

ORIGINAL ARTICLE

# The Effect of Beetroot Juice Supplementation on Physiological Fatigue and Quality of Sleep in Male Athletes

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## ABSTRACT

Sleep loss and low tolerance to fatigue are among reasons that decline the athletic performance. Thus, the aim of the study was to investigate the effect of beetroot juice on physiological fatigue (time to exhaustion and blood lactate levels) and quality of sleep among male athletes. 30 male athletes with mean age of  $20.7 \pm 3.7$  years participated in the study voluntarily and divided randomly into three groups of supplement; placebo and control. Subjects in groups of supplement and placebo received 100 cc beetroot juice and placebo for a week, 2 hours prior to competition. 24-h recall questionnaire was used to monitor the nutrition status of subjects. Blood lactate levels and time to exhaustion were measured before and after one session of high-intensive exercise. The Pittsburgh Sleep Quality Index was given to the subjects for filling up before and after intervention. ANOVA and dependent t-tests were used to analyze the data. The results suggested that supplement group had a significant improvement in quality of sleep compared to placebo and control groups ( $p=0.001$ ) while no significant difference was found between in placebo and control groups ( $p=0.97$ ). In addition, both physiological fatigue indices including time to exhaustion and blood lactate levels were significantly improved after study intervention in supplement group ( $p \leq 0.05$ ). Athletes are highly recommended to take beetroots supplement for the aim of postponing lactate acid accumulation. On the other hand, hence, it can be considered as a noninvasive and effective strategy to counteract sleep loss induced fatigue.

**Keywords:** Beetroot, blood lactate, sleep, athlete

## INTRODUCTION

One of the major concerns of coaches, health policy makers is to alleviate the physiological and mental fatigues in athletes (Irandoust & Taheri, 2015, 2018; Reza Sharif & Sayyah, 2018). In this regard, high quality of sleep and

high tolerance to exercise intensity are of utmost importance. Therefore, appropriate monitoring of current status of fatigue in athletes is highly recommended. As a strategy, many coaches are following scientific approach to undertake training programs in such a way that lead to maximal athletic performance (Monleon, Hemmati Afif, Mahdavi, & Rezayi, 2018; Yousef Abadi, Mirzaei, Habibi, & Barbas, 2017). Consistent with the notion, the necessity of supplementation for improving athletic performance has well been documented in previous research (Burke, 2017; Irandoust & Taheri, 2017; Pfeifer, Arvin, Herschberger, Haynes, & Renfrow, 2017; Taheri & Irandoust, 2017). Given the importance of athletic preparation for events, having provided the

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relaxation conditions leading to an optimal sleep is another issue which must be taken into consideration. There are several studies reporting the high rate prevalence of sleep deprivation among athletes due to stressful conditions caused by competitions. This deteriorating condition affects negatively cognitive, motor functioning and psychomotor performance such as reaction time and memory tasks (Monleon et al., 2018; Taheri & Arabameri, 2012). In one site, the adverse effect of sleep deprivation on general health has been well documented (Fullagar et al., 2015; Taheri & Irandoust, 2017; Thun, Bjorvatn, Flo, Harris, & Pallesen, 2015), on the other side, the relationship between fatigue and low quality of sleep has been well reported (Fortier-Brochu, Beaulieu-Bonneau, Ivers, & Morin, 2010; Monleon et al., 2018; Taheri & Arabameri, 2012). Based on the evidences, a diet rich in vegetables has been found to have an optimal effect on physiological functions (Pinna, Roberto, Milia, Marongiu, Olla, Loi, Migliaccio, Padulo, Orlandi, & Tocco, 2014). As an example, it has been shown that beetroot juice supplementation (BJS) improves the performance in cycling, walking, and running (Pinna, Roberto, Milia, Marongiu, Olla, Loi, Migliaccio, Padulo, Orlandi, & Tocco, 2014). However, to the best of our knowledge, no research has been conducted investigating the effect of BJS on quality of sleep and physiological fatigue measured by lactate levels. All in all, knowing

about the important factors which positively affect athletic performances is a topic of great interest among researchers. Thus, the purpose of this investigation was to ascertain whether physiological fatigue (Blood lactate levels and time to exhaustion) and quality of sleep in male athletes could be improved by a week of beetroot juice supplementation.

**METHODS**

30 male athletes with mean age of 20.7±3.7 years participated in the study voluntarily and divided randomly into three groups of beetroot juice supplement (BJS); placebo and control. Subjects in groups of supplement and placebo received 100 cc beetroot juice and placebo for a week, 2 hours prior to competition. 24-h recall questionnaire was used to monitor the nutrition status of subjects. Blood lactate levels and time to exhaustion as indices of physiological fatigue were measured before and after one session of high-intensive exercise. Pittsburgh Sleep Quality Index was given to fill up by the subjects before and after intervention. Exclusion criteria included: having a background of regular exercise, three sessions a week within the past six year with; no history of beetroots or ergogenic drugs at least 6 month prior to the study. The study design is seen in Table 1.

