



ABSTRACT

Sodium bicarbonate/alkalinization may reduce muscle mitochondrial damage caused by reactive oxygen species during intense exercise. Such damage can induce post-exercise inflammation and pain, which may be linked to delayed onset muscle soreness, or DOMS. However gastrointestinal side effects limit the use of oral sodium bicarbonate.

PURPOSE: This study evaluated the efficacy of a commercially available, topical transdermal sodium bicarbonate (TSB) lotion (Topical Edge™), which is claimed to be delivered through the skin using a novel patent-pending transdermal delivery system for impacting DOMS.

METHODS: 20 trained cyclists (Category 1-3) and professional triathletes participated in this randomized, cross-over, double-blinded, placebo-controlled study. After application of TSB or a placebo, subjects completed a variety of exercise and performance tests varying in duration. On one day, subjects completed a series of high-intensity exercises which included a ramped protocol to a rating of perceived exertion (RPE) of 17 out of 20, a 30-sec sprint performance test, and a 5-min time trial with 5 minutes of recovery between tests. On a separate day, subjects completed a 1-hr time trial. Subjects completed DOMS questionnaires 24- and 48-hours after exercise sessions. Muscle soreness was rated on a scale of 0-100 where 0 = “no soreness”, 25 = “mild pain”, 50 = “moderate pain”, 75 = “severe pain” and 100 = “the worst pain you can imagine”.

RESULTS: DOMS was reduced following the high-intensity series with TSB compared to placebo. Similar effects were not observed following the 1-hr exercise bout. From the first to second day following the high-intensity exercise series, subjects using TSB experienced a 54% reduction in DOMS versus an increase in DOMS of 34% with placebo (p=0.007).

CONCLUSIONS: Findings from this study suggest that TSB can significantly shorten recovery from DOMS following high-intensity exercise. Findings also support the effectiveness of the transdermal system in delivering sodium bicarbonate topically and may allow athletes to achieve these results while avoiding the side-effects of oral bicarbonate. Furthermore, we believe this study is the first to provide a direct link between sodium bicarbonate use and DOMS in athletes. Additional research is underway to further substantiate these findings.

INTRODUCTION

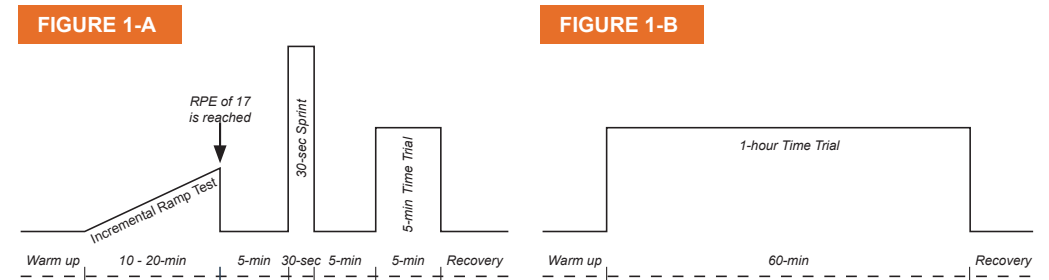
DOMS is characterized by discomfort of muscles peaking 24-48 hours following exercise. A body of evidence is mounting that suggests that generation of reactive oxygen species (ROS) after strenuous exercise may be involved in DOMS. The significant increase in ROS (superoxide, nitric oxide, hydrogen peroxide and hydroxyl radical) release, following muscle contractions, leads to oxidative stress. Research has recently shown that alkalization reduces ROS release. Therefore, theoretically, since oxidative stress-related muscle damage may be a key contributor to DOMS, the use of sodium bicarbonate may reduce DOMS following intense exercise. However gastrointestinal side effects limit the use of oral sodium bicarbonate.

