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Effect of *Citrus sinensis* and *Musa textilia* Consumption on Lactic Acid Levels and Muscle Tension in Fish Auction Workers

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ABSTRACT
Potassium deficiency is known to induce muscle fatigue, necessitating the inclusion of potassium-rich foods, such as orange (*Citrus sinensis*) and banana (*Musa textilia*) in diet. Previous studies have shown that consuming 150 g and 300 g of banana is effective in preventing muscle fatigue, with orange containing 237.4 mg of potassium per 300 ml. Therefore, this study aims to examine the relationship between lactic acid concentration and muscle tension reduction in fish auction workers after the administration of orange and banana. The study procedures were carried out with a quasi-experimental pre-test and post-test group design, and the samples were divided into 4 groups. Group 1 received both orange and banana, 2 was given only orange, 3 received only banana, while 4 was not given any intervention. Supplemental observations were then conducted over 3 consecutive days, followed by data analysis using Two-Way Analysis of Variance (ANOVA) and Multivariate Analysis of Variance (MANOVA) to compare lactic acid levels (independent variable) with muscle tension and strength (dependent variables). The results showed that banana significantly affected lactic acid levels but did not influence muscle tension. The combination of orange and banana produced varying levels of lactic acid and muscle tension, indicating the ineffectiveness of only banana. The intake of both fruits was also reported to influence lactic acid levels but did not affect muscle strength, suggesting the ineffectiveness of orange. These results indicated that while orange and banana could reduce lactic acid levels, the fruits did not significantly affect muscle strength or tension.

INTRODUCTION

Transportation workers are an essential demographic that demands special consideration due to the numerous hazards associated with their job procedures. These workers typically rely on physical strength to carry heavy loads, which often exceed the recommended weight limits. The issue is particularly evident among fish auction workers in Indonesia, who play an essential role in fishing sector by transporting fish from the port to auction sites.[1-3] Several studies have shown that sustained physical activity without sufficient rest causes an imbalance, leading to the accumulation of lactic acid faster than the body can eliminate the compound. This buildup exacerbates fatigue rapidly and decreases workplace performance.

The recognized health risks associated with physically demanding activities are extensive. Previous studies reported a significant association between extended periods of physical exertion, incorrect lifting methods, and back discomfort and muscular fatigue. For instance, data from the United States indicate that a significant percentage of low back pain is associated with occupation lifting, with 80% of cases ascribed to this factor.[3] In addition, studies conducted in Sweden emphasized that incorrect lifting methods significantly contributed to musculoskeletal problems, specifically among those engaged in manual labor.[4] This indicates that it is essential to use efficient measures to regulate lactic acid levels and muscle tension, specifically in physically demanding professions, such as fish auction employment.

One of the primary challenges faced by fish auction workers is the effective management of lactic acid buildup and the consequent muscle fatigue caused by the strenuous physical requirements of their profession. Engaging in repetitive lifting of loads that are frequently above the recommended weight thresholds not only leads to immediate exhaustion but also exacerbates chronic musculoskeletal problems. Endogenous lactic acid buildup, resulting from an imbalance between the body's capacity to eliminate the compound and its generation, causes persistent muscle fatigue and exhaustion. This issue is worsened in settings, such as Fish Auction Place/*Tempat Pelelangan Ikan (TPI)* in Juwana, where workers often bear substantial burdens weighing up to 210 kg for prolonged durations.[2]

A promising solution to this issue lies in dietary therapies that can effectively decrease lactic acid levels and improve muscle strength. Vitamin-dense foods, such as orange (*Citrus sinensis*) and banana (*Musa textilia*) have been recognized as efficacious in addressing fatigue due to their abundant potassium content and other advantageous nutrients. Given their abundant availability in Indonesia, these fruits are readily suitable for inclusion into the diet of fish auction workers. The ingestion of the fruits can alleviate the consequences of lactic acid buildup and decrease muscular tension, thereby enhancing general physical performance and decreasing the likelihood of work-related accidents.[5,6]

The health benefits of *Citrus sinensis,* commonly known as sweet orange, have been extensively investigated, specifically focusing on its contribution to muscle recovery and mitigation of oxidative stress. Previous studies have shown that its addition to the diet can enhance metabolic parameters, such as glucose and lactate levels, which are essential for controlling the accumulation of lactic acid.[7] Moreover, the orange's antioxidant characteristics help enhance general health by reducing muscle tension and facilitating more effective recovery from physical exhaustion.[8] These qualities make the fruit a promising dietary supplement for reducing muscle tension and regulating lactic acid levels in physically strenuous occupations.

