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The effect of vitamin c and shirataki combination on reducing blood glucose levels in diabetic mice

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Abstract

Diabetes mellitus (DM) is a metabolic disease characterized by persistent hyperglycemia blood glucose levels. A dietary intervention for diabetes mellitus includes the consumption of low-glycemic-index carbohydrates and vitamin C supplementation. This study aims to determine the effect of combining vitamin C and shirataki on reducing blood glucose levels. This experimental study was conducted on male mice (*Mus musculus*) with induced diabetes mellitus over 14 days in the Laboratory of Animal Testing Department of Physiology and Biochemistry Faculty of Medicine, Universitas Airlangga. The data were analyzed using Shapiro-Wilk test for normality and homogeneity test. Parametric data were analyzed using ANOVA, while non-parametric data were analyzed using Kruskal-Wallis test for data that were not normally distributed. The results indicated a reduction in blood glucose levels accross all treatment groups. A significant reduction in blood glucose levels was observed in treatment groups 1, 2, and 3 from day 1 to day 7. However, a slight increase in blood glucose levels occured from day 7 to day 14. Despite this, overall blood glucose levels remained lower at day 14 in all treatment groups compare to the first day. The most significant reduction was observed on day 7 in treatment group 1, which received the lowest dose of vitamin C. In conclusion, the combination of vitamin C with shirataki effectively reduced blood glucose levels in diabetic mice, particularly by day 7. Among the doses tested, the low dose of 500 mg per day was the most effective in reducing blood glucose levels.

Keywords: Diabetes mellitus; Vitamin C; Shirataki; Blood Glucose Levels

1. Introduction

Diabetes is a chronic metabolic disease characterized by elevated blood glucose levels [13]. There are two types of diabetes mellitus (DM): type 1, caused by an autoimmune reaction to pancreatic islet cell proteins; and type 2, caused by a combination of genetic and environmental factors [8]. Diabetes can cause gradual complications such as heart attack, stroke, foot infections, kidney failure, and sexual dysfunction. Diabetes mellitus can be diagnosed by measuring blood glucose levels. The Indonesian Ministry of Health [12] recommends this regulation for the diagnosis of diabetes mellitus. Over the past three decades, the WHO [13] has found a significant increase in diabetes across all countries, with the disease ranking as the world's seventh-leading cause of death. In 2013, 382 million had diabetes, with 95% having type 2. Type 2 diabetes is the most common form of diabetes, accounting for 85-90% of cases. Indonesia has 19.5 million people with diabetes, and this number is expected to reach 28.6 million by 2045. Several risk factors contribute to type 2 diabetes, including age, gender, obesity, genetics, diet, smoking, alcohol, and lack of exercise.

The main food in Indonesia is rice, one of the source for carbohydrates, that provides main energy for the body but doesn't provide all nutrients. Other foods are needed to reach nutritional needs [3]. Rice is a high-carb, low-protein food with a high glycemic index, which raises blood glucose levels. Treatment for DM includes insulin therapy, diabetes

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medications, and a healthy lifestyle. Additionally, understanding risk factors such as diet, age, and gender can help prevent DM disease [10]. Based on the research of Heather et al, low glycemic index foods can improve metabolic control in patients with type 2 DM. The glycemic index is a rating of how foods affect blood glucose levels. People with diabetes have dietary restrictions, especially foods with glucose content. There are several food sources that are good for people with DM, including shirataki and vitamin C.

Shirataki contains water, glucomannan, a soluble fiber, and calcium additives. As a soluble fiber, glucomannan slows digestion, resulting in a long-lasting feeling of fullness. Shirataki also has a low glycemic index. Vitamin C increases insulin sensitivity and lowers blood glucose levels because vitamin C reduces glucose toxicity and helps maintain insulin levels. Glucose in red blood cells can lead to hyperglycemia by inhibiting the uptake of DHA. DHA uptake into cells is mediated by GLUT1 and GLUT3. Competition between DHA in the form of vitamin C and glucose for uptake can be overcome by ingesting large amounts of vitamin C. This study was conducted to determine the effectiveness of shirataki carbohydrate substitutes combined with vitamin C supplementation as a nutritional therapy for diabetes mellitus and tested on diabetic mice to see if it can reduce blood glucose levels. Shirataki is expected to act as a carbohydrate substitute and the combined dose of vitamin C can reduce blood glucose levels.

