The potential of B-Star snacks (banana and tempeh nastar) to prevent muscle fatigue

Potensi snack B-Star (nastar pisang dan tempe) untuk menunda kelelahan otot

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Abstract

Muscle fatigue is a common problem experienced by athletes when undergoing exercise. Sports snacks are an effective solution for preventing them because they can be consumed between workouts without requiring a particular time. However, the availability of sports snacks is still rarely traded in the market. The purpose study is to produce a nastar based on a mixture of banana flour and tempeh (named B-Star Snack) as a sports snack that can prevent muscle fatigue. The research was carried out in July - December 2020 at the Food Technology Lab, Department of Nutrition, Denpasar Health Polytechnic, where wheat flour as the main ingredient for making nastar was substituted with tempeh flour and banana flour with the five combinations of banana flour and tempeh mixtures. All observations were analyzed by ANOVA. Especially for the results of the organoleptic test, in order to meet the assumption of a normal distribution, the data is transformed into an interval scale using the successive interval method. There was a significant difference in the preference for B-Star Snack between formulas (p = 0,014). The most preferred is the combination of tempeh and banana flour (40:60%). The B-Star Snack with a 40:60% combination contains the complete nutrition of both macro and micronutrients. The B-Star Snack with a tempeh and banana flour 40:60% as much as 100 grams per serving can be recommended to prevent muscle fatigue due to the exercise.

Keywords: Banana, tempeh, sport snack, muscle fatigue

Abstrak

Kelelahan otot merupakan masalah yang sering dialami oleh para atlet saat menjalani latihan. Snack olahraga merupakan solusi pencegahan yang efektif, karena dapat dikonsumsi di sela-sela latihan tanpa memerlukan waktu khusus. Namun ketersediaan snack olahraga masih jarang diperjualbelikan di pasaran. Penelitian ini bertujuan untuk menghasilkan nastar berbahan dasar kombinasi campuran tepung pisang dan tempe (dinamai B-Star Snack) sebagai snack olahraga yang dapat mencegah kelelahan otot. Penelitian dilaksanakan pada bulan Juli - Desember 2020 di Lab Teknologi Pangan Jurusan Gizi Politeknik Kesehatan Denpasar. Tepung terigu sebagai bahan utama pembuatan nastar disubstitusi dengan tepung tempe dan tepung pisang dengan lima kombinasi campuran tepung pisang dan tempe. Semua pengamatan dianalisis dengan ANOVA. Khusus untuk hasil uji organoleptik, agar memenuhi asumsi sebaran normal maka data ditransformasi menjadi skala interval menggunakan metode succsessive interval. Terdapat perbedaan preferensi Snack B-Star yang signifikan antar kombinasi perlakuan (p= 0,014). Kombinasi yang paling disukai adalah tempe dan tepung pisang (40:60%). B-Star Snack dengan komposisi 40:60% mengandung nutrisi yang lengkap baik zat gizi makro maupun mikro. The

B-Star Snack dengan komposisi tempe dan tepung pisang 40:60% sebanyak 100 gram per porsi dapat direkomendasikan untuk mencegah kelelahan otot akibat latihan.
Kata Kunci: Kelelahan otot, pisang, snack olahraga, tempe

Introduction

Muscle fatigue occurs due to strong or prolonged contractions. This is characterized by a decrease to the loss of muscle contraction ability in a certain period. Muscle fatigue refers to reducing muscle response to a stimulus (Chan et al., 2016). According to Burleigh et al., (2020) muscle fatigue that occurs in high-intensity exercise is caused by several factors, including high levels of acidity due to increased production of lactic acid; inadequate concentrations of blood glucose, liver glycogen and muscle glycogen for energy production; and the inadequacy of food and drinking arrangements before and during the exercise (Temesi et al., 2011).

