Original article:

Dietary Nitrate Supplementation Enhances Maximal Oxygen Consumption of well-Trained Male Athletes

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Abstract

The purpose of the study was to find out the effect of dietary nitrate supplementation on maximal oxygen consumption of well - trained male athletes. Fifteen well - trained male athletes; 18 to 28 years of age were selected for the study. Experimental and control groups were made consisting of males players. In this study beetroot supplementation was considered as independent variables and athletes' performance of maximal oxygen consumption was considered as dependent variable. Maximal oxygen consumption performance was measured with help of 12 min run and walk test. In order to find out the effect of beetroot supplementation on a maximal oxygen consumption performance, descriptive statistics and analysis of covariance (ANCOVA) was used. The level of significance was set at 0.05 levels. In this study, dietary nitrate supplementation in a form of beetroot juice (250 ml/day for two weeks) was given to the subjects of experimental group only in afternoon. The result of the study showed that there was a significant effect of dietary nitrate supplementation on maximal oxygen consumption of well - trained male athletes.

Key words: dietary nitrate supplementation, nitrate, nitrite, maximal oxygen consumption.

Introduction

Food supplements play a vital role in enhancing athletic performance. Athletic performance is being influenced by a number of factors, nutrition is an important factor which should be taken care of by athletes and sports personnel, they should explore the possibility of maximum advantage that can be gained by the same. Beetroot juice supplement had shown beneficial in the improvement of the performances of the endurance athletes. Effect of beetroot juice can be observed within an hour and remains active for days. Consumption of beetroot in any form has no side effects but have a number of benefits like increased movement efficiency with nonoxidative energy production, increased anaerobic threshold, increased dilation of blood vessel. Beetroot supplementation helps in reducing the energy cost of activity thus, leads to improved economy of movement. Improved movement economy is very vital for performance of long distance events where storage of glycogen is an important factor whereas increased anaerobic threshold helps short distance runners.

In aerobic activities which last longer than seconds or minutes, majority of the oxygen consumed is converted in to water but for 4 percent. A few oxygen molecules become free radicals, i.e. oxidants. These free radicals have to be neutralized by anti oxidant to avoid damage of cell membranes and tissues. Beetroot juice has been shown to lower blood pressure and thus help prevent cardiovascular problems. Research published in the American Heart

Association journal Hypertension showed drinking 500 ml of beetroot juice led to a reduction in blood pressure within one hour. The reduction was more pronounced after three to four hours, and was measurable up to 24 hours after drinking the juice. The effect is attributed to the high nitrate content of the beetroot. The study correlated high nitrate concentrations in the blood following ingestion of the beetroot juice and the drop in blood pressure. Dietary nitrate, such as that found in the beetroot, is thought to be a source for the messenger nitric, which is used by the endothelium to signal smooth muscle, triggering it to relax. This induces vasodilation and increased blood. The changes from beetroot take effect in about 30 minutes, peak after 90 minutes, stay elevated for 6 hours and remain effective for at least 15 days. Taking beetroot juice daily will build up the effect over a 3 – 4 days then plateau.

Recent studies have demonstrated that chronic (3–15 d) and acute (single dose prior to exercise) protocols of beetroot juice intake are associated with a consistent enhancement of exercise economy (reduced oxygen cost of exercise). Evidence is also emerging that supplementation with beetroot juice prior to exercise can enhance exercise capacity and sports performance.

Beetroot supplementation has shown physiological effects and it has assumed that it can also lead to increased athletic performance by supporting cardio vascular system. Physical activity, athletic performance, and recovery from exercise are enhanced by optimal nutrition. Nutritional requirements should be take care by athlete and there should be appropriate selection of food and fluids, timing of intake, and supplement choices for optimal health and exercise performance. Training programs should also includes assessment of body composition, strategies for weight change, athletes' nutrient and fluid needs, special nutrient needs, the use of supplements and nutritional ergogenic aids. During times of high physical activity, energy and macronutrient needs have to be taken care off.

Methodology

Subjects

Fifteen well - trained male athletes of 18 to 28 years of age were selected for the present study. One experimental group consisting of 8 athletes and one control group consisting of 7 athletes were made.

Variables

In this study dietary nitrate supplementation in a form of beetroot juice was considered as independent variables and athletes' performance of maximal oxygen consumption was considered as dependent variable.

