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CHARACTERISTICS RELATED TO THE NUTRIENT COMPOSITION OF WHITE BREAD WITH THE ADDITION OF TARO LEAVES (*Colocasia Esculenta* (L). Schott) AS ANTIDIABETIC FOOD

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ABSTRACT

Diabetes Mellitus (DM) is a metabolic disease that occurs due to increased blood glucose levels as a result of the body's inability to process carbohydrates or glucose. The most crucial thing in diabetes mellitus is diet, especially when it comes to choosing food. The good news is that Taro leaf (*Colocasia esculenta* (L). Schoot), as a raw material, has a potential to control blood glucose levels and can be functional by adding it to food such as white bread. The aim of this study is to determine the best formula of white bread modified with the addition of taro leaves that can have a positive impact on people with diabetes. This is an experimental study with one factor completely randomized design using four treatments in which white bread with additional taro leaves 0%, 5%, 10%, and 15%. These breads will be analyzed for their nutrition (carbohydrate, protein, fat, water, ash) product acceptance, antioxidant activity, and glycemic index and glycemic load. The best formula was obtained by the De Garmo method. There was no difference in the mean percentage value of inhibition and protein content of white bread with taro leaves added even though carbohydrate, fat, water, and ash content showed a difference. The highest value of carbohydrate content was at 15% taro leaf white bread (52.46%), the highest fat was at 0% (7.71%), the highest water was at 10% (36.52%), the highest ash was at 0% (1.56%) and the highest antioxidant activity was at 10%. The glycemic index and load of 10% indicated a high category (93.07% and 21.78 g/100 g of food). However, based on the results, there was a decrease in blood glucose response in taro leaves white bread compared to white bread without the taro leaves added. Organoleptic analysis showed that the formulation with the highest acceptance level was 10%. Therefore, the best formulation chosen based on The Effectiveness Index (De Garmo) was 10% taro leaf white bread with a value of 0.75.

Key words: taro leaves, white bread, functional food, nutrient content, antidiabetic

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INTRODUCTION

Type 2 Diabetes Mellitus (T2DM) is very common and accounts for about 90% of all Diabetes mellitus (DM) cases in the world [1]. Indonesia is the 7th of the top 10 countries estimated to have many DM patients of about 5.4 million by 2045 [2]. Reactive oxygen species (ROS), as a result of hyperglycemia, are known to destroy nucleic acids, lipids, and proteins [3]. Associated pathophysiological mechanisms suggest that the presence of excess oxygen and nitrogen species causes oxidative stress [4].

Selection of food types is crucial for people with diabetes. Taro leaves (*Colocasia esculenta* (L). Schoot) is raw ingredient with a low Glycemic Index (GI) [5] and can be as a source antioxidant. Studies show that it has the highest alpha-glucoside inhibitor activity among the other parts of the plant that can act competitively and reversibly in inhibiting alpha-glucosidase, an intestinal enzyme. This slows the digestion of carbohydrates as well as delay glucose absorption, which also slows and reduces the increase in blood glucose levels. Another study showed ethanolic extract of *Colocasia esculenta* (Araceae) in diabetic rats at 400 mg/kg for 14 days exhibited antihyperglycemic activity which showed potential anti-diabetes [5].

Taro leaves have complex carbohydrates known as amylose and amylopectin [6] and rich in protein, ascorbic acid, fiber, and other important minerals including, thiamine, riboflavin, iron, phosphorus, zinc, vitamin B6, vitamin C, niacin, potassium, copper, and manganese. The fiber in taro leaf stops the addition of cholesterol and fat in the bloodstream, while potassium helps in maintaining normal blood pressure [7].

White bread is a processed food product, with the main ingredient being wheat flour. Furthermore, it is tasteless, therefore, various toppings such as jam, margarine, or sprinkles can be added. According to the National Socio-Economic Survey (SUSENAS) data, in 2018 the consumption of white bread was 19,085 per small pack/year [8].

Based on the description above, this study aims to develop functional food processed products based on local ingredients, white bread with the addition of taro leaves as an antidiabetic food. This product can later be consumed by DM patients and healthy people. Therefore, this study conducted tests on the nutritional content, antioxidant activity, glycemic index and load, as well as organoleptic tests of bread with the addition of taro leaves.

