

Effects branched-chain amino acids supplementation on muscle soreness and total antioxidant capacity after a session of exhaustive strength exercise in male rock climbers

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ABSTRACT

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Background: The aim of this study was to investigate the effect of branched-chain amino acids (BCAA) supplementation on lactate dehydrogenase, creatine kinase and total antioxidant capacity after a session of exhaustive strength exercise.

Methods: Twenty four men rock climbers aged 27 to 37 from Tehran province were randomly assigned to two groups of 12 subjects (amino acids, placebo). Five ml of blood was taken from all subjects in three stages: 30 post-exercise hours post-exercise. The subjects participated in a session of intense physical activity (70% repetition maximum resistance movements) and then the supplementation group received BCAA at the rate 6 g per day for 14 days. The placebo group received Maltodextrin capsules during this time. A day after completing the course, the subjects were once again present in the same location as the one in the pre-test and post-test was performed on all subjects. An independent t test at $p < .05$ was conducted to analyze the data.

Results: The results showed that the use of BCAA has a significant impact on creatine kinase and lactate dehydrogenase before, immediately, and 24 hours post-exercise ($p > 0.05$), but it has no significant impact on total antioxidant capacity ($p < 0.05$).

Conclusion: According to the results, it can be said that BCAA may be useful in reducing the release of lactate dehydrogenase enzymes and creatine kinase.

Introduction

In the context of rock climbing, Strength exercise and the subsequent muscle soreness is an important issue affecting the performance of rock climbers? For using the least energy for the most power and balance, rock climbers always try to reduce muscle soreness. These two factors cause an improvement in climbers' performance (1).

Delayed onset muscle soreness is a condition

which occurs as people start a relatively intense exercise for the first time, or turn to an unusual activity. This condition is generally divided into two categories of acute and delayed (2). The acute soreness is temporary and is usually caused between a few minutes and a few hours post-exercise, and it is attributed to ischemia (inadequate blood flow to active muscles) and concentration of metabolic waste products. Delayed onset muscle soreness reaches its height about 24 to 48 hours post-exercise, and it fades away after five to seven days. Studies have indicated eccentric exercise to be the main cause of this condition. The symptoms of delayed onset muscle soreness include reduction in muscle

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strength, reduction in joint range of motion, muscle stiffness and fatigue, muscle pain, swelling and inflammation of the muscle (3).

Observations show that using BCAA during and after exercise has anti catabolic effects. BCAA have been suggested to hasten muscle repair after exercise (4). During exercise, BCAA may help increase muscle protein synthesis through regulation of leucine. In addition, it is possible that after exercise an increase in free amino acids occurs as a result of changes in the endocrine system, hence preventing muscle protein degradation (5).

Coomes et al. stated that using BCAA inhibits the increase in serum creatine kinase activity for a few days after exercise (4). Thomas et al. studied the effects of these amino acid on blood creatine kinase and lactate. Their study showed no difference in lactate levels two and six minutes after the test between the supplementation group and the placebo group (6).

Due to scarcity and contradictory results of studies on the effects of BCAA on muscle soreness and total antioxidant capacity after exhaustive strength exercise, conducting some precise and controlled studies in this field seems necessary. If the results of the present study confirm the beneficial effects of BCAA, consuming them could be suggested to rock climbers and athletes before and after exhaustive strength exercise in order to enhance and maintain their athletic performance through quick recovery and preventing fatigue.

The results of studies investigating the effect of BCAA on sports injuries are limited and vague. Therefore, the present study was designed to investigate the effects of BCAA on LDH, CK and total antioxidant capacity after a session of exhaustive strength exercise in men rock climbers.

Subjects and methods

This study was a quasi-experimental study. The subjects were 24 men rock climbers aged 27 to 37 from Tehran province with at least three years' experience in rock climbing. The subjects were randomly and systematically assigned to two groups of 12 (supplementation and placebo).

The subjects were evaluated by a questionnaire with regard to their general health, history of diseases, use of medicines, diet and daily physical activity. All the stages of the study were explained to the subjects. Then, the necessary coordination was done with the subjects for the next steps of the study after they

had filled out personal information and informed consent forms. The subjects were asked to stick to normal patterns of sleep (at least eight hours) and normal daily activities and diet (12 hours fasting before the test) during the study and avoid any intense physical activity, supplements, medicines, coffee, smoking and coco, which could affect their immune system, 48 hours before the test and until blood samples were taken.

