Journal of Bionursing
2024, VOL.6, NO. 2, 179-190

# Effectiveness of Brown Rice (*Oryza Nivara*) in Lowering Blood Glucose Levels in Patients with Diabetes Mellitus

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ABSTRACT

***Background :*** Diabetes is defined as a state of hyperglycemia in either the fasting or postprandial state. The chronic hyperglycemia of diabetes mellitus (DM) is associated with organ damage, dysfunction, and failure in organs and tissues including the retina, kidney, nerves, heart, and blood vessels.
***Objective :*** This systematic review aims to study the potential of brown rice as a food substitute for white rice that can reduce blood sugar levels in patients with Diabetes Mellitus.
***Methods :*** This study is a systematic review using the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) method by searching journals in electronic databases published in PubMed, Science Direct, Scopus, and Google Scholar, published from 2013 to 2023. These articles were then extracted by looking at the titles and abstracts to see if they were relevant to the topic.
***Results :*** The 6 selected articles showed that brown rice has the potential as an additional food ingredient to reduce blood glucose levels. Brown rice contains complex carbohydrates that can control the increase in the glycemic index (GI) in the blood so that it does not increase drastically. Research results from Sulistyowati show that in addition to its high fiber content, brown rice also has a mineral content seven times higher in Magnesium and Manganese than white rice. Fiber and minerals are important components needed by people with DM as they are thought to help control blood glucose.
***Conclusion :*** Brown rice consumption can reduce blood glucose levels and thus prevent more severe diabetes mellitus.

KEYWORDS
*Brown rice, white rice, type II diabetes mellitus, blood sugar level*

## INTRODUCTION

Health is a priority issue faced by the government and society. One type of disease experienced by the community is diabetes mellitus. Diabetes mellitus (DM) is a group of metabolic diseases characterized by hyperglycemia as a result of defects in insulin secretion, insulin action, or both (Wayan et al., 2015). (Wayan et al., 2015). Type 2 diabetes mellitus (DM) is the most common type of diabetes (90%) of all types of diabetes and has the highest prevalence in the world. (Yuliani et al., 2014).. Patients with diabetes mellitus are expected to increase by 50% by 2045, namely 629 million people aged 20-79 years when compared to 2017, namely 425 million people (Handayani et al., 2045). (Handayani et al., 2022).. In Indonesia, diabetes is also still a serious health problem and even continues to experience an increase in the number of sufferers every year along with the increasing population, increasing age, increasing unhealthy lifestyles, unhealthy diets, unhealthy diets, and obesity. (Aryastami & Tarigan, 2017).

Controlling blood glucose levels in people with diabetes mellitus is related to excessive food intake which can result in increased blood sugar levels. (Ardiansyah & Nawawi, 2021). Dietary intervention is one of the important management of the 4 pillars of diabetes mellitus management, especially type 2 diabetes mellitus. (Kurnia, 2019). People with type 2 diabetes mellitus are advised to choose foods that contain high fiber and have a low glycemic index. In addition, it is necessary to emphasize the importance

of regularity of eating, and the type and amount of food consumed, especially in patients who use blood glucose-lowering drugs or insulin. (Rahmawati & Lestari, 2019). Changes in lifestyle and consumption patterns of rice with low amylose, which is still high, increase the risk of diabetes mellitus. (Septianingrum et al., 2016).

Elevated blood glucose (hyperglycemia) can cause damage to insulin-producing pancreatic β-cells. In these cases, antioxidants are needed to fight free radicals. An antioxidant to overcome the decrease in blood glucose levels in patients with DM is brown rice (Oryza Nivara). Brown rice, especially when sprouted, is a healthier alternative to white rice. Nutrigenomics studies, which address interactions at the diet-genome interface, have expanded our understanding of the role of diet on health. The nutrigenomic basis of functional properties of brown rice has been mentioned viz: its antihyperglycemic, hypocholesterolemic, and antioxidant effects are mediated by its bioactive, in part through transcriptional regulation of genes involved in gluconeogenesis, cholesterol metabolism, and oxidative stress (Imam & Ismail, 2015).

