Original article:

A study of beet root derived dietary nitrate efficacy on performance of runners

Vungarala Satyanand[1*], Shaik MahaboobVali[3], B PhaniKrishna[2], Dhanalakshmi.Narayanasamy[1], N Lilly[1] Shaik.Mujeer[4], Shaik.Salma[1]

[1] Department of philosophy of Nature Cure, Narayana Yoga Naturopathy Medical College and Hospital, Nellore.

[2] Department of Cardiology, Narayana Medical College and Hospital, Nellore.

[3] Advanced Research Center, Narayana Medical College, Nellore.

[4] Physical Education trainer, ZRR ZPHS, Nellore.

Corresponding author: Dr Vungarala Satyanand

Abstract:

Increased plasma nitrate concentrations from dietary sources of nitrate have proven to benefit exercise performance. Beetroot (BR) contains relatively high levels of nitrate (NO3), which increases nitric oxide stores. This study investigated whether dietary nitrate supplementation, in the form of a BR juice, would improve running performance .Limited data are available regarding the effect of nitrate ingestion on athletic performance, and limited studies were investigated the potential ergogenic effects of a small-volume, concentrated dose of beetroot juice. In a randomized open design, 100 male healthy volunteers aged between 12-30 years are assigned to consume the 250 ml of Beetroot juice for three consecutive days up to 9 weeks period. Present study demonstrate that dietary NO3-, administered in the form of beetroot juice (250 ml/day for 9 weeks), decreases systolic blood pressure (SBP). These results may provide a mechanism by which nitrate exerts beneficial effects on muscle function with applications to sports performance and a potential therapeutic role in conditions with muscle weakness.

Keywords: Beetroot, Betaine, Nitrate, Blood Pressure, Runners.

INTRODUCTION:

Inorganic nitrate (NO3-) and nitrite (NO2-) are circulating oxidation products from endogenous nitric oxide (NO) production. Emerging data show that these anions can be recycled back to NO, thereby constituting a large pool of potential NO bioactivity, existing in parallel with the more classical L-arginine-NO synthase pathway.[1] Interestingly, this pool can be supplemented by the diet where green leafy vegetables such as spinach and beetroot are especially rich in inorganic nitrate. Numerous studies now show that administration of nitrate or nitrite has NO-like bioactivity in animals and humans including a reduction of blood pressure, protection against ischaemia-reperfusion injury, and modulation of mitochondrial function.[2] Beetroot is a rich source of both betaine and nitrate (NO_3^-) [3]. Betaine is a tri-methyl derivative of amino acid glycine. [4] Betaine supplementation promotes muscular endurance, strength and power [5].A study stated that after beetroot ingestion plasma nitrate level raises about 96%. [6] In another study it was proved that the dietary supplementations with inorganic nitrate in the form of beetroot juice (BR) reduces the O2 cost of sub maximal exercise and enhance the tolerance to high-intensity exercise [6]. Dietary nitrate converts into nitrite and nitric oxide, which induces vasodilatation, there by decreases blood pressure and O_2 consumption [7].NO is known to be an important endothelial relaxing factor, it acts as a secondary messenger in production of cyclic guanosine monophosphate, concluding in smooth muscle

relaxation [8].The formed NO directly inhibit cytochrome oxidase activity thereby reduces oxygen to water. NO increases the efficacy of mitochondrial oxidative phosphorylation and also P/O ratio (i.e., the amount of ATP formed per amount of oxygen consumed). Therefore the increased mitochondrial P/O ratio also reduces the Oxygen cost during exercise. Mechanically the NO decreases the appearance of ATP/ADP translocase, which is a protein complex in proton conductance. Therefore dietary nitrate shows the intense effect on the function of basal mitochondria. Similarly there is a chance that NO possibly will decrease the ATP cost of exercise and also decreases the Ca2+ from the sarcoplasmic reticulum. It protects the release of Ca2+ through the channels which is brought by the reactive oxygen species [9].Bailey et al shown that beet root also lowers systolic blood pressure by an average of 6 mm hg than placebo [6]. Recent study suggested that ingestion of concentrated dietary nitrate for 6 days reduces VO_2 during submaximal exercise and progresses 10-km time – trial performance in trained endurance cyclists [10]. Therefore nitrate is considered as a key ingredient in reducing both oxygen consumption and blood pressure. The aim of this study is to evaluate the efficacy of nitrate rich beetroot juice in the performance of runners.

