Journal of Complementary Medicine And Alternative Healthcare
ISSN: 2572-1232

Research Article
Volume 10 Issue 1 - August 2019
DOI: 10.19080/JCMAH.2019.10.555780

J Complement Med Alt Healthcare

Effects of Sodium Bicarbonate Supplementation on Repeated-sprint Ability in Professional vs. Amateur Soccer Players

Matthew L Jones[1], Adam L Owen[2,3]*, Mehdi Rouissi[4] and Karim Chamari[5]

[1]*Department of Sport & Exercise Sciences, University of Chester, England*

[2]*University Claude Bernard Lyon1, Villeurbanne, France*

[3]*Centre de Recherche et d'Innovation sur le Sport, Université Claude Bernard Lyon1, France*

[4]*Tunisian Research Laboratory, National Center of Medicine and Science in Sports Tunis, Tunisia*

[5]*Athlete Health and Performance Research Centre, Qatar Orthopaedic and Sports Medicine Hospital, Qatar*

Submission: July 11, 2019; **Published:** August 08, 2019

***Corresponding author:** Adam L Owen, Univ Lyon, LIBM EA7424, University Claude Bernard Lyon 1, Villeurbanne, Francemedicine, philosophy of education, Russia

Abstract

Soccer is described within the research as a high-speed and high-intensity intermittent sport exposing players across many levels to a continued physical, physiological, technical, tactical and psychological demands. This variance of stressors encountered during actual training and competitive match-play have shown fatigue to become a prevalent issue, especially following periods of high intensity bouts. As a result this investigation has been developed in order to compare the effects of sodium bicarbonate ingestion (NaHCO3) on professional and amateur soccer player's RSA (7 x professional players: mean±SD: age 21.7±2.1yrs; weight 79.7±9.5kg; and 7 x amateur players: mean±SD: age 22.8±1.2yrs; weight 79.3±4.9kg). Each player ingested $0.3g.kg^{-1}$ $NaHCO_3$ or placebo microcrystalline cellulose (MC) in a randomized, double-blind, crossover order, 90-minutes before the repeated-sprint ability (RSA) test (5 x 6-seconds maximal-effort sprints). No differences were found in La- concentrations among professional or amateur players in MC or NaHCO3 conditions pre-exercise (P>0.05). The NaHCO3 trial revealed significantly higher post-exercise La-concentrations in professional (9.57±1.09vs. 10.77±0.90mmol/L^{-1}) vs. amateur players (10.06±1.45 vs. 10.87±1.25 mmol/L^{-1}). $NaHCO_3$ resulted in significant improvements in mean power output in sprints 2 (512.3±199.4 vs. 547.6±185.3W) and 3 (468.6±209.4 vs. 491.6±199.0W) in amateurs, but no effect in professionals. Therefore, it may be suggested that amateur participants in soccer may benefit from $NaHCO_3$ ingestion more than professional players as a result of their reduced physical conditioning level when compared to professional level players.

Keywords: Sodium bicarbonate; Repeated sprint; Soccer

Introduction

Soccer is characterized by its unique, unpredictable, intermittency profile in both training and competitive games [1]. Previous research has suggested that during match play, high intensity efforts last for anything between 3.7-4.4 seconds in duration [2,3]. Furthermore, elite level players complete significantly more sprints than their amateur counterparts (1.4±0.1 vs. 0.9±0.1%, p<0.05) [4]. Recent research has revealed a strong correlation between repeated-sprint ability and elite soccer performance [3]. Energy produced during repeated sprints predominantly derives from anaerobic glycolysis [5], a metabolic pathway limited by the progressive increase in acidity through the accumulation of lactate (La) and hydrogen ions (H^+) in muscle and blood [6]. Fatigue during high-intensity exercise remains contentious, with further uncertainty surrounding fatigue in soccer [7]. While the mechanism of H^+ accumulation is well documented, other mechanisms are largely involved in the RSA fatigue. Earlier research in this area suggestH^+accumulation could result in alterations in enzyme activity, perceived effort, ion regulation; or inhibition of essential glycolytic rate limiting enzymes phosphofructokinase and lactic dehydrogenase [8]. Various intracellular buffering mechanisms become active with increased repeated-sprints in an attempt to neutralize the increased H+ in the blood, including the monocarboxylate transporters 1 and 4, although it is believed bicarbonate (HCO_{3-}) is the most active [9]. The body's natural stores of HCO_{3-} are limited; therefore, when the body's buffering capacity is exceeded through increased H+ production acidosis occurs, resulting in fatigue [6]. Elevated H+ concentrations as a result may increase pyruvate dehydrogenase activity, thus enhancing aerobic participation. Evidence indicates La- and H^+ accumulation, and the resultant acidosis are not the sole cause of fatigue [2].

