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# The Formulation, Characterization and Determination of Glycemic Index of Snack Barst Made from Goroho Banana Flour with Added - Palm Sugar

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**Abstract:- Snack bars available on the market today generally contain high energy, sugar, fat, and carbohydrate, so that they cannot be consumed by type 2 diabetes mellitus (DM) patients. The purpose of this study is to obtain the best ingredients made from *Goroho* banana flour and palm sugar in making snack bars based on sensory and chemical characteristics and a low glycemic index value that is in compliance with snack requirements for the aforementioned patients. This study included the stages of ingredients preparation, snack bars making, and the analysis of organoleptic, chemical, and glycemic index characteristics of snack bars. There were four different formulations in this study, determined by the Microsoft Exel Solver. It employed a Completely Randomized Design of single factor with three replications and the determination of the best formulation using the Bayes method. Further, the glycemic index test utilized the Trapezoid method. The results indicate that there is a difference of organoleptic test of the flavor and texture. Meanwhile, there is no significant difference in the level of 5% for the aroma and color based on the ANOVA statistical test. The proximate analysis shows that different formulations have an effect on the contents of protein, fat, carbohydrate, water, and ash of snack bars. The best formulation is formula 4 in which the panelists like the flavor, slightly like the texture and color; meanwhile, the aroma is in a neutral rate. Moreover, the contents of protein, fat, carbohydrate, water, and ash are 13.70%, 8.28%, 53.39%, 17.72%, and 1.92% respectively; the total energy value is 66.76 kcal/bar with a total energy of 200.28 kcal/3 bars, indicating that snack bars can fulfill the needs of snacks (10-15%) out of calorie needs per day (2100) of type 2 diabetes mellitus patients. Glycemic Index Value of snack bars of the best formulation (formula 4) is 21.94, included in the low category (<55). It is expected that the product of snack bars can be an alternative snack for type 2 diabetes mellitus patients.**

***Keywords:-*** *Snack Bars, Goroho Banana Flour, Type 2 Diabetes Mellitus, Glycemic Index.*

## I. INTRODUCTION

Snack bars available on the market today generally tend to contain high energy, simple glucose, fat, and carbohydrate, so that they cannot be consumed by type 2 diabetes mellitus (DM) patients. This is due to risk factors for such a disease, such as an unbalanced intake that the consumption of foods with high fat, glucose, and low fiber is able to cause obesity and related to the increased blood glucose.

It is recommended for type 2 DM patients to have snack bars at 10-15% of calorie needs per day of each serving and can be consumed 2-3 times in one day. Therefore, this study designed snack bars with a calorie content of 210 kcal/bar, consisted of 55% of carbohydrate (27.5 g), 20% of protein (10 g), and 25% of fat (27.5) out of snacks' calorie needs per one serving size of snack bars. The total calorie of snack bars is taken into account in determining the serving size because it plays an important role in providing energy for doing activities and keeping an ideal body weight.

In addition to helping to fulfill nutritional needs, snack bars for diabetics can also control the blood glucose as a preventive effort of complication risks. For that reason, snack bars that must be developed for people with DM are formulated to help preventing hyperglycemia by using low glycemic index ingredients, do not cause increased blood glucose and high fiber as well as fulfilling the energy and nutritional requirements for diabetics.

Snack bars in this study were designed for diabetics by utilizing ingredients that have the potential to reduce blood sugar levels, such as *goroho* banana, used tofu dregs, brown sugar, and Virgin Coconut Oil (VCO). The use of *goroho* banana flour as the primary ingredient for making snack bars for diabetics is because it has been shown to reduce blood glucose level (Kaempe et al. 2013). The source of protein that will be used in this research is tofu dregs. Soybeans as the base ingredient for tofu dregs are also known to have the potential to reduce blood glucose level in rats (Herning, 2009). The source of fat utilized in these snack bars is vegetable fat extracted from Virgin Coconut Oil (VCO). The results of a study conducted by Handajani and Dharmawan (2008) reveal that consuming 0.003 Ml/35g of VCO more

than 18 days is able to reduce blood glucose level in hyperglycemic mice. Snack bars that will be made are specifically for diabetics, so that sucrose is not used in the making process. Instead, the sweet taste comes from the palm sugar. Palm sugar is known to have a glycemic index of 30-31 (Maspeke, 2013). This value is included in a low category (<55) in order that the utilization of such palm sugar will be safer for people with diabetes mellitus.