METHOD: This open label randomized study with 100 healthy volunteers will be conducted at Narayana yoga naturopathy Medical college Hospital, Nellore, India. The study protocol will be executed after approval by the Institutional Ethical committee. Informed consent will be obtained from study participant's .The volunteers are familiar with the aims and objectives of the study. The inclusion criteria will be healthy volunteers aged between 12-30 Years, a body mass index (BMI) within normal limits .The volunteers are screened through taking a medical history and clinical examination. The exclusion criteria will be any history of any serious illness including infectious diseases on systemic medication and smoking. Volunteers will be explained about not to have alcohol, and any sort of addictions.

STUDY PROTOCOL: In this study 100 runners are selected as healthy volunteers among them 50 are grouped under subjects, 50 under controls. The subjects are assigned in an Open label randomized study for about 9 week's period. First day the subjects and controls were made to practice six minute walk test. Pulse rate, Blood Pressure, Speed, Time, Distance were measured. Only the subjects were instructed to consume the 250ml of Beetroot juice for three consecutive days while the controls were instructed not to consume beetroot juice. Fifth day once again the measurements were recorded. Throughout the study, volunteers were instructed to maintain their normal daily activities and food intake, i.e. subjects were instructed to minimize the consumption of nitrate- rich foods throughout the study period.

SAFETY EVALUATION: Any adverse events will be recorded at during the study period. The NO_3^- supplementation regimen employed in this study was well tolerated with no deleterious side effects. Subjects did, however, report beeturia (red urine) and red stools during beetroot consumption.

RESULTS:-

BLOOD PRESSURE: First day the subjects and controls were made to practice six minute walk test to warm up their physical fitness. Runners those present

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experimental group were instructed to consume the 250 ml of Beetroot juice for 9 weeks and the control group were not given any juice. All physiological parameters like pulse rate, Blood pressure, speed, time and distance were measured. After 9 weeks intake of Beetroot juice (250ml/day), the experimental subjects showed systolic blood pressure (SBP) of 113±1.4 mm of Hg (mean±S.D) and Control group showed systolic blood pressure (SBP) 123±1.6 mm of Hg. Whereas diastolic blood pressure (DBP) of experimental and control group subjects showed as 71±2.3and 73± 2.3. Therefore lower Systolic and diastolic blood pressure were observed in experimental group when compare with control subjects. Pulse rate of experimental group showed 76±8.0 beats/min (mean±S.D) and control group showed 78±8.8 beats/min. the mean pulse rate during the time trial does not showed any difference between treatments. (Table)

Table. blood pressure, speed, distance and Pulse rate comparison between control group & experiment group. Results expressed in mean ± Standard deviation.

VARIABLE	CONTROL GROUP	EXPERIMENT GROUP
SYSTOLIC BLOOD PRESSURE (SBP) mm Hg	123±1.6	121±1.4
DIASTOLIC BLOOD PRESSURE (DBP) mmHg	73±2.3	71±2.3
PULSE (beats/min)	78±8.8	76±8.8
DISTANCE (m)	410±78.7	464±114.7
SPEED (m/sec)	68±13.2	77±19.1

TIME-TRIAL PERFORMANCE: The experimental group covered distance 464±114.7 meters (mean±S.D) with speed of 77±19.1 (m/sec). Whereas the control subjects covered distance of 410±78.7 meters with speed of 68±13.2 (m/sec).The within-subject day to day variability in time trial performance was increased by intake of Beetroot juice (250 ml/day.) for 9 weeks.

Discussion: In the typical western diet, an individual will consume 1-2mmols of nitrate per day which will rapidly and completely be absorbed in the upper gastrointestinal tract; 60% of ingested nitrate is excreted in the urine within 48 h, with the fate of the remainder as yet unknown. The half-life of an oral dose of inorganic nitrate is surprisingly long, estimates ranging between 5 and 8 h. this is mainly because, although it readily passes through the glomerulus into the renal tubule, it is mostly reabsorbed by the proximal renal tubules. The administration of nitrite has been shown to produce vasodilatation in numerous physiologically distinct vascular beds including pulmonary, cerebral, and other vascular beds. Using an L-NAME- induced hypertensive rat model, tsuchiya et al. demonstrated the ability of dietary nitrite-derived NO to attenuate the ensuing hypertension and ameliorate the renal injury in rats treated with L-NAME for 8weeks.[11]Red beets are rich in betacyanins, while yellow beets contain high levels of betaxathins. Beets are a good source of the essential mineral potassium – vital for maintaining normal blood pressure – as well as calcium, magnesium, phosphorus and the antioxidant vitamins A and C. however, clinical research on beets' effects on patients with high blood pressure or

