International Journal on Food, Agriculture, and Natural Resources
Volume 04, Issue 03, Page 27-31
ISSN: 2722-4066
http://www.fanres.org

Original Paper

Substitution of Tempeh and Addition of Dates in The Manufacture of Snack Bar as High Protein and Iron Snack

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Received: 15 February 2023; Revised: 23 June 2023; Accepted: 27 June 2023
DOI: *https://doi.org/10.46676/ij-fanres.v4i3.157*

Abstract*—Snack bar is a ready-to-serve and nutrient-dense snack, making this product popular among people with a modern and practical lifestyle. The raw material for making snack bars in general is soy flour added with dried fruit. Along with the development of science and technology, efforts can be made to improve the quality and nutritional content of snack bar products. Tempe is a processed soybean product that has a higher nutritional content and quality than pure soybeans. Dates are one of the fruits that are abundantly available and have a complete nutritional composition. As an effort to improve the quality and nutritional content, research was conducted on the substitution of tempeh and the addition of dates in the manufacture of soy flour-based snack bars. Quantitative research using the experimental method using a completely randomized design (CRD), 3x2 factorial design resulted in 6 treatment formulas. Formula 4 with 30% tempeh substitution and 40% addition of dates became the best product based on the results of statistical analysis of product organoleptic assessment using a two-way ANOVA and DMRT follow-up test involving 50 panelists. The nutritional content test was carried out on formula 4 with the result that every 100 grams of product contained 19% protein and 4.62 mg of iron. The best snack bar formula per serving size of 15 g has a higher protein content than the three comparison products. Existing snack bars using soy flour as raw material are known to have a lower protein content compared to snack bars made from soybean flour substituted with tempeh. Likewise, the protein content in tempeh-based snack bars in the previous study and the USDA peanut-based snack bars still had lower protein content. In this regard, the combination of soy flour and tempeh in the manufacture of snack bars can increase the protein content of the product. In addition, the iron content of snack bars in this study was higher than USDA product 1980811. This is related to the composition of one of the raw materials for its manufacture, namely dates, which are known to be rich in iron minerals.

Keywords*— Snack Bar, Soybean Flour, Tempeh, Dates, Protein, Iron, Organoleptic Test

I. INTRODUCTION

Snack bar is a type of bar-shaped snack that is dense in nutrition and has practical ready-to-eat characteristics, making this product a snack that is quite popular among people with a modern and practical lifestyle [1]. The raw material for making snack bars in general is soy flour added with dried fruit [22]. Soy flour is a semi-finished processed soybean product that is commonly used as a basic ingredient in the food industry. It is known that soy flour has a higher protein content than wheat flour [2]. Soybeans and their processed products also contain high levels of isoflavone antioxidants, where these antioxidants play a very important role in preventing oxidation processes which cause degenerative diseases including cancer [3]. Therefore choosing a snack bar as a snack for daily consumption is the right step in an effort to fulfill nutrition and maintain a healthy body.

One of the commercial snack bar products made from soybean flour that is popular among the public is known to contain protein that meets the Nutrition Adequacy Rate (RDA) of 8% in a 30 gram portion based on an energy requirement of 2,150 kcal [4]. The protein content of commercial products contributes 12% of energy from protein in 100 grams of product serving, which value does not meet the quality requirements based on SNI (Indonesian National Standard) 01- 4126-1996 where snack bar products should be able to contribute energy from protein by 25 - 50%[5].

Science and technology continues to develop, this brings various updates in all fields including food technology. More processed soybeans are being created, one of which is tempeh. Tempe is a traditional fermented product from Indonesia. Tempe has long been known and consumed by the people of Indonesia as an affordable and inexpensive source of protein [21]. The raw material for making tempeh in general is soybeans which have undergone a fermentation process by the Rhizopus sp. The process of making tempeh includes several stages including stripping, soaking, boiling, inoculation, with starter, and incubation at room temperature [18]. There is digestive enzymes produced by tempeh mold, then protein, fat, and carbohydrates in tempeh become easier to be digested in the body compared contained in soybeans. Therefore, Tempe is very good to be given to all age group (from infants to the elderly) [19]. Tempeh as one of the local foods that is very easy to find in Indonesia is a fermented product from soybeans which in fact has a much higher nutritional content and quality than the soybeans themselves. The amino acid content in tempeh is 24 times higher

than soy milk [6]. Tempe has a high protein almost equivalent to milk [20]. Tempeh is one of the foods that can function to prevent muscle damage, which is very beneficial for individuals with high activity intensity. This is because tempeh contains high levels of branched chain amino acids (BCAAs), namely valine, leucine, isoleucine [7]. Based on this, efforts can be made to improve the quality and protein content by substituting tempeh in the process of making soy flour-based snack bars.

