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Original Article

A Pilot Study to Evaluate the Effect of Nitrate Supplements on Anaerobic Performance in Young Elite Sportsmen

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ABSTRACT

The role of dietary Nitrates on exercise performance, both aerobic and anaerobic on trained/untrained individuals has been the topic of research for last few years in the world of exercise physiology. A few prominent studies have shown significant effect on enhancing performance while others have reported no such effect. In this study we tried to find the effect of nitrate supplements specifically on anaerobic performance in elite sportsmen using Wingate Test for Upper Body and Lower Body. The results show there was no significant change in anaerobic performance as a result of short duration nitrate supplementation.

Key Words: *Nitrate, Wingate Test, Anaerobic Performance*

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INTRODUCTION:

Anaerobic performance is defined as the work capacity or sports performance during maximal exercise lasting from about 10 s (e.g., 25 m sprint swim, 100 m sprint run) to approximately 100 s (e.g., 100 m sprint swim, 400 m sprint run) [1]. The anaerobic performance is an important criterion for improving performance in sports where short-term explosive efforts are required. Performing at a higher intensity in a short duration of time challenges the body energetics [2]. At these times, it is the anaerobic power that will determine the outcome of explosive efforts. Explosive efforts require increased demand of energy which can be gained from anaerobic performance. To assess this anaerobic performance the Wingate anaerobic test is commonly used.

Anaerobic performance isan important motor quality for any sports. There are several modifiable and non-modifiable factors which determine improvement of anaerobic performance. Out of which, use of nutritional supplementation is one vital factor to improve Anaerobic performance. "Supplements containing nitrates are considered to improve the anaerobic performance"[3]. Nitrate containing supplements can be taken through beetroot juice or through extracted powder form. Nitric oxide production can be augmented by ingestion of foods containing nitrate, a precursor for nitrite, which is ultimately reduced to nitric oxide [4]. This Nitric Oxide (NO) is Later absorbed along with the nonreduced nitrite in the gut passing into the bloodstream where blood NO and NO2 concentrations rise[5]. Nitric oxide is a signalling molecule which contributes to numerous physiological functions including mitochondrial respiration and biogenesis, vasodilation, muscle glucose uptake, angiogenesis, and sarcoplasmic reticulum calcium handling[6]. Hence, in endurance exercise modalities, BJ(Beetroot Juice) supplementation has been reported to reduce VO2 at work rates equivalent to the ventilatory threshold (VT)[7]. Similarly,numerous studies analysed the effect of nitrate supplements on anaerobic performance. The results are still inconclusive from the previous studies.So we endeavour to evaluate the effect of nitrate supplementation on anaerobic performance in young elite sportsmen.

Materials and Methods

The study was carried out in a reputed sports institute. A Total of 10 physically activeyoung elite sportsmen were included in the study. All participants were taken from the Tertiary sports institute. Cross sectional study was conducted on 10 participants. Out of 10 participants, 5 were randomly selected for nitrate supplements containing juice& remaining 5 participants were given cocam juice. Cocam juiceacted here as a placebo. For the study, the subjects were selected as per following inclusion and exclusion criteria. Inclusion criteria included physically active sportsmen who were involved inminimum 6 months of regular training. Exclusion criteria included any history of hospitalization or not practicing for

more than 2 weeks in last 3 months due to any reason viz. acute illness/ musculoskeletal injuries. Subjects were briefed before the study.

Study Design:

On testing day subjects' characteristics were measured according to International standard for anthropometric assessment committee (ISAAC) guidelines[8,9]. After the measurement of body parameter, Wingate testwas conducted on day 1 and day 7. Baseline value for anaerobic performance was measured using upper body and lower body Wingate test. Following baseline test both test subject and control subject were given nitrate containing supplements juice and cocam juice respectively for 6 days. Both drinks were supplied in an unlabelled 100 ml glass. Nitrate juice was prepared using nitrate supplements. Each sachet contained 7.5 mmol of nitrate. Placebo was prepared by cocam juice which has no nitrate content.

Wingate test for upper body and lower body consist of warm up, test procedure and cool down. 5 mins to 10 mins of intermittent warm up was given to subjects. The warm up was done on Monarklower body cycle ergometer to promote more specific physiological and motor adaptation. During the warm up 2-3 times submaximal load was given until the heart rate of 130-150 beats/min was attained[10]. After 3 mins of rest, test procedure for lower body Wingate test was started with the command START. Predetermined load i.e. 0.75gm/Kg was applied during the test[11]. For upper body Predetermined load i.e. 0.50 gm/Kg was applied during the test[12]. If subject failed to complete the test, the test was repeated. Indices measured included Peak power and Mean power, these were expressed in absolute value and relative value.

