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The different effects of banana juice and sport drink on lactic acid among volleyball students in Surakarta



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ABSTRACT

Introduction: The response of lactic acid as a result of exercise in recent times has received considerable attention from physiologists, particularly in term of sports aspect. Lactic acid level is one of the most common measured parameter to determine the performance of athletes. Provision of supplements containing potassium for athletes is usually given such fruit juice or sport drink to prevent muscle fatigue. This study examined the effect of the banana juice and sport drinks to lactic acid in volleyball students.

Methods: The study was a randomized experimental trial using pre-post test with control group. The study populations were all volleyball

students aged 15-17 years in Pundong Senior High School. The subjects divided into three equal group, 10 subjects in each group treated with either banana juice, sport drink and mineral water as a control group. Sampling was done by a double-blind method.

Results: The results of the paired sample T-Test showed a significantly difference of lactic acid levels by intervention with banana juice and sport drink compared to control group with mean difference the mean were 4.43, 3.59, 2.68 respectively ($p < 0.05$).

Conclusions: Intervention of banana juice significantly decreased the lactic acid levels compared to sport drinks in volleyball students.

Keywords: Exercise, lactic acid, muscle fatigue, potassium

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INTRODUCTION

One of the characteristic of developed and developing country is able to show achievements and competing with other country. By this means, the nation must have a high level of health and productivity both at regional and international levels. These all are influenced by nutritional conditions.¹ Sports achievement is one way to advance the nation until it is known by other nations and respected in every appearance of its athletes. Sports achievements in Indonesia tend to ups and downs, uncontrolled and unstable, even recently they had continued to decline in several international events such as in multi-branch international championships, SEA Games, Asian Games, and Olympics. Indonesia's sport achievements tend to decline compared to the progress of other nations' sports achievements in Southeast Asia such as Thailand, Malaysia and Singapore.¹

The success key of an athlete's performance is a combination of genetic factors, enthusiasm, good practice and proper nutrition. An athlete who struggles to win a competition will try several diet regimens including nutritional supplements, oral medications and/or injections. This method aims to improve health status and achieving a better physical performance. Some studies suggest that athletes should get some recommendations

and intervention by nutritionists to improve their knowledge and health practice regarding the right diet.²

The benefits of the exercise will greatly affect the outcome of an athlete in any sport game. Everyone who exercises properly will get varied benefits such as healthiness, fitness and ability to improve their achievement. Regular, systematic and continuous training, become an ideal exercise program to significantly improve physical abilities.³ Besides the positive benefits of exercise, it also has a negative impact as lactic acid and free radicals formed, causing stressor signal for the body which in turn affects all bodily system.^{4,5} The formation of lactic acid is a result of high-intensity exercise activities and training for a long time (prolonged excretion).

Excessive burden or lack of recovery phase will produce symptoms of excessive exercise syndrome, which affects both physically and psychologically.⁶ Therefore, after doing such exercises, recovery should be done. The recovery phase is needed by the body to restore the condition to the initial resting state before doing the next exercise and prevent quicker fatigue response. Muscle fatigue is also influenced by micronutrients, such as potassium. Potassium is an electrolyte which acts as fluid balance in the body, it is responsible to delivering

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nerve impulses and muscle contractions. Potassium deficiency may cause muscle weakness and muscle fatigue.⁷ Provision of supplements containing potassium for athletes is usually given in the form of natural supplements such as fruit juice.⁸

The urgency of the phenomenon become more relevant, as in the recent time, increasingly fierce sports competition demands optimization both in the period of physical exercise and recovery period. In addition, it was considered so far most of the efforts are to increase physiological capacity has been mainly focused on the training phase. This study aimed to complement this by emphasizing efforts to optimize the recovery phase of athletes, which has an impact on improving athlete's performance and achievement.