Substitution of tempeh in the snack bar to improve quality and protein content can be accompanied by the addition of dates. Dates are a type of fruit that grows in the Middle East but this fruit is easy to find in Indonesia. Dates are crowned as a fruit with almost complete nutritional content and a balanced composition. Dates can supply sufficient energy for the body because they contain high calories. Dates are also high in iron content which can help meet the body's hemoglobin levels for the formation of red blood cells which transport oxygen throughout the body. In addition, dates are classified as fruits with a low glycemic index (GI), where consuming foods with a low GI can increase and maintain blood glucose levels without drastically removing insulin so that they can extend cardiorespiratory endurance and delay fatigue [8]. In addition, the value of iron content in dates is known to be around 0.3-10.4 mg in 100g of fruit. Eating a few dates every day can meet the daily iron needs of the body [9]. In commercial snack bar products that are used as research references, it is known that they do not represent the value of the product's iron content. Therefore, based on the high iron content in dates which also have one of the same nutritional function characteristics as tempeh, it is expected that snack products that contain protein and iron are higher than similar snack bar products that are already on the market.

II. Materials And Methods

A. Material and Equipment

The materials used in this study were soy flour, tempeh, dates, egg, margarine, palm sugar, and powdered sugar. The study included the following equipment: digital scales, blender, mixer, basins, knives, cutting boards, spoons, mortar and pestle, tins, and oven.

B. Research Design

The The type of research used in this study is quantitative research with an experimental method using a 3x2 factorial design. The factorial design consisted of 3 levels of tempeh (T) substitution and 2 levels of addition of dates (K) to the total soybean flour used in making the product. The design resulted in 6 treatments, namely T1K1 (30%;20%), T2K1 (40%;20%), T3K1 (50%;20%), T1K2 (30%;40%), T2K2 (40%;40%), and T3K2 (50%;40%).

C. Prosedure

The procedure for making snack bar in this study was divided into 3 work procedures.

i. Production of Tempe Flakes

The flake tempeh production process begins with selecting pure soy tempeh, cutting it into 0.2 cm thin slices, arranging the tempeh slices on a thin baking sheet, baking for 20 minutes at 155°C, grinding with a blender until it reaches a fine degree of 80 mesh.

ii. Production of Date Palm Paste

Date paste is made by removing the skins of the dates and separating them from the seeds, then grinding them with a mortar and pestle to a paste. The type of date used is the Golden Valley Egyptian date which has a soft texture.

iii. Production of Snack Bar

The process of making snack bars in this study began with beating eggs (60g) and palm sugar (50g) for 5 minutes using a mixer; mixing margarine (30g), soy flour, and powdered sugar (25g) in the beaten eggs; adding tempeh flakes and date palm paste into the dough; stirring until homogeneous; then print the dough on a 22x9x3 cm tin; bake for 30 minutes; cut the product with a size of 8.5x1.5x1.5 cm; the final process is to bake again for 45 minutes.

D. Analysis Method

Data collection was carried out using an organoleptic test form involving 50 panelists to assess aroma, color, taste and snack bar texture with an interval rating scale from very dislike (1) to like very much (6).

The panelists assessment data were processed using a two-way ANOVA statistical test. When a significant difference is found, DMRT tests will be carried out and these results are used to determine the best product. The best products are identified its nutritional value at the Surabaya City Industrial Standardization Research Center through a series of tests to determine the content of calories, protein, fat, carbohydrates, and iron.

This research has been approved by the Health Research Ethics Commission, Airlangga University Faculty of Dentistry together with reference number 363/HRECC.FODM/VI/2022.

III. Results AND DISCUSSION

A. The Average Level of Preference of Panelists on Sensory Properties of Snack Bars

Organoleptic tests on 50 panelists were carried out to determine the acceptability of snack bar products substituted with tempeh and added dates based on the sensory properties of color, taste, aroma, and texture of the six treatments, the following results were obtained:

Based on table I, the panelist's average assessment of the color sensory properties of the 6 snack bar treatments ranged from 4.72 to 4.90, that is, between a little dislike to like. The level of significance is denoted by the same letter notation indicating that there is no effect of treatment on the color of the snack bar. Substituting tempeh and adding dates did not have a

significant effect on the color of the products produced from each treatment due to the caramelization process during baking [10]. In addition, the same control of temperature and baking time for each treatment makes the product tend to have the same color.