Statistical Analysis

In order to find out the effect of dietary nitrate supplementation on maximal oxygen consumption, descriptive statistics and analysis of covariance (ANCOVA) was used. The level of significance was set at 0.05 levels.

Treatment

In this study, dietary nitrate supplementation in a form of beetroot juice (250 ml/day) was given to the subjects of experimental group for 15 days to each subject in afternoon.

Results

Table – 1

Descriptive Statistics of Maximal Oxygen Consumption of Experimental Group and Control Group in Pre-Test and Post-Test of Male

Descriptive Statistics	**Different Groups**			
	Experimental Group		Control Group	
	Pre test	Post test	Pre test	Post test
Mean	63.97	66.35	65.0386	65.8743
Std. Error of Mean	.94266	. 85349	1.57701	1.38057
Std. Deviation	2.66624	2.41404	4.17236	3.65265
Variance	7.109	5.828	17.409	13.342
Skewness	-.043	-.062	-.394	.129
Std. Error of Skewness	.752	.752	.794	.794
Kurtosis	.273	.405	-1.802	-1.744
Std. Error of Kurtosis	1.481	1.481	1.587	1.587
Range	7.55	7.66	9.78	9.37
Minimum	59.97	62.24	59.45	61.37
Maximum	67.52	69.90	69.23	70.74
N	8	8	7	7

Table – 2

Analysis of Variance of Comparison of Means of Experimental Group and Control Group of Male in relation to Maximal Oxygen Consumption

		Sum of Squares	**df**	**Mean Square**	**f**	**Sig.**
Pre Test	Between Groups	4.233	1	4.233	.357	.561
	Within Groups	154.214	13	11.863		
Post Test	Between Groups	.840	1	.840	.090	.768
	Within Groups	1.132	13	.087		

Insignificant at .05 levels

f value required to be significant at 1, 13 df = 4.67

In relation to pre test, table – 2 revealed that the obtained ‘f’ value of 0. 357 was found to be insignificant at 0.05 level, since this value was found lower than the tabulated value 4.67 at 1, 13 df.

In relation to post test, insignificant difference was found among experimental and control group pertaining to **Maximal Oxygen Consumption**, since f value of 0. 090 was found insignificant at .05 levels.

Table – 3

Adjusted Post Test Means of Experimental Group and Control Group of Male in relation to Maximal Oxygen Consumption

Treatment Group	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Experimental	66.758[a]	.417	65.850	67.666
Control	65.407[a]	.446	64.436	66.379
a. Covariates appearing in the model are evaluated at the following values: pretest =64.4707.				

Adjusted means and standard error for the data on **Maximal Oxygen Consumption** of Experimental and Control Groups in Male during post testing had been shown in table – 3 and fig – 1. This indicated that the initial differences in the scores were compensated in the post-testing or the effect of covariate was eliminated in comparing the effectiveness of the treatment groups during post-testing.