MATERIALS AND METHODS

This study was a randomized trial with pretest-posttest control group design. This study has been approved by the Research Ethics Committee of Faculty of Medicine, Sebelas Maret University, Surakarta with ethical number 383/UN27.6/KEPK/2018. The study was conducted on September 2018. The population in this study were all volleyball students aged 15-17 years in Pundong Senior High School, Surakarta. The samples that met the inclusion criteria and committed to be the subject of research by signing informed consent. A total of 30 male adolescents were enrolled by a double blind method. In this study, the subjects divided into three equal group, 10 subjects were treated with banana juice, 10 subjects were treated with sport drink as the treatment group, while the others were treated with mineral water as a control group. In both groups it was started with a pretest,

and after giving treatment a post-test was obtained. The independent variable in recent study was the administration of banana juice and sport drinks, while the dependent variable was lactic acid levels. Lancet capillary blood sampling was carried out before and after RAST (Running Based Aerobic Sprint Test).

The IBM SPSS statistics v.23 software was used for statistical analyses. The characteristic of subjects showed with descriptive mean±SD value. Test the normality of data used Saphiro Wilk and the result showed data distribute normally. Differences in mean lactic acid before and after intervention in each group analyzed using Paired t-test. The p value <0.05 was considered to be significant.

RESULTS

The characteristics of the subjects in this study were shown by descriptive data of age, weight, height, and BMI as seen in Table 1. The mean of age, body weight, height, and BMI were 16.12 ± 1.20 years, 60 ± 7.35 kg, 178.3 ± 3.78 cm, 20.87 ± 2.22 kg/m² respectively.

From the normality test using Saphiro Wilk, the data distribution was normal (Table 2). The results of the normality test using the Shapiro Wilk test giving the p-value for the pre and post variables both in the intervention by administration of mineral water, banana juice and sport drinks, showing data were normally distributed.

Based on the results, the mean differences of lactic acid levels before and after treatment in the group of banana juice group, sports drink group, and the control group were 4.43, 3.59, 2.68, respectively (Figure 1) and it was significantly different compared to control group (p -value<0.05).

Table 1 Characteristic of Subjects

Variable	Total (n)	Mean±SD
Age (years)	30	16.12±1.20
Weight (kg)	30	60±7.34
Height (cm)	30	178.3±3.78
BMI (kg/m ²)	30	20.87±2.23

Table 2 Normality Test Using Shapiro Wilk

Variable	Mineral Water		Banana Juice		Sport Drink	
	Statistic	p-Value	Statistic	p-Value	Statistic	p-Value
Pre	0.906	0.256	0.979	0.960	0.861	0.078
Post	0.909	0.272	0.946	0.618	0.871	0.103

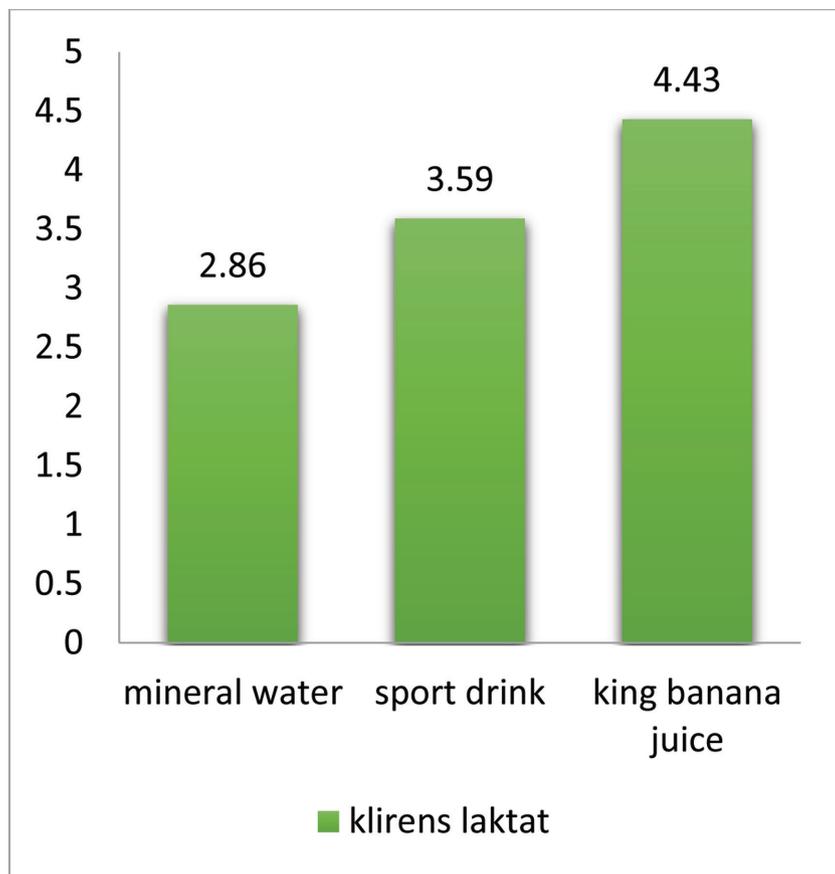


Figure 1 Difference of Mean Lactic Acid Levels in Mineral Water, Sport Drinks and Banana Fruit Juice

