

## Effects of single dose of beta alanine on performance in weight lifters

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### Abstract

The aim of present study is to see the effects of single dose of beta alanine on performance in weight lifters. 20 male weight lifters (age 23.95±1.23 years) were selected based on inclusion and exclusion criteria. Subjects were randomly divided into two groups. After pretest measurements, group A (n=10) ingested beta alanine beverage and group B (n=10) consumed placebo drink (glucon D plain). One hour later, subjects performed pushups to fatigue and immediately, posttest measurements were documented. After a wash out period of one week, crossing over of subjects was done. Group A consumed placebo beverage while group B had beta alanine beverage and same procedure was performed. Pre and post measurement of blood lactate, vertical jump height (VJH) and VO<sub>2</sub> max was documented. Blood lactate values was significantly lower in beta alanine group 47.92% as compared to placebo 104.60% (p=0.0001). VJH was significantly higher in beta alanine group 6.30% as compared to placebo group 1.76% (p=0.0001). Reduction in VO<sub>2</sub>max in beta alanine group 16.91% was significantly lesser when compared with placebo 41.21% (p=0.0001). It was concluded that ingestion of single dose of beta alanine significantly improves performance in weight lifters.

**Keywords:** VO<sub>2</sub> max, fatigue, blood lactate threshold, physical work, work capacity.

### INTRODUCTION

Pre workout supplementation has become a fundamental component in nutrition programs and a growing interest in the sports nutrition industry (20). In the never-ending quest for improved athletic performance, persons interested in greater exercise prowess and physical appearance have ingested a variety of substances touted to act as ergogenic aids, sometimes to the point of an increased risk to their own health (1,15). Recent research indicates energy drinks are the most popular supplement, next to multivitamin in the young adult population (18-35). Many athletes believe supplementation prior to training will result in greater focus, quicker reaction time, and increase power. Performances in having claims of dietary supplement have not been fully addressed in the context of sport (18).

The category of sport supplements known as the "pre-workout" class appears to be stable in the regimen of many athletes, bodybuilders, and strength athletes in particular. These products typically contain a combination of several (30+) ingredients, and usually contain stimulants (e.g., caffeine), energy

producing agents (e.g., creatine), agents that acts as hydrogen ion buffers (e.g., beta-alanine), protein recovery nutrients (e.g., amino acids) antioxidants and nitric oxide precursors, (e.g., arginine) (24). Companies developing and selling such supplements boldly claim that a single dose use of the product will rapidly and dramatically increases circulating nitric oxide and result in an improvement in blood flow, muscle pump and exercise performance (12, 26, 8). Due to the well-defined role of beta alanine as a substrate of carnosine, (a major contributor to H<sup>+</sup> Buffering during high intensity exercise) beta alanine is a fast becoming a popular ergogenic aid among the athletes and fitness enthusiasts (2). Although the specific mechanism remains to be determined the ergogenicity of beta alanine has been most commonly attributed to an increased muscle buffering capacity (22).

The disparity in results from recent reviews clearly indicate the types of studies and exercise bouts previously employed have not allowed oral beta alanine supplementation to be optimally examined and utilized for its ergogenic properties (1,15,18,24,12). Beta alanine supplementation is a relatively recent

and growing area of research. It carries potential beneficial effects with high intensity exercise including anaerobic sprints and resistance training. Limited research has been done till now to see the ergogenic effect of single dose of beta alanine (28). Moreover, most of the studies claiming ergogenic effects of beta alanine, have used supplements with multiple ingredients thus, the effects of pure form has still not documented. Therefore, this study aims towards exploring the effects of single dose of pure form of beta alanine on performance in weight lifters.

