# GLUCOSE AND PROXIMATE ANALYSIS IN CEREALS SUBSTITUTING CASSAVA FLOUR AND RED BEANS

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## ABSTRACT

Diabetes mellitus is a disease or chronic metabolic disorder characterized by high blood sugar levels accompanied by disorders of carbohydrate, lipid and protein metabolism as a result of insulin function insufficiency. Diabetics are advised to pay attention to the food they consume, preferably low in sugar. In general, cereals on the market are made from wheat flour which contains quite a lot of sugar, so it is necessary to modify cereal recipes to increase nutritional value. Cassava flour is a food source of carbohydrates with a lower calorie content than wheat flour. Red bean flour has a fairly high protein content and a low glycemic index, so the substitution of cassava flour and red bean flour is expected to increase the nutritional value. This study aims to determine the effect of substituting cassava flour and red bean flour on the nutritional value of cereals. This research used True Experimental with 4 treatment levels and 6 replications. The treatment applied was the ratio of wheat flour: cassava flour: red bean flour at each P0 (100:0:0), P1 (10:50:40), P2 (10:60:30), P3 (10: 70:20). Based on the research results, it shows that there is an effect of reducing glucose, energy, fat, carbohydrate and water levels compared to those without substitution. There was an increase in protein and ash content in the treatment. The cereal formulation that has the expected nutritional content is the P3 formulation

Keywords: Cereals; Cassava Flour; Red Bean Flour; Proximate Test

## 1. INTRODUCTION

The prevalence of DM in the world continues to increase from year to year. According to the latest data from *the World Health Organization* (WHO), almost 150 million people in the world suffer from DM and it is estimated that the number will continue to increase every year (Kemenkes R1, 2020). The latest data for 2021 shows that around 19.46 million people in Indonesia suffer from diabetes, this number has increased by 81.8% compared to 2019 (RI, 2024). Based on the East Java Health Profile, the prevalence of diabetes mellitus in East Java in 2021 is around 6.8% of the population, while in Tuban Regency the prevalence of diabetes mellitus is 1.7% and is ranked second in degenerative diseases (East Java, 2021).

One of the therapies carried out is diet therapy. The principles of regulating food for (Sulistyowati, 2017). The typical eating schedule for DM sufferers is 6 meals per day divided into 3 large meals and 3 snacks. (Zaddana et al., 2021), (A., 2012). Advances in food technology have produced various food products that are practical to consume, such as cereals (Zaddana et al., 2021). Cereal is a type of processed food made from wheat flour which is processed into flakes, strips or extrudates through an extrusion process. Cereals are usually eaten cold or warm with milk and water for breakfast or as a snack. (Bayu & Aminah, 2017). According to *the Food and Agriculture Organization of the United Nations* (FAOStat, 2015), Indonesia was ranked 15th in the world in

cereal consumption per capita in 2011, with an increase in cereal consumption from 180 tonnes in 2008 to 196 tonnes per capita population in 2012 Cereal Indo. Cereals as a snack can fulfill 10% of daily needs. Cereal raw materials are a source of carbohydrates, such as wheat and oats (Zaddana et al., 2021).

One modification to the recipe is to substitute wheat flour with cassava flour and red bean flour. Cassava has quite complete nutritional content, including carbohydrates, fat, protein, and other nutrients. Cassava contains 154 calories per 100 gr, while wheat flour contains 363 calories per 100 gr. The protein content in cassava is considered low, so it can replace wheat flour in making all types of cakes (Apriyani et al., 2022). Due to the low protein content in cassava flour, it is necessary to substitute other flours that support it as a source of protein in nutrient-dense snacks. Red beans are classified as a vegetable food in the legume group, in the same group as green beans, soybeans and cowpeas. Red beans themselves contain protein, B vitamins, calcium, phosphorus and iron. The protein content of red beans is quite high, namely 22.1 grams per 100 grams of dried red beans (Kementerian Kesehatan RI, 2017). Red beans also have a low GI, namely 26, the lowest among types of beans (Istiqomah & Rustanti, 2015). Apart from its high protein value, red beans are also cholesterol-free, so they are safe for consumption by all groups of people from various age groups (Carella, 2016). Consuming red beans has also been found to be beneficial for reducing LDL cholesterol levels which are bad for human health, as well as increasing HDL cholesterol levels which are good for human health (Iqbal et al., 2015). Red bean flour has a higher protein content when compared to the protein content of other flours. 100 grams of red bean flour contains 17.24 grams of protein. Apart from the high protein content, the energy content of red bean flour is also higher than other types of flour (Kurnianingtyas et al., 2014).

