

# CHAPTER I

## INTRODUCTION

### 1.1. Background

Type 2 Diabetes Mellitus (T2DM) was one of the global health issues with a significantly increasing prevalence. The International Diabetes Federation (IDF) reported in 2021 that 10.5% of the population, equivalent to 537 million adults aged 20–79 years, are living with diabetes, and this number is projected to rise by 46% by 2045.<sup>1</sup> Based on the Indonesian Health Survey 2023 results, the prevalence of DM in Indonesia among individuals aged  $\geq 15$  years reached 11.7%.<sup>2</sup>

Insulin dysfunction in individuals with T2DM affects how the body processes and eliminates lipids in the blood, known as lipoproteins. As a result, lipid production decreases while lipid breakdown increases in adipose tissue. Excessive lipid breakdown leads to elevated blood cholesterol levels, causing a condition known as dyslipidemia.<sup>3</sup> The prevalence of dyslipidemia in DM patients reaches 91.4%. Dyslipidemia causes lipotoxicity and glucotoxicity, characterized by decreased levels of High-Density Lipoprotein (HDL) and increased levels of Low-Density Lipoprotein (LDL).<sup>4,5,6</sup>

One way to lower blood cholesterol levels is to reduce modifiable risk factors, such as diet, through changes in nutrient intake. Fiber can help

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<sup>1</sup> IDF, "Diabetes around the World," *IDF Diabetes Atlas 10th Edition*, 2021.

<sup>2</sup> Kemenkes RI, "Prevalensi, Dampak, Serta Upaya Pengendalian Hipertensi & Diabetes Di Indonesia," 2023, 1–3, <https://www.badankebijakan.kemkes.go.id/hasil-ski-2023/>.

<sup>3</sup> Abrar Naufal Hidayatullah *et al.*, "Hubungan Antara Dislipidemia Dengan Diabetes Melitus Tipe 2 Di Rumah Sakit Ibnu Sina Makassar," *Fakumi Medical Journal* 2, no. 9 (2022): 668–77, <http://103.133.36.76/index.php/fmj/article/view/122%0Ahttp://103.133.36.76/index.php/fmj/article/download/122/110>.

<sup>4</sup> Ziad A Bataineh *et al.*, "Prevalence and Pattern of Dyslipidemia and Its Associated Factors Among Patients with Type 2 Diabetes Mellitus in Jordan: A Cross-Sectional Study," *International Journal of General Medicine* 15, no. September (2022): 7669–83, <https://doi.org/10.2147/IJGM.S377463>.

<sup>5</sup> Subarna Dhoj Thapa *et al.*, "Dyslipidemia in Type 2 Diabetes Mellitus," *Journal of Pathology of Nepal* 7, no. 2 (2017): 1149–54, <https://doi.org/10.3126/jpn.v7i2.17978>.

<sup>6</sup> Renato Quispe *et al.*, "Total Cholesterol/HDL-Cholesterol Ratio Discordance with LDL-Cholesterol and Non-HDL-Cholesterol and Incidence of Atherosclerotic Cardiovascular Disease in Primary Prevention: The ARIC Study," *European Journal of Preventive Cardiology* 27, no. 15 (2020): 1597–1605, <https://doi.org/10.1177/2047487319862401>.

achieve this. Sinulingga's research (2020) shows fiber regulates blood lipid levels effectively. The study showed that fiber could increase HDL levels and lower LDL cholesterol. There were several types of fiber, including whole grains, tubers, fruits, and vegetables.<sup>7,8,9</sup> The recommended fiber intake for DM patients is 20-35 grams/per day.<sup>10,11</sup>

Local foods that can serve as alternative high-fiber sources include suweg tuber (*Amorphophallus paeoniifolius*) and bambara groundnut (*Vigna subterranea*). In 100 grams of fresh suweg tuber (*Amorphophallus paeoniifolius*), the fiber content reaches 1.4 grams, higher than Bogor taro, which contains 0.9 grams of fiber. Suweg tuber that has been processed into flour contains 13.58 grams of fiber.<sup>12,13</sup> Suweg tubers have a Glycemic Index (GI) value of less than 55, which is considered low. Based on research conducted by Kumalasari et al. (2022) on diabetic rats, food formulated with suweg tuber flour has the lowest glycemic index and can reduce blood glucose response.<sup>14,15</sup>

One type of legume that serves as a source of fiber is the bambara groundnut (*Vigna subterranea*). The fiber content in 100 grams of dried bambara groundnuts reaches 26.3 grams, higher than dried mung beans with

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<sup>7</sup> Lestar Reni Purnama Indah, Harna, and Novianti Anugrah, "The Relationship of Consumption Pattern, and Level of Fiber Adequacy, with Total Cholesterol Levels Heart Polyclinic Patients," *Jurnal Gizi Dan Kuliner* 1 (2020): 64–71.