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MATERIALS AND METHODS

This research used a completely randomized single factor experimental design. Analysis of nutrient content and antioxidant activity was carried out at the Integrated Laboratory of Universitas Diponegoro, Semarang. There were four different formulas, each having taro leaves added in varying amounts (0%, 5%, 10%, and 15%). The composition of the ingredients used in each formulation is presented in Table 1 and the process of bread making in Figure 1.

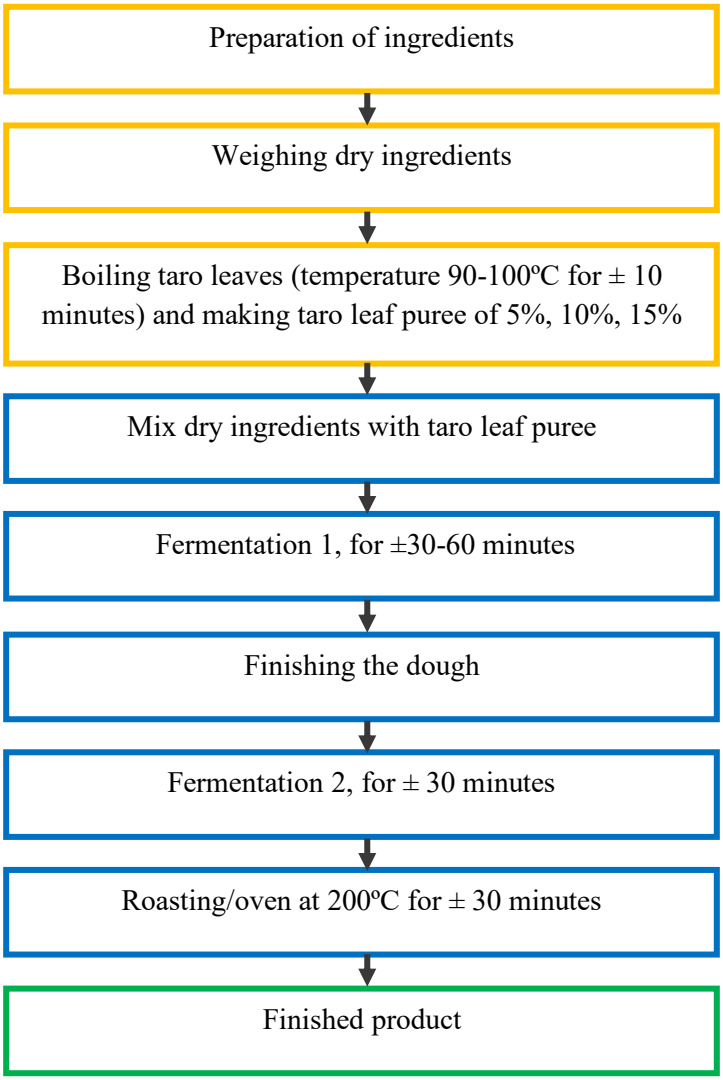

Figure 1: Making Taro Leaf White Bread

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Nutritional Content Analysis

Protein Analysis

Analysis of protein content was measured using the Kjeldahl method [9]. A measure of 0.5 grams was put into the Kjeldahl flask. Twenty five ml of concentrated sulphuric acid and 2 g catalyst (contain SeO_2, K_2SO_4, and $CuSO_4$) was added into the flask. The flask was shaken gently to mix the sample, acid, and catalyst. The solution was heated for approximately 2 hours to digest the solution until a clear green colour was seen that indicates a complete chemical digestion. The solution was then cooled to room temperature.

The digest solution was transferred into a conical flask and distilled water added until had final volume of 100 ml. Five (5) ml of diluted digest solution was taken into a distillation flask. Five (5) ml NaOH 30% was added and the digest solution distilled for 10 minutes and the result were collected in a conical flask that contained 10 ml of boric acid 2% and few drops of phenolphthalein. The distillate colour was adjusted with HCl 0.1 N till it became slightly pinkish. The amount of HCl 0.1 N used in the titration to determine crude protein was noted.

