



The Role of Local Porang Glucomannan and Its Hydrolysate in Diabetes Mellitus Management: An Experimental Study on Rat

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Abstract. Diabetes Mellitus (DM) refers to a group of metabolic disorders marked by elevated blood glucose levels, which occur as a result of abnormalities in insulin production, its effectiveness, or a combination of both. Combination therapy for DM patients includes dietary intake and increased physical activity. Functional foods are known to be a beneficial food source for improving health. Porang Flour (GP) is a food source rich in glucomannan content, and its hydrolysis product (GPA) is claimed to be a prebiotic that, in sufficient quantities, can increase the population of beneficial gut microbiota and produce secondary metabolites beneficial to health. The effects of local porang glucomannan from East Kalimantan and GPA can be used as a therapeutic diet for diabetes. The study was conducted using a pre-test and post-test control group design, testing the efficacy of porang glucomannan through glucose loading and glucose level testing in mice. Glucose loading in mice was performed with four treatments in the control group, Porang flour (K2), Porang glucomannan flour (K3), and commercial glucomannan flour (K4), with a dose of 0.9 g/200g observed over 120 minutes. Meanwhile, the efficacy test was conducted by administering a diet to streptozotocin nicotinamide-induced diabetic mice. The diabetic mice were treated via sondage for 21 days, with GP and GPA diets in each group at doses of 100, 200, and 400 mg/kg BW. The result showed GPA2 with dose 200 mg/kg was found to reduce blood glucose levels. GPA2 treatment showed a potential therapeutic agent and additional alternative for lowering blood sugar levels in diabetes to prevent hyperglycemic condition.

Keywords: Blood glucose level, Porang Glucomannan, Kalimantan Timur

I. Introduction

Indonesia ranks seventh among the ten countries with the highest number of diabetes based on data from the International Diabetes Federation (IDF) sufferers, reaching 10.7 million people. This number is projected to continue rising to 13.7 million by 2030 and 16.6 million by 2045. Among the various types of diabetes mellitus (DM), type 2 (DMT2) is the most common, accounting for approximately 90% of all recorded diabetes cases [1]. Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder influ-

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enced by multiple factors. It involves disruptions in the normal processing of carbohydrates, fats, and proteins, resulting in elevated levels of sugar and lipids in the bloodstream [2]. Controlling body weight in individuals diagnosed with type 2 diabetes requires more than a single intervention. A coordinated, multidisciplinary strategy that brings together various aspects of healthcare is essential. This typically includes personalized nutrition plans, consistent physical activity, behavioral therapy, and, when necessary, medical treatments or surgical options. Such an all-encompassing approach has proven effective in improving glycemic balance and reducing the likelihood of metabolic-related health issues [3, 4]. Recent findings highlight that implementing a diet with a low glycemic index and glycemic load plays an important role in stabilizing blood sugar levels and supporting weight control in individuals with type 2 diabetes. This approach has proven to be an effective component of nutritional therapy for better diabetes management [5]. Numerous studies have demonstrated that konjac glucomannan (KGM), a soluble dietary fiber derived from *Amorphophallus konjac*, has promising antidiabetic properties. In vivo experiments using type 2 diabetic rats showed that KGM significantly reduced fasting blood glucose, plasma insulin levels, and oxidative stress by activating the Nrf2 pathway and suppressing NF- κ B-mediated inflammation, ultimately protecting hepatic and renal tissues from diabetic damage [2].

Konjac glucomannan (KGM), a soluble fiber from *Amorphophallus konjac*, has shown promise in supporting type 2 diabetes management [6]. Its ability to delay carbohydrate absorption helps reduce post-meal glucose spikes, while also lowering cholesterol. Studies report that KGM can improve blood glucose levels, insulin sensitivity, and inflammatory markers. Additionally, it modulates gut hormones and microbiota, making it a valuable complementary approach to diabetes care. A high-viscosity soluble fiber extracted from *Amorphophallus konjac*, is gaining recognition as a specialized therapeutic food for managing type 2 diabetes. Its viscosity-driven actions help slow gastric emptying and hinder carbohydrate absorption in the small intestine, effectively reducing post-meal blood glucose spikes and cholesterol uptake [7]. Additionally, replacing high-glycemic staples like white rice with konjac-based alternatives has been shown to reduce postprandial glycemic response without compromising satiety. Collectively, these findings support the role of KGM in improving glycemic control, reducing inflammation, and contributing to a healthier metabolic profile in individuals with type 2 diabetes. In clinical study based on regular intake of konjac-based foods has been shown to support better blood glucose control in individuals with type 2 diabetes [8]. During a 12-week intervention, participants who consumed konjac-based products on a daily basis showed significant decreases in fasting blood glucose and HbA1c levels. Despite the absence of changes in body weight, notable improvements were detected in several metabolic indicators, particularly an increase in adiponectin levels. These outcomes suggest that incorporating konjac into the daily diet may contribute positively to diabetes management without requiring changes in overall energy intake.

