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The Effect of Giving Sweet Orange Juice (Citrus *sinensis*) on The Fatigue Level of Football Athletes

Faqilah Fadiyah Fatah[1]*, Erni Rukmana[2], Esi Emilia[3], Hardi Firmansyah[4], Risti Rosmiati[5]

[12345]Universitas Negeri Medan, Indonesia

*Email: faqilahfadiya@gmail.com

ABSTRACT

Background: Football is a sport that combines aerobic and anaerobic endurance during training and matches. Physical fitness can support blood circulation function and heart work and increase muscle strength, speed, agility, and explosiveness. Muscle fatigue can be affected by various internal and external factors, including physiological, nutritional, exercise, psychological, environmental, and health factors. One of the nutritional factors that can affect muscle fatigue is micronutrients such as potassium. Potassium and vitamin C deficiency can lead to muscle weakness and fatigue. **Objective:** The purpose of this study is to determine the difference in the effect of giving isotonic drinks and sweet orange juice on the fatigue level of North Sumatra PPLP football athletes. **Method:** The research design is true experimental, with the post-test only with a control group design. The subjects consisted of 24 athletes who were selected using systematic random sampling. The level of fatigue is known through the RAST test. Bivariate analysis uses an independent sample t-test to determine the difference in influence between each variable. **Results:** As a result of this study, there was a significant difference in fatigue levels in the two groups. The average fatigue level value in the treatment group was 4.61±1.42, while the control group was 6.62±2.33 or the Sig. $p<0.05$ value was $p = 0.01$. **Conclusion:** This showed a significant difference in the mean level of athlete fatigue between the treatment group and the control group.

Keywords: orange juice, fatigue, football

INTRODUCTION

Sport is a form of physical activity carried out structured, planned, and sustainably by following specific rules and aims to improve physical fitness and achievement. Football is a sport that is widely loved by people around the world, including in Indonesia. The game of football requires a lot of energy and can be equated with the energy needs of very heavy workers. The movements carried out by the players are running, kicking, jumping, and *sprint-sprint* short, whose percentage is quite large (Dieny, 2019).

Football is one of the sports that combines aerobic and anaerobic endurance. This requires muscular physical endurance, speed, and continuous energy expenditure throughout training and matches. Excellent physical fitness will positively impact the ability of blood circulation and heart work to increase in strength, speed, and agility; muscle explosiveness is the ability of muscles to perform muscle contractions very quickly, which is greatly influenced by muscle strength (Dieny, 2019). Football players are required to have the ability to move quickly and precisely to win the ball so that they score goals. This physical fitness is very useful in supporting physical work capacity, which is ultimately expected to increase achievement.

Consistent and repetitive training will improve athletes' achievements. Still, if it is excessive, it will cause fatigue so that instead of achievements achieved, it will cause a sense of boredom and may cause injuries for athletes (Hasyim & Saharullah, 2019). Alternatively, what is commonly referred to as physical fatigue (muscles). Muscle fatigue is decreased energy production or maximum power in response to muscle endurance (Wan *et al*., 2017). *Running-based Anaerobic Sprint Test* (RAST) is one of the tests to measure anaerobic muscle fatigue. RAST is more specific for testing anaerobic muscle fatigue in running-based sports.

Muscle fatigue is also affected by micronutrients, namely potassium. Potassium is an electrolyte that balances bodily fluids and transmits nerve and muscle impulses along with sodium, magnesium, and calcium. Potassium deficiency can result in muscle weakness, which can cause muscle fatigue. (Pohl *et al*., 2013). The administration of potassium-containing supplements for athletes is usually given as natural supplements such as fruit juices and isotonic drinks.

Isotonic drinks function to retain body fluids and salts and provide energy in the form of carbohydrates when doing activities. Based on SNI 01-4452-1998, isotonic drinks must contain sugar (at least 5%), citric acid, and minerals (Na maximum 800-1000 mg/Kg; K maximum 125-175-mg/Kg), maximum pH four and safe to consume (meets microbial and heavy metal contamination standards) (Sutrisno, 2009).

Along with technological development, fruit is consumed fresh and can be consumed in fruit juice. Fruit juice is a liquid obtained from edible parts of the fruit that are washed, crushed, clarified (if needed), with or without pasteurization, and three packed to be consumed directly. (BPOM, 2022). One of the fruits that can be used as juice is citrus.