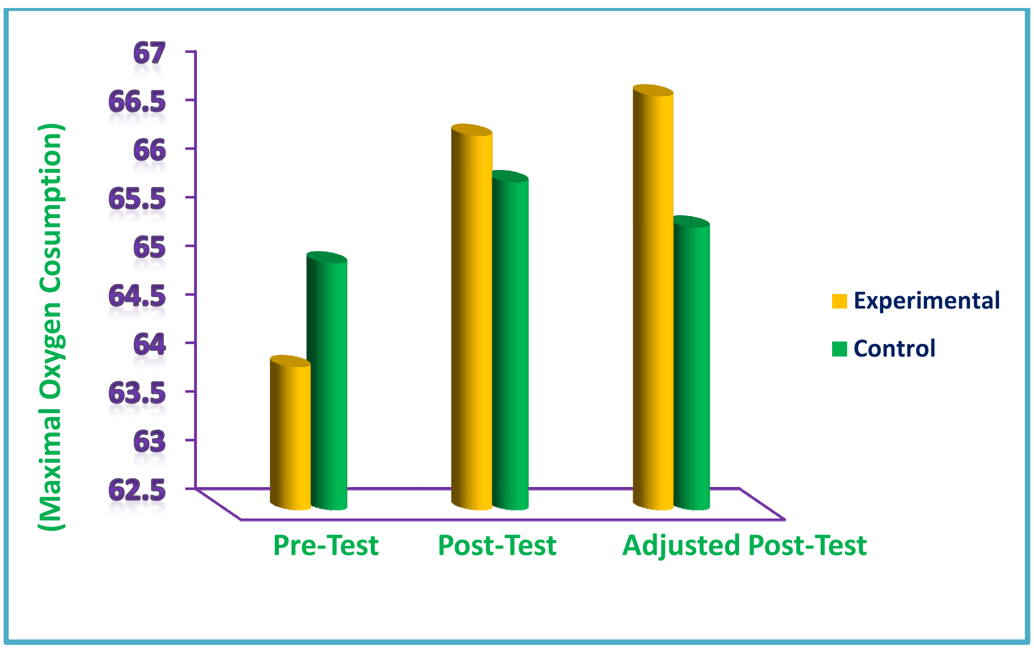

Fig 1: Graphical representation of Maximal Oxygen Consumption between pre and post test means among the Experimental and Control Groups of Male

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Table – 4

Analysis of Covariance of Comparison of Adjusted Post Test Means of Experimental Group and Control Group of Male in relation to Maximal Oxygen Consumption

Source	Sum of Squares	df	Mean Square	f	Sig.
Contrast	6.627	1	6.627	4.831*	.048
Error	16.461	12	1.372		

*Significant at .05 level

f value required to be significant at 1, 12 df = 4.75

Table – 4 revealed that the obtained ‘f’ value of 4.831 was found to be significant at 0.05 level, since this value was found higher than the tabulated value 4.75 at 1, 12 df.

Discussion of Findings

The result of the present study revealed that two weeks of dietary nitrate supplementation in a form of beetroot juice was proved to be effective (‘f’ value of 4.831, $p < .05$) in enhancing maximal oxygen consumption ($VO_{2\ max}$.) of experimental group. Dietary nitrate supplementation with beetroot juice reduced VO_2 during sub maximal exercise **(Lansey et. al. 2011)** and improved 10–km time–trial performance in trained cyclists **(Cermark et al. 2012)**. Improved endurance exercise performances have been reported by many researchers **(Bailey et al. 2009, Larsen et al. 2010, Bescos et al. 2011 and Lansey et al. 2011).**

A diet rich in vegetables and fruits has been found a beneficial impact on several body functions. These effects may be attributing to the high inorganic nitrate (NO3-) content of vegetables, particularly leafy greens and beetroot. NO3 can be reduced to nitrite and converted to nitric oxide (NO), which affects hemodynamics and muscles metabolic functions. However, evidence is emerging that dietary NO_3^- supplementation may also positively impact the physiological responses to exercise. In detail, it has been found that beetroot juice can enhance NO production in the skeletal muscle, which leads to increased blood flow and improved muscle oxygen delivery. Therefore nitrate is considered as a key ingredient in reducing oxygen consumption.

Beetroot juice has been shown to help the body respond better to exercise, by balancing oxygen use and increasing stamina. Beetroot juice is one of the richest dietary sources of antioxidants and naturally occurring nitrates. Nitrates are compounds which improve blood flow throughout the body – including the brain, heart, and muscles. These natural nitrates increase a molecule in the blood vessels called nitric oxide, which helps open up the vessels and allows more oxygen flow as well as lower blood pressure. These results indicate that the positive effects of six days of BR supplementation on the physiological responses to exercise can be ascribed to the high nitrate content. (**Glaberson, 2010**).

Beetroot juice supplementation may positively affect performance of trained master swimmers. This beneficial effect results in a reduction of aerobic energy cost and increased workload at anaerobic threshold, whereas maximum oxygen uptake and maximum workload are not affected **(Pinna et al. 2014)**. Moreover, nitrate supplementation using 500 ml of beetroot juice for 6 days demonstrated a clear improvement in maximal repeated 6x500 m rowing ergometer bouts. Beetroot supplementation appears to provide greater benefit in the later stages of performance and improved rowing performance times in repeated high intensity efforts **(Bond et al. 2012)**. These results supports that the effects of dietary nitrate supplementation on the athletes' performance of maximal oxygen consumption can be ascribed to the high nitrate content.

Conclusion

Conclusively, result of the present study suggests that there was a significant effect of two weeks of dietary nitrate supplementation on maximal oxygen consumption of well-trained male athletes.

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