DISCUSSION

The subjects in this study were 30 students who were given two different interventions. The first intervention was the intake of banana juice, the second intervention was given sports drink intake, meanwhile mineral water given in control group. The results of this study indicated that the group of students given the mineral water intervention (control) had the lowest difference in lactic acid levels compared to the treatment group given the banana juice and sport drink, while the group that had the highest difference in lactic acid was the treatment group who was given banana juice. The results of statistical analysis using the paired sample t-test showed a mean difference in total p -value <0.05 for both intervention of banana fruit juice and sport drink. This data showed that there were significant differences from these two interventions. From these results it was shown that the banana juice has a greater difference in lactic acid in students compared to sports drink and mineral water.

This study used the parameters of Running-based Anaerobic Sprint Test (RAST), which is a set of test that able to measure anaerobic capacity of a person represented in the two main components

termed power and fatigue index.¹ The RAST test was first developed at the University of Wolverhampton (UK) and used to determine the anaerobic capacity of athletes. In order to obtain the RAST test, several supporting devices are needed including a straight track marked with a 35 meter cone, a whistle and a stopwatch. In addition, two test persons are needed who are dealing with recording data on test results and dealing with giving orders. The mechanism for implementing the RAST test is very simple and does not require many tools. First, the track and cone distance markers must be ready with a 35 meter long track. Then the subject did six repetitions of a fast run of 35 meters, with a phase of resting every single repetition for 10 seconds.

In this situation there is a decrease in the supply of ATP (adenosine triphosphate). PCr (Phosphocreatine) and muscle glycogen, also produce metabolic waste and made lactate accumulation in the blood and muscles. The availability of ATP (adenosine triphosphate) became an obstacle considering that the anaerobic glycolysis system is inefficient, because from one molecule of glycogen it only produces 3 ATP (adenosine triphosphate), while aerobic glycolysis can produce 39 moles of ATP (adenosine triphosphate). In other side, the increase of lactic acid greatly affects the performance of athletes.⁹

Increased levels of lactate in muscles and blood will inhibit the action of such enzymes needed to produce ATP, besides increasing the acidity of sarcoplasm caused by accumulation of lactate in muscles, resulting in Ca^{2+} ions being delayed transported from the sarcoplasmic reticulum. Hence, actin cannot attach to the myosin head, resulted in inhibition of mechanism of the sliding filament of contractile muscles that decrease the capability of effective muscle contraction.⁴

The previous study conclude that administration of 150 g and 300 g of banana found to prevent anaerobic muscle fatigue in *takraw* soccer athletes.¹¹ Increased blood glucose levels after consumption of 150 g and 300 g of banana have the potential to prevent muscle cramps. Muscle fatigue that occurs continuously will impact on muscle cramps.¹² Continuous high-intensity anaerobic activity will reduce the reserves of energy sources and cause the accumulation of lactic acid in the muscles, hence, the ability of muscles to contract will decrease and cause muscle fatigue.¹³

In this study, there were significant differences between lactic acid levels from the group of banana juice and the control group. This might be caused by the treatment group were given banana juice which contains complete nutrients while the control group is given mineral water. Therefore, bananas in which processed into juices

are effective in overcoming muscle fatigue, especially in anaerobic activities. This phenomenon was supported by the results of statistical analysis using the paired sample t-test which showed a mean difference in total ρ -value <0.05 difference in the lactic acid level of the group given the banana juice and the control group (4.43 vs 2.86). Nutrients that play a role in this condition are carbohydrates and potassium.

