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Original Research

The Effect of Ambon Banana (*Musa acuminata Colla*) Consumption on VO_2max in Futsal Athletes

Pengaruh Konsumsi Pisang Ambon (Musa acuminata Colla) terhadap VO_2max pada Atlet Futsal

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Abstract: *Proper nutritional intake is a key factor in supporting optimal athletic performance during competition. Bananas are a natural source of energy that can help improve endurance due to their carbohydrates content and essential nutrients such as potassium. Potassium plays an important role in carbohydrates metabolism, including the formation and storage of glycogen and glucose as energy sources, thereby helping to maintain muscle function. This study aimed to determine the effect of Ambon banana consumption on improving VO_2 Max. Methods: This study employed a quasi-experimental method with a quantitative approach using a one-group pretest-posttest design. A total of 37 participants were given an intervention in the form of 150 grams of whole Ambon banana daily for 7 days. Results: The majority of participants had normal nutritional status (73.0%), while 21.6% were underweight and 5.4% were classified as overweight and obese. The results showed that the mean VO_2 Max value increased from 36,36 before the intervention to 39,57 after the intervention. Statistical analysis indicated a significant effect of Ambon banana consumption on improving VO_2 Max ($p < 0.05$). Conclusion: The consumption of Ambon bananas has a significant effect on Improving VO_2 Max in Futsal players.*

Key Words: Ambon banana; VO2 Max; Futsal Athletes; Sports Nutrition

1. INTRODUCTION

Sport is a form of physical activity that provides numerous benefits for human health. It has increasingly become a lifestyle practiced by many individuals to maintain physical fitness and overall well-being. Beyond its health benefits, sport also serves as a medium for education and achievement. One sport that is particulary popular among teenagers and children is futsal [1]. Futsal players are required to process good speed, agility, endurance, strength and flexibility to perform effectively during training sessions and matches. Among these components, the dominant aspects of physical fitness in futsal are aerobic endurance, commonly measured by VO_2max, and power endurance [2]. VO_2max or maximal oxygen uptake, refers to the body's maximum capacity intake, transport, and utilize oxygen during physical activity. Players with higher endurance levels tend to have higher VO_2max values, enabling them to perform more intense physical activities compared to those with lower endurance [3,4]. VO_2max can be measured using several methods, including the Astrand bicycle ergometer test and the Balke 15-minute running test. Futsal is similar with football in terms of gameplay, as it involves prolonged duration, high intensity, and continuous movement requiring speed and muscular strength. Therefore, futsal athletes are at a considerable risk of experiencing fatigue during matches [5].

Proper nutrition is a fundamental factor in supporting optimal athletic performance during competition. In addition, adequate nutritional intake is essential for maintaining the body's physiological functions. Carbohydrate and fat intake are known to play important roles in influencing an athlete's endurance [6]. Carbohydrates serve as the primary source of energy during physical activity and are associated with increased VO_2max values. Adequate carbohydrate intake during exercise helps provide glucose as an energy source while also preserving muscle glycogen stores [7]. In addition to carbohydrates, potassium plays a crucial role in supporting endurance. It is involved in glucose and glycogen metabolism and contributes to the transmission of nerve impulses required for muscle contraction. Futhermore, potassium helps maintain stable blood pressure. Several studies have shown that certain foods, particulary banana, can help maintain and improve stamina and endurance during prolonged physical activity [8, 9, 10].

Bananas (Musa paradisiaca) are fruits rich in carbohydrates, minerals, particularly potassium and vitamins such as vitamin B6 and vitamin C. The nutritional composition of ripe Ambon bananas per 100 g includes approximately 373 mg of potassium and 250–335 µg of vitamin A. In addition, Ambon bananas contain 102.89 kcal of energy, 72.28 g of water, 24.72 g of carbohydrates, 1.02 g of protein, 0 g of fat, and 217 mg of potassium per 100 g [11, 12]. In addition to their favorable nutritional profile, bananas have a soft texture that makes them easy to digest, allowing them to be consumed before or during physical activity [13]. The combination of simple and complex carbohydrates in bananas serves as an efficient energy source, which may help reduce muscle fatigue. Previous studies have shown that consuming 150 g of bananas can increase blood potassium levels within 30-60 minutes after intake and elevate blood glucose levels at 15, 30, and 60 minutes, thereby potentially helping to prevent muscle cramps during physical activity [14,15,16]. Furthemore, carbohydrate intake during exercise is important to prevent hypoglycemia, delay fatigue, and maintain muscle performance. Adequate carbohydrate consumption can increase glycogen stores by approximately 25%-100%, which may delay the onset of fatigue during training or matches by up to 20% [17].