2. Material and methods

This study is an experimental study using mice with diabetes mellitus for 14 days at the Laboratory of Animal Experiments, Faculty of Medicine, Universitas Airlangga. This study has ethical approval from the Ethics Committee of the Faculty of Medicine, Universitas Airlangga. Mice were induced with the diabetic agent,streptozotocin, then divided into 4 groups with 1 control group and 3 treatment groups. In this experiment, blood glucose tests were performed on days 1, 7, and 14, which were then analyzed using normality and homogeneity tests. ANOVA and Kruskal-Wallis tests were performed to follow up the previous tests.

3. Results and discussion

3.1. The Role of Vitamin C as an Antioxidant in Reducing Blood Glucose Levels

Vitamin C supplementation for individuals with diabetes can be an effective strategy to prevent and ameliorate diabetic complications. Vitamin C reduces glucose toxicity and helps prevent the decline in β-cell mass and insulin content. This suggests that vitamin C may improve insulin sensitivity, allowing for more efficient glucose uptake by body cells, which results in lower blood glucose levels. Research by Afkhami-Ardekani and Shojaoddiny-Ardekani [1] demonstrated that vitamin C supplementation can reduce fasting blood glucose levels and enhance insulin function in patients with type 2 diabetes. This study observed a decrease in blood glucose levels in treatment groups 1, 2, and 3, as indicated by the graphs from the 1st and 14th day tests.