The ingestion of sodium bicarbonate ($NaHCO_3$) prior to exercise is suggested to enhance high-intensity sport performance particularly in sports which involve rapid motor-unit activity and large muscle-mass recruitment such as soccer [10]. Induced alkalosis following $NaHCO_3$ ingestion is thought to increase the body's extracellular buffering capacity, delaying the onset of fatigue, and pH decrease, increasing muscle contractile capacity, through enhanced muscle glycolytic ATP production, and increased muscle La- efflux [11]. Evidence suggests $NaHCO_3$ ingestion~120-minutes pre-exercise in a dosage of 0.3g. kg-1. BM may improve high-intensity sport performance by~2% [12]. However, conflicting reports exist during repeated-sprint protocols with performance enhancement in some [2] but not others [13].

Some suggest physical characteristics have a significant impact upon participant's responses to $NaHCO_3$ supplementation [14]. Anaerobically trained, elite participants are likely to fatigue as a result of mechanisms other than acidosis during high-intensity exercise [15] as they possess higher muscle buffer capacities which blunt the ergogenic effects of exogenous buffers [16]. This may have specific implications on soccer performance, where amateur or youth players, or players returning from injury who display significantly lower anaerobic capacities [17]. A recent meta-analysis [18] concluded that the ergogenic effects of $NaHCO_3$ are diminished among amateur or untrained athletes. Additionally, this is the first study to examine the impact of training status upon the ergogenic effects of $NaHCO_3$ supplementation during repeated-sprint ability exercise. As a result, the purpose of this investigation is to compare the effects of $NaHCO_3$ ingestion on the repeated-sprint performance in amateur and professional soccer players.

Methods

Experimental approach to the problem

Upon commencement of the investigation, participants completed 3-separate sessions composed of one familiarization session (e.g. laboratory introduction, testing requirements, introduction to testing equipment, practice sprints and anthropometrics) and two testing sessions. Although a familiarization session was performed, the players involved within the study were fully aware of the tests used due to their on-going club seasonal sport science testing battery [19]. To begin the investigation, players were placed in a randomized placebo-controlled, double-blind crossover design method. Following the ingestion of either 0.3g.kg^{-1}.bm (body mass) of $NaHCO_3$ or 0.3g. kg.bm of microcrystalline cellulose (MC-Placebo) in identical capsules, the players completed 5 x 6-second cycle bursts with 24-seconds passive rest between maximal efforts. Following a 7-day separation crossover trial period, both sets of repeated-sprints were conducted at the same time of day (10:00hrs to 11:30hrs) to control for diurnal effects. Capillary blood was taken from the fingertip before capsule ingestion (baseline), 100-minutes post-ingestion (pre-exercise), and immediately after repeated-sprint (post-exercise). Participants were informed to maintain normal dietary patterns and training throughout the study. Participants were also asked to refrain from consuming food and beverages (other than water) 2-hours before testing, they were also asked to avoid alcohol or any vigorous exercise 24-hours before testing. The experimental design is shown in Figure 1, with the overview of the experimental protocol presented in Figure 2. The experimental protocol has previously been described used in accordance with recent research [2]. This research was approved by the ethics board and research committee within the nominated University and participants were informed of the research requirements, benefits and risks before giving written consent.

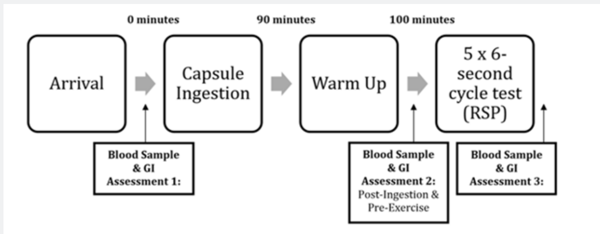

Figure 1: An outline of the experimental design, RSP = Repeated sprint performance.