HYPOTHESIS: We hypothesized that the topical transdermal sodium bicarbonate (TSB) lotion (Topical Edge PR™) would positively impact DOMS. Specifically it would lower the DOMS score at ~24 hours after exercise and would result in faster recovery from DOMS as observed by a larger decrease in DOMS scores from ~24 hours to ~48 hours after exercise.

METHODS

- 20 trained cyclists (Category 1-3) and professional triathletes with an average VO₂ Peak (VO₂mL/kg/min) of 58.9+/-7.2 participated in this randomized, cross-over, double-blinded, placebo-controlled study.
- After application of Transdermal Sodium Bicarbonate (TSB) or placebo lotions, subjects completed a variety of exercise and performance tests (Figure 1).
- Subjects completed delayed-onset muscle soreness (DOMS) questionnaires ~24 and ~48 hours after exercise sessions. Muscle soreness was rated on a scale of 0-100 where 0 = “no soreness”, 25 = “mild pain”, 50 = “moderate pain”, 75 = “severe pain” and 100 = “the worst pain you can imagine”.
- Statistical analyses were performed using a mixed effects linear model with subject as a random effect and DOMS as a fixed effect. DOMS results are reported as least-squares means ± SE. Post hoc analyses were completed to analyze DOMS results for the subset of subjects reporting scores >0 at day 1 after exercise. Significant differences are p≤0.05.

Figure 1. Schematic of Study Protocol. Subjects completed both tests; A) High-intensity series of exercise tests, and B) 1 hour time trial, on separate days, and for each study product (placebo or active).



RESULTS

- DOMS, measured over a 2-day period following exercise testing, showed faster recovery from muscle soreness with TSB lotion use versus placebo lotion after the series of high-intensity exercise tests, but not after the longer duration 1-hour time trial.
- A post hoc analysis of DOMS reporters (those who reported scores >0) and non-reporters (those consistently reporting scores of 0 points) at ~24 hours after testing, was also completed. In DOMS reporters (n=9 placebo and n=11 TSB) the reduction in DOMS was significantly greater (p=0.02) for TSB versus placebo (Figure 3).
- In this sub-population, although baseline scores were similar, there was a significantly different (p=0.02) mean (±SD) scores of 10.5 ±2.9 for TSB, and 21.0 ±3.3 for placebo at 48 hours.
- Additionally, for DOMS reporters, when evaluating % change from 24 hours to 48 hours while adjusting for ~24 hour observed values, TSB use resulted in a 54% reduction in DOMS scores versus an increase in DOMS scores of 34% when using placebo (p=0.007).

Figure 2. Delayed-onset muscle soreness (DOMS) was measured on a 0-100 point scale. *Subjects had a significantly greater reduction in DOMS when using the transdermal sodium bicarbonate lotion compared to the placebo lotion (p=0.045).

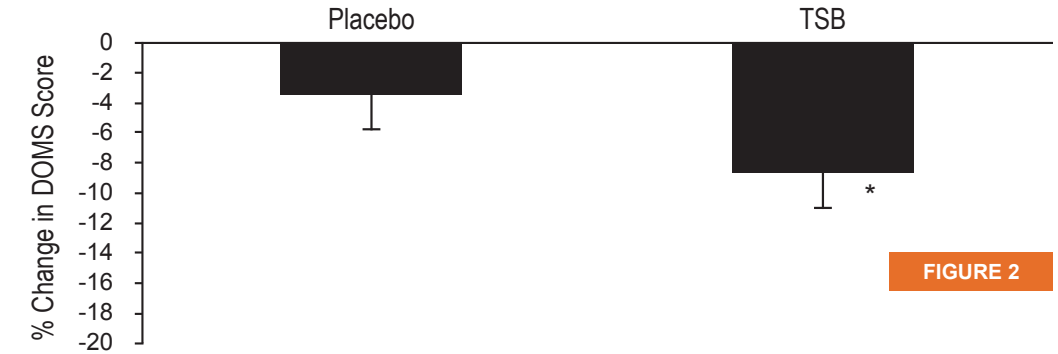
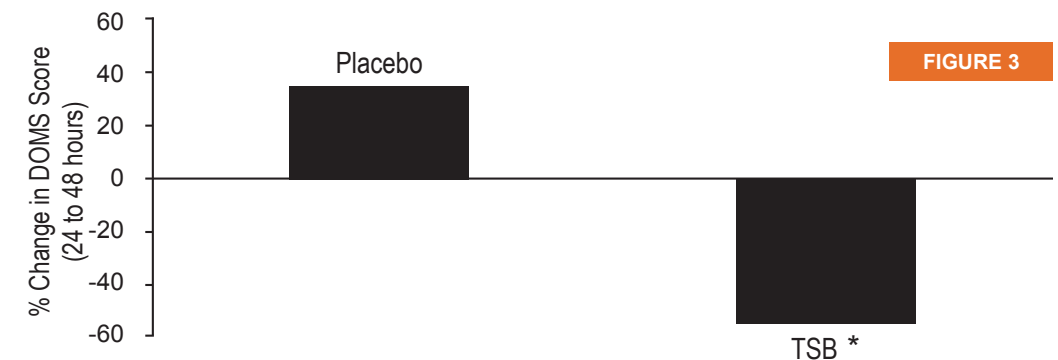