<sup>8</sup> Brigitta Olivia Sinulingga, "Pengaruh Konsumsi Serat Dalam Menurunkan Kadar Kolesterol," *Jurnal Penelitian Sains* 22, no. 1 (2020): 9–15, <https://doi.org/10.26554/jps.v22i1.556>.

<sup>9</sup> Ghavami Abed et al., "Soluble Fiber Supplementation and Serum Lipid Profile: A Systematic Review and Dose-Response Meta-Analysis of Randomized Controlled Trials," *American Society for Nutrition* 14, no. 3 (2023): 465–74.

<sup>10</sup> Aman Andi et al., *Panduan Pengelolaan Dislipidemia Di Indonesia 2021* (PB PERKENI, 2021).

<sup>11</sup> Soelistijo Soebagijo Adi, *Pedoman Pengelolaan Dan Pencegahan Diabetes Melitus Tipe 2 Dewasa Di Indonesia 2021, Global Initiative for Asthma* (PB PERKENI, 2021), [www.ginasthma.org](http://www.ginasthma.org).

<sup>12</sup> Putu Ayu Gaudiya Waisnawi, Ni Luh Ari Yusasrini, and Putu Timur Ina, "Pengaruh Perbandingan Tepung Suweg (*Amorphophallus Campanulatus*) Dan Tepung Kacang Hijau (*Vigna Radiata*) Terhadap Karakteristik Cookies," *Jurnal Ilmu Dan Teknologi Pangan (ITEPA)* 8, no. 1 (2019): 48, <https://doi.org/10.24843/itepa.2019.v08.i01.p06>.

<sup>13</sup> Kementerian Kesehatan RI, *Tabel Komposisi Pangan Indonesia*, vol. 2 (Jakarta: Kementerian Kesehatan Indonesia, 2017), <https://doi.org/10.29103/averrous.v2i2.412>.

<sup>14</sup> Gafrila Fani et al., "Aktivitas Anti Obesitas Tepung Umbi Suweg (*Amorphophallus paeoniifolius*) Pada Model Tikus Obesitas," *Usadha* 1, no. 3 (2022): 301–13.

<sup>15</sup> Ika Dyah Kumalasari et al., "Pengembangan Produk Mi Suweg–Bekatul Rendah Indeks Glikemik Bagi Penderita Diabetes Melitus," *Indonesian Journal of Human Nutrition* 9, no. 1 (2022): 90–102, <https://doi.org/10.21776/ub.ijhn.2022.009.01.9>.

5.7 grams of fiber and dried soybeans with 3.2 grams of fiber. Bambara groundnuts have a GI 66.1 and a Glycemic Load (GL) 1.33. Bambara groundnut flour contains carbohydrates consisting of starch and dietary fiber, with a dietary fiber content of 17.81 grams. Based on a study by Mohammed et al (2021), Bambara groundnuts have good potential for blood glucose management in diabetic patients.<sup>16,17,18,19</sup>

In the Qur'an, Al-Baqarah verse 61, Allah says, which means: "*And recall when you said, "O Moses, we cannot endure one kind of food, so call to your Lord to produce for us of what the earth grows: of its herbs, and its cucumbers, and its garlic, and its lentils, and its onions."* (QS. Al-Baqarah: 61).<sup>20</sup>

The verse explains the ingratitude of the Bani Israil, who asked the Prophet Musa to give them several types of food because they could not survive on one type. Allah SWT commands humans to be grateful for their blessings, including food, and to pay attention to halalness, nutritional value, and food safety. This verse also reminds humans that they are grateful for what Allah has given them in the form of several foods and not to waste the benefits and values contained therein.

Therefore, the author is interested in conducting further scientific research to analyze the effect of suweg tuber flour (*Amorphophallus Paeoniifolius*) and bambara groundnut flour (*Vigna subterranea*) formulation on HDL and LDL levels study on Sprague Dawley diabetic dyslipidemia.

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<sup>16</sup> Rizki Maryam Astuti *et al.*, "Karakterisasi Fisiko-Kimia Biji Dan Kulit Ari Kacang Bogor Asal Jampang-Sukabumi Jawa Barat," *Jurnal Teknologi Dan Industri Pangan* 33, no. 2 (2022): 178–88, <https://doi.org/10.6066/jtip.2022.33.2.178>.

<sup>17</sup> Kementerian Kesehatan RI, *Tabel Komposisi Pangan Indonesia*.

