

## The Influence of Dahlia Tubers Extract (*Dahlia Variabilis*) on Diabetic in Rats

Veni Dayu Putri<sup>1\*</sup>, Sri Yanti<sup>2</sup>, Fitri Dyna<sup>3</sup>, Saryono<sup>4</sup>, Ismawati<sup>5</sup>

<sup>1</sup>Bachelor's Degree Program in Nursing, Institut Kesehatan Payung Negeri Pekanbaru, Pekanbaru, Indonesia

\* Corresponding Author Email: [venidayu@gmail.com](mailto:venidayu@gmail.com) – ORCHID: [0000-0001-7097-7392](https://orcid.org/0000-0001-7097-7392)

<sup>2</sup>Bachelor's Degree Program in Nursing, Institut Kesehatan Payung Negeri Pekanbaru, Pekanbaru, Indonesia

Email: [sri.yanti@payungnegeri.ac.id](mailto:sri.yanti@payungnegeri.ac.id) – ORCHID: [0000-0002-8098-4243](https://orcid.org/0000-0002-8098-4243)

<sup>3</sup>Nursing Professional Program, Institut Kesehatan Payung Negeri Pekanbaru, Pekanbaru, Indonesia

Email: [fitridyna1781@gmail.com](mailto:fitridyna1781@gmail.com) – ORCHID: [0000-0002-1933-9480](https://orcid.org/0000-0002-1933-9480)

<sup>4</sup>Study Program of Chemistry, Faculty of Mathematics and Natural Science, Universitas Riau, Pekanbaru, Indonesia

Email: [saryono@lecturer.unri.ac.id](mailto:saryono@lecturer.unri.ac.id) – ORCHID: [0000-0002-7813-1364](https://orcid.org/0000-0002-7813-1364)

<sup>5</sup>Faculty of Medicine, Universitas Riau, Pekanbaru, Indonesia

Email: [ismawati75@yahoo.com](mailto:ismawati75@yahoo.com) – ORCHID: [0000-0003-0742-2719](https://orcid.org/0000-0003-0742-2719)

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### Abstract:

Diabetes mellitus is a chronic metabolic problem disease defined by hyperglycemia that is recognized as a silent killer and the mother of the disease, causing complications and endangering health. Inulin is a natural fiber found in dahlia tubers (*dahlia variabilis*) that functions as a dietary fiber and is suitable for diabetics to consume. The purpose of this study was to see how inulin from dahlia tubers affects blood glucose levels in diabetic rats. The rats were randomized into five groups at random: normal control, STZ-induced diabetic, STZ-induced diabetic with inulin (0.5 mg/g BW), STZ-induced diabetic with inulin (1.0 mg/g BW), and STZ-induced diabetes (1.5 mg/g BW). Before and after treatment, rats' blood glucose levels were assessed. This study discovered that inulin doses of 0.5mg/g BW, 1.0mg/g BW, and 1.5mg/g BW lowered rats' fasting blood glucose levels. When compared to the other treatment groups, the rats administered inulin at a dose of 1.5mg/g BW demonstrated the most significant drop in fasting blood glucose levels ( $p < 0.05$ ). The reduction in fasting blood glucose levels of rats in the treatment group was accompanied by a substantial reduction in body weight compared to the normal control group ( $p < 0.05$ ) at the end of the treatment. From the study, it was found that administration of inulin from dahlia tuber extract at a dose of 1.5 mg/g BW could significantly reduce blood glucose levels and body weight in diabetic rats.

## 1. Introduction

Diabetes mellitus (DM) is a group of symptoms caused by a malfunction in the body's management of blood sugar levels. These conditions are characterized by either insufficient insulin production or impaired insulin activity (insulin resistance), or a combination of the two, resulting in hyperglycemia (1). Diabetes is widely described as a silent killer because its early stages are often asymptomatic, leading many individuals to remain undiagnosed and to receive delayed treatment, which in turn predisposes them to serious complications.

