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Krzysztof Sas-Nowosielski
The Jerzy Kukuczka Academy of Physical Education in Katowice, Poland, k.sas-nowosielski@awf.katowice.pl

Piotr Kaczka
The Jerzy Kukuczka Academy of Physical Education in Katowice, Poland, kaczor81@o2.pl

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Article

A pilot study to examine the effects of beta-alanine and sodium citrate (CarnoRush™, Olimp®) supplementation on climbing-specific performance

Krzysztof SAS-NOWOSIELSKI[1] *, Piotr KACZKA[2]

[1] The Jerzy Kukuczka Academy of Physical Education in Katowice, Poland;
ORCID 0000-0002-9569-5954
[2] The Jerzy Kukuczka Academy of Physical Education in Katowice, Poland;
ORCID 0000-0002-1730-6335

* Correspondence: Krzysztof Sas-Nowosielski, The Jerzy Kukuczka Academy of Physical Education in Katowice, 40-065 Katowice, Mikołowska 72A; Poland; e-mail: k.sas-nowosielski@awf.katowice.pl

Abstract: Introduction. Competitive and rock climbers primarily rely on anaerobic energy metabolism, and acidosis may limit their performance. It is supposed that supplements that improve buffering capacities of the body, like β-alanine (BA) and sodium bicarbonate/citrate (SB/SC), may be useful in this sport. The aim of the study was to explore the efficacy of co-supplementation of BA and SC on climbing performance. Material and methods. 13 climbers (age 40.2 ±7.9 years, height 175.4 ±8.4 cm, body mass 68.6 ±13.9 kg, UIAA metric 9.2 ±0.8) were randomly assigned to the supplement (SG; n = 7) or control group (CG: n = 6). For 4 wks, the SG was taking a supplement containing: BA 4 g·d, SC 0.6 g·d and histidine 0.2 g·d. Climbers were tested on two bouldering circuits done back and forth until exhaustion: "hard" and "easy". Results. Climbers from the SG significantly increased their performance in terms of the number of moves done in both circuits, hard $F_{(1,11)} = 5.44$, $p = 0.04$, $\eta^2 = 0.33$ and easy $F_{(1,11)} = 4.91$, $p = 0.05$, $\eta^2 = 0.33$. Within group effect sizes were $d = 0.49$ and 0.46 for SG and 0.18 and 0.27 for CG, respectively. Conclusions. Co supplementation of BA and SC may improve performance in climbing, especially efforts lasting at least about one minute of continuous effort.

Keywords: climbing, supplementation, beta-alanine, sodium citrate.

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1. Introduction

Indoor and rock climbing are activities that are becoming more and more popular among wide masses of people. Among the climbing activities that are also gaining in popularity is sport climbing, which was included in the program of the Olympic Games in Tokyo, postponed to the year 2021 due to the SARS-CoV-2 pandemic.

As a sport discipline, climbing contains three kinds of events, called a lead, speed and bouldering. Each of them imposes slightly different physiological requirements on the participants, but in all of them anaerobic metabolism plays an important role – in speed climbing the phosphagen system, while in bouldering and lead – fast glycolysis [1]. In the former, climbers are forced to do a series of moves requiring a high rate of force development or be able to maintain certain body positions that require intense isometric contractions. While individual efforts of this type may last from a few to tens of seconds, they are often repeated in rapidly successive intervals for a total of 4 or 5 minutes (in the final and qualifying rounds, respectively), called the rotation time, i.e. the interval that the competitor has at his disposal to complete a given boulder problem. In "lead" climbing, the competitor has to go as far as possible on the route, and the limiting factor – apart from technical and tactical skills – is the ability to sustain high-intensity continuous effort. Therefore, in contemporary climbing anaerobic power and power endurance, especially in relation to the upper body, are considered to be important factors influencing chances of success in competitive climbing [2–4].

