

## ***EFFECT OF RED BEANS AND BLACK BEANS WITH A DIABETES MELLITUS: A SYSTEMATIC REVIEW***

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### **ABSTRACT**

*Diabetes mellitus is a chronic metabolic disease that requires dietary management. One of the diet strategies is a high consumption of antioxidants and fiber contained in red beans and black beans. The purpose of this article is to prove that red beans and black beans can treat diabetes mellitus. The method is a systematic review using the PRISMA protocol and JBI's Critical Appraisal Tools. The source of the article is experimental studies published in the last 10 years (2013-2023) in Google Scholar, Pubmed, and Science Direct databases. The results showed that red beans and black beans are rich in antioxidants and fiber. Antioxidants and fiber are known to reduce blood glucose levels and increase insulin levels. The conclusion of this article is red beans and black beans can treat diabetes mellitus. The suggestion of this review is that better to increase the daily dose of red beans and black beans consumption to treat diabetes.*

**Keywords:** *Blood glucose, Diabetes, Beans, Insulin*

### **ABSTRAK**

Diabetes melitus merupakan penyakit metabolik kronis yang membutuhkan pengaturan pola makan. Salah satu strategi pola makannya dengan konsumsi tinggi antioksidan dan serat yang terkandung pada kacang merah dan kacang hitam. Artikel ini bertujuan untuk membuktikan bahwa kacang merah dan kacang hitam dapat digunakan untuk mengobati diabetes melitus. Metode penelitian ini adalah *systematic review* menggunakan protokol PRISMA dan JBI's *Critical Appraisal Tools*. Sumber jurnal yang digunakan adalah penelitian eksperimental yang terbit dalam 10 tahun terakhir (2013-2023) pada database Google Scholar, Pubmed, dan Science Direct. Hasil menunjukkan kacang merah dan kacang hitam tinggi antioksidan. Kandungan antioksidan dan serat tersebut diketahui dapat menurunkan kadar glukosa darah dan meningkatkan kadar insulin. Kesimpulan artikel ini adalah kacang merah dan kacang hitam dapat digunakan untuk mengobati diabetes mellitus. Sebaiknya meningkatkan asupan harian kacang merah dan kacang hitam untuk pengobatan diabetes.

**Kata Kunci:** *Glukosa darah, Diabetes, Kacang-kacangan, Insulin*

### **INTRODUCTION**

Diabetes mellitus (T2DM) is the most common type of metabolic disorder in the world. T2DM is caused by two main mechanisms: a defective secretion of insulin by pancreatic beta-cells and a failure of insulin sensitive tissues to respond appropriately to insulin.<sup>1</sup> T2DM is a complex disease characterized by high plasma glucose levels. It involves different cellular pathways such as insulin secretion and insulin resistance.<sup>2</sup> The International Federation of Diabetes estimates that 537 million adults (20-79 years) are diagnosed with T2DM worldwide. This number is predicted to increase to 643 million in 2030 and 783 million in 2045.<sup>3</sup> Based on national research, the prevalence rate of diabetes in Indonesia has reached 10.9 percent which is predicted to continue to increase.<sup>4</sup>

Bad eating habits and a sedentary lifestyle have increased the prevalence of chronic degenerative diseases, such as type 2 diabetes mellitus (T2DM).<sup>5</sup> Adherence to a healthy lifestyle that

includes a high-quality diet, regular exercise, and adequate weight maintenance, is strongly associated with the best T2DM management.<sup>6</sup> Administration of a diet high in antioxidants and fiber, which can be used to maintain blood glucose and insulin levels, can be sourced from legumes.<sup>7</sup> Local food ingredients, such as legumes, that have high antioxidant content are red beans and black beans.<sup>7,8</sup> Red beans and black beans are small, sweet-tasted, soft-textured, oval in shape, and have an anti-inflammatory response.<sup>9</sup> Red and black beans have antidiabetic potential and are also excellent sources of anthocyanins.<sup>10</sup> The color of red and black bean varieties is due to anthocyanins. Dark-colored beans usually have the highest anthocyanin content.<sup>7</sup>

The antioxidant properties of polyphenols such as anthocyanin can neutralize free radicals.<sup>7</sup> Anthocyanins from black beans have strong antioxidant abilities to scavenge free radicals along with anti-inflammatory activity.<sup>11</sup> Anthocyanins play an important role in T2DM prevention.<sup>12</sup> Previous studies have shown that the anthocyanins found in black beans can modulate the activity of proteins involved in different T2DM pathway mechanisms.<sup>11</sup> Other research has shown that anthocyanin consumption can positively modulate GLUT4 and its phytochemicals to affect the gastrointestinal microbiota.<sup>13</sup>