Muscle fatigue can be overcome by eating a balanced nutritious diet on time. Food and drink consumed before, during, and after exercise can help maintain blood glucose levels, maximize muscle performance, and speed recovery time. High daily carbohydrate intake before, during and after exercise improves performance and recovery (Hearris et al., 2018). An increase in glycogen stores of 25-100% can be done by consuming carbohydrates before training or competition to reduce the risk of fatigue by up to 20%. Carbohydrates are the main source of energy that is important for high-intensity exercise; giving 30-60 g/hour of carbohydrates can maintain blood glucose levels and maintain the level of carbohydrate burning in the body so that fatigue can be delayed for 30-60 minutes (Mata et al., 2019).

Micronutrient deficiencies are also known to trigger muscle fatigue. A study proves that increased activity of Na^+, K^+, and ATP-ase during exercise can stabilize membrane sodium and potassium concentrations to prevent fatigue (Wyckelsma et al., 2019). Several studies have used protein-based drinks to restore muscle damage (Eddens et al., 2017; Röhling et al., 2021).

In addition to complete meals, athletes need snacks that can be consumed before and after an exercise to delay fatigue (Burke & Manore, 2020). The right type and number of snacks positively impact improving athlete performance. However, the availability of local food-based snacks specifically for athletes is still rarely. Therefore, the development of snack products by utilizing local food needs to be developed. Snacks are given to complement the amount of nutrients from food, and the form is practical or following sports situations (Marangoni et al., 2019).

Tempeh is a traditional Indonesian food containing various nutrients and bioactive components beneficial for health. Tempeh is a complete and nutrition food containing macronutrients and micronutrients such as vitamins and minerals (Ahnan-Winarno et al., 2021). Tempeh contains protein (amino acids) as the foundation for muscle building which is also needed to keep red blood cells healthy. Tempeh also contains Branched Chain Amino Acids (BCAA), namely high valine, leucine, and isoleucine, which are needed to recover muscle damage after strength training (Mardiana et al., 2021). Bananas contain carbohydrates, a source of energy during exercise, have a high potassium content, and contain antioxidants. The bananas can provide good nutritional support during intensive training (McKenna et al., 2008). Carbohydrates have an important role for endurance athletes in replenishing muscle and liver glycogen stores that are used up during muscle contraction (Vitale & Getzin, 2019). Potassium functions to maintain fluid and electrolyte balance. Changes in the body's electrolytes affect muscle contraction. Potassium increases the strength and speed of muscle contraction (Terwoord et al., 2018). Consumption of bananas before exercise can increase blood glucose and potassium, thus potentially preventing muscle fatigue (Pritchett & Moore, 2018).

There are circulating various supplements and sports drinks today. Although some products have gone through clinical trials, some claim benefits but are not backed by healthy nutrition and exercise physiology. So far, to prevent muscle fatigue, many-based drinks have been produced, which are relatively expensive. For this reason, it is necessary to develop snacks that are rich in

nutrients and have good taste by utilizing local food. Based on the potential; of tempeh and banana, these two ingredients can be used as an alternative for developing muscle fatigue and delaying snacks. The purpose study is to analyze the nutrient content and preference level of the B-Star Snack, which is known to prevent muscle fatigue. The snack developed was named the B-Star Snack, an acronym for the banana and tempeh nastar snack. This snack is designed to delay muscle fatigue so that athletes become the superstar they want to be.

Methods

This research is an experimental study with a randomized block design at the Food Technology Laboratory of the Department of Nutrition, Poltekkes Denpasar.

The research has been conducted for five months, from July to December 2020. In this study, wheat flour as an ingredient for making nastar was substituted with banana flour and tempeh. Substitution of materials is designed into five combinations of mixtures, namely F1 (30% tempeh flour + 70% banana flour), F2 (40% tempeh flour + 60% banana flour), F3 (50% tempeh flour + 50% banana flour), F4 (60% tempeh flour + 40% banana flour), and F5 (70% tempeh flour + 30% banana flour).