In Indonesia, the consumption of brown rice is still very low, due to the people's habit of consuming white rice. Brown rice is usually consumed by people with diabetes mellitus or for dieting. Brown rice also tends to have a lower glycemic index (GI) when compared to white rice, due to its low fiber content and slower absorption rate. (Yu et al., 2022). The low glycemic index (GI) can control the increase in blood glucose levels so that it does not increase drastically. The results of research from Sulistyowati show that in addition to its high fiber content, brown rice also has a mineral content that is seven times higher in Magnesium and Manganese than white rice. (Sulistyowati et al., 2019).. Fiber and minerals are important components needed by people with DM as they are thought to help control blood glucose. (Handayani et al., 2022).. Thus, further research is needed to prove the effectiveness of brown rice in reducing blood glucose levels in patients with diabetes mellitus.

## RESEARCH METHODS

### 1. Database Search

This study is a systematic review using the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) method. The article search was conducted comprehensively in studies published from January 2013 to January 2023 in PubMed, Science Direct, and Google Scholar databases. For example, the article search strategy for the effectiveness of brown rice to reduce blood glucose levels in patients with diabetes mellitus in the PubMed database is "brown rice" AND "diabetes mellitus" OR "diabetes". The search criteria in this study were articles limited to the last 10 years (2013-2023), in English, available in full text, research article type (non-literature), comparable, and in which there was a discussion of the effectiveness of brown rice to reduce blood glucose levels in patients with diabetes mellitus.

### 2. Data Extraction and Findings Reporting

The article search began by using the keywords "brown rice" and "diabetes mellitus". From the search results using keywords, 745 articles from PubMed, articles from Science Direct, articles from Scopus, and articles from Google Scholar were obtained. After that, articles that were double-published and published by the three search engines used were eliminated using

Mendeley. After eliminating duplicate articles, 658 articles were found that met the criteria. Screening continued by looking at titles that included the words "brown sugar" and "diabetes mellitus" and looking at articles that could be accessed in full, resulting in 105 articles. Furthermore, we read the abstract of each article to see the relevance of the topic discussed in this systematic review. The final result of the data search found 6 articles that were eligible and suitable for use in the systematic review.