<sup>18</sup> Chiemela Enyinnaya *et al.*, "Heliyon Physicochemical Properties , in Vitro Digestibility , Antioxidant Activity and Consumer Acceptability of Biscuits Prepared from Germinated Fi Nger Millet and Bambara Groundnut Fl Our Blends," *Heliyon* 8, no. April (2022): e10849, <https://doi.org/10.1016/j.heliyon.2022.e10849>.

<sup>19</sup> Mohammed Abdulrashid and Daniel Mhya Hassan, "Evaluation of Phytochemical Constituents, Proximate Contents and Glycemic Index of Bambara Groundnut (*Vigna Subterranea* L. Verdc) Varieties Grown in Northeastern Nigeria," *African Journal of Biochemistry Research* 15, no. 2 (2021): 22–27, <https://doi.org/10.5897/ajbr2021.1120>.

<sup>20</sup> Kementerian Agama Republik Indonesia, "QS. Al-Baqarah: 61," Qur'an Kemenag, accessed February 23, 2024, <https://quran.kemenag.go.id/quran/per-ayat/surah/2?from=61&to=286>.

## 1.2. Research Problem

The formulation of the problem in this study is:

Is there an effect of suweg tuber flour (*Amorphophallus paeoniifolius*) and bambara groundnut flour (*Vigna subterranea*) formulation on HDL and LDL levels in diabetic dyslipidemia rats?

## 1.3. Research Objectives

### 1. General Purpose

This study was conducted to analyze the differences in the effects of feeding a formulation of suweg tuber flour (*Amorphophallus paeoniifolius*) and bambara groundnut flour (*Vigna subterranea*) on HDL and LDL levels in diabetic dyslipidemia rats.

### 2. Special Purpose

- a. To analyze the effect of feeding a formulation of suweg tuber flour (*Amorphophallus paeoniifolius*) and bambara groundnut flour (*Vigna subterranea*) on HDL levels in diabetic dyslipidemia rats before and after the intervention.
- b. To analyze the effect of feeding a formulation of suweg tuber flour (*Amorphophallus paeoniifolius*) and bambara groundnut flour (*Vigna subterranea*) on LDL levels in diabetic dyslipidemia rats before and after the intervention.
- c. To analyze the differences in the effects of feeding a formulation of suweg tuber flour (*Amorphophallus paeoniifolius*) and Bambara groundnut flour (*Vigna subterranea*) on HDL levels in diabetic dyslipidemia rats between treatment groups.
- d. To analyze the differences in the effects of feeding a formulation of suweg tuber flour (*Amorphophallus paeoniifolius*) and Bogor bean flour (*Vigna subterranea*) on LDL levels in diabetic dyslipidemia rats between treatment groups.
- e. To analyze the formulation of suweg tuber flour (*Amorphophallus paeoniifolius*) and bambara groundnut flour (*Vigna subterranea*) that significantly affects HDL and LDL levels in diabetic dyslipidemia rats.

## **1.4. Research Benefits**

### **1. Theoretical Benefits**

The results of this study are expected to increase scientific insight and provide insight to readers about the effect of feeding suweg tuber flour (*Amorphophallus paeoniifolius*) and bambara groundnut flour (*Vigna subterranea*) formulations on HDL and LDL levels in diabetic dyslipidemia rats.

### **2. Practical Benefits**

#### **a. For Researches**

The results of this study are expected to be the basis for further research aimed at developing more effective local food-based nutritional interventions in managing lipid disorders in patients with T2DM. In addition, this study is expected to be applied to humans as a more natural and affordable alternative therapy to prevent and manage dyslipidemia in diabetes patients.

#### **b. For Educational Institutions**

This research is expected to be used as a reference source/initial reference for developing research to be carried out.

#### **c. For the Community**

This research is expected to be as a reference in providing food formulas and food diversification.

## **1.5. Originality of Research**

This study is based on previous studies with similar themes. However, there are specific differences in several aspects, such as subject/sample criteria, types of objects, number and research variables, and the analysis methods applied. As with several previous studies seen in Table 1.

Table 1. Authenticity Research

Research Title	Research Design	Variable	Result	Research Differences
The Effect of Suweg ( <i>Amorphophallus campanulatus</i> ) Tuber Flour on Triglyceride Levels in Wistar Strain White Rats Modeling Diabetes Mellitus <sup>21</sup>	Experimental pre-post test control group design	Independent: Effect of Suweg ( <i>Amorphophallus campanulatus</i> ) Tuber Flour  Dependent: Triglyceride Levels	There was a significant difference in pre-test and post-test triglyceride levels and a mean difference in all treatment groups.	Independent: Combination of Suweg Tuber Flour and Bambara groundnut Flour  Dependent: HDL and LDL Levels
The Effect of Giving Red Bean Flour ( <i>Phaseolus vulgaris</i> ) and Breadfruit Flour ( <i>Artocarpus communis</i> ) Formula on Blood Lipid Profiles in Streptozotocin-Nicotinamide (STZ-NA) Induced Diabetic Rats <sup>22</sup>	Experimental pre-post test control group design	Independent: Effect of Giving Red Bean Flour Formula ( <i>Phaseolus vulgaris</i> ) and Breadfruit Flour ( <i>Artocarpus communis</i> )  Dependent: Blood Lipid Profile	There was a significant difference between the levels of lipid profiles (total cholesterol, LDL, HDL, and triglycerides) in the five experimental groups with a p-value of 0.000 (p < 0.05). Furthermore, each experimental group's paired t-test pre-test and post-test showed a significant difference in lipid profile levels.	Independent: Combination of Suweg Tuber Flour and Bambara groundnut Flour  Dependent: HDL and LDL Levels

