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The effect of red watermelon juice on the anaerobic muscle fatigue index during physical exercise

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ABSTRAK

Latar Belakang: *Kelelahan merupakan salah satu masalah yang sering dialami oleh olahragawan. Biasanya terjadi pada aktivitas anaerobik karena intensitas yang tinggi dan membutuhkan energi cepat dalam waktu yang singkat. Pemberian jus buah semangka merah (Citrullus lanatus) diharapkan mampu menurunkan kelelahan otot.*
Tujuan: *Tujuan dari penelitian ini adalah mengetahui pengaruh pemberian jus buah semangka merah terhad*
ap indeks kelelahan otot.
Metode: *Penelitian ini menggunakan desain eksperimental semu dengan rancangan randomized post test only group with crossover dengan membandingkan pengaruh pemberian jus buah semangka merah. Subjek penelitian ini yaitu anggota bimbingan meraih cita-cita (MCC). Luaran utama pada penelitian ini adalah indeks kelelahan otot yang diukur dengan menggunakan Running-based Anaerobic Sprint Test (RAST). Analisis data dilakukan menggunakan uji independent t test.*
Hasil:.*Ada perbedaan indeks kelelahan otot anaerobik pada kelompok perlakuan sebesar 2,55 sedangkan pada kelompok kontrol sebesar 3,75. Pada penelitian ini terjadi peningkatan kategori indeks kelelahan otot dari yang rata-rata subjek memiliki kategori cukup menjadi kategori baik, dan ada perbedaan yang signifikan pada kelompok perlakuan dan kelompok kontrol secara statistik (p=0,004).*
Kesimpulan: *Jus buah semangka merah dapat menurunkan angka indeks kelelahan otot anaerobic pada anggota bimbingan MCC. Penelitian selanjutnya dapat meneliti mengenai perbedaan indeks kelelahan otot anaerobik dengan pemeriksaan kadar asam laktat.*

KATA KUNCI: *eksperimental semu; jus semangka merah; kelelahan otot anaerob; latihan fisik*

ABSTRACT

Background: *Fatigue is a common problem experienced by athletes, typically occurring during anaerobic activities due to high intensity and the need for quick energy. The administration of red watermelon juice (Citrullus lanatus) is expected to be able to reduce muscle fatigue.*
Objectives: *The purpose of this study is to assess the effects of providing red watermelon juice on muscle fatigue.*
Methods: *This study used a quasi-experimental design with a randomized post-test-only group with a crossover design by comparing the effects of delivering red watermelon juice to subjects. Subjects of this study were MCC (Meraih Cita Cita) tutoring members. The primary outcome was the index of anaerobic muscle fatigue that was measured by the Running-based Anaerobic Sprint Test (RAST). Data analysis was conducted using an independent t-test.*
Results: *There was a difference in the index of anaerobic muscle fatigue in the treatment group 2.55, while in the control group 3.75. In this study, there was an increase in the category of muscle*

fatigue index from an average of subjects having a fairly good category to a good category, and there was a significant difference in the treatment group and control group statistically (p=0.004). ***Conclusions:*** *Red watermelon juice can reduce the rate of anaerobic muscle fatigue. Further research can examine the differences in anaerobic muscle fatigue index with lactate acid examination.*

KEYWORDS: *quasi experimental; red watermelon juice; anaerobic muscle fatigue; physical exercise*

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INTRODUCTION

Due to physical activity, muscle fatigue is a reduction in muscle performance. Muscle fatigue diminishes the muscle's ability to perform tasks under constant load over time (1). Anaerobic fatigue is caused by high-intensity activities that demand rapid energy in a short period (2). During high-intensity physical activity, muscles contract in an anaerobic state, resulting in the production of ATP (adenosine triphosphate) via the anaerobic glycolysis process. Therefore, to reduce anaerobic fatigue, it is necessary to find alternatives derived from natural materials (3). One of them is watermelon, which is rich in citrulline amino acids and has a high water and sugar content. Citrulline, at 2.33 mg kg1 f.w., is the most abundant non-essential amino acid in watermelon flesh (4).

The citrulline content of red watermelon can reduce the accumulation of lactic acid, a byproduct of the anaerobic glycolysis process, which can delay the onset of anaerobic fatigue (5). Functional food is a processed nutrient-rich food or beverage that contains substances that regulate or influence bodily processes (6). It is possible to increase VO2 max, delay muscle fatigue, and reduce post-exercise muscle soreness by consuming citrulline in the form of supplements and watermelon for seven days or just once an hour before a physical exercise test. However, there is no standard dosage recommendation for enhancing athletic performance (7).