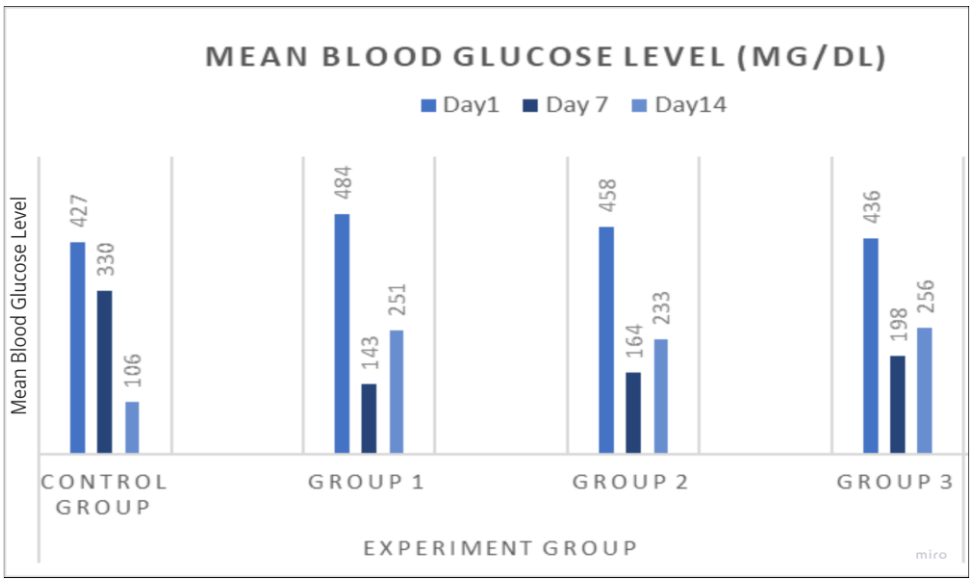

Figure 1 Graphic of Mean Blood Glucose Level

A decrease in blood glucose levels was observed in Treatment Group 1, with an average change of 233 mg/dL. Treatment Group 1 received a vitamin C dose of 500 mg, which was equivalent to 1.3 mg per day for the mice over a period of 14 days. The reduction in blood glucose was most pronounced on day 7, with an average change of 341 mg/dL for Treatment Group 1. A decrease was also observed in Treatment Group 2, with an average change of 225 mg/dL. Treatment Group 2 received a vitamin C dose of 1000 mg, equivalent to 2.6 mg per day for the mice. The optimal reduction in blood glucose occurred on day 7, with an average change of 321 mg/dL in Group 2. These findings suggest an increase in blood glucose levels after the first 7 days of vitamin C administration. Finally, Treatment Group 3 showed a decrease in blood glucose levels, with an average change of 180 mg/dL. Treatment Group 3 received a vitamin C dose of 2000 mg, which was equivalent to 5.2 mg per day for the mice over 14 days. The most significant reduction in blood glucose occurred on day 7, with an average change of 238 mg/dL in Group 3.

This finding is consistent with the study by Mutiarani [2], which reported a change in average blood glucose levels, with the control group showing an average change of 181 mg/dL, while the vitamin C group showed an average change of 118.75 mg/dL. These results suggest that vitamin C supplementation has an effect on reducing blood glucose levels. As an antioxidant, vitamin C can inhibit the formation of free radicals and cellular damage, thus aiding in the repair of damaged β-pancreatic cells. In this study, an increase in blood glucose levels was observed, as indicated by the results from treatment groups 2, 3, and 4 on days 7 and 14. This increase may be attributed to potential stress factors experienced by the study subjects, such as stress caused by the administration of vitamin C via sonding. Stress can lead to elevated cortisol levels, which in turn may increase blood glucose levels. This finding is consistent with the study by Labindjang et al. [5], which suggests that stress is a contributing factor to the elevation of stress hormones, subsequently leading to increased blood glucose levels. In addition, this study aligns with the research conducted by Sari [9], which found that vitamin C doses of 500 mg and 1000 mg do not affect blood glucose levels, while doses of 2000 mg and 3000 mg lead to an increase in blood glucose levels.

3.2. The Role of Shirataki in Reducing Blood Glucose Levels

Glucomannan, derived from porang tubers, has been shown to strengthen gel formation, improve texture, thicken, and reduce blood glucose and cholesterol levels [4]. When dissolved in water, glucomannan forms a viscous gel that slows gastric emptying and the transit of food through the intestine. This delay in digestion reduces the absorption rate of glucose into the bloodstream, thereby mitigating postprandial glucose spikes. A study by Vuksan et al [11] demonstrated that glucomannan consumption significantly lowers postprandial blood glucose levels.

In this study, treatment groups 1, 2, and 3 were fed a shirataki-based diet as the primary diet for the diabetic mice. The average blood glucose levels decreased in each treatment group, as shown in the blood glucose graph. This decrease is consistent with the theory that glucomannan, a component of shirataki, functions as dietary fiber, which is known to lower blood glucose levels [7]. These findings are also aligned with research by Atieh Mirzababaei et al [6] which demonstrates that glucomannan significantly reduces fasting blood glucose levels in individuals with type 2 diabetes.

4. Conclusion

Conclusions drawn from this research are as follows:

- The combination of low-dose vitamin C and shirataki effectively reduces blood glucose levels in diabetic mice on day 7.
- The combination of medium-dose vitamin C and shirataki effectively reduces blood glucose levels in diabetic mice on day7.
- The combination of high-dose vitamin C and shirataki effectively reduces blood glucose levels in diabetic mice on day 7.
- The most effective dose of vitamin C for reducing blood glucose levels is the low dose of 500 mg.

Recommendations for future research include:

- Investigating the optimal dose of vitamin C and its timing to determine the most effective regimen for lowering blood glucose.
- Regularly monitoring the body weight of the mice throughout the study.

Compliance with ethical standards

Disclosure of Conflict of interest

There is no conflict of interest to be disclosed.

Statement of ethical approval

This research received ethical approval from the Health Research Ethics Committee of the Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia, under reference number 79/EC/KEPK/FKUA/2024, granted on August 07, 2024.