Figure 3. Delayed-onset muscle soreness (DOMS) was measured on a 0-100 point scale. In subjects who reported scores of >0 (n=9 placebo and n=11) the % change in DOMS scores from 24 to 48 hours was had a significantly greater reduction when using the transdermal sodium bicarbonate lotion compared to the placebo lotion (p=0.007, indicated by *).



CONCLUSIONS

- Findings from this study suggest that TSB can significantly shorten recovery from DOMS following high-intensity exercise.
- Findings also support the effectiveness of the transdermal system in delivering sodium bicarbonate topically and may allow athletes to achieve these results while avoiding the side-effects of oral bicarbonate.
- Furthermore, we believe this study is the first to provide a direct link between sodium bicarbonate use and DOMS in athletes.
- Additional research is underway using an objective measure of DOMS to further substantiate these findings and to further elucidate the mechanisms that may be responsible for this observation.

ACKNOWLEDGMENTS

Ampersand Biopharmaceuticals, LLC (DBA AmpHP), the manufacturers of Topical Edge PR sodium bicarbonate sports lotion, provided an unrestricted research grant and placebo and active products for testing.



ABSTRACT

Oral sodium bicarbonate has been used for decades as an ergogenic aid by buffering muscle acid production during exercise and subsequently delaying the onset of fatigue in athletes. However, gastrointestinal side effects limit the use of sodium bicarbonate.

PURPOSE: This study evaluated the efficacy of a commercially available topical transdermal sodium bicarbonate (TSB) lotion (Topical Edge™) which is claimed to be delivered through the skin using a novel patent-pending transdermal delivery system for impacting exercise metabolism and performance.

METHODS: 20 trained cyclists (Category 1-3) and a professional triathlete participated in this randomized, cross-over, double-blinded, placebo-controlled study. After application of TSB or placebo lotions, subjects completed a variety of exercise and performance tests. On one day, subjects completed a high-intensity series of exercise tests which included a ramped protocol until reaching a rating of perceived exertion (RPE) of 17 out of 20, a 30-second sprint performance test, and a 5-minute time trial performance test, with 5 minutes of recovery between tests. On a separate day, subjects completed a 1-hour time trial. Heart rate, RPE, blood lactate and pH were assessed before, during, and after performance testing.

RESULTS: Heart rate and RPE were significantly ($p < 0.05$) lower for TSB compared to placebo at the 15-min mark of the 1-hour time trial, but not at other time points. When TSB was applied, lactate was higher ($p < 0.05$) after the high-intensity ramp, sprint and 5-min time trial series (10.8 ± 3.2 mmol/L versus 9.7 ± 3.1 mmol/L for TSB and placebo, respectively). Similar effects were not observed after the 1-hour time trial. Significance was not reached when examining performance differences ($p > 0.05$).