Statistical analysis: The collected data was subjected to statistical analysis using SPSS version 20.0. for Windows (SPSS Inc., Chicago, IL). Values were expressed in mean and standard deviation. Between the groups comparisons were made using unpaired t test, statistical significance was set at $p \leq 0.05$.

Results and Discussion:

Characteristic of the participants is shown in Table 1. There was no statistically significant difference in anthropometrical and physical characteristics of the athletes. Wingate test results for upper body and lower body are presented in table 2 and 3. Result indicate that there is no significant difference after intervention. Statistical analysis was done using Unpaired Student t test. Level of significance as $p \leq 0.05$.

Table 1: Subject characteristics in Mean ± SD

Data	Test Mean (SD)	placeboMean (SD)	P value
N	5	5	
Age (in Years)	22.1 (2.7)	21.4(2.4)	0.7
Weight (in Kg)	62.8 (4.87)	65(5.96)	0.5
Height (in Cm)	167.80 (6.72)	171.80(5.12)	0.3

Statistical analysis was done using Unpaired Student t test. Level of significance as $p \leq 0.05$

Table 2: Upper body (UB) Wingate test result in intervention group and control group before and after intervention.

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	Pvalue
						Lower Bound	Upper Bound			
UB Wingate Test Peak Power	Intervention	5	540.80	91.527	40.932	427.15	654.45	398	620	.917
	Control	5	551.80	177.130	79.215	331.86	771.74	269	755	

	Total	10	546.30	133.046	42.073	451.12	641.48	269	755	
UBWingate Test Peak Power afterNitrate supplement	Intervention	5	528.80	33.417	14.945	487.31	570.29	501	582	.221
	Control	4	570.75	156.509	78.254	321.71	819.79	344	687	
	Total	9	547.44	101.157	33.719	469.69	625.20	344	687	
UBWingate Test Peak Power Per Kg	Intervention	5	8.60	1.342	.600	6.93	10.27	7	10	.750
	Control	5	8.60	2.191	.980	5.88	11.32	5	11	
	Total	10	8.60	1.713	.542	7.37	9.83	5	11	
UB Wingate Test Peak Power Per Kg_After Nitrate Supplement	Intervention	5	8.20	.837	.374	7.16	9.24	7	9	.315
	Control	4	8.75	1.893	.946	5.74	11.76	6	10	
	Total	9	8.44	1.333	.444	7.42	9.47	6	10	
UB Wingate Test Average Power	Intervention	5	343.40	37.733	16.875	296.55	390.25	278	368	.465
	Control	5	366.40	121.348	54.268	215.73	517.07	183	476	
	Total	10	354.90	85.582	27.063	293.68	416.12	183	476	
UBWingate Test Average Power_After Nitrate Supplement	Intervention	5	352.00	24.010	10.738	322.19	381.81	317	375	.221
	Control	4	384.00	98.482	49.241	227.29	540.71	240	454	
	Total	9	366.22	64.882	21.627	316.35	416.10	240	454	
UBWingate Test Avarage Power Per Kg	Intervention	5	5.40	.548	.245	4.72	6.08	5	6	.511
	Control	5	5.60	1.673	.748	3.52	7.68	3	7	
	Total	10	5.50	1.179	.373	4.66	6.34	3	7	
UB Wingate Test Avarage Power Per Kg_afterNitrate supplement	Intervention	5	5.80	.447	.200	5.24	6.36	5	6	.771
	Control	4	5.75	1.258	.629	3.75	7.75	4	7	
	Total	9	5.78	.833	.278	5.14	6.42	4	7	

Table3: Lower body (LB) Wingate test result in intervention group and control group before and after intervention.

			Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	Pvalue
						Lower Bound	Upper Bound			
LBWingate Test Peak Power	Intervention	5	641.00	102.211	45.710	514.09	767.91	460	708	.175
	Control	5	621.60	46.096	20.615	564.36	678.84	551	675	
	Total	10	631.30	75.445	23.858	577.33	685.27	460	708	
LBWingate Test Peak Power_afterNitrate Supplement	Intervention	5	655.20	30.597	13.684	617.21	693.19	627	688	.806
	Control	4	647.75	96.938	48.469	493.50	802.00	506	725	