Analysis of Fat Content

The Soxhlet apparatus was used to measure the fat content. Twenty (20) grams of the material were weighed and wrapped in Whatman filter paper. The flat-bottom flask was put in the oven for one hour at 105°C, while the round bottom flask was cooled before being placed in a desiccator for 30 minutes. The round bottom flask's weight was measured and recorded. The boiling stone was placed in a round bottom flask using a single spatula spoon, and the flask's weight was recorded after that. Then, 250 ml of hexane was added to a flask with a round bottom.

The condenser's water circulation system was activated. The temperature level was set to number 5 and turned on to heat. The hexane solvent was boiled, releasing vapour into the vapour pipe, where it would then condense. The sample and the hexane solvent reacted to separate the components. The solvent was redirected into the flat-bottom flask once the syphon was filled. The sample was cooled for 30 minutes in a fume hood. The weight of the flask with a circular bottom that contained the extracted oil was measured and recorded. A rotary evaporator operating at 40°C and 500 mmHg was used to evaporate the solvent from the fat extract. The fat-containing bottom flask was weighed and the results recorded.

$$\% \text{ Fat} = \frac{W - W_1}{W_2} \times 100\%$$

W: weight of flask containing boiling stones and oil extracted
W_1: weight of flask containing boiling stones

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W_2: weight of sample

Carbohydrate Analysis

Carbohydrate content analysis used difference method. Content of carbohydrate obtained by subtracting total energy with total protein and total fat. The water content analysis was done by weighing the bottle with the cap on and recording the weight. One gram sample was put in a bottle. It was dried in a 105°C oven for three hours then used a desiccator to cool it. The outcome was weighed and repeated until a set weight was reached.

$$\%water = \frac{W}{W_1} \times 100\%$$

W: sample weighed before drying
W_1: sample weighed after drying

An analysis of the ash composition was carried out using samples that weighed 2 grams. The sample's liquid was evaporated until it was completely dry. The electric furnace was run at its highest setting until full ashing was attained. After cooling in a desiccator, the sample was weighed to a consistent weight.

$$\%ash = \frac{W_1 - W_2}{W} \times 100\%$$

W: sample weighed before ashing
W_1: sample and petri dish weighed after ashing
W_2: petri dish weighed

Organoleptic Test

The organoleptic test includes parameters of color, taste, aroma, and texture of taro leaf white bread using four scales, 1=very dislike, 2=dislike, 3=like and 4=very like. The test was conducted on 40 panelists at Universitas Diponegoro.

Antioxidant Activity Test

The antioxidant activity test using the DPPH method (1, 1 dhipenyl-1-pycrilhidrazyl) was carried out three times. Before conducting the test, a sample of fresh bread was extracted as the ingredient being tested. The ingredients used in the sample extraction were bread and methanol solvent. Furthermore, the equipment used were a universal oven, test tube, measuring cup, magnetic stirrer, and centrifuge.

The extraction process was initiated by drying the white bread sample in a universal oven at 40°C for 24 hours before grinding. The bread was ground using a

grinding machine that has a 0.5 mm filter. The extraction process was carried out with methanol as a solvent according to the method by Yu *et al.* [10] with some modifications. Furthermore, 200 mg bread sample was mixed with 1 mL of methanol in a beaker. The mixture was stirred with a magnetic stirrer for 45 mins. Subsequently, the resulting mixture was centrifuged at 10.000 rpm at 5°C for 15 mins. The resulting supernatant was stored in a dark place at 20°C.

The DPPH solution was prepared at a concentration of 0.1 mM by dissolving 3.9 mg DPPH in 100 mL methanol and stirring at room temperature. Also, the control solution was prepared by mixing 4 mL of methanol and 1 mL of DPPH solution. The solutions need to be mixed and stored in the dark for 30 mins at room temperature. For sample analysis, every 1 mL of extracted sample was added to 4 mL of methanol. Furthermore, 1 mL of 0.1 mM DPPH solution was added to the solution and shaken vigorously. The mixture was subsequently kept in the dark for 30 mins at room temperature. In addition, the absorbance was measured at 517 nm against blank [10]. The inhibitory activity of free radicals is stated as follows [11]:

$$\%\text{Inhibition} = [(Ac-As)/Ac] \times 100$$

Description: As: sample solution absorbance
Ac: control absorbance

Determination of the Best Formula

Determination of the best formulation uses The Effectiveness Index (De Garmo) method [12]. The calculation begins with determining the variable weights with a scale of 0-1 for each parameter based on priority. It was continued by determining the effectiveness value (Ne) for each variable. The final step was to calculate the yield value (Nh) for each variable obtained. Therefore, the best formulation chosen was the formulation with the highest total Nh from adding up Nh of all variables.