2. METHODS

This study employed a quasi-experimental design using a one-group pretest-posttest approach. The study was conducted in the Jerowaru area, East Lombok Regency, in January 2025. The study population consisted of futsal players in the Jerowaru area. A purposive sampling technique was used to select a total of 37 respondents, taking into account a potential 10% dropout rate. The participant received an intervention in the form of 150 g of Ambon banana for 7 consecutive days. The inclusion criteria were as follows: male participants aged 18-25 years, not consuming any supplements, not experiencing injuries at the time of the study, willing to participate as respondents, and residing in the Jerowaru area, East Lombok Regency. The exclusion criteria included participants who sustained injuries or underwent medical treatment during the study period, as well as those who relocated during the study.

Participant characteristics, including age, were collected using a structured questionnaire. Nutritional status was assessed using Body Mass Index (BMI), calculated from body weight and height measurements. Body weight was measured using a digital scale with an accuracy of 0.1 kg, and height was measured using a stadiometer with an accuracy of 0.1 cm. BMI was calculated using the formula weight (kg)/height (m^2) and categorized according to WHO standards. Dietary intake was assessed using the 24-hour food recall method conducted through direct interviews. The collected data were analyzed to estimate daily energy, protein, fat, and carbohydrate intake using a standard nutritional analysis reference.

VO_2max was measured using the Multistage Fitness Test (MFT), also known as the bleep test. This test involves a 20-meter shuttle run in which participants run back and forth between two lines, following the rhythm of an audio signal "bleep" [18,19]. The test was conducted on a flat surface with two boundary lines set 20 meters apart. Participants were instructed to run contunuosly between the lines in accordance with the audio signal. The initial running speed was set at 8.5km/h and increased by 0.5 km.h at each level. Each level consisted of several shuttles, with progressively shorter intervals between audio signals as the level increased. Participants were required to reach the line before the next signal sounded. The test was terminated when a participant failed to reach the line on two consecutive occasions. The final was determined based on the highest level and the number of shuttles successfully completed [20].

VO_2max values were calculated using the equation developed by Léger:

$$\mathbf{VO_2max\ (ml/kg/min) = 3.46 \times maximum\ speed\ (km/h) + 12.2}$$

Where V_{max} represents the maximum running speed (km/h) achieved at the final level of the MFT. In addition to this equation, VO_2max values may also be estimated using standard conversion table based on the level and number of shuttles completed [21,22]. All measurement were expressed in units of ml/kg/min as indicator of the aerobic capacity.

This study received ethical approval from the Ethics Committee of the Faculty of Medicine, Al-Azhar University (No. 205/EC-02/FK-06/UNIZAR/1/2025).

3. RESULTS

This study involved 37 respondents who met the established inclusion and exclusion criteria. The data collected included respondent characteristics, such as age, nutritional status, and anthropometric parameters, as well as dietary intake assessed using a 24-hour food recall method. In addition, aerobic capacity was measured through VO_2max assessments conducted before and after the intervention.

The results are presented systematically, beginning with the distribution of respondent characteristics based on age, as shown in Table 1.

Table 1. Respondent Characteristics Based on Age and Nutritional Status

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	18–20	26	70.3
	21–23	7	18.9

	24–25	4	10.8
Nutritional Status	Underweight	8	21.6
	Normal	27	73.0
	Overweight	1	a2.7
	Obesity I	1	2.7
Total		**37**	**100**

Source: Primary Data (2025)

Based on Table 1, the majority of respondents were aged 18–20 years, comprising 26 individuals (70.3%). A total of 7 respondents (18.9%) were in the 21–23 age group, while the smallest proportion was in the 24–25 age group, with 4 respondents (10.8%). The mean age of respondents was 19.73 ± 2.23 years, indicating that the most respondents were in the early adulthood stage.

In terms of nutritional status, most respondents had normal nutritional status, accounting for 27 respondents (73.0%). A total of 8 respondents (21.6%) were classified as underweight, while overweight and obesity category were each observed in 1 respondent (2.7%). These findings indicate that the majority of respondents had a normal nutritional status.

Table 2. Energy and Macronutrient Intake

Category	**N**	**Mean ± SD**
Energy (kcal)	37	2006.32 ± 120.23
Protein (g)	37	61.86 ± 4.62
Fat (g)	37	23.40 ± 1.20
Carbohydrates (g)	37	257.90 ± 7.79

Source: Primary Data (2025)

Based on Table 2, the mean daily energy intake of respondents was 2006.32 ± 120.23 kcal. The average intake of protein, fat, and carbohydrates was 61.86 ± 4.62 g, 23.40 ± 1.20 g, and 257.90 ± 7.79 g.