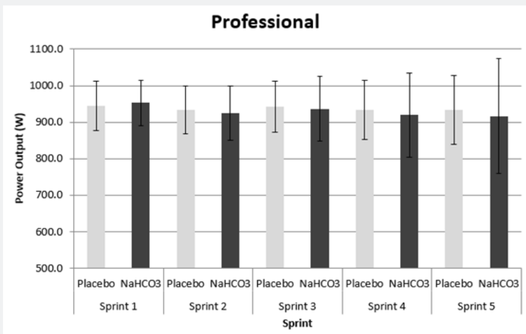

Figure 2: Professional participants mean power output (W) during repeated sprints in placebo and $NaHCO_{3.}$

Subjects

Fourteen soccer players were tested as part of this investigation (7 x professional players: mean±SD: age

How to cite this article: Matthew L Jones, Adam L Owen, Mehdi Rouissi, Karim Chamari. Effects of Sodium Bicarbonate Supplementation on Repeated-sprint Ability in Professional vs. Amateur Soccer Players. J Complement Med Alt Healthcare. 2019; 10(1): 555780.
DOI: 10.19080/JCMAH.2019.10.555780

24.7±2.8yrs; weight 79.7±9.5kg; and 7 x amateur players: mean±SD: age 19.9±1.2yrs; weight 79.3±4.9kg). All participants had been involved in soccer for over 5 years at various levels ranging from amateur participation to professional and the testing took place in the mid-season phase as to ensure stable physical player profiles. Participants were excluded from the study if they were taking medication known to affect pH balance, suffering from chronic disease, recently suffered an episode of fatigue/ flu or were currently taking performance enhancing supplements.

Training Status

Participants were assigned to one of two groups based on their training status; characteristics of each group are presented (Table 1). Professional soccer players were assumed to be well trained, whereas amateur soccer players were assumed to be untrained. These assumptions were confirmed by the results of a non-exercise model questionnaire [20], and a high-intensity training questionnaire. Participants were deemed to be well trained if they had a MET of <13 and took part in at least 3 high-intensity training sessions each week, for at least 5 consecutive weeks.

Table 1: Weekly Training Content.

Day	Amateur	Professional
Monday	Rest	Train
Tuesday	Rest	Train
Wednesday	Train	Rest
Thursday	Rest	Train
Friday	Rest	Train
Saturday	Rest	Match day
Sunday	Match day	Rest

Procedures

Substance ingestion

Participants ingested either 0.3 $g.kg^{-1}$ $NaHCO_3$ or 0.3$g.kg^{-1}$ MC in 18-24 gelatin capsules, 120-minutes prior to performing the repeated-sprint test. Capsules were closely matched for weight, sight and size, and were assigned in a randomized, double-blind, crossover manner.

Repeated sprint protocol

Participants performed a pre-test warm up 90-minutes following capsule ingestion consisting of 5-minutes cycling at 80W. This was followed by 3 practice starts, where participants were required to pedal at near maximal speed for 2-3 seconds interspersed with 20-seconds slow pedaling followed by a 90-second rest. Participants then performed a 6-second maximal assessment sprint test on the cycle ergometer (Monark Ergomedic 828e, Sweden). The power output completed in the first sprint was used as the criterion score during the subsequent 5 x 6-second cycle test. The subjects were allowed 5-minute off bike rest following the assessment sprint. The 5 x 6-second cycle test consisted of five, 6-second maximal sprints commencing every 30-seconds, with mean power output recorded for each individual sprint. Participants were required to achieve at least 95% of the criterion score for the first sprint, as a check of pacing. Participants that failed to achieve the 95% criterion score were allowed further 5-minutes rest and recommenced the 5 x 6-second cycle test. The 24-seconds between sprints consisted of active recovery, with participants instructed to maintain a cycling speed of 80 RPM with no load and counted in from 5-seconds before commencing the next sprint. All maximal tests were undertaken using the standard Wingate anaerobic test load (7.5$g.kg^{-1}$.BW) and procedures [21]. Standardized verbal encouragement was provided to each subject during all sprints, with all sprints performed in the seated position. A similar repeated-sprint has been used previously [2] and has been reported to be a valid and reliable test of repeated-sprint ability [22].

Blood sampling and analysis

Whole-blood La- was taken from finger-prick blood samples and assessed for physiological responses to both $NaHCO_3$ and MC. Participants fingers were prepared for sampling using an alcoholic wipe, dried with a tissue then punctured with a disposable lancet (Owen, Mumford, Oxford, UK). The initial droplet of blood was removed with a tissue; subsequent droplets of volume 5µl were collected on the La strip of the La Pro LT-1710 (Arkray, Kyoto, Japan). Blood samples were taken on arrival~100-minutes post-capsule ingestion, and immediately post-exercise. The La Pro is considered a viable measuring tool for the analysis of blood La owing to its proven reliability [23].

