Lumnitzera racemosa Asal Perairan Teluk awur, Jepara," *J. Mar. Res.*, vol. 11, no. 4, pp. 794–804, Nov. 2022, doi: 10.14710/jmr.v11i4.34325.

[16] A. Luviana *et al.*, "Pengaruh Pelarut yang Digunakan terhadap Hasil Ekstraksi Kunyit (Curcuma Longa L.)," *Pros. Ind. Res. Workshop Natl. Semin.*, vol. 14(1), pp. 123–127, Jul. 2023, doi: https://doi.org/10.35313/irwns.v14i1.5372.

[17] E. Edison, A. Diharmi, N. M. Ariani, and M. Ilza, "Komponen bioaktif dan aktivitas antioksidan ekstrak kasar Sargassum plagyophyllum: Bioactive Components and Antioxidant Activity of Sargassum plagiophyllum Crude Extract," *J. Pengolah. Has. Perikan. Indones.*, vol. 23, no. 1, pp. 58–66, Apr. 2020, doi: 10.17844/jphpi.v23i1.30725.

[18] W. Susmayanti and A. Rahmadani, "Uji Aktivitas Antioksidan Fraksi Daun Melinjo (Gnetum Gnenom L.) Menggunakan Metode CUPRAC (Cupric Ion Reducing Antioxidant Capacity): Antioxidant Activity of Fraction From Gnetum Gnenom L.Leaves Using Cuprac (Cupric Ion Reduxing Antioxidant Capacity) Methods," *Indones. J. Pharm. Nat. Prod.*, vol. 6, no. 01, pp. 97–106, Mar. 2023, doi: 10.35473/ijpnp.v6i01.2178.

[19] R. A. Alfauzi, L. Hartati, D. Suhendra, T. P. Rahayu, and N. Hidayah, "Ekstraksi Senyawa Bioaktif Kulit Jengkol (Archidendron jiringa) dengan Konsentrasi Pelarut Metanol Berbeda sebagai Pakan Tambahan Ternak Ruminansia: Extraction of Jengkol (Archidendron jiringa) Peel Bioactive Compounds with Different Concentrations of Methanol Solvents as Supplementary Feed for Ruminants," *J. Ilmu Nutr. Dan Teknol. Pakan*, vol. 20, no. 3, pp. 95–103, Dec. 2022, doi: 10.29244/jintp.20.3.95-103.

[20] V. Mierza, I. Salsabila, C. V. Advaita, A. Oktavianti, and S. Rahayu, "Pengembangan Berbagai Metode Analisis Kadar Natrium Siklamat Pada Minuman Ringan," *J. Pharm. Sci.*, vol. 6, no. 2, pp. 787–794, Jun. 2023, doi: 10.36490/journal-jps.com.v6i2.139.

[21] E. G. Novoselova *et al.*, "Peroxiredoxin 6 Attenuates Alloxan-Induced Type 1 Diabetes Mellitus in Mice and Cytokine-Induced Cytotoxicity in RIN-m5F Beta Cells," *J. Diabetes Res.*, vol. 2020, pp. 1–11, Aug. 2020, doi: 10.1155/2020/7523892.

[22] Y. Lou *et al.*, "Inhibition of the Keap1/Nrf2 Signaling Pathway Significantly Promotes the Progression of Type 1 Diabetes Mellitus," *Oxid. Med. Cell. Longev.*, vol. 2021, no. 1, p. 7866720, Jan. 2021, doi: 10.1155/2021/7866720.

[23] Y. Watanabe *et al.*, "Exogenous Glucose Administration Impairs Glucose Tolerance and Pancreatic Insulin Secretion during Acute Sepsis in Non-Diabetic Mice," *PLoS ONE*, vol. 8, no. 6, p. e67716, Jun. 2013, doi: 10.1371/journal.pone.0067716.

