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Original Research

The effects of acute beetroot juice supplementation on lower and upper body isokinetic strength of the wrestlers

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Abstract

Background and objective: Peak torque, as measured by the gold standard method of isokinetic dynamometry, is affected by consumed of dietary nitrate (NO^{3-}) in the form of beetroot juice (BRJ). The increasing strength performance effect of BRJ has also started to arouse interest in combat sports. This study aims to investigate the effects of acute dietary nitrate supplementation on lower and upper body isokinetic strength of trained Greco-Roman wrestlers.

Materials and methods: The study is a double-blind, randomized, crossover design in which eight trained male Greco-Roman wrestlers (21.87 $\pm$ 2.3 years; height 176.87 cm $\pm$ 4.1 cm; body weight 76.75 kg $\pm$ 5.4 kg) consumed beetroot juice (140 mL) or placebo (140 mL, cherry juice with lemon juice) 150 min before performing isokinetic strength. Participants performed knee extensors and flexors and shoulder internal and external rotator isokinetic strength test (in the dominant limbs) concentrically at 60° with by Cybex device (Cybex NORM®, Humac, CA, USA). The same trial procedure was repeated with the other supplement (BRJ or Placebo) in a second testing session five days later. BRJ and Placebo trials' isokinetic strength values were compared with parametric testing (paired sample *T*-test).

Results: Although there was a significant difference in peak torque of shoulder internal and external rotator values in favor of BRJ ($P < 0.05$), there was no significant difference in the knee strength test. Additionally, all average isokinetic strength values were significantly increased in the BRJ trial ($P < 0.05$).

Conclusions: These results suggest that BRJ can be used as an ergogenic effect for improving strength values in Greco-Roman wrestling.

Keywords

Beetroot juice; Dietary nitrate; Isokinetic strength; Wrestlers

1. Introduction

Greco-Roman wrestling style is to aim athletes gain superiority over the opponent by holding only the upper body of the opponent with their upper body, whereas freestyle wrestler can use their whole body in the competition [1]. The wrestling rules emphasize aggressive wrestling and scoring by exhibiting repetitive bouts of high-intensity moves (e.g., attacks and counterattacks) instead of blocking or holding the opponent [2, 3]. In wrestling competition, such characteristics as aerobic capacity [4], anaerobic power and maximal strength are required for success [5]. Wrestlers have to produce high-level maximal strength for defense or offense [6–8]. In wrestling competitions, the upper and lower body maximal strength is one of the most crucial factors to obtain scores by applying the needed technique [9–11]. Studies have emphasized that successful wrestlers are capable of produce higher muscle strength than their less successful counterparts [2, 10–14]. Therefore, increasing muscle strength can help be one of the key factors for wrestlers [1].

Acute dietary supplementation (with beetroot juice) supplementation has been primarily examined in endurance-

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based exercise and conflicting results have been found. Compared with endurance-based exercise, beetroot juice (BRJ) effects' on strength were less studied [15]. Studies have shown that BRJ supplementation can affect different muscle fiber types in different level [16]. Since the percentages of skeletal muscle fiber distribution in the body are different [17], it is hypothesized that the effect of BRJ supplementation on lower and upper body strengths in the same individual may be different. To author's knowledge, there are limited studies in the literature investigating acute dietary supplementation to increase wrestlers' muscular strength. BRJ has recently been examined in the literature on different athletes for its potential effects on aerobic capacity, anaerobic power and muscle strength [18].

Beetroot juice, which has a high amount of inorganic nitrate (NO^{3-}), has complete attention in sports fields [19]. This NO^{3-} in the BRJ is transformed to nitrite (NO^{2-}) and then to the nitric oxide (NO) through the loss of oxygen [20]. NO is affecting some physiological processes related to exercise (i.e., regulating blood flow and producing muscle strength) [21]. NO can stimulate the conversion of cyclic guanosine monophosphate (cGMP) that resulting in dilating blood vessels [21], so the amount of blood flow to the muscle tissues increases [22]. Furthermore, the increase of cGMP increases the rate of contraction of muscle fibers and thus may affect maximal strength [21].

