

THE EFFECT OF VITAMIN E SUPPLEMENTATION ON MUSCULAR FATIGUE IN PROFESSIONAL MEN'S ATHLETICS

Yusni¹, Amiruddin²

¹Department of Physiology, Faculty of Medicine, ²Physical Education, Health and Recreation, Faculty of Education, Syiah Kuala University, Banda Aceh, Indonesia

ABSTRACT

High-intensity exercise (3000-meter runner) contributes to muscle fatigue. Fatigue can be determined by measuring blood lactate levels. Blood lactate levels are a product of anaerobic metabolism. Lactate accumulation due to anaerobic physical activity can inhibit the glycolytic enzyme that affects decreased ATP production, damage of the calcium and sodium pumps in the muscles and causes fatigue. This study aimed to analyze the effect of vitamin E on the level of fatigue through the response of blood lactate levels in the runner 3000 meters. This research was a quasi-experimental research with a pretest-posttest design. Research subjects were 9 volunteer athletes (3000 meters runners) Aceh province, male, and aged 15-20 years. The treatments were vitamin E at a dose of 1x400 IU per day and administered for 14 days. Blood lactate levels were examined using the method of calorimetry. The statistical analysis was using the homogeneity test of variance (Levene's test), the normality test (Kolmogorov-Smirnov test) and paired t-test with a significant level of 5% (p-value<0.05). The results showed that blood lactate levels decreased approximately 13.93% after vitamin E supplementation. There was no significant difference (p=0.27) between blood lactate levels before and after vitamin E supplementation in athletes. In conclusion, vitamin E supplementation did not significantly lower blood lactate levels therefore vitamin E did not significantly reduce muscle fatigue in men's athletics.

Keywords: Antioxidant; vitamin E; fatigue; blood lactate; athlete

ABSTRAK

Olahraga intensitas tinggi (lari 3000 meter) mengakibatkan kelelahan otot. Kelelahan dapat diketahui melalui pengukuran kadar laktat darah. Kadar laktat darah merupakan produk akhir dari metabolisme anaerobik. Penumpukan laktat akibat aktivitas fisik anaerobik dapat menghambat enzim glikolisis yang berdampak terhadap menurunnya produksi ATP, gangguan pada pompa kalsium dan natrium di otot dan menimbulkan kelelahan. Penelitian ini bertujuan untuk menganalisis pengaruh pemberian vitamin E terhadap kelelahan melalui respon kadar laktat darah pada pelari 3000 meter. Metode penelitian yang digunakan adalah quasi eksperimental dengan pretest-posttest design. Subjek penelitian adalah 9 orang atlet lari 3000 meter provinsi Aceh, jenis kelamin laki-laki, dan usia 15-20 tahun. Perlakuan yang diberikan adalah vitamin E dengan dosis 1x400 IU perhari dan diberikan selama 14 hari. Kadar laktat darah diperiksa dengan menggunakan metode kalorimetri. Analisis statistik yang digunakan adalah uji homogenitas varians (Levene's test), uji normalitas data dengan Kolmogorov-Smirnov test dan uji beda yaitu uji t untuk data berpasangan dengan derajat kemaknaannya adalah 5% (p<0.05). Hasil penelitian menunjukkan bahwa kadar laktat darah menurun sebanyak 13,93% setelah suplementasi vitamin E. Terdapat perbedaan yang tidak bermakna (p=0,27) antara kadar laktat darah sebelum dan sesudah diberikan vitamin E pada atlet lari 3000 meter. Simpulannya adalah suplementasi vitamin E tidak signifikan menurunkan kadar laktat darah oleh karena itu vitamin E tidak signifikan mengurangi kelelahan otot pada atlet lari.