In a situation where the body's oxygen supply is insufficient, carbohydrates are broken down into pyruvate which can be subsequently converted into lactate [5–6]. The resultant reduction of a muscle cell pH due to accumulation of H^+ ions affects its contractile properties decreasing the muscle’s ability to force production and leads to fatigue, e.g. by inhibiting glycolytic enzymes, interfering with cross-bridge formation between actin and myosin, or interfering with the release of cations Ca_2^+ from the sarcoplasmic reticulum [7–8]. Thus, interventions that may reduce H^+ accumulation, enhance its removal from muscle cells and increase buffering capacities of the body may be advantageous for efforts taking place in the zone of anaerobic metabolism [9, 10]. Among these interventions, the leading role is played by supplementation with sodium bicarbonate or sodium citrate and β-alanine, the former by inducing extracellular alkalosis and increasing H + efflux from the muscles [9, 11], and the latter as a promoter of carnosine, which is the most important intracellular muscle buffer [12]. Both of these supplements have been the subject of extensive research, although, in the majority of studies, each of them has been examined individually, and their effectiveness in this area has also been a subject of several meta-analyses [12–16]. As both these compounds act in different spaces within the body (intracellular vs extracellular), co-supplementation of both should theoretically have an additive effect. However, the studies that were carried out to verify this hypothesis gave inconclusive results [17–19]. For example, Tobias [17] in a study of judo and ju-jitsu athletes performing 4 series of 30-second test battles, found that although β-alanine supplementation improved results by 7% and sodium bicarbonate by 8%, simultaneous intake of both of these substances resulted in a 14% improvement. However, in Ducker, Dawson and Wallman’s [18] study, sodium bicarbonate supplementation alone resulted in better performance in repeated-sprints (lasting 2–4 seconds) with brief recovery periods than the combination of β-alanine and sodium bicarbonate. Of course, the direct comparison of research results is limited in that it concerned two different forms of activity, both motor and physiological, although in both cases they were intermittent high-intensity efforts.

In view of the rapid development that is observed in sport and rock climbing, coaches and athletes are looking for methods to optimise training and competitive performance. However, although an increasing number of studies on some aspects of motor preparation can be observed, only a few studies have been devoted to dietary and supplementation strategies, some of them were only theoretical considerations, attempting to extrapolate to climbing the results of research conducted in the broader context of sports activities [1–2].

To date, to the best of our knowledge, no study addressed the issue of the ergogenic potential of combined supplementation of the abovementioned compounds on specific climbing performance. Therefore, the aim of the study was to explore the efficacy of Carno Rush™ (Olimp®), a supplement containing β-alanine (57.8%) and sodium citrate (8.7%), with the addition of L-histidine (2.9%) and vitamin B6, on climbing performance..

2. Materials and Methods

2.1. Participants

Thirteen climbers, members of the climbing team practicing in an artificial wall located in the Academy of Physical Education in Katowice, Poland, participated in the study. The participants’ mean age was 40.2±7.9 years, height 175.4±8.4 cm, body mass 68.6±13.9 kg, and the climbing level expressed in the International Association of Rock Climbing Research scoring method was 16.5±2.1 [20]. They were randomly assigned to the supplement ([SG] n = 7) or control group ([CG] n = 6). Initially, both groups were equally numerous; however, one climber from the CG resigned due to professional duties, and another one from the SG received an injury being forced to stop his training regimen for a week. The study was approved by the local bioethical commission.

The SG has taken the supplement for 4 wks in daily doses of β-alanine 4 g/d and sodium citrate 0.6 g/d. Both groups completed the same exercise protocol 2 days/wk (bouldering and lead climbing). At weekends, they climbed on their own. Climbers were tested on two bouldering circuits done back and forth until exhaustion: a) "hard" – difficulty from ca FB 7a to 7a+ one way, wall overhang 30°, type of holds: crimps (Split Grip Line™, Bluepill®); b) "easy" – difficulty from ca 6a+ to 6b one way, wall overhang 10°, type of holds: slopers and rounded jugs (GatewayTM, T-wall®). Both circuits had a "continuous" character, i.e. the route setter tried to make the difficulties of all individual movements more or less similar, and in particular not establishing the so-called "selective place," meaning single movement much harder than the others. In both traverses, plenty of footholds were screwed on, and their use was not determined allowing climbers to use them to their convenience. During both trials, participants were allowed to use chalk to keep their hands dry.

After initial trials, all holds were removed from the wall and screwed on just before the POST test. In this way, participants could neither train on the circuits nor on the holds used on them. Climbers were assessed in the same way as in climbing competitions i.e. counting the furthest hold "controlled" (full number) or "used" (full number and 0.5 decimal points added). Additionally, time to exhaustion (TtE) was measured. The rest period between both trials was 10 min. As a result of the draw, two best (8c) climbers were found in the SG; therefore, in the mean PRE number of moves of the hard circuit the trend towards the significance between the groups was observed ($p = 0.070$). The difference in the easy circuit was not significant ($p = 0.115$).