The increased NO in blood after drinking BRJ may support the improved type 2 skeletal muscle fiber contractile ability [16] and improved calcium (Ca^{2+}) handling 23, decrease ATP cost of force production [23]. Bender *et al.* [24] found an increased maximal strength in the mid-tight pull. Coggan *et al.* [25] found increased strength in isokinetic dynamometry. Rodríguez-Fernández *et al.* [26] reported that BRJ increased eccentric contractions besides concentric contractions.

The isokinetic dynamometer has high reliability and can measure peak torque at different velocities and throughout the complete range of motion [27–29]. Given that isokinetic dynamometer has been shown as a gold standard strength assessment method [30, 31], isokinetic dynamometry was used in this study. There are studies on the effects of BRJ on the isokinetic strength of the knee [23, 25, 32–40]. The BRJ supplementation effect on isokinetic strength is not well established for the upper and lower body together. However, there are no studies on Greco-Roman wrestlers' upper and lower body isokinetic strength does not exist. Thus, the present study aims to examine the effects of acute BRJ supplementation on upper and lower isokinetic strength parameters in trained Greco-Roman wrestlers.

2. Materials and methods

2.1 Participants

Eight Greco-Roman wrestlers from Konya Selcuklu Municipality wrestling club (age 21.87 $\pm$ 2.3 years; height 176.87 cm $\pm$ 4.1 cm; body weight 76.75 kg $\pm$ 5.4 kg), regularly trained 3 days, volunteered for this study. All participants met the inclusion criteria: being a trained Greco-Roman wrestler, not having injurie or sickness, not taking any other nutritional supplements, and not smoking tobacco in the past six months (Table 1).

Participants were informed about the risks of the study. All participants provided written informed consent. The study was approved by the local ethics committee (Protocol number 79, 19.10.2020, Ethics Committee of Selcuk University, Faculty of Sports Science, Konya, Turkey).

2.2 Experimental design

Participants were asked not to participate in any exercise 24 hours before the testing session and were randomly administered BRJ or placebo (PLA) supplements (four participants in each group). The investigators were not aware of the supplement provided to the participants once provided as the study design was double-blind. Participants waited for 150 min (for peak ergogenic effect) in a lying-down position [41].

Five min standardized warm-up protocol was performed on a cycle ergometer at a rate of 60–70 rpm before isokinetic strength testing. The second trial was conducted with the same frame, with the participants consuming the opposite supplement from the first session. Between the first and second trials, five days waited for washout [42]. Each participant randomly consumed beetroot juice from 2 mL $\times$ 70 mL shots (Beet it, James White Drinks Ltd., Ipswich, UK) or placebo (placebo was made of cherry juice (Cappy, Coca-Cola Company, Istanbul, Turkey)) [43].

Participants consumed a standardized diet (55% carbohydrates, 25% lipids, and 20% protein) 24 hours before both trials. Participants avoid brushing their teeth, using mouthwash or chew gum because of interfering with the effects of BRJ [43]. At last, participants did not eat or drink any foods or drinks that include alcohol, caffeine, or NO^{3-} because of the stimulant effects 24 hours prior to testing [44].

2.2.1 Anthropometric measurements

The weight and height of each participant was measured. Body weight was recorded to the nearest 100 g using with scale (Tanita 401 A, Tokyo, Japan) each participant wearing light clothing and no footwear. Height was measured with stadiometer (Holtain Ltd., Crosswell, UK) the nearest $\pm$1 mm [45].

2.2.2 Isokinetic strength measurement

The isokinetic strength measurements of the knee were performed by an isokinetic dynamometer (Cybex NORM®, Humac, CA, USA) in the kinatropometry laboratory of Selcuk University. Participants were seated in the correct position in the test seat. The participants' holders and the middle sections of the thighs were stabilized to the seat by the tapes. In addition, they were allowed to brace for support by holding the handles on the right and left sides of the seat during the test. The participants were instructed to complete a ROM from 90° to 10°. The point of the beginning was 90° of flexion, then moving into extension.

