

Formulation of Snack Bar Based on White Mussel as TFA (Therapeutic Food for Anemia) To Improve Adolescents Nutrition

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ABSTRACT

The purpose of this study is to enhance adolescent nutrition, specifically anemia and stunting, in accordance with the National Research Master Plan's public health and nutrition theme. In order to break the chain of stunting, giving TFA (Therapeutic Food for Anemia) to adolescent females at school is one of the measures taken. This study employed four formulation groups (P1) 0:80:20; (P2) 15:65:20; (P3) 25:55:20; (P4) 35:45:20 (White Mussel Powder: Moringa Flour: Brown Rice Flour) to create the refreshment bar. This study's objective was to evaluate the TFA food formula based on organoleptic and nutrient content tests prior to administering it to panelists. This is experimental research in the form of a formulation of a local seafood product with white mussel (*Corbula faba* Hinds) as the primary ingredient. The obtained data were then analyzed using ANOVA (Analysis of Variance) to determine which TFA formula was the panelist team's organoleptic preference. The P4 formulation contained the maximum levels of protein (11.31%) and iron (87.42 mg/100 g), as determined by the results. In addition, the organoleptic test revealed that formulation P3 was the most preferred treatment. In conclusion, TFA with formulation P3 can be used to enhance the nutrition of adolescents.

Keywords: adolescent, anemia, recovery food, malnutrition, iron

INTRODUCTION

Nutritional problems in adolescence will increase susceptibility to disease in adulthood and are at risk of giving birth to a generation with nutritional problems. Anemia is a condition when the number of red blood cells or hemoglobin is lower than the normal number. Adolescents who have poor nutritional status or are often called malnutrition, if it has been too long, there will

be a chronic energy deficiency. Chronic energy deficiency is when a person suffers from a long or chronic lack of energy and protein nutrition. Chronic energy deficiency in adolescents if not addressed quickly will have a major and sustainable impact when these young women become pregnant later.

UNICEF revealed data in 2017, the prevalence of anemia is the most common worldwide in women aged over 15 years as

much as 23% and 37% of pregnant women. A study by Mengistu, et al (2019) stated that adolescent girls with Hb between 11 to 11.9 g/dl and 8 to 10.9 g/dl showed mild and moderate anemia, respectively. The prevalence of anemia in Indonesian adolescents continues to increase from 6.9% in 2007, 18.10% in 2013 and 32% in 2018. The prevalence of anemia in adolescent girls in the city of Surabaya is 26%. While anemia during pregnancy is very high, reaching a prevalence of 48.9% in 2018.

White Mussels (*Corbula faba*), contain nutrients useful for humans, especially fresh mussels. Fresh mussels contain quite a lot of nutrients, especially protein content. The nutritional content of mussels is much higher when compared to other people's foods, such as crackers and tofu. The nutritional components of white mussel meat (*Corbula faba*) include a water content of 75.70%, ash content of 3.09%, protein content of 10.85%, fat content of 2.68%, and carbohydrate content of 1.02%. In addition, mussels contain 133,800 ppm Fe, 14,836 Zn, 12.31% linolenic acid, 6.25% EPA, and 6.61% DHA (Baswardono in Yuniar, 2019). Moringa leaf flour can be added to any food as a nutritional supplement, such as iron (6). The nutritional content of Moringa leaves is 5.1 g/100 g protein, 6 mg/100 g iron, 1.077 mg/100 g calcium, and 1.6 g/100 g fat. Chocolate (contains non-heme iron), milk (contains protein), and dates (contains iron and low in fibre) (Rahmayanti, 2020).

The snack bar is a practical form of snack, with complete nutritional value and includes durable food for storage. Every 100 grams of Snack Bar is estimated to contain 3.7 mg of iron and 24.2 grams of protein, so it can meet 23.56% of the adequacy of Fe and 38.61% of the adequacy of protein. Enough eight grams of Moringa leaf flour daily can contribute nutrients to adolescents (16-18 years), namely 14% protein, 40% calcium,

23% iron and almost all the needs of vitamin A. As much as 100 grams of Moringa leaf flour can provide more than a third of the need for calcium, iron, protein, copper, sulfur and B vitamins (Syahwal, 2018).