According to previous studies, *Musa textilia*, a variety of banana, is rich in potassium and other essential elements that promote muscular performance and recuperation. Potassium has been reported to play an important role in maintaining ion concentration in cell membranes, which is crucial for controlling muscle contraction and relaxation. Due to its carbohydrate content, banana has been reported to be associated with the replenishment of glycogen stores and the provision of a rapid source of energy.[9] Despite the scarcity of studies on the impact of banana on lactic acid and muscle tension in fish auction workers, the recognized nutritional advantages indicate that it may greatly enhance physical performance and facilitate recuperation.

Orange and banana have shown great potential in lowering muscle tension and lactic acid levels, but there need to be more studies on their use among fish auction workers. Although existing literature has emphasized these fruits' overall advantages in muscle recovery and fatigue reduction, they have yet to investigate their impact in real-life, high-pressure settings, such as fish auction.[7,8] In addition, the majority of studies are carried out either on animals or in controlled environments, which may not comprehensively show the difficulties encountered by manual workers in the fishing sector.[5]

Another significant gap in the existing literature is the absence of a thorough investigation that integrates nutritional therapies with ergonomic evaluations. The majority of studies have either concentrated on the nutritional components of orange and banana or ergonomic hazards without considering these concerns to establish a comprehensive strategy for controlling muscle tension and lactic acid build up.[6] Therefore, this study aims to examine the correlation between the intake of orange and banana berries and decreased in lactic acid levels and muscle fatigue in fish auction workers. The results are expected to address the existing gap in the literature by presenting empirical data on the efficacy of these fruits in a high-pressure, real-life setting. The present study is innovative in emphasising a particular occupational cohort frequently disregarded in ergonomic and nutritional investigations. This helps to enhance the overall comprehension of how dietary interventions improve the health and performance of workers. The present study evaluated lactic acid and muscle tension levels in transport workers at Fish Auction Place (TPI) in Juwana, Pati Regency, both before and after administering orange and banana. The results are anticipated to offer valuable knowledge on effective nutritional interventions that may be applied to improve the health of workers in physically strenuous occupations, thereby decreasing the occurrence of work-related injuries and enhancing overall productivity.

MATERIAL AND METHOD

The sample population consisted of 100 transport workers at Juwana TPI in Pati Regency, selected through total sampling. The samples were then divided into 4 groups using a randomization system. Group 1 received both orange and banana, 2 received only orange, 3 received only banana, and 4 was not given any intervention. The inclusion criteria for participants were normal Body Mass Index (BMI), male, and aged 20-60 years, while the exclusion criteria were a history of diseases affecting lactic acid levels, such as hypoperfusion, hypoxemia, chronic kidney failure, liver failure, diabetes mellitus, cancer, malaria, and cholera.

Data collection was carried out by filling out observation questionnaires that covered personal data, work history, disease history, group division, and BMI measurement. Lactic acid levels were then measured before the participants began their work, and intervention was administered according to the assigned groups. In addition, lactic acid levels, muscle tension, and muscle strength were measured 2 hours after intervention. Ethical clearance for this study was obtained from the Faculty of Public Health, with approval number 245/EA/KEPK-FKM/2021.

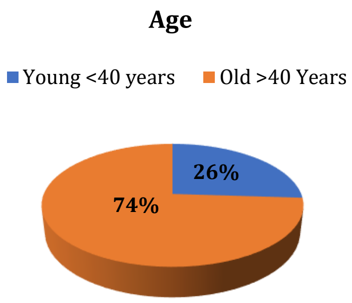
This quasi-experimental study employed a Pre-Test-Post-Test Group Design, and observations were conducted over 3 consecutive days for each group. Data collected over these days were averaged for analysis to account for daily variations and ensure reliable results.