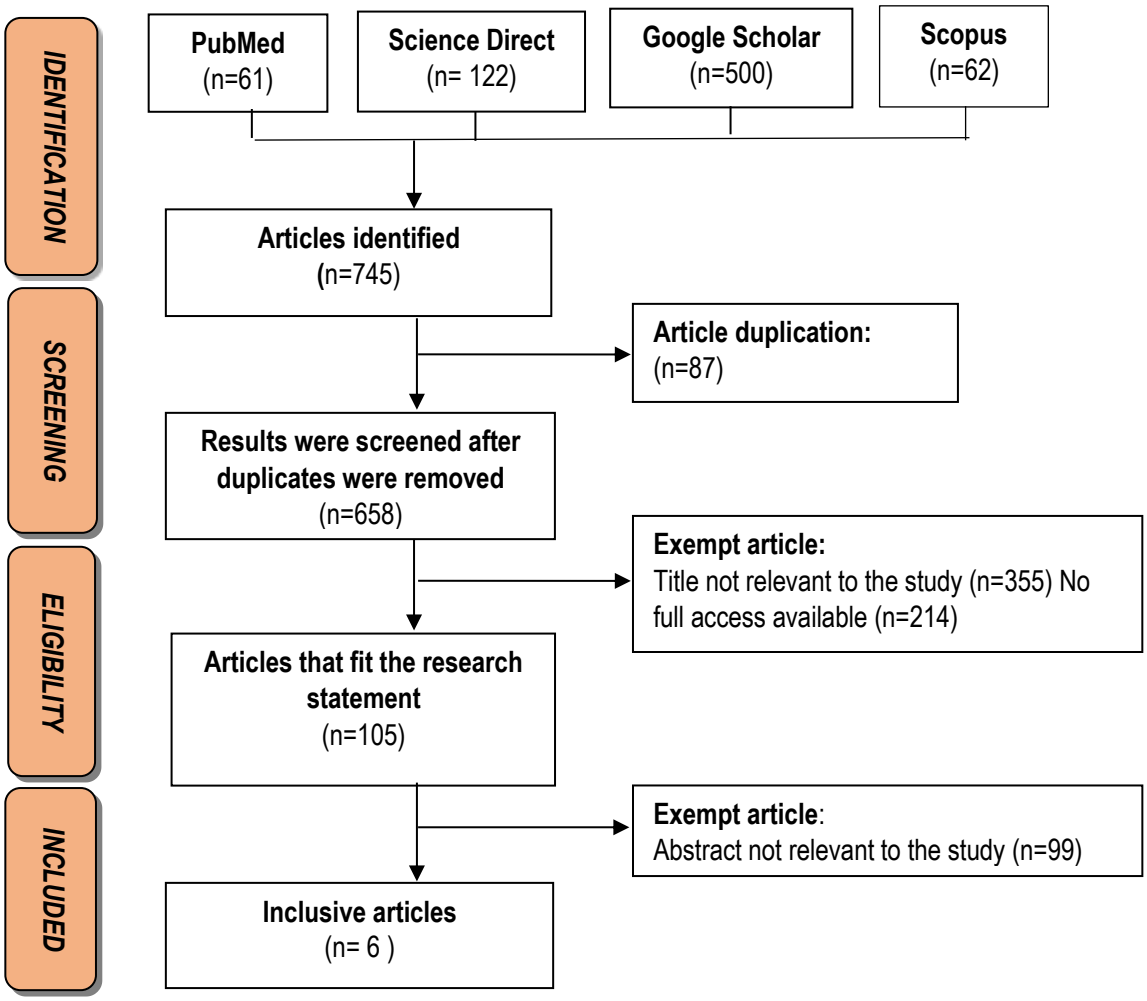


**Figure 1. Research Flowchart**

## 3. Utilization of Brown Rice in Preventing Diabetes Mellitus

**Table 1. Utilization of Brown Rice in Preventing Diabetes Mellitus**

| Title | Methods | Respondents | Place of Research | Research Results | Conclusion |
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| Effects of Brown Rice powdered drink on glucose control and lipid profile of type 2 diabetes patients. (Mansor et al., 2019) | This study used the power method and sample size software with the power of the study at 80% and the α level. than 0.05. The number of participants was determined after calculating the sample size for each objective independently. The largest sample size is taken as the research sample size: 64 participants. This figure includes a 20 percent dropout rate. Sample size calculation was based on the variable HbA1c with a significant difference of 0.18% and a standard deviation 0.23, taken from research conducted by Hayakawa et al. 2009. | Participants were recruited from outpatient clinics from Universiti Sains Malaysia Hospital, in Kelantan, Malaysia from July 2016 to November 2016. The sixty-four participants were randomized into an intervention group and a control group. Participant criteria are ages 18 to 70, diagnosis of type 2 diabetes mellitus for at least six months, HbA1c level between 6.5% and 9% in the last three years months, use of oral hypoglycemic drugs, and not swallowing of other types of supplements or traditional herbs medication during the study. Patients with end-stage renal disease or proliferative retinopathy disease due to diabetes, as well as pregnant women and patients taking insulin, are excluded of the study. | Kota Bharu, Kelantan, Malaysia | No significant difference between the two groups in terms of HBA1c levels at the end of the intervention (P=0.081). However, the BR group experienced a decrease in HbA1c with an average of 0.11%, and the control group experienced a decrease in HbA1c with an average of 0.11%. an increase in HbA1c by 0.25%. There was a significant increase in total cholesterol, triglycerides, and blood pressure at the end of the intervention (P<0.005) in the intervention group. Surprisingly, there was a significant decrease in blood pressure in the BR group. This blood pressure effect maybe is due to the higher fiber content and micronutrients and vitamins contained in brown rice. | From this research, it can be concluded that instant brown rice powder is proven to be promising in reducing HbA1c, although the reduction is not significant. A decrease in HbA1c levels in the BR group may be explained by the fact that brown rice generally has a low glycemic index and lower area under the glucose curve, which results in a low glycemic response. |
| Substituting brown rice for white rice on diabetes Risk factors in India: a randomized controlled trial. | Non-blinded randomized cross-over dietary method intervention trial, consisting of parboiled brown rice or | A total of 166 overweight (BMI ≥ 23 kg/m2 ) adults aged 25-65 years registered. Participants were recruited from MDRF (Madras Diabe | Chennai, South India | Significant reduction in HbA1c observed in the brown rice group among participants with metabolic syndrome (-0-18 (SE 0-08) %) relative to those without metabolic syndrome (0-05 (SE 0-05) %) (P-for-heterogeneity = 0-02). Improvement in HbA1c, | From this study, it can be concluded that the consumption of brown rice can reduce the body's GI, also replacing brown rice with white rice shows |