To improve nutrition for young women as prospective mothers, a TFA (Therapeutic Food for Anemia) formula was formed. This TFA is in the form of snack bar covered chocolate so that it attracts young women to consume it. The TFA formula is prepared based on the Nutrient Adequacy Number recommended in Permenkes No. 28 of 2019. Therefore, this research was conducted to develop a snack bar product made from white mussel (*Corbula faba*), moringa leaf flour and brown rice flour.

MATERIALS AND METHODS

Tools and Materials

The snack bar's production begins with white mussels (*Corbula faba*) sourced from Surabaya's Kenjeran District. The moringa plant is native to Sumenep in East Java. The Java Rice Organic Farmers Group in Wates Village in Tulungagung's Sumbergempol District supplied the brown rice used in this dish. Dried pineapple, almonds, chocolate, dates, butter, sugar, and vanilla extract are also added. The necessary equipment for creating snack bars includes: kitchen scale, washbasin, baking sheet, pan, Teflon, knife, cutting board, tablespoon, 80 mesh sieve, gas stove and oven. The tools used for the analysis of nutrient content, namely: aluminum dish, porcelain dish, oven kiln, desiccator, condenser, soxhlet, Kjeldhal flask, distillation apparatus, Erlenmeyer flask, upright cooler, measuring flask, measuring cup, hotplate, burette, pipette, filter paper, muscles and Thermo Scientific Genesys 10S UV-Vis spectrophotometer. The instrument used in the organoleptic test was an organoleptic form with 5 hedonic scales covering taste, aroma, color and texture to measure the level of acceptance of

the snack bar, which was carried out by 30 moderately trained panelists.

Method

This research consists of two stages, namely preliminary research and main research. Preliminary research aims to 1) Develop a formula and process for making white mussel snack bars, Moringa leaves, and brown rice; 2) Proximate analysis and Fe content and organoleptic test on snack bars. The formulation of the snack bar is based on Table 1.

The data collected was processed quantitatively using statistical analysis to determine the formulation of white mussel flour, Moringa leaf flour, and brown rice flour on the characteristics and nutritional content of the snack bar. Data on nutrient content, chemical characteristics and glycemic index values were analyzed descriptively. Data from organoleptic test results with 26 panelists (hedonic test and hedonic quality test) were analyzed using One Way ANOVA and Kruskal-Wallis nonparametric test according to the results of data normality. If the analysis results are $p < 0.05$, then the difference is considered statistically significant, and Duncan's further test was carried out.

RESULTS AND DISCUSSION

Nutritional Content Test Results

The results of the nutrient content test showed that the treatment with the highest nutrient content (fats, proteins, and iron/Fe) was in the P4 formulation and the lowest was the P1 formulation. The complete results of the nutrient content test are presented in Table 3.

The results of the carbohydrate analysis on the snack bar were the highest in the P2 treatment group with a value of 67.19%. This value indicates the biscuit formulation has met the biscuit quality requirements according to SNI 01-2973-199.

The white kupang, moringa leaf and brown rice snack bars have carbohydrate content of 64.12% - 67.19%. The carbohydrate content in white shellfish, Moringa leaves, and brown rice is quite high, this makes the snack bar produce sufficient carbohydrate content. The results of this study differ from studies which show that there is a reduction in carbohydrate content due to partial replacement of wheat flour which is the main source of carbohydrates with seaweed flour (Wiranata et al, 2017).

The results of the carbohydrate content test in each snack bar formulation were in accordance with the requirements for the nutritional content of the snack. Snack bars are generally in small portions with sufficient carbohydrate content ranging from 60% of daily energy needs, which is 20-40 g. The addition of white mussel flour reduces carbohydrate content because it contains high protein (Ferazuma 2009, Kusharto et al. 2012). Likewise, with Moringa leaf flour which contains high protein and minerals (Broin 2010) so that the carbohydrate content decreases.

The results of the analysis of the nutritional content showed that the protein content of the snack bar ranged from 5.59% - 11.31%. Based on the protein requirement of 10% of the total daily energy, each serving of the three snack bar formulas (35 g) contributes 4.4 to 5% of the total protein requirement per day. White Mussels as a source of animal protein because of its relatively high protein content. This supports the community's nutritional needs for animal protein needs, where the price is affordable. As an alternative source of protein. Research on the protein content of white mussels is quite high, from the results of research by Subani it was reported that the proximate content of white mussels was 24.24%, while the total protein content by adding up the amino acid levels studied by PKMT-Lemlit Unair (2000) in Yuniar (2019) found the

protein of rice mussels at 9.054%, and mussels wasps 10.854%. Protein plays a role in preventing malnutrition and hypoalbuminemia. Protein is known to play an important role in the transportation of iron in the body, if there is not enough protein in the body, the iron that is consumed cannot be distributed to the organs. The protein that functions to transport iron is transferrin. Transferrin is a glycoprotein synthesized in the liver. This protein plays a central role in the body's iron metabolism because transferrin transports circulating iron to places that need iron, such as from the intestines to the bone marrow to form new hemoglobin.

