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The Effect of Composites Containing Daluga on Blood Glucose Levels of White Rats (*Rattus norvegicus*)

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Abstract. Blood glucose is a term that refers to the glucose level in the blood. The food type and physiological functions of the body can increase blood glucose. The right food can maintain stable blood sugar. One food source that can maintain stable blood sugar is tubers. One of them is daluga tubers which have a low glycemic index value. This study aims to determine the effect of giving composites made from daluga tubers for 42 days on the blood glucose levels of white rats (*Rattus norvegicus*). This study used a completely randomized experimental design with nine treatments and three replications. An experimental animal was given 30 g of food each day for 42 days based on the group of treatments. The drinking water was given ad libitum. Blood glucose was measured on days 21 and 42. The results showed that providing daluga-based composite feed to mice affected blood glucose levels ($p<0.05$). The feeding treatment was 100% composite 3 consisting of 30% daluga flour, 40% rice flour, and 30% corn flour, a daluga-based food can potentially be a food ingredient that can maintain stable blood glucose levels. So it can be concluded that composite 3 could be safe to consume by the diabetes patient.

***Keywords*:** blood glucose; *Cyrtosperma merkusii*; daluga; glycemic index

I. INTRODUCTION

Functional food is food or drink that can provide health benefits for the body is useful in fulfilling nutrition and does not have a bad impact on the metabolism of other nutrients if used in recommended amounts. Daluga tubers (*Cyrtosperma merkusii* (Hassk.) Schott) are a type of food that has high fiber value [1]. The concentration of glucose in the blood may be affected by the amount of dietary fiber consumed. A high dietary fiber intake is associated with a reduced glycemic index (GI) value [2]. The glycemic index is a value that shows the potential for increasing blood sugar from carbohydrates in a food. Foods with low GI experience a slow digestion process so their absorption is also slow, whereas foods with high GI experience a faster digestion process so their absorption is higher [3].

Daluga (*Cyrtosperma merkusii* (Hassk.) Schott) is a species from Araceae family. The carbohydrate content, especially starch, in daluga, is 89.5%. High starch content can potentially be used as raw material for starch-resistant starch [4]. According to Santonia [5], the glycemic index value of daluga will differ based on the form of planting maintenance and processing.

Diabetes is a generative disease that currently attacks people regardless of age. This is caused by lifestyle and the type of food consumed [6,7]. Blood glucose levels are a parameter used to determine the presence or absence of diabetes [8,9]. Blood glucose levels can indicate a disturbance in metabolic activity in the body.

This research aims to prove that consuming composites made from daluga can maintain stable blood glucose levels and is safe for consumption. It will also be determined which type of composite made from daluga has the best effect in maintaining stable blood glucose levels. This study used white rats (*Rattus norvegicus*) because they are physiologically and metabolically similar to humans [10].

II. METHODS

Research Design

The research design used was a completely randomized design (CRD) with 9 treatments and 3 replications:

- Composite 1 = 20% daluga flour, 10% rice flour, and 70% corn flour
- Composite 2 = 30% daluga flour and 70% rice flour
- Composite 3 = 30% daluga flour, 40% rice flour, and 30% corn flour
- Composite 4 = 35% daluga flour, 60% rice flour, and 5% konjac gum

Treatment Groups:

- Group A = 100% composite 1
- Group B = 100% composite 2
- Group C = 100% composite 3
- Group D = 100% composite 4
- Group E = 50% composite 1 + 50% commercial feed
- Group F = 50% composite 2 + 50% commercial feed
- Group G = 50% composite 3 + 50% commercial feed
- Group H = 50% composite 4 + 50% commercial feed
- Group I = 100% commercial feed

Research Procedure

This study was conducted within the experimental animal facility at the Faculty of Veterinary Medicine, Brawijaya University, Malang, East Java. Each rat was housed in a cage with designated areas for feeding and drinking. Before treatments, the experimental animals underwent a one-week acclimatization period. The daily food allowance was set at 30 grams per animal, with water provided ad libitum.

The experimental feeding treatment for rats was carried out for 42 days. Blood glucose measurements were carried out on the 21st and 42nd days after treatment. On the twenty-first day, blood was collected from the retro-orbital plexus vein of the rat. The collected blood was put into a microtube and then centrifuged.

On the 42nd day, the blood was taken via cardiac puncture using a 5 cc syringe. Before the blood collected rats were anesthetized. The rats were then dissected and the blood was taken through the left heart ventricle. The blood obtained is then put into an EDTA microtube and centrifuged to obtain blood plasma.