The main ingredients for the B-Star Snack are tempeh and banana. The tempeh used is H.B Original Tempeh produced in Denpasar (Bali) by the tempeh company assisted by "Rumah Tempeh Indonesia". In contrast, the bananas were obtained from the Denpasar Renon Market. Banana criteria: plantains that are old but not yet ripe. To add to the nastar flavor, Pineapple jam is made by its own cook by buying pineapple raw materials at the Denpasar Renon Market. The other ingredients consist of wheat flour, cornstarch, chicken eggs, margarine, sugar, and powdered milk.

The production process of the B-Star Snack begins with the manufacture of tempeh flour and banana flour. Bananas are steamed for 15 minutes, peeled and coarsely grated with a thickness of ±2 mm. Grated bananas were soaked in 0,2% citric acid solution for 3 minutes and then drained. Grated bananas are dried in the sun until dry and brittle, then ground and sieved using an 80 mesh sieve. In the manufacture of tempeh flour, tempeh is used with a size of 19.5 cm x 8 cm

x 2 cm and a weight of 200 grams per pack. Tempeh is sliced at 1 cm x 1 cm x 0,2 cm, then steamed for 10 minutes, then dried until it shrinks and is easily broken. The dried tempeh was then ground and sieved through an 80 mesh sieve. Pineapple jam is made by perfectly ripe pineapple, grated, and cooked over low heat until the water evaporates. Then added sugar and cooked again while stirring until thickened and golden brown.

Nastar with the main ingredients of banana flour and tempeh flour made with the composition according to the treatment. Making nastar begins by whisking margarine and powdered sugar until well blended, then adding egg yolks, cornstarch, flour, and milk powder and stirring until smooth. The dough is shaped round, flattened and filled with pineapple jam, then round again. It was then heated in the oven until cooked.

Product testing analysis is carried out both subjectively and objectively in the objective analysis. Water content was analyzed by gravimetric method, protein by Kjeldahl method, fat by soxhlet extraction and carbohydrates by spectrophotometry. Micronutrient levels (potassium, sodium, calcium, and magnesium) by spectrometric method. The preference of the B-Star Snack was analyzed by an organoleptic test with five hedonic scales, namely, strongly dislike (1); dislike (2); neutral (3); like (4); and very like (5). The analyzed parameters include colour, flavour, texture, taste, and overall acceptance. 30 moderately trained panellists carried out the organoleptic test. In order to meet the assumption of normality, before further analysis, the Likert scale of the organoleptic test results was first transformed into an interval scale using the successive interval method (MSI) (Ningsih & Dukalang, 2019). Differences in acceptability between formulas were analyzed by analysis of variance (ANOVA) with 95% confidence level.

The research was conducted after obtaining a recommendation from the Ethics Committee for Health Research Health Polytechnic Denpasar through letter No. LB.02.03/EA/KEPK/0299/2020.

Results and Discussion

The Product of the B-Star Snack
The complete product B-Star snack produced in this study is presented in picture 1.

Formulation	**Product Picture**
F1 (30% tempeh flour + 70% banana flour)	
F2 (40% tempeh flour + 60% banana flour)	
F3 (50% tempeh flour + 50% banana flour)	
F4 (60% tempeh flour + 40% banana flour)	
F5 (70% tempeh flour + 30% banana flour)	

Nutritional content of B-Star Snack

Tempeh flour is rich in protein with a content of 56,2%, while banana flour is rich in carbohydrates 62,0% and fat 23,2%. The complete formula composition of tempeh and banana flour is presented in table 1.

As presented in table 1, the comparison of the composition of tempeh and banana flour determines the nutritional content of the formulas. The higher the proportion of tempeh flour, the higher the protein content and conversely, the higher the proportion of banana flour, the higher the carbohydrate content. From the result of the analysis of variance (p= 0,0136) means that there are differences in the composition of nutrients based on the different formulas of banana and tempeh flour.

