The Efficacy of Therapeutic-Diabetes Mellitus Functional Drink on Blood Glucose and Plasma Malondialdehyde (MDA*)* Levels of Type 2 Diabetes Mellitus Patients

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Abstract. A long-time condition of hyperglycemia in type 2 diabetes mellitus (DM) will cause glucose auto-oxidation, which can increase reactive oxygen stress. Improving the balance between the composition of gut microbiota and host cells in DM patients with prebiotics and probiotics concepts is a therapy to reduce the risk of ongoing inflammation. This study aimed to examine the efficacy of the therapeutic diabetes mellitus functional beverage product from local functional food on blood glucose levels and plasma malondialdehyde (MDA) levels of type 2 DM patients. This study used a "pre-posttest control design". The research subjects were 46 patients with type 2 DM who were divided into two groups: the intervention and control groups. The research sample was selected by a purposive sampling technique. The intervention was conducted by giving 200 ml of *yogurt bengkuang tape ketan hitam* for two weeks. Meawhile, the statistical test used an independent t-test. The results showed that the samples did not have a difference in the mean blood glucose levels before and after the *Yobetam* treatment. The blood glucose levels of the control group were 4.9 ± 39.3, and those of the intervention group were -14.1 ± 52.1. However, the samples showed a difference in the mean MDA levels before and after the *Yobetam* treatment. The mean *MDA* levels of the control group were 0.16 ± 0.39, and those of the intervention group were 0.46 ± 0.37. The functional drink is expected to be an alternative to oral therapy.
Keywords: *Blood Glucose; Malondialdehyde; Diabetes Mellitus*

1. Introduction

The increasing cases of type 2 diabetes mellitus (Type 2 DM) worldwide are considered alarming, especially in the elderly population [1]. The prevalence of type 2 DM sufferers in Indonesia is estimated to increase from 6.9 million people in 2010 to 12 million people in 2030 [2], [3]. The American Diabetes Association has reported that 90-95% of diabetes cases are type 2 diabetes, characterized by insulin resistance resulting in hyperglycemia [4]. Hyperglycemia conditions for a long time will cause glucose autoxidation or non-enzymatic protein glycosylation reactions that can increase reactive oxygen compounds (ROS) [5], [6].

One of the specific environmental factors that remarkably develop metabolic disorders is the composition of the gut microbiota. Patients with diabetes and obesity are characterized by

changes in the gut barrier that leads to disruption of the symbiotic relationship between the gut microbiota and host cells [7], [8]. The concept of prebiotics and probiotics is applied to health by improving the balance of intestinal microbiota, inhibiting the growth of harmful bacteria, and stimulating beneficial bacteria to the host [9], [10].

The development of functional food Ingredients as oral therapy for diabetes mellitus is one of the factors that significantly suppresses the occurrence of complications and reduces the mortality rate from diabetes mellitus [11]–[13]. Animal studies and several human studies have shown that functional food and its bioactive compounds can control carbohydrate metabolism and hyperglycemia and prevent micro and macrovascular complications [13]–[15].

Using functional food ingredients and their bioactive compounds is an effective strategy for a complementary treatment for type 2 diabetes mellitus [1], [11], [14]. *Bengkuang* is a local food ingredient that has excellent functional values and contains bioactive components of inulin with a naturally sweet taste [16], [17]. This component of inulin is very useful for products consumed by people with diabetes mellitus and those on a low-calorie diet [18]. Another known functional food ingredient is *tape ketan hitam*, which contains anthocyanins including the flavonoid group, a group of polyphenols crucial for food because of their beneficial biological effects on the body [16], [19].

The functional food product currently developed is yogurt, fermented milk with bacterial culture consisting of a mixture of Streptococcus thermophilus and Lactobacillus bulgaricus [20]. Two studies analyzing the effects of probiotics on glucose metabolism of rats revealed that consuming probiotics decreased fasting blood glucose, postprandial blood glucose, and HbA1C [21], [22].

The fermentation causes a sour taste and smells so that yogurt is not liked by some groups of people [23]. *Tape ketan hitam* liquid contains lactic acid bacteria and proteolytic enzyme activities that can coagulate milk; thus, *tape ketan hitam* liquid can be combined with yogurt to produce yogurt with a sweet and not too sour taste preferred by many people [18]. The results of the initial laboratory experimental research obtained a functional drink product in the form of *yogurt bengkuang tape ketan hitam* which was named *Yobetam*. The sensory (taste, aroma, color, and texture) of *Yobetam* product had been tested. Moreover, the viscosity test was carried out to explore the thickness of the drink, and the test revealed that *Yobetam* had a value of 150 poise or 150 d.Pa.S. This value is within a normal limit [24], [25]. The nutritional content of protein o *Yobetam* was 1.9432%, fat was 1.3803%, Vitamin C was 0.0361%, and glucose content was 0.9611%. This study continued to test the efficacy of therapeutic-diabetes mellitus

functional drink on blood glucose and plasma malondialdehyde (MDA) levels in type 2 diabetes mellitus patients.