2.2. Data analysis

All data are presented as means and standard deviations. To determine differences in SG and CG at baseline, t-tests were conducted. Repeated measures ANOVA – time (Pre, Post) × group (SG, CG) were used to investigate the effects of supplementation on performance in climbing. When significant main effects were found, a Bonferroni post-hoc was conducted to determine where the differences occurred. The within group effect size was calculated using Cohen's d, and the obtained values were interpreted, as recommended by Cohen, as "small" $d = 0.20$, "moderate" $d = 0.50$, and "large" $d = 0.80$ [21]. Statistical significance was accepted at $p < 0.052.2$.

3. Results

All performance results of climbers are shown in Table 1. There were significant interactions time × group for mean changes in the number of movements done in both circuits, "hard" and "easy", with similar effect size $\eta^2 = 0.33$. As post hoc analyses revealed, the difference between pre and post reached significance in SG, but not in CG. This result was supported by large effect sizes in the SG, which were: Cohen's $d = 0.49$ and $d = 0.46$, respectively, comparing to $d = 0.18$ and $d = 0.27$ in CG. Detailed statistics are shown in Table 1.

Taking into consideration the number of moves done in both traverses, CG added about two moves from baseline to post supplementation period. This progress can be attributed to the effects of the training stimuli that were applied regularly over the 4-week duration of the experiment. By contrast, climbers from SG were able to do on average six moves more on the hard circuit (and stay on the wall for over 29 s longer) and seven moves on the easy one (staying on the wall about 22 s longer). In relative terms, these improvements were 33.5% and 33.7%.

Table 1. Effects of supplementation on mean (± SD) number of moves on circuits, "hard" and "easy".

Variable	Group	Pre (mean±SD)	Post (mean±SD)	*F*(1, 11), *p*, η^2	post hoc	Cohen's *d*
Easy travers	Control	8.3 ±3.6 (4.6-12.1)	8.8 ±1.8 (6.9-10.8)	5.44, 0.04, 0.33	NS	-0.18
	Supplement	17.4 ±10.6 (7.7-27.2)	23.4 ±13.8 (10.6-36.2)		0.019	-0.49
Easy traverse	Control	25.0 ±8.5 (16.1-33.9)	27.2 ±7.9 (18.8-35.5)	4.91, 0.05, 0.33	NS	-0.27
	Supplement	37.0 ±20.5 (15.5-58.5)	48.0 ±27,2 (19.5-76.5)		0.018	-0.46

NS – non-significant

4. Discussion

To the best of our knowledge, this is the first study to examine the ergogenic effects of the supplement containing β-alanine with sodium citrate (CarnoRush™) on specific climbing performance. To our best knowledge, only Wood [22] has studied the effects of β-alanine supplementation on bouldering performance, finding that the 4-week supplementation programme did not improve climbing performance with the exception of the rate of perceived exertion. Contrary to this result, the main finding of our study is that 4 weeks of supplementation may enhance short-term endurance in climbing. As mean times to exhaustion in our study were from about half to three minutes depending on the difficulty of the circuit, it is consistent with findings that efforts from the range 0.5–10 min are the most prone to β-alanine supplementation [6].