Moreover, diabetes underlies multiple chronic conditions—including hypertension, cardiovascular and cerebrovascular disease, chronic kidney failure, and diabetic retinopathy—so it is frequently regarded as a major root cause of many other diseases (2, 3). If left uncontrolled, it might lead to further complications that risk one's health. A diabetes is one of the world's fastest-growing health concerns and the leading cause of morbidity in both developing and developed countries. The global prevalence of diabetes continues to rise, affecting an estimated 589 million adults aged 20–79 years (11.1% of this age

group) in 2024. Projections indicate a 45% increase to 853 million people by 2050 (4). According to the International Diabetes Federation (IDF), Indonesia ranks fifth globally with 20.4 million adults aged 20–79 years living with diabetes in 2024, projected to rise to 28.6 million by 2050 (5). Dahlia (*Dahlia* spp.) is a tuberous perennial plant from the Asteraceae (formerly Compositae) family, widely cultivated for ornamental and food uses. The tubers contain high levels of inulin, accounting for 72.48–84.08% of total carbohydrates, positioning it as a promising source for prebiotic functional foods. Inulin is a macromolecule composed of fructose units linked by  $\beta$ -(1-2) D-fructosyl-fructose bonds that usually terminate with only one glucose and can be utilized as a sugar or fat alternative due to its low-calorie content (6). Inulin is classified as a fructan fiber, resistant to human digestive enzymes and thus serving as a soluble dietary fiber and prebiotic fermented by gut microbiota. Both inulin and fructo-oligosaccharides (FOS) promote beneficial bacteria such as *Bifidobacterium* and *Faecalibacterium prausnitzii*, yielding short-chain fatty acids (SCFAs) that support blood glucose reduction, enhanced insulin sensitivity, improved lipid profiles, immune modulation, and increased mineral absorption including vitamins. As non-absorbable carbohydrates, they contribute to colon cancer prevention via microbiota modulation and bioactive metabolite production like butyrate. (7). Inulin demonstrates excellent tolerability among diabetics due to its low caloric content and capacity to foster beneficial gut flora such as *Bifidobacterium* and *Lactobacillus*, thereby alleviating insulin resistance and enhancing glucose sensitivity. It also addresses digestive issues like constipation through healthy gut fermentation while providing broader health benefits, including glycemic control and reduced systemic inflammation in prediabetic or obese individuals (8). Research has examined inulin from plants like chicory, Jerusalem artichoke, and dahlia as a functional food ingredient for its prebiotic and structuring properties. Clinical trials also support its benefits for diabetics, improving insulin sensitivity and reducing kidney damage in type 2 diabetes (9–11). However, only a little information on how inulin from dahlia tubers affects blood glucose levels and body weight in diabetics. The purpose of this study was to determine how inulin from dahlia tubers affected the blood glucose levels and body weight of Streptozotocin (STZ)-induced wistar Wistar rats.

## 2. Materials and Methods

### 2.1 Inulin extract

The object of this study is inulin, which is derived from dahlia bulbs (*dahlia variabilis*). Dahlia bulbs are harvested from fresh dahlia plants in Bukittinggi, West Sumatra Province. Dahlia tuber extraction was performed to get inulin, which was then administered to diabetic rats as an intervention and their blood glucose levels were examined. The extraction begins by boiling 2500 g of fresh dahlia tubers that have been cleaned and finely sliced in 5000 ml of distilled water for 30 minutes at 80°- 90°C. It should be allowed to cool to room temperature before filtering the resultant filtrate and residue. The filtrate was chilled at 4°C for 18 hours after being mixed with ethanol in a 1:1 (v/v) ratio. The filtrate was then centrifuged at 3500 rpm for 10 minutes and a white precipitate of inulin was obtained. The white precipitate was dried at 60°C until dry and yellowish-white dry inulin was obtained (12).

### 2.2 Animals

Healthy male Wistar rats with an average weight of 150–200 g were obtained from the STIFAR Experimental Animal Laboratory in Riau (Indonesia). At the Riau STIFAR Experimental Animal Laboratory, rats were housed in cages in a room with good ventilation settings, a temperature of 22±2°C, humidity of 60±10%, and a light-dark cycle of 12 hours each. During the study, the animals are given a conventional pellet meal and allowed to drink ad libitum.

### 2.3 Trial procedure

This experimental study employed a pretest-posttest control group design using 25 male Wistar rats randomly assigned to 5 groups (n=5/group). Male rats were selected due to their pathophysiological similarities to human diabetes, including reduced insulin sensitivity and response to glucose challenge, leading to insulin resistance. (13,14). Rats were acclimated for 7 days (daily cage cleaning, sawdust changed every 3 days). After 12-hour fasting, diabetes was induced by single IP STZ injection (60 mg/kg BW in 0.1M citrate buffer pH 4.5), followed 15 min later by NA (120 mg/kg BW) (15,16). After 72 hours, blood glucose was measured via tail vein glucometer; rats >250 mg/dL were confirmed diabetic and received oral inulin gavage for 21 days (16,17). Rats were divided into 5 groups: normal control group, STZ-induced diabetic group, STZ-induced diabetic group, STZ-induced diabetic group treated inulin (0.5 mg/g BB), STZ-induced diabetic group treated inulin (1.0 mg/g BB) and STZ-induced diabetic treated inulin (1.5 mg/g BB).

