PHYSICAL EDUCATION OF STUDENTS

The effect of 8 weeks beta-alanine supplementation and resistance training on maximal-intensity exercise performance adaptations in young males

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Abstract

Purpose: The aim of this study was to examine the effects of 8 weeks beta-alanine (BA) supplementation with resistance training on some components of physical fitness and body composition in young males.

Material: Twenty healthy young men volunteered to participate for the study and divided into two groups and performed 8-week resistance training while supplementing with either BA or placebo (4.8 g per day). The subjects were evaluated for 1 repetition maximum (1RM) bench press and leg press, vertical jump (VJ), anaerobic power (RAST) prior to and after training intervention. In addition, body composition variables such as percent body fat, and BMI were assessed per and post training period.

Results: Both the groups showed significant increases in 1RM bench press and leg press, VJ, and anaerobic power (RAST), and also the BA supplementation group showed greater gains compared with the placebo. In addition, percent body fat decreased significantly in BA and placebo groups, while no statistically significant changes were seen in BMI for the BA supplementation group and placebo group.

Conclusions: The results indicated that resistance training improved physical performance and BA supplementation induced greater gains and therefore it could be recommend to coaches and athletes who use this supplementation to greater gains in physical fitness variables.

Keywords: recovery, strength training, body composition, performance, alanine.

Introduction

β-alanine (BA) has been used as a nutritional supplement for enhancing recovery, and increasing power and aerobic performance [1]. It appears that supplementations with BA could results in reducing muscle fatigue and increasing in muscle buffering capacity [2-4]. Studies assessing the effects of BA in physically active individuals have mainly focused on verifying changes such as physical and neuromuscular performances [5, 6, 7]. BA 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 [8-10].

In the studies by Hill et al. [5] and Harris et al. [11], they demonstrated that one month of BA supplementation increased intramuscular levels of carnosine by approximately 60%. It has been suggested that carnosine serves as a buffer and helps maintain skeletal muscle acid-base homeostasis when a large quantity of His produced during high-intensity exercise [2, 12]. Harris et al. [11] demonstrated improvements in performance during a 4-minute maximal cycle ergometry test in men after supplementing with BA for 5 weeks. The authors concluded that the improvements may have been caused by an enhanced H buffering capacity as a result of increased muscle carnosine levels after BA supplementation. In theory, increasing skeletal muscle carnosine concentrations via BA supplementation will work to delay fatigue by decreasing intramuscular lactate accumulation, and buffering H during exercises [4]. However, no previous studies have examined the effects of long term BA supplementation during resistance training on maximal-intensity exercise performance tests in young males.

Although very few findings suggest that BA supplementation during training may enhances adaptive changes, the available scientific literature on BA supplementation in humans is still preliminary in nature and should be considered with reservation [13-15]. Also, the data about the influence of BA supplementation, particularly with resistance training, in younger males are still scarce in the literature regarding the effect of BA supplementation on these variables.

Therefore, the aim of the present study was to assess the effect of BA supplementation on body composition, muscular strength and, performance adaptations after 8 weeks resistance training in younger males. We hypothesized that BA supplementation will lead to greater adaptive responses than placebo groups in adaptive responses in maxima-intensity exercise performance tests and body composition.

Materials and Methods

Participants

The subjects were 20 healthy men who were familiar with resistance exercise and training volunteered to participate in this study. Subjects were randomly assigned to one of two training groups: BA plus resistance training group (BA; N = 10, age = 17.7 ± 1.0 y, height = 176.1 ± 6.1 cm, and body mass = 78.4 ± 1.3 kg) and (b) placebo

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plus resistance training group (PL; N = 10, age = 17.1 ± 0.6 y, height = 175.2 ± 4.3 cm, and body mass = 76.3 ± 2.2 kg). The subjects did not have medical or orthopedic problems that compromised their participation in this study. Each parent subject was informed of the risks and benefits of the study and subsequently signed an informed consent form in accordance with the guidelines of the university's Institutional Review Board.

Procedure

This study was designed to examine the effects of resistance training plus BA or PL supplementation on body composition and performance adaptations. Subjects in both groups were instructed on proper technique of training one week prior to initiation of study. The subjects subsequently underwent 8 weeks of training and were tested a week pre-and a week post-training for the variables.

The participant underwent 4 days of testing, namely 2 pre- (48 h apart between testing sessions) and 2 post-test day (48 h apart between testing sessions), respectively. A week before the initiation of training, each subject was familiarized with the training programs, and the demographic data were gathered and anthropometric measurements taken. The subjects were tested at the exact same time of day (2 to 4 P.M, post-test day) and same day of the week as the pre-test day to minimize the effect of circadian variations in the test results. All subjects had to continue with the normal daily life activity and dietary intake.