Studies in East Kalimantan show that porang harvested locally can yield glucomannan with up to 82.8% purity using water-based extraction techniques [9]. Porang tubers are naturally rich in glucomannan, a water-soluble dietary fiber known for its applications in food, pharmaceuticals, and health supplements particularly for weight management

and blood sugar control. Furthermore, in this study to evaluate local porang glucomannan of East Kalimantan as a therapeutic diet for diabetes on mice.

II. Methods

This study is laboratory-based experimental research with a pre- and post-test control group model. The subjects are randomly selected, assigned to treatment groups, and compared against a control group to measure the intervention's effectiveness [10]. The determination of the sample size was based on the Federer formula, expressed as $(t - 1)(n - 1) \geq 15$, in which t denotes the number of treatment groups and n indicates the number of subjects per group. In this research, five treatment groups ($t = 5$) were applied, and the minimum sample size was calculated according to the formula.

The minimum sample size was calculated using the Federer formula:

$$(t - 1)(n - 1) \geq 15$$

where t represents the number of treatment groups and n is the number of subjects in each group. In this study, there were five treatment groups ($t = 5$), thus:

$$(5 - 1)(n - 1) \geq 15 \Rightarrow 4(n - 1) \geq 15 \Rightarrow 4n \geq 19 \Rightarrow n \geq 4.75$$

Therefore, the minimum number of subjects required per group is rounded up to 5 to meet the statistical requirement. The result of the calculation is $\geq 19/4 = 4.75$, which means that each experimental group will include 5 white rats as test subjects.

Glucose Loading Test

A total of 25 mice were randomly divided into five groups, with each group consisting of five animals. Each group was housed in a separate cage, and the body weight of each mouse was recorded prior to treatment. Before glucose loading, the mice underwent fasting for 12–16 hours to stabilize blood glucose levels and eliminate any influence of recent food intake. Following the fasting period, a blood

sample was collected from the tail vein of each mouse to determine the baseline blood glucose concentration.

Afterward, a glucose solution at a dosage of 0.9 g per 200 g body weight was administered orally to all groups. Thirty minutes post-glucose loading, blood samples were again collected from each mouse to confirm the onset of hyperglycemia (≥ 200 mg/dL) before administering the test substances.

The treatments were as follows:

- K1: (Negative Control): No treatment
- K2: Received porang flour (GP)
- K3: Received porang glucomannan (GPA)
- K4: Received commercial porang glucomannan (GPM)

Each test group was treated with a dose of 200 mg/kg body weight of the corresponding material. Blood glucose measurements were conducted at 30, 60, 90, and 120 minutes after treatment to monitor the post-treatment glucose decline. Blood glucose levels were assessed using a glucometer with test strips.

Blood Glucose Testing in Diabetic Rat (Curative Dietary Therapy)

The rat were allocated into five groups, with five rats per group, categorized as follows:

1. Negative Control: No treatment
2. Positive Control: Diabetic rat + porang flour (GP)
3. Treatment Group 1: Diabetic rat + porang glucomannan (GPA1) at 100 mg/kg BW
4. Treatment Group 2: Diabetic rat + porang glucomannan (GPA2) at 200 mg/kg BW
5. Treatment Group 3: Diabetic rat + porang glucomannan (GPA3) at 400 mg/kg BW

The experimental procedure began on day 7 following the adaptation period. Rats were induced with Type 2 diabetes using streptozotocin nicotinamide, at a dose of 45 mg/kg body weight, injected intraperitoneally. Seventy-two hours after induction, fasting blood glucose was measured after the rat were deprived of food for 8–12 hours, while water remained available. Rat with blood glucose levels exceeding 175 mg/dL were classified as diabetic.

For pre-treatment glucose measurement, the tail tip was disinfected with alcohol, followed by a small incision to collect a drop of blood, which was placed on a glucometer test strip. After confirming diabetic status, rat received oral treatment via gavage for 21 consecutive days. On day 21 (post-test), rat were anesthetized using ether inhalation. Blood was then collected via cardiac puncture, and a drop was applied to a glucometer test strip. The glucose level was read on the device within 10 seconds, and the result was expressed in mg/dL.

Data Analysis

The study was structured using a control group model with both pre- and post-treatment evaluations for blood glucose testing using T-test Design. The data were expressed as mean \pm standard deviation. Comparisons of body weight and glucose tolerance among groups were performed using two-way ANOVA, and significant differences were further evaluated with Duncan's multiple range test at a confidence level of $\alpha = 0.05$.