Kata kunci: Antioksidan; vitamin E; kelelahan; laktat darah; atlet

Correspondence: Yusni, Department of Physiology, Faculty of Medicine, Syiah Kuala University, Banda Aceh, Indonesia. Phones: +626517551843, +62811225692; Fax: +626517551843. E-mail: yusni@unsyiah.ac.id

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INTRODUCTION

Energy systems that contribute to the middle-distance runners (3000 meters) are more predominantly aerobic (86%) than anaerobic (14%) (Duffield et al 2003, Hassane et al 2010). The 3000-meter run is a high-

intensity and exhaustive exercise (Duffield et al 2003, Menzies et al 2010). High-intensity exercise resulted in increased production of free radicals in muscle, increased the formation of blood lactate and fatigue (Haymes 1991, Westerblad et al 2002, Urso & Clarkson 2003, Menzies et al 2010). Exhausting exercise

increases the production of creatine phosphokinase (CPK) and lactate dehydrogenase (LDH) enzymes (Bhagat et al 2006). The lactate by the enzyme lactate dehydrogenase is oxidized to pyruvate and produces energy, but high lactate formation or excessive accumulation of lactate can lead to muscle fatigue (Ishii and Nishida, 2013; Westerland et al 2010; Rashidi et al 2013; Westerblad et al 2002). Muscle fatigue can be measured by muscle lactate examination and muscle lactate levels can be determined by examination of blood lactate levels (Maglischo 1970, Rashidi et al 2013, Westerblad et al 2002). Muscle fatigue due to high-intensity exercise is associated with anaerobic metabolism (Rashidi et al 2013, Westerblad et al 2002). Anaerobic metabolism results in increased lactic acid and acidosis. The lactate ion and pH play a role in controlling muscle contraction and fatigue (Maglischo 1970, Rashidi et al 2013, Westerblad et al 2002).

Strenuous exercise increases the production of oxygen free radicals (Bhagat et al 2006, Zimmermann 2003). Strenuous exercise causes impaired endogenous oxidative production and decreased concentrations of endogenous vitamin E, therefore, require additional exogenous vitamin E (Zimmermann 2003). Research shows that vitamin E deficiency contributes to fatigue and decreases as much as 40% of endurance capacity during exercise in rats (Haymes 1991). Vitamin E has a role as a major lipid-soluble antioxidant in membrane cells and inhibits muscle damage due to exercise and enhancing recovery from exercise (Haymes 1991, Clarkson & Thompson 2000, Urso & Clarkson 2003, Lukaski 2004). Vitamin E is a key nutrient to help improve physical performance (Lukaski 2004). The need for vitamin E increases in athletes (Lukaski 2004). Heavy exercise induces muscle damage (Mohammed et al 2015). Improvement of muscle damage during exercise leads to the loss of integrity of the sarcoplasmic reticulum, lipid peroxidation, the release of myoglobin into the circulation and damage to the muscle enzyme (Mohammed et al 2015).

Vitamin E was significant decreases the activity of the enzyme lactate dehydrogenase (LDH) (Silva 2010). The antioxidant treatment (vitamin E) is already inhibiting the increase of LDH levels in non-athletes (Bhagat, 2006). Through this mechanism, we predicted that vitamin E supplementation may decrease fatigue in athletes run 3000 meters. Lactic acid accumulation contribute to inhibiting glycolysis enzyme (LDH), which have an impact on the ATP production decline and disruption in calcium and sodium pump in the muscles. As a result, muscle strength decreases, muscle contraction weakens and fatigue (Bhagat 2006). The aim of the study was to analyze the effect of exogenous antioxidant supplementation (vitamin E) to muscle

fatigue in men's athletics by measuring blood levels of lactic acid (Bhagat 2006).