After pretest, the experimental and placebo groups

**Table 1. Research design**

Groups \ Phase	pretest	Intervention	Post-test
Beetroot Juice	Lactate Quality of Sleep	One week supplementation of beetroot	Lactate Quality of Sleep
Placebo		Juice	
Control		-	

**Table 1. Physical and physiological fatigue characteristics of subjects before and after intervention**

Variable \ Group	WEIGHT (kg)		BL (mm)		TTE (min)	
	pretest	posttest	pretest	posttest	pretest	posttest
Supplement	73.1±7.1	73.06±6.9	14.3±1.5	11.76±1.5***	13.7±1.51	14.9±1.6***
Placebo	73.3±6.4	74.06±6.7	14.4±1.92	14.8±2.3	14.1±0.78	13.8±0.70
Control	73.1±6.2	73.5±6.4	14.1±1.23	14.01±1.26	13.8±0.84	13.5±0.84

Abbreviation: BL, Blood Lactate; TTE, Time to Exhaustion. \*\*\*. p<0.001

were given respectively 300 cc of beetroot and juice 2 hours prior to exercise. The supplementation was continued for seven days. The beetroot contain 300 mg of nitrate per 100 cc. the placebo included a combination of sour cherry drink and rose water (Pinna, Roberto, Milia, Marongiu, Olla, Loi, Migliaccio, Padulo, Orlandi, & Tocco, 2014).

The research was approved by the Ethics Committee of Imam Khomeini international university (ref no. 17628). Written informed consent was obtained from all subjects. The study was conducted in accordance with the ethical standards of the Helsinki Declaration (1964).

The exercise protocol for determining the physiological fatigue consisted of one-session high intensity test to measure the exercise tolerance to lactate accumulation (Jafari, Pouryamehr, & Fathi, 2017). The intensity of exercise protocol was monitored by Polar Electro, Kempele, Finland. Normality distribution of variables was tested using Kolmogorov Smirnov test. The data were analyzed by Dependent and ANOVA tests using statistical package version 21 (SPSS Inc., Chicago, IL).

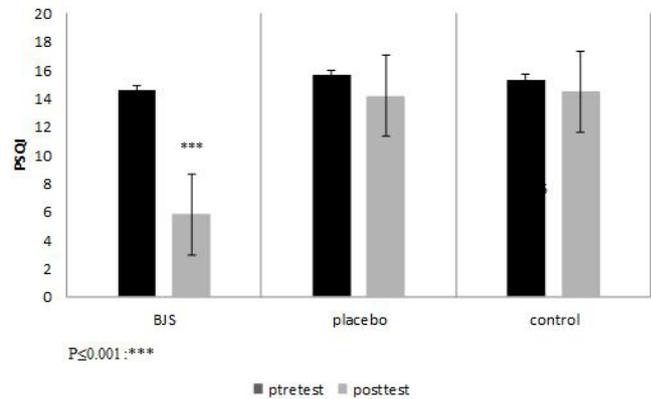
## RESULTS

ANOVA test results suggested that there were no significant differences in weight, blood lactate and time to exhaustion at baseline ( $p \geq 0.05$ ). T-test analysis indicated that both physiological fatigue indices including time to exhaustion (TTE) and blood lactate (BL) were significantly improved after study intervention ( $p < 0.05$ ). However, No significant change was found in BL and TTE of placebo and control groups in posttest ( $p \geq 0.05$ ).

As depicted in Figure 1, the results suggested that BJS group had a significant improvement in quality of sleep compared to placebo and control groups ( $p = 0.001$ ) while no significant difference was found between in placebo and control groups ( $p = 0.97$ ).

## DISCUSSION

The research was designed in such a way that any difference in quality of sleep and physiological fatigue of subjects could be attributed to the BJS. Two key findings were found in the study. First, quality of sleep was



**Figure 1. The effect of beetroot Juice supplementation on quality of sleep**

improved by BJS. According to the European Journal of Neuroscience, the increase of nitric oxide levels is one way to improve the quality of sleep. Since, insomnia lowers nitric oxide levels. So it seems necessarily to replace nitric oxide with specific ingredients in a supplement and nitrite rich food to restore nitric oxide on a daily basis.

Second, time to exhaustion and blood lactate were significantly improved followed by BJS. Basically, there is a direct relationship between these two factors. The more blood lactate gets, the time to exhaustion is longer. One possible explanation for the obtained results could be attributed to the increase of NO production in the skeletal muscle, thereby increasing blood flow and improving muscle O<sub>2</sub> delivery (Pinna, Roberto, Milia, Marongiu, Olla, Loi, Migliaccio, Padulo, Orlandi, & Tocco, 2014). This result is consistent with Pinna, et al (2014), who reported that beetroot Juice Supplementation improve the sleep cycles in athletes. On the other hand, the positive effects of the exercise other than BJS on improvement of performance during sub-maximal endurance exercise have been well proven (Collins et al., 2017; Wylie et al., 2016). In contrary to our results, some research reported no improvement was found in athletic performance after supplementation (Christensen, Nyberg, & Bangsbo, 2013; Wylie et al., 2016). One reason for equivocal findings might be attributed to different assessments (Reza Sharif & Sayyah, 2018) and procedure, inter-study differences in the supplementation status of the subjects, variable age groups and research designs. Given the importance of supplementation in athletes, it

highly recommended to use those which mitigate the muscular fatigue and cause the relaxation (Appel et al., 1997; Ferguson et al., 2013; Pinna, Roberto, Milia, Marongiu, Olla, Loi, Migliaccio, Padulo, Orlandi, Tocco, et al., 2014; Wylie et al., 2016). Additionally, our findings shed more light to the issue that athletes should consume BJS for improving their sleep status and performance. These results raise the possibility that taking BJS may be one component of improving the athletic performance in athletes via optimizing the sleep quality and physiological

fatigue. Further research with larger sample size and longitudinal designs is needed to elucidate the efficacy of BJS on quality of sleep and fatigue in athletes.

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