## MATERIAL AND METHOD

Twenty male weight lifters (age  $23.95 \pm 1.23$  years) were selected based on inclusion (no abnormal findings in Electrocardiogram (ECG), Liver Function Tests (LFT) values within normal range, normal Hemogram) and exclusion criteria (any musculoskeletal, cardio-pulmonary, neurological complications and systemic disorders in past 6 months diagnosed by physicians, consumption of any pre-workout supplement in last 6 months, involvement in other heavy training workout). Subjects were randomly divided into group A (n=10) and group B (n=10). The study was approved by local ethical committee and a duly signed consent form was obtained from all the participants. Before commencement, a brief explanation about the procedure was given to all the subjects.

The subjects underwent LFT, ECG and complete blood hemogram to rule out any abnormality related to liver and blood.

### Testing for Blood Lactate

All the standard precautions were taken before taking blood sample. Pre test measurement of blood lactate were obtained and documented with the help of portable lactate analyzer (SensLab Lactate Scout<sup>+</sup>, Blood Lactate Meter, SN 0117602072) in millimoles/litre.

### Testing for Anaerobic Power

Testing for anaerobic power was done using vertical jump height. Prior to the vertical jump height, the subjects were lead through an 8-10 minute dynamic warm-up which consisted of squats, lunges, quad stretches. The subject chalked the end of his finger tips and stands side onto the wall, keeping both feet remaining on the ground, reached up as high as

possible with one hand and marked the wall with the tips of the fingers (M1). The subject from the static position jumps as high as possible and marked the wall with the chalk on fingers (M2). The therapist measured and record the distance between M1 and M2. The player repeated the test 3 times. The therapist recorded the best of the 3 distance in centimeters and used this value to assess the player's performance (10).

### Testing for Aerobic Power

Testing of aerobic power was done using Queen's College Step Test. Following 5-7 minutes warm up, subject undertook the step test, which was performed on a stool of 16.25 inches (41.3 cm) height for a total duration of 3 minute. The metronome was used to monitor the stepping cadence, which was set at 90 beats per minute (complete 24 bilateral steps) for males. After completion of test, the subjects remained standing while the carotid pulse was measured for 15 seconds, 5-20 seconds into recovery (11).

This 15 second pulse rate was converted into beats per minute and the following equation was used to predict the maximum oxygen uptake capacity:

$$PVO_2 \text{ max (ml/kg/min)} = 111.332 (0.426 \text{ pulse rate in beats/min})$$

The experimental group i.e. group A (n=10) ingested 200 ml GNC<sup>™</sup> beta alanine beverage (8 grams beta alanine, and filter water until complete 200 ml of solution) and control group i.e. group B (n=10) ingested placebo beverage (8 gram Glucon D plain, and filter water until complete 200 ml of solution). Both beverages were shaken until fully dissolved and served in disposable white plastic glasses. Subjects drank the beverages one hour before the testing work out. Subjects were instructed to report any possible side effects or discomfort to the researcher as well as their compliance with the performance of activities during the study.

### Testing Work Out

The testing workout involved standard pushups to fatigue test. Each participant performed standard push up positioning themselves with their hands directly under the shoulder, pointed forward, head up, back straight, using the toes as pivot point. The participant began in the down position, with elbows bent and the chest touching a 3.75 inch (9.5 cm/ plastic

cup, which was centered directly below the sternum. They then raised the upper body and straightened the arms without locking the elbows; then lowered back down to touch the cup with the chest. The up and down movement of the push up was coordinated by the beat of the metronome.

The metronome was set to 60 beats per minute, as this was found to be a reliable cadence, according to Kim et al (2002) and Kravitz et al (2003). With each beat, there was a movement, either an upward push of the body to straight arms or the lowering of the body to the point that the chest touched the plastic cup. This continued until fatigue, or the point at which the participant could no longer maintain the exercise cadence with metronome beat or proper form (13).

After the testing work out, post test measurements were taken to check the blood lactate, VO<sub>2</sub> max and vertical jump height. A wash out phase of one week was kept. After wash out period of one week, crossing over was done. Pre tests measurements were repeated before group A ingested with placebo beverage (8 grams Glucon D plain, and filter water until complete 200 ml of solution) and group B ingested with GNC™ beta alanine beverage (8 grams beta alanine, and filter water until complete 200 ml of solution). After one hour of the same, the testing workout and post test measurements were done.

