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Mung Bean and Soy Snack Bars as an Alternative Snack for Athletes

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Abstract

Snack bars are snacks that are suitable to be consumed after exercise. This research aims to determine the effect of substitution of mung bean flour and addition of soybean flour on the acceptability of a snack bar, as well as the nutritional content of carbohydrates, proteins, and BCAA of the best formula. This research is a pure experiment, with 3x2 factorial research design. The panelists consist of 35 untrained panelists, namely 35 inkai karate athletes at ADLI KBD. The research data were obtained by filling out organoleptic acceptability test questionnaires, then analyzed with Friedman and Wilcoxon test. While the nutritional content is obtained through laboratory tests. The substitution of mung bean flour and the addition of soybean flour significantly affect the aroma (p=0.02), texture (p=0.00), and taste (p=0.00); But it does not significantly affect the color (p=0.40). The best formula were the substitution of 10% mung bean flour and the addition of 5% soybean flour. A piece of snack bar (50g) contains 28.05g carbohydrates; 7.03g protein; and 28.47mg BCAA (10.52mg leucine; 12.05mg isoleucine; 5.9mg valine). One snack bar can fulfill 77,2% of carbohydrates and 72,8% protein needs. Athletes need to consume two pcs after exercise to reach 10% of their daily nutrition needs.

How to Cite

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INTRODUCTION

Athletes are people who are programmed to train their strength to achieve maximum performance. Athletes› nutritional requirements are different compared to ordinary people. They must consume enough energy to meet their bodyweight and body composition. Energy balance is needed by athletes to avoid pain, fatigue, and injury. Injury is a risk that athletes are susceptible to, so proper nutrition is essential.

Previous research on the eating habits of Yogyakarta Pre-PON athletes proved that around 38.5% did not pay attention to nutritional content when consuming food (Faoziyah, 2018). This result is aligned with initial observations done by researchers. It was found that inkai karate athletes in Kota Baru Driyorejo have the habit of consuming meatballs, fried foods, and softdrinks after training. This made researchers interested to focus their research on inkai karate athletes in Kota Baru Driyorejo. Researchers took the initiative to provide a nutritious snacks so that energy recovery can be quickly achieved.

Energy requirement for teenage athletes depends on age, gender, and their level of physical activity. Athletes in the 'active' category need 2200-2800 Kcal of energy for men, and 2000-2200 Kcal of energy for women. Meanwhile, athletes in the 'very active' category need 2400-3000 Kcal of energy for men, and 2200-2400 Kcal of energy for women (Zahra and Muhlisin, 2020). Smith et al (2017) provided nutritional recommendations for post-exercise consisting of 20g of high-quality protein, 1-1.5g/kg carbohydrates body within 30 minutes after completing the exercise, and 450-675 ml/0.5kg fluids. Then Azzahra et al (2020) also stated that the amount of carbohydrates needed by athletes is 55-67%, fat is 20-30%, and protein is 13-15% of total daily energy.

Consuming the right amount of carbohydrates aims to form muscle and liver glycogen which produce energy in the form of adenosine triphosphate (ATP). The nutrients used at rest and during training are carbohydrate or glycogen stores, blood glucose, and fat stores. Increased exercise intensity from low to high will cause a higher and greater ues of carbohydrate. Protein or amino acids are also used as enzymatic keys at each stage of metabolism (Rahadianti, 2019). BCAA (Branched-Chain Amino Acids) is an important amino acid for the body to maintain its muscle health. This essential amino acid is not produced by the body so it must be obtained from food.

Athletes need to consume nutritious snacks, aside from staple foods, to meet their body needs. Athletes need to consume snacks to fulfill 10% of their daily needs (Dewi et al, 2021). One of a snack that is suitable for consumption after exercise is a snack bar. It usually comes in the form of blocks or sticks. The chemical characteristics of a good snack bar are that it contains high protein at least 9.38%. As for its physical characteristics, it has a dense texture, brownish color, and has a sweet taste.

