CHAPTER I
INTRODUCTION

1.1 Research Background

Based on data from the World Health Organization (WHO) in 2023, about 422 million people worldwide have diabetes, and 1.5 million people die each year as a direct result of diabetes.[1] Meanwhile, according to data from the International Diabetes Federation (IDF) report in 2021 that there were around 537 million adults aged 20 - 79 years living with diabetes worldwide. The prevalence of diabetes is expected to increase by 46% until 2045.[2] According to the Basic Health Research Report (RISKESDAS) of the Ministry of Health in 2018, the prevalence of diabetes among individuals aged 15 and older was 10.9%, while the 2023 Indonesian Health Survey Report (SKI) found that this figure had risen to 11.7%, and increase of 0.8% from the previous year.[3,4] Long-term diabetes can lead to blindness, heart disease, and death. The complications can result in paralysis and even death in people with diabetes.[5]

Type 2 diabetes is characterized by hyperglycemia, hyperinsulinemia, and insulin resistance, which lead to endothelial dysfunction and diabetic dyslipidemia.[6] Type 2 diabetes mellitus is accompanied by various complications categorized into microvascular and macrovascular. Such macrovascular complications can be through various pathogenetic mechanisms, especially hyperglycemia and insulin resistance.[7]

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[1] Diabetes, accessed December 8, 2023, https://www.who.int/health-topics/diabetes.

[2] IDF, *IDF Diabetes Atlas*, 10th ed., 2021, 4, www.diabetesatlas.org.

[3] RISKESDAS, *Laporan Nasional RISKESDAS 2018*, 2018th ed. (Jakarta: Lembaga Penerbit Badan Penelitian dan Pengembangan Kesehatan, 2019), 129.

[4] Kemenkes, *Laporan Tematik Survei Kesehatan Indonesia (SKI) Tahun 2023* (Kementerian Kesehatan RI, 2024), 239, https://drive.google.com/file/d/1zip9fu-Y_OGe-ybhX2d-VCD5F511IoXC/view.

[5] N. Syamsiyah, *Berdamai dengan Diabetes* (Bumi Medika, 2022), 2.

[6] Unai Galicia-Garcia et al., Pathophysiology of Type 2 Diabetes Mellitus, *International Journal of Molecular Sciences* 21, no. 17 (August 30, 2020): 6275, https://doi.org/10.3390/ijms21176275.

[7] Margus Viigimaa et al., Macrovascular Complications of Type 2 Diabetes Mellitus, *Current Vascular Pharmacology* 17 (April 5, 2019), https://doi.org/10.2174/1570161117666190405165151.

Complications of type 2 diabetes are largely characterized by the onset of atherosclerosis. The pathophysiologic process begins with the deposition of lipoproteins into the arterial wall, accumulating foam cells in the subendothelial region.[8] Hypertriglyceridemia is the most common serum lipid abnormality in individuals with type 2 diabetes. Serum triglyceride levels increase with the severity of hyperglycemia, while hyperinsulinemia, a compensatory response to insulin resistance, shows a significant correlation with triglyceride concentrations.[9] Approximately 60% to 70% of individuals with type 2 diabetes are affected by lipid metabolism disorders, and hyperglycemia acts to accelerate the development of atheromatous lesions in patients affected by diabetic dyslipidemia.[10] Diabetic dyslipidemia was characterized by increased triglycerides, low-density LDL, and decreased HDL levels.[11]

Dietary therapy given to prevent hyperlipidemia and hypercholesterolemia in type 2 diabetics is to limit the intake of saturated fat, trans fat, and excessive cholesterol and increase the consumption of macronutrients in the form of soluble fiber to reduce cholesterol levels and affect lipid profiles.[12] A research study indicates that dietary fiber intake significant effects total cholesterol levels and blood triglyceride levels in patients with type 2 diabetes mellitus.[13] To reduce the prevalence and severity of type 2 diabetes mellitus and improve the quality of life of patients, management strategies were implemented, including lifestyle modifications, diet therapy, physical activity, and the use of medications when necessary to

[8] Huifang Guan et al., Advances in Secondary Prevention Mechanisms of Macrovascular Complications in Type 2 Diabetes Mellitus Patients: A Comprehensive Review, *European Journal of Medical Research* 29, no. 1 (March 4, 2024): 152, https://doi.org/10.1186/s40001-024-01739-1.