Measurements

Anthropometric measurements were done in light clothes before and after the training period. Height and weight were measured by an automatic height–weight scale, to the nearest 0.1 cm and 0.1 kg, respectively. BMI was calculated by dividing weight (kg) by the square of the height (m2). To estimate the amount of subcutaneous fat in the body, skinfold thickness was measured (Lafayette Caliper, model 01128, USA) at three sites (Chest, Abdomen and Quadriceps) in the right of body. Each measurement was performed in triplicate and the average was taken for analysis. All the measurements were made with the subject in standing position and body fat percent were estimated in accordance with Jackson and Pollack [16]. LBM was determined by subtracting the fat mass from weight.

The RAST test was used to measure subjects' anaerobic performance ability, maximum power. Subjects run 35-m intervals, six times, with 10 s of rest between each interval. Power was calculated as previously suggested [17].

In the vertical jump test (VJT), subjects performed three trials with 30-sec of rest in between each jump. The following procedure was used for each subject during data collection. Subjects stood directly under the Vertec, fully extending an arm to touch the highest vane possible while remaining flat-footed to establish standing reach height, which was recorded. Subjects were instructed to perform the highest jump vane possible. The difference between standing reach height and each vertical jump height was calculated and the highest jump was used in the data analysis [10].

A bilateral leg press test was selected to provide data on maximal strength through the full range of motion of the muscles involved. Maximal strength of the lower extremity muscles was assessed using concentric 1RM leg press action. Bilateral leg press tests were completed using standard leg press equipment, with the subjects assuming a sitting position and the weight sliding obliquely at 45°. On command, the subjects performed a concentric leg extension (as fast as possible) starting from the flexed position to reach the full extension against the resistance determined by the weight. Warm-up consisted of a set of 10 repetitions at loads of 40-60% of the perceived maximum [18].

For the bench press, each participant lowered the bar until contact with the chest was achieved and subsequently lifted the bar back to the fully extended elbow position. Any trials failing to meet the standardized technique criteria were discarded. A warm-up consisting of 5-10 repetitions with approximately 40-60% of perceived maximum was performed. The rest period between the actions was always 2 minutes. Subjects were allowed to perform maximum 8 repetitions during bench press and leg press, and were used equation of Brzycki [19]: estimated 1RM= weight (kg)/1.0278 – (repetitions x 0.0278) for determining of 1RM.

Training program

The resistance training programs included three days weekly (on Saturday, Monday and Wednesday) for 8 weeks. Each training session lasted 85-min, including 10-min warm-up (e.g., jogging, stretching and ballistic exercises), 70-min training, and 5-min cool-down (e.g., jogging and stretching exercises). The resistance training program stressed all major muscle groups and included the following exercises (or variations of) in each session: leg press, knee extension, knee flexion, lat pull-down, bench press, shoulder press, cable biceps curl and triceps push down 3 sets of 12 to 8 repetitions with 70 to 80 % of 1RM. Exercise volume and intensity progressed during the training program according to previous recommendations [18]. Two and three minutes of rest intervals were assigned between sets and exercises, respectively.

Supplementation

The BA supplementation consisted of 4.8 g (6 × 0.8 g each 2 h) of BA in the tablet form (GNC, USA) in each daily meal. Likewise, the subjects in PL group ingested 4.8 g of polydextrose [14].

Statistical Analysis

All data are presented as mean ± SD. The distribution of each variable was examined using the Shapiro-Wilk test. A two-way analysis of variance with repeated measures (2 [group] x 2 [time]) was used to determine significant differences between groups. A criterion α level of $P \leq 0.05$ was used to determine statistical significance. All statistical analyses were performed through the use of a statistical software package (SPSS®, Version 16.0, SPSS, Chicago, IL.(

Results

The results of this study are presented in Table 1.

There were significant improvements in the percent body fat, RAST test, VJT, 1RM bench press and 1RM leg press after 8 weeks resistance training for both the BA and PL groups ($P < 0.05$). In addition, the BA group indicated greater changes than PL group in RAST test, VJT, 1RM leg press and bench press after training intervention ($P < 0.05$).

Discussion

The present study investigated the effect of 8 weeks BA supplementation on body composition, muscular strength and power performance after resistance training. The results have shown that BA supplementation induced significant change in maximal-intensity exercise performance variables, including power performance and strength gains after 8 weeks resistance training and the changes in strength, and power were greater for the BA group compared to PL group. These results are in contrast with previous studies which found positive effects of BA supplementation for performance adaptations.