References

[1] Afkhami-Ardekani M., Shojaoddiny-Ardekani A. (2007). Effect of vitamin C on blood glucose, serum lipids & serum insulin in type 2 diabetes patients. Indian J Med Res. 126(5), pp.471-4.

[2] Anugrah Linda Mutiarani (2015) Pengaruh Pemberian Kromium (Cr3+), Vitamin C, Dan Vitamin E Terhadap Kadar Glukosa Darah Dan Insulin Tikus Wistar Jantan (Rattus Novergicus) Yang Diinduksi Aloksan. Tesis, UNIVERSITAS AIRLANGGA.

[3] Hidayati, Ratna. 2014. PENINGKATAN KUALITAS OLAHAN BERAS SEBAGAI MAKANAN POKOK MELALUI PENAMBAHAN DAUN KELOR (Moringa oleifera). E-journal boga. 3(1), p. 205-211

[4] Kumar, S. & Pandey, A., 2013, Chemistry and Biological Activities of Flavonoids: An Overview, The ScientificWorld Journal, 2013, 1-16

[5] Labindjang. 2015. Hubungan stres dengan kadar glukosa darah pada penderita diabetes melitus di Puskesmas Bolangitang Barat Kabupaten Bolaang Mongondow Utara. Universitas Negeri Gorontalo.

[6] Mirzababaei, A., Zandkarimi, R., Moradi, S. dkk. Efek Glukomannan pada glukosa darah puasa dan pasca makan pada orang dewasa: tinjauan sistematis dan meta-analisis uji coba terkontrol acak. J Diabetes Metab Disord 21 , 1055–1063 (2022). https://doi.org/10.1007/s40200-022-00993-6

[7] Mulyono, E. 2010. Peningkatan Mutu Tepung Iles-iles (Amorphophallus oncophiyllus) (Foodgrade: Glukomannan 80%) sebagai Bahan Pengelastis Mie (4% Meningkatkan Elastisitas Mie 50%) dan Pengental (1% = 16.000 cps) melalui Teknologi Pencucian Bertingkat dan Enzimatis pada Kapasitas Produksi 250 kg umbi/hari. Program Insentif Riset terapan. Balai Besar Penelitian dan Pengembangan Pasca Panen Pertanian. Cimanggu, Bogor

[8] Ozougwu, J., Obimba, K., Belonwu, C. and Unakalamba, C. (2013) The Pathogenesis and Pathophysiology of Type 1 and Type 2 Diabetes Mellitus. Journal of Physiology and Pathophysiology, 4, 46-57. https://doi.org/10.5897/JPAP2013.0001

[9] Sari S. K. (2007). Pengaruh Vitamin C (Ascorbic Acid) Terhadap Peningkatan Kadar Glukosa Darah Mencit. Fakultas Kedokteran Universitas Kedokteran Maranatha Bandung. Karya Tulis Ilmiah.

[10] Suiraoka, I. (2012). Penyakit Degeneratif: Mengenal, Mencegah dan Mengurangi Faktor Risiko 9 Penyakit Degeneratif (Pertama). Yogyakarta: Nuha Medika

[11] Vuksan, V., Jenkins, D. J., et al. (1999). "Konjac-mannan (glucomannan) improves glycemia and other associated risk factors for coronary heart disease in type 2 diabetes." Diabetes Care, 22(6), 913–919. Studi ini meneliti pengaruh glucomannan pada kontrol glikemik dan risiko penyakit jantung pada diabetes tipe 2.

[12] Kementerian Kesehatan Republik Indonesia [Internet]. Indonesia [dikutip 7 Agustus 2024]. Available at https://www.kemkes.go.id/article/view/414/tahun-2030-prevalensi-diabetes-melitus-di-indonesia-mencapai-213-juta-orang.html.

[13] World Health Organization [Internet]. [cited at 7 Agustus 2024]. Available at https://www.who.int/health-topics/diabetes#tab=tab_3