Each participant was given a familiarization at 60° sec^{-1} for five repetitions [46]. When the familiarization was done,

TABLE 1. Participants Characteristics.

	N	Min	Max	Mean	Std. dev.
Age	8	20.00	25.00	21.87	2.3
Height	8	171.00	181.00	176.87	4.1
Body Weight	8	71.00	84.00	76.75	5.4

TABLE 2. Comparison of BRJ and PLA Supplementations' Peak Torque.

Parameters	Supplementations	Mean (Newton meter)	Std. Deviation	Confidence Interval		*P*
				Lower	Upper	
Extension peak	BRJ	244.25	44.88	−6.54	38.29	0.138
	PLA	228.37	46.46			
Flexion peak	BRJ	141.12	31.25	−12.30	30.55	0.347
	PLA	132.00	25.13			
Internal peak	BRJ	67.37	13.75	0.08	17.41	0.048*
	PLA	58.62	6.41			
External peak	BRJ	47.50	5.63	0.95	9.79	0.024*
	PLA	42.12	4.70			

BRJ, Beetroot juice; PLA, Placebo. * Significant differences ($P < 0.05$).

each participant had a 2 min rest. After the rest period, each participant was asked to perform five repetitions as hard and fast as possible he could at a speed of 60° sec^{-1}. The test for the dominant leg was performed, then each participant was given a 5 min rest, and the shoulder internal and external test started.

Dominant shoulder internal and external rotation strength was obtained from the participants in a standing position, with the elbow flexed at 90°. To measure the muscle strength of the shoulder internal and external, the peak torque (Nm) done with five repetitions at a velocity of 60° sec^{-1} was determined.

2.3 Statistical analysis

The Shapiro-Wilk test is used to check a data set for normality to make parametric tests applicable. Performance data from the isokinetic strength measurement were analyzed with the paired sample *T*-test (BRJ vs. PLA). Cohen's d effect sizes (d $\leq$ 0.2, small; 0.5–0.79, moderate; $\geq$0.8, large) [47] were calculated to assess the magnitude of difference between experimental trials. All statistical tests were performed using the software package SPSS version 24.0 (SPSS Inc., Chicago, IL, USA). An alpha value of $<$0.05 was considered to be statistically significant.

3. Results

Peak torque data are shown in Table 2. As intended, BRJ supplementation improved muscle contractile function. Peak torque of knee extension and flexion improved with BRJ ingestion but not statistically. Shoulder internal (P = 0.048) (ES = 0.84) and external peak torque (P = 0.024) (ES = 1.01) increased significantly in favor of BRJ (large effect size).

Average torque data are shown in Table 3. Average knee strength significantly increased in BRJ trial (extension P = 0.023 (ES = 1.02) and flexion P = 0.027 (ES = 0.98)). In addition, shoulder internal (P = 0.023) (ES = 1.02) and external average torque (P = 0.021) (ES = 1.04) increased significantly in favor of BRJ.

4. Discussion

This study examined the effects of BRJ supplementation on isokinetic strength in trained wrestlers of the upper and lower body. The isokinetic knee extension (P = 0.13) and flexion (P = 0.34) strength of the wrestlers did not change significantly in both trials, but average strength increased in the BRJ trial than the PLA trial (extension 9.57% and flexion 12.94%). Furthermore, the peak isokinetic strength of the shoulder increased in favor of the BRJ trial (internal 15.06% and external torque 13.39%). The average isokinetic shoulder internal (19.61%) and external (12.81%) strength of the wrestlers improved significantly.