Glycaemic Index and Glycaemic Load Tests

The Glycaemic Index (GI) and Glycaemic Load (GL) tests were carried out at one of the research team residences without repetition. Subjects for the GI and GL tests were eight students who were carried out by purposive sampling. All subjects fasting for 10 hours before measuring blood glucose [13]. After fasting, respondents consumed standard foods in the form of 0% taro leaf white bread and test food in the form of 10% that each of which contained 50 g of available carbohydrate that can be determined from the total sugar and starch content [13]. Each treatment was given a minimum interval of 3 days to avoid bias from each

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food tested [13]. After consuming the standard and test food, respondents' blood glucose was measured and recorded at 0, 30, 60, 90, and 120 mins [13] using Gluco Dr blood glucose measuring device. The results were subsequently presented in tables and figure. The area of the curve in Figure 2 was calculated using the trapezoid method, calculating the area under the trapezoidal blood glucose response curve and then adding it up. The formula for calculating the area under the curve is as follows [14]:

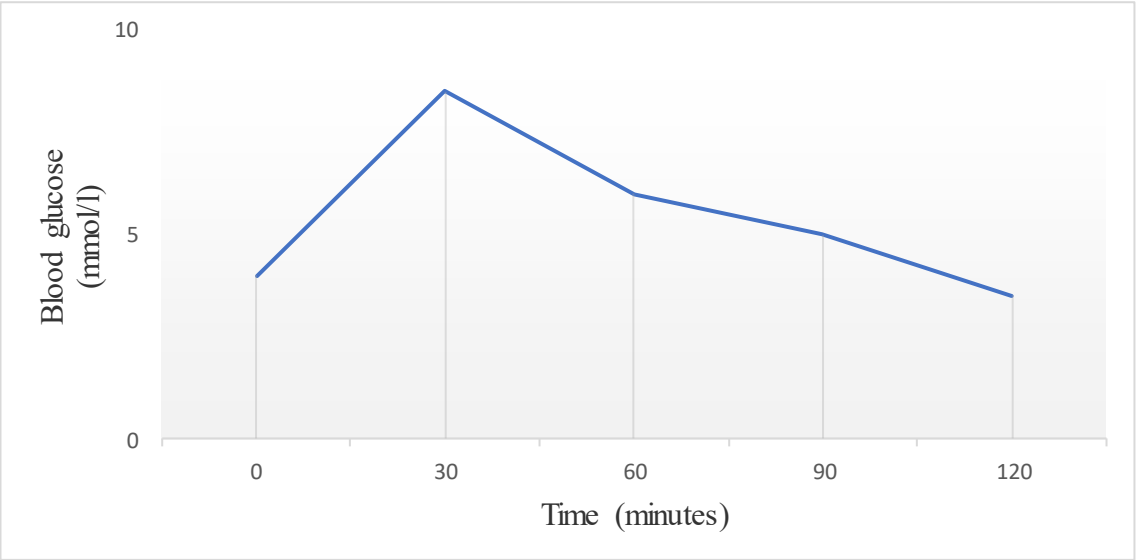

Figure 2: Illustration of the IAUC Curve

After obtaining results of area under the curve, the glycemic index was calculated using the formula as follows [13]:

$$GI = \frac{\text{The area under the blood glucose response curve to the test food}}{\text{The area under the blood glucose response curve to the standard food}} x100\%$$

The GI value was divided into three groups, low (≤55), medium (56-69), and high (≥70) [13]. After obtaining the GI results, the glycaemic load (GL) was calculated using the following formula:

$$GL = \frac{\text{Glycemic index x total carbohydrates of one serving}}{100}$$

The GL is the calculation result from the GI of a food and its carbohydrate content. GL can be used as an indicator of blood glucose response and insulin response induced by one food serving [15]. The GL values are classified into 3, low (≤10), medium (11-19), and high (≥20) [15].