Table 1. The formula composition of tempeh and banana flour

Parameter	The compotition of tempeh and banana flour (%)				
	30:70	40:60	50:50	60:40	70:30
Carbohydrates (%)	50,63	46,84	43,05	39,26	35,47
Fat (%)	18,89	17,44	16,00	14,56	13,11
Protein (%)	21,92	26,82	31,73	36,63	41,53
Potassium (mg/100 g)	129,01	110,88	92,76	74,64	56,51
Sodium (mg/100 g)	1,08	1,42	1,75	2,09	2,43
Magnesium (mg/100 g)	50,22	43,28	36,33	29,39	22,45
Calsium (mg/100 g)	146,61	125,67	104,72	83,78	62,83

Annotation: F-value= 3,8671 (p= 0,0136)

Tempeh flour is an alternative to tempeh processing to increase its usefulness. The results showed the yield of tempeh flour was 36,6%. This is following the yield of tempeh flour from Mulyani et al. (2013) research result, which obtained a yield of about 35% of the raw material of tempeh. As a result of this study, Tempeh flour has a protein content of 56,24%, not much different from the results obtained by Astawan et al. (2014) equal to 52,22%.

Bananas contain high starch so that they can be processed into flour. In addition to increasing the resilience of banana products, flouring also facilitates the development of products such as cakes, bread, biscuits, porridge and nastar. Based on the study results, the yield of banana flour was 21,2%. Almost the same results were also obtained in the research of Wahyuningtyas et al. (2014), which was 20-24%. However, according to Pratiwi & Krisbianto (2019) the yield of banana flour can reach 25-28%. This difference is thought to occur because of the type of banana, water content, starch content of bananas, and the ripeness of banana used as flour. The starch content decreases significantly at the higher the ripeness level of bananas. It is converted into various sugars such as glucose, sucrose, and maltose by carbohydrate hydrolase enzymes (Campuzano et al., 2018). The carbohydrate content of banana flour obtained was 62,1%, lower than that obtained by Pratiwi & Krisbianto (2019) who obtained the carbohydrate content of Tongko Langit banana at 83,72%. This is probably due to the type of banana used. The characteristics of the banana flour produced are brownish white.

The Preference Level of the B-Star Snack
The preference level of the B-Star Snack was assessed by conducting organoleptic analysis with five hedonic scales from 1 (very dislike) to 5 (very like). The B-Star Snack formula's level of preference is as shown in Table 2.

Table 2. The preference level of B-Star snack

Parameter	The Organoleptic Test Parameter				
	Colour	Flavour	Taste	Texture	Overall
F1 (30:70)	3,32[ab]	3,65[a]	3,97[a]	3,76[a]	3,74[ab]
F2 (40:60)	3,41[ab]	3,68[a]	4,06[a]	3,62[a]	3,85[a]
F3 (50:50)	3,50[a]	3,65[a]	3,76[ab]	3,71[a]	3,74[ab]
F4 (60:40)	3,18[b]	3,35[ab]	3,44[bc]	3,74[a]	3,50[b]
F5 (70:30)	3,21[ab]	3,26[b]	3,18[c]	3,68[a]	3,50[b]
F-value	1,852	3,277	8,816	0,444	2,378
p-value	0,123	0,013	0,000	0,777	0,055

Annotation:
Values followed by different letters in the same column show a significant difference ($p < 0,05$) with the Anova test.

The B-Star has a golden yellow appearance. Formula F3 with the composition of tempeh: banana flour (50:50%) has the most preferred colour ($x = 3,5$). The flavour is also a consideration in the selection of the B-Star Snack. The addition of excessive tempeh flour will increase the intensity of the unpleasant flavour of the B-Star Snack. The flavour and taste of the B-Star Snack that the panellist most preferred was the F2 formula with the composition of tempeh: banana flour (40:60%). For texture parameters, all formulas tend to be favoured by the panellist. This shows that the texture of the B-Star Snack is following the texture of nastar which is soft and melts in the mouth. Overall, all the formulas tended to be favoured by the panellists, with the highest level of preference being the F2 formula with the composition of tempeh: banana flour (40:60%). Judging from the result of the post hoc statistical test, it was found that F2 had the highest preference number which was significantly different from F4 and F5 ($p < 0,05$). However, when compared to the value of preference for F1 and F3, there is no significant difference ($p > 0,05$).