Gastrointestinal tolerability assessment

Acute GI discomfort questionnaires were completed at rest, pre-exercise and post-exercise. The questionnaire has been used in previous literature [24] and participants were required to report the intensity of sickness and stomachache by self-selecting a number along the scale provided. The scales showed integers from 0 to 10, with descriptors at 0, 3, 6, 9, and 10. The descriptors along the sickness scale included: not at all, slightly, quite, very, and sickness, and along the stomach ache scale: none at all, dull ache on and off, moderate continuous, severe continuous and severe doubled up.

Statistical analyses

All values are reported as mean±standard deviation. Within group difference in blood La, mean power output and GI-tolerability was analyzed using a paired t-test. Independent t-test was used to analyze the percentage change between groups for mean power outputs from placebo to $NaHCO_3$, and absolute difference for La concentrations and GI-tolerability from placebo to $NaHCO_3$. Statistical significance was accepted at $P<0.05$. Between trial differences were also assessed using Cohen's effect size with modified descriptors (Hopkins, 2002), using the following criteria:<0.2= trivial, 0.2-0.6 = small, >0.6-

How to cite this article: Matthew L Jones, Adam L Owen, Mehdi Rouissi, Karim Chamari. Effects of Sodium Bicarbonate Supplementation on Repeated-sprint Ability in Professional vs. Amateur Soccer Players. J Complement Med Alt Healthcare. 2019; 10(1): 555780. DOI: 10.19080/JCMAH.2019.10.555780

1.2 = moderate, >1.2–2.0=large, and >2.0=very large. Precision of the estimate of observed effects was indicated with confidence limits (±95% CL).

Results

Power output

All participants achieved at least 95% of the criterion score on first attempt. $NaHCO_3$ improved power output in sprint 2 (P=0.011) and sprint 3 (P=0.021) in amateur participants. $NaHCO_3$ had no effect on the power output of professional participants in any of the repeated sprints (P>0.05) (Figure 3). From sprint 1, mean power output was reduced in all subsequent sprints in both placebo and $NaHCO_3$ in amateur (P<0.001) (Figure 4). No reduction in power output occurred in subsequent sprints from sprint 1 in professional participants (P>0.05) (Figure 3). Absolute difference between trials in professional and amateur was trivial (effect size = <0.01). Percentage difference in mean power output was greater amongst amateur players in sprint 2 (P=0.013; d=-0.183) and sprint 3 (P=0.025; d=-0.113) when compared to professional players.

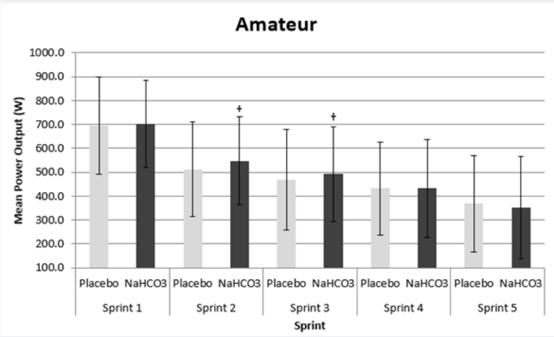

Figure 3: Amateur participants mean power output (W) during repeated sprints in placebo and $NaHCO_3$.

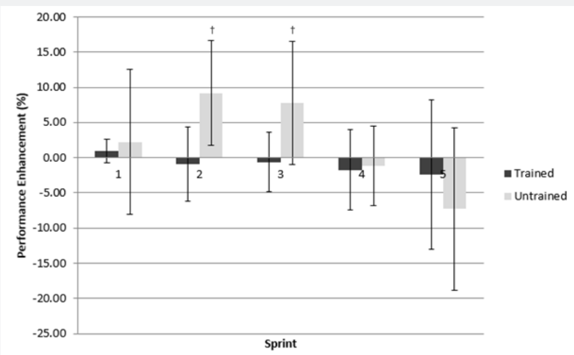

Figure 4: A graph displaying the percentage performance enhancement in professional and amateur participants from placebo to $NaHCO_3$ in each repeated sprint.