Parameter Observation

Blood glucose levels were determined using the method of glucose oxidase-peroxidase aminoantypyrine (GOD-PAP). Blood plasma was taken from each treatment and replication. The standard tube is filled with 10 µL of glucose standard and 1000 µL of kit reagent, the sample tube is filled with 10 µL of sample and 1000 µL of kit reagent. The solution was homogenized and allowed to incubate at 25°C for 10 minutes. The blank contains 1000 µL of kit reagent. The absorbance was read with a spectrophotometer at 500 nm within 60 minutes. Blood glucose levels are calculated using the formula:

Glucose (mg/dL) =

$$\text{Standard concentration} \times \frac{\text{Sample Absorbance}}{\text{Standard Absorbance}}$$

Data Analysis

The data were analyzed using One Way ANOVA and Duncan test with a 95% confidence level ($p<0.05$) using SPSS software.

III. RESULTS AND DISCUSSION

Results

Data on blood glucose levels of white rats after receiving treatment with 9 types of daluga-based composites for 42 days can be seen in Figure 1.

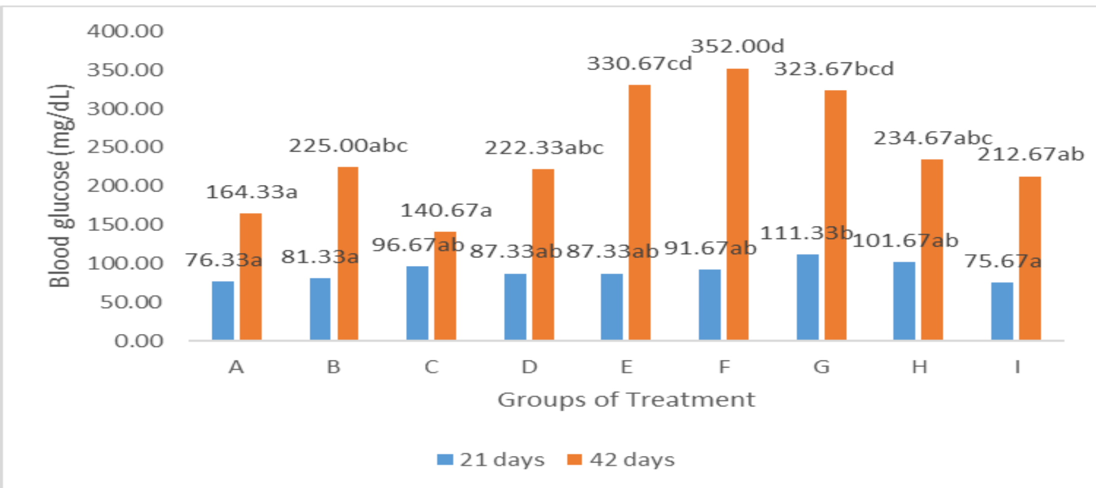

Figure 1. Blood glucose levels (mg/dL) of treated rats. Blood samples were taken after 21 and 42 days of treatment.

Based on Figure 1, it appears that giving treatment till day 21 influenced white rat's blood glucose levels significantly ($p<0.05$). Control (group I) showed the lowest blood glucose level values but was not significantly different ($P>0.05$) from groups A, B, C, D, E, F, and H. However, the blood glucose levels in groups A, B, and I different significantly (P<0.05) from treatment group G. The 42 days after treatment, showed that there were significant differences in blood glucose levels between groups (p<0.05). Group F showed the highest blood glucose level 352 mg/dL, and the lowest in group C was 140.67 mg/dL (Figure 1).

Statistical tests on the average difference between 21 days to 42 days in blood glucose levels of white rats showed that there were differences between groups (P<0.05) (Figure 2). The highest average difference in blood glucose levels was shown by treatment group F at 260.33 mg/dL, and the lowest was in group C at 44 mg/dL.

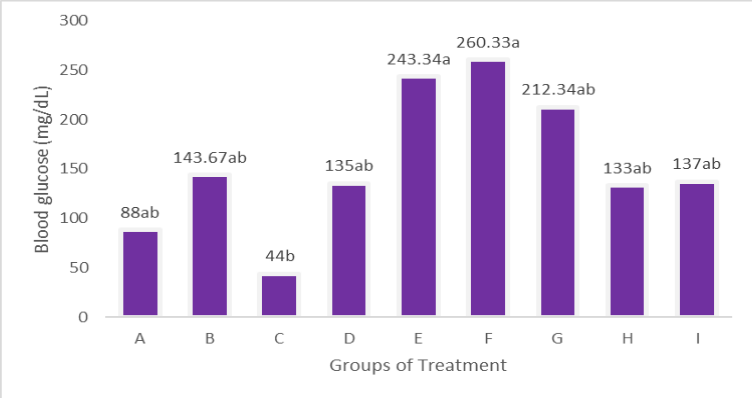

Figure 2. The average difference in blood glucose levels of white rats (*Rattus norvegicus*) on days 21 and 42.