Beans especially red beans also have high fiber content.<sup>6</sup> This fiber consists of soluble and insoluble fiber.<sup>14</sup> Soluble fiber can reduce postprandial blood sugar and increase insulin levels.<sup>14,15</sup>

Beans Based on research other by it is suggested that regular consumption of beans is beneficial in the prevention and management of diabetes.<sup>16</sup> Clinical studies show that consumption of three or more servings of beans in a week reduces the risk of diabetes by almost 35%, compared to less or no consumption of beans. Beans were found to have anti-hyperglycemic activity due to their phenolic compounds, such as flavonoids, in in vitro anti-diabetic studies.<sup>17</sup> In vivo studies have also shown that bean-containing phenolic compounds reduce blood glucose and increase insulin levels in animals.<sup>18</sup> Other studies have shown that red beans are digested slowly in the digestive system and remain stable in the digestive tract for a longer time, which exerts a slight stimulatory effect on postprandial insulin secretion, thereby maintaining insulin function and sensitivity. Based on these studies, kidney beans can prevent metabolic syndromes such as hyperinsulinemia and insulin resistance in T2DM.<sup>19</sup>

Various studies have proven the effect of giving red and black beans on reducing blood glucose and increasing insulin levels. The goal of this study was to examine the effect of giving red beans and black beans on blood glucose levels and insulin levels using a systematic review approach.

## **METHOD**

This study is a systematic review of studies using the PRISMA protocol and the JBI Critical Appraisal Tools to evaluate the risk of bias. The four stages of searching for articles using the PRISMA method are 1. Identification, namely entering four keywords in the database; 2. Screening,

namely filtering articles using inclusion and exclusion criteria; 3. Eligibility, namely the feasibility test of articles using JBI Critical Appraisal Tools to exclude low-quality studies (score 50%); 4. Included are articles that are relevant and meet the requirements. The articles searched for were found using electronic databases such as Google Scholar, PubMed/Medline, and Science Direct on February 2, 2023.

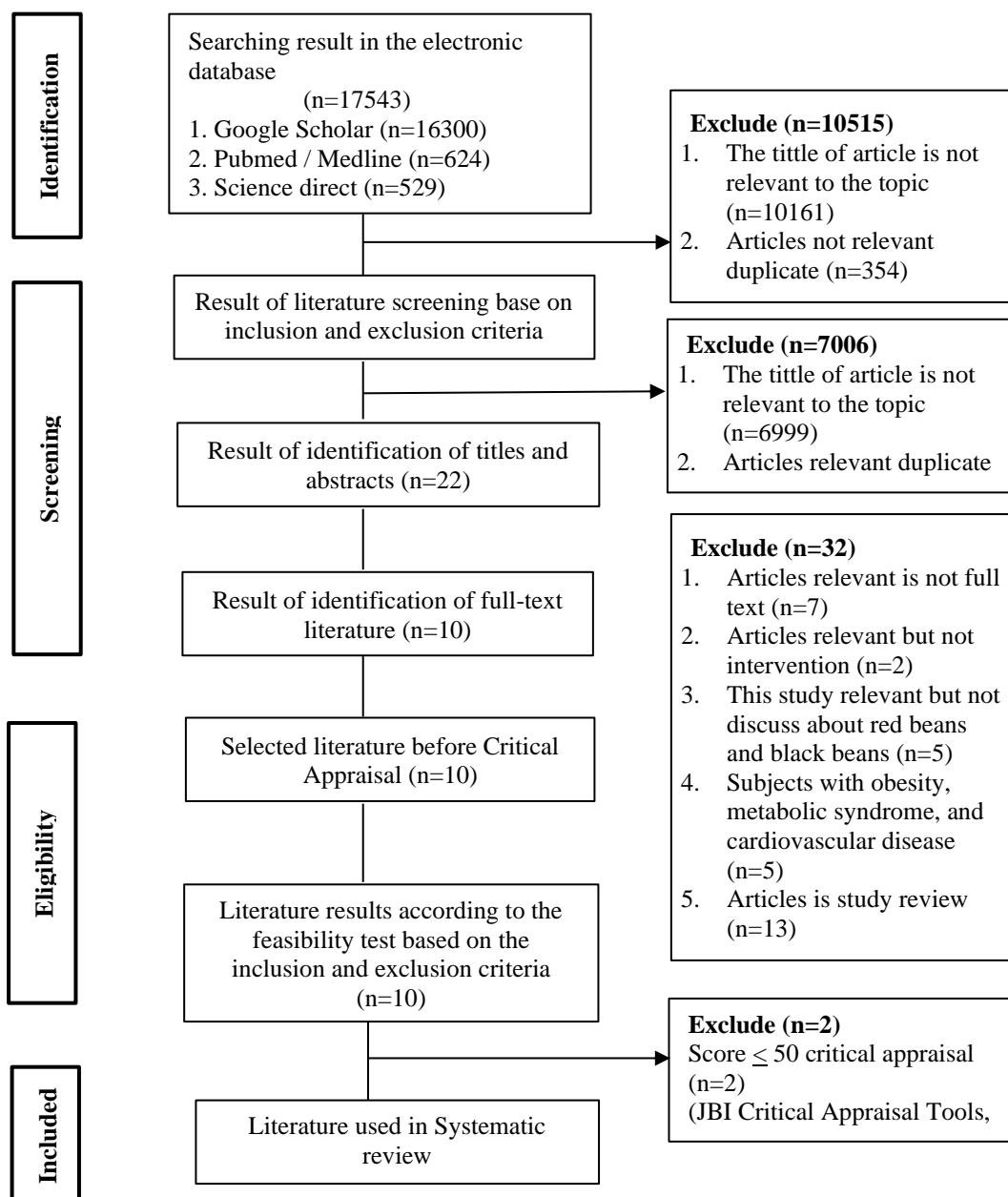
The selected types of articles were published in the last ten years, from 2013 to 2023. The articles used were searched using four keywords, namely "beans", "blood glucose," "insulin," and "diabetes," which can be searched in national and international journals that are accessible. The inclusion and exclusion criteria follow the PICOS framework guidelines, which consist of five question indicators, namely: 1. Population or problem; 2. Interventions or indicators; 3. Comparison; 4. Outcomes; and 5. Design studies.