Blood lactate

Blood La concentrations for the placebo and $NaHCO_3$ trials are summarized in Table 2. Blood La concentrations were similar in both trials at rest in professional (P=0.893; d=-0.107) and amateur (P=0.080; d=0.045), although increased in both conditions pre-exercise but still remained similar in professional (P=0.176; d=-0.87) and amateur (P=0.849; d=-0.09). Post-exercise blood La concentration was significantly greater in professional participants during $NaHCO_3$ trial than placebo trial (P=0.011; d=-1.19) although no difference in the two conditions in amateur (P=0.093; d=-0.59). Additionally, the absolute difference from placebo to $NaHCO_3$ was similar in both professional and amateur at rest (P=0.497), pre-exercise (0.250) and post-exercise (0.491).

Gastrointestinal discomfort

Stomachache and sickness feelings in both trials did not differ at rest in professional (P=0.317), amateur (P=0.317) or pre-exercise in professional (P=0.157) or amateur (P=0.083). Post-exercise gastrointestinal discomfort increased from rest in $NaHCO_3$ trial in both professional and amateur participants (P=0.002), but not in placebo trial (P>0.05). The absolute difference in feelings of gastrointestinal discomfort between professional and amateur were no different when compared to rest (P=1.00), pre-exercise (P=0.298) or post-exercise (P=0.268) values.

Discussion

The primary aim of this investigation was to compare the effects of sodium bicarbonate ingestion ($NaHCO_3$) on anaerobic performance of professional and amateur soccer players during repeated-sprint bouts. Results have revealed that despite an improved mean power output of amateur participants in the mid-section of the repeated bouts (sprint 2 and 3 out of 5) in the test, $NaHCO_3$ had no greater effect on amateur than professional participants throughout the testing protocol. Additionally, secondary findings from the study highlighted the failure of $NaHCO_3$ to affect post-exercise blood La concentrations of amateur participants, whereas $NaHCO_3$ increased the post-exercise blood La concentrations of professional participants.

As seen within the study, the mean power output of professional participants was not altered by $NaHCO_3$ ingestion. The higher endogenous muscle buffer capacity of the professional participants within this study may provide a possible explanation to this observation. Indeed, muscle buffer capacity may be increased by 25% following five consecutive weeks of high-intensity interval training (3-sessions/week) [25]. Furthermore, elite athletes are known to possess greater muscle buffer capacities when compared to their amateur counterparts [25,26]. In accordance with the findings of this specific study, previous research also suggests a greater endogenous muscle buffer capacity of professional participants is more than likely responsible for the maintenance of mean power output throughout both $NaHCO_3$ and placebo trials. Subsequently, it should be noted that this would not explain the conflicting reports of Bishop et al. [2] who, using a similar experimental protocol, reported an 8.5% reduction from sprint 1 to 5.

How to cite this article: Matthew L Jones, Adam L Owen, Mehdi Rouissi, Karim Chamari. Effects of Sodium Bicarbonate Supplementation on Repeated-sprint Ability in Professional vs. Amateur Soccer Players. J Complement Med Alt Healthcare. 2019; 10(1): 555780.
DOI: 10.19080/JCMAH.2019.10.555780

Table 2: Blood lactate concentrations (mmol/L) and percentage difference (%) for both professional and amateur at rest, pre-exercise and post-exercise.

	Mean La (mmol/L)	Placebo	$NaHCO_3$	Difference	Significance	95% CI	d
Professional	Rest (0-mins)	1.25	1.32	0.07	0.893	-29.82-57.25	-0.107
	Pre-exercise (100-mins)	3.43	4.09	0.66	0.176	-1.74-0.40	-0.87
	Post-exercise (130-mins)	9.57	10.77	1.2	0.011	-1.61	-1.19
Amateur	Rest (0-mins)	1.34	1.07	-0.27	0.08	-0.08-0.62	0.45
	Pre-exercise (100-mins)	3.28	3.19	-0.09	0.849	-0.97-1.14	0.09
	Post-exercise (130-mins)	10.06	10.87	0.81	0.093	-1.81-0.18	-0.59

The lack of any ergogenic effect of $NaHCO_3$ among professional participants suggests their greater endogenous buffering capacity blunted any performance enhancing effects of the $NaHCO_3$ supplementation [16]. The improved performance amongst the amateur participants following the $NaHCO_3$ supplementation highlights the positive buffering effect of acute supplementation on less trained individuals. Such findings are in agreement with previous data associating $NaHCO_3$ with no performance effect in anaerobically trained professional athletes when compared to amateurs [2,13,14]. From a practical perspective, professional players who are recently returning to training (e.g. injured) may benefit from a $NaHCO_3$ supplementation to maintain increased training intensity.