[24] S. W. Munawwaroh, Sri Peni Fitrianingsih, and Ratu Choesrina, "Studi Literatur Aktivitas Antidiabetes Biji Mahoni (Swietenia mahagoni (L.) Jacq.)," *Bdg. Conf. Ser. Pharm.*, vol. 2, no. 2, Jul. 2022, doi: 10.29313/bcsp.v2i2.4159.

[25] S. B. Choi and S. Park, "A Steroidal Glycoside from *Polygonatum odoratum* (Mill.) Druce. Improves Insulin Resistance but does not Alter Insulin Secretion in 90% Pancreatectomized Rats," *Biosci. Biotechnol. Biochem.*, vol. 66, no. 10, pp. 2036–2043, Jan. 2002, doi: 10.1271/bbb.66.2036.

[26] S. Hidayati, F. Oktavianti, D. A. Susanti, and Q. Aini, "Aktivitas Antiinflamasi In Vitro dan In Vivo Ekstrak Etanol Daun Mangga Arumanis (Mangifera indica L.): In Vitro and In Vivo Anti-Inflamatory Activities of Ethanol Extract Mangifera indica L. Leaves," *J. Sains Dan Kesehat.*, vol. 4, no. 5, pp. 488–494, Oct. 2022, doi: 10.25026/jsk.v4i5.1195.

[27] A. M. Zulkhaidir, "Potensi Cyanidin-3-Glucoside Buah Senggani (Melastoma Malabathricum L.) Sebagai Anti Hiperkolesterolemia Secara In Silico," *Program Studi Pendidik. Dr. Fak. Kedokt. Dan Ilmu Kesehat. Univ. Islam Negeri Maulana Malik Ibrahim Malang*, pp. 1–74, 2020.

[28] D. Różańska and B. Regulska-Ilow, "The Significance Of Anthocyanins In The Prevention And Treatment Of Type 2 Diabetes," *Adv. Clin. Exp. Med.*, vol. 27, no. 1, pp. 135–142, Jan. 2018, doi: 10.17219/acem/64983.

[29] M. G. P. Pertiwi and F. F. Perdhana, "Peranan Senyawa Fenolik Dalam Menurunkan Glukosa Darah Pada Penderita Diabetes Melitus Tipe 2," *Food Agro Ind. J.*, vol. 4, no. 1, pp. 42–56, Jul. 2023.

[30] Y. Zhou and B. Xu, "New insights into anti-diabetes effects and molecular mechanisms of dietary saponins," *Crit. Rev. Food Sci. Nutr.*, vol. 63, no. 33, pp. 12372–12397, Dec. 2023, doi: 10.1080/10408398.2022.2101425.

[31] Z. Chen, J. Luo, M. Jia, Y. Chai, and Y. Bao, "Polygonatum sibiricum saponin Exerts Beneficial Hypoglycemic Effects in Type 2 Diabetes Mice by Improving Hepatic Insulin Resistance and Glycogen Synthesis-Related Proteins," *Nutrients*, vol. 14, no. 24, p. 5222, Dec. 2022, doi: 10.3390/nu14245222.

[32] N. Insani, N. Marlina, and V. Buanawati, "Skrining Fitokimia Seduhan Teh Celup Daun Insulin (Tithonia Diversifolia (Hemsl.) A. Gray) dan Daun Teh Hijau (Camellia sinensis L.) Phytochemical Screening of Insulin (Tithonia Diversifolia (Hemsl.) A. Gray) and Green Tea (Camellia sinensis L.) Leaf Brewing Teabags," *J. Ilm. Kesehat. Delima*, vol. 5(1), pp. 33–36, Jul. 2022, doi: https://doi.org/10.60010/jikd/v5i1.75.

[33] S. Sinulingga, "Uji Fitokimia dan Potensi Antidiabetes Fraksi Etanol Air Daun Benalu Kersen (Dendrophtoe petandra (L) Miq)," *J. Kedokt. Dan Kesehat.*, vol. 16, no. 1, pp. 76–83, Jan. 2020, doi: https://doi.org/10.24853/jkk.16.1.76-83.