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| (Malik et al., 2019) | white rice regiment, each of which provides two meals per day (breakfast and lunch), 6 days/week for 3 months. Randomization was performed using computer-generated random numbers with equal treatment allocation ratios. The stratification factor for gender was included in the randomization Scheme. Intervention meals are provided and consumed at on-site dining facilities. To monitor whether participants received the correct test food according to randomization, they are given photo identification badges with color-coded ribbons when they enter the dining hall. | Research Foundation test ) as well as from neighboring offices through advertisements. The staff of this facility and Their relatives were invited to participate in the study. Eligibility The criteria were age 25-65 years; BMI ≥ 23 kg/m2 and rice consumption habits. Two additional decisive eligibility criteria were daily consumption of rice >200 g per day and having a waist circumference of great for eligibility and logistical reasons. A total of 352 participants were screened of which 171 were eligible and willing to participate. | | total, and LDL cholesterol were observed in the brown rice group among participants with a BMI ≥ 25 kg/m2 compared to those with a BMI ≥ 25 kg/m2. BMI < 25 kg/m2 (P-for-heterogeneity < 0.05).<br><br>Based on data from repeated 24-h dietary recalls across the country intervention, the brown rice group had a lower GI and a significant decrease in the intake of refined grains and the percentages of energy from carbohydrates and a significant increase in intake in whole grains, fiber, and energy percentage of total saturated fat compared to the white rice group. The brown rice group also showed a suggestive trend of increased intake of the percentage of energy from protein, which This may be due to the higher protein content of brown rice compared to white rice. | potential benefits for reducing GI. HbA1c among participants with metabolic syndrome and increased BMI. |
| Eating glutinous brown rice twice a day for 8 weeks improves glycemic control in Japanese patients with diabetes mellitus. (Nakayama et al., 2017) | The method used in this study was an open-label randomized crossover study in outpatients with type 2 diabetes. Among the 18 subjects enrolled in the study, 2 were excluded from the analysis. After an observation period of 1 week by consuming white rice 2 times a day, the patients were randomly assigned to two groups. One group consumed brown rice as a staple food twice a day for 8 weeks and then switched to white rice for | Patients with type 2 diabetes recruited at the outpatient clinic of St. Marianna University Hospital (Kawasaki, Japan). Inclusion criteria were as follows: (1) 20 years of age, (2) stable HbA1c for 6 months (HbA1c46.0 ando8.9 with ΔHbA1co0.5%), and (3) treatment with multiple daily insulin injections. with or without oral hypoglycemic agents. | Kawasaki, Japan | The result of this study was that none of the subjects failed to complete the study because they did not like the taste of brown rice. In the group that ate GBR first, the baseline HbA1c was 7,5 ± 0,5%. After 8 weeks of eating GBR twice a day, HbA1c appeared to be decreased to 7.1 ± 0.5%. After switching to WR for 8 weeks, The HbA1c of this group remained at 7.1 ± 0.5%. Hemoglobin A1c (7.5-7.2%, P = 0.014) and glycoalbumin (20.4-19.4%, P = 0.029) both decreased significantly when patients consumed brown rice. In addition, | From this study, it can be concluded that GBR is well tolerated for 8 weeks and has better glycemic control in patients with type 2 diabetes. |