Citrus fruit (*Citrus sinensis*) is a fruit that contains simple carbohydrates and complex carbohydrates. Simple carbohydrates in citrus fruits, namely fructose and glucose, can provide energy quickly (Baghurst, 2003). This is to the research conducted by Irawan (2007) Previous in (Kusumastuti & Widyastuti, 2016). The amount of carbohydrates needed to increase endurance is 30-60 grams/hour; this amount can maintain glucose levels and maintain the level of carbohydrate burning in the body so that it can increase endurance for about 30-60 minutes.

Based on data (2018, 2018) Nutritional content of sweet citrus fruits (*Citrus sinensis*) per 100 grams of carbohydrates of 11.2 grams, 87.2 grams of water, and 472.1 mg of potassium. The potassium content in orange juice (1416 mg/300mL) is higher than that of other fruit juices such as apple (390 mg/300mL), melon (501 mg/300mL), and mango (420 mg/300mL). Andani & Widyastuti (2017), explains that potassium in sweet citrus fruits helps maintain fluid balance and lactic acid. This amount can increase athletes' endurance during training and matches.

This research was conducted at the North Sumatra Student Education and Training Center (PPLP) at Jalan Sekolah Pembangunan No. 7A Medan Sunggal, a dormitory. The researcher chose this location because, based on the observations conducted with the RAST test on 10 football athletes, it was known that eight athletes had an average level of fatigue categorized as high with a result of >10 (the subject was said to be exhausted. The results of interviews with football coaches

found that athletes at PPLP North Sumatra were rarely given isotonic drinks or juice drinks, and only food was provided in the dormitory. This also affects the performance of athletes, as the results of matches carried out in the last 6 months are unsatisfactory.

Based on the background description above, the researcher is interested in researching the Effect of Giving Sweet Orange Juice (*Citrus sinensis*) on the Fatigue Level of Athletes at the Student Education and Training Center (PPLP) of North Sumatra because from several references it was found that the prevalence of athlete fatigue is increasing due to the lack of consumption of isotonic drinks or fruit juices. The benefits of this study are expected that athletes can consume isotonic drinks or fruit juices more often, especially sweet orange juice (*Citrus sinensis*), high in potassium and vitamin C, which can reduce athletes' muscle fatigue during training and matches.

METHOD

This study is experimental research with a post-test design only with a *control group design*. This study's control variable (dependent) is the provision of isotonic drinks produced by PT. Amerta Indah Otsuka as much as 300 mL. The treatment variable (*independent*) was the administration of sweet orange juice as much as 300 mL.

The calculation of the subjects in this study uses the Lemeshow formula so that 24 subjects are needed. The subjects were divided into two groups, namely the control group (300 mL of isotonic drinks produced by PT. Amerta Indah Otsuka), as many as 12 athletes, and the treatment group (300 mL of sweet orange juice), 12 athletes using a *systematic random sampling technique.* The study subjects were carried out using the following inclusion criteria: male soccer athletes aged 16-18 years, willing to participate in the research through informed *consent*, not taking supplements, and not being under the care of a doctor. Subjects were declared out of the study if they did not follow any stage of the research process, became sick or injured during the study, consumed sports drinks or other similar drinks that were not given by the researcher during the study, and consumed vitamin and mineral source supplements or supplements that function as a power generator during the study.

The administration of sweet orange juice was carried out 30 minutes before the RAST (*Running-based Anaerobic Sprint Test*) test was carried out. Athletes are given 3 minutes to finish the orange juice or isotonic drinks. The test procedure of this study is that subjects should not eat the principal meal 4 hours before the test; the control group gets 300 mL of isotonic drink while the treatment group gets 300 mL of sweet orange juice, and the subject is only allowed to drink water during the test. The procedure for implementing the RAST test is that the subject is asked to warm up for 10 minutes, then the subject is asked to run 6 times as far as 35 meters at maximum speed with a rest phase for 10 seconds per repetition. After obtaining the *sprint* running time from 6 reps, the minimum *power data* was obtained as the lowest value among six reps, and the *maximum power* in the form of the highest value between 6 reps. The data was calculated with the help of the RAST

(*Anaerobic Sprint Test) Android application, which can be downloaded through the Play Store,* and the subject was rested.

The subject was said to experience fatigue if the fatigue index value was >10. The fatigue index value data between the control group and the treatment was tested for data normality with *the Saphiro-Wilk test* because the sample was less than 50. The difference in the mean fatigue index values between the control group and the treatment was tested using *the Independent Sample T-test*. The difference is considered significant if p<0.05.