Recent research has suggested that $NaHCO_3$ is effective in its role of decreasing post-exercise La- [2,27]. Consistent with previous research [2,28] $NaHCO_3$ failed to improve mean peak power output of both professional and amateur participants during the first sprint. It was suggested that a single 6-second sprint maybe too brief for the buffering mechanisms of $NaHCO_3$ to be effective, however, repeated 6-second sprints may benefit through greater facilitation of H+ efflux from the muscle [28]. Similarly, it has been suggested that single short sprints with brief recovery (~17-seconds) may not allow adequate translocation of metabolites from the myoplasm [5]. Again, consistent with previous research [28] and supportive of recent suggestions that $NaHCO_3$ is effective during longer exercise of ~1-minute for instance [12].

In contrast to previous findings [2] $NaHCO_3$ failed to improve the performance of professional or amateur participants in sprints 4 or 5. Early research suggested the ergogenic effects of $NaHCO_3$ are associated with large decrements in resting H+ [27] suggested maximal decrease in H+ occurs 60-90-minutes post-ingestion of $0.3g^{-1}.kg^{-1}$ $NaHCO_3$ however, $NaHCO_3$ administered 60-minutes pre-exercise resulted in a 42% performance enhancement [28]. Latterly, recent research has suggested peak blood alkalosis can be expected ~120^{-1}50-minutes post-ingestion of $0.3g^{-1}.kg^{-1}$ $NaHCO_3$ [12].

It is possible the amateur participants began the exercise with suboptimal PCr stores following an intensive warm up (3 practice sprints and 10-second sprint) and only 5-minutes recovery; with PCr resynthesis reported to reach only 85.5±3.5% of resting levels during 6-minutes recovery following a 30-second sprint in amateur participants [29]. With strong correlations between percentage PCr resynthesis and percentage recovery of power output and maintenance of muscle power output [29] Professional athletes were better able to maintain power output during the repeated sprint than amateur, presumably because the rate of PCr resynthesis is known to be more rapid in professional athletes [30].

Interestingly, pre-exercise blood La concentrations were increased from rest in both professional and amateur participants, suggesting high rates of glycolysis during the warmup. Early studies suggested that La accumulation was the cause of fatigue during high-intensity exercise [31] meaning both professional and amateur participants began the exercise in an acutely relative fatigued state. Although recent reports reject this relationship, with new evidence suggesting reduced rates of PCr resynthesis is the main cause of reduced exercise performance during repeated sprints and not the acidosis resulting from La production [31].

Strong correlations exist between aerobic power and the maintenance of repeated-sprint performance [13]. The increased contribution of aerobic metabolism and reduced contribution of anaerobic glycolysis through repeated sprint repetition as reported by Gaitanos et al. [13] provides sufficient explanation of the current results; where the contribution of anaerobic glycolysis probably fell during sprints 4 and 5, offsetting the potential for performance enhancement by $NaHCO_3$. Further, the probable lower aerobic power of the amateur participants meant they were unable to meet the increased contribution of aerobic metabolism in the latter sprints meaning they were unable to maintain mean power output.

Perspective

Results within this investigation have revealed that despite an improved mean power output of amateur participants in the mid-section of the repeated bouts (sprint 2 and 3) test, $NaHCO_3$ had no greater effect on amateur than professional participants throughout the testing protocol. This is in contrast to previous research who failed to show any performance improvement of professional or amateur players following $NaHCO_3$ supplementation [2]. Furthermore, within this study professional players were better able to maintain power output

How to cite this article: Matthew L Jones, Adam L Owen, Mehdi Rouissi, Karim Chamari. Effects of Sodium Bicarbonate Supplementation on Repeated-sprint Ability in Professional vs. Amateur Soccer Players. J Complement Med Alt Healthcare. 2019; 10(1): 555780. DOI: 10.19080/JCMAH.2019.10.555780

during the repeated-sprint protocol than amateurs, presumably because the rate of PCr resynthesis is known to be more rapid in professional athletes [30]. From a practical perspective, the current investigation although unique in its concept suggests that amateur participants in soccer may benefit from $NaHCO_3$ ingestion more than professional players.