**Data Analysis**

Statistical analysis was performed using SPSS 15.0 version software. Independent t test was used for between group analysis to find out the differences in lactate, vertical jump height (VJH) and VO<sub>2</sub> max. Level of significance was set at 0.05.

**RESULTS**

A total of 20 subjects were divided into two groups A (experimental group) and B (control group) participated in the study with their mean age (23.95±1.23), (23.95±1.23); height (170.15±4.68), 170.15±4.68); and weight (67.10±3.98), (67.10±3.98) respectively.

Baseline data: To analyze the difference between pre lactate, pre VJH and pre VO<sub>2</sub> max independent t-test was used. Results reflected insignificant difference between the two groups with pre lactate

(p=0.930), pre VJH (p=0.629) and pre VO<sub>2</sub> max (p=0.549; Table 1).

**Between group analysis**

The mean difference of lactate (gained scores) for group A (experimental group) and group B (control group) are (3.00±0.79) and (6.59±1.20) respectively (Table 2 and Figure 1).

Table 1. Representing pretest measurements of group A and group B (Mean ± SD).

Variables	Group A	Group B	P Value
Pre-Lactate	6.26 ± 1.65	6.30 ± 1.15	0.930
Pre-VJH	37.25 ± 2.31	36.85 ± 2.85	0.629
Pre-VO <sub>2</sub>	47.65 ± 5.36	48.58 ± 4.23	0.549

Table 2. Representing gained scores (pretest - posttest difference) of lactate (Mean ± SD).

	Group A	Group B	P value
Difference lactate	3.00 ± 0.79	6.59 ± 1.20	0.0001

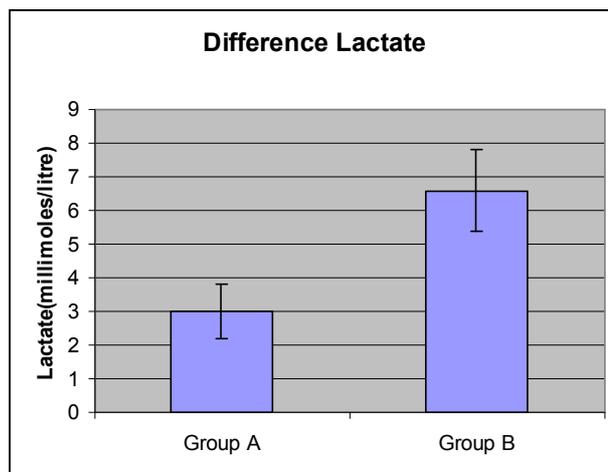


Figure 1. Representing gained scores (pre-test, post-test difference) of lactate.

The mean difference of VJH (gained scores) for group A (experimental group) and group B (control group) are (2.35±1.69) and (0.65±0.67) respectively (Table 3 and Figure 2).

Table 3. Representing gained scores of VJH (Mean ± SD).

	Group A	Group B	P value
Difference VJH	2.35 ± 1.69	0.65 ± 0.67	0.0001

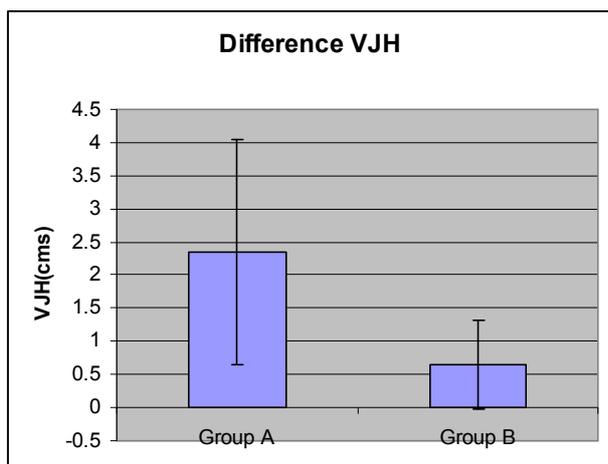


Figure 2. Representing gained scores of VJH.