RESULT AND DISCUSSION

Subject Characteristics

The test results differed from those of the Independent Sample T-test, which showed no difference in age, weight, or height between the two groups (p>0.05). The study began with the condition of the sample between the same groups between variables.

Table 1. Characteristics of the Research Subject

Variable	Control (n=12)	Treatment (n=12)	P*
	Average±SB	Average±SB	
Age (years)	16.75±0.754	16.92±0.793	0,603
Weight (kg)	63.63±7.14	61.30±7.42	0.443
Height (cm)	173.57±7.78	169.87±5.42	0,189

Description: *based on *independent sample t-test*

RAST Test

The results of the RAST test in two groups showed that the treatment group with a fatigue level of <10 (not tired) was 12 athletes (100%), and there were no athletes in the treatment group with a fatigue level of >10 (tired). In the control group, 11 athletes (91.6%) with a fatigue level of <10 (not exhausted) and one athlete (8.3%) with a fatigue level of > 10 (tired).

Table 2. RAST Test Results

Group	Fatigue Level				Total	Percent (%)
	< 10 (Not tired)		> 10 (Tired)			
	Frequency	Percent (%)	Frequency	Percent (%)		
Treatment	12	100	0	0	12	100
Control	11	91,6	1	8,3	12	100

Data Analysis

The results of this study show that the value of Sig. p = 0.01, which states that Ha is accepted. So, it can be concluded that the administration of orange juice significantly influences football athletes' fatigue levels. It can also be interpreted that orange juice can affect athletes' level of fatigue and improve their performance.

Table 3. Test Results *Independent Sample T-test*

Variable	Treatment (n=12)			Control (n=12)			P*
	Average±SB	Min	Max	Average±SB	Min	Max	
Fatigue Index	4,61±1,42	2,86	7,45	6,62±2,33	3,61	10,09	0,01

Based on the results of this study, after giving orange juice to the treatment group as much as 300 mL, the results showed a lower level of fatigue compared to the control group given isotonic drinks. Independent analysis test results *Sample T-test* showed a significant difference in fatigue levels in the two groups. The average fatigue level in the treatment group was 4.61±1.42, while the control group was 6.62±2.33. The results of the study show that sweet orange juice can reduce athlete fatigue, and this study proves the existing hypothesis. The lower the fatigue level value, it can be said that the athlete's fatigue level of 40 decreases. In line with the research conducted by Kusumastuti & Widyastuti (2016) Suggests that sweet orange juice can reduce anaerobic muscle fatigue.

In general, the activities contained in sports activities consist of a combination of 2 types of activities, namely aerobic and anaerobic activities; one example of sports that use aerobic and anaerobic activities is football. Anaerobic activity is a working system in the body carried out without using oxygen, while aerobic activity is the opposite, namely using oxygen for fuel. Anaerobic activity in soccer athletes occurs when athletes experience tough training while running, so the muscles contract and require much oxygen. In sports activities that are carried out with high intensity and require power quickly, the body's energy metabolism will run anaerobically (Irawan, 2007). *Running-based Anaerobic Sprint Test* (RAST) is one of the tests to measure anaerobic muscle fatigue. RAST is more specific for anaerobic muscle fatigue tests in running-based sports such as soccer (Abbasian S et al., 2012).

In this study, the nutrients that play a role are carbohydrates, potassium, and vitamin C. Based on what has been explained in the introduction, citrus fruits contain simple and complex carbohydrates. In contrast, simple carbohydrates in citrus fruits are glucose that can provide energy quickly. Complex carbohydrates are nonstarch polysaccharides (commonly called dietary fiber) that can later be used to store muscle glycogen reserves. The carbohydrate content in 300 mL of orange juice is 33.6 grams. Previous research shows that fatigue can be inhibited by 30-60 minutes with the administration of carbohydrates of 30-60 grams/hour. Carbohydrates are stored in the bloodstream as energy reserves as glycogen in the liver and muscles. The greater the glycogen reserves in the

muscles determines the length of muscle endurance, and vice versa. If the glycogen reserves are depleted, then the muscles will experience fatigue (Roesdiyan, 2019).