## 2.4 Weight weighing, blood sampling, and blood glucose level measurement

The rats were weighed eight times: on day 0 (before induction), and day 3 (baseline when the rat was certified diabetic), followed by the intervention on days 6, 9, 12, 15, 18th, and 21. The blood was taken three times: before induction, after induction, and after treatment. Before the blood sample, rats were fasted for 12 hours. Following ketamine anesthesia, a 1 mL blood sample was obtained through a vein in the right or left eye. For 10 minutes, blood was centrifuged at 3000 rpm. The serum portion was evaluated for blood glucose levels using a Mindray BA-88A photometer and the measurement parameters on the Mindray insert kit.

## 2.5 Statistical analysis

Data were analyzed using SPSS 25.0 (SPSS, Inc., Armonk, NY, United States) with a one-way analysis of variance (ANOVA) statistical test and followed by post hoc analysis to determine which groups had significant differences against other groups. All data are presented as mean and standard deviation (SD) with a p-value of 0.05. Adobe Photoshop was used to display the image (Adobe Software, San Diego, CA, United States).

## 2.6 Ethical approval

This study has received ethical approval from the Health Research Ethics Committee of the Perintis Indonesia University Number: 206/KEPK.F2/ETIK/2021. In accordance with the Regulation of the Food and Drug Supervisory Agency Number 18 of 2021, every test using animals must obtain an ethical clearance from the Ethics Commission (18).

## 3. Results

STZ induction of 60mg/kg BW significantly increased fasting blood glucose levels in rats compared to normal control rats, which was more than 250mg/dL according to the cut point used in this study. After 21 days of treatment, fasting blood glucose levels of diabetic rats were significantly higher than all groups ( $p < 0.05$ ). The group of rats given inulin doses of 0.5mg/g BW, 1.0mg/g BW and 1.5mg/g BW obtained fasting blood glucose levels lower than the diabetes control group ( $p < 0.05$ ) however it is higher than the normal control group ( $p < 0.05$ ). Dealing with the three treatment groups, the group of rats administered inulin at a dose of 1.5 mg/g BW significantly

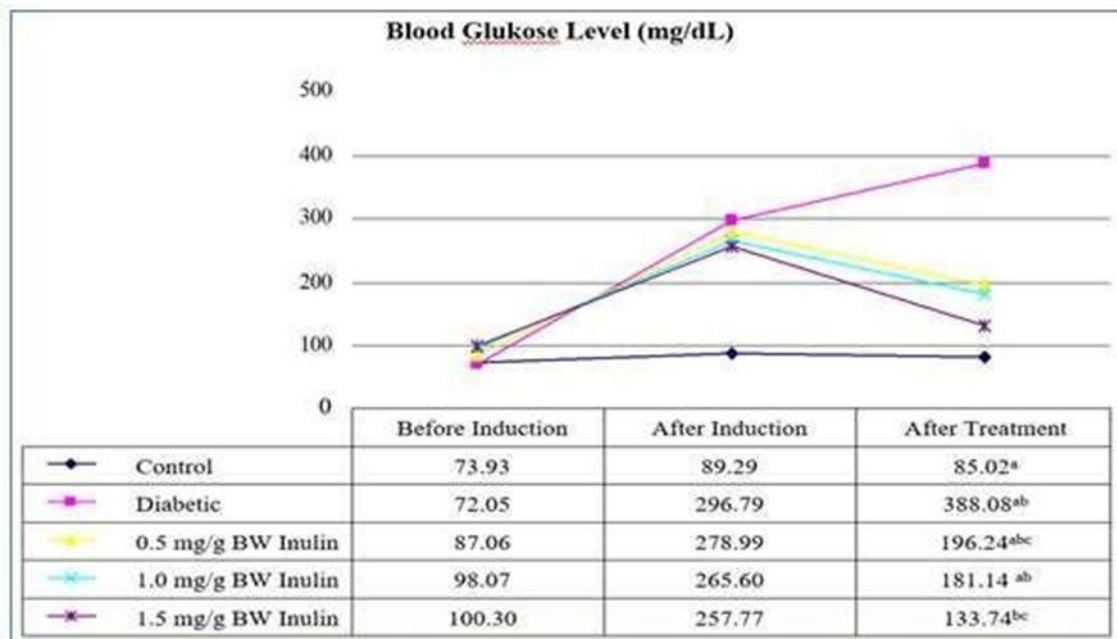
showed the most significant reduction in fasting blood glucose levels at the end of the treatment period (Figure 1). After the rats were induced by STZ, on the 3rd day the rats were weighed and there was a decrease in body weight except for the normal control rat group ( $p < 0.05$ ). In normal control group rats gained weight until day 15 and after that they experienced weight loss until day 21. In contrast to the rats in the diabetes control group and the treatment group, until the 9th day there was weight loss, the 12th day there was an increase in body weight and on the 18th and 21st days there was a significant weight loss ( $p < 0.05$ ) (Figure 2).