The mean difference of VO<sub>2</sub> max (gained scores) for group A, (experimental group) and group B (control group) are (8.06±2.35) and (20.02±4.57) respectively (Table 4 and Figure 3).

Table 4. Representing gained scores of VO<sub>2</sub> max (Mean + SD).

	Group A	Group B	P value
Difference VO <sub>2</sub> max	8.06 ± 2.35	20.02 ± 4.57	0.0001

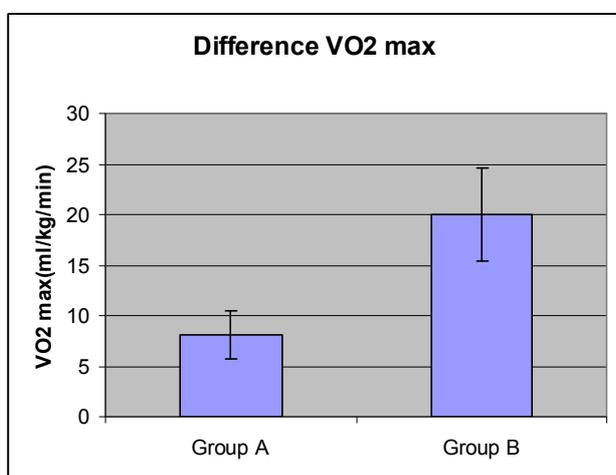


Figure 3. Representing gained scores of VO<sub>2</sub> max.

Significant differences were observed in levels of lactate, vertical jump height and VO<sub>2</sub> max in group A (experimental group) as compared with group B (control group).

## DISCUSSION

Results of present study indicate that beta alanine was effective in improving aerobic and anaerobic indices in weight lifters.

### Effect of Beta Alanine Supplementation on Lactate Kinetics and Anaerobic Performance

Previous studies have suggested that beta alanine may elevate muscle carnosine level, raised anaerobic thresholds and delayed fatigue with incremental exercise (29). Carnosine raises exercise performance via greater muscle buffer capacity, heightened Ca<sup>2+</sup> release, improved troponin C sensitivity for Ca<sup>2+</sup>, reduced reactive O<sub>2</sub> species accrual, and vasodilation. Beta-alanine appears to be efficacious for brief supramaximal exercise immediately preceded by a fatigue bout of physical activity. Such paradigms evoke sharp intracellular pH losses and thus may benefit from beta alanine supplementation (5,16,19,27,30).

Studies have documented that beta alanine supplementation permits higher work capacities and yield greater peak blood lactate concentrations, due to increased proton buffering. This theory concurs and is in contrast to text from prior reviews that examined the workload-lactate relationship. As assessed through blood lactate kinetics, higher intracellular lactate accrual should also result in a faster rate of entry into the vasculature. Thus, it may be hypothesized that beta-alanine supplementation will improve intracellular H<sup>+</sup> buffer capacity and permit greater exercise performance as higher amounts of lactate accrue within, and are removed from, the engaged musculature (1,9,23,24,31).

Moreover, literature also suggests that muscle acidosis is likely to contribute to the onset of fatigue during high-intensity exercise, increasing the muscle carnosine concentration would theoretically increase the intracellular buffering capacity, thereby potentially delaying the onset of fatigue. This provides the rationale for the ergogenic role of beta alanine supplementation on exercise that induces H<sup>+</sup> formation and muscle acidosis (6,7).

There are other proposed mechanisms by which beta-alanine supplementation can influence exercise performance, namely through acting as a sacrificial peptide to protect against glycation, acting as an anti-

oxidant and/ or increasing calcium sensitivity in contractile fibers (15,25).