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cardiovascular conditions is lacking. Beets have been used for thousands of years as both a root vegetable and an herbal medicine. The ancient Romans, who considered beets an aphrodisiac, employed them to spark romance. Beets were also traditionally used to treat fever, constipation, bloating, gas and tumors. Present –day herbalists may advise beets to treat indigestion, lower blood pressure, prevent heart disease and help to fight cancer. In a study published in 2008 in "Hypertension," researchers explored the mechanism by which beet juice reduces blood pressure.[12] Nothing that beet juice also reduced platelet aggregation – or the tendency of platelets to stick together and form artery – narrowing plaque – the team endorsed beet juice as a natural and low cost approach for treating cardiovascular disease. In a randomized clinical study published in 2010 in "Hypertension," researchers confirmed that nitrates – administered to some subjects by way of 250ml of beet juice, administered to others in an inorganic form – were converted into nitrites by entero-salivary circulation, causing a decrease in blood pressure.[13] Nitrate is known as a potent vasodilator[14], and it is hypothesized that nitrite- induced vasodilatation may be responsible for the effect on blood pressure seen after exercise in the BR group. It is hypothesized that this vasodilatation results in improved blood flow to working muscles.[15] Significant changes in both systolic and diastolic blood pressure after nitrate supplementation have been observed in previous studies, even acute doses in the form of nitrate- rich BR juice.[12] Dietary NO3 (from green leafy vegetables and beetroot) is reduced to NO2 by nitrate reductase,[16] causing a sustained increase in circulating NO2 levels [17]. The precise mechanisms by which nitrate administration lowers blood pressure during running have not been clearly elucidated. Actually, a runner will typically have a lower pulse and blood pressure than someone who isn't as fit because a runner's body is able to work more efficiently. Normal blood pressure for a runner is around 110/75, compared to around 120/80 for a sedentary person. Blood pressure that is too low could cause dizziness or even nausea, but low blood pressure is much better than high blood pressure, which increases the risk of a heart attack. Previous studies have reported performance improvements after nitrate supplementation at submaximal workloads, constant-work-rate exercise[6], and in cycling time –trial performance[18]. The current study demonstrates that 9weeks of nitrate supplementation using concentrated beetroot juice (0.25L/day) the experimental subjects showed low systolic blood pressure (SBP) i.e. 113±1.4 mm of Hg. Whereas diastolic blood pressure (DBP) of experimental and control group subjects showed as 71±2.3 and 73±2.3 with in 9weeks duration supplementation of BR juice, variability observed in distance coverage day to day. The maximum distance coverage observed after 2 weeks supplementation of Br juice after that it shows the same distance up to 3rd week. Therefore lower systolic and diastolic blood pressure were observed in experimental group than compare with control subjects. Pulse rate of experimental group does not showed any difference between treatments. Therefore, lower systolic blood pressure in BR juice consumed runners might to be results in increased speed efficiency to cover maximum distance.

Conclusion: In conclusion, nitrate supplementation using 0.25 liter of BR juice for 9 weeks demonstrated a improvement in maximal running efficiency. BR supplementation appears to provide greater benefit in

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the running performance by lowering blood pressure. The BR juice was well tolerated by the subjects, and food based supplements with true ergogenic potential in as little as 9weeks are worthy of adoption into elite athletes' nutritional regimen. There is little to no risk of a positive result in a drug test, while elite athletes are fearful of, and BR juice adds additional vegetable serves to the diet. Although the physiological mechanisms behind the performance effects of BR juice are still unclear, the results of this study indicate that 0.25 liter of BR juice per day for 9weeks may result in improved performance, particularly in 500 meters efforts. Whether these results would be found in a competition setting or a race situation of 2,000m is yet to be established, but an improvement in training output may result in improved competition performance.

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