Data analysis was performed using several statistical tests. First, a normality test was conducted to determine if the data were normally distributed. The homogeneity of variance was tested using Levene's test. When the data were normally distributed, Two-Way Analysis of Variance (ANOVA) was used to identify significant differences between groups, followed by post-hoc analysis for pairwise comparisons when needed. Meanwhile, when the data were not normally distributed, the Kruskal-Wallis test was applied. Multivariate Analysis of Variance (MANOVA) test was used to examine the relationships between the independent variable (lactic acid) and the dependent variables (muscle strength and muscle tension) post-intervention.

RESULTS

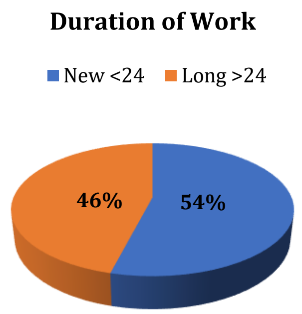
The characteristics of respondents based on age are shown in Figure 1. The results indicated that 74 out of 100 respondents were over 40 years old, while the remaining 26 were < 40 years. Based on duration of work, Figure 2 shows that 54 out of 100 had been working for more than 24 months, while 46 respondents had been working for less than 24 months.

Lactic acid inhibited enzymes in energy-producing pathways and interfered with the excitation-contraction process, leading to the depletion of muscle energy reserves.[10] Muscle fatigue was assessed using muscle tension measurements with an electromyograph, while muscle strength was examined with a leg dynamometer. The accumulation of lactic acid, which played a significant role in muscle fatigue, was also measured. The frequency distribution of lactic acid levels, muscle tension, and muscle strength among respondents is presented in Table 1.



Source: Primary Data, 2021

Figure 1. Frequency Respondent Characteristics by Age



Source: Primary Data, 2021

Figure 2. Frequency Respondent Characteristics by Duration of Work

The results indicated that 60 respondents experienced muscle tension, and 60 had abnormal lactic acid levels. This high level of muscle tension and lactic acid accumulation suggested that many workers were experiencing significant physical strain (Table 1).

Lactic acid was often produced as a by-product during the process of anaerobic glycolysis. Approximately 80% of the lactate produced in anaerobic glycolysis was transported from muscle into the bloodstream. This process occurred when muscle required a quick supply, but oxygen was limited, as evident in individuals exercising at a high intensity. Under conditions of low oxygen supply, reoxidation of Nicotinamide Adenosine Dinucleotide Hydrogen (NADH) formed from Nicotinamide Adenosine Dinucleotide (NAD+) during glycolysis is disrupted. Consequently, NADH is reoxidized through an anaerobic pathway by reducing pyruvate to lactate, where 2 hydrogen atoms are added to form lactate.[11]

The average lactic acid level in the first measurement was 2.568 mmol/L with a standard deviation of 0.699 mmol/L. In the second measurement, an average of 2.004 mmol/L was obtained with a standard deviation of 0.449 mmol/L. The results revealed that there was an average decrease in lactic acid content of 0.564 mmol/L with a standard deviation of 0.250 mmol/L after giving interventions in the form of orange and banana. In addition, the results of the statistical test obtained a P-value of 0.001, hence, it could be concluded that there was a significant difference between the measured lactic acid levels before and after the administration of orange and banana in this group (Table 2).

Table 1. Frequency Distribution of Muscle Tension, Muscle Strength, and Lactic Acid Levels

Variable	n = 100	%
Muscle Tension		
Relaxed (<3 μV)	40	40
Tense (>3 μV)	60	60
Muscle Strength		
Strong	55	55
Very Powerful	45	45
Lactic Acid		
Normal (<2 mmol/L)	40	40
Abnormal (>2 mmol/L)	60	60

Source: Primary Data, 2021

Table 2. Average Distribution of Lactic Acid Levels Before and After Giving Orange and Banana

Measurement Time	Group 1			
	Mean± SD	Median (Min-Max)	SE	p-value
Before	2.568±0.699	2.4 (1.6-4.8)	0.140	0.001
After	2.004±0.449	2 (1.2-3.2)	0.090	

Source: Primary Data, 2021

In group 2, treatment was given in the form of banana to 25 respondents. The results of the analysis of the average lactic acid level before intervention was 1.972 mmol/L with a standard deviation of 0.403 mmol/L. In the second measurement, an average of 1.940 mmol/L was obtained with a standard deviation of 0.563 mmol/L. In addition, there was an average difference in lactic acid content of 0.032 mmol/L before and after intervention. The results of the statistical test obtained a p-value of 0.841, hence, it could be concluded that there was no significant difference between the measured lactic acid levels before and after the administration of orange (Table 3).