According to research by (Mulyani, 2013), the smaller the proportion of fermented cassava flour, the higher the protein content in the cake. In another study, the energy content of green bean cassava cereal contained 114.5 kcal, this amount is the same as the energy for snacks. The fat content of F3 cereal contains 2.66 grams of fat, slightly lower than commercial cereal, namely 3 grams (Purbowati et al., 2022)

Based on research (Istiqomah & Rustanti, 2015), feeding red beans with 20% energy is more effective in reducing blood sugar levels in DM rats by up to 69%. This is because dietary fiber and resistant starch affect the viscosity and absorption of sugar, thereby potentially lowering blood sugar. Other research related to making cereal from brown rice flour and red bean flour states that the water content analysis is in accordance with SNI 01-4270-1996, which states that the maximum water content in cereal milk is 3%. Wet water content has a theoretical maximum limit of 100%, while water content based on dry weight can be more than 100% (Wahjuningsih et al., 2018).

Substituting cassava flour and red bean flour can be an alternative to wheat flour to further increase the nutritional value of these cereals. Diabetes mellitus sufferers are advised to pay attention to the sugar content of the types of food they consume by choosing foods that contain various types of carbohydrates, such as processed grains, tubers, and nuts. The food chosen is also low in sugar to control blood sugar levels (Ruslan, 2015), For it to be a suitable snack for DM sufferers, it is necessary to modify the cereal recipe to increase its nutritional value.

Based on the background above, researchers want to analyze the

nutritional content of cereals by substituting cassava flour and red beans as low-glucose foods.

## 2. METHOD AND ANALYSIS

This research design uses an experiment with the *True Experimental Design research type* with a *Completely Randomized Design* (CRD) method aimed at assessing a treatment or action. The main ingredients used in this research were cassava flour and red bean flour and other supporting ingredients such as wheat flour, sugar, chicken eggs, margarine, vanilla and salt. The tools used in processing cereal substitutes for cassava flour and red bean flour are basins, scales, mixers, baking pans, ovens, spoons and aluminum foil. This research used 4 treatment levels and 6 replications. The treatment applied was the ratio of wheat flour : cassava flour : red bean flour at each P0 (100:0:0), P1 (10:50:40), P2 (10:60:30), P3 (10: 70:20).

This research was carried out in May-June 2023. The manufacture of cassava flour and red bean flour cereals was carried out at the Nutrition Undergraduate Laboratory of the Nahdlatul Ulama Institute of Health Sciences, Tuban. Analysis of glucose and proximate levels of nutrients in cereals substituted for cassava flour and red bean flour at the Chemistry Laboratory, Faculty of Science and Mathematics, Satya Wacana Christian University, Salatiga.

## 3. RESULT AND DISCUSSION

### Blood Glucose Analysis

Based on the results of the laboratory test analysis, cereal glucose with the addition of cassava flour and red bean flour level increased. The highest percentage of glucose value was found in treatment P2 with a ratio of 10% wheat flour, 60% cassava flour, 30% red bean flour containing 0.77% glucose, while the lowest glucose was in treatment P3 with a ratio of 10% wheat flour, 70% cassava flour, 20% red bean flour contains 0.51% glucose as shown in table 1.

Table 1. Lab test for glucose levels

| Nutrients | Treatment Comparison Wheat Flour: Cassava Flour: Red Bean Flour | | | |
|---|---|---|---|---|
| | P0 (100:0:0) | P1 (10:50:40) | P2 (10:60:30) | P3 (10:70:20) |
| Glukosa(%) | 0,52% | 0,52% | 0,77% | 0,51% |

### Energy Analysis

Based on the results of lab test analysis, the energy of cereals with the addition of cassava flour and red bean flour has increased. The highest percentage of energy value was in treatment P1 with a ratio of 10% wheat flour, 50% cassava flour, 40 red bean flour, namely 593.45 kcal, while the lowest energy was in treatment P0 with a ratio of 100% wheat flour, 0% cassava flour, red bean flour. 0% contains 498.48 kcal of energy.