Review of the past literature suggests that during moderate to high intensity exercise, hydrogen ions (H<sup>+</sup>) begin to accumulate leading to a drop in intramuscular pH and ultimately influencing muscle performance. The greater the reliance on glycolysis as the primary energy system (as seen with high-intensity exercise), the greater production of lactic acid and H<sup>+</sup>, thus leading to further decreases in intramuscular pH. This decrease in intramuscular pH has been suggested to be linked to fatigue-induced increases in muscle activation and electromyography (EMG) amplitude. Thus, if the intramuscular pH decline can be prevented or delayed, the fatigue induced EMG increase may also be delayed. Beta alanine supplementation has been shown to increase muscle carnosine levels, which can act as a buffer to reduce the acidity in the active muscles during high-intensity exercise. Beta alanine supplementation has been shown to have beneficial effects on exercise performance variables such as cycling capacity, ventilatory threshold, and time to exhaustion. For this reason, beta alanine has become a widely used nutritional supplement for improving high-intensity exercise performance (7,17,19,25,29).

Further it has been documented that carnosine is a pleiotropic molecule, with pH buffering capacity in muscle as only one of several possible other physiological functions. Carnosine can act as metal chelator, an anti-oxidant and an antiglycation agent. In skeletal muscle, where the majority of the body's carnosine is found, carnosine can act as a Ca<sup>++</sup> sensitizer for the sarcomeres and by this mechanism possibly protect against fatigue (6, 4).

Documented research findings support present study results which reflect that blood lactate increased (104.60%) in placebo group and (47.92%) in beta alanine group, which was significantly lower in beta alanine group as compared to placebo group. There is incremental increase of V<sub>JH</sub> in beta alanine group (6.30 %), which was found to be significantly higher when compared to placebo group (1.76%).

### **Effect of Beta Alanine Supplementation on Aerobic Performance**

The concept of physical working capacity (PWC), a measure of aerobic power, muscular endurance and

efficiency is typically measured by oxygen consumption rate (VO<sub>2</sub>) during a maximal graded exercise test (GXT). Several studies have reported the effect of beta alanine supplementation on PWC<sub>FT</sub>. It has been proposed that exercise-induced decrease in intramuscular pH may interfere with the excitation-contraction coupling process of skeletal muscle, which in turn, may lead to decrease in power output and fatigue. Maintaining intracellular pH during exercise could therefore be important for normal muscle function. In order to maintain pH homeostasis, various buffering systems are involved, including active H<sup>+</sup> export from the muscle. However, immediate line of defence remains the buffering of H<sup>+</sup> intracellular physio-chemical buffers, principally phosphates and carnosine (3,7).

Marsh et al demonstrated that there was a significant delay in the onset of intracellular acidosis during progressive exercise, resulting in increased capacity and submaximal work. Based on these results, it is not unreasonable to expect that introducing beta alanine supplementation have increased muscle carnosine levels, prior to starting an exercise programme, would lead to an improvement in quality of training (14).

Harris et al (2003) and Hill et al (2005) suggested that oral beta alanine supplementation improves exercise performance. The proposed physiological roles of carnosine in skeletal muscle are many and include pH buffering, functioning as an anti-oxidant, regulating muscle contractibility by exerting effects on Ca<sup>2+</sup> sensitivity and excitation contraction coupling inhibiting protein glycation and preventing formation of protein-protein cross links (27).

The greater reliance aerobic metabolism for energy has been further linked to an up-regulation of various glycolytic enzymes, beta alanine supplementation and high-intensity interval training (HIIT) as well as with increased mitochondrial density and improved blood flow due to increased capitalization. While a series of physiological adaptations are apparent, improvements in aerobic performance are also manifested in respiratory gas exchange (quantified by VT) (21).

VO<sub>2</sub> max decreased for beta alanine (16.91%), as well as for placebo group (41.21%) and the results reflected that the decrement of VO<sub>2</sub> max was

significantly lesser for beta alanine supplementation group as compared to placebo group.

In conclusion; it is concluded from present study that ingestion of single dose of beta alanine decreases fatigue and significantly improves aerobic and anaerobic performance in weight lifters.

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