In Table 4, the average lactic acid level in the first measurement was 2.204 mmol/L with a standard deviation of 0.733 mmol/L. In the second measurement, there was an average decrease to 1.660 mmol/L with a standard deviation of 0.095 mmol/L. In addition, there was an average decrease in lactic acid content of 0.544 mmol/L with a standard deviation of 0.052 mmol/L after banana supplementation. In this group, the p-value (0.001) was < 0.05, indicating that there was a significant difference between the measured lactic acid levels before and after the administration of banana.

Table 3. Average Distribution of Lactic Acid Levels Before and After Orange Feeding

Measurement Time	Group 2			
	Mean± SD	Median (Min-Max)	SE	p-value
Before	1.972±0.403	2.0(1.1-3.0)	0.081	0.841
After	1.940±0.563	1,9(1.2-3.3)	0.112	

Source: Primary Data, 2021

Table 4. Average Distribution of Lactic Acid Levels Before and After Banana Feeding

Measurement Time	Group 3			
	Mean± SD	Median (Min-Max)	SE	p-value
Before	2.204±0.733	2.0(1.3-4.4)	0.147	0.001
After	1.660±0.473	1.6(1.0-2.6)	0.095	

Source: Primary Data, 2021

Muscle tension increased on average after the intervention of orange and banana in 25 respondents in group 1. The average of the first measurement was 4.268 mV with a standard deviation of 3.015 mV. In the second measurement, an average of 4.280 mV was obtained with a standard deviation of 2.509 mV. The results of the statistical test obtained a p-value of 0.985 (>0.05), indicating that there was no significant difference between muscle tension before and after the administration of orange and banana (Table 5).

Group 2, with intervention in the form of giving orange, had an average muscle tension before the intervention of 8.548 mV with a standard deviation of 10.995 mV. In the second measurement, an average of 6.648 mV was obtained with a standard deviation of 9.057 mV. In addition, there was an average reduction in muscle tone of 1.9 mV before and after intervention. The results of the statistical test obtained a P-value of 0.985, indicating that there was no significant difference in muscle tension before and after the administration of orange (Table 6).

Based on Table 7, there was an average decrease in muscle tension of 1.02 mV after intervention in the form of banana. The average muscle tension at the first measurement was 6.640 mV, with a standard deviation of 5.322 mV. In the second measurement, an average of 5.620 mV was obtained with a standard deviation of 5.376 mV. The results of the statistical test obtained a p-value of 0.404, indicating that there was no significant difference between muscle tension before and after intervention in this group.

Group 1, with intervention in the form of giving orange and banana to 25 respondents, had an average muscle strength of 162.85 before intervention, with a standard deviation of 64.02. In the second measurement, an average of 159.46 was obtained with a standard deviation of 60.32. There was also an average decrease in muscle strength of 3.39 before and after intervention. The results of the statistical test obtained a p-value of 0.679, indicating that there was no significant difference in muscle strength before and after the administration of orange and banana (Table 8).

Table 5. Average Distribution of Muscle Tension Before and After Giving Orange and Banana

Measurement Time	Group 1			
	Mean± SD	Median (Min-Max)	SE	p-value
Before	4.268±3.015	3.0(0.7-10)	0.603	0.985
After	4.280±2.509	3.0(1.0-10)	0.502	

Source: Primary Data, 2021

Table 6. Average Distribution of Muscle Tension Before and After Orange Feeding

Measurement Time	Group 2			
	Mean± SD	Median (Min-Max)	SE	p-value
Before	8.548±10.995	5.0(0.7-50)	2.198	0.985
After	6.648±9.057	4.0(0.7-45)	1.811	

Source: Primary Data, 2021

Table 7. Average Distribution of Muscle Tension Before and After Banana Feeding

Measurement Time	Group 3			
	Mean± SD	Median (Min-Max)	SE	p-value
Before	6.640±5.322	5.0(2.0-20)	1.065	0.404
After	5.620±5.376	4.0(1-20)	1.075	

Source: Primary Data, 2021

The average muscle strength at the first measurement was 151.1, with a standard deviation of 72.05. In the second measurement, there was an average increase of 172.26 with a standard deviation of 72.76. There was also an increase in average muscle strength of 21.16 with a standard deviation of 0.71 after the administration of citrus fruit supplementation. In this group, with a p-value of 0.073, it can be concluded that there is no significant difference in muscle strength before and after the administration of intervention (Table 9).