The results of the analysis of the nutritional content showed that the fat content of the snack bar ranged from 22.32% - 23.92%. Mussels also contains fatty acids that the human body needs. Red Mussels contains 8.97% LA (Linoleic Acid), 2.77% EPA (Eicosapentanoic), 3.65% DHA (Docosa-hexanoic Acid) while Mussels contains 12.31% LNA (Linolenic Acid), 6.52 % EPA, 6.61% DHA (Baswardono 1983) in Yuniar (2019). Omega 3 essential fatty acids form components that facilitate the transportation of oxygen and macronutrients (proteins, fats, and carbohydrates) into body cells so that they can help remove metabolic waste products such as carbon dioxide from body cells. Fat is the most important raw material in the manufacture of biscuits. The more fat you add to the dough, the crumblier the biscuit will turn out. Utami *et. al* (2021) revealed that fat is a food substance that is important to maintain the health of the human body. In the body, fat functions primarily as an energy reserve in the form of fat tissue. The function of fat in food is to provide a savory taste, crunchy quality and give soft and soft properties to baked cakes.

The moisture content of the white mussel snack bar, Moringa leaves and brown rice in this study was influenced by the

roasting process (temperature and roasting time). The water content of the snack bar in this study ranged from 6.39% - 10.12%, which was lower when compared to commercial snack bar products which contained 8.7 - 11.4% water content. Moisture content is an important analysis during processing and testing of food products. According to Septiani (2016) stated the water content of foodstuffs that are safe for storage is less than 14% so that snack bars with low water content are sufficient to prevent the growth of bacteria and molds. The drying process is strongly influenced by temperature and drying time. Analysis of water content as the dominant component in food products because water affects the stability and quality of the ingredients. In addition, the reduction and reduction of water content in certain products can simplify the process of packaging and storing products. Water content analysis is also used to determine the percentage standard of water content in a food ingredient (Utami, 2021). The water content in biscuits will affect consumer acceptance, especially on texture (crispy). All biological activity is possible only in the presence of water. The main causes of food spoilage are microbial growth, enzyme activity and chemical changes. This reaction takes place most rapidly at high water activity and is supported by environmental factors that can cause bacterial contamination so that damage occurs more quickly (Yuniar, 2019).

The ash content of this research snack bar ranged from 1.04% - 1.87%. The ash content exceeds the range of cookie quality requirements according to SNI 01-2973-1992. Measurement of ash content aims to determine the amount of mineral content contained in food. Ash content that exceeds the quality requirements of this SNI can indicate the minerals contained in the food. Mineral elements and inorganic substances are not destroyed and do not evaporate so as



to produce greater ash content (Krisyanella et al. 2013).

The highest Fe content value obtained was 87.42%. This is sufficient to meet the requirements for Iron/Fe needs per day based on RDA (2013) for adolescent girls, a maximum of 20-30 mcg per day and which is almost close to the Fe needs of adolescents. The high content of Vitamin B-12 in mussel is efficacious for the formation of a person's DNA which can maintain nerve function. Consuming mussels regularly can avoid feeling tired and lethargic due to anemia. The high iron content in mussels can also help improve blood circulation, so energy will be formed quickly to prevent fatigue and anemia. High levels of iron are needed to form hemoglobin, a special protein that carries oxygen in your blood throughout the body.

Iron is one of the minerals that plays a role in the formation of hemoglobin by forming a heme which is able to bind and transport oxygen to all body tissues (Suryani, et al., 2019). Iron (Fe) is an important mineral for the body because of its function in hematopoiesis, namely in the synthesis of hemoglobin. Iron (Fe) is an essential microelement for the body. Iron is mainly needed in hematopoiesis (blood formation), namely in the synthesis of hemoglobin. The body cannot produce iron itself, the fulfillment of iron in the body is obtained from intake. The amount of iron intake will affect the increase in hemoglobin production. Several studies have shown that substitution of biscuits with high-iron ingredients can increase the Hb value of experimental animals. Mahmoed et al (2009) also stated that wheat biscuits supplemented with fenugreek seed flour which has a high iron content can increase the hemoglobin levels of anemic rats, further Sari et al (2018) also stated that iron deficiency anemia can be treated by providing food. such as in his research using Moringa leaf flour.