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Statistical Analysis

The collected data were processed and analysed using a computer statistics program. Data normality was tested using the Shapiro-Wilk test. The difference in protein content in white bread with the addition of different taro leaves was tested using the Kruskal Wallis test. The differences in carbohydrate, fat, water and ash contents were tested using the one-way ANOVA statistical test. Furthermore, Bonferroni's post hoc test was carried out. The difference in the acceptance level was tested using the Kruskal Wallis test and followed by the Mann Whitney test. Therefore, effect of the independent on the dependent variable was considered significant when the p-value is ≤ 0.05.

RESULTS AND DISCUSSION

The protein content test results in Table 2 showed taro leaf white bread products ranged from 11.13 - 8.96%. The results showed the highest protein content value was found in 0% by 11.13%, while the lowest was found in 15% by 8.96%. These results were in accordance with previous studies that showed protein content in the white bread produced, with a composition of 80% wheat flour and 20% taro flour was 3.20%, while the control sweet bread made from 100% wheat flour had a content of 4.54%. Therefore, the more flour used, the higher the protein content. This is because the protein in wheat flour is higher than that in taro flour. The taro flour has a content of 3.9% and wheat flour of 8% [16]. The protein value in white bread is also obtained from other ingredients such as egg yolks and milk. The addition of water to the process can reduce the protein content because the water that binds it will be lost in the baking process.

Table 2 showed that fat content in taro leaf white bread decreased in the formulation group, and the content test results ranged from 7.71-2.94%. The highest fat content was found in 0% by 7.71%, while the lowest was 15% by 2.94%. Therefore, it can be concluded that the higher the use of taro leaf, the lower fat content because taro leaf have a lower fat content than wheat flour while the fiber content is higher than wheat flour [17]. Very low fat content makes taro leaf bread not easily damaged (rancid) due to oxidation reactions and can be stored for a longer time [17].

Results in Table 2 showed the highest carbohydrate content was found in 15% taro leaf white bread products (52.46%) while the lowest was 0% (44.21%). The high carbohydrate content in it was because taro leaves contain complex carbohydrates like amylopectin and amylose. In addition, taro leaf has more calories, where every 100 grams provide 112 calories. This was in accordance with the management of

the DM (Diabetes Mellitus) diet that carbohydrates consumed by DM patients should be complex types [18].

White bread is a food with quite high-water content causing its low shelf life. The results in Table 2 showed the highest water content value was found in 10% taro leaf white bread products (36.52%) while the lowest was 5% (33.37%) water. The addition of taro leaves had a significant effect on the water content of white bread. These results were consistent with a previous study that showed the water content of white bread with the addition of taro flour (*Xanthosoma sagittifolium*) to be higher than those with 100% wheat flour. According to the Indonesian National Standard, the water content in white bread is a maximum of 40% wet weight (WW) (SNI 01-3840-1995); therefore, the bread produced in this study fulfilled the quality requirements [19].

The ash content of an ingredient is strongly influenced by the use of raw material, processing ingredients and methods. The ash content test results in Table 2 showed that taro leaf white bread products ranged from 1.56-1.20%, and the highest was found in 0% products (1.56%) and the lowest ash content is 15% (1.20%). This was because the leaves contribute lower ash content (0.8%) than wheat flour (1.3%). The high ash content can cause gluten to break up easily; therefore, the ability to hold gas during fermentation is reduced, and ultimately the bread will not expand properly. According to the Indonesian National Standard, the ash content in white bread has a maximum of 3% BW (SNI 01-3840-1995), and therefore, all breads fulfilled the quality requirements [19].

The statistical test results in Table 3 showed that there were differences in the color of 0%, 5%, 10%, and 15% (p=0.008). Based on the hedonic test of color parameters, panellists preferred 10% taro leaf white bread samples (2.9) and the lowest was 5% (2.5). The addition of taro leaves causes the color produced on the inside of the bread to be even greener. Color is a sign of foodstuffs in case of maturity or damage. The color changes can occur as a result of naturally occurring pigments in food, caramelization and Maillard reactions, interaction between organic compounds and air, as well as dye addition.