In Table 10, the average muscle strength of group 3 at the first measurement was 157.9, with a standard deviation of 50.522. In the second measurement, an average of 186.6 was obtained with a standard deviation of 55.289. In addition, there was an increase in average muscle strength of 28.7, with a standard deviation of 4.767 after the administration of banana. The results of the statistical test obtained a p-value of 0.001, indicating that there was a significant difference between muscle strength before and after the administration of banana in this group.

A multivariate analysis was conducted to test the effect of the administration of orange and banana, orange only, and banana only on the respondents' lactic acid levels, muscle tone, and muscle strength.

Table 8. Average Distribution of Muscle Strength Before and After Giving Orange and Banana

Measure-ment Time	Group 1			
	Mean± SD	Median (Min-Max)	SE	p-value
Before	162.85±64.02	165(25-335)	12.804	0.679
After	159.46±60.32	155(34-317.5)	12.064	

Source: Primary Data, 2021

Table 9. Average Distribution of Muscle Strength Before and After Orange Feeding

Measure-ment Time	Group 2			
	Mean± SD	Median (Min-Max)	SE	p-value
Before	151.1±72.05	150(25-265)	14.41	0.073
After	172.26±72.76	170(30-300)	14.55	

Source: Primary Data, 2021

Table 10. Average Distribution of Muscle Strength Before and After Banana Feeding

Measure-ment Time	Group 3			
	Mean± SD	Median (Min-Max)	SE	p-value
Before	157.9±50.522	155(40-275)	10.104	0.001
After	186.6±55.289	200(55-280)	11.058	

Source: Primary Data, 2021

The analysis results showed that there was a decrease in lactic acid levels in groups 1 and 3, while in group 2, there was an increase. Group 1, with the supplementation of orange and banana, experienced the highest decrease in lactic acid of -0.629 (95% CI: -1.060 to -0.198), with a p-value of 0.005. The next highest lactic acid reduction score was in group 3 with the administration of banana with a reduction score of -0.536 (95% CI: -0.973 to -0.009), and the decrease was significant with a p-value of 0.017. Group 2 with citrus fruit administration experienced an increase in lactic acid with a score of 0.025 (95% CI: -0.411 to 0.461) and had a significance value of 0.911. This indicated that there was no significant increase in lactic acid (Table 11).

Table 11 revealed that group 2, with treatment in the form of citrus fruit supplementation, experienced the highest decrease in muscle tension compared to other groups. This decrease score is -5.307 (95% CI: -9.796 to -0.818) and significant with a p-value of 0.021. The next highest muscle tone reduction score was in group 3 with the administration of intervention in the form of banana with a reduction score of -4.747 (95% CI: -9.249 to -0.246), and the decrease was significant with a p-value of 0.039. In group 1, with the administration of orange and banana, there was a decrease with a score of -3.874 (95% CI: -8.312

to 0.564) and a significance value of 0.085. This indicated that there was no significant decrease in muscle tone in the group.

Based on the analysis results, muscle strength of respondents had increased when compared to the control group. The highest muscle strength increase score was in group 3 with banana administration intervention. In this group, there was an increase of 50.068 (95% CI: 20.112 to 80.023) with a p-value of 0.001, indicating that there was a significant increment. In addition, group 2, with the treatment of citrus fruit supplementation, experienced an increase in muscle strength of 43.162 (95% CI: 13.289 to 73.034) and a significant increase in muscle strength with a p-value of 0.005. Group 1, with intervention in the form of orange and banana, experienced an increase with a score of 15.643 (95% CI: -13.892 to 45.178) and had a significance value of 0.296, indicating there was no significant increase in muscle strength (Table 11).

DISCUSSION

This study investigated the impact of orange and banana consumption on lactic acid serum levels and muscle strain in transport workers. The results revealed a statistically significant decrease in lactic acid levels following intervention, as evidenced by a p-value of 0.001. This suggested that ingesting of these fruits successfully reduced lactic acid in the body. However, the intervention had no substantial effect on muscular tension, as indicated by a P-value of 0.403. This indicated that although lactic acid levels declined, there was no evidence of a significant decrease in muscle tension.