Based on these indicators, the inclusion criteria used to select research articles were:

1. Patients with type 2 diabetes mellitus, adults, or type 2 diabetes mellitus rats models; Rats has many similarities to humans in terms of anatomy, physiology and genetics. The genome is very similar to our own, making rats genetic research particularly useful for the study of human diseases one of them T2DM. The rats models the best indicator of how humans will react to a new diabetes drug or medical treatment.
2. Empowerment interventions;
3. Comparison with other interventions or control groups;
4. The outcome explaining the effect of the empowerment intervention;
5. The study design was a randomized controlled trial, cohort study, or quasi-experimental study;
6. Abstract; full text;
7. Scholarly journals.

The exclusion criteria in this study were:

1. Subjects with obesity, other metabolic syndrome, and cardiovascular disease;
2. No intervention with subjects;
3. No compassion;
4. The results of the study showed no effect or change after the intervention was given;
5. The systematic review, meta-analysis, scoping review, and literature review;
6. No full text. The following is a detailed article selection process (Figure 1).



**Figure 1. Diagram of Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA)**

## RESULTS AND DISCUSSION

Based on searches of three electronic databases, using 4 keywords namely "beans", "blood glucose," "insulin," and "diabetes," 17543 were found, the results were then eliminated based on exclusion criteria using PICO guidelines and criteria resulting in 8 articles were selected to report on the results of the systematic review. The selected articles can be seen in (Table 1).