The energy component of bananas affects the process of energy metabolism in the body. Energy which is almost entirely derived from carbohydrates can increase glycogen reserves in the muscle.¹⁴ The energy content of bananas are in the form of easily available in a short time and provides energy needs quickly according to anaerobic metabolism, hence, it can affect the duration of struggling in rat.¹⁵ Banana carbohydrates are energy stores that can be quickly available to the body because they are easily digested so that it is suitable for anaerobic metabolism.¹³ Banana carbohydrates were complex carbohydrates in the form of starch and were available in stages. Banana contains sugar as it found in many fruits, which consists of sucrose, glucose, and fructose.

Besides containing high energy and complex carbohydrates, bananas have a high mineral content of potassium. In this study, potassium acts as a catalyst in energy metabolism, namely in the process of breaking down muscle glycogen into glucose and may provide energy quickly.^{16,17} Potassium also affects muscle fatigue for the long term period. Potassium can be absorbed quickly by the body but is also quickly excreted by the body throughout sweat.¹⁸

High potassium content in bananas can prevent muscle weakness and prevent injury. Potassium content in bananas functions in fluid balance, strength and speed of muscle contraction, glycogen storage, and glucose transport into cells.^{1,19} The mineral potassium along with sodium played a role in the mechanism of muscle fatigue, which are to maintain sarcolemal and membrane t-tubular depolarization. If there is a disturbance in the tubular sarcolemal and membrane depolarization, it will cause interference with the regulation of Ca^+ ions in the intracellular. The ion K^+ plays a role in terms of muscle contraction, by opening the cross bridge of myosin to bind actin. The ion transportation on a cross bridge caused muscle contraction. Changed in electrolytes and disruption of fluid balance in the body will affect the tubular sarcolemal and membrane depolarization and affect on muscle fatigue because muscle contraction has weakened.^{20,21}

Significant differences were also found between the group of banana juice and the sport drink group as seen by the Paired Sample T-Test which showed a mean difference in total ρ -value <0.05 difference in lactic acid levels (4.43 vs 3.59). This result showed that these two treatments had a significant difference in lactic acid levels compared to the control group. However, from the results of testing the nutrient content showed that there was no significant difference between the juice of the banana and sport drink except the content of carbon and potassium. This phenomenon may be caused by several factors such as the dilution process of bananas into banana juice and the level of solubility. Banana juice is made from a ratio of fruit and water 1: 2 so that there will be a change in the nutrient content of the fruit into juice by 1/3. When the process of blending the banana were done, a sediment was formed. When the content test were obtained, the sediment was not taken up along with the juice, so when tested the nutritional content decreased by more than 1/3 and the results did not differ much from the sport drink. This can also be the cause of the content of carbon and potassium of banana juice lower than sports drinks.

Bananas become a kind of fruit that are easily to had an enzymatic browning reactions. This reaction occurs because bananas contain a lot of polyphenol enzymes and contact with air (oxygen) because they are left too long or not immediately processed. Nutrients that might changed because this reaction were protein and vitamins. Polyphenol compounds in bananas will be easily oxidized in the presence of oxygen and form orthoquinon compounds. If these compounds react with proteins, complex compounds will be formed which can reduce the protein content. Vitamin B6 was easily damaged if the fruit was too long exposed to air, heat and light. Carbohydrates and fats are easily damaged when processed at high temperatures.²² In this study the browning reaction was minimized by reducing direct contact with oxygen by giving banana juice directly to students after the blending of banana was finished.

CONCLUSION

The administration of banana juice and sports drink significantly decreased lactic acid in high school volleyball students. There were significantly differences decreased of lactic acid level between banana juice group compared to sport drink and mineral water (control) among high school volleyball students. It is necessary to do research on

professional athletes so that the results of the study are more homogeneous and more representative. Further research is needed to elucidate the effectiveness of bananas in overcoming muscle fatigue. Banana can be an alternative as a daily supplement of natural food to overcome muscle fatigue in athletes and can be given before, during, or after exercise or competition.

CONFLICT OF INTEREST

All authors declare there is no conflict of interest regarding publication of this manuscript.

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AUTHOR CONTRIBUTIONS

RR, conceptualize and design the study, prepare drafts, collect and study data (data acquisition), and manuscript preparation; MD leads data collection, helps analyze and interpret data and manuscript review; AK leads data collection, helps analyze and interpret data and manuscript review.

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