Muscle fatigue is a complex physiological phenomenon characterized by a temporary decline in muscle ability to generate force or power during physical activity. This reduction in performance can arise from both central and peripheral mechanisms, making it a multifaceted issue in exercise physiology and rehabilitation. Muscle fatigue can vary significantly depending on the type of exercise performed, the duration of the activity, and individual factors, such as fitness level and muscle fiber composition.[12]

Disruptions in the body's energy metabolism system had been reported to have the potential to cause muscle fatigue. The accumulation of lactic acid in muscle interferes with cellular mechanisms, inhibiting aerobic and anaerobic enzymes and as reducing endurance capacity. In addition, the formation of Creatine Phosphate (CP) is inhibited, affecting the coordination of muscle movements. This process also inhibits the enzyme phosphofructokinase, leading to decreased release of Ca^{++} ions in troponin C, which disrupts muscle fiber contraction. ATP activity in these fibers can be quickly inhibited because ATP is highly sensitive to acid.

Table 11. Effect of Intervention on Lactic Acid Levels, Muscle Tension, and Muscle Strength

Parameter	B	SE	Sig	LB for B	UB for B
Lactic Acid, R square = 0.162					
Intercept	-0.513	0.370	0.169	-1.248	0.222
Group 1	-0.629	0.217	0.005	-1.060	-0.198
Group 2	0.025	0.220	0.911	-0.411	0.461
Group 3	-0.536	0.220	0.017	-0.973	-0.009
Group 4	0[a]	.	.	.	.
Muscle Tention, R square = 0.114					
Intercept	-0.472	3.811	0.902	-8.040	7.095
Group 1	-3.874	2.235	0.086	-8.312	0.564
Group 2	-5.307	2.260	0.021	-9.796	-0.818
Group 3	-4.747	2.267	0.039	-9.249	-0.246
Group 4	0[a]	.	.	.	.
Muscle Strenght, R square = 0.134					
Intercept	-34.175	25.361	0.181	-84.536	16.186
Group 1	15.643	14.873	0.296	-13.892	45.178
Group 2	43.162	15.043	0.005	13.289	73.034
Group 3	50.068	15.085	0.001	20.112	80.023
Group 4	0[a]	.	.	.	.

Source: Primary Data, 2021

The analysis of lactic acid and muscle tension after administering orange and banana yielded different results. Muscle tension is also affected by various physiological and pathological conditions. For example, increased muscle tension can be a response to stress or anxiety, leading to muscle tightness and discomfort.[13] However, these results differ from the results obtained in this study that lactic acid levels decreased after the administration of orange, but this did not lead to a reduction in muscle tension, as indicated by a P-value of 0.117. Orange contains various nutrients, including potassium, crucial for fluid balance, nerve impulses, and muscle contractions. Both potassium and sodium play important roles in preventing muscle fatigue by maintaining the depolarization of sarcolemmal and tubular membranes, which are essential for contraction. Disruptions in these membranes can affect Ca++ ion regulation in cells, crucial for muscle contraction by facilitating the binding of myosin to actin.[14]

Despite the potassium content in orange being capable of balancing bodily fluids and preventing muscle tension, banana proved to be more effective. Banana contains tryptophan, an essential amino acid the body converts into serotonin, which helps relax and improve mood, reducing muscle tension. The study showed that while banana significantly affected lactic acid levels, the fruit did not significantly affect muscle tension. A previous study by Mitha found that banana smoothies did not significantly impact anaerobic muscle fatigue in football athletes. However, muscle tension leading to fatigue can occur when sudden or excessive movements exceed muscle strength, as reported by respondents in this study.[15] Muscle tension leading to fatigue occurs when sudden or excessive waist movements exceed muscle strength involved. For example, respondents in this study reported the presence of sudden and excessive movements when changing positions.