2. Methodology

This study was an experimental study with a pre-posttest control design. The sample in this study were 46 diabetes mellitus patients, aged years and above. They were selected using the purposive sampling technique. The sample was divided into two groups: 23 patients in the intervention group and 23 patients in the control group. The dependent variables were fasting blood glucose levels and malondialdehyde levels (MDA). Meanwhile, the independent variable was the intervention of 200cc of *yogurt bengkuang tape ketan hitam* (*Yobetam*) functional drink consumed every day for 2 weeks.

The data were collected using interviews, questionnaires, forms and checklists, home observations by trained enumerators, and direct measurements by professionals, such as nutritionists, doctors, and health analysts. The intervention was conducted by field workers who had been trained and invited to work together; they were two nutritionists as the daily person-in-charge. The characteristics of research subjects were collected with interviews, questionnaires, and direct observations. Anthropometric data were measured using standard procedures. Fasting blood glucose levels were measured under fasting conditions for 8-12 hours and examined using the enzymatic method with the enzyme glucose oxidase or hexokinase [10]. The MDA measurements were carried out using a spectrophotometer at an excitation wavelength of 515 nm and emission of 553 nm [10]. the data were analyzed using the paired t-test if the data had been normally distributed; the data were analyzed using the Wilcoxon test if the data had not been normally distributed. This research was guided by three basic principles of research on humans and paid attention to the principles of respecting humans, benefit, and justice with the ethical reviews.

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3. Results and Discussion

The characteristics of the research sample are presented in Figure 1.

Figure1. Distribution of Interventions and Controls by Gender

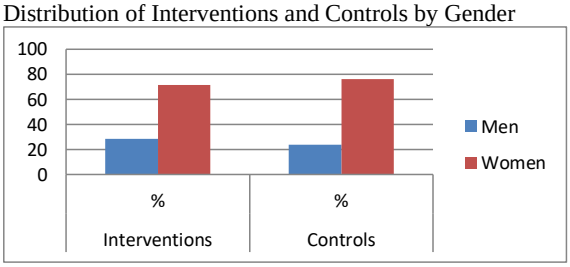

Figure 1 denotes that there are more women than men in both groups. The percentage of women in the intervention group was 71.4%, while that in the control group was 76.2%.

The average blood glucose and malondialdehyde (MDA) levels before and after the treatment with *Yobetam* are described in Figure 2.

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Figure 2. Average Blood glucose Levels before and after *Yobetam* Treatment

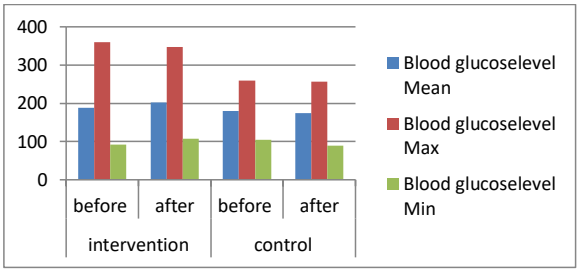

Figure 2 denotes that the average intervention blood glucose levels after the treatment were 187.8 ± 65.9 (before) and 201.6 ± 66.6 (after). Blood glucose levels of the control group decreased from 179.5 ± 48.5 before the treatment to 174.6 ± 44.0 after the treatment.

Figure 3. MDA Levels before and after *Yobetam* Treatment

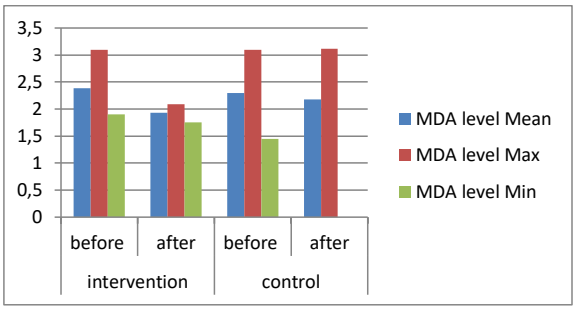

Figure 3, the MDA levels of the intervention and control groups decreased after receiving the treatment: from 2.39 ± 0.37 (before) to 1.93 ± 0.10 (after) in the intervention group and from 2.30 ± 0.44 (before) to 2.18 ± 0.34 (after) in the control group.