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| | 8 weeks later, the other group consumed white rice first and then switched to brown rice. A mixed meal tolerance test was conducted at<br>baseline and after 8 and 16 weeks of dietary intervention to evaluate plasma glucose and serum C-peptide. | | | 30-min postprandial plasma glucose levels (194-172 mg dl - 1, P = 0.031) and an additional area under the concentration of vs.<br>serum C-peptide time curve (31.3-22.1 ng min ml-1, P=0.023) during the mixed food tolerance test also decreased<br>significantly with brown rice intake. In contrast, there was no change in glycemic control during the white rice period. | |
| Pre-germinated brown rice prevents high-fat diet-induced hyperglycemia through elevated insulin secretion and glucose metabolism pathway in C57BL/6J strain mice.<br>(Shen et al., 2015) | The method used in this study was that six-week-old rats were randomly divided into three groups. Group 1 (n=8) was fed SRD and Group 2 (n=8) was fed a high-fat diet (HFD) for 16 weeks. The HFD was made from SRD with the addition of lard and cholesterol to increase calories and184 metabolic syndrome. And whey protein was added to the HFD to increase protein levels as it is similar to the SRD. The HFD contained 60% energy from fat, 21.4% energy from carbohydrates, and 18.7% energy from protein. In group 3 (n=8), we replaced the carbohydrate source in the HFD with brown rice and fed it to the rats for 16 weeks. The dietary fiber content of all diets was not significantly different. The nutritional composition of the diets we used in this experiment is shown in Table 1. For all groups, body weight was measured weekly, and an oral glucose | Animals. Mice (strain C57BL/6J) were obtained by the National Laboratory Animal Research and Breeding Center (Taipei, Taiwan) and housed under constant temperature and lighting (light between 7:30 and 19:30). | Taipei, Taiwan | The results of this study were the effects of PGBR on body weight and weight gain. After 16 weeks, the body weight of the SRD group gained about 50.4%, and the body weight of the HFD group gained about 116.8%. The HFD group gained significantly more weight in total than the SRD group.<br>In the HFD + PGBR group, body weight gained but more gradually (68.2%). Compared to the HFD group, weight gain was inhibited in the HFD + PGBR group.<br>Effects of PGBR on OGTT. After glucose administration (oral, 2 g/kg) 0, 30, 60, and 120 min, the HFD group had higher blood<br>glucose levels compared to the SRD group. In the HFD + PGBR group, blood glucose recovered, indicating that PGBR exerted a significant hypoglycemic effect on hyperglycemic rats. | From this study, it can be concluded that PGBR reduced blood glucose and blood pressure and improved glucose tolerance in rats with HFD-induced hyperglycemia. Based on our results, PGBR ameliorated hyperglycemia by increasing insulin secretion, and insulin receptor levels, improving glucose transport into cells and184 glucose metabolism. PGBR was able to increase insulin secretion, insulin receptor expression, glucose uptake, and glycolysis, glycogenesis. |

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| | tolerance test (OGTT) was recorded every four weeks. At the end of the study, we collected blood for biochemical tests and removed liver and skeletal muscle from all rats, and stored these tissues in protein lysis buffer solution at -80°C until analysis. This study was approved by the Animal Care and Use Committee of Meiho University. | | | | |
| Pre-Germinated Brown Rice Reduces Both Blood Glucose Concentration and Body Weight in Vietnamese Women with Impaired Glucose Tolerance. (Bui et al., 2014) | The methods used in this study were designed with the Declaration of Helsinki on Human Studies. The potential beneficial health effects of grains (including PGBR) were explained to all subjects and informed consent was obtained from each participant. To facilitate screening, we measured rapid capillary blood glucose using the One Touch Ultra smart device (Johnson & Johnson, New Brunswick, NJ). Participants were asked to fast for a minimum of 10 hours and then report to the local health center where blood was drawn. From the screening survey we selected all women who had a blood glucose of more than 5.6 mmol/dL; then women who had further oral glucose tolerance were subjected to the entrance test and IGT was determined by 2 h post-50 blood glucose levels of 7.8 to 11.0 mmol/L (140 to 199 mg/dL) (18). | About 1,000 women aged 45-65 years in an urban area community and not on DM treatment.<br><br>From the screening survey, all women with blood glucose greater than 5.6 mmol/dL were selected. | Hai Duong Province, Vietnam | There were no highly significant differences in age, height, weight, BMI, percent body fat, waist, hip, blood pressure, glucose, HbA1c, triglycerides (TG), total cholesterol (TC), LDL-C, or HDL-C. The mean BMI of both the PGBR group (23.9) and the WR group (23.5) Table 2 shows a comparison of the physical traits and blood sugar parameters of the WR and PGBR groups at baseline and end line. In the PGBR group, body weight, BMI, waist, hip, waist-hip ratio, and blood pressure were significantly reduced after the intervention compared to baseline. Such reductions were not found in the WR group. Trial blood biochemical parameters improved significantly in the PGBR group but only HDL-C in the WR group. | In conclusion, the Vietnamese study with IGT showed that replacing WR with PGBR can lower blood glucose and lipid levels and reduce body weight. The taste of PGBR was also well received. Therefore, the increase in Diabetes mellitus (DM) in Vietnam can be largely controlled by the use of PGBR. |