The supplementation of BRJ increases NO availability in metabolism [37]. Literature shows that NO affects contractile properties in animals, also in human muscle [23–25, 33, 37, 48]. However, the present study found no significant increased knee isokinetic strength in both extension and flexion parameters at 60° sec^{-1} (slow angular velocity), consistent with Jonvik *et al.* [21] and Kokkinoplitis *et al.*'s findings [39]. In addition, studies showed that peak isokinetic strength of the knee values performed at 90° sec^{-1} angular velocity (moderate angular velocity) was not significantly affected by NO^{-3} supplementation [25, 37, 40]. Inconsistent with the present study, Jonvik *et al.* [21] found significant improvement in knee flexion at 60° sec^{-1} angular velocity, but their participants were formed by recreationally active individuals. Individuals with more training benefit less from NO^{-3} supplementation [41, 49], which could be the underlying reason why isokinetic leg flexor peak strength was not significant in our study. In this study, BRJ supplementation did not significantly affect the peak isokinetic strength of the lower body but increased the peak isokinetic strength of the upper body significantly. NO^{3-} can be more effective at

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TABLE 3. Comparison of BRJ and PLA Supplementations' Average Torque.

Parameters	Supplementations	Mean (Watts)	Std. Deviation	Confidence Interval		*P*
				Lower	Upper	
Extension average	BRJ	170.50	25.57	2.64	25.60	0.023*
	PLA	156.37	25.98			
Flexion average	BRJ	107.75	18.69	1.95	23.79	0.027*
	PLA	94.87	16.03			
Internal average	BRJ	55.12	11.60	1.69	16.55	0.023*
	PLA	46.00	5.23			
External average	BRJ	38.62	5.70	0.85	7.64	0.021*
	PLA	34.37	4.53			

* Significant differences ($P < 0.05$).

type 2 muscle fiber contraction [50]. Horswill *et al.* [51] reported that Greco-Roman wrestlers could generate more anaerobic power by the upper body than lower due to type II muscle fiber distribution. It can be hypothesized that type 2 muscle fiber distribution can be dominant in the shoulder muscle group than leg muscle, therefore, shoulder internal and external peak torque increased significantly in this study. To the author's knowledge, although there is no study on upper extremity and isokinetic BRJ-strength in the literature, Williams *et al.* [15] reported that bench press power positively increased. Similar to our findings obtained in this study, there are studies in the literature that emphasized that lower extremity average strength outputs improved after ingestion of BRJ [26, 35, 52]. BRJ supplementation reported declining the ATP cost of force production [21, 52]. Since local perfusion, fatigue resistance, increasing the intracellular release of calcium in the muscle and contractility of fast-twitch muscle fibers, in particular, can be improved by BRJ supplementation [53], the isokinetic strengths outputs were thought to increase in this study.

Due to the nature of wrestling, wrestlers should have advanced maximal strength, strength endurance, aerobic capacity and anaerobic power levels in addition to technical and tactical skills [1, 5]. To perform a proper technique during the wrestling match, it is often necessary to move with high maximal strength and be able to repeat that movement at the highest strength possible [1]. Furthermore, the wrestlers should maintain maximal strength when they eat less for rapidly losing weight because studies stated that the muscle strength [54] and power [55] of the wrestlers could be affected by the rapid weight loss [56]. Thus, increasing maximal strength and strength endurance with acute BRJ supplementation can help wrestler's performance in competition and training.

This study was conducted with limited resources, and it only provided insights into the strength of the lower and upper body of Greco-Roman wrestlers. Another limitation of the present study can be said as the number of participants was eight.

5. Conclusions

The data obtained by this study indicates that BRJ supplementation increased peak and average isokinetic strength of the lower and upper body of trained Greco-Roman wrestlers. These results suggest that beetroot juice can be used as an ergogenic aid before competition for increasing muscle strength performance in trained Greco-Roman wrestlers.

Ethics approval and consent to participate

The study was approved by the local ethics committee (Protocol number 79, 19.10. 2020, Ethics Committee of Selcuk University, Faculty of Sports Science, Konya, Turkey). Before the assessment, every participant received the same detailed information about the testing procedure. Every participant signed the informed consent.

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Conflict of interest

The author declares no conflict of interest.

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