Table 2. Energy Lab Test

| Nutrients | Treatment Comparison Wheat Flour: Cassava Flour: Red Bean Flour | | | |
|---|---|---|---|---|
| | P0 (100:0:0) | P1 (10:50:40) | P2 (10:60:30) | P3 (10:70:20) |
| Energy (%) | 498,48% | 593,45% | 567,37% | 512,98% |

### Analysis of Protein Levels

Based on the results of laboratory test analysis, the protein content of cereals with the addition of cassava flour and red bean flour decreased. The highest percentage value of protein content was in treatment P0 as a control treatment with a ratio of 100% wheat flour, 0% cassava flour, 0% red bean flour. The highest comparison of treatments between P1, P2 and P3 was in treatment P1 with a ratio of 10% wheat flour, 50% cassava flour, 40% red bean flour containing a protein content of 9.96% while the lowest protein content was in treatment P3 with a ratio of wheat flour. 10%, cassava flour 70%, red bean flour

20% contain protein levels of 8.33% shown in table 3.

Table 3. Lab test for protein levels

| Nutrients | Treatment Comparison Wheat Flour: Cassava Flour: Red Bean Flour | | | |
|---|---|---|---|---|
| | P0 (100:0:0) | P1 (10:50:40) | P2 (10:60:30) | P3 (10:70:20) |
| Protein (%) | 12,18% | 9,96% | 9,98% | 8,33% |

Fat Content Analysis

Based on the results of laboratory test analysis, the fat content of cereals with the addition of cassava flour and red bean flour has increased. The highest percentage of fat content values was in treatment P2 with a ratio of 10% wheat flour, 60% cassava flour, 30% red bean flour, which contained a fat content of 35.05%, while the lowest fat content was in treatment P0 with a ratio of 100% wheat flour. 0% cassava flour, 0% red bean flour contain a fat content of 21.04% as shown in table 4.

Table 4. Lab test for fat content

| Nutrients | Treatment Comparison Wheat Flour: Cassava Flour: Red Bean Flour | | | |
|---|---|---|---|---|
| | P0 (100:0:0) | P1 (10:50:40) | P2 (10:60:30) | P3 (10:70:20) |
| Fat Level (%) | 21,04% | 34,21% | 35,05% | 30,78% |

Carbohydrate Content Analysis

Based on the results of laboratory test analysis, the carbohydrate content of cereals with the addition of cassava flour and red bean flour decreased. The highest percentage value of carbohydrate content was in treatment P0 with a ratio of 100% wheat flour, 0% cassava flour, 0% red bean flour. The highest treatment comparison between P1, P2 and P3 was in treatment P1 with a ratio of 10% wheat flour, 50% cassava flour, 40% red bean flour containing a carbohydrate content of 61.43% while the lowest carbohydrate content was in treatment P3 with a ratio of 10% wheat flour, 70% cassava flour, 20% red bean flour contain carbohydrate levels of 50.66% as shown in table 5.

Table 5. Lab test for carbohydrate levels

| Nutrients | Treatment Comparison Wheat Flour: Cassava Flour: Red Bean Flour | | | |
|---|---|---|---|---|
| | P0 (100:0:0) | P1 (10:50:40) | P2 (10:60:30) | P3 (10:70:20) |
| Carbohydrate (%) | 65,10% | 61,43% | 53,30% | 50,66% |

Water Content Analysis

Based on the results of laboratory test analysis, the carbohydrate content of cereals with the addition of cassava flour and red bean flour decreased. The highest percentage of carbohydrate content values was in treatment P1 with a ratio of 10% wheat flour, 50% cassava flour, 40% red bean flour containing a water content of 10.91% while the lowest water content was in treatment P2 with a ratio of 10% wheat flour, flour cassava 60%, red bean flour 30% contains a water content of 5.22% shown in table 6.