Snack bars made from *goroho* banana flour have never been done before. In this study, the ingredients formula of *goroho* banana, VCO, tofu dregs flour, and palm sugar was designed to produce snack bars that fulfill the nutritional requirements for type 2 diabetes mellitus patients with a low glycemic index. Hence, the purpose of this study is to obtain the best formulation from ingredients made of *goroho* banana flour with the addition of palm sugar that produces snack bars, preferred from sensory characteristics as well as fulfilling nutritional requirements, calorie value, and a low glycemic index for Type 2 DM patients.

## II. MATERIALS/INGREDIENTS AND METHOD

### *A. Ingredients*

The ingredients used in making snack bars were *goroho* bananas with a harvest age of 80-90 days, tofu dregs flour, VCO, palm sugar, and egg white. Materials needed for proximate analysis. The materials utilized in testing the glycemic index were snack bars, glucose, cotton, and alcohol. Further, the tools used in this study were a stainless baking pan for blanching, stove, grater, knife, cutting board, aluminum foil, container, grinder, 80 mesh sieve, glass jar, cloth for squeeze, griddle, baking oven, scale, mixer, mold, and spatula. Tools used for proximate analysis. The tool utilized for glycemic index testing was a set of blood sugar test equipment (*gluko dr*).

### *B. Method*

➢ *Procedures of the Study*

- *Goroho Banana Flour Making (Sayangbati, 2012)*

*Goroho* flour making began with the process of sorting the bananas before blanching. The blanching process was carried out by immersing the bananas in warm water with a temperature of 80ºC for 5 minutes. Then, the bananas that had been blanched were cooled by using ice cubes, peeled, and scaled. The bananas were then sliced with a slicer. The sliced bananas were dried with the sun drying method for 2-3 days. After dried, they were smoothed by a grinder and were sieved with an 80 mesh sieve.

- *Snack Bars Making*

The basis for calculating the product's energy was by total energy of 70 kkl/bar. The determination of formulations employed the Excel Solver program. The results of the formula calculation were shown in Table 1.

| Ingredients | F 1 (g) | F 2 (g) | F 3 (g) | F 4 (g) |
|---|---|---|---|---|
| GBF | 6.5 | 5,8 | 7 | 4 |
| TDF | 2.2 | 5 | 3,2 | 5 |
| VCO | 1.4 | 1,1 | 1,2 | 1,3 |
| PS | 5.5 | 4 | 4,5 | 5 |
| EW | 16 | 11,7 | 14,5 | 13 |

Table 1:- The Formulation of Ingredients per Bar

Information: GBF: *Goroho* Banana Flour; TDF: Tofu Dregs Flour; VCO: Virgin Coconut Oil; PS: Palm Sugar; EW: Egg White

The process of making snack bars began with scaling all snack bars' ingredients according to the results of four ingredient formulations with 3 replications. Then, mixed all the dry ingredients, including *goroho* banana flour and tofu flour. Meanwhile, wet ingredients, such as palm sugar was diluted, and VCO and egg white were mixed with a mixer for 10 minutes. The dry ingredients mixture was then added to the wet ones and stirred until they were well-blended. The finished batter was then followed by molding snack bars by a special bar-shaped mold of 10 cm x 3 cm with a thickness of 1.3 cm. The next process was gradual baking in which the initial baking of 100ºC for 20 minutes, and continued by 160ºC for 40 minutes (Kasim et al., 2017). After being baked, snack bars were cooled down for 30 minutes, which then packed with an aluminum plastic packaging (Chandra, 2010).