MATERIALS AND METHODS

The materials were informed consent forms, anamnesis form, physical examination forms, weight scales, body measures, mercury sphygmomanometers, stethoscopes, kits for blood lactate analysis, and vitamin E. The research method was a quasi-experimental with the pretest-posttest design. The research was conducted in Department of Physiology Faculty of Medicine, Syiah Kuala University (Unsyiah) Banda Aceh and Harapan Bangsa sports field Banda Aceh. Blood lactate examination was done at Prodia laboratory in Jakarta. The research was carried out for 5 months. A total of 9 junior athletes, 3000-meter run, men and 15-20 year old were volunteered as participants in the study. The sampling technique was done in total sampling. The inclusion criteria of the participants were junior athlete, 3000-meter runners aged 15-20 years, fit and healthy. Exclusion criteria were injured during the study, doing strenuous physical exercise 24 hours before performing the test, and consuming foods and other supplements (besides vitamin E).

Research procedure: all volunteer athletes signed written informed consent. All participants have examined the physical characteristics of the study subjects: body weight, height, systolic and diastolic blood pressure, and lactate levels. Blood sampling was performed to measure lactate levels. Blood sampling was done 2 times: before and after treatment with vitamin E. Blood sampling was done by all participants warming up for 10 minutes, furthermore run for 3000 meters. Subjects rested for 12 minutes after the run and blood sampling performed after being rested.

The treatments were vitamin E doses of 400 IU per day and physical exercise three times per week, duration of 60-120 minutes exercise. Treatment was given for 14 days from the first day after pre-trial examination. Measurement of blood lactate levels for post-trial data was performed on day 15. Measurement of blood lactate level was conducted by calorimetry. Statistical analysis was performed using computer software. Statistical analysis was performed by homogeneity test of variance with Levene test, normality test with Kolmogorov-Smirnov and paired t-test ($p < 0.05$).

RESULTS

Physical characteristics of participants

Table 1 shows that the physical characteristics of participants: age (year), body weight (kg), height (cm), body mass index (BMI = kg/m²) and blood pressure (mmHg) were not significantly different (p>0.05). Homogeneity tests show that the variance of blood lactate levels is homogeneous. Normality test showed that blood lactate levels were normally distributed, and therefore ineligible for the paired t-test (p<0.05). Figure 1 shows that the mean lactate blood levels after treatment decreased (=6.82 vs 5.86) after vitamin E supplementation. The results showed that blood lactate levels decreased by 0.95 mmol/L or approximately 13.93% after treatment at 3000 meters runner.

Table 1. The paired t-test showed that there was a non-significant difference (p=0.27) between blood lactate levels before and after treatment of athletes running 3000 meters. This indicates that the treatment of vitamin E 400 IU daily for 14 days can not maximize the decreased of blood lactate levels in athletes run 3000 meters. This is probably due to the duration of treatment less.

DISCUSSION

The results of this study found that vitamin E lowers blood lactate levels as much as 13.93% in the 3000-meter runners. The 3000-meter run is classified as high-intensity exercise so that its energy system uses ATP-PC energy systems and anaerobic glycolysis (Devlin et al 2014, Menzies et al 2010, Sarma, 2018). High-intensity exercise increases the production of lactic acid. Accumulation of lactic acid in muscles during strenuous exercise is resulting in fatigue (Baker and King, 1991). High levels of lactic acid result in decreased metabolic capacity and impaired production of ATP including impairment of calcium and sodium pumping systems for muscle contraction (Baker and King, 1991; Sarma, 2018). Decreased metabolic capacity will affect muscle weakness, weakening muscle contraction, decreased muscle performance resulting in fatigue (Ishii & Nishida 2013, Sarma 2018). The chronic and progressive increase of lactic acid without adequate recovery time will inhibit the energy supply from aerobic energy metabolism in muscle cells and lead to intracellular metabolic acidosis (Westerblad 2002).