[9] Tsutomu Hirano, Pathophysiology of Diabetic Dyslipidemia, *Journal of Atherosclerosis and Thrombosis* 25, no. 9 (2018): 771–82, https://doi.org/10.5551/jat.RV17023.

[10] Juan José Parcero-Valdés, Dislipidemia Diabética, *Cardiovascular and Metabolic Science* 32, no. S3 (2021): 168–72, https://doi.org/10.35366/100791.

[11] Bruno Vergès, Pathophysiology of Diabetic Dyslipidaemia: Where Are We?, *Diabetologia* 58, no. 5 (2015): 886–99, https://doi.org/10.1007/s00125-015-3525-8.

[12] Rita Suhadi et al., *Seluk-Beluk Hiperlipidemia: Peningkatan Partisipasi dan Kompetensi Farmasis dalam Pencegahan Penyakit Kardiovaskuler* (Sanata Dharma University Press, 2021), 57.

[13] Muhammad Dani Nugraha and Aep Saepudin, Pengaruh Asupan Serat Terhadap Kadar Kolesterol Total, Trigliserida Darah Penderita DM Tipe 2, *Jurnal Fakultas Ilmu Kesehatan* 1, no. 1 (September 2020): 28–31.

optimally control blood glucose levels, blood pressure, weight, and lipid profiles.[14]

One type of tuber that has a relatively high fiber content is suweg tuber. Fresh suweg tubers typically contains 1.4 grams of dietary fiber per 100 grams.[15] Based on several studies, suweg tuber flour contain 13.58 g of crude fiber per 100 g and has a significant effect on lowering total cholesterol by 42.55 mg/dL with a dosage of 2.5 g/day of suweg flour, and lowering triglycerides by 23.08 mg/dL with a dosage of 2.5 g/day suweg flour in Wistar rats with type 2 diabetic.[16,17,18]

In addition to tubers, legumes constitute a significant component of dietary ingredients aimed at improving lipid profiles, with bambara groundnuts being one such sample. The fiber content of dried bambara groundnuts is 26.3 gr per 100 gr.[19] A research study states that the fiber content of bambara groundnut flour is 17.81 g/100 g. The starch content in bambara groundnut flour is 42.60 g/100 g, which can improve the lipid profile in the blood.[20]

Various plant-based foods, such as vegetables and fruits, which were high in dietary fiber, played a crucial role in protecting the body from a range of diseases, including diabetes mellitus. These foods contributed to

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[14] Kemenkes, *Pedoman Pelayanan Kefarmasian Pada Diabetes Melitus* (Jakarta: Kementerian Kesehatan Republik Indonesia, 2019), 9, https://farmalkes.kemkes.go.id/en/unduh/pedoman-pelayanan-kefarmasian-pada-diabetes-melitus/.

[15] Kemenkes, *Tabel Komposisi Pangan Indonesia*, 2017 (Jakarta: Direktorat Jenderal Kesehatan Masyarakat, Kementerian Kesehatan Republik Indonesia, 2018), 16.

[16] Putu Ayu Gaudiya Waisnawi, Ni Luh Ari Yusasrini, and Putu Timur Ina, Pengaruh Perbandingan Tepung Suweg (Amorphophallus campanulatus) Dan Tepung Kacang Hijau (Vigna radiate) Terhadap Karakteristik Cookies, *Jurnal Ilmu dan Teknologi Pangan (ITEPA)* 8, no. 1 (March 29, 2019): 48, https://doi.org/10.24843/itepa.2019.v08.i01.p06.

[17] Rahma Almira, Pengaruh Pemberian Tepung Suweg (Amorphophallus Campanulatus) Terhadap Kadar Kolesterol Pada Tikus Putih Galur Wistar Model Diabetes Melitus (S1, Universitas Muhammadiyah Yogyakarta, 2020), https://doi.org/10/Lampiran.pdf.

[18] Sajidah Salsabila, Pengaruh Tepung Umbi Suweg (Amorphophallus Campanulatus) Terhadap Kadar Trigliserid Pada Tikus Putih Galur Wistar Model Diabetes Melitus (S1, Universitas Muhammadiyah Yogyakarta, 2020), https://doi.org/10/Lampiran.pdf.

[19] Kemenkes, *Tabel Komposisi Pangan Indonesia*, 20.