Aroma is a smell caused by chemical stimulation of olfactory nerves in the nasal cavity. The organoleptic test results for aroma parameters in Table 3 showed panellists preferred the 10% taro leaf white bread sample with the highest value (3.1), followed by 15% (3.0), then 5% (2.9), and the lowest was 0% (2.82). The use of taro leaves in making white bread affects the product aroma. The 10% product was the most preferred, which had a distinctive aroma. This was influenced by such ingredients as eggs, fat, and powdered milk [20]. Previous studies showed

that the use of substitutes for corn flour and purple sweet potato flour affects the aroma caused by purple sweet potato cornbread. Therefore, the more substitutes used for corn and purple sweet potato flour result in an aroma is more distinctive and sharp [21].

Based on the organoleptic test results in Table 3 for texture parameters, the panellists preferred the 10% sample with the highest value (3.2) and the lowest sample was 0% (2.7). Texture is a sensation of pressure felt in the mouth when food is bitten, chewed, swallowed or touched with the fingers. Based on a study, it was found that changes in the texture or viscosity of the ingredient can alter the taste and smell because it can affect the stimulation speed of the olfactory receptor cells and salivary glands [21]. The main component contained in flour that affects texture is gluten, which causes the dough to be elastic and able to withstand gas (CO_2) and can, therefore, produce a good texture in white bread products [22]. Taste is a stimulation caused by the food ingredients, especially felt by the sense of taste, as well as other stimuli such as touch and acceptance of heat degree in the mouth. The organoleptic test results in Table 3 for taste parameters showed the panellists preferred 10% taro leaf samples with highest value (3.2) and sample of 0% was the lowest (2.32). The use of taro leaves in making white bread affected the taste of the product because it can produce a distinctive taste of taro, which was preferred by panellists compared to 0% treatment. The taste formed is also supported by the addition of sugar and salt, which is thought to be caused by the use of milk and margarine in making white bread.

The statistical test results in Table 1 showed there was no difference in the inhibition value of all white bread. However, there was an increase in the inhibition percentage value of taro leaf white bread compared to fresh bread without taro leaf addition. This increase in the inhibition percentage value because taro leaves have a high antioxidant content. A previous study showed that the inhibitory activity of the ethanol extract of taro leaves was 78.92%, 74.46% in methanol and 72.46% in chloroform [23]. Meanwhile, the half-maximal inhibitory concentration or IC_{50} value of taro leaf extract was 0.28 ppt [24].

Food processing such as baking in bread making plays a role in increasing antioxidant activity. This was evidenced by an increase in the inhibition percentage value of taro leaf white bread compared to fresh taro leaves. According to Aisyah *et al.* [25], eggplant has a higher antioxidant activity after the boiling compared to those that has not been boiled [25].

The very strong antioxidant value of bakery products is formed on the bread crust during baking through the Maillard reaction. These are non-enzymatic reactions in

food between reducing sugars and amino acids, peptides or proteins [26]. Antioxidants are formed in the bread crust due to the presence of melanoidin or structural bonds such as pronyl-lysine, which is a protein-bound compound found in bread crust [26]. Furthermore, melanoidin is a primary-macromolecule compound derived from the Maillard reaction and is formed from interaction between carbohydrates (reducing sugars) and groups of free amino compounds such as amino acids [27].

Determination of the best formulation was conducted by using the product effectiveness test (De Garmo) method [12]. Determination of the selected formulation was seen from all aspects of the parameters tested. Therefore, based on the calculation results in Table 4, the selected formulation is white bread with 10% taro leaves addition by 0.75.

The Glycaemic Index (GI) is a number that shows the potential for an increase in blood glucose levels from carbohydrates available in a food. The test and standard foods given to the respondents contained 50 g of available carbohydrate which can be determined from the total sugar and starch content. Based on Table 5, the 0% taro leaf white bread given to each respondent was 74.65 g. Meanwhile, 10% given to each respondent was 64.12 g. Based on the statistical test results in Table 6, it was found that there was no significant difference between the blood glucose response of 0% and 10% taro leaf white bread ($p=0.360$). Based on Table 6, there was an increase in blood glucose in the 30th min, both 0% and 10%. Furthermore, there was a decrease in the 60th min on the two white breads. In the 90th min, the blood glucose of 0% decreased, while 10% increased. In the second 120th mins, the two white bread blood glucose decreased.