Several studies on the effect of citrulline in juice or other beverage treatments on anaerobic fatigue in humans have been conducted. According to research by Maharani et al. (2019), giving 500 ml of yellow watermelon juice (*Citrullus lanatus*) containing 1.8 g of citrulline for 7 days 60 minutes before a test could increase the muscle fatigue index from good to very good (8). According to Hasanah and Fitranti (2015), the anaerobic fatigue value of those given 72 g of red watermelon with 1.17 g of citrulline has a lower value than those who were not given red watermelon (5). Providing soccer players with 500 ml of processed red watermelon fruit drinks can reduce muscle fatigue (7).

Meraih Cita Cita (MCC) tutoring is a location for physical training in preparation for the TNI (Army) and POLRI (Police) physical tests, which require excellent physical condition, optimal body health, and ideal body posture. According to data held by the MCC tutoring, in 2019 there were 34 members and 29 individuals who passed the selection process. The average failure during medical tests was caused by the participants' poor physical performance, which was triggered in part by muscle fatigue. Before the time of the physical selection, members may not engage in strenuous physical activity as usual to maintain their stamina.

Generally, quite strenuous physical activity is performed five days per week for an average of five hours per day. Five to seven months of continuous or constant physical activity are performed before selection registration. Routine sports or physical exercises include running, push-ups, sit-ups,

pull-ups, shuttle runs, and planks lasting between 15 and 60 minutes. Lactate accumulation causes depleted energy reserves, muscle fatigue, muscle pain, and even injury as a result of high-intensity physical exercise. Energy plays a crucial role in physical exercise because muscle fatigue results from insufficient glycogen and glucose stores in the muscle and blood (1).

According to the findings of direct observations and interviews with trainers and several trainees of MCC Tutoring, muscle pain is a common issue during and after physical exercise. Muscle fatigue results in suboptimal training, which negatively impacts the performance of the trainee. Muscle fatigue can result from minor muscle injuries sustained during exercise (1). In addition to reducing muscle fatigue, researchers will deliver red watermelon juice containing citrulline compounds during the training process to reduce the risk of muscle injury, which can interfere with the physical training process of MCC's trainees. This study aimed to determine the influence of red watermelon juice on the muscle fatigue index in MCC trainees.

MATERIALS AND METHODS

The study applied a quasi-experimental design with a posttest-only, randomized control group and a 2x2 crossover. The research was conducted in December 2020 at Sidoarjo MCC (*Meraih Cita Cita*) Tutoring, a non-formal educational institution for candidates to the police academy.

The participants in this study were males between the ages of 18 and 21; they did not consume electrolyte drinks, sports drinks, supplements, herbal medicines, caffeine, or energy drinks, which served as energy generators, before or during the study. Twenty participants were separated into two groups with a two-day washout period. The intervention group received 500 millilitres of watermelon juice. The red watermelon used was a local, seedless watermelon that is $\pm$3 months old and was pulverized in a blender. The placebos were given to the control group in the form of a sugar-free syrup with the same red hue as the treatment group's syrup, diluted with 500 ml of water. Consumption of treatment products, either intervention or placebo, 60 minutes before the muscle fatigue test.

Anaerobic muscle fatigue was measured using the Running-based Anaerobic Sprint Test (RAST), which consisted of six 35-meter sprints separated by 10-second rest periods. After calculating the sprint running time for six repetitions, the muscle fatigue index was determined by evaluating:

Anaerobic Fatigue (AF) = (*maximum power - minimum power) / total sprint time (6 sprints*) (9).

Evaluation of body mass used digital scales with 0.1 kg of precision. The height was determined by using a microtoise. Dietary intake was determined through a 24-hour recall for two time periods. The independent t-test was utilized in the statistical analysis to compare the mean fatigue scores of the control and treatment groups. Subjects participated in the study by filling out the informed consent. This study has been approved through the hearing of the Health Research Ethics Commission (KEPK), State Polytechnic Of Jember with No.11929/PL17/PG/2020.