The 200 ml of the functional drink of *yogurt bengkuang tape ketan hitam (Yobetam)* was daily administered to 21 samples (intervention) for 15 days was given. The effects of the yogurt on blood glucose levels and MDA interventions and controls are summarized in Tables 3 and 4.

Table 1. Mean Differences in Blood Glucose Levels before and after *Yobetam* Treatment

Groups	Before (mean ± SD)	After (mean ± SD)	Differences (mean ± SD)	p-value
Intervention	187.8 ± 65.9	201.6 ± 66.6	-14.1 ± 52.1	0.189
Control	179.5 ± 48.5	174.6 ± 44.0	4.9 ± 39.3	

Table 1 denotes that there was no difference in the mean blood glucose levels of the control group (4.9 ± 39.3) and the intervention group (-14.1 ± 52.1) before and after the *Yobetam* treatment. The statistical analysis discovered that the p-value was 0.189 or $p > 0.05$.

Table 2. Mean Differences in MDA Levels before and after *Yobetam* Treatment

Group	Before (Mean ± SD)	After (Mean ± SD)	Differences (Mean ± SD)	p-value
Intervention	2.39 ± 0.37	1.93 ± 0.10	0.46 ± 0.37	0.006
Control	2.30 ± 0.44	2.18 ± 0.34	0.16 ± 0.39	

Table 2 signifies that there was a difference in the mean levels of MDA before and after the *Yobetam* treatment in the control group (0.16 ± 0.39) and the intervention group (0.46 ± 0.37). The statistical analysis revealed that the p-value was 0.006 or $p < 0.05$.

The statistical results showed that the *Yobetam* treatment had no effect on blood glucose levels because the p-value was 0.189 ($p > 0.05$). This was due to the small mean difference between the two groups, namely 8.3 which shows almost the same mean. Therefore, the results of the significance test between the two groups were not significantly different. Blood glucose values of the control and intervention groups were close to the normal limits of 179.5 mg/dL and 187.8 mg/dL. In addition, the blood glucose value of the intervention group did not increase significantly, and that of the control group insignificantly decreased.

Yogurt is referred to as a probiotic drink, containing good bacteria; meanwhile, yam contains inulin which acts as a probiotic component because it can increase the growth of good bacteria [26]. Therefore, using yam juice in yogurt production will result in 5ncreasin drink products [26]. Probiotics can lower blood glucose by increasing inflammation and preventing cell destruction in animals. However, human clinical studies using various probiotics have shown mixed results. Some studies found no effects, while other studies have identified significant glucose-lowering effects.

The second assumption Is that the”rese’rch subjects were less obedient to their diet. Diet in maintaining the consumed food is often an obstacle for people with type II diabetes mellitus because they are still tempted to consume all forms of food that can worsen their health. The weakness of this study was that it could not strictly control the diet of the research subjects.

The statistical results showed that the *Yobetam* treatment affected MDA levels with a p-value of 0.006 ($p \leq 0.05$). Meanwhile, [22] discovered that physical exercise and dietary restrictions could decrease plasma MDA levels of diabetic subjects after 12 weeks.

Malondialdehyde (MDA) is the end product of PUFA of which levels increase due to increasing acyl-CoA activities. This causes oxidative stress, which is a state of imbalance between pro-oxidants and antioxidants by the formation of reactive oxygen species (ROS) that exceeds the ability of the antioxidant defense system and decreases or persists the ability of antioxidants. The reaction between ROS and polyunsaturated fatty acids on the cell wall will form aldehydes, such as MDA, through the lipid peroxidation process [27].

MDA is used as an oxidative stress marker in people with diabetes mellitus and other diseases. MDA can be found in plasma, serum, tissue, and urine. The indications of oxidative stress are related to lipid peroxidation and cellular damage. A high concentration of MDA indicates an oxidation process in the cell membrane. High antioxidant status is usually followed by a decrease in MDA levels. MDA is measured as the lipid peroxidase index in the patient’s plasma. An increase in antioxidant activities will be able to reduce MDA levels in the body. Such a condition illustrates that some antioxidants, such as vitamin C, vitamin E, and carotenoids in fruits and vegetables, protect against oxidative damage to lipid peroxidation and antioxidant status. In this case, these antioxidants decreased. The MDA value indicates lipid peroxidation and antioxidant status.

4. Conclusion

The research samples showed no difference in the mean blood glucose levels before and after the *Yobetam* treatment; the control group’s mean blood glucose levels were 4.9 ± 39.3, and the intervention group’s mean blood glucose levels were -14.1 ± 52.1. However, the research samples showed a difference in the mean levels of malondialdehyde (MDA) before and after the *Yobetam* treatment; the control group’s MDA level were 0.16 ± 0.39, and the intervention group’s MDA level were 0.46 ± 0.37.

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