## 4. Discussion

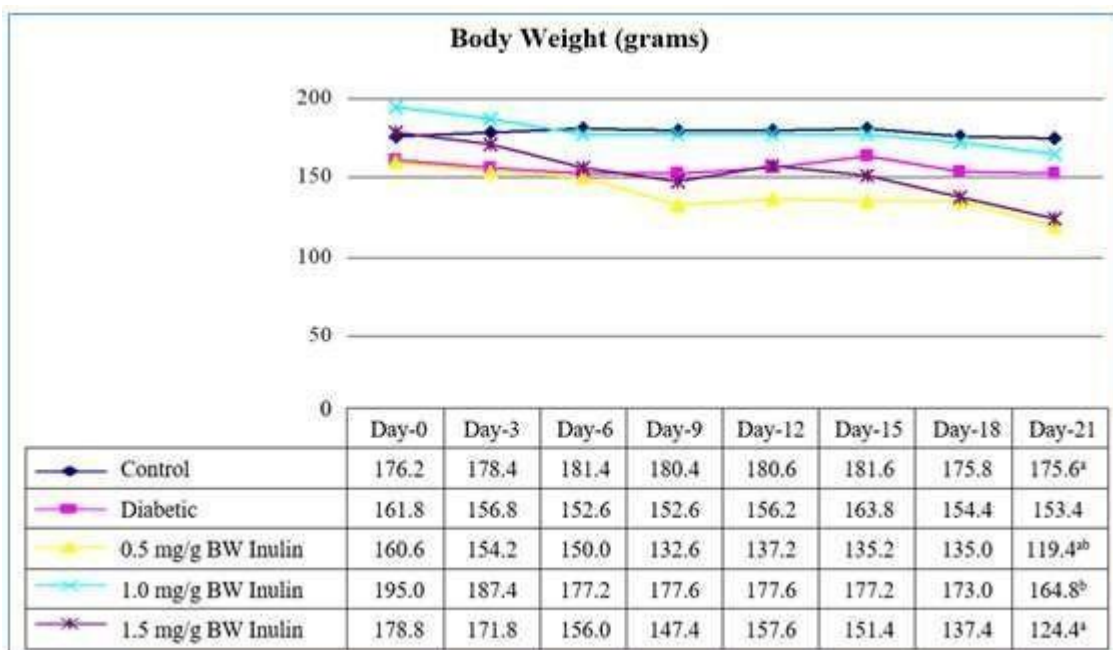
Intraperitoneal administration of streptozotocin at 60 mg/kg body weight significantly elevated fasting blood glucose ( $p < 0.05$ ) by selectively entering pancreatic  $\beta$ -cells via GLUT2, causing DNA alkylation, NAD<sup>+</sup> depletion, and inhibition of glucose oxidation. This disrupted insulin biosynthesis/secretion, leading to hypoinsulinemia, hyperglycemia, and peripheral insulin resistance through downregulated receptor signaling in muscle/adipose tissue. The model effectively mimics type 2 diabetes pathophysiology for testing interventions like inulin (15,19). STZ disrupts glucose homeostasis through three key mechanisms: (1) blunting the first-phase insulin response, delaying secretion and failing to control postprandial glucose spikes; (2) reducing insulin sensitivity to glucose, resulting in hyperglycemia; and (3) impairing adequate insulin secretion in response to glycemic stimuli (15,20). Dahlia tubers (*Dahlia variabilis*), commonly used as ornamental plants, serve as a rich natural source of inulin starch, recognized as a functional food ingredient with proven health benefits. Studies confirm inulin's physiological effects, including glycemic stability through delayed glucose absorption, modulation of intestinal microflora via selective fermentation by beneficial bacteria (*Bifidobacterium/Lactobacillus*), and reduction of serum cholesterol/triglycerides by inhibiting lipid synthesis and enhancing SCFA production. Inulin from local dahlia tubers (*Dahlia variabilis*) demonstrates promising antidiabetic potential through its established physiological effects on glycemic regulation and gut microbiota modulation. In this study, oral administration of inulin at doses of 0.5, 1.0, and 1.5 mg/g BW to STZ-NA induced diabetic Wistar rats significantly reduced fasting blood glucose levels after 21 days compared to diabetic controls ( $p < 0.05$ ). The highest dose (1.5 mg/g BW) yielded the most pronounced effect, lowering glucose to 133.74 mg/dL—within