The subjects were summoned to the gym a week before the beginning of the study. The correct way of lifting weights, proper breathing techniques and method of calculating one repetition maximum were explained to them. Leg Press, bending the knee, straightening the knee, chest press, seated underarm exercise and abs exercises performed by Italian techno gym machines were used to calculate one repetition maximum using the Brzycki equation:

One repetition maximum = $\text{Weight} \div (1.0278 - (0.0278 \times \text{Number of repetitions}))$

Some information including weight, height, gender, level of fitness (beginner, intermediate, professional) was given to the machine and it suggested a weight to lift. The subjects did 10 repetitions while looking at the monitor and the pointer to control the speed of the movement. If the subjects were successful in doing the movement, the machine chose a heavier weight after a two-minute resting time; this process continued until the subjects were not able to do ten repetitions correctly. Then, based on the formula above, the machine calculated the one repetition maximum (7).

One session of intense physical activity in this study included doing four sets of Leg Press, bending the knee, straightening the knee, chest press, seated underarm exercise and abs exercises for 10 reps at 70% of one repetition maximum. The resting time between sets was two minutes.

Five cc of blood was taken from the subjects in each of three stages: thirty minutes before (at rest condition and after 12 hours of fasting), immediately and 24 hours post-exercise. In the next stage and after three days of recovery, the subjects in the supplementation group received supplementation in the form of capsules for 14 days. This supplementation was taken after each meal in doses of 2 grams (6 grams per day). The placebo group received Maltodextrine capsules during this period. The subjects were asked to avoid receiving other supplements during this period. One day after the end of the supplementation, the subjects were post tested under the same conditions as those of the pretest.

Table 1. Characteristics of participants

Group	Age	Height	Weight	Sports Background	BMI
	(year)	(CM)	(KG)	(year)	(kg/m ²)
Amino acids	30.14±3.27	181.28±5.80	78.19±4.32	1.20±6.46	2.71±23.19
Placebo	4.55±31.29	6.19±182.55	4.68±80.44	1.42±6.51	2.60±23.45

One-way analysis of variance was used to analyze the results and Tukey's post hoc test was used to detect the source of the difference. The statistical significance level was set at $\alpha = 0.05$. All statistical analyses were performed using SPSS version 20.

Results

In Table 1 shows the information related to age, height, weight, sports background and BMI of the subjects.

Figure 1 shows changes in the average lactate dehydrogenase in both groups of the study at different stages of blood samples collection at pretest and posttest. The independent t test showed significant differences in lactate dehydrogenase of the subjects of both groups in different stages of blood samples collection (pre-exercise $p=0.002$, immediately post-exercise $p=0.001$, and 24 hours post-exercise $p=0.002$). In other words, receiving branched-chain amino acids had a meaningful effect on the decrease of lactate dehydrogenase pre-exercise, immediately, and 24 hours post-exercise.

Figure 2 shows changes in the average creatine kinase in both groups of the study at different stages of blood samples collection at pretest and posttest. The independent t test showed significant differences in creatine kinase of the subjects of both groups in different stages of blood samples collection (pre-exercise $p=0.000$, immediately post-exercise $p=0.000$, and 24 hours post-exercise $p=0.001$). In other words, receiving branched-chain amino acids had a meaningful effect on the decrease of creatine kinase enzyme pre-exercise, immediately and 24 hours post-exercise.

Figure 3 shows changes in the average total antioxidant capacity in both groups of the study at different stages of blood samples collection at pretest and posttest. The independent t test showed no significant differences in total antioxidant capacity of the subjects of both groups in different stages of blood samples collection (pre-exercise $p=0.248$, immediately post-exercise $p=0.329$, and 24 hours post-exercise $p=0.119$). In other words, receiving branched-

chain amino acids had no meaningful effect on the total antioxidant capacity pre-exercise, immediately, and 24 hours post-exercise.

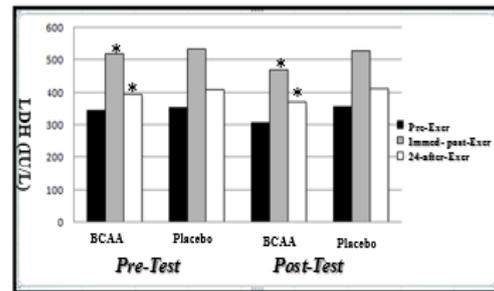


Figure 1. Changes in lactate dehydrogenase different stages of blood samples collection a pre-test and post-test, *P value < 0.05

Discussion

Creatine kinase and lactate dehydrogenase intracellular enzymes and total antioxidant capacity are biochemical markers of muscle damage. Intense contraction and tension of the muscles cause these enzymes to be released, which leads to muscle damage. The level of these enzymes changes easily under different conditions (length of exercise, intensity of exercise, style of exercise and temperature) (8).