RESULTS AND DISCUSSIONS

Subjects Characteristics

Table 1 shows the characteristics of the research subjects. The majority of the subjects were young adults between the ages of 19 and 21 with normal nutritional status. The majority of the research subjects were between the ages of 19 and 21. Physical fitness increases during childhood until the ages of 25-30, after which it declines by 0.8%-1% annually. This decline can be mitigated by exercising more frequently (10). With age, strength, and muscle mass decline (5). Muscle strength is one of the most important physical

Table 1. Subjects Characteristic

Variable	mean±SD	n	%
Age			
16-18 years	19.75±1.02	3	15%
19-21 year		17	85%
Nutritional Status (kg/m^2)	21.72±1.83		
Underweight		1	5%
Normal		19	95%

components for supporting athletic performance. Several factors, such as genetics, gender, age, dietary habits, and exercise intensity, have a significant impact on decreases or increases in muscle strength (11)(12). (13).

According to nutritional status, the majority of research participants had normal nutritional status. Optimal nutritional status is required for maintaining fitness and health, promoting growth, and supporting athletic performance (14). Regular monitoring of MCC trainees' weight, height, and nutritional status were conducted so that the goal of having an ideal body shape with a normal BMI can be attained, allowing them to pass the medical examination. Periodic monitoring of body weight was performed to maintain a healthy weight. Monitoring was typically performed monthly or more frequently. A person with poor nutritional status and dehydration is susceptible to fatigue, tissue damage, and diminished strength (15). Regulation of the nutrient balance between dietary intake and the body's requirements is crucial, as nutrient deficiency or excess affects health conditions and nutritional status. With this nutritional status, a member will achieve optimal health and physical capabilities that enable him or her to endure physical activity (16).

Table 2. Nutrition Intake Before Treatment

Variable	Group (mean±SD)		p
	Intervention	Control	
Energy	2,207.0±312.87	2,216.7±318.42	0.923
Protein	68.5±12.12	76.7±18.00	0.970
Fat	80.9±27.61	84.5±24.92	0.671
Carbohydrate	300.0±63.16	285.6±69.11	0.496
Natrium	1,011.3±688.38	957.1±603.23	0.793
Kalium	391.0±19.55	429.0±21.45	0.607
Calsium	406.0±20.30	414.0±20.70	0.914
Magnesium	313.1±125.23	297.0±145.73	0.710

Intake of energy, protein, fat, carbohydrates, sodium (Na), potassium (K), calcium (Ca), and magnesium (Mg) for 24 hours before the intervention did not differ between the treatment groups and the control group, as determined by a different test. This demonstrates that the conditions of the subjects are identical across groups. The subject's nutritional intake before the intervention can influence the anaerobic fatigue index or score.

Intake of macronutrients such as energy, protein, fat, and carbohydrates from daily food consumption is essential for supporting the body so that it can carry out activities properly and provide energy to the body, particularly the muscles, so they can continue to contract. Carbohydrate consumption can maintain carbohydrate oxidation levels to prevent hypoglycemia and has a beneficial effect on the central nervous system, which can enhance performance, whereas protein consumption increases muscle protein synthesis (17).

If a person cannot meet his body's nutrient needs, especially if he skips meals to continue intense training, fatigue will set in sooner. This is due to a lack of glycogen in the liver, which prevents the body from replenishing glucose in the blood. As a result, blood glucose levels will drop (18). When carbohydrate reserves are depleted, the body

will attempt to release more fat and protein. Ingestion of nutrients is an essential component of long-term physical exercise; in addition to optimizing growth, it is also intended to prepare the body for optimal performance before, during, and after exercise (19).

Fresh fruit can be consumed to increase the body's carbohydrate consumption. Fresh fruit, such as papaya, watermelon, and melon, is easily absorbed by the body and maximizes energy replacement after exercise (20). According to the USDA National Nutrient Database, 100 grams of watermelon (*Citrullus lanatus*) contains 7.6 grams of carbohydrates.

Table 3. Anaerobic Muscle Fatigue Index

Variable	Treatment Group	Control Group	p
	Mean±SD	Mean±SD	
Anaerobic Muscle Fatigue Index	2.55±1.03	3.75±1.39	0.004*

**significant (p<0.005)*

The citrulline found in red watermelon juice is a non-essential amino acid. Citrulline in watermelon reduces the accumulation or buildup of lactic acid, a factor in accelerating muscle fatigue (22). Lactate accumulation occurs when the body requires energy but lacks sufficient oxygen to generate energy. Anaerobic glycolysis, in which glucose is metabolized to produce Adenosine Triphosphate (ATP) and lactate as a byproduct, will produce energy (23). This decrease in pH inhibits glycolytic enzymes and interferes with muscle cell chemical reactions, weakening muscle contractions and causing fatigue. Then, citrulline will rapidly break down lactate in the muscles, allowing lactate to be re-metabolized in the liver and kidneys via the cory cycle (2). Citrulline acid is a compound that facilitates the formation of Nitric Oxide (NO), which increases blood flow. With citrulline consumption, NO production will increase, resulting in blood vessel dilation. Numerous studies on watermelon fruit have demonstrated significant effects on anaerobic fatigue, muscle fatigue, lactic acid levels, anaerobic endurance, and delayed onset muscle soreness (5)(8)(21).