In conclusion, the subjects taking the supplement, consisting of β-alanine and sodium citrate, were able to climb longer and make more moves on both the hard and the easy circuit. This observation has two kinds of consequences: Firstly, for the conditioning process, where more training volume means a stronger training stimulus, which should result in stronger adaptive responses. Secondly, the possibility of making more than one move may determine where the competitor will rank during a climbing competition, where sometimes the win or lose is determined by the difference of one move or even by its initiation from a given hold. In rock climbing, being successful on the route is at stake. In the case of "speed climbing", it is somehow by its definition, because the essence of this kind of event is to climb the wall as quickly as possible, which for world-class athletes means climbing a 15-meter wall in six to seven seconds. In bouldering, the issue is a bit more complicated due to the varied nature of the so-called problems (i.e. short climbing routes done without belay ropes), both between competitions and within the same round in the same competition. Since, according to the regulations, the longest problem in a competition can cover up to 12 holds, the time to overcome such a problem can be several dozen seconds, and thus reach the zone of lactate anaerobic metabolism, where substances such as β-alanine or sodium bicarbonate/citrate show the greatest effectiveness. Even if a significant part of the problems during bouldering competitions requires a shorter time to overcome them, it is not uncommon for such an effort to be repeated many times in short intervals, e.g. in a situation where a given competitor during his/her rotation time falls many times before reaching the first scoring hold ("the zone") or reaches the top. However, our study did not evaluate the effectiveness of a multi-component supplement containing alkalizing ingredients for efforts typical of bouldering competitions. Therefore, one should be careful in drawing conclusions about the effectiveness of the assessed supplement for this type of effort. However, the effectiveness of multi-ingredient performance supplement containing buffering agents in terms of competitive-like bouldering efforts (intermittent, high-intensity) has not been assessed in our study.

This study has some limitations which should lead readers to interpret the findings with some caution. Firstly, although most climbers could be classified as advanced according to the criterion proposed by Draper et al. [20], two of them represented an elite level and because they had been drawn into the supplement group their performance influenced the mean results of this group. Secondly, the sample size within each group was quite small which might have led to less meaningful results. Thirdly, although we are convinced of the practical value of the "real world" performance, the lack of measurements of intramuscular carnosine or blood lactate may be considered as another limitation. However, although these are objective biochemical indicators showing the body's reaction to supplementation, at the same time, from the point of view of training practice, the most interesting for coaches and athletes are specific quantitative and qualitative parameters of effort (such as intensity, power output, training volume, etc.) and behavioural indicators (in the case of climbing, it is the extent to which the competitor effectively manages the climbing route). Since, due to the invasiveness of this measurement, it would be difficult to maintain the hygiene of sampling in the conditions of a climbing gym with high air dust caused by airborne magnesium and it would be difficult to recruit climbers who would agree to violate the integrity of the skin during climbing, we focused only on the observed behavioural parameters as the most important from a practical point of view. Another important limitation, which should be mentioned, was not controlling the participants' diet during the study. Similarly, although all participants took part together in two training sessions per week, the remaining days of the week were at their disposal. As far as we know, at weekends they climbed on their own at other climbing gyms and/or in the rocks, and also took part in competitions of the regional boulder league season starting at that time. Despite obvious limitations, we believe our work could be a starting point for further research in supplementation strategies that could be used by sport climbers. This area remains largely unexplored.

5. Conclusions

Four weeks of co supplementation with beta-alanine and sodium citrate led to an improvement in performance during climbing tasks, especially efforts lasting at least about one minute of continuous effort. This study suggests that a supplement containing both compounds might be an effective ergogenic aid for climbers.

References

1. Michael MK, Witard OC, Joubert L. Physiological demands and nutritional considerations for Olympic-style competitive rock climbing. Cogent Med. 2019;6:166-199. doi: 10.1080/2331205X.2019.1667199
2. Smith EJ, Storey R, Ranchordas MK. Nutritional considerations for bouldering. Int J Sport Nutr Exerc Metab. 2017;27:314-324. doi: 10.1123/ijsnem.2017-0043
3. Mabe J, Butler SL. Analysis of contemporary anaerobic sport specific training techniques for rock climbing. Sport J. 2016;1.
4. Phillips KC, Sassaman JM, Smoliga JM. Optimizing rock climbing performance through sport-specific strength and conditioning. Str Cond J. 2012;34:1-18. doi: 10.1519/SSC.0b013e318255f012
5. Danaher J, Gerber T, Wellard RM, Stathis CG. The effect of β-alanine and $NaHCO_3$ co-ingestion on buffering capacity and exercise performance with high-intensity exercise in healthy males. Eur J Appl Phys. 2014;114:1715-1724. doi: 10.1007/s00421-014-2895-9
6. Saunders B, Elliott-Sale K, Artioli GG, Swinton PA, Eimear D, Roschel H, et al. β-alanine supplementation to improve exercise capacity and performance: A systematic review and meta-analysis. Br J Sports Med. 2017;51:658-669. doi: 10.1136/bjsports-2016-096396