The colour is the first parameter of concern in food products. The colour is one of the physical parameters that consumers consider in choosing food, because colour can represent a characteristic of a food as a trigger for the first perception for consumers. The ideal colour for the B-Star Snack is golden yellow. Baking time is the main factor that affects the colour of the nastar cake. Burning for too long will produce dark coloured nastars due to non-enzymatic browning reactions, namely caramelization and mallards reactions (Lund & Ray, 2017).

The flavour was also a consideration in the selection. Formula F1 (tempeh:banana flour 30:70), F2 (40:60), and F3 ((50:50), were found to be preferred by panellists compared to F4 (60:40) and F5 (70:30). Formula F2 ($x = 3,68$) is the product with the most preferred flavour. The flavour of the B-Star Snack is obtained from a combination of ingredients used, such as tempeh flour, banana flour, milk, sugar, and margarine so that it can produce a distinctive fragrant flavour of nastar. The baking process causes the starch from the flour to be degraded. Starch changes with the elimination of water molecules and the fragmentation of sugar molecules, i.e. there is a breaking of the carbon bond, which produces carbonyl compounds and volatile compounds (Wang et al., 2021), giving rise to the distinctive flavour of the B-Star Snack. Statistical test results show that there is a significant difference in flavour. The more the addition of tempeh flour, the lower the value of the B-Star Snack's preference due to the appearance of the unpleasant flavour of tempeh.

The taste of the B-Star Snack with the composition of F1, F2, and F3 is more preferred by the panellists than F4 and F5. Formula F2 ($x = 3,68$) is the B-Star Snack's most preferred product. So it can be concluded that the B-Star Snack that the panellists prefer is the formula with the addition of less than 50% tempeh flour. The greater the addition of tempeh flour, the lower the value of the product's preference, because soya saponin contains in tempeh has a slightly bitter taste (Chitisankul et al., 2021). On the other hand, banana flour has a distinctive and special taste so that it can be used as a mixture in making nastar cakes, which gives the panellists a taste is preferred by the panellists.

For the texture parameters, all the formulas were favoured by the panellists. This shows that the texture of the B-Star Snack is in accordance with a good nastar texture, which is soft and melts in the mouth. Overall, all formulas tended to be favoured by panellists, with the highest level of preference being F2 (tempeh:banana = 40:60%). So it can be concluded that the difference in the composition of the addition of tempeh flour and banana flour will affect B-Star in terms of colour, flavour, texture, and taste.

The Nutrient Composition in the Most Preferred of the B-Star Snack

Based on the result of the organoleptic test, the panellists chose the F2 formula as the most preferred the B-Star Snack. Formula F2 is the B-Star Snack made with the composition of tempeh:banana flour (40:60%). The results of the analysis of the nutrient composition of the B-Star Snack with such flour composition are presented in table 3.

Table 3. The nutrition composition of the B-Star snack

Parameter	Ingredient
Carbohydrates (%)	45,15
Protein (%)	18,67
Fat (%)	12,21
Energy (kkal/100g)	365,17
Potassium (mg/100 g)	98,5863
Sodium (mg/100 g)	276,693
Magnesium (mg/100 g)	10,7654
Calsium (mg/100 g)	104,864

From table 3 it appears that the B-Star Snack is rich in protein and minerals such as potassium, sodium, calcium. The macronutrient composition of the B-Star Snack consist of protein (20,5%), carbohydrates (49,5%), and fat (30,0%). The energy and nutrient content of B-Star Snack per serving as well as the fulfilment of the Recommended Daily Allowance (RDA) rate can be seen in table 4.