Conclusion

It can be concluded from this particular investigation that despite no significant differences were found concerning the ergogenic effects of $NaHCO_3$ among professional players, there was however a positive effect amongst the amateur soccer participants. Findings revealed how $NaHCO_3$ may be used to create a positive buffering capacity during initial stages of repeated-sprint exercise bouts when supplemented amongst amateur participants or individuals with a less trained physical profile (e.g. recently injured, post-cessation of training). In addition, it was found that the increased levels of alkalosis failed to improve the mean power output of professional participants. Therefore, in conclusion, it may be suggested that amateur participants in soccer may benefit from $NaHCO_3$ ingestion more than professional players.

Acknowledgement

This manuscript is original and not previously published, nor is it being considered elsewhere until a decision is made as to its acceptability by the Editorial Review Board. There are no funding sources and are no conflicts of interest surrounding this scientific investigation.

Conflict of Interest

There are no conflicts of interest concerning this paper.

References

1. Nicholas CW, Nuttall FE, Williams C (2000) The Loughborough Intermittent Shuttle Test: a field test that simulates the activity pattern of soccer. J Sports Sci 18(2): 97-104.
2. Bishop D, Edge J, Davis C, Goodman C (2004) Induced metabolic alkalosis affects muscle metabolism and repeated-sprint ability. Med Sci Sports Exerc 36(5): 807-813.
3. Edge E, Bishop D, Hill-Haas S, Dawson B, Goodman C (2006) Comparison of muscle buffer capacity and repeated-sprint ability of amateur, endurance semi-professional and team-sport athletes. Eur J Appl Physiol 96: 225-234.
4. Mohr M, Krustrup P, Bangsbo J (2003) Match performance of high-standard soccer players with special reference to development of fatigue. J Sports Sci 21(7): 519-528.
5. Bishop D, Girard O, Mendez Villanueva A (2011) Repeated-sprint ability-part II: recommendations for training. Sports Med 41(9): 741-756.
6. Cairns SP (2006) Lactic acid and exercise performance: culprit or friend? Sports Med 36(4): 279-291.
7. Bangsbo J, Mohr M, Krustrup P (2006) Physical and metabolic demands of training and match-play in the elite football player. J Sports Sci 24(7): 665-674.
8. Favero TG, Zable AC, Bowman MB, Thompson A, Abramson JJ (1995) Metabolic end products inhibit sarcoplasmic reticulum Ca2+ release and [3H] ryanodine binding. J Appl Physiol 78(5): 1665-1672.
9. Juel C, Halestrap AP (1999) Lactate transport in skeletal muscle-role and regulation of the monocarboxylate transporter. J Physiol 517(Pt 3): 633-642.
10. Requena B, Zabala M, Padial P, Feriche B (2005) Sodium bicarbonate and sodium citrate: ergogenic aids? J Strength Cond Res 19(1): 213-224.
11. McNaughton LR, Siegler J, Midgley A (2008) Ergogenic effects of sodium bicarbonate. Curr Sports Med Rep 7(4): 230-236.
12. Carr AJ, Hopkins WG, Gore CJ (2011) Effects of acute alkalosis and acidosis on performance: a meta-analysis. Sports Med 41(10): 801-814.
13. Gaitanos GC, Nevill ME, Brooks S, Williams C (1991) Repeated bouts of sprint running after induced alkalosis. J Sports Sci 9(4): 355-370.
14. Cameron SL, Mc Lay Cooke RT, Brown RC, Gray AR, Fairbairn KA, et al. (2010) Increased blood pH but not performance with sodium bicarbonate supplementation in elite rugby union players. Int J Sport Nutr Exerc Metab 20(4): 307-321.
15. Hamilton AL, Nevill ME, Brooks S, Williams C (1991) Physiological responses to maximal intermittent exercise: differences between endurance-trained runners and games players. J Sports Sci 9(4): 371-382.
16. Horswill CA (1995) Effects of bicarbonate, citrate, and phosphate loading on performance. Int J Sport Nutr 5: S111-S119.
17. Le Gall F, Carling C, Williams M, Reilly T (2010) Anthropometric and fitness characteristics of international, professional and amateur male graduate soccer players from an elite youth academy. J Sci Med Sport 13(1): 90-95.
18. Carr AJ, Slater GJ, Gore CJ, Dawson B, Burke LM (2011) Effect of sodium bicarbonate on [HCO_3-], pH, and gastrointestinal symptoms. Int J Sport Nutr Exerc Metab 21(3): 189-194.
19. Mauger AR, Jones AM, Williams CA (2009) Influence of feedback and prior experience on pacing during a 4-km cycle time trial. Med Sci Sports Exerc 41(2): 451-458.
20. Jurca R, Jackson AS, La Monte MJ, Morrow JR, Blair SN, et al. (2005) Assessing cardiorespiratory fitness without performing exercise testing. Am J Prev Med 29(3): 185-193.
21. Inbar O, Rotsein A, Jacobs L, Kaiser P, Dlin K, et al. (1983) The effect of alkaline treatment on short-term maximal exercise. Journal of Sports Science 12: 95-104.
22. Bishop D, Spencer M, Duffield R, Lawrence S (2001) The validity of a repeated sprint ability test. J Sci Med Sport 4(1): 19-29.
23. McLean SR, Norris SR, Smith (2004) Comparison of the lactate pro and the YSI 1500 sport blood lactate analysers. International Journal of Applied Sports Sciences 36: 22-30.
24. Van Montfoort MC, Van Dieren L, Hopkins WG, Shearman JP (2004) Effects of ingestion of bicarbonate, citrate, lactate, and chloride on sprint running. Med Sci Sports Exerc 36(7): 1239-1243.
25. Edge J, Bishop D, Goodman C (2006) The effects of training intensity on muscle buffer capacity in females. Eur J Appl Physiol 96(1): 97-105.
26. Bishop D, Lawrence S, Spencer M (2003) Predictors of repeated-sprint ability in elite female hockey players. J Sci Med Sport 6(2): 199-209.
27. Matson LG, Tran ZV (1993) Effects of sodium bicarbonate ingestion on anaerobic performance: a meta-analytic review. Int J Sport Nutr 3(1): 2-28.