In body composition variables such as BMI and body fat, both the groups showed decrements in body fat, while the changes in BMI was not statistically significant for both the groups. Recent data suggests that BA supplementation does not improve superiorly fatty acid oxidation following resistance training. In line with our finding, Hill et al. [5] reported that 4 to 6.4 g per day BA supplementation did not induce greater fat oxidation than placebo groups after training.

Power is one of the most critical attributes underlying success in sport [20]. This variable is intimately related and allows athletes to be successful in their respective sport. In this study, both the groups showed meaningful gains in VJ and RAST test after 8 weeks training, while the BA group indicated more changes than PL group in power performance. In line with the present study, Kern et al. [10], suggest that changes in power following BA supplementation are optimized within the training

Table 1. Changes in anthropometric and performance variables in response to 8 weeks training intervention (mean ± SD).

Variables	BA (n = 10)	PL (n = 10)	Significance
Body fat (%)			
Pre	13.8±3.2	14.5±5.7	G=0.88
Post	12.3±4.5*	12.2±5.0*	T=0.03
			G×T=0.91
BMI (kg/m²)			
Pre	25.2±1.9	26.1±3.3	G=0.55
Post	25.7±1.5	26.4±3.2	T=0.51
			G×T=0.76
RAST (w)			
Pre	560±30.3	568.1±25.5	G=0.23
Post	581.1±17.1*, **	577 ±23.3*	T=0.001
			G×T=0.03
VJT (cm)			
Pre	36.4±2.9	37.1±2.2	G=0.12
Post	45.7±3.6*, **	41±2.2*	T=0.02
			G×T=0.02
1RM leg press (kg)			
Pre	180.7±39.1	177.1±45.8	G=0.23
Post	195.9±27.8*, **	191.8±37.2*	T=0.03
			G×T=0.03
1RM bench press (kg)			
Pre	56.8±17.4	54.2±10.5	G=0.16
Post	65.1±18.2*, **	61.2±12.7*	T=0.04
			G×T=0.048

*: denotes significant differences between baseline and post-training values ($p \le 0.05$); **: denotes significant differences between the BA and PL supplementation groups at post-training ($p \le 0.05$). G = group, T = time.

program. Moreover, other researchers found positive effects of BA supplementations for the power gains after training [1, 6, 9, 14]. The greater adaptive responses in power performance after BA supplementations could be due to increased fatigue-resistance during repetitions in each training sets, allowing greater training intensity and muscle workout during the latter part of resistance training sessions, decreasing H and blunting lactate production and maintain pH for better muscle contractile ability during resistance exercise [2, 8] and thus increasing chances for greater RAST and VJT-related performance adaptations, such as neuromuscular related explosive improvements; however, it only could be speculations and more studies are necessary.

Regarding to strength performance, the results of our study indicated that BA supplementation induced greater changes in 1RM leg press and bench press which is in line with previous findings that BA supplementation resulted in a significant greater strength gain after training [9, 12]. Luis et al. [15] reported that 4.6 g BA supplementation for one month induced greater gains in strength performance after resistance training. Typically, changes in strength are largely due to neurological adaptations early in practice (i.e., changes in motor unit recruitment, asynchronous to synchronous contractions, etc.) [18], while increases in lean muscle mass, which increases the capacity of the body to produce force, accounts for a greater percentage of strength gain later on. Currently, the ability of BA to increase strength has been attributed to the changes in muscle contractile ability and also buffering capacity during resistance training [21]. In fact, the ability of BA supplementation to enhance strength is generally thought to be related to an elevated muscle carnosine content [3]. As muscle carnosine stores increase fatigue rates during exercise are thought to decrease, providing the athlete with a higher quality workout [4]. It does appear that the addition of BA to resistance training regime provides an additive benefit in reducing fatigue rates during training sessions. Previous research has demonstrated that BA is involved with the synthesis of muscle carnosine, and that oral ingestion of BA may elevate muscle carnosine levels [11]. Carnosine, a histidine-containing dipeptide, is known to contribute to acid-base buffering in skeletal muscle [8]. Increasing muscle carnosine and also buffering capacity of muscles during training sessions from a nutritional supplement, such as BA, would likely provide a strength performance via increasing subject ability to with stand and maintain higher intensity workouts resulting in improved strength performance [6, 21].

Conclusions

In summary, the results of this eight-week study demonstrated the efficacy of BA supplementation on strength and power performance. The use of these supplements appears to provide greater changes compared with placebo supplementation. It could be concluded that eight weeks of BA supplementations induced meaningful increases in power and strength performance in young males.

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Conflict of interest

The authors declare no conflict of interest.

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