the normal physiological range for rats (50-135 mg/dL)—suggesting dose-dependent efficacy and potential for functional food development. These findings align with inulin's mechanisms of delayed carbohydrate absorption and enhanced insulin sensitivity (21). Aliasgharzadeh et., al from their research revealed that giving 10 g of inulin supplement daily for 8 weeks was able to increase the glycemic index, lipid profile, and reduce MDA concentrations in type 2 DM patients (22). Several studies have shown that Soluble fibers like inulin attenuate postprandial glycemia by delaying gastric emptying, slowing glucose absorption, and

blunting serum glucose excursions. Colonic fermentation of inulin yields SCFAs and stimulates GLP-1 secretion, enhancing insulin secretion and glucose homeostasis. Oligofructose further improves glucose tolerance by elevating GLP-1, plasma/pancreatic insulin,  $\beta$ -cell mass, and GLP-2 levels (23,24). Diabetic rats (day 3 post-induction) exhibited significant body weight loss compared to normal controls ( $p < 0.05$ ). STZ-induced hyperglycemia and hypoinsulinemia promote muscle wasting and protein catabolism through increased gluconeogenesis, lipolysis, and ubiquitin-proteasome pathway activation, resulting in reduced body mass (25,26). The pancreas normally secretes insulin to



**Figure 1.** Blood glucose levels of rats between groups. *a* The treatment group was compared with the normal control group,  $p < 0.05$ ; *b* The treatment group was compared with the diabetes control group,  $p < 0.05$ ; *c* The treatment group was compared with the treatment group,  $p < 0.05$ , the results of the post hoc ANOVA analysis



**Figure 2.** Body weight of rats between groups. *a* The treatment group was compared with the normal control group,  $p < 0.05$ ; *b* The treatment group was compared with the treatment group,  $p < 0.05$ , the results of post hoc ANOVA

facilitate cellular glucose uptake and energy production, but in diabetes,  $\beta$ -cell dysfunction and insulin resistance impair this process, leading to persistent hyperglycemia. To compensate for inadequate glucose utilization, the body accelerates lipolysis and subsequently proteolysis, mobilizing fat and skeletal muscle protein as alternative energy substrates, which manifests clinically as progressive weight loss. Accordingly, weight reduction observed in diabetic rats reflects underlying pancreatic damage and the resultant catabolic state driven by insulin deficiency and resistance (27,28). Treatment groups exhibited significant weight loss by day 21 ( $p < 0.05$ ). The American Diabetes Association endorses weight reduction, exercise, and reduced high-calorie intake as cornerstone strategies for glycemic control. In this study, rats receiving 1.5 mg/g BW inulin achieved normal blood glucose alongside body weight reduction, consistent with clinical evidence that inulin supplementation promotes weight loss in type 2 diabetes patients through enhanced satiety, gut hormone modulation, and reduced energy intake (29). Regarding the results of this study, it can be concluded that inulin from dahlia tuber extract at a dose of 1.5 mg/g BW can control blood glucose levels and body weight of diabetic rats. Hence, inulin has the potential as a functional food that is useful as an antidiabetic and antiobesity.

### Author Statements:

- **Ethical approval:** Approved by Health Research Ethics Committee of Perintis Indonesia University (No: 206/KEPK.F2/ETIK/2021).
- **Conflict of interest:** The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.
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- **Data availability statement:** The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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