**Table 1. Systematic Review Study Results**

Number	Year	Author	Research Title	Research Methods	Results
1	2020	Bai, Z., Meng, J., Huang, X., Wu, G., Zuo, S., & Nie, S. <sup>20</sup>	Comparative study on the antidiabetic function of six legume crude polysaccharides	Desain: Experimental study Subject: Type II diabetic mice with streptozotocin-induced Variable: Chemical composition with Polysaccharides from legumes Instruments: GSP and insulin levels were determined by the ELISA kit Data analysis: One-way ANOVA	Red kidney bean polysaccharides (RK) decreased the levels of Fasting Blood Glucose (FBG), Total Cholesterol (TC), low-density lipoprotein cholesterol (LDL-c) and increased the concentration of serum insulin levels (HOMA-IR) ( $p < 0.05$ ). Red kidney exhibited greater antidiabetic potential in type II diabetic mice, compared with other legume polysaccharides.
2	2021	Utama, L. J., Suryana, S., & Sembiring, A. C. <sup>21</sup>	Effects of mixture powder of black rice ( <i>Oryza sativa</i> L indica), red beans ( <i>Phaseolus vulgaris</i> L), and moringa leaves ( <i>Moringa oleifera</i> L) on blood glucose concentration in hyperglycemic Rats	Desain: Experimental research with pre and post-control group design. Subject: Sprague Dawley female rats with hyperglycemic Variable: Mixture powder of red beans with Fasting Blood Glucose (FBG) Instruments: Blood serum glucose analysis was executed according to the Glukosa Oksidase Para Amino Phenazone (GOD-PAP) method Data analysis: One-way ANOVA	The results showed that after 28 days of intervention, the mixture powder decreased the serum glucose concentration from 122.69 mg/dL to 97.70 mg/dL (20.37%) in the 80% mixture powder (PB8) and from 123.91 mg/dL to 113.28 mg/dL (8.58%) in the 50 % mixture powder PB5 group. The average value of fasting blood glucose levels in the intervention of a mixture of powder PB8 and PB5 experienced a significant decrease ( $p < 0.05$ ).
3	2022	Khatija, A., & Marikkar, N. <sup>22</sup>	Biochemical Study on the Anti-Hyperglycemic Effects of Coconut Testa ( <i>Cocos nucifera</i> L.) and Red Kidney Bean ( <i>Phaseolus vulgaris</i> ) Seed	Desain: Experimental study Subject: Reptozotocin-induced diabetic Sprague-Dawley rats Variable: Anti-hyperglycemic from red kidney bean	The results showed the blood glucose level of the group treated with RKB (Red Kidney Beans) 400 mg/kg b.wt was found to be significantly ( $p < 0.05$ ) lower than that of the negative control group. This study suggested that the improvements in

Number	Year	Author	Research Title	Research Methods	Results
			Coat in Streptozotocin-Induced Diabetic Rats	Instruments: The glucose concentration in the serum samples was analyzed immediately by the glucose oxidase method using a Randox assay kit and a spectrophotometer Data analysis: ANOVA and Tukey's test	glucose tolerance would be the result of increased secretion of insulin due to the presence of hypoglycemic components in the extracts.
4	2022	Damián-Medina, K., Milenkovic, D., Salinas-Moreno, Y., Corral-Jara, K. F., Figueroa-Yáñez, L., Marino-Marmolejo, E., & Lugo-Cervantes, E. <sup>11</sup>	Anthocyanin-rich extract from black beans exerts anti-diabetic effects in rats through a multi-genomic mode of action in adipose tissue.	Desain: Experimental study Subject: Male Wistar diabetic rats Variable: Anthocyanin from black beans with Type 2 Diabetes Mellitus Instruments: Insulin levels were quantified using the Rat Insulin ELISA kit RayBio Data analysis: Two-Way Repeated Measures ANOVA and Tukey's test	The results showed, that at the end of the treatment period, rats in BB (black beans) group showed significant ( $p < 0.05$ ) decreases in fasting blood glucose levels. Further, TNF- $\alpha$ levels in the BB group exhibited a significant decrease ( $p < 0.05$ ) when compared with the DB (without treatment) group.
5	2017	Winham, D. M., Florian, T. L. A., & Thompson, S. V. <sup>23</sup>	Glycemic Response to Black Beans and Chickpeas as Part of a Rice Meal: A Randomized Cross-Over Trial	Desain: Randomized cross-over study Subject: Adult women, aged 18–65 years, were currently not taking medications known to affect glucose or insulin concentrations. Variable: Glycemic response from black beans and combination of white rice for blood glucose Instruments: Plasma glucose concentrations were assessed using the	In the present study, whole black bean combination with white rice, a high glycemic index food, significantly reduced glycemic response in comparison to white rice control among healthy adult women. Timepoint differences in glucose concentrations were significantly lower at 60 and 90 min postprandial for black beans and white rice ( $p = 0.026$ and $p = 0.001$ , respectively). A significant reduction in postprandial glucose concentrations was also observed for the black bean and rice meal at the