Discussion

This study showed that giving a daluga-based composite as biscuits for 21 days can increase white rats' blood glucose levels. However, the increase in blood glucose is still within the normal range. Different things happened when the treatment was continued until the 42nd day. Rat's blood glucose levels in all treatments increased above normal limits. On day 42 (end of treatment), the rats' average blood glucose level ranged from 140.67-352 mg/dL. According to Hidayaturrahmah [11], the normal value for blood glucose levels in white rats is 50 – 135 mg/dL. This shows that on the 42nd day after treatment, there was an increase in blood glucose levels above normal values. Blood glucose levels reflect the energy sources in the body. Carbohydrates not only provide energy but also function in maintaining the body's acid-base balance. This equilibrium is essential for numerous metabolic processes and the form of cell structures [12].

Increased blood glucose levels can be caused by the type of food intake that comes from carbohydrates, damage to the pancreas because it cannot produce insulin, and also stress. The increase in blood glucose levels noted on day 42 of this study is postulated to stem from sustained feeding practices, as evidenced by the increased value across all groups. Upon the entry of glucose into the cells, a process of phosphorylation is commenced, leading to the conversion of glucose into glucose-6-phosphate. This phosphorylation process is assisted by the hexokinase enzyme as a catalyst. Carbohydrates have a metabolic function as fuel for oxidation processes, and provide energy for metabolic processes [13].

In this study, group F showed the highest blood glucose level, and group C showed the lowest. This showed that the composition of the feed ingredients used will influence the value of glucose absorption. Feed F consists of 50% composite 2 (30% daluga flour and 70% rice flour) and 50% commercial feed, meanwhile, Feed C consists of 100% composite 3 (30% daluga flour, 40% rice flour, and 30% corn flour %). It is suspected that the composition of composite 3 can affect the glycemic index (GI) value so that glucose absorption in the intestine becomes slower.

According to Santonia *et al.* [5], daluga flour has a GI value of 70.98, different from corn flour which has a GI value of < 55 [14], and rice flour has a GI value of 88.0 [15]. The glycemic index can provide an overview of the effects of certain foods on blood glucose levels. So the glycemic index can be used as an easy and effective way to control blood glucose conditions. A high glycemic index indicates that the food can increase blood glucose levels rapidly. On the other hand, foods that have a low GI slow down the rise in blood glucose levels [16].

Low glycemic index foods cause slow absorption of the food suspension. This is because the resulting food suspension is slower to reach the small intestine therefore the digestion process occurs slowly. The food glycemic index is affected by many factors, for instance, the amount of dietary fiber and the proportion of amylose to amylopectin [3], the digestibility of starch, protein, and fat, and their processing method [17]. This research shows that the food ingredients in treatment C can lower the speed at which blood glucose levels increase in white rats.

Research conducted by Moko *et al.* [1] shows that daluga tubers have a high total fiber value, namely 2.77%. The presence of dietary fiber can affect blood glucose levels. High dietary fiber content can lower the GI values [2]. This is then one of the main factors in low blood glucose levels of white rats due to the provision of feed components of daluga tubers. Dietary fiber can slow down the food movement through the digestive tract and decrease the activity of digestive enzymes, resulting in a slower digestion process, especially for starches. As a result, this leads to a reduced blood glucose response, which is indicated by a lower glycemic index. According to Lal *et al.,* [3], carbohydrates from different plants have different glycemic responses. Differences in glycemic response can also occur in carbohydrates from the same plant but have some varieties. This research shows that differences in the composition and concentration of the ingredients in feed can affect the metabolism of the feed in the body which can then affect the blood glucose levels.

IV. CONCLUSION

The intake of certain daluga composites may help maintain stable blood glucose levels. Composite 3, consisting of 30% daluga flour, 40% rice flour, and 30% corn flour, shows potential for reducing and stabilizing blood glucose levels. Additional investigation is required to fully explore the effects of this composition on individuals with diabetes.

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