III. Results and Discussion

1. The effect of Glucomannan Porang on Body Weight in Diabetic Rats

Nowdays, konjac as glucomannan source can induce weight loss which is associated with high viscosity and ingestibility [11]. Previous studies have reported that konjac glucomannan promotes weight loss by regulating the intake of cholesterol- and glucose-rich foods, inhibiting cholesterol synthesis in liver cells, and enhancing the excretion of bile acids [12]. Group of GPA1, GPA2, GPA3 showed trend increasing body weight on diabetic rat than both of control positive and negative. GPA1 has an elevating body weight entire 21 days were 178.80, 181.20, 184.20, 188.40. GPA2 and GPA3 has the same trends that were (179.40, 184.20, 189.20, 193.80) and (179.80, 185.20, 189.60, 195.20) respectively.

The findings are consistent with previous studies showing that KGM exerted favorable effects on body weight, accompanied by notably higher food and water intake in

type 2 diabetic rats [13]. It was reported that konjac glucomannan with a medium molecular weight exhibited superior physiological effects compared to those with lower or higher molecular weights.

effects on increasing body weight with decreasing levels of fasting blood glucose. The body weight of diabetics rats in GPA1, GPA2, dan GPA3 treatments are represented on Fig. 1.

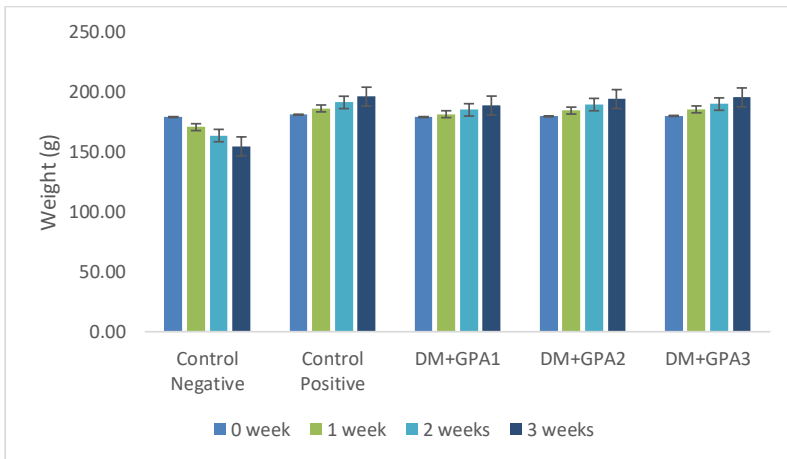


Fig.1. The Effects of GPA1, GPA2, dan GPA3 on the Body Weight in Diabetics Rats

2. Glucose Loading Test

All subjects were fasted overnight to establish a baseline metabolic state. Following oral administration of glucose, blood glucose levels were measured at 30, 60, 90, and 120 minutes. **Fig 2** showed that in the diabetic control group (K1), blood glucose levels continued to rise significantly up to the 90-minute point, with only a slight decline observed at 120 minutes. The groups treated with porang flour (K2) and commercial porang flour (K4) demonstrated moderate improvements in post-load glucose levels. These groups showed notable reductions at 90 and 120 min. The group receiving glucomannan porang (K3) exhibited the most favorable glycemic response, with early and sustained reductions in blood glucose. Reductions began as early as 60 minutes (0.1%) and continued at 90 (9.3%) and 120 minutes (8%), suggesting an early-onset and stable hypoglycemic effect post-glucose intake. Meanwhile reduction blood glucose concentration after 60 min was represented by 11.2% and 5.6% in K2, and by 9.5% and 5.2% in K4, respectively. Overall, the glucose loading results suggest that porang-derived dietary treatments, especially glucomannan, offer beneficial effects in controlling postprandial glucose levels.

Konjac-derived glucomannan exhibited a more potent blood glucose-lowering effect. In diabetic rats, elevated glucose levels were observed, likely because of disrupted glucose regulation. However, the administration of konjac was able to significantly reduce fasting glucose concentrations[13]