Table 3. Distribution of VO_2max Categories Before and After Intervention

Category	**Before (n, %)**	**After (n, %)**
Bad	13 (35.1)	3 (8.1)
Currently	19 (51.4)	24 (64.9)
Good	5 (13.5)	10 (27.0)
Total	**37 (100)**	**37 (100)**

Source: Primary Data (2025)

Based on Table 3, prior to the intervention, most respondents were in the moderate VO_2max category, (n= 19; 51.4%), followed by the poor category (n= 13; 35.1%) and the good category (n= 5; 13.5%). After the intervention, a shift in the distribution of VO_2max categories was observed. The proportion of respondents in the moderate category increased to 24 individuals (64.9%), while those in the good category increased to 10 individuals (27.0%). Converserly, the proportion of respondents in the poor category decreased to 3 individuals (8.1%).

Table 4. Differences in VO_2max Values Before and After Intervention

Variables	N	Mean ± SD	Min–Max	p-value
Before	37	36.63 ± 4.77	28.0 – 45.5	
After	37	39.57 ± 4.37	32.6 – 49.0	**0.001** *

*Paired t-test, significant if p < 0.05

Based on Table 4, the mean VO_2max value before the intervention was 36.63 ± 4.77 ml/kg/min with a range of 28.0–45.5 ml/kg/min. After the intervention, the mean VO_2max increased to 39.57 ± 4.37 ml/kg/min with a range of 32.6–49.0 ml/kg/min. The results of the paired t-test indicated a statistically difference in VO_2max values before and after the intervention (p=0.001; p < 0.05).

4. DISCUSSION

The results of this study showed that the majority of respondents had normal nutritional status (73.0%), with a mean BMI of 19.81 ± 2.09 kg/m^2. Adequate nutritional status plays a crucial role in supporting aerobic capacity, as it is closely related to efficient energy metabolism and optimal physiological function. Individuals with normal nutritional status tend to have better physical performance compared to those with undernutrition or overnutrition [23,24,25,26]. Nutritional status in this study was assessed only once at baseline, as it reflects a relatively stable physiological condition that does not change significantly over a short intervention period. Unlike variables such as VO_2max, which can respond acutely to short-term interventions, changes in nutritional status—particularly those measured by BMI—generally require a longer duration to show meaningful differences. Therefore, baseline nutritional status measurement was considered sufficient to describe the participants' initial condition and to support the interpretation of the intervention effects.

Furthermore, the respondents' average energy and macronutrient intake indicated generally adequate consumption, particularly carbohydrate intake, which averaged 257.90 ± 7.79 g per day. Carbohydrates serve as the primary energy source during moderate to high-intensity physical activity. Previous studies have shown that adequate carbohydrate consumption can enhance carbohydrate oxidation, maintain blood glucose levels, and prolong time to exhaustion, all of which are closely associated with VO_2max performance [27,28,29,30]. In addition, the predominance of carbohydrate utilization during high-intensity exercise (>60% VO_2max) has been shown to be more efficient than fat oxidation in supporting aerobic performance [31,32].

A significant increase in the mean VO_2max was observed after the 7-day Ambon banana intervention, rising from 36.63 ± 4.77 to 39.57 ± 4.37 ml/kg/min ($p = 0.001$). This increase of approximately 2.94 ml/kg/min represents a meaningful improvement in aerobic capacity, as even small increases in VO_2max are associated with enhanced endurance performance and delayed onset of fatigue during high-intensity exercise. Practically, this improvement may allow athletes to sustain higher intensity activity for longer durations and improve overall match performance. This finding aligns with the study by Nieman et al., which showed that consuming bananas during exercise produced effects comparable to carbohydrate beverages in maintaining performance, blood glucose levels, and metabolic responses [33]. Other studies have also suggested that consuming natural carbohydrates before and during physical activity can improve endurance and aerobic capacity [34,35,36,37].

However, some studies have reported inconsistent findings. Maunder et al. found that improvements in physical performance are not always accompanied by a significant increase in VO_2max, particularly in short-term interventions [38]. Furthermore, studies on high-fat diets indicate that increased fat oxidation is not always directly associated with improvements in VO_2max or aerobic performance [39]. These findings suggest that increases in VO_2max are influenced not only by nutritional intake but also by long-term physiological adaptations, such as enhanced cardiovascular capacity and increased mitochondrial density in skeletal muscle.