Organoleptic Test Results

The results of the organoleptic test showed that the most preferred treatment was formulation P3 (White mussels flour: moringa leaf flour: brown rice flour = 25:55:20%) and the least preferred was formulation P4 (Mussel flour: Moringa leaf flour: flour brown rice = 35:45:20%). These results were obtained based on four parameters of taste, aroma, color and texture. The results be shown in Table 2.

Within the color attribute, treatment P1 achieves the highest value, while treatment P4 obtains the lowest value. This disparity is attributed to the panelists' growing disapproval of snack bar products as the quantities of white mussel flour, Moringa leaves, and brown rice increase, primarily due to the resulting darker color. Based on the results of the Anova test analysis, it was found that the p value = $0.019 \leq 0.05$, indicating a significantly different value between each treatment, meaning that the addition of white mussels affected the panelists' acceptance of the snack bar color parameter.

Color in food is the first appearance that greatly influences consumers to choose a product. An ingredient that is considered nutritious, delicious, and has a very good texture will not be eaten if it has an unattractive color or gives the impression that it has deviated from the proper color (Larasati, 2017). The function of the color of a food product is very important because it can affect consumer tastes and is able to arouse appetite. The decrease in color preference of the panelists along with the addition of white mussel flour, moringa leaves, and brown rice was in accordance with previous research, which stated that the more Moringa leaf flour was mixed into the dough, the darker the color of the snack bar and the lower the level of preference for color (Hasniar, 2019). Green vegetables contain a lot of chlorophyll pigment, usually found on

the leaves and stem surfaces of plants. Therefore, it is necessary to pay attention to the proportion of adding Moringa leaf flour to the snack bar to make it look more attractive, namely the ratio between the amount of white mussel flour and Moringa leaves. The color is obtained from the use of sugar, the brown color of mussel jerky is also obtained from the caramelization reaction of sugar and the Maillard reaction between sugar and protein when heating. The use of sugar accelerates the non-enzymatic browning process which is supported by heating in the drying process plus the frying process. Cooking with heat repeatedly will add a brown color to the results of the snack bar (Rahmayanti, 2020).

The aroma attribute indicates the treatment with the highest value is P2 and the lowest value is treatment P4. This is because The snack bar prepared in treatment P2, which includes white mussel flour and Moringa leaves, possesses a harmonious scent combining both the white mussel and moringa. Conversely, treatment P4 exhibits a predominant aroma of white mussel. The results of the ANOVA test analysis indicate a significant difference in values among the treatments, as the calculated p-value of 0.018 is less than or equal to the significance level of 0.05. This suggests that altering the concentration of mussels in the snack bar formulation significantly impacts the panelists perception of the aroma parameter in the mussel snack bars. The flavor of a food ingredient plays a crucial role in its overall appeal. The aroma aspect, which is closely tied to our sense of smell, holds significant importance. An identifiable and appealing aroma has the potential to enhance consumer preference for food products, thus necessitating careful consideration during ingredient processing. In the case of the snack bar, the panelists expressed a growing aversion to the scent as the quantity of white mussels increased. This is primarily since the

aroma of mussels contributes significantly to the snack bar's distinctive fragrance, typically characterized by a marine animal scent.

This study aligns with prior research conducted on the development of functional sausage products containing mackerel fish and Moringa leaf flour. Consistent with previous findings, it has been observed that an excessive amount of Moringa flour diminishes the panelists' liking for the aroma of the sausage (Nurlaila et. al, 2018)). The distinctive aroma of excessive Moringa leaves can be one of the factors that affect the aroma of tempeh sausage with the addition of too much Moringa leaf flour. Green vegetables contain lipoxidase enzymes which if the cooking process is not perfect it will cause a quite unpleasant aroma that is less pleasant (Rahmayanti, 2020).