Pain and muscle soreness could be the result of general inflammation during and after exercise. Following muscle fiber injury, toxic intracellular material is released and the increase in the sensitivity of pain receptors leads to muscle soreness (9). The edema resulting from injury and excitation of free nerve endings or release of inflammatory markers which stimulate pain receptors may all account for muscle soreness (10). Although the time period of changes in soreness witnessed in this study was similar to that of the previous studies (10, 11), the amount of muscle damage was less than that in the previous studies. The subjects of this study were athletic individuals. Several studies have shown that trained individuals experience less muscle destruction than the untrained ones. Although the clear reason has not been determined yet, it is supposed that stimulation of protein synthesis by

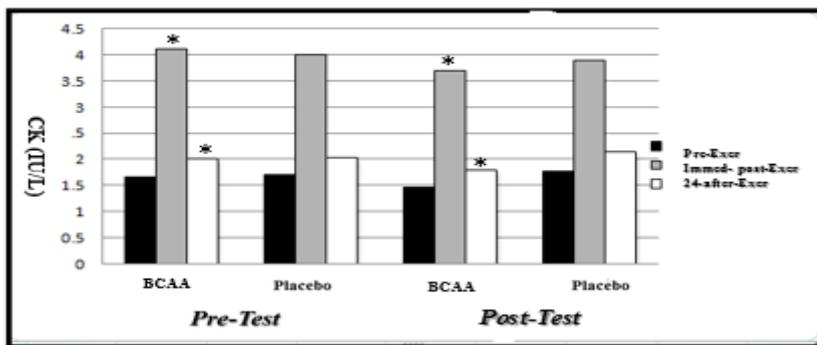


Figure 2. Changes in creatine kinase at different stages of blood samples collection at pretest and posttest *P value < 0.05

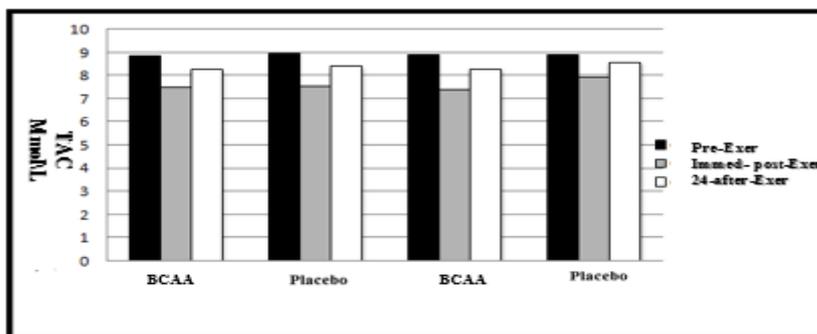


Figure 3. Changes in total antioxidant capacity at different stages of blood samples collection, *P value < 0.05.

leucine and prevention of exercise-induced protein degradation by amino acids may account for this (12). Muscle cell membrane or their complete degeneration allows the muscle enzymes to drain into the blood or lymphatic system (13). The results of the present study showed that receiving amino acids meaningfully affects creatine kinase and lactate dehydrogenase enzymes level before, and immediately, 24 hours after exhaustive strength exercise (p<0.05). The results of this part corroborate the findings of some studies (4, 12, 14, 15) and contradict the findings of some others (6, 10, 16, 17).

As an example, in corroboration with the present study, Coombes and Mc (2000) reported that lactate dehydrogenase concentration decreased in amino acids supplementation group compared with placebo group post-exercise (4). In contradiction with the findings of the present study, Gereer (2006) found no meaningful difference in lactate dehydrogenase levels between amino acids supplementation group and

placebo group (10). It is suggested that since the protocol intensity is one of the main factors in muscle destruction, difference in protocol intensity is the main reason (the protocol be used in the present study was about 70% and the protocol be used in Gereer's study was about 55% of maximum heart rate).

It has been shown that ingesting amino acids increases anabolic and decreases catabolic processes of muscle proteins. Changes in protein renewal during exercise leads to reduction of damage to myofibrillar proteins and membrane proteins. It decreases ultra-structural disruption of the muscles resulting from muscle soreness post workout (4).