TABLE I. THE AVERAGE VALUE OF THE PANELIST'S PREFERENCE

Parameter	The Average Value of Each Treatment					
	T1K1	T2K1	T3K1	T1K2	T2K2	T3K2
Color	4,84[a]	4,90[a]	4,72[a]	4,84[a]	4,76[a]	4,82[a]
Taste	4,28[a]	4,48[a]	4,26[a]	4,52[a]	3,92[a]	4,16[a]
Aroma	4,38[ab]	4,58[b]	4,42[ab]	4,64[b]	3,96[a]	4,20[ab]
Texture	4,00[ab]	4,38[b]	4,12[ab]	4,42[b]	3,70[a]	4,06[ab]

Explanation: T1 = 30% tempeh, T2 = 40% tempeh, T3 = 50% tempeh; K1 = 20% dates, K2 = 40% dates; T,K percentage of total soy flour (standard recipe=75g soy flour) a, b = similar letter notation means no effect on treatment.

Furthermore, the panelists' average assessment of the sensory taste properties of the 6 snack bar treatments ranged from 3.92 to 4.52, that is, between a little dislike to like. The level of significance is denoted by the same letter notation indicating that there is no effect of treatment on the taste of the snack bar. The desired taste parameter is sweetness. The sweet taste of the product is obtained from the use of dates, refined and palm sugar. Both contain fructose and sucrose monohydrate respectively [10]. Even though the dominant taste is sweet because of these ingredients, each treatment has a distinctive tempeh flavor so that the taste of each product tends to be the same.

The process of testing 6 snack bar treatments on the aroma parameter showed an average range from 3.96 to 4.64, that is, between a little dislike to like. In contrast to the color and taste parameters, the results of statistical analysis on the aroma parameters have different letter notations. To find out which treatment was affected, the DMRT follow-up test was carried out, the test results showed that there was an effect of the snack bar aroma on treatments 2 and 4. Aroma is a substance that arises due to exposure to heat on food volatile substances. Dates are a food ingredient that contains volatile substances [10]. Tempe has an aroma that is produced due to enzymatic activity that breaks down various kinds of tempeh raw material macromolecules, such as proteases which break down proteins and lipases which break down fats so that they are simpler in size and produce volatile compounds[11]. The interaction of the two materials used in the manufacture of snack bars in this study and processing by baking exposes the product to heat, makes the aroma of the product stronger and can affect sensory characteristics and panelist assessments.

In testing the texture parameters, the average panelist's assessment of the 6 snack bar treatments ranged from 3.70 to 4.42, which is between a little dislike to like. The statistical analysis test showed the same results as the aroma parameter, that there was an effect on the texture of the snack bar treatment 2 and 4. Substitution of tempeh in the snack bar has an effect on the texture of the product. The greater the proportion of added tempeh flour, the harder the texture of the product will be [12]. The addition of dates in the manufacture of snack bars also affects the texture of the product. The proportion of more dates can cause a softer texture [13]. The interaction between the two different material characteristics creates a unique product texture so that it can affect the sensory assessment of the product on texture parameters.

B. Best Snack Bar Determination

The best product is known by looking at the average value of the panelists' assessment of each treatment which shows the effect on the results of statistical analysis. Based on the previous discussion, treatments 2 and 4 are products that have a treatment effect on aroma and texture parameters. Of the two, the best product was selected with the help of analysis using Nutrisurvey 2007 software to see an overview of nutritional content. It was found that treatment 4 had a higher nutritional content than treatment 2, so it was chosen as the best formula. Treatment 4 had a proportion of 30% tempeh substitution and 40% addition of dates or equivalent to 22.5 g of mesh 80 tempeh flour and 22.5 g of dates paste (1:1). Based on the same weight ratio it can also be concluded that formula 4 is the best product with a balanced aroma and texture compared to other treatments. Treatment 4 as the best product will be tested for nutritional content including calories, protein, fat, carbohydrates and iron.

C. The Results of The Best Snack Bar Nutritional Content

Analysis of the nutritional content of the best snack bar products was carried out at the Surabaya Industrial Standardization Research Institute with test parameters including calories, protein, fat, carbohydrates and iron.

TABLE II. NUTRITIONAL CONTENT OF THE BEST FORMULA PER 100 G SERVING SIZE

Parameter	Nutrient Content
Protein (%)	19,0
Fat (%)	18,06
Carbohydrates (%)	61,92
Calories (Kcal)	330,08
Iron (mg)	4,62

Source: Baristand Surabaya (2022)

The nutritional content of the best snack bar formula in 100 g contains 19 g of protein which contributes 23.02% of energy. It is also known that the iron content in 100 g of the product is 4.62 mg. Based on the quality requirements referring to SNI 01-4126-1996, snack bar products must contain 25-50% energy from protein and contain 16 mg of iron.