Nuryanti et al (2019) stated that snack bars can be given as an additional food to help the recovery process after exercise. The snack bar must provide a practical source of carbohydrates with varying amounts of protein and micronutrients. The basic ingredient for making snack bars in this research is oats. Oats contain limited amino acids, namely lysine and threonine, while mung beans and soy flours also contain limited amino acids, namely methionine. Substituting mung bean flour and adding soy flour to oats is the ideal combination to complement each ingredient›s limited amino acid content. Apart from that, mung beans and soy flours are ingredients that are high in carbohydrates and BCAA. This statement is in line with Solekah (2019) who stated that the largest component of mung bean seeds is 55% carbohydrates.

Choosing to substitute mung bean flour and soy flour making this snack bar is expected to have a higher carbohydrate and protein content compared to oats alone. The expected results of the snack bar product in this research is a product that has a sweet taste, a dense texture, a light brown color, and a dominant aroma of mung beans so that this snack bar can be liked by athletes. This research aims to determine whether there is an effect of the substitution of mung bean flour and the addition of soy flour on the acceptability of snack bars, as well as to determine the nutritional content of the best results which include carbohydrates, total protein, and BCAA. Thus, the results of this research can provide innovation regarding product development that can help athletes in the energy recovery process and muscle recovery process, by making snacks that are high in carbohydrates and protein.

METHOD

This research is quantitative research with true experimental design. This research started with ingredient planning, experiments, acceptability tests (color, aroma, texture, taste), and laboratory tests on the best results of the snack bar to see the carbohydrate, total protein, and BCAA. The independent variables in this research are the substitution of mung bean flour and the additi-

on of soy flour in the form of a ratio data. The dependent variable in this research is acceptability as seen by color, aroma, texture, and taste in the form of ordinal data. The control variables in this study are the type and quality of ingredients (oats, mung bean flour, soy flour, peanuts, margarine, peanut butter, honey, granulated sugar), tools (scales, pans, spatulas, bowls, spoons, soles, baking pans, knife, baking paper), and production stages. The stages of making a snack bar in this research can be seen in the following picture:

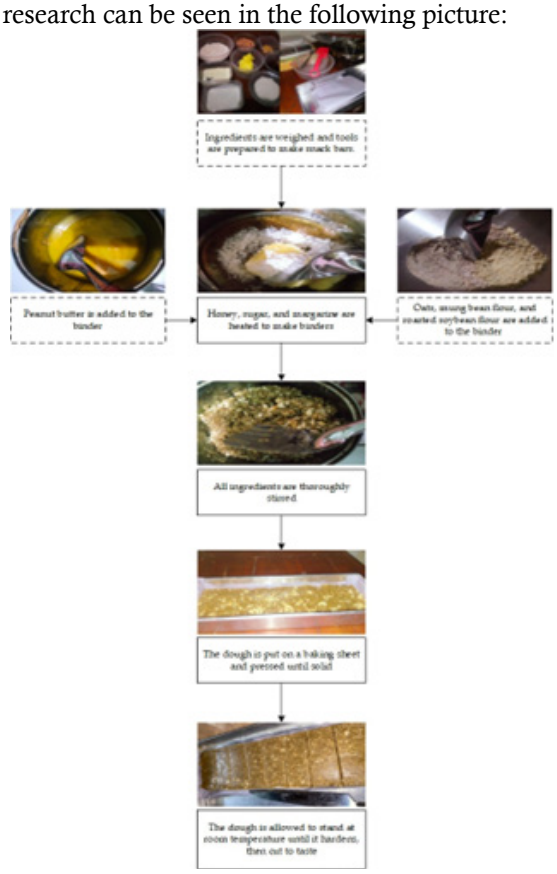

Figure 1. Stages of making a snack bar

This research procedure was carried out in two experimental stages which are pre-experiment and main experiment. The pre-experimental stage started with testing the standard recipe Hapsari (2017) and the commercial formula Ningrum (2019), pre-experiment I is conducted to determine the amount of substitution for mung bean flour, and pre-experiment II is conducted to determine the amount of soy flour addition. The Hapsari (2017) recipe was chosen because it was considered to meet the standards and criteria for a snack bar: brown, dominant aroma of oats, dense and rough texture, and a sweet taste. After the pre-experimental stage was completed, the main experiment is started by manipulating the amount of substitution for mung bean and oat flour and the addition of soy flour. This research uses a 3x2 factorial design. The experimental design in this research can be seen in the following **Table 1.**