[20] Chiemela Enyinnaya Chinma et al., Physicochemical Properties, in Vitro Digestibility, Antioxidant Activity and Consumer Acceptability of Biscuits Prepared from Germinated Finger Millet and Bambara Groundnut Flour Blends, *Heliyon* 8, no. 10 (October 2022): e10849, https://doi.org/10.1016/j.heliyon.2022.e10849.

maintaining overall health and well-being.[21] Additionally, in Islamic teachings, individuals were strongly encouraged to prioritize their physical and spiritual health. The consumption of halal and thayyib food aligned with the concept of *hifdzu al-nafs* (preserving the soul). Eating and drinking were essential human needs that had to be fulfilled to sustain life.[22]

The formulation of suweg tuber flour and bambara groundnut flour had not been shown to reduce total cholesterol and triglyceride levels in diabetic dyslipidemia Sprague-Dawley rats. Therefore, research was necessary to determine the effect of administering the formulation of suweg tuber flour and bambara groundnut flour on total cholesterol and triglyceride levels in diabetic dyslipidemia Sprague-Dawley rats.

1.2 Research Problems

Is there an effect of suweg tuber flour (*Amorphophallus campanulatus*) and bambara groundnut flour (*Vigna subterranea*) on total cholesterol and triglyceride levels in diabetic dyslipidemic Sprague-Dawley rats?

1.3 Research Objectives

1. General Objective

   To determine the effect of suweg tuber flour (*Amorphophallus campanulatus*) and bambara groundnut flour (*Vigna subterranea*) on total cholesterol and triglyceride levels in diabetic dyslipidemia Sprague-Dawley rats.

2. Specific Objectives

   a. Analyzed the effect before and after intervention with the formulation of suweg tuber flour (*Amorphophallus campanulatus*) and bambara groundnut flour (*Vigna subterranea*) on total cholesterol levels in diabetic dyslipidemia Sprague-Dawley rats.

[21] Lajnah Pentashihan Mushaf Al-Qur'an, *Tafsir Ilmi Makanan Dan Minuman Dalam Perspektif Al-Qur'an Dan Sains*, Pertama (Jakarta: Lajnah Pentashihan Mushaf Al-Qur'an, Kementerian Agama Republik Indonesia, 2013), 43.

[22] Rofiul Wahyudi, Lu'liyatul Mutmainah, and Maimunah Binti Ali, Halal Food Based on Maqâshid Al-Syarî'ah Perspective, *Journal of Halal Science and Research* 2, no. 2 (September 30, 2021): 43–50, https://doi.org/10.12928/jhsr.v2i2.3778.

b. Analyzed the effect before and intervention with the formulation of suweg tuber flour (*Amorphophallus campanulatus*) and bambara groundnut flour (*Vigna subterranea*) on triglyceride levels in diabetic dyslipidemia Sprague-Dawley rats.
c. Analyzed the average total cholesterol levels in diabetic dyslipidemia Sprague-Dawley rats after interventiom with the formulation of suweg tuber flour and bambara groundnut flour.
d. Analyzed the average triglyceride levels in diabetic dyslipidemia Sprague-Dawley rats after interventiom with the formulation of suweg tuber flour and bambara groundnut flour

1.4 Research Benefits

1. Theoretical Benefits

   Theoretically, this research is expected to provide valuable information and knowledge to the public regarding the functions and benefits of the formulation of suweg tuber flour and bambara groundnut flour in affecting total cholesterol and triglyceride levels in diabetic dyslipidemia.

2. Practical Benefits
   a. Contributing to the community to improve total cholesterol and triglyceride levels, especially dietary therapy by giving formulations of suweg tuber flour and bambara groundnut flour.
   b. Providing alternative local food ingredients that influence on total cholesterol and triglyceride levels in diabetic dyslipidemia.