The protein content of snack bar substitutes for tempeh and the addition of dates is close to the quality requirements based on SNI 01-4126-1996. This is related to the substitution of tempeh with soy flour in the manufacture of snack bars, where it is known that tempeh contains higher nutritional value and quality than pure soybeans. The amino acid content in tempeh is also 24 times higher than soy milk [6].

Apart from protein, this product also contains 4.62 mg of iron in 100 g. This figure does not meet the quality requirements of SNI 01-4126-1996 which requires snack bar products to contain 16 mg of iron in 100 g. The iron content in this product is obtained from its raw materials, one of which is dates. Dates are crowned as a fruit with almost complete nutritional content and a balanced composition. Dates can supply sufficient energy for the body because they contain high calories. Dates are also high in iron content which can help meet the body's hemoglobin levels for the formation of red blood cells which transport oxygen throughout the body. In addition, dates are classified as fruits with a low glycemic index (GI), where consuming foods with a low GI can increase and maintain blood glucose levels without drastically removing insulin so that they can extend cardiorespiratory endurance and delay fatigue [8]. In addition, the value of iron content in dates is known to be around 0.3-10.4 mg per 100g. Thus, eating a few dates every day can meet the body's daily iron needs [9].

TABLE III. COMPARISON OF THE NUTRITIONAL CONTENT OF SNACK BARS

Calories And Nutritional Substances	Best Snack Bar Product (15g)	USDA 1980811 * (15g)	Existing product ** (15g)	Similar Research Product *** (15 g)
Calories (Kcal)	49,5	62,4	80	-
Protein (g)	2,8	1,2	2,5	2
Fat (g)	2,7	3,2	4,5	0,4
Carbohydrates (g)	9,2	8,9	6	9,2
Iron (mg)	0,7	0,4	-	-

Source:
*U.S. Department of Agriculture (2020)
** PT. Amerta Indah Otsuka (2019)
*** Andriani and Saputri (2019)

The best snack bar formula per serving size of 15 g has a higher protein content than the three comparison products. Existing snack bars using soy flour as raw material are known to have a lower protein content compared to snack bars made from soybean flour substituted with tempeh. Likewise, the protein content in tempeh-based snack bars in the previous study and the USDA peanut-based snack bars still had lower protein content. In this regard, the combination of soy flour and tempeh in the manufacture of snack bars can increase the protein content of the product. In addition, the iron content of snack bars in this study was higher than USDA product 1980811. This is related to the composition of one of the raw materials for its manufacture, namely dates, which are known to be rich in iron minerals [9]. Iron is one of the micronutrients which is an essential element for all living things. This is related to the function of iron which plays a role in various metabolic processes in the body, including oxygen transportation, deoxyribonucleic acid (DNA) synthesis, and electron transport [15]. Although the body's need for iron is relatively small, iron has a number of important roles, namely as a carrier of O2 and CO2, the formation of red blood cells, and part of enzymes. Iron deficiency for a long time will result in iron nutritional anemia which affects the health and endurance of individuals [16]. Dates are a source of nutrition and have many health benefits. The chemical composition of dates includes carbohydrates, dietary fiber, protein, fat, minerals and vitamins, enzymes, phenolic acids and carotenoids, providing direct nutritional benefits to the health of consumers. Numerous studies have also confirmed the therapeutic effects of dates and their efficacy in the treatment of many disease conditions [17].

Each serving of snack bar products substitution of tempeh and addition of dates, can meet the recommended RDApercentage in Indonesia for the category of 2,150 kcal calorie needs with an energy requirement of 5% protein, 4% fat, 3% carbohydrates and 3% iron.

IV. CONCLUSION AND SUGGESTION

A. *Conclusion*

1. Two-Way ANOVA statistical test showed that there was no treatment effect on color and taste, but there was a treatment effect on the aroma and texture of the snack bar. The DMRT follow-up test showed that formulas 2 and 4 were products that were affected by the treatment on aroma and texture parameters. Furthermore, treatment 4 became the best product based on analysis of nutritional content using Nutrisurvey 2007 software.
2. The results of the nutritional content analysis showed that the best product selected, namely treatment 4 per 100 gram serving size, contained 330.08 kcal of calories, 19.0% protein, 18.06% fat, 61.92% carbohydrates and 4.62 mg iron.

B. *Suggestion*

In future studies it is suggested to test the nutritional content and glycemic index in all treatments to determine the nutritional content of the six formulas. In addition, it is also advisable to analyze the target market and product selling prices.

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