In addition, providing the energy needed during resistance exercise through ingesting amino acids supplementation may reduce muscle destruction (18). It is assumed that providing energy through amino acids supplementation inhibits gluconeogenesis process. Also it has been reported that total antioxidant capacity is

responsible for increasing muscle protein catabolism. Therefore ingesting amino acids may decrease muscle protein catabolism through increasing the mediators of antioxidant capacity cycle (10). Furthermore, preventing protein destruction through increasing amino acids and plasma insulin, and decreasing the use of endogenous amino acids through ingesting supplementation reduce muscle destruction during and after exercise. Reduced level of serum lactate dehydrogenase after ingesting amino acids supplementation results from membrane integrity and less leakage of enzymes out of muscle cells during recovery hence reducing damage to myofibrillar proteins and membrane proteins (4). In effect, less damage to membrane proteins leads to increased membrane integrity, explaining the decrease in the release of lactate dehydrogenase and creatine kinase (19).

On the other hand, mechanical forces could disrupt the structure and performance of muscle fibers during resistance exercise. In addition, as seen in physical exercise, the increased cell membrane permeability leads to calcium efflux from interstitial fluid. The increase in calcium concentration in muscle fibers activates proteolytic enzymes which destroy the structure of troponin, tropomyosin and Z-disc, and causes damage to sarcolemma through destruction of Z-lines and stimulating nerve endings. Also, influx of monocytes and neutrophils into the damaged area stimulates sensory neurons and feeling of pain. All in all, amino acids supplementation reduces muscle soreness perhaps through maintaining the integrity of membrane and less damage to membrane proteins (20).

Regarding total antioxidant capacity, the findings of the present study indicated that the use of branched-chain amino acids has no significant impact before, immediately, and 24 hours post-exercise ($p > 0.05$). The results of this part corroborate the findings of some studies (7, 22) and contradict the findings of some others (23, 24, 25, 26, 27).

For instance, investigating healthy men and women, Diaz et al (2011) stated that total antioxidant capacity does not meaningfully change after one session of under maximum exercise (22). However, investigating 113 non-athlete men and women, Demirbag et al (2006) found that total antioxidant capacity decreased after Bruce Treadmill Test meaningfully (27). The reasons for the inconsistencies in findings could be the number of subjects, characteristics of the populations (race, age, gender, health

condition, and physical fitness), intensity of the exercises and also differences in measuring this factor. On the other hand, the average age of the subjects in the above study was 46 years, and they were both males and females; however, the subjects in the present study were all men athletes with the average age of 30. Perhaps the findings of the present study have been due to low daily dosage or too short time for the supplementation to take effect on this variable.

A lot of researchers have investigated the effects of anti-oxidative supplementation along with physical exercise. Considering the likely side effects of chemical supplements, a few studies have clearly witnessed the beneficial effects of these supplementations in offsetting the oxidative stress of exercise. Unlike this belief, the findings of the present study showed taking amino acids supplements does not meaningfully affect the antioxidant capacity of men rock climbers.

Conclusion

The findings of the present study showed that taking branched-chain amino acids has a meaningful effect on creatine kinase and lactate dehydrogenase pre and post exercise, but it does not have a significant impact on total antioxidant capacity. It seems that the results of the present study have been due to the shortness of the period of supplementation for the branched-chain amino acids to take intracellular effect on total antioxidant capacity. In order to achieve optimum results for the branched-chain amino acids, it is suggested that they be used for a longer period of time and with regard to scientific research methods. Taking the results into consideration, we can conclude that receiving branched-chain amino acids for 14 days (6 grams per day) can be beneficial for men rock climbers.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

References

1. Egaña, M and Donne, B (2004). Physiological changes following a 12 week gym based stair-climbing, elliptical trainer and treadmill running program in females. *Journal of Sports Medicine and Physical Fitness*; 44(2): 141-6.
2. Close GI, Ashton T, Ardle Mc and McLaren Dp (2005). The emerging role of free radical in delayed onset muscle soreness and contraction-induced muscle injury, comparative biochemistry and physiology journal; 142: 257-66.
3. Connolly DA, Lauzon C, Agnew J, Dunn M and