➢ *Analysis of Chemical and Organoleptic Characteristics and the Measurement of Glycemic Index of Snack Bars*

- *Organoleptic Testing*

An organoleptic test was performed by employing a hedonic test method. The hedonic method was testing the level of preference for flavor, smell, and color. Examples that had been coded were served randomly to 30 panelists; then they were asked to give scores according to their level of preference. The number of scales used were 7 test scales (1 = really dislike, 2 = dislike, 3 = slightly dislike, 4 = neutral, 5 = slightly like, 6 = like, 7 = really like).

- *Chemical Characteristics Testing*

The proximate analysis which included protein, fat, water, and ash contents was conducted based on the testing procedures by Andarwulan et al., 2011). Whereas, the carbohydrate content testing was done employing the *by difference* method by using the following formula:

Carbohydrate content (bb) = 100% - (contents of protein + fat + water + ash)

- *Total Energy per Bar*

The total energy per bar from a snack bar was calculated by utilizing the proximate analysis results of snack bars produced from four formulas. The total energy value was obtained by the energy conversion results from protein, fat, and carbohydrate contents without considering the fiber value, i.e., the number of macronutrients of the ingredients used were multiplied by each calorie value. Proteins have an energy value of 4 kcal/g, fats of 9 kcal/g, and carbohydrates of 4 kcal/g (Zoumas, 2002).

- *Measurement of Glycemic Index of Snack Bars*

The first stage was the selection of research subjects purposively to facilitate this study. The required subjects were seven people, consisting of five women and two men.

The calculation of the glycemic index was based on the comparison of the curve area of the increase in blood glucose after consuming standard foods (glucose). The number of sample portions given to panelists for testing the glycemic index used the following formula:

$$\text{The number of tested portions (gram)} = \frac{\text{50 g of carbohydrate}}{\text{Sample carbohydrate content}} \times 100$$

The best formula obtained will get the Glycemic Index test by employing the Trapezoid method. Formula :

$$L = \frac{(\Delta 30-0)}{\frac{X\,t}{2}} + \frac{(\Delta 60-0)}{\frac{X\,t}{2}} + \frac{(\Delta 60-30)}{\frac{X\,t}{2}} + \frac{(\Delta 90-0)}{\frac{X\,t}{2}} + \frac{(\Delta 60-90)}{\frac{X\,t}{2}} + \frac{(\Delta 120-0)}{\frac{X\,t}{2}} + \frac{(\Delta 90-120)}{\frac{X\,t}{2}}$$

Information: L = the area under curve; t = time; $\Delta$ = blood glucose level

➢ *Data Processing*

- *Determination of the Best Formula*

$$\text{Total score} = \sum_{j=i}^{m} Nilai\ ij\ \ (krit\ j)$$

Information :

Total score = total final score from alternative –i

$Nilai_{ij}$ = Score from alternative -i in criterion -j

$Krit_j$ = Importance rate (weight) of criterion -j

- *Determination of the effect of formulations on the characteristics of snack bars*

The data were analyzed by Analysis of Variance (ANOVA) statistical test. If there is a real difference among the treatments, then it will be continued to Duncan Multiple Range Test (DMRT) with $\alpha = 0{,}05$. The data were processed by utilizing Microsoft Excel 2007.

$$Y_{ij} = \mu + \tau i + \varepsilon ij$$

Information:
$Y_{ij}$ = observation score towards treatments formula -i in repetition -j,;
$\mu$ = general median ;
$\tau i$ = the effect of ingredient formulation -i;
$\varepsilon ij$ = Random effects that are normally spread

## III. RESULTS AND DISCUSSION

### *A. The Effect of Ingredients Formulation towards Organoleptic Characteristics*

Snack bars produced by different ingredients formulas have organoleptic testing which includes flavor, texture, aroma, and color. The score of the organoleptic test results of the snack bars can be seen in Table 2.