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| | Hemoglobin A1c (HbA1c) was also measured from these samples. | | | | |
| Substitution of local Indonesian varieties of brown rice on anthropometry and blood glucose level improvement in type 2 DM patients: A pilot project. (Handayani et al., 2022) | The research method used was preliminary with an experimental design to analyze the effects of brown rice alone. This brown rice study is part of a crossover study of the content of brown rice and white rice in patients with type 2 diabetes mellitus In the project 18 women with type 2 diabetes mellitus was given a 12-week brown rice intervention diet (three meals and three snacks times a day for six days/week) provided by a professional food provider. Energy requirements were calculated based on individual respondents' weight, height, age, and activity using the Harris-Benedict formula with a macronutrient composition of ±20% pro-protein, ±30% fat, and ±50% carbohydrate of total energy. | 18 women with type 2 diabetes mellitus aged 42-60 years. | Malang City, Indonesia | On basic measurements all respondents (100%) had HbA1c levels ≥6.5%. All respondents had a high percentage of body fat (normal range: 20-29%) by the OMRON HBF-375 Karada Scan manual, and 16 respondents (88.9%) had abdominal obesity (nor-mal range <80 cm)2 (Table 1). Effect of intervention A total of 18 respondents with type 2 DM underwent a 12-week program. weeks of the brown rice diet study period without drop-outs. The The results of the baseline and post-intervention data analysis showed that brown rice substitution improved anthropometric parameters and blood glucose control of type 2 DM respondents through weight loss, BMI, body fat percentage, abdominal circumference Ference, fasting blood glucose level, 2 hours postprandial blood glucose levels, and HbA1c. In anthropometric parameters, there are no significant difference in body fat index and visceral fat performance percentage. | This study found that the consumption of brown rice for three months as a daily staple food for overweight and obese patients with type 2 diabetes will reduce body weight, body fat percentage, and waist circumference. In addition, it can improve blood glucose control by lowering blood glucose. Brown rice can be part of nutrition therapy to combat obesity and improve blood glucose control. |

Previous studies have been conducted to determine the potential of brown rice in reducing blood sugar levels and glycemic index in patients with diabetes mellitus, especially type 2 diabetes mellitus. In the research article (Mohan et al., 2014) HbA1c results were obtained which decreased significantly in the group that consumed brown rice with metabolic syndrome. In addition, the group that consumed brown rice had a lower glycemic index and a significant increase in the intake of whole grains and fiber. Findings in other articles (Terashima et al., 2017) explained that in the group that consumed brown rice first twice a day for 8 weeks, HbA1c decreased. After switching to consuming white rice for 8 weeks, HbA1c did not change at all. This statement proves that brown rice works effectively as an alternative food that can maintain blood sugar and glycemic index in people with diabetes mellitus and people with metabolic syndrome.

## DISCUSSION

The chronic metabolic disorder diabetes mellitus is a rapidly growing global problem with enormous social, health, and economic consequences. It is estimated that in 2010 globally 285 million people (about 6.4% of the adult population) had the disease. This number is expected to increase to 430 million if there is no better control or treatment. The aging population and obesity are the two main reasons for the increase. Diabetes mellitus can lead to complications if not treated promptly. One way to control the rise in blood sugar is to change your food intake. Patients with type 2 diabetes mellitus are advised to choose foods that contain high fiber and have a low glycemic index. This statement can be supported by the results of research by (Chandalia et al., 2000) that high fiber food intake can improve glycemic control, reduce hyperinsulinemia, and reduce plasma lipid concentrations in type 2 DM patients.