Table 1. Physical characteristics

Variables	n	Means	SD	p-value
Age (year)	9	17.55	2.96	0.20
Weight (kg)	9	58.22	7.47	0.20
Height (m ²)	9	167.88	6.00	0.20
body mass index (kg/m ²)	9	20.60	1.37	0.20
Systolic Blood Pressure (mmHg)	9	118.88	7.81	0.20
Diastolic Blood Pressure (mmHg)	9	74.44	8.81	0.20

p<0.05, the data show significant differences

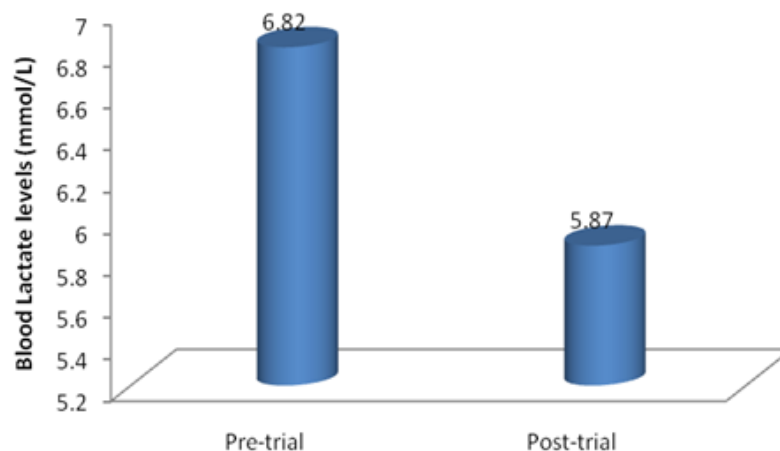


Fig. 1. Mean decreased blood lactate levels after vitamin E supplementation.

Table 2. Differences in pre-test and post-test blood lactate levels

Variables	Data	n	Means	SD	t-test	p-value
Blood Lactate (mmol/L)	Pre-trial	9	6.82	3.16	1.17	0.27
	Post-trial	9	5.86	3.48		

*: significant at 5% error level ($p < 0.05$)

High levels of lactic acid also affect the activity of the enzyme glycolysis (phosphofructokinase) and enzyme glycogenolysis (phosphorylase) (Westerblad 2002). Increased lactic acid results in acidosis (Westerblad, 2002). Acidosis causes low blood pH and therefore inhibits the activity of both enzymes. Disturbance of activity of both glycolytic enzymes causes disruption of energy supply to muscle and also calcium pumping in the sarcoplasmic reticulum (SR) (Westerblad, 2002). Inhibiting Ca^{2+} release from the SR is induced by acidosis results in decreased muscle performance and fatigue (Westerblad 2002).

Exercise results in a production imbalance between antioxidants and reactive oxygen species (ROS) (Zimmermann, 2003; Urso and Clarkson, 2003). Exercise is increasing the production of oxygen free radicals (Zimmermann 2003). Antioxidant supplementation such as vitamin E is essential for athletes (Paulsen et al 2014). Vitamin E is the primary antioxidant and one of the non-enzymatic antioxidants that contribute to neutralizing the increase in free radicals due to strenuous exercise (Urso and Clarkson, 2003; Braakhuis, 2012). Other researchers found that vitamin D supplementation at 300 mg for 6 weeks significantly decreased the activity of creatine kinase muscle enzyme and lactate dehydrogenase after strenuous exercise (Zimmermann, 2003). Boyali Research, 2012 found that vitamin E dosing of 300 mg for 4 weeks can increase antioxidant activity and suppress lactate levels during acute taekwondo exercise (Boyali, 2012). Taghiyar's study, et al 2013 found that there was no effect of vitamin C and E supplementation on body composition, performance, and muscle damage in athlete women.

We found that there was no significant decrease in blood lactate level after supplementation of vitamin E dose 400 IU per day for 14 days. Therefore, we suggest that further research with a sample size of more than 9 people, a control group design, vitamin E supplementation longer than 14 days, and a dose of vitamin E greater than 400 IU. Run 3000 meters is athletics with the dominant anaerobic energy system so that free radical production increases, therefore 3000-meter run athletes require high doses of antioxidants.

CONCLUSION

Vitamin E supplementation decreased blood lactate level as much as 13.93%. However, blood lactate level was not significantly decreased. Therefore, vitamin E was not reduced fatigue in men's athletics.

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