Table 1. Experimental Design

Soy flour	Oats:Mung bean flour		
	90%:10%	80%:20%	70%:30%
5%	X1Y1	X2Y1	X3Y1
10%	X1Y2	X2Y2	X3Y2

This research uses random sampling (probability sampling) with a stratified sampling based on age. The research data was obtained through observation by filling out an organoleptic acceptability questionnaire which was measured using a Likert scale. The Likert scale used in this research can be seen in the following **Table 2.**

Table 2. Likert Scale

Criteria	Likert scale
Do not like it at all	1
Do not like it	2
Do not like it much	3
Neutral	4
Quite like it	5
Like it	6
Realy like it	7

Panelists must state that they are willing to take part in research activities from start to finish before carrying out an organoleptic acceptability tests by filling out informed consent. The snack bar samples assessed by each panelist were served in the same quantity of 6 pieces with different formulas. Research data was also obtained by laboratory tests on the best snack bar products. The data obtained was analyzed using descriptive analysis by changing the data which was originally in a tabular form into a descriptive form, and statistical analysis using the Friedman test to see whether there were differences in effects amongst treatments, as well as the Wilcoxon test to find out which two treatments had significant differences.

RESULTS AND DISCUSSION

Research related to organoleptic acceptability tests was carried out to obtain product results with the best formula. This research was conducted in August 2023 at the ADLI KBD Inkai Karate Dojo. The duration of the organoleptic acceptability test is around 120 minutes. The pa-

nelists used in this research were untrained panelists, namely 35 ADLI KBD inkai karate athletes. The organoleptic acceptability test is carried out by assessing snack bar products based on color, aroma, texture, and taste.

The results of the panelists assessment of the color of the snack bar can be seen in the following **Figure 2.**

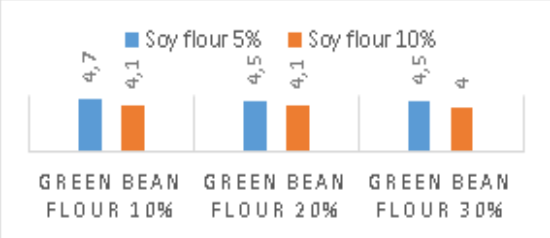

Figure 2. Average color assessment of snack bars

The average rating value of the color of the snack bar ranged from 4 – 4,7, it falls under a neutral category. The highest value for snack bar color was obtained in the treatment of X1Y1 which used 10% mung bean flour substitution and 5% soy flour addition with an average value of 4,7. On the other hand, the lowest value was obtained in the X3Y2 treatment which used 30% substitution of mung bean flour and the addition of 10% soy flour with an average value of 4. The results of the Friedman test on the color of the snack bar showed a p-value of 0,40. Thus, the hypothesis which stated that the substitution of mung bean flour and the addition of soy flour flour affected the color of the snack bar was rejected, it means there was no need to carry out further tests. This is related to the brown color produced in each treatment which is not very different.

The results of this research are in line with research by Kartika, et al (2019) regarding the analysis of variance using the One Way Anova test, the type of addition of mung bean flour does not affect the level of liking for the color attribute of kahimela bars with a p-value of 0,962. However, Dewi, et al (2021) stated that based on the results of the One Way Anova statistical test, there was a significant color difference with a p-value <0,05. Then, research by Nuryanti et al, (2019) also stated that based on the Anova test, the calculated F value was 3.019 with a significance value of 0.033, so it can be concluded that there is a significant difference in color between the four snack bar formulations. These statements shows that the results of the research are not in line with this research, because the substitution of mung bean flour and the addition of soy flour did not affect the color of the snack bar.