Table 6. Water content lab test

| Nutrients | Treatment Comparison Wheat Flour: Cassava Flour: Red Bean Flour | | | |
|---|---|---|---|---|
| | P0 (100:0:0) | P1 (10:50:40) | P2 (10:60:30) | P3 (10:70:20) |
| Water content (%) | 9,35% | 10,91% | 5,22% | 5,60% |

Ash Content Analysis

Based on the results of laboratory test analysis, the protein content of cereals with the addition of cassava flour and red bean flour decreased. The highest percentage of ash content values was in treatment P3 with a ratio of 10% wheat flour, 70% cassava flour, 20% red bean flour containing an ash content of 4.02% while the lowest ash content was in treatment P0 with a ratio of 100% wheat flour, flour. 0% cassava, 0% red bean flour contains an ash content of 2.89% as shown in table 7.

Table 7. Lab test for ash content

| Nutrients | Treatment Comparison Wheat Flour: Cassava Flour: Red Bean Flour | | | |
|---|---|---|---|---|
| | P0 (100:0:0) | P1 (10:50:40) | P2 (10:60:30) | P3 (10:70:20) |
| Ash content (%) | 2,89% | 3,90% | 3,28% | 4,02% |

DISCUSSION

a. Glucose Levels

Cereals with substitution of cassava flour and red bean flour have glucose levels P1 0.52% /100 gr, P2 0.77% /100 gr, P3 0.51% /100 gr and cereals without substitution P0 0.52% /100 gr . The highest glucose levels were in P2 cereal with a ratio of 10% wheat flour, 60% cassava flour, 30% red bean flour, namely 0.77% / 100 gr. The lowest glucose levels were in P3 cereal with a ratio of 10% wheat flour, 70% cassava flour, 20% red bean flour, namely 0.51%. This shows that the average glucose levels in the three treatments do not differ significantly, so that the three treatments comply with SNI requirements. 01.42701996 and is good for consumption, namely max. 10.0% and the decrease in glucose levels that occurs is due to having undergone a heating process such as an oven which can affect the glucose levels in a food item.

b. Energy

Cereals with substitutions for cassava flour and red bean flour have higher energy than cereals without substitutions. The highest energy was in P1 cereal with a ratio of 10% wheat flour, 50% cassava flour, 40% red bean flour, namely 593.45 kcal, while the lowest energy was found in P0 cereal with a ratio of 100% wheat flour, 0% cassava flour, 0% red bean flour. % contains 498.48 kcal of energy. An increase in energy can occur in accordance with an increase in the balanced ratio of cassava flour and red bean flour compared to the ratio of other treatments in the resulting cereal substitution. This is in line with research (Pontang & Wening, 2021), the energy produced from the formulation of 50% red bean flour and 50% mocaf flour is good as an alternative snack for athletes because it meets the criteria for *sports foods* and the energy produced is higher than the formulation.

c. Protein

Cereals with substitutions for cassava flour and red bean flour have lower protein levels than cereals without substitutions. The highest protein content in cereal without substitution or P0 is 12.18% / 100 gr. The lowest protein content was in P3 with a ratio of 10% wheat flour, 70% cassava flour, 20% red bean flour with a protein content of 8.33%/100 gr. A decrease in protein levels can occur as the ratio of cassava flour to red bean flour increases and heating processes such as ovens can affect the protein levels in a food ingredient. This is in line with research (Putri et al., 2015) where the protein content in cassava flour is lower, namely 1.1%. Meanwhile, the protein content in wheat flour is 4%. The results of this research are also in accordance with the final results of research in reference journals which state that the protein content in mocaf flour is lower, namely 1.2%, while the protein content in wheat flour is higher, namely 8-13%.