Table 4. Nutritional composition of the B-Star Snack per serving and Adequacy of RDA for 19-29 years age group

Parameter	Value per serving (100 g)	Women		Men	
		RDA	%	RDA	%
Carbohydrates (%)	49,6	360	13,8	430	11,5
Fat (%)	13,4	65	20,6	75	17,9
Protein (%)	20,6	60	34,3	65	31,7
Energy (kkal)	401,6	2250	17,8	2650	15,2
Potassium (mg)	108,4	4700	2,3	4700	2,3
Sodium (mg)	304,4	1500	20,3	1500	20,3
Magnesium (mg)	11,8	330	3,6	360	3,3
Calsium (mg)	115,4	1000	11,5	1000	11,5

As presented in table 4, the energy and macronutrient values of the B-Star Snack formula per serving (100 gram/10 seeds) are energy 401,6 kcal (15,2 – 17,8% RDA); protein 20,6 g (31,7 – 34,3% RDA); carbohydrates 49,6 g (11,5 – 13,8% RDA); fat 13,4 g (17,9 – 20,6% RDA), value of micronutrients: potassium 108,4 mg (2,3% RDA); sodium 304,4 mg (20,3% RDA);

magnesium 11,8 mg (3,3 – 3,6% RDA); and calcium 115,4 mg (11,5% RDA).

The macronutrient composition of the B-Star Snack is protein (20,5%), fat (30,0%) and carbohydrates (49,5%). This formula almost achieves the RDA balanced and is even rich in protein. Bananas contains both simple and complex carbohydrates and are good for use as an energy source. The simple cabs of bananas provide a quick energy source, making them useful when making quick moves during exercise. Complex carbohydrates store muscle glycogen stores and can be used when performing endurance movements (Hargreaves & Spriet, 2020). The results showed that consuming two bananas 30 minutes before exercising can provide 90 minutes of energy. Bananas is a fruit that is recommended for athletes because it has the advantage of a combination of carbohydrate and B Vitamins that can provide energy quickly.

Research by David et al stated that bananas can be used to replace the function of energy drinks (Ranjha et al., 2022). Sufficient energy reserves during exercise, especially long duration exercise, can prevent fatigue. The simple sugars such us glucose, fructose, and sucrose are converted to glucose into the body. The glucose is then stored in the form of glycogen in the liver by 18%-22% and in the muscles by ±80%, and stored in the bloodstream as blood glucose. When muscle glycogen stores are depleted, blood glucose is used as an energy source, when muscles are deprived of energy, liver glycogen is broken down so that the rate of carbohydrate burning can be maintained to meet the energy need of the muscles. This process helps prevent muscle fatigue in the aerobic phase (Pavel et al., 2017).

Inadequate carbohydrate store will reduce the body's ability to maintain performance, resulting in muscle fatigue. Adequate muscle glycogen and exogenous glucose during endurance exercise can prevent fatigue. Aerobic muscle fatigue can be caused by decreased energy reserve and inadequate oxygen consumption per minute to support aerobic metabolism. In such condition lactic acid cannot be converted back into pyruvic acid. The accumulation of lactic acid in the aerobic phase of metabolism is what triggers muscle fatigue (Halim et al., 2017).

The result showed that the nutrient composition of the B-Star Snack per serving (100

grams) was energy 401,6 kcal (15,2-17,8% RDA); carbohydrates 49,6 g (11,5-13,8% RDA); protein 20,6 g (31,7-34,3% RDA); and 13,4 g fat (17,9-20,6% RDA). This result is equivalent to the nutrient composition of tempeh-based sports drinks as researched by Jauhari et al. (2014) with an energy composition of 438 kcal; 23 g protein; 48 g carbohydrates; and 17,11 g fat per serving (600 ml). A meta-analysis study recommends giving carbohydrates as much as 30-80 grams per hour during exercise with duration of 1 hour to increase endurance with VO_2 max parameters. This means that the consumption of 1 serving of the B-Star snack can already meet the recommended carbohydrate consumption (Halim et al., 2017).