How to cite this article: Matthew L Jones, Adam L Owen, Mehdi Rouissi, Karim Chamari. Effects of Sodium Bicarbonate Supplementation on Repeated-sprint Ability in Professional vs. Amateur Soccer Players. J Complement Med Alt Healthcare. 2019; 10(1): 555780.
DOI: 10.19080/JCMAH.2019.10.555780

28. Costill DL, Verstappen F, Kuipers H, Janssen E, Fink W (1984) Acid-base balance during repeated bouts of exercise: influence of HCO3. Int J Sports Med 5(5): 228-231.

29. Bogdanis GC, Nevill ME, Boobis LH, Lakomy HK (1996) Contribution of phosphocreatine and aerobic metabolism to energy supply during repeated sprint exercise. J Appl Physiol80(3): 876-884.

30. Stolen T, Chamari K, Castagna C, Wisloff U (2005) Physiology of soccer: an update. Sports Med 35(6): 501-536.

31. Macedo DV, Lazarim FL, Catanho da Silva FO, Tessuti LS, Hohl R (2009) Is lactate production related to muscular fatigue? A pedagogical proposition using empirical facts. Adv Physiol Educ 33(4): 302-307.

32. Baguet A, Everaert I, De Naeyer H, Reyngoudt H, Stegen S, et al. (2011) (2011) Effects of sprint training combined with vegetarian or mixed diet on muscle carnosine content and buffering capacity. Eur J Appl Physiol 111(10): 2571-2580.

33. Bishop D, Spencer M (2004) Determinants of repeated-sprint ability in well-trained team-sport athletes and endurance-trained athletes. J Sports Med Phys Fitness 44(1): 1-7.

34. Fitts RH (1994) Cellular mechanisms of muscle fatigue. Physiol Rev 74(1): 49-94.

35. Hopkins W (2002) A scale of magnitudes for effect statistics.

36. News Holme E, Leech A (1989) Biochemistry for the medical sciences. John Wiley and Sons Ltd., London.

37. Price MJ, Singh M (2008) Time course of blood bicarbonate and pH three hours after sodium bicarbonate ingestion. Int J Sports Physiol Perform 3(2): 240-242.

38. Renfree A (2007) The time course for changes in plasma [h+] after sodium bicarbonate ingestion. Int J Sports Physiol Perform 2(3): 323-326.

DOI: 10.19080/JCMAH.2019.10.555780

How to cite this article: Matthew L Jones, Adam L Owen, Mehdi Rouissi, Karim Chamari. Effects of Sodium Bicarbonate Supplementation on Repeated-sprint Ability in Professional vs. Amateur Soccer Players. J Complement Med Alt Healthcare. 2019; 10(1): 555780. DOI: 10.19080/JCMAH.2019.10.555780