1.5 Authenticity Research

Table 1. Authenticity Research

Research Title	Type of Research	Variable	Results	Research Differences
The Effect of Suweg Flour (*Amorphophallus campanulatus*) Intervention on Cholesterol Levels in Wistar Strain White Rats with a Diabetes Mellitus Model[23]	Experimental with pre-post test with control group design	Dependent: Cholesterol Level Independent: Suweg flour doses of 1.25 g/day and 2.5 g/day	Suweg flour (*Amorphophallus campanulatus*), at a dose of 2.5 gr/day, in male Wistar strain rats (Rattus norvegicus L.) was found to help reduce cholesterol levels under diabetic conditions.	Dependent Variable: Triglyceride Level Independent Variable: Formulation of Suweg Flour and Bambara Groundnut Flour Research Design: pre-post test with randomized control group design
The Effect of Suweg Flour (*Amorphophallus campanulatus*) on Triglyceride Levels in Wistar Strain White Rats with a Diabetes Mellitus Model[24]	Experimental with pre-post test with control group design	Dependent: Triglyceride Levels Independent: Suweg flour dose of 1.25 g/day and 2.5 g/day	Suweg flour (*Amorphophallus campanulatus*), at a dose of 2.5 gr/day, was found to reduce triglyceride levels in a white Wistar rats model diabetes mellitus.	Dependent Variable: Triglyceride Level Independent Variable: Formulation of Suweg Flour and Bambara Groundnut Flour Research Design: pre-post test with randomized control group design
The Effect of a Mixed Formula of Red Bean Flour (*Phaseolus vulgaris*) and Breadfruit Flour (*Artocarpus communis*) on Blood Lipid Profile in Streptozotocin-Nicotinamide (STZ-NA)-Induced Diabetic Rats[25]	Experimental with pre-post test with control group design	Dependent: Lipid Profile Independent: Mixed Formulas of Red Bean Flour and Breadfruit Flour 75%:25%; 50%:50%; 25%:75%.	The mixed formula of red bean flour and breadfruit flour, at a ratio of 75%: 25%, can be developed as a food alternative for individuals with diabetes mellitus accompanied by dyslipidemia.	Dependent Variable: Triglyceride Level Independent Variable: Formulation of Suweg Flour and Bambara Groundnut Flour Research Design: pre-post test with randomized control group design

[23] Almira, Pengaruh Pemberian Tepung Suweg (Amorphophallus Campanulatus) Terhadap Kadar Kolesterol Pada Tikus Putih Galur Wistar Model Diabetes Melitus.

[24] Salsabila, Pengaruh Tepung Umbi Suweg (Amorphophallus campanulatus) Terhadap Kadar Trigliserid Pada Tikus Putih Galur Wistar Model Diabetes Melitus.

[25] Mega Nurdini, Pengaruh Pemberian Formula Campuran Tepung Kacang Merah (Phaseolus Vulgaris) Dan Tepung Sukun (Artocarpus Communis) Terhadap Profil Lipid Darah Pada Tikus Diabetes Yang Diinduksi Streptozotosin – Nikotinamid (STZ-NA) (skripsi, Poltekkes Kemenkes Yogyakarta, 2021), https://poltekkesjogja.ac.id.

Research Title	Type of Research	Variable	Results	Research Differences
The Role of Mung Bean Sprouts (Phaseolus radiatus L) in Retroperitoneal Fat Cells of Sprague Dawley Rats Fed a High-Fat Diet[26]	Experimental with post-test with control group	Dependent: Retroperitoneal Fat Cells Independent: Mung bean sprouts doses of 1.34g and 0.67g	Effect of mung bean sprouts on the reduction retroperitoneal fat cell diameter	Dependent Variable: Triglyceride Level Independent Variable: Formulation of Suweg Flour and Bambara Groundnut Flour Research Design: pre-post test with randomized control group design
The Administration of Soybean Sprouts on Malondialdehyde (MDA) and Superoxide Dismutase (SOD) Levels in Hypercholesterolemic Sprague Dawley Rats[27]	Experimental with post-test only with control group	Dependent: MDA and SOD levels Independent: Black rice bran extract doses of 0.53g; 1.06g; and 2.12g	Prevention of increased MDA levels and enhancement of SOD levels at a dose of 2.12g	Dependent Variable: Triglyceride Level Independent Variable: Formulation of Suweg Flour and Bambara Groundnut Flour Research Design: pre-post test with randomized control group design

[26] Dwi Lestari et al., Peran kecambah kacang hijau (Phaseolus radiatus (L.)) pada sel lemak retroperitoneal tikus Sprague Dawley yang diberi diet tinggi lemak, *Jurnal Gizi Klinik Indonesia* 16, no. 1 (July 27, 2019): 31, https://doi.org/10.22146/ijcn.41676.

[27] Monikasari Monikasari et al., Pengaruh Pemberian Ekstrak Bekatul Beras Hitam (Oryza Sativa L. Indica) Terhadap Kadar MDA, SOD Dan Trigliserida Pada Tikus Diabetes Mellitus Tipe 2, *AcTion: Aceh Nutrition Journal* 8, no. 1 (March 25, 2023): 129–38.