Color has one role in the attractiveness in food commodities. The color produced in treatment X1Y1 is light brown and the color produced in treatment X3Y2 is dark brown. This is aligned with research by Nuryanti et al (2019) which states that the preferred snack bar color is found in formula 1 which has a lighter brown. The color of the snack bar is formed from the caramelization process. The higher the amount of mung bean flour substitution and the addition of soy flour, the darker the color will be. The high carbohydrate and protein content in mung beans and soy flours can also cause a Maillard reaction, resulting in a dark color in the processed product as the proportion of ingredients used increases.

The results of the panelists assessment of the snack bar aroma can be seen in the following **Figure 3.**

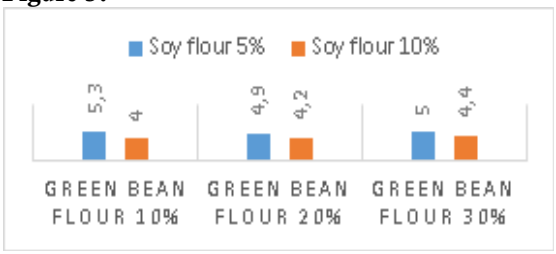

Figure 3. Average rating of snack bar aroma

The average rating value of the snack bar aroma ranged from 4 – 5,3. It is included in the neutral to quite favorable category. The highest value for the aroma of the snack bar was obtained in treatment X1Y1 which used the substitution of 10% mung bean flour and the addition of 5% soy flour with an average value of 5,3. Meanwhile, the lowest value was obtained in treatment X1Y2 which used 10% substitution of mung bean flour and 10% addition of the soy flour with an average value of 4. The results of the Friedman test on the color of the snack bar showed a p-value of 0,02. Thus, the hypothesis that states that the substitution of mung bean flour and the addition of soy flour flour affects the aroma of the snack bar is accepted, so it is necessary to carry out the Wilcoxon test to determine which two treatments have significant differences. Based on the Wilcoxon test results, it is known that 6 formulas have significant differences, namely X1Y2 with X1Y1, X2Y2 with X1Y1, X3Y2 with X1Y1, X1Y2 with X2Y1, X1Y2 with X3Y1, and X2Y2 with X3Y1. Meanwhile, the other 9 formulas did not have significant differences.

The results of this research are in line with the research of Nuryanti et al., (2019), it is known that the Anova test results obtained a calculated F value of 2.997 with a significance value of 0.034. It can be concluded that there is a significant dif-

ference in the aroma between the four snack bar formulations. Then, research by Dewi et al (2021) also stated that based on the results of the One Way Anova statistical test, there was a significant difference in aroma with a p-value <0,05. However, Novia et al, (2022) stated that the results of statistical tests showed that the two factors did not have a significant effect with a p-value >0,05 on the level of panelists liking for the attributes of color, aroma, taste, texture, and overall product. This statement shows that the results of the research are not in line with this research, because the substitution of mung bean flour and the addition of soy flour affects the aroma of the snack bar.

Aroma can be used as an indicator to determine the occurrence of damage to the product. The substitution of mung bean flour and the addition of higher levels of soy flour flour will produce a stronger mung bean aroma. Apart from that, the distinctive aroma of caramel comes from the sugar content in the use of honey, granulated sugar, and butter as adhesives in making snack bars. Then, during the roasting process, the combination of margarine as fat, honey as adhesive, and the amino acid content in mung beans can reduce the unpleasant aroma of the snack bar (Radiatus et al, 2019).

The results of the panelists assessment on the snack bar texture can be seen in the following **Figure 4.**