The taste of a product plays a significant role in determining consumer preference and acceptance. According to the findings presented in Table 2, the organoleptic quality test results for taste attributes indicate that the P4 snack bar has a slightly bitter taste. The analysis of the ANOVA test further reveals that the p-value of 0.010 is less than or equal to the significance level of 0.05, indicating a significant difference in hedonic quality among the taste attributes. Duncan's further test results confirm that the different formulations used in the snack bar exhibit significantly different values between each treatment ($p < 0.05$). It can be concluded that the addition and increase in the concentration of Moringa leaf flour in the snack bar formulation result in a bitter taste. This finding is consistent with multiple studies conducted on this topic such as research by Pratiwi, K (2018) regarding the manufacture of cookies, and Darmawan (2017) regarding Moringa leaf-based buns. The presence of saponins in Moringa leaves imparts a bitter taste, as well as specific properties such as foaming and easy solubility in water



(Indriasari et al., 2016). The presence of glutamic acid in white mussel flour influences the taste of the snack bar. Glutamic acid plays a crucial role in food processing as it contributes to the development of a savory taste and enhances the overall flavor balance in processed foods. White mussel flour contains approximately 1.443% glutamic acid per 100 grams, while Moringa leaves have a glutamic acid content of 30106.87 ppm. The findings from the organoleptic test revealed that the P1 snack bar was the most preferred in terms of texture. The results of the ANOVA test indicated that the p-value of 0.010 indicated a significant effect ($p < 0.05$) of the varying levels of Moringa leaf flour substitution on the texture attributes assessed in the organoleptic test. However, Duncan's further test results showed no significant differences in texture attributes among the formulations of P1, P2, P3, and P4 snack bars. Texture is an essential component evaluated in sensory tests, utilizing the oral cavity and the sense of touch, such as using fingers. These findings are consistent with previous research conducted by Pratiwi, F (2018), which concluded that the formulation of Moringa leaf flour in snack bar products does not significantly impact texture attributes. The texture of each food form varies and can be assessed in terms of hardness, elasticity, or crunch, depending on its physical characteristics. (Hariyani, 2017).

CONCLUSION

The sensory evaluation conducted on the snack bar formulations containing white mussel, Moringa leaf, and brown rice assessed attributes such as color, aroma, taste, and texture. Among the formulations, P3 (25:55:20%) was found to be the most preferred in terms of overall organoleptic acceptability. Moreover, the analysis of nutrient content, including carbohydrates, protein, fat, ash, water, and iron, in the snack

bar formulation P2 met the quality standards for snack bar biscuits. Therefore, this snack bar formulation holds potential as a healthy snack option based on locally sourced ingredients.

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Table 1. Formulation of snack bar therapeutic for anemia

Ingredients	Unit	Recipe Groups			
		P1	P2	P3	P4
White mussel powder	%	0	15	25	35
Moringa Flour	%	80	65	55	45
Brown Rice Flour	%	20	20	20	20
Dates	g	15	15	15	15
Pineapple	g	15	15	15	15
Almond	g	15	15	15	15
Chocolate	g	20	20	20	20
Margarine	g	15	15	15	15
Sugar	g	10	10	10	10
Vanilla flavor	g	5	5	5	5

Table 2. Organoleptic test results

Sample	Mean Rank			
	Colour	Aroma	Flavor	Texture
P1 (0:80:20%)	3,97 ± 0,12 ^a	3,68 ± 0,57 ^b	3,96 ± 0,72 ^a	3,59 ± 0,28 ^b
P2 (15:65:20%)	3,72 ± 0,14 ^a	3,89 ± 0,85 ^b	3,73 ± 0,21 ^a	3,50 ± 0,17 ^c
P3 (25:55:20%)	3,62 ± 0,35 ^a	2,58 ± 0,30 ^b	2,62 ± 0,35 ^c	2,58 ± 0,12 ^b
P4 (35:45:20%)	2,54 ± 0,84 ^a	2,19 ± 0,76 ^b	2,15 ± 1,26 ^c	2,19 ± 0,51 ^b

Values with different letters in the same row are demonstrate significantly different ($p < 0.05$)

Table 3. Proximate test results of white mussle snackbar

Sample	Parameters					
	Protein (%)	Carbohydrate (%)	Fat (%)	Water (%)	Ash (%)	Iron (mg/100g)
P1	5,59	66,95	22,72	6,39	1,25	15,36
P2	6,01	67,19	22,89	6,14	1,87	35,61
P3	9,19	66,81	23,44	8,52	1,04	66,33
P4	11,31	64,12	23,92	10,12	1,53	87,42