CONCLUSIONS: Overall, the findings from this study provide evidence that TSB can significantly impact blood lactate, heart rate and RPE during performance tests of varying intensity/length. These significant findings support the ability of this lotion to transdermally deliver sodium bicarbonate, which could allow athletes to avoid the side-effects of oral bicarbonate use. Further research is warranted to substantiate these findings and determine the most effective use for this commercially available transdermal sodium bicarbonate lotion.

INTRODUCTION

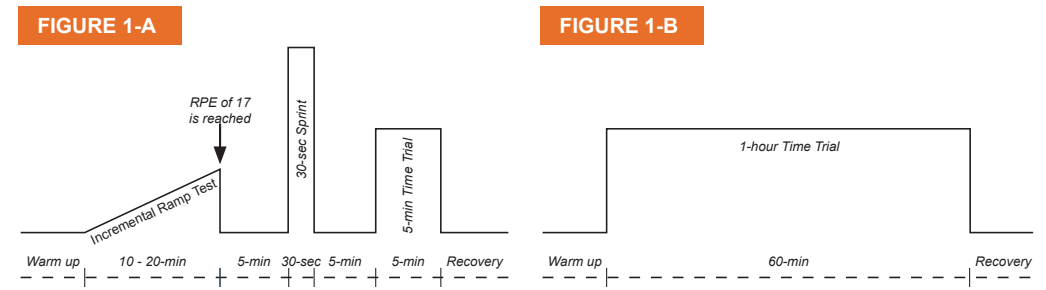
Muscle acidosis is a contributor to reduced exercise capacity by causing subsequent muscle fatigue. Oral sodium bicarbonate has been used for decades to buffer muscle acid production during exercise and subsequently delay the onset of fatigue in athletes. Several studies of cyclists have demonstrated the ergogenic effects of sodium bicarbonate. However, gastrointestinal side effects limit its use. A commercially available sports lotion has recently been developed using the manufacturer's patent-pending transdermal delivery technology to deliver sodium bicarbonate through the skin in order to impact performance and recovery without the limiting side-effects of oral use.

HYPOTHESIS: We hypothesized that the topical transdermal sodium bicarbonate (TSB) lotion (Topical Edge PR™) would increase pH and lactate levels, and would confer a performance benefit, similar to the effects observed when oral sodium bicarbonate is ingested, but without the gastric side-effects.

METHODS

- 20 trained cyclists (Category 1-3) and a professional triathlete with an average VO_2 Peak (VO_2 mL/kg/min) of 58.9 ± 7.2 participated in this randomized, cross-over, double-blinded, placebo-controlled study.
- After application of Transdermal Sodium Bicarbonate (TSB) or placebo lotions, subjects completed a variety of exercise and performance tests (Figure 1).
- Heart rate, RPE, blood lactate and pH were assessed before, during, and after performance testing.

Figure 1. Schematic of Study Protocol. Subjects completed both tests; A) High-intensity series of exercise tests, and B) 1 hour time trial, on separate days, and for each study product (placebo or active).



RESULTS

- When TSB was applied, lactate was higher ($p < 0.05$) after the high-intensity ramp, sprint and 5-min time trial series (10.8 ± 3.2 mmol/L versus 9.7 ± 3.1 mmol/L for TSB and placebo, respectively) (Figure 2).