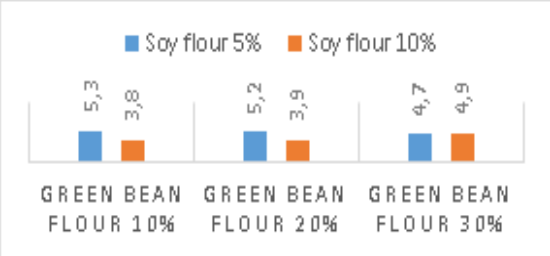

Figure 4. Average assessment of snack bar texture

The average rating value of the texture of the snack bar ranged from 3,8 – 5,3. It falls under the category of 'not like it much' to 'quite like it'. The highest value for snack bar texture was obtained in treatment X1Y1 which used 10% mung bean flour substitution and 5% soy flour addition with an average value of 5,3. On the other hand, the lowest value was obtained in treatment X1Y2 which used the substitution of 10% mung bean flour and the addition of 10% soy flour with an average value of 3,8. The results of the Friedman test on the texture of the snack bar with the substitution of mung bean flour and the addition of soy flour showed a p-value of 0,00. Thus, The hypothesis which states that the substitution of mung bean flour and the addition of soy flour flour affects the texture of the snack bar is accepted, so it is necessary to carry out the Wilcoxon test to determine which two treatments have significant differences. Based on the Wilcoxon test results, it is known that 8 formulas have significant differences, namely X1Y2 and X1Y1, X2Y2 with X1Y1, X1Y2 with X2Y1, X2Y2 with X2Y1, X1Y2 with X3Y1, X2Y2 with X3Y1, X3Y2 with X1Y2, and X3Y2 with X2Y2. Meanwhile, the other 7 formulas do not have significant differences.

The results of this research are in line with the research of Nuryanti et al, (2019), it is known that the Anova test results obtained a calculated F value of 3.573 with a significance value of 0.016. It can be concluded that there is a significant difference in texture between the four snack bar formulations. However, research by Dewi et al, (2021) stated that based on the results of the One Way Anova statistical test, there were no significant differences in texture. Kartika et al, (2019) also stated that the analysis of variance (Anova test) of the type of addition of mung bean flour had no effect on texture with a p-value of 0,375. These statements show that the results of the research are not in line with this research because the substitution of mung bean flour and the addition of soy flour affects the texture of the snack bar.

Texture has an important influence on the product for example the level of crispness, hardness, and so on. The non-hard texture of the snack bar is affected by the use of fat in the form of butter and the use of honey. Substituting mung bean flour and adding more soy flour flour will produce a denser texture. The high or low breaking strength of snack bars is affected by the heating which can cause proteins to become denatured and fats to melt so that they are dispersed throughout the food (Radiatus et al, 2019). Food texture is also determined by the water content, fat content, and structural content such as cellulose and protein contained in a product.

The results of the panelists assessment of the taste of the snack bar can be seen in the following **Figure 5.**

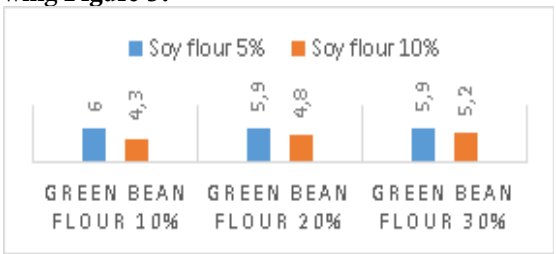

Figure 5. Average assessment of snack bar taste

The average rating value of the snack bar aroma ranged from 4,3 – 6. It falls under the neutral to 'like it' category. The highest value for snack bar taste was obtained in treatment X1Y1 which used 10% mung bean flour substitution and 5% soy flour addition with an average value of 6. On the other hand, the lowest value was obtained in treatment X1Y2 which used the substitution of 10% mung bean flour and the addition of 10% soy flour with an average value of 4,3. The results of the Friedman test on the taste of snack bars with the substitution of mung bean flour and the addition of soy flour showed a p-value of 0,00. Thus, the hypothesis which states that the substitution of mung bean flour and the addition of soy flour flour affects the taste of the snack bar is accepted, so it is necessary to carry out the Wilcoxon test to determine which two treatments have significant differences. Based on the results of the Wilcoxon test, it is known that 9 formulas have significant differences, namely X1Y2 with X1Y1, X2Y2 with X1Y1, X3Y2 with X1Y1, X1Y2 with X2Y1, X2Y2 with X2Y1, X3Y2 with X1Y2, X1Y2 with X3Y1, X2Y2 with X3Y1, and X3Y2 with X1Y2. Meanwhile, the other 6 formulas do not have significant differences.