Anaerobic Muscle Fatigue

The statistical test results shown in Table 3 indicate that the anaerobic muscle fatigue index differs between the treatment and control groups following the pre-exercise intervention ($p<0.05$). The treatment group was conducted with red watermelon juice, whereas the control group was given a placebo.

Increased vasodilation expedites nutrient delivery to muscles, thereby enhancing exercise performance and reducing muscle soreness (24).

This study demonstrated that the Anaerobic Fatigue (AF) index was lower in the group treated with red watermelon juice compared to the control group. So that it can be said that the subject is less fatigued, it can improve exercise or physical performance. After receiving the intervention, 85% of the subjects demonstrated muscle fatigue within the range (0.21 to 3.31), so it was classified as good. Trainees of the MCC can maintain an ideal physique due to their consistent and frequent physical activity. Anaerobic exercise stimulates muscle activity during high-intensity performance, thereby enhancing muscular strength and endurance (3).

During anaerobic physical activity, lactic acid is produced and accumulates, resulting in fatigue. According to the study, anaerobic endurance improves as the anaerobic fatigue index value decreases. The decrease in lactic acid levels is directly proportional to the decrease in the value or index of muscle fatigue (21). The L-citrulline content of watermelon juice can reduce the accumulation or accumulation of lactate, which is a factor in rapid muscle fatigue (25). The citrulline content of watermelon can prevent fatigue and boost athletic performance. Citrulline will detoxify ammonia in the liver, which is a manufacturer of excessive lactic acid

that can result in fatigue (7). Ammonia functions to activate phosphofructokinase, which assists in the lactic acid production process. Increased levels of ammonia will result in elevated levels of lactic acid, which will cause fatigue. Taking up to 6 grams of citrulline per day in tablet form decreases lactate accumulation and enhances athletic performance (26).

Other studies have demonstrated that supplying citrulline in the form of citrulline malate as much as 6 grams for up to 15 days can significantly reduce muscle pain, increase ATP by 34% during exercise, and increase phosphocreatine by 20% after exercise (27). Consuming fruits rich in carbohydrates and antioxidants will improve performance, health, and endurance during physical activity. Watermelon contains carbohydrates, lycopene, l-citrulline, and l-arginine. Carbohydrate consumption maintains blood sugar levels during moderate and intense physical activity, thereby enhancing endurance performance by up to 2-6% and decreasing the risk of inflammation by up to 25-40%. During exercise, consuming different carbohydrate transporters such as glucose and fructose increases Sodium-Glucose Transporter 1 (SGLT1), Glucose and Fructose Transporter (GLUT2), and Fructose Transporter (GLUT5). The ratio of fructose-to-glucose-containing liquid consumption is 0.8:1, and an average daily consumption ≥ 1.7 grams can enhance athlete performance (28).

Consuming adequate carbohydrate-containing foods during exercise helps provide glucose as an energy source, retains stored glycogen in muscle, and prevents hypoglycemia, which can cause fatigue due to limited blood glucose oxidation (29). Liquid foods, such as red watermelon juice, facilitate the digestion of nutrients by the stomach and digestive tract. In addition, consuming fruit juices such as watermelon juice will assist in maintaining a healthy level of hydration, increase energy savings, and prevent hypoglycemia. Before, during, and after exercise, dietary considerations must be made to reduce the risk of fatigue and maintain physical endurance (30).

The strenghths of this study were that it used a control group that was given a placebo to prevent the placebo effect of the intervention and the subjects used were MCC tutoring members who were different from other studies. While the limitations of this study are not controlling the subject's activity before the study which can affect fatigue before the intervention is carried out. In addition, this study did not measure blood lactic acid levels.

CONCLUSIONS AND RECOMMENDATIONS

Based on the research conducted, it can be concluded that there are differences in the anaerobic muscle fatigue index of MCC mentoring trainees. *Citrullus lanatus* (red watermelon) juice can reduce muscle fatigue. Future research can examine the differences between the anaerobic muscle fatigue index and blood lactic acid levels measured in the laboratory. Consumption of red watermelon juice should need to be recommended during an exercise program to reduce muscle fatigue.

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