- Reed B (2006). The effect of vitamin c supplementation on symptoms of delayed onset muscle soreness, *J Sport Med Phys Fitness*; 46(3): 262-7.
4. Coombes JS (2000). Effects of branched-chain amino acid supplementation on serum creatine kinase and lactate dehydrogenase after prolonged exercise. *J Sports Med Physiol Fitness*; 40:240-6.
 5. Tipton KD and Wolfe RR (1998). Exercise-induced changes in protein metabolism. *Acta Physiol Scand*; 162:377-87.
 6. Thomas C, Jeukendrup AE, Mann CH and Jones DA (2011). Effect of branched amino acids on blood creatine kinase and lactate after exhaustive exercise; 36(9): 1543-50.
 7. atashak S, batoorakK and ghaderi M (2013). Effect of bcaa supplementation on serum C - reactive protein after acute resistance exercise in soccer players. *Knowledge and health*; 8 (1); 12-6.
 8. Williams and Melvin H (2005). *Nutrition for health, fitness, & sport*. McGraw-Hill Science Engineering.
 9. Nottle C and Nosaka K (2005). The magnitude of muscle damage induced by downhill backward walking. *U Sci Med Sport*; 8:3:264-73.
 10. Greer BK (2006). Dissertation: The effects of Branched-chain amino acid supplementation on indirect indicators of muscle damage and performance. ProQuest Information and Learning Company. *J Sport Nutrition Exercise Metabolism*; 19(6):659-72.
 11. Kyle J Hackney (2005). Delayed onset muscle soreness and resting metabolic rate following full-body resistance exercise with an eccentric concentration, ProQuest Information and Learning Company. Degree: Master of Education.
 12. Shimomura Y (2004). Exercise promotes BCAA catabolism: effects of BCAA supplementation on skeletal muscle during exercise. *The Journal of nutrition*; 134(6):1583-7.
 13. Newham, DJ, Jones DA and Edwards RH (1983). Large delayed plasma creatine kinase changes after stepping exercise. *Muscle Nerve*; 6:380-5.
 14. Kaitlin C, Kleisinger AK, Grenier S and Dorsch KD (2011). The effect of 4 weeks of intense interval training with branched amino acid consumption on anaerobic power and fatigue index. *Journal of Strength and Conditioning Research*; 23(4):1271-5.
 15. Koba, T, Hamada K, Sakurai M and etal (2007). Branched-chain amino acids supplementation attenuates the accumulation of blood lactate dehydrogenase during distance running. *J Sports Med Physiol Fitness*; 47(3): 316-22.
 16. Coombes JS and McNaughton LS (2000). Effects of branched-chain amino acid supplementation on serum creatine kinase and lactate dehydrogenase after prolonged exercise. *Journal of Sports Medicine and Physical Fitness*; 40(3):240-6.
 17. Casini L, Gatta D, Magni L and Colombani B (2000). Effect of prolonged branched-chain amino acid supplementation on metabolic response to anaerobic exercise in standardbreds. *Journal of Equine Veterinary Science*; 20(2):120-3.
 18. Hightona J, Craig Twista, Kevin Lamba and Ceri Nicholasa (2013). Carbohydrate-protein coingestion improves multiple-sprint running performance. *Journal of Sports Sciences*; 31(4) 361-9.
 19. Carli G, Bonifazi M, Lodi L and et al (1992). Changes in the exercise-induced hormone response to branched chain amino acid administration. *Eur J Appl Physiol Occup Physiol*; 64:272-7.
 20. Kyle J Hackney (2005). Delayed onset muscle soreness and resting metabolic rate following full-body resistance exercise with an eccentric concentration, ProQuest Information and Learning Company. Degree: Master of Education.
 21. White JP, et al (2008). Effect of carbohydrate-protein supplement timing on acute exercise-induced muscle damage. *Journal of the International Society of Sports Nutrition*; 5(1): 1-7.
 22. Diaz KM, Fearheller DL, Sturgeon KM, Williamson ST and Brown MD (2011). "Oxidative stress response to short duration bout of submaximal aerobic exercise in healthy young adults. *International Journal of Exercise Science*; 4: 247-56.
 23. Schröder H, Navarro E, Mora J, Galiano D and Tramullas A (2001). Effects of α -tocopherol, β -carotene and ascorbic acid on oxidative, hormonal and enzymatic exercise stress markers in habitual training activity of professional basketball players. *European Journal of Nutrition*; 40 (4):178-84.
 24. Calder PC (2006). Branched-chain amino acids and immunity. *The Journal of nutrition*; 136(1), 288S-293S.
 25. Rainer, Lisa, and Cynthia J. Heiss (2004). Conjugated linoleic acid: health implications and effects on body composition. *Journal of the American Dietetic Association*; 104.6: 963-968.
 26. Davis J, Mark, et al (2007). Curcumin effects on inflammation and performance recovery following eccentric exercise-induced muscle damage." *American Journal of Physiology-Regulatory, Integrative and Comparative Physiology* 292.6: R2168-R2173.
 27. Demirbag R, Yilmaz R, Guzel S, Celik H, Kocyigit A and Ozcan E (2006). Effects of treadmill exercise test on oxidative/antioxidative parameters and DNA damage. *Anadolu Kardiyol Derg*; 6: 135-140.