Based on the glycemic index calculation in Table 7 derived from the average GI of 8 respondents, 10% taro leaf white bread has a GI of 93.07% and included in the high category. The cooking or heating process causes the breakdown of the carbohydrate components in white bread, therefore it is easily absorbed in the body and increases glycemic index.

Blood glucose in taro leaf white bread group is lower than white bread without taro leaf group because the antioxidants act as potential agents to regulate glycemic control by affecting carbohydrate digestion in the small intestine due to inhibition of α-glucosidase in the intestinal mucosa or inhibition of α-amylase, a key enzyme for starch breakdown [28,29]. Previous study showed taro plants have alpha glucoside inhibitor activity. The Alpha-glucosidase inhibitors act competitively and reversibly in inhibiting alpha-glucosidase, an intestinal enzyme. This slows down

carbohydrate digestion, as well as delays glucose absorption which also slows and reduces the increase in blood glucose levels [7].

Based on the glycemic load calculation in Table 8, 10% taro leaf white bread has a glycemic load of 21.78 g/100 g food and included in the high category. Therefore, a diet with a high glycemic load is associated with persistent increases in circulating glucose and insulin levels. In addition, the impact is in part determined by the state of the body's metabolism [30].

The relationship between GI and GL is not always directly proportional. High GI foods can have low GL when eaten in small amounts. Conversely, low GI foods can have high GL depending on the portion size eaten. Although food has an unchanging GI value, it can have low, medium, or high GL because it depends on the amount eaten [30].

CONCLUSION, AND RECOMMENDATIONS FOR DEVELOPMENT

There were significant differences in the carbohydrates, fat, water, and ash content, as well as different organoleptic tests of taro leaf white bread. The highest value of carbohydrate content was 15% (52.46%), the highest fat was 0% (7.71%), the highest water was 10% (36.52%) and the highest ash content was 0% (1.56%). There was no difference in the inhibition value of white bread with the addition of different taro leaves and the highest was in 10% (76.32%), while the lowest was 0% (45.47%). Furthermore, 10% taro leaf white bread has high category of glycemic index of (93.07%), its glycemic load was also in the high category (21.78g/100g). However, based on the results, there was a decrease in blood glucose response in taro leaves white bread compared to white bread without the addition. This demonstrates that the taro leaves in white bread play a part in halting the rise in blood sugar. The organoleptic test results showed 10% was the most preferred sample by the panelists, while 0% had the lowest average organoleptic yield value. Therefore, the chosen formulation was white bread with the addition of 10% taro leaves at a value of 0.75.

Further study is needed relating to white bread and the addition of taro leaves by improving the formulation and optimizing processing techniques to avoid bias in the bread produced. This is important to determine the effect of taro leaf white bread on the blood glucose levels of diabetes patients.

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Table 1: Formulation of taro leaf white bread

Name of Ingredients	Control (0% taro leaves)	Sample A (5% taro leaves)	Sample B (10% taro leaves)	Sample C (15% taro leaves)
Wheat flour (gr)	250	235	225	215
Taro leaves (gr)	0	15	25	35
Egg (gr)	12.5	12.5	12.5	12.5
Milk powder (gr)	25	25	25	25
White butter (gr)	20	20	20	20
Instant yeast (gr)	2.5	2.5	2.5	2.5
Sugar (gr)	12.5	12.5	12.5	12.5
Salt (gr)	2	2	2	2
Bread improver (gr)	3	3	3	3
Coldwater (gr)	150	150	150	150

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Table 2: Results of Nutrition Content and Antioxidant on Taro Leaf White Bread