The results are consistent with prior studies, which showed the efficacy of orange and banana in decreasing lactic acid levels. This supports the notion that the nutritional compositions of the plants can impact metabolic processes associated with muscular fatigue.[7,9] Similarly, a previous study conducted on Sepak Takraw athletes reported that the administration of banana before exercise significantly prevented muscle fatigue in the aerobic phase.[16] Other studies focusing on the influence of banana on metabolism and glucose found no adverse effects on normal rats, although a significant reduction in body mass and improvement in metabolism, which affected lactic acid levels, was discovered.[17]

The absence of a substantial impact on muscle tension is inconsistent with a previous study,highlighting the essential role of potassium and other nutrients in promoting muscle relaxation and reducing tension.[14] The disparity implies that although these fruits help to decrease lactic acid, their effect on muscular tension may be restricted, or other variables, such as the level of physical exertion, may have a more significant influence on regulatory muscle tension.

Dietary therapies incorporating orange and banana can alleviate muscle tiredness in physically demanding employment, as shown by the notable decrease in lactic acid levels. This holds special significance for workers in demanding settings, such as fish auction, maintaining physical stamina is key. The results also suggest that the reduction of muscle tension may need further measures beyond dietary interventions, potentially including physical activities or ergonomic modifications. The results emphasize the need to adopt a holistic strategy toward workers' health, which includes combining dietary and physical measures to improve performance and minimize the likelihood of injury.

The present study examined the synergistic impact of orange and banana consumption on lactic acid levels and muscular strength among individuals employed in the transportation industry. The results revealed a notable decrease in lactic acid levels, as evidenced by a P-value of 0.001, indicating that intervention successfully reduced lactic acid in the body. However, intervention failed to reinstate muscular strength, as shown by a P-value of 0.989. These data indicate that although ingesting these fruits is advantageous in decreasing lactic acid levels, it does not greatly affect muscle strength. Several studies have shown that muscle strength cannot be restored by giving orange and banana, but through specific exercises, such as Range of Motion (ROM) exercises. A previous study on stroke patients by Chris suggested that muscle strength was restored by implementing ROM at least twice a day for 10 to 15 minutes.[18]

The decrease in lactic acid levels is consistent with previous studies that reveal the significance of potassium-rich foods, such as banana, in controlling lactic acid buildup and enhancing muscular recovery.[19] However, the absence of significant enhancement in muscle strength revealed that dietary changes alone may be inadequate. Evidence suggests that targeted activities, such as ROM exercises, are more efficient in restoring muscle strength compared to dietary methods alone.[18] This reveals the necessity of adopting a holistic strategy that integrates both dietary interventions and physical activity to tackle muscular weakness.

The results of this study emphasize the need to take into account several aspects when attending to muscle tension and strength in physically strenuous occupations. Although the decrease in lactic acid levels implies that nutritional treatments can influence the alleviation of muscle fatigue, the absence of effect on strength suggests that these interventions in isolation are inadequate. From a practical standpoint, this implies that those in physically strenuous occupations must not only depend on nutritional remedies but should also integrate specialized physical activities aimed at enhancing muscle strength. The adoption of this holistic strategy has the potential to result in improved general health results, including decreased weariness and increased physical performance.

Based on this study, p-value of lactic acid and muscle strength were 0.675 and 0.073, respectively, indicating the absence of effect after the administration of orange to transport workers. This is consistent with a previous investigation on giving orange juice and yellow watermelon juice before 400 m sprint, which does not affect lactic acid levels.[20] However, Evi expressed a different opinion that the administration of orange juice 30 minutes before exercise significantly prevented muscle fatigue in the anaerobic phase.[20] Orange contains various bioactive compounds, including flavonoids and ascorbic acid, which may enhance metabolism and reduce the accumulation of lactic acid. Previous studies revealed that these compounds could increase antioxidant capacity in the body, helping to reduce oxidative stress and inflammation associated with lactic acid buildup.[21] Moreover, consuming foods rich in antioxidants, such as orange, can expedite muscle recovery after intense exercise by enhancing the clearance of lactic acid from the bloodstream.[22] A study by Fitrianto and Maarif found that active recovery could lower lactate levels in athletes, suggesting that a good recovery strategy could mitigate the negative effects of lactate accumulation.[23] Given that orange are a good source of hydration and nutrition, consuming the fruits after exercise may contribute to better recovery and a reduction in lactic acid levels, thereby supporting muscle strength.[24]

Orange consumption can play an important role in regulating lactic acid levels and supporting muscle strength. By reducing the accumulation of lactic acid through antioxidant mechanisms and better recovery, orange can become an important part of the diet for physically active individuals. A previous study on giving orange and yellow watermelon juice before the 400 m sprint showed that it did reduce lactic acid levels.[20]

The provision of orange intervention was selected due to the nutrients, such as carbohydrates and el citrulline contained in the fruits. Orange contains 54.9 g carbohydrates, which can rapidly provide energy. Generally, all types of carbohydrates consumed are converted into glucose in the body. By giving carbohydrates at a rate of 30-60 g/hour, it was expected to maintain glucose levels, thereby potentially reducing lactic acid levels in the body.