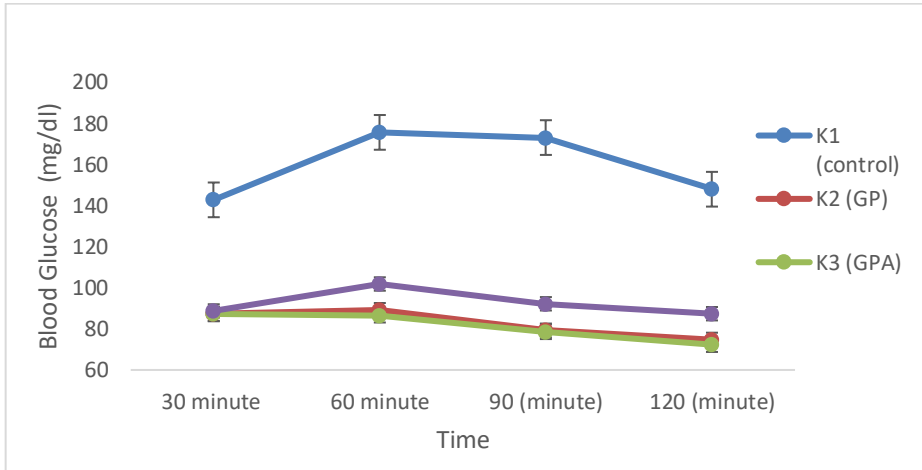


Fig. 2. The Effects of GP, GPA, GPM on Blood Glucose Rats

3. Blood Glucose Testing in Diabetic Rat (Curative Dietary Therapy)

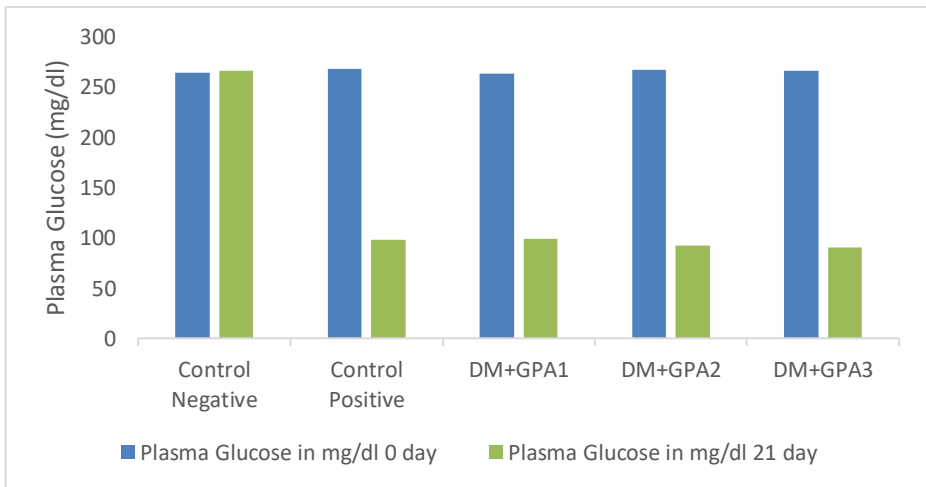


Fig.3. The Effects of GPA1, GPA2, GPA3 on Blood Glucose in Diabetics Rats

The glucose levels of diabetic rats under the konjac glucomannan treatment with the medium molecular weight showed the levels of plasma glucose decreases, this finding was in line with previous study . They reported that the results demonstrated that the

anti-diabetic effect of konjac glucomannan may be achieved partially by anti hyperglycemic and improved cell sensitivity to insulin[2] . Thus, the results of GPA (1,2,3) are comparable to diabetic rat by considering these effects, the GPA treatment could improve insulin sensitivity and upregulate more glucose for energy production. Our research demonstrated similar results as compared to [14]. The extract porang resulted in study as a potential therapeutic agent and additional alternative for lowering blood sugar levels in diabetes to prevent hyperglycemic condition due to its glucomannan content. With context to this, glucomannan is a water soluble dietary polysaccharide derived from mostly tuber of *Amorphophallus konjac*, included as the viscous water soluble fibers have been shown to increase the viscosity of digested food in gut and reduce blood glucose [15][16].

Conclusions

Our hypothesis has successfully developed diabetic rat treated with GPA groups compared to control. The results of our study indicate that GPA is the potential source of functional compound for treating diabetic rat. In brief, the group receiving glucomannan porang (K3) with the same treatment using GPA exhibited the most favorable glycemic response, with early and sustained reductions in blood glucose. Reductions began as early as 30 minutes (0.1%) and continued at 60 (9.3%) and 90 minutes (8%), the glucose postprandial loading around 72.32 mg/dL. GPA significantly improved the body weight on diabetic's rat at 21 days were GPA1(188.40 g), GPA2(193.80 g), dan GMPA3 (195.20 g) with reducing blood glucose fluctuation. The results indicated that the most effective reduction ($p < 0.05$) was achieved in the dose GPA2 (200 mg/kg) and high dose GPA 3 (400 mg/kg), but we considering with standard drugs used 200 mg/kg so GPA2 has best treatment in this study showed decreased blood glucose $91.63 \text{ mg/dL} \pm 2.12$.

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