The results of this research are in line with the research of Nuryanti et al., (2019), it is known that the Anova test results obtained a calculated F value of 3.028 with a significance value of 0.032. It can be concluded that there is a significant difference in taste between the four snack bar formulations. Dewi et al (2021) also said that based on the results of the One Way Anova statistical test, there was a significant difference in taste with a p-value <0,05. Then Kartika et al, (2019) stated that the analysis of variance (Anova test) of the type of addition of mung bean flour had an effect on taste with a p-value of 0,024. However, Rahman (2021) said that brown rice flour and mung beans did not affect the taste of the snack bar because the sweet taste was obtained from other additional ingredients in the same amount in each formula. This statement show that the results of the research are not in line with this research, because the substitution of mung bean flour and the addition of soy flour affects the taste of the snack bar.

Taste is the most important factor in determining a consumer's decision to accept a product or not. The taste of the snack bar by substituting mung bean flour and adding soy flour flour is sweet, slightly savory, and more dominant in oats, but the mung beans are still present. The concentration of soy flour does not affect the taste, because soy flour does not have a distinctive taste that influences a product (Taufik, 2018). The sweet taste in snack bars is obtained from the addition of sugar. Also, the addition of margarine can be used as a flavor enhancer.

The results of the Wilcoxon test for aroma, texture, and taste parameters show that there are 3 best formulas for snack bars with the substitution of mung bean flour and the addition of soy flour. The three formulas are X1Y1 (10% mung bean flour and 5% soy flour flour), X2Y1 (20% mung bean flour and 5% soy flour flour), and X3Y1 (30% mung bean flour and 5% soy flour flour). Texture is the most important food quality factor to provide satisfaction when consuming food. Snack bar with 10% mung bean flour substitution and 5% soy flour is the best formula in this study because it has a dense texture but is not as dense as other formulas; light brown color; a dominant mung beans aroma but not too strong like other formulas; the taste is sweet, slightly savory, and more dominant in the oats but the mung beans are still present.

Laboratory test results show that 100g of the best product contains 56,10% carbohydrates; total protein of 14,06%; and BCAA of 56,95mg (leucine 21,05mg; isoleucine 24,10mg; valine 11,80mg). The National Standardization Agency of Indonesia does not yet have general nutritional content standards for snack bar products that can be used as a reference in research. Another standard that can be used refers to the United States Department of Agriculture (USDA) for snack bar products based on grains, fruit, and nuts, various proximate parameters must meet the standards including a minimum protein content of 8% and a maximum carbohydrate content of 63,60%. The carbohydrate and protein content in the best snack bar shows that it meets the standards set by the USDA by containing 56.1% carbohydrates. and protein of 14,06%.

Yanti et al, (2021) stated that the carbohydrate content in their research was 41,87%, the best snack bar also had a higher carbohydrate content. This can be caused by the use of mung bean flour which contains high levels of carbohydrates which is 55% of mung bean seeds (Solekah, 2019). Apart from that, sugar and honey also contribute to the high carbohydrate content. However, the best snack bar had a lower protein content compared to the research which is 19,87%. The low protein content in this study was caused by the substitution of mung bean flour and the addition of less soy flour in the X1Y1 formula compared to other formulas. The BCAA in this study was also lower compared to that study, containing 154 mg of leucine; isoleucine of 88 mg;

and valine of 95 mg.

Daily nutritional requirements for teenage athletes are 2000 - 2800 Kcal of energy, carbohydrates of 275 - 469 g, and protein of 65 - 105 g. One snack bar can meet 77,2% of the carbohydrate requirements and 72,8% of the protein requirements of 10% daily nutritional requirements for teenage athletes. If adjusted to the carbohydrate and protein content in the snack bar of the best result, athletes need to consume 2 pcs to meet their carbohydrate and protein needs.

CONCLUSION

The results of the analysis in this study show that there is an effect of the substitution of mung bean flour and the addition of soy flour on acceptability based on aroma, texture, and taste. Meanwhile, based on color, there is no effect on the acceptability of the snack bar. Athletes need to consume 2 pcs snack bars after exercising to reach 10% of their daily needs.

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