Carbohydrates are the primary source of energy for an athlete when doing sports. All of these carbohydrates will be converted into glucose in the body. The glucose formed can then be stored as an energy reserve as glycogen in the liver (18% - 22%) and muscles (80%) and stored in the bloodstream as blood glucose or carried into the body's cells in need. 11.24 grams of glucose derived from blood glucose and glycogen will undergo a glycolysis process that produces ATP and pyruvic acid molecules (Andani & Widyastuti, 2017). Energy metabolism is by an anaerobic glycolysis system, also known as the lactate-forming system. When the supply of oxygen in the body is limited, the formation of pyruvic acid occurs as quickly as when doing a sprint. Then, pyruvic acid will be converted to lactic acid. Through the bloodstream, lactate enters the liver. Then, in the liver, the lactate is converted back into glucose. Glucose returns to the blood and is then used in the muscles. Glucose is converted back into glycogen, called the lactic acid or Cori cycle. The energy produced from the cycle can only last 2-3 minutes, then the body will experience fatigue due to lactic acid deposits in the blood and muscles. (Septyani, 2022).

Research conducted (Lone *et al*., 2017) Plantains were used as a source of carbohydrates and potassium to prevent anaerobic muscle fatigue in sepak takraw athletes. This showed a difference in the average anaerobic fatigue (AF) value between the control and treatment groups. A comparison of 150 and 300 grams of plantains, whereas 300 grams before exercise, proved more effective in preventing anaerobic muscle fatigue. Some research in (Kusumastuti & Widyastuti, 2016) It supports the idea that administering carbohydrates in liquids 15-60 minutes before training can improve performance by delaying fatigue in athletes. Research conducted by Arribalzaga et al (2021) In Spain, it was found that the group that consumed large amounts of carbohydrates/per hour had lower fatigue levels.

Citrus fruits have a potassium content that functions in carbohydrate metabolism, is active in glycogen and glucose metabolism, and converts glucose into glycogen stored in the liver for energy. Potassium also functions to maintain muscle work, prevent muscle cramps, overcome muscle fatigue, and maintain fluid stability during prolonged sports competitions (Septyani, 2022). Oranges and bananas are good to consume during exercise to obtain their potassium content. The potassium loss may result from increased aldosterone secretion during the body's warmth adjustment, so athletes lose potassium through urine and sweat (Kusumastuti & Widyastuti, 2016).

Vitamin C in citrus fruits is an antioxidant and helps reduce oxidative damage during exercise. The content of citrus fruits, such as vitamin B complex, includes thiamin, niacin, vitamin B6, riboflavin, and pantothenic acid (Ramlah *et al*., 2021) They are involved in the energy production line and are needed in higher amounts for athlete fatigue. (Kusumastuti & Widyastuti, 2016). In addition, vitamin C is necessary for glucocorticoid synthesis since ascorbic acid is a cofactor for enzymes in the adrenal cortex and participates in glucocorticoid biosynthesis pathways. (Moritz *et al*., 2020).

The HPA (Hypothalamic/Pituitary/Adrenal) axis is activated when exposed to stress through a tightly controlled process that initially involves the release of corticotropin-releasing hormone (CRH) by the supraventricular nucleus of the hypothalamus, followed by the CRH-induced secretion of adrenocorticotropin hormone (ACTH) by the adrenal glands. ACTH activates membrane receptors in the adrenal glands, further stimulating the release of glucocorticoids, such as cortisol. In negative feedback loops, cortisol decreases the activity of the HPA axis. Some studies have shown a link between stress behavior and vitamin C (Moritz *et al*., 2020).

CONCLUSION

Based on the results of the study, it can be concluded that there is no difference between the variables of age, BMI, and BMI, which is characterized by a value of p>0.05. An overview of the fatigue level of North Sumatra PPLP football athletes after the administration of orange juice in the treatment group of 300 mL showed the results of the RAST test with a fatigue level of < 10 (not tired) as many as 12 athletes (100%) and no athletes in the treatment group with a fatigue level of > 10 (exhausted). Meanwhile, in the control group, after providing isotonic drinks from PT. Amerta Indah Otsuka was obtained by 11 athletes (91.6%) with a fatigue level of < 10 (not tired) and one athlete (8.3%) with a fatigue level of > 10 (tired).

The Independent Sample T-test analysis test showed a significant difference in fatigue levels in the two groups. The average fatigue rate value in the treatment group was 4.61±1.42, while the control group was 6.62±2.33 or the Sig. p<0.05 value was p = 0.01; there was a significant difference in the average fatigue level of athletes between the treatment group and the control group.

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