	Total	9	651.89	63.304	21.101	603.23	700.55	506	725	
LBWingate Test Peak Power Per Kg	Intervention	5	9.80	1.095	.490	8.44	11.16	8	11	.478
	Control	5	9.60	.548	.245	8.92	10.28	9	10	
	Total	10	9.70	.823	.260	9.11	10.29	8	11	
LB Wingate Test Peak Power Per Kg_after Nitrate Supplement	Intervention	5	192.80	408.195	182.550	-314.04	699.64	9	923	.197
	Control	4	9.75	.500	.250	8.95	10.55	9	10	
	Total	9	111.44	304.334	101.445	-122.49	345.38	9	923	
LB Wingate Test Average Power	Intervention	5	483.60	58.526	26.174	410.93	556.27	379	513	.346
	Control	5	438.80	67.921	30.375	354.47	523.13	348	528	
	Total	10	461.20	64.266	20.323	415.23	507.17	348	528	
LB Wingate Test Average Power_After Nitrate Supplement	Intervention	5	499.60	15.534	6.947	480.31	518.89	482	517	.219
	Control	4	504.00	70.076	35.038	392.49	615.51	399	543	
	Total	9	501.56	44.357	14.786	467.46	535.65	399	543	
LBWingate TestAvarage Power Per Kg	Intervention	5	7.60	.548	.245	6.92	8.28	7	8	.699
	Control	5	7.60	.894	.400	6.49	8.71	6	8	
	Total	10	7.60	.699	.221	7.10	8.10	6	8	
LB Wingate Test Avarage Power Per Kg_after Nitrate Supplement	Intervention	5	7.40	.548	.245	6.72	8.08	7	8	.322
	Control	4	7.75	.500	.250	6.95	8.55	7	8	
	Total	9	7.56	.527	.176	7.15	7.96	7	8	

Statistical analysis was done using Unpaired Student t test. Level of significance as $p \leq 0.05$

DISCUSSION:

This cross-sectional study is to examine the efficacy of nitrate supplementation on anaerobic performance inyoung elite sportsmen. The result of our analysis shows that when compared with placebo group, nitrate supplementation did not significantly affect the anaerobic performance. However previous studies results shows nitrate supplementation increases anaerobic as well as aerobic performance [13,14,15].

The final outcome of the current study was that 6 days of nitrate supplementation does not enhance peak power and average power output in Wingate cycling test among trained active sportsmen when assessed 24 h following the final nitrate dose. Previous studies by Wilkersen et al, Wylieet el and Hoon et al have established that nitrate supplementation reduces the metabolic cost of exercise, and this effect is maintained 24 h following the final dose of a nitrate supplementation regimen [16]. However, in the same study whether this ergogenic effect is present following 24 h nitrate ingestion, or if this ergogenic effect translates to performance improvements in sport-specific tasks dependent on power has not been determined. The difference in result might be because in previous study population is well trained international athleteand mean body mass is significantly higher than our study population. Also, the dose used in our study varies from the previous study. In our study nitrate supplement content was 7.5 mmol per 100ml of juice, whereas in previous studies nitrate content was variable[17]. Coggan et el[18] reported enhanced peak power following acute nitrate supplementation. The study reported men and women have enhanced isokinetic knee extensor power 2 hrs following 140 mL of nitrate supplementation. Additionally, Rimer et al reported enhanced peak power in a Wingate test among endurance and power-trained athletes following the 140 mL beetroot juice dose [19]. This increased power in Wingate test might be due to increased production of skeletal muscle structural proteins involved in calcium handling. There have been reports that Beetroot Juice (BJ) reduces ATP demands during the exercise effort, manifesting as the reduced degradation of phosphocreatine (PCr) both in low and high intensity exercise. A diminished PCr cost during the

maximum intensity effort would delay the depletion of PCr reserves. Given the essential role of PCr in high intensity efforts, its delayed depletion during the Wingate test should help maintain greater power peaks during the first part of the test, thus explaining the significant improvement noted in average power 0–15 s (6.7%).Additionally, studies like Hernandezet el have indicated that nitrate supplementation causes increased production of mouse skeletal muscle structural proteins involved in calcium handling. But these changes may be maintained for a period of time following reduction in plasma nitrite post-supplementation [20]. Similarly Piknova et el study mentions that, skeletal muscle and/or other tissues may act as a reservoir for nitric oxide precursors like nitrate and nitrite, and storage of these products and thereby effect may be maintained ≥ 24 h[21].

There are number of limitations in this study. The most obvious is insufficient sample size. Although double blinded randomised placebo-controlled design is conducted, cross over between groups was not done.

CONCLUSIONS:

The above study shows that Nitrate Supplement did not significantly affect the anaerobic performance in young elite sportsmen.

Ethics approval and consent to participate: Ethics committee approval was taken from Internal Ethics Committee, Army Sports Institute, Ref no IEC/2022/005.

Data Availability: The data is available and can be assessed by contacting the authors.

Conflicts of Interest: The author(s) declare that there is no conflict of interest regarding the publication of this paper

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