The micronutrient composition of the B-Star Snack includes potassium 108,4 mg (2,3% RDA); sodium 304,4 mg (20,3% RDA); magnesium 11,8 mg (3,3-3,6% RDA); and calcium 115,4 mg (11,5% RDA). Potassium serves to maintain muscle work and prevent muscle cramps. Potassium and sodium play role in the mechanism of muscle fatigue (Miller, 2012).

Disruption of the balance of K^+, Na^+ and water affects the depolarization of the sarcolemma and tubular t membranes, resulting in impaired Ca^+ activation and impaired energy supply. This caused impaired interaction between actin and myosin in muscles and affects the resulting muscle strength. Potassium and sodium are needed in endurance training. These micronutrients have a function to maintain fluid balance when doing long-duration exercise (Apostu, 2014).

Electrolyte changes can affect nerve transmission and muscle contraction. During exercise, there is a decrease in micronutrients that are lost through sweat. To prevent that, athletes are recommended to consume fruits such as bananas as a source of electrolytes. Electrolytes loss can be overcome through the provision of foods such as salt in food, fruits that contain high potassium, namely bananas, and sources of calcium found in milk, cheese and dairy product. Soldavini (2019), stated that potassium along with other mineral substances plays a role in stabilizing ion concentration in cell membranes.

Potassium in bananas also has a function as an electrolyte and plays a role in regulating the balance of body fluids. Increased activity of Na^+, K^+, and ATPase will stabilize the concentration of Na and K on the membrane so as to prevent muscle fatigue (Hew-Butler et al., 2019). Potassium levels in intracellular fluid can increased 30-60 minutes after consumption of bananas (Miller, 2012). Thus, the combination of nutrients in bananas is recognized to have the potential to prevent muscle fatigue.

Magnesium is a mineral that has a role in physical activity. There will be change in the body's mineral levels during physical activity according to the intensity and duration of exercise (Hazar et al., 2013). Magnesium has an impact on muscle function and performance (Barbagallo & Dominguez, 2014). Magnesium affects muscle performance by playing a role in energy metabolism and the maintenance of muscle contraction and relaxation. Magnesium deficiency affect neuromuscular function and high level of physical activity increase magnesium needs for body (Zhang et al., 2017). The need for magnesium is higher during exercise, especially during vigorous-intensity exercise. During physical exercise, magnesium is redistribute in the body to accommodate metabolic needs (Geiger & Wanner, 2012).

Calcium is one of the micronutrients that are important in athlete's health and achievement. Calcium deficiency causes fatigue, decreased fitness, and increases the risk of sport injuries. Calcium needs increase in line with increasing physical activity (Abrams et al., 2018). The daily calcium requirement for adults is around 1000-1200 mg (Kementerian Kesehatan RI, 2019). Calcium has a role in bone and joint strength and for muscle contraction (Spriet, 2019). Calcium levels are positively correlated with leg muscle strength for soccer athletes (Yusni et al., 2017) According to Al-Eisa et al. (2016) calcium can prevent muscle fatigue.

The results showed that the combination of Banana - Tempeh can be considered as a basic ingredient for sports snacks that play a role in preventing muscle fatigue. However, there is one weakness of this conclusion. Due to limited mobility during the COVID-19 endemic, The B-Star Snack has not been tested directly on actual athletes. Panellists are only selected on the basis that they have been trained to carry out organoleptic tests. In further research, direct trials should be carried out with the target athletes, so that the B- Star snack product can be widely accepted among athletes.

Conclusion

Among the five combinations of banana flour and tempeh mixtures tested in this study, the most preferred B-Star is the formula with the composition of tempeh flour and banana flour 40:60%. In addition to having a composition of macronutrients following the principles of balanced nutrition, B-Star Snacks are also known to contain micronutrients, especially potassium, sodium, magnesium, and calcium, in sufficient quantities to maintain muscle health.

To increase endurance and prevent muscle fatigue, athletes are recommended to consume the B-Star Snack as 100 grams. The recommended B-Star Snack is a product made with a 40:60% composition of tempeh flour and banana flour.

Acknowledges

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