The increase in VO_2max observed in this study may also be explained by the potassium content in Ambon bananas. Potassium plays an essential role in maintaining electrolyte balance, facilitating nerve impulse transmission, and supporting muscle contraction. Previous studies have shown that optimal electrolyte balance, particularly sodium and potassium, is crucial for maintaining muscle function and preventing fatigue during physical activity [40]. In addition, the activity of the Na^+/K^+-ATPase enzyme during exercise contributes to maintaining muscle cell membrane stability, which is associated with improved aerobic endurance [41].

Bananas also contain vitamin B6, which plays a role in energy metabolism, as well as antioxidants such as dopamine, which may help reduce oxidative stress caused by physical activity [42]. High levels of oxidative stress have been shown to impair muscle performance and accelerate fatigue; therefore, adequate antioxidant intake may contribute to maintaining physical performance [43]. This is supported by studies indicating that the consumption of antioxidant-rich fruits can enhance physical performance and reduce fatigue [9,24]. Furthermore, the findings of this study suggest that overall dietary patterns contribute to nutritional status and physical performance. Previous studies have shown that fruit and vegetable consumption is associated with improved health outcomes and nutritional status [51]. Conversely, unbalanced dietary patterns, such as excessive sugar intake without adequate nutrient balance, may negatively affect body composition and physical fitness [50].

In addition to nutritional factors, various other factors influence VO_2max. Physical exercise is a primary determinant of VO_2max improvement through adaptations in the cardiovascular and respiratory systems. The frequency, intensity, and duration of exercise contribute to increased cardiac output and improved efficiency of oxygen utilization [44]. Age and sex are also important factors, as VO_2max tends to decline with age and is generally higher in males than in females [45].

Nutritional status also plays a significant role in determining aerobic capacity. In this study, nutritional status was assessed using Body Mass Index (BMI), which reflects an indirect indicator of body composition. Although body composition (such as fat mass and lean body mass) is known to influence VO_2max, this study did not directly assess body composition variables. Therefore, the interpretation of nutritional status in this study is limited to BMI as a proxy indicator. Individuals with normal nutritional status tend to have more optimal physiological conditions that support efficient oxygen utilization during physical activity. In contrast, undernutrition may lead to reduced muscle mass and lower energy reserves, while overnutrition may increase the workload on the cardiovascular system, thereby reducing aerobic efficiency. In addition, the intake of other nutrients such as iron, B-complex vitamins, and adequate hydration contributes to oxygen transport and energy metabolism [47]. Genetic factors and psychological conditions, such as motivation during testing, may also influence VO_2max measurements [48].

Thus, the increase in VO_2max observed in this study can be attributed to a complex interaction between nutritional interventions (carbohydrates and potassium derived from Ambon bananas), nutritional status, and physiological factors, including physical activity levels. Although variations in findings have been reported in previous studies, the present results support the potential of banana consumption as a natural energy source to enhance aerobic capacity, particularly in short-term and practical field settings [49].

This study offers novelty by evaluating the effect of Ambon banana consumption as a source of natural carbohydrates and potassium on VO_2max improvement in futsal athletes using a quasi-experimental design. In contrast to previous studies that mostly used sports supplements or commercial carbohydrate drinks, this study emphasizes the use of natural local foods that are easily accessible, economical, and practical. Furthermore, this study provides empirical evidence that a short-term intervention (7 days) using Ambon bananas may improve aerobic capacity, which is still limited in the literature, particularly among futsal athletes in Indonesia. However, it is important to note that the observed increase in VO_2max cannot be attributed solely to the banana intervention, but rather reflects a multifactorial interaction involving carbohydrate intake, electrolyte balance (potassium), nutritional status, and other physiological and training-related factors.

This study has several limitations. First, the study design did not include a control group, which limits the ability to fully account for external factors that may have influenced the results. Second, the intervention period was relatively short (7 days) and therefore does not reflect long-term effects on VO_2max improvement. Third, control over participants' daily nutritional intake and physical activity relied primarily on instructions, which may have introduced potential bias.

5. CONCLUSION

The Ambon banana intervention significantly increased VO_2max values in futsal athletes. The mean VO_2max improved from pre- to post-intervention, accompanied by a shift in fitness category distribution, characterized by a decrease in the proportion of the poor category and an increase in the good category.

This improvement may be attributed to the carbohydrate content of bananas, which serves as a primary energy source for maintaining muscle glycogen availability, as well as their potassium content, which supports electrolyte balance and muscle contraction. Together, these nutrients make Ambon bananas a potential natural energy source for enhancing aerobic capacity.

Therefore, the consumption of Ambon bananas can be recommended as a simple, natural, and practical nutritional strategy to improve endurance and physical fitness, particularly among athletes.

CONFLICT OF INTEREST

The authors declare that there were no conflicts of interest in this study.

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