d. Fat

Cereals with substitution of cassava flour and red bean flour have higher fat content compared to cereals without substitution. The fat content in cereal without substitution or P0 is 21.04% / 100 gr. The highest fat content was in P2 cereal with a ratio of 10% wheat flour, 60% cassava flour, 30% red bean flour with a fat content of 35.05% / 100 gr. The increase in fat content occurred in accordance with the substitution ratio of cassava flour and red bean flour, the

smaller the proportion of red bean flour, the higher the fat content produced. This is in line with research (Agusta et al., 2020) that the greater the proportion of red beans eaten, the higher the fat content of the nuggets produced. This is related to the fat content of the raw material, based on the analysis results, red beans have a fat content of 2.21 grams, while cassava's fat content is 0.5 grams. In line with Mahmud et al (2018), red beans have a higher fat content (2.2 gr/100 gr BDD) than cassava (0.5 gr/100 BDD).

e. Carbohydrate

Cereals with substitutions for cassava flour and red bean flour have lower carbohydrate levels compared to cereals without substitutions. The highest carbohydrate content was found in the P0 cereal treatment which was made from 100% wheat flour, namely around 65.10% /100 gr. The lowest carbohydrate content is in P3 with a ratio of 10% wheat flour, 70% cassava flour, 20% red bean flour with a carbohydrate content of 50.66% / 100 gr. The high carbohydrate content in the P0 formulation is because cassava flour and red bean flour have lower carbohydrate levels than wheat flour. This is in line with research (Salimna et al., 2014) which shows that there is a decrease in carbohydrate levels as the amount of red bean flour is increased. Rice formulas with lower levels of red bean flour cause higher carbohydrate levels. This is because in this formula the composition of cassava flour is more than red bean flour and cassava itself has a high amount of carbohydrates (higher than rice), for example in the F1 treatment. The addition of red beans can increase the water content in food, thereby causing a decrease in carbohydrate levels in the remaining mass.

f. Water level

Cereals substituted for cassava flour and red bean flour have higher water content than cereals without substitution. The highest water content was obtained in treatment P1, namely 10.91% / 100 gr. The lowest cereal moisture content was obtained in treatment P2 with a ratio of 10% wheat flour, 60% cassava flour, 30% red bean flour, namely 5.22% /100 gr. The water content increased and then decreased because the greater the ratio of cassava flour, the lower the water content produced. This is in line with research (Hamidah et al., 2019) where the water content of white bread decreases with the addition of the proportion of cassava flour and soybean tempeh. According to (Hamidah et al., 2019) the pre-gelatinization process in making cassava flour can reduce the water content at the parboiling stage, applying heat can cause water absorption so that the starch granules swell. This swelling is *irreversible* and drying after gelatinization causes water to easily escape from the hydroxyl bonds. The decrease in water content in white bread was caused by the addition of cassava flour. Cereal is a type of dry food product, so the lower the water content, the better the quality and the longer it lasts.

g. Ash content

Cereals with substitutions of cassava flour and red bean flour have higher ash content compared to cereals without substitutions. The ash content in cereal without substitution or P0 is 2.89% / 100 gr. The highest ash content was in P3 cereal with a ratio of 10% wheat flour, 70% cassava flour, 20% red bean flour, namely 4.02% /100 gr. This is because the ash content of cereals increases as the addition of cassava flour and red bean flour increases. The higher the addition of cassava flour and the lower the addition of wheat flour, the higher the ash content of the cereal product produced. Ash content is one of the factors that can influence the color of flour, high ash content produces a duller/darker color. This is not in accordance with Salimna's

(2014) statement that there was an increase in ash content with the addition of red bean flour. Red beans contain 65 mg calcium, 44 mg phosphorus and 1.1 gr/100 gr iron and the ash content should not exceed 4%. According to the statement (Herlina & Nuraeni, 2014), the ash content of flakes increases with each addition of red bean flour.

## 4. CONCLUSION

From research on cereals made from cassava flour and red bean flour, it can be concluded as follows:

a. Analysis of glucose levels of substituted cassava flour and red bean flour decreased compared to the control treatment.
b. Analysis of the protein content of substituted cassava flour and red bean flour decreased compared to the control treatment.
c. Analysis of the fat content of substitute cassava flour and red bean flour increased compared to the control treatment.
d. Analysis of the carbohydrate content substituted for cassava flour and bean flour decreased compared to the control treatment.
e. Analysis of the water content of substituted cassava flour and red bean flour decreased compared to the control treatment.
f. Analysis of the ash content of substitute cassava flour and red bean flour increased compared to the control treatment.

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