Number	Year	Author	Research Title	Research Methods	Results
				colorimetric glucose oxidase method and insulin concentrations in serum were determined utilizing the Immulite 1000 Data analysis: Multivariate Analysis of Variance (MANOVA)	120 min postprandial (p = 0.024) and time point differences in insulin concentrations were significantly higher at 30 minutes postprandial for black beans and rice (p=0.037)
6	2016	Kim, M., Kim, D. K., & Cha, Y. S. <sup>24</sup>	Black Adzuki Bean (Vigna angularis) Extract Protects Pancreatic $\beta$ Cells and Improves Glucose Tolerance in C57BL/6J Mice Fed a High-Fat Diet	Desain: Experimental study Subject: Male C57BL/6J mice Variable: Black Adzuki Bean extract improves glucose tolerance Instruments: Levels of insulin in the culture medium were quantified using a rat high-range insulin ELISA kit Data analysis: One-way ANOVA. After ANOVA, differences between means were assessed using Duncan's multiple-range test.	The animals fed an HD control group along with Black Adzuki Bean (BAB) extract had a significantly lower fasting blood glucose level throughout the experimental period than animals in the HD group. Black Adzuki Bean improves high glucose-impaired insulin secretion with stated significant differences among groups (p<0.05). In summary, in vitro and in vivo, data indicate that BAB extract improves glucose tolerance by protecting pancreatic cells from damage from chronic hyperglycemia and improving insulin response.
7	2017	Mojica, L., Berhow, M., & Gonzalez de Mejia, E. <sup>25</sup>	Evaluation of the hypoglycemic potential of a black bean hydrolyzed protein isolate and its pure peptides using in silico, in vitro, and in vivo approaches	Desain: Experimental study Subject: Hyperglycemic rat model Variable: Hypoglycemic potential of black beans with glucose absorption Instruments: Insulin and GLP-1 levels were determined by ultra-sensitive insulin Rat ELISA assay	The result showed, that the hyperglycemic rat model (HPI) caused a reduction in blood glucose. Black bean HPI was capable of significantly reducing glucose absorption and uptake in vitro, The lowest fasting glucose was found in rats receiving 150 and 200 mg/kg BW/day HPI, (p < 0.05). The black bean HPI is an inexpensive food source of bioactive compounds that could be



Number	Year	Author	Research Title	Research Methods	Results
				Data analysis: One-way ANOVA, Comparisons among groups were performed by Tukey	used in the management of blood glucose
8	2020	Sánchez-Tapia, M., Hernández-Velázquez, I., Pichardo-Ontiveros, E., Granados-Portillo, O., Gálvez, A., Tovar, A. R., & Torres, N. <sup>26</sup>	Consumption of Cooked Black Beans Stimulates a Cluster of Some Clostridia Class Bacteria Decreasing Inflammatory Response and Improving Insulin Sensitivity	Desain: Experimental study Subject: Male Wistar rats were given 2 g/kg glucose weight Variable: Cooked black beans stimulated insulin sensitivity Instruments: Serum insulin was determined using commercial ELISA kits. Data analysis: Two-way ANOVA followed by Bonferroni's posthoc test	Consumption of black beans (BB) decreased the glucose curve, glucose and increased insulin sensitivity to insulin concentration with a significant difference (p<0.05). Consumption of black beans can be recommended to prevent insulin. Black bean consumption maintains gut integrity and insulin signaling after acute metabolism with glucose.

The results of the literature review found that giving red beans and black beans had an impact on reducing blood glucose and increasing insulin levels. One important criterion for the diagnosis of diabetes is an abnormal increase in postprandial or fasting blood glucose. Therefore, lowering the blood glucose of diabetic patients is the main goal of diabetes treatment.<sup>27</sup> Studies on the effect of red beans are proven by the results of a study conducted which stated that red bean polysaccharides (RK) can reduce fasting blood glucose (FBG) and increase serum insulin concentrations (HOMA-IR).<sup>20</sup> Red beans showed greater antidiabetic potential in type II diabetic rats, compared to other legume polysaccharides in this study (soybean, white kidney bean, small black soybean, field bean, and lentil). As an effective indicator, glycosylated serum protein (GSP) levels can reflect the average blood glucose level of all diabetic patients in the last 2-3 weeks. T2DM is characterized by lower serum insulin concentrations and insulin resistance in STZ-induced diabetic rats.<sup>28</sup> Insulin concentration can reflect the function of  $\beta$  cells, stating that the anti-diabetic properties of polysaccharides from natural sources are mediated by increased insulin action.<sup>27</sup> HOMA-IR is an important indicator of insulin resistance.<sup>29</sup> As shown in the results of the red beans intervention study, significant in HOMA-IR, which showed that the two polysaccharides increase insulin levels.