Nutrition Content	Control (0% taro leaves)	Sample A (5% taro leaves)	Sample B (10% taro leaves)	Sample C (15% taro leaves)	
Protein Content (%)	11.13±0.37	10.21±0.22	9.11±0.07	8.96±0.01	p 0.01[a]
Fat Content (%)	7.71±0.42*	6.65±0.07*	5.79±0.19*	2.94±0.06*	p 0.00[a]
Carbohydrate content (%)	44.21±0.72*	48.32±0.28*	47.2±0.19*	52.46±0.29*	p 0.00[a]
Water content(%)	35.38±0.50*	33.37±0.43*	36.52±0.24*	34.43±0.29*	p 0.00[a]
Ash Content (%)	1.56±0.02*	1.44±0.04*	1.35±0.10*	1.20±0.02*	p 0.00[a]
Inhibition (%)	45.47±17.268	71.58±5.657	76.32±1.039	64.53±2.531	p 0.140 [a]

Description: *there is a significant difference in the mean. [a] ANOVA (Analysis of Variance) test

Table 3: Results of Organoleptic Analysis on Taro Leaf White Bread

%Taro Leaf	Receiving Power (Mean ± SD)				Mean
	Color	Aroma	Texture	Taste	
0%	2.7 ± 0.51[a] (Like)	2.82 ± 0.38[a] (Like)	2.7 ± 0.46[a] (Like)	2.32 ± 0.47[a] (Dislike)	2.63
5%	2.5 ± 0.50[b] (Dislike)	2.9 ± 0.33[b] (Like)	2.8 ± 0.43[b] (Like)	2.5 ± 0.55[b] (Dislike)	2.67
10%	2.9 ± 0.60[c] (Like)	3.1 ± 0.46[c] (Like)	3.2 ± 0.48[c] (Like)	3.2 ± 0.57[c] (Like)	3.1
15%	2.67 ± 0.65[d] (Like)	3 ± 0.39[d] (Like)	3 ± 0.40[d] (Like)	2.9 ± 0.49[d] (Like)	2.89
P	p 0.008*	p 0.005*	p 0.00*	p 0.00*	

Description: Numbers followed by superscript letters (a, b, c, d) indicate significant differences. * Kruskal Wallis test, Man-Whitney post-hoc test

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Table 4: Determination of the Best Formulation

Formula / Yield value (Nh)*	0%	5%	10%	15%
Carbohydrate	0	0.04	0.22	0.07
Protein	0	0.2	0.17	0.17
Fat	0.17	0.01	0.01	0
Water content	0	0.14	0.04	0
Ash content	0	0.13	0.12	0.13
Organoleptic	0	0.00	0.11	0.06
Antioxidant Activity	0	0.06	0.08	0.04
Total Yield Value (Nh)	0.17	0.58	0.75	0.47

Description: * the yield value (Nh) is obtained from the calculation of the De Garmo Effectiveness Index

Table 5: Determination of Total Test Food Equivalent to 50 g Available Carbohydrate

Food Ingredient	Starch (%)	Total Sugar (%)	Available Carbohydrate* (%)	Total Test Food ** (g / respondent)
0% Taro leaf white bread	45.15	28.32	66.976	74.65
10% Taro leaf white bread	39.96	23.02	77.985	64.12

Description: *available carbohydrate = total sugar + (1,1 x starch)

**The Total Test Food = $\frac{50\ g}{available\ carbohydrate} x100$

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Table 6: Respondents' Blood Glucose Response after Eating Taro Leaf White Bread

Food Ingredient	Time (minutes)				
	0	30	60	90	120
0% Taro leaf white bread	99.00±12.74	133.88±23.74	127.00±11.88	120.13±5.06	106.75±9.04
10% Taro leaf white bread	90.25±18.13	125.50±18,.49	112.38±13.22	117.00±9.01	97.50±14.26

Table 7: Average Glycemic Index of Taro Leaf White Bread for 8 Respondents

Test Food Ingredients	Glycemic Index (%)	Category*
10% Taro leaf white bread	93.07 ± 9.35	High

*Category: low GI (<55), medium GI (55-70), high GI (> 70)

Table 8: Glycemic Load of Taro Leaf White Bread

Test Food Ingredients	Number of servings (g)	Available Carbohydrate (g)	Available Carbohydrate/ portion (g/serving)	Glycemic Load (g/100g of food)	Category*
10% Taro leaf white bread	30	77.985	23.40	21.78	High

*Category: low GL (<10), medium GL (11-19), high GL (> 20)

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