The flavor of food products is influenced by the composition of ingredients (Kasim *et al.*, 2017). Table 2 shows that the average result of hedonic test towards the flavor of snack bars is ranged from 4.83 to 6.03 (neutral-like). Based on the aspect of flavor, the treatment of formula 2 arrives at the lowest rating from the panelists, which is 4.8 (slightly like). At the same time, the highest preference of 6.03 is achieved by formula 4 (like). This is because the amount of palm sugar and tofu dregs flour added to formula 4 snack bars is more than other formulas. This is in line with the study by Fransiska and Deglas (2017), stating that the more tofu dregs added to the tofu dregs substitution sticks, the more the panelists like the flavor of tofu dregs (typical tofu). Based on variance analysis data, F-count (8.27) is greater than F-table (2.68). This signifies that the difference in the formula for making snack bars made from *goroho* banana flour and palm sugar statistically has a significant effect on the rate of flavor preference. Further, the Duncan test reveals that the flavor of formula 1 snack bars is the same as formula 4 and different from formula 2 and formula 3. This is because the flavor produced in each formula has a significant difference. Panelists' preference for the flavor parameter of snack bars tends to increase along with the increased amount of palm sugar used in each formula.

The results of organoleptic testing from the texture aspect of snack bars are ranged from 4.27 to 5.73 (neutral - like). The treatment of formula 2 gets the lowest score of 4.27 from the panelists (neutral); meanwhile, the most favorite texture is obtained by formula 4, achieving a score of 5.73 (like). In addition, variance analysis data shows that F-

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count (12.15) is greater than F-table (2.68), implying that the difference in the formula for making snack bars made from *goroho* banana flour and palm sugar statistically provides a significant effect on the rate of texture preference. The texture of foodstuffs is strongly affected by its compositions (Fellow 2012). The Duncan test indicates that the texture of formula 4 snack bars is the same as formula 1 and different from formula 2 and formula 3. The criterion for compact texture is when it is broken, it does not produce too many crumbs scattered so that the panelists prefer such a texture (Fellows, 2000). Fellows (2000) argues that the texture of foods is largely determined by the water content, fat content, amount and type of carbohydrates and proteins that make it up.

Aroma is one of the key variables because in general, the taste of consumers towards foods is determined by the aroma. According to Ramadhani (2012), a fresh aroma is the combination of appropriate ingredients. The average rate of panelists' preference for the aroma of snack bars is ranged from 4.33 to 4.63 (neutral). Formula 4 reaches the highest average score of 4.63 of panelists' preference for the aroma of snack bars (neutral). Formula 2, in contrast, achieves the lowest average score of 4.33 of panelists' preference for the aroma of snack bars (neutral). Based on the analysis of variance, the difference in the formula for making snack bars has no significant effect on the aroma, as evidenced by F-count (0.72) < F-table (2.68). This is due to the fact that the aroma of each formula is almost the same, i.e., food aroma is one of the criteria for foodstuffs quality. The aroma determines the delicacy of foods. Further, chemical reactions that occur during the baking process is also possible to produce aroma compounds.

Color is a visualization of a product which is immediately seen in comparison with other variables, and it directly affects the panelists' perception. According to Winarno (2002), the color factor visually will appear first and often determines the value of a product. The average rate of panelists' preference for the color of snack bars is ranged from 5.33 to 5.73 (slightly like). The analysis of variance reveals that the difference in the formula for making snack bars has no significant effect on the color, as evidenced by F-count (1.30) < F-table (2.68) in the level of 5%. Formula 4 gets the highest average score of 5.73 of panelists' preference for the color of snack bars (slightly like). Formula 2, on the other hand, arrives at the lowest average score of 5.33 of panelists' preference for the color of snack bars (slightly like).

*B. The Effect of Ingredients Formulation towards Proximate Content of Snack Bars*

The chemical characteristics testing of snack bars which include carbohydrates, proteins, fats and water content with different ingredient formulas is used to calculate the energy value per bar. The basis for calculating energy is that carbohydrates and proteins contribute 4 kcal/g of their energy value and fats contribute 9 kcal/g. The results of the proximate testing and the energy value of the snack bars in this study are presented in Table 3.

Table 3 indicates that the value of protein content from snack bars made from *goroho* banana flour and palm sugar in all different ingredient formulas is ranged from 12.15% - 14.58%. The results of the analysis of variance show that the F-count (22) is greater than the F-table (4.76) at the level of α 0.05. The Duncan test brings out the fact that the protein content of snack bars in formula 1 is the same as formula 3 and different from formula 2 and formula 4. This means that the different ingredient formulations have a significant effect on the content of the protein of the snack bars. The percentage of the lowest protein content is in the formula 3 (12.15%); meanwhile, the highest protein content is in the formula 2 (14.58%). The increased content of protein of an ingredient is closely related to the water content of the material itself as noted by Adawyah (2007) that a decrease in water content will cause the protein content in the ingredients to increase. The use of heat in the processing of foodstuffs is able to reduce the percentage of water content which leads to the increased percentage of protein content.