The results of another study conducted by another study showed that after 28 days of intervention, the mixed powder reduced blood glucose levels in male Wistar rats that were given a glucose load.<sup>21</sup> This is due to the administration of mixed flour in the group containing a high fiber



composition, causing satiety quickly compared to the standard feed group. In this study, the mixed powder was used as a flour mixture in the intervention feed, one of the compositions of which was red bean, so that a decrease in fasting blood sugar levels in animal models could be associated with red bean. Kidney beans are a good source of fiber, every 100 grams of dry kidney beans provides about 4 grams of fiber consisting of soluble and insoluble fiber.<sup>14</sup> Soluble fiber significantly lowers blood sugar, because soluble fiber can substantially lower blood sugar and reduce the glycemic response. Starch hydrolysis in the small intestine is relatively slow and causes a delayed postprandial glycemic response, which can reduce postprandial blood sugar and increase insulin levels.<sup>14,15</sup> The results of another study regarding red beans conducted by another study showed that the blood glucose level of the group that was given red kidney beans (RKB) resulted in lower blood glucose levels than the negative control group.<sup>22</sup> This is because RKB extract is rich in polyphenols and flavonoids which are known to reduce the risk of diabetes and improve glycemic control, thereby helping to lower blood glucose levels in diabetic animals.<sup>30</sup>

Black beans (BB) are a source of a variety of plant-based bioactive compounds, such as polyphenols and, in particular, anthocyanin. Several studies support that eating BB has health benefits, including the prevention of T2DM.<sup>11</sup> Plants are an important source of bioactive compounds with many valuable health effects. Functional foods contain bioactive compounds that can provide health benefits beyond their natural properties when consumed regularly and consistently through a diet.<sup>31</sup> Anthocyanins are an important class of polyphenols featured by their promising effect on T2DM acting on (a) suppression of carbohydrate metabolizing enzymes; (b) decreased transporter expression or glucose activity; (c) inhibition of glycogenolysis and (d) modifying the gut microbiota with anthocyanin breakdown products.<sup>32</sup> In this study it was found that anthocyanin-rich black beans extract increased glucose levels in diabetic rats. One of the effects of anthocyanins on T2DM is to suppress postprandial glycemia through inhibition of  $\alpha$ -amylase and  $\alpha$ -glucosidase enzymes.<sup>31</sup> In other studies of the effects of black beans, based on research results a combination of whole black beans with white rice, a high glycemic index food, significantly reduced the glycemic response in comparison to a white rice control among healthy adult women.<sup>23</sup>

Black beans originate in South America and are most frequently eaten in Latin American and Caribbean cuisine.<sup>33</sup> Legume consumption within traditional diets improves short-term glycemia and insulinemia and reduces the risk of chronic conditions such as T2DM.<sup>34</sup> Findings indicate that even a 1/2 cup of beans can produce reductions in postprandial glycemia. A half cup of beans was provided to study participants during treatment days. This quantity is likely more representative of actual per-meal consumption and beneficial effects for reducing the glycemic response. This result is also in line with study other which showed black bean extract type Black Adzuki Bean had significantly lower

fasting blood glucose levels during the experimental period. Rats that were given Black Adzuki Bean extract had improved insulin response.<sup>24</sup>

The other research results by other study showed in the hyperglycemic rat model black beans caused a reduction in blood glucose. Black bean hydrolyzed protein isolate (HPI) was capable of significantly reducing glucose absorption and uptake in vitro. The black bean HPI is a food source with bioactive compounds that could be used in the management of blood glucose. The effective dose in the in vivo study was 200 mg HPI/kg BW in rats.<sup>25</sup> The HPI generated from black bean protein could be used as a preventive approach to decrease glucose levels in patients with type 2 diabetes.<sup>16</sup> The results of the research also show the consumption of black beans can reduce the curve of glucose and increase insulin sensitivity.<sup>26</sup> Black bean consumption maintains intestinal integrity and insulin signaling after an acute metabolic with glucose, because of modification in gut microbiota.<sup>16</sup> Based on this literature use black beans can be recommended as a part of the dietary strategy to treat subjects with insulin resistance.

## CONCLUSION AND SUGGESTIONS

The benefits of beans for health are that they have a high nutritional content, which can be added to the daily menu. Beans are rich in antioxidants, especially dark-colored beans such as red beans and black beans. These beans are rich in polyphenols and other bioactive compounds that can improve therapeutic T2DM by lowering blood glucose levels and increasing insulin levels. Red beans also have a high fiber content which can decrease blood glucose levels. This suggests that it is better to increase the daily dose of red beans and black beans consumption to treat diabetes.

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