The consumption of banana after work decreased lactic acid levels and muscle strength in transport workers. Banana and its nutrients contribute to muscle recovery and the reduction of lactic acid levels. The consumption of fruits, such as banana, is generally associated with replenishing glycogen stores and providing essential nutrients that support muscle function and recovery.[9] The presence of potassium is highly beneficial for muscle function, potentially reducing cramps and tension that may arise from heavy activity.[9] In addition, the presence of dietary fiber in banana can support overall digestive health, leading to better nutrient absorption and energy availability for muscle function.[25]

The study conducted by Faturochman on the effectiveness of giving banana and vitamins B1, B6, and B12 against fatigue showed that the group treated with intervention before anaerobic running was effective in preventing muscle fatigue compared to others.[19] Ryan also investigated the effect of giving banana juice and sports drinks on volleyball athletes, finding that banana juice significantly reduced lactic acid levels in the pre-test group compared to the post-test and sports drink groups. Banana provides a high amount of energy to the body and are easily digested due to their soft texture.[26] The carbohydrate content, in the form of crude fiber and pectin, also contributes to energy provision.

Banana is also rich in tryptophan, a type of essential amino acid that is converted into serotonin by the body to relax and improve mood. This leads to a sense of happiness and helps the performance of blood energy muscle. Banana is included in the type of fruits with an abundant source of potassium, providing about 23% to the body. Lio Ways also reported that the fruits and yellow watermelons were effective in preventing muscle fatigue in anaerobic running. Therefore, athletes are recommended to consume 200 g banana and 575 g watermelon to prevent muscle fatigue.[27]

The results of this study indicate that while both orange and banana significantly reduce lactic acid levels, the fruits do not significantly affect muscle strength. Banana appears to be more effective in reducing muscle tension due to the serotonin-boosting properties. Therefore, while incorporating these fruits into the diet can help reduce lactic acid levels and potentially prevent fatigue, they are not sufficient to restore muscle strength without complementary physical exercises.

CONCLUSION AND RECOMMENDATION

In conclusion, this study revealed that the consuming orange and banana had distinct effects on lactic acid levels and muscle tension among transport workers. Banana is more effective in reducing muscle tension compared to orange. Both fruits significantly reduced lactic acid levels, but neither had a significant impact on muscle strength. The potassium content in orange supports carbohydrate, glycogen, and glucose metabolism and acts as an antioxidant due to its vitamin C content. The results showed that banana is more effective in reducing muscle tension due to itsserotonin-boosting properties.

Based on the results, transport workers can incorporate banana into their daily diet to reduce muscle tension and lactic acid levels, thereby enhancing physical performance and reducing fatigue. Orange can also be included in the diet for its beneficial effects on lactic acid levels and overall health, but additional strategies are needed to improve muscle strength; Regular physical exercises, such as ROM exercises, should also be implemented to restore and maintain muscle strength, ideally performed at least twice a day for 10-15 minutes. In addition, employers must educate workers on proper lifting techniques to prevent excessive muscle strain and reduce the risk of chronic muscle fatigue and injuries. Implementing regular breaks and ergonomic interventions can help manage and reduce physical workload, thereby improving workers' health and productivity. Future studies are advised to explore the combined effects of dietary interventions and structured physical exercise programs on muscle strength and fatigue in transport workers. Investigations into other potassium-rich foods and their comparative effectiveness on muscle health could provide more comprehensive dietary recommendations.

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AUTHOR CONTRIBUTIONS

The authors conceptualized and designed the study. BK and MZR drafted the manuscript, N conducted the data analysis, and SY and N provided additional analysis. The authors have read and approved the manuscript. The authors equally contributed to this study. BK = Bina Kurniawan; MZR = Mohammad Zen Rahfiludin; N = Nurjazuli; SY = Setyaningsih Yuliani.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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