7. Debold EP, Beck SE, Warshaw DM. Effect of low pH on single skeletal muscle myosin mechanics and kinetics. Am J Physiol Cell Physiol. 2008;295:173-179. doi: 10.1152/ajpcell.00172.2008
8. Bishop D, Edge J, Davis C, Goodman C. Induced metabolic alkalosis affects muscle metabolism and repeated-sprint ability. Med Sci Sport Exerc. 2004;36(5):807-813. doi: 10.1249/01.MSS.0000126392.20025.17
9. Hollidge-Horvat MG, Parolin ML, Wong D, Jones NL, Heigenhauser GJF. Effect of induced metabolic alkalosis on human skeletal muscle metabolism during exercise. Am J Physiol. 2000;278:316-329. doi: 10.1152/ajpendo.2000.278.2.E316
10. Kaczka P, Batra A, Kubicka K, Maciejczyk M, Rzeszutko-Belzowska A., Pezdan-Sliz I, et al. Effects of pre-workout multi-ingredient supplement on anaerobic performance: Randomized double-blind crossover study. Int J Environ Res Publ Health. 2020;17;8262. doi: 10.3390/ijerph17218262
11. McNaughton LR, Siegler J, Midgley A. Ergogenic effects of sodium bicarbonate. Curr Sport Med Rep. 2008;7:230-236. doi: 10.1249/JSR.0b013e31817ef530
12. Culbertson JY, Kreider RB, Greenwood M, Matthew C. Effects of β-alanine on muscle carnosine and exercise performance: A review of the current literature. Nutrients. 2010;2:75-98. doi: 10.3390/nu2010075
13. Quesnele JJ, Laframboise MA, Wong JJ, Kim P, Wells GD. The Effects of β-alanine supplementation on performance: A systematic review of the literature. Int J Sport Nutr Exerc Metab. 2014;24:14-27. doi: 10.1123/ijsnem.2013-0007
14. Grgic J, Rodriguez Ramon RF, Garofolini A, Saunders B. Effects of sodium bicarbonate supplementation on muscular strength and endurance: A systematic review and meta-analysis. Sports Med. 2020;2. doi: 10.1007/s40279-020-01275-y
15. Matson LG, Tran ZV. Effects of sodium bicarbonate ingestion on anaerobic performance: A meta-analytic review. Int J Sports Nutr. 1993;3(1):2-28. doi: 10.1123/ijsn.3.1.2
16. Hadzic M, Eckstein ML, Schugardt M. The impact of sodium bicarbonate on performance in response to exercise duration in athletes: A systematic review. J Sports Sci Med. 2019;18:271-281.
17. Tobias G, Benatti FB, de Salles Painelli V, Roschel H, Gualano B, Sale C, et al. Additive effects of β-alanine and sodium bicarbonate on upper-body intermittent performance. J Amin Acids. 2013;45:309-317. doi: 10.1007/s00726-013-1495-z
18. Ducker KJ, Dawson B, Wallman, KE. Effect of beta alanine and sodium bicarbonate supplementation on repeated-sprint performance. J Strength Cond Res. 2013:27(12):3450-3460. doi: 10.1519/JSC.0b013e31828fd310
19. Danaher J, Gerber T, Wellard RM, Stathis CG. The effect of β-alanine and $NaHCO_3$ co-ingestion on buffering capacity and exercise performance with high-intensity exercise in healthy males. Eur J Appl Physiol. 2014;114:1715-1724. doi: 10.1007/s00421-014-2895-9
20. Draper N, Giles D, Schöffl V, Fuss KF, Watts PB, Wolf P, et al. Comparative grading scales, statistical analyses, climber descriptors and ability grouping: International Rock Climbing Research Association Position Statement. Sports Tech. 2015;8(3-4):88-94. doi: 10.1080/19346182.2015.1107081
21. Lakens D. Calculating and reporting effect sizes to facilitate cumulative science: A practical primer for t-tests and ANOVAs. Front Psychol. 2013;4:863. doi: 10.3389/fpsyg.2013.00863
22. Wood D. The effects of beta-alanine on indoor bouldering performance. [Available at: https://www.semanticscholar.org/paper/THE-EFFECTS-OF-BETA-ALANINE-ON-INDOOR-BOULDERING-Wood/f9132a3f819c59c338c3119819cfc29323a7804f Accessed on 8 January, 2020].

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