Brown rice (*Oryza Nivara*) is part of a herbal plant that contains carbohydrates, fats, proteins, fiber, and minerals and also contains flavonoid compounds that have the ability as antidiabetics that lower blood glucose by increasing insulin secretion and preventing insulin resistance. (Ardiansyah & Nawawi, 2021). Apart from containing carbohydrates, fat, protein, fiber, and minerals, brown rice also contains anthocyanins. Anthocyanins are red pigments contained in the pericarp and tegmen (skin layer) of rice or are also found in every part of the grain. The anthocyanin content found in brown rice functions as an antioxidant (Abdullah, 2017). (Abdullah, 2017) . High fiber content is also owned by brown rice, the fiber content of organic brown rice is 1.6232% b/b, followed by non-organic brown rice at 0.9590% b/b. The value of reducing sugar in brown rice is also in the normal range, namely organic brown rice 0.1018% w/b, and non-organic brown rice 0.1268% w/b. (Hernawan & Meylani, 2016). The benefit of fiber in brown rice content is that it can increase the viscosity of the lumen in the intestine so that it can reduce the efficiency of carbohydrate absorption and insulin response. With the decrease in insulin response, the work of the pancreas will be lighter in producing insulin. Brown rice can also reduce serum lipid levels so that it can suppress blood glucose levels. (Kuszairi, 2017).

The consumption of brown rice in patients with diabetes mellitus is proven to have a lowering effect on blood glucose levels because it contains flavonoid compounds that have anti-diabetic abilities. At (Handayani et al., 2022) obtained the results that

consuming brown rice for three months as a daily staple food in patients with type 2 DM can improve blood glucose control so that glucose levels in the body can decrease. The study also found that patients with type 2 DM with overweight and obesity experienced a decrease in body weight, body fat percentage, and waist circumference after consuming brown rice for three months. It can be concluded that brown rice consumption can also control weight gain in overweight and obese patients. This statement is reinforced by research by (Lim et al., 2016) titled Brown Rice Improves Obesity in Obese Mice Induced by High Fat Diet, the results of the study stated that giving brown rice to the 50% brown rice group and 100% brown rice group significantly reduced weight gain and food intake and improved lipid profiles in obese mice. In addition, the administration of brown rice has reduced adiposity by showing a decrease in white adipose tissue mass, adipocyte size, and leptin level along with a higher ratio of fat excretion into the feces.

Brown rice is a more beneficial food for diabetics and hypoglycemic individuals, that is because brown rice contains less amount of blood glucose when compared to white rice. Modifying the type of rice consumed and choosing foods with a low GI can have a major effect on the total glycemic load. (Upadhyay & Karn, 2018)... Research conducted (Bui et al., 2014) stated that studies in Vietnam showed that replacing white rice with brown rice can reduce blood glucose levels, therefore the increase in people with type 2 DM in Vietnam can be largely controlled by the use of brown rice. In essence, replacing white rice with brown rice and consumed regularly can have the effect of reducing blood glucose levels, preventing weight gain, and reducing body fat percentage.

Current rice-based diets contain nutritional gaps, mainly due to the milling process that can remove health-enhancing compounds found in rice bran. (Lee et al., 2019). Therefore, the consumption of brown rice is recommended to achieve nutritional sustainability. The utilization of brown rice can be consumed directly by cooking it into rice, processed into brown rice flour, processed into other foods such as noodles, and can be processed into instant drinks of brown rice powder. As in research (Mansor et al., 2019) brown rice is processed into brown rice powder instant drink products and it is proven that after consumption by type 2 DM patients, the HbA1c results are reduced. This can be explained by the fact that brown rice generally has a low glycemic index, which results in a low glycemic response in type 2 DM patients.

## SUMMARY

Brown rice contains complex carbohydrates that can control the increase in glycemic index (GI) in the blood so that it does not increase drastically. Brown rice is high in fiber, which increases the viscosity of the intestinal lumen, thus reducing the efficiency of carbohydrate absorption and insulin response. Brown rice can reduce serum lipid levels to suppress blood glucose levels. Brown rice contains flavonoid compounds that have the ability as antidiabetics that lower blood glucose by increasing insulin secretion and preventing insulin resistance. Brown rice can reduce body weight, body fat percentage, and waist circumference in patients with type 2 diabetes and obesity.

## ADVICE

People with diabetes mellitus should consume brown rice (Oryza Nivara) as a parameter for changes in blood glucose levels. In addition, it is necessary to conduct socialization to increase public interest in making modified foods from brown rice and to increase the consumption rate of brown rice.

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