Fat content from snack bars made from *goroho* banana flour and palm sugar in table 3 from all different ingredient formulas is ranged from 6.62% - 8.28%. The results of the analysis of variance reveal that the fat content of snack bars in all formulas is significantly different, with the F-count (13.46) > the F-table (4.76) at the level of α 0.05. The Duncan test signifies that the fat content of snack bars of formula 1 is the same as formula 2 and formula 4, yet it is different from formula 3. This means that the different ingredient formulations have a significant effect on the fat content of the snack bars. The percentage of the lowest fat content is in the formula 3 (6.62%), whereas, the highest fat content is in the formula 4 (8.28%). The fat content in snack bars comes from VCO and tofu dregs flour. Based on the characterization results of ingredients, the fat content of VCO is 99.5%, and tofu dregs are 14.7%.

Carbohydrates are the primary component of foodstuffs that have important functional properties in foods processing. Total carbohydrates can be determined by the *by difference* method. The value of carbohydrate content from snack bars is ranged from 58.39% - 63.5%. The results of the analysis of variance reveal that ingredient formulations of snack bars in all formulas are significantly different, with the F-count (16.53) > the F-table (4.76) at the level of α 0.05. The Duncan test indicates that the carbohydrate content of snack bars in formula 1 is the same as formula 2 and significantly different from formula 3 and formula 4. This signifies that different ingredient formulations have a significant effect on the carbohydrate content of the snack bars. The highest carbohydrate content is shown by formula 2 of 63.49% because the formula used the largest number of *goroho* banana flour compared to formula 2 and formula 4. In

accordance with the results of the previous study, the carbohydrate content of *goroho* banana is 79.54%, so that the use of this ingredient is very influential on the carbohydrate content of the snack bars produced.

Water is an important component in food ingredients because it can affect the foods' appearance, texture, and flavor (Winarno in Datunsolang 2018). The percentage of the lowest water content is in the formula 2 (11.79%), and the highest fat content is in the formula 3 (20.35%). Such an increase in water content in formula 3 is due to the amount of tofu flour used that is more than formula 1. This is because tofu dregs flour is able to bind water, the coarse fiber content in the dregs is higher so that the higher the substitution of tofu dregs flour, the more water content of the snack bars. Coarse fiber has the ability to bind water, water that is tightly bound in food fiber is difficult to evaporate even by the drying process. The results of the analysis of variance show that ingredient formulations of snack bars in the water content are significantly different, with the F-count (26.76) > the F-table (4.76) at the level of α 0.05. The Duncan test reveals that the water content of snack bars in formula 1 is the same as formula 4 and different from formula 2 and formula 3. This implies that different ingredient formulations have a significant influence on the water content of the snack bars.

Ash content shows that the amount of mineral content in snack bars is strongly related to the purity and cleanliness of an ingredient. Based on Table 3, the value of ash content from snack bars made from goroho banana flour and palm sugar with different ingredient formulas is ranged from 1.82% - 2.16%. The results of the analysis of variance indicate that the effect of ingredient formulations of snack bars is significantly different, with the F-count (17.91) > the F-table (4.76) at the level of α 0.05. The Duncan test brings out the fact that the ash content of snack bars in formula 1 is the same as formula 2 and different from formula 3 and formula 4, meaning that different ingredient formulations have a significant change on the ash content of the snack bars.

It is recommended for type 2 DM patients to have snack bars at 10-15% of calorie needs per day (2100). The energy of snack bars is obtained by converting carbohydrates, fats, and proteins in which 9 kcal/g for fats and 4 kcal/g for carbohydrates and proteins. According to the Table 3, the total energy value of snack bars made from *goroho* banana flour and palm sugar in all different ingredient formulations is ranged from 66.11 kcal/bar to 68.06 kcal/bar. The results of the analysis of variance prove that ingredient formulations of snack bars in all formulas are significantly different towards the total energy of snack bars, with the F-count (2.86) < the F-table (4.76) at the level of α 0.05.