<sup>21</sup> Salsabila Sajidah, "Pengaruh Tepung Umbi Suweg (*Amorphophallus Campanulatus*) Terhadap Kadar Triglisierid Pada Tikus Putih Galur Wistar Model Diabetes Melitus" (Universitas Muhammadiyah Yogyakarta, 2020), <https://etd.umy.ac.id/id/eprint/2444/>.

<sup>22</sup> Mega Nurdini, Agus Wijanarka, and Almira Sitasari, "Pengaruh Pemberian Formula Campuran Tepung Kacang Merah (*Phaseolus Vulgaris*) Dan Tepung Sukun (*Artocarpus Communis*) Terhadap Profil Lipid Darah Pada Tikus Diabetes Yang Diinduksi Streptotosin-Nikotinamid (STZ-NA)" (Poltekkes Kemenkes Yogyakarta, 2021), <http://eprints.poltekkesjogja.ac.id/6372/>.



Research Title	Research Design	Variable	Result	Research Differences
Effect of Giving Processed Soybean Products on Fasting Blood Glucose and Insulin Resistance in a Rat Model of Diabetes Mellitus <sup>23</sup>	Experimental	Independent: The Effect of Giving Processed Soybean Products  Dependent: Fasting Blood Glucose and Insulin Resistance	The administration of processed soybeans, such as tempeh, tofu, and soybean flour, significantly improves fasting blood glucose levels and insulin resistance in a streptozotocin-induced DM rat model.	Independent: Combination of Suweg Tuber Flour and Bambara groundnut Flour  Dependent: HDL and LDL Levels
Antidyslipidemic Activity of Tempeh Flour and Soy Milk on Lipid Profile of Streptozotocin-Induced Diabetic Rats <sup>24</sup>	Post-test-only randomized controlled group trial.	Independent: Antidyslipidemic Activity of Tempeh Flour and Soy Milk  Dependent: Lipid Profile	The decrease in total cholesterol, triglyceride, and LDL levels in the group given tempeh flour showed significant results compared to the group given soy milk.	Independent: Combination of Suweg Tuber Flour and Bambara groundnut Flour  Dependent: HDL and LDL Levels
The Effect of Giving Fermented Red Beans with Dahlia Tubers Inulin Fortification on Cholesterol and Triglyceride Levels in Diabetes Mellitus Rats <sup>25</sup>	Experimental pre-post test control group design	Independent: The Effect of Giving Fermented Red Beans with Inulin Fortification to Dahlia Tubers  Dependent: Cholesterol and Triglyceride Levels	Fermented red beans and dahlia tuber inulin synergize in reducing cholesterol and triglyceride levels in Wistar rats induced by diabetes mellitus.	Independent: Combination of Suweg Tuber Flour and Bambara groundnut Flour  Dependent: HDL and LDL Levels

<sup>23</sup> Kendra Hosea *et al.*, "Pengaruh Pemberian Produk Olahan Kacang Kedelai Terhadap Glukosa Darah Puasa Dan Resistansi Insulin Pada Model Tikus Diabetes Melitus," *Medicinus* 35, no. 3 (2022): 11–16, <https://doi.org/10.56951/medicinus.v35i3.102>.

<sup>24</sup> Kartika Nugraheni and Siti Harnina Bintari, "Antidyslipidemic Activity of Tempe Flour and Soymilk on Lipid Profile in Streptozotocin-Induced Diabetic Rats," *Indonesian Journal of Nutrition and Dietetics* 4, no. 3 (2017): 147.

<sup>25</sup> Setyaningrum Nurul Fajriati, Perdana Samekto, and Fatma Zuhrotun Nisa', "Pengaruh Pemberian Kacang Merah Terfermentasi Dengan Fortifikasi Inulin Umbi Dahlia Terhadap Kadar Kolesterol Dan Trigliserida Tikus Diabetes Melitus" (2020), <https://etd.repository.ugm.ac.id/penelitian/detail/187435>.