*C. Determination of the Best Formula*

Determination of the best formula is obtained by employing the Bayes method. It is one of the techniques that can be used to analyze the best decision-making from a number of alternatives with the purpose of generating optimal results as well as optimal decisions that need to be considered various criteria (Marimin 2004 in Ahmad 2013). Before determining the best formulation, it is necessary to rank the observed parameters according to the importance index.

The analysis results of the Bayes method signify that Formula 4 achieves the 1st rank, indicating that formula 4 is the optimal formula that produces the best quality from the aspect of organoleptics, proximate, and total energy. Additionally, formula 1, formula 2, and formula 3 reach the 2nd, 3rd, and 4th rank respectively.

*D. Glycemic Index (GI) Content of Snack Bars*

The method of GI analysis conducted in this study was according to Miller et al. (1996). GI testing was an *in vivo* test because it utilized human's blood as the subject. Humans are used as the subject because their metabolism is very complicated that it is difficult to imitate in *vitro* way (Ragnhild et al. 2004).

The first stage was the recruitment or selection of research subjects by employing a purposive technique to facilitate research. The required subjects were seven students, consisting of five female and two male students. Rimbawan and Nurbayani (2013) explain that research subjects must meet two criteria; inclusion and exclusion criteria. The inclusion criteria consist of aged 18-30 years, having a normal body mass index (BMI) between 18.5-24.9 kg/m2 i.e. 18-23 kg/m2 for women and 20-25 kg/m2 for men, having a healthy condition, and willing to let their blood taken. On the other hand, the exclusion criteria consist of having a history of diabetes mellitus, experiencing indigestion, undergoing medical treatment, using illegal drugs, drinking alcohol, and smokers. The calculation of GI was based on the comparison between the curve area of the increased blood glucose after consuming tested foods and after consuming standard foods (glucose).

Single food that its GI will be determined has a weight equivalent to 50g of carbohydrates (Miller 1996 in Samauna 2017). The best snack bars formulation (formula 4) that will be tested has the carbohydrate content of 58.39% bb. Therefore, 85.63 gram of snack bars per panelist is given in order to get snack bars containing 50 grams of carbohydrate.

The results show that the GI content of snack bars made from *goroho* banana flour and palm sugar of the best formulation (formula 4) is 21.94 and included in the low category. This is in compliance with the grouping of GI categories according to Miller et al. (1996) and Foster -

Powwel et al. (2002), namely Low GI (<55), moderate GI (55 - 69), and high GI (>70).

One of the factors that influences the glycemic index is the content of foods fiber. Marangoni and Poli (2008) state that foods fiber in biscuits will decrease the glycemic index value. The ingredients used in making snack bars are *goroho* bananas flour and tofu dregs flour. Goroho banana flour contains ± 2% of fiber, and tofu dregs flour contains 3.23% of fiber (Wati, 2013). Research by Kustanti (2016) used *klutuk* banana (or known as *pisang batu)* flour in making biscuits containing coarse fiber of 1.87% and foods fiber of 13.5% in the low GI category which is around 36.18.

## IV. CONCLUSION

The best ingredients formulation from the organoleptic and chemical analysis along with the total energy of snack bars made from *goroho* banana flour and palm sugar is formula 4, in which the panelists like the flavor, slightly like the texture and color, and the aroma is in a neutral rate. Moreover, the contents of protein, fat, carbohydrate, water, and ash are 13.70%, 8.28%, 53.39%, 17.72%, and 1.92% respectively; the total energy value is 66.76 kcal/bar with a total energy of 200.28 kcal/3 bars, indicating that snack bars are able to fulfill the needs of snacks (10-15%) out of calorie needs per day (2100) of type 2 diabetes mellitus patients. Glycemic Index Value of snack bars of the best formulation (formula 4) is 21.94, and includes in the low category (<55).

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