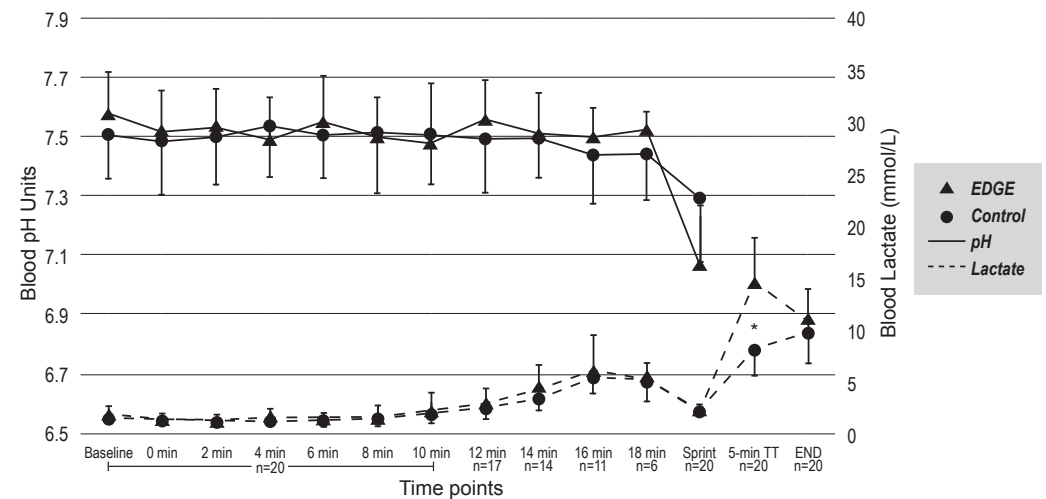


Figure 2. Blood pH and Lactate. When the transdermal sodium bicarbonate lotion was applied, subjects had significantly higher lactate levels following the high-intensity series of tests compared to when applying placebo lotion. pH differences did not reach significance.

- Heart rate and RPE were significantly ($p < 0.05$) lower for TSB compared to placebo at the 15-min mark of the 1-hour time trial, but not at other time points (Figure 3).
- Significance was not reached when examining other performance differences ($p > 0.05$). This may potentially be due to inadequate dosing or inadequate time allowed for the lotion to penetrate prior to testing.

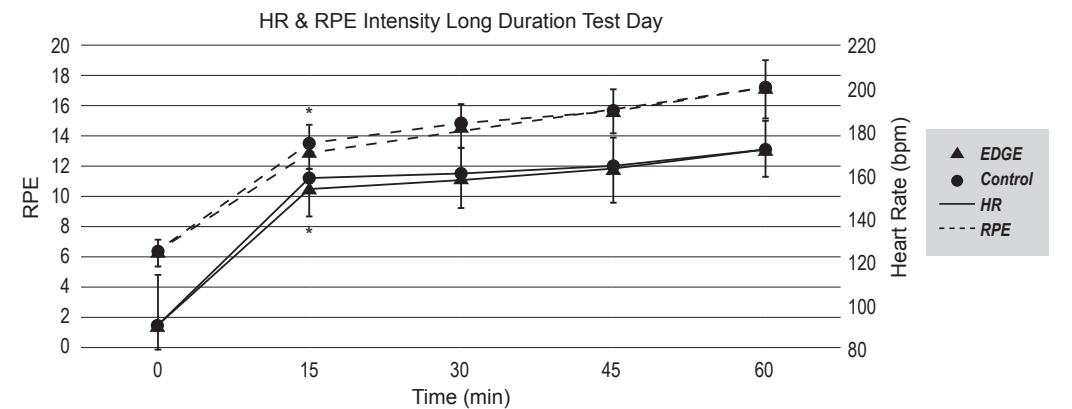


Figure 3. Heart Rate (HR) and Rate of Perceived Exertion (RPE). When the transdermal sodium bicarbonate lotion was applied, subjects had significantly lower HR and RPE at the 15 min. time point of the 1 hour time trial despite completing the same total work load.

CONCLUSIONS

- Transdermal sodium bicarbonate significantly impacted blood lactate, heart rate and RPE during performance tests of varying intensity/length.
- Higher lactate levels and other significant effects support the ability of this lotion to transdermally deliver sodium bicarbonate.
- This route of bicarbonate delivery could allow athletes to avoid the side-effects of oral bicarbonate use.
- Although promising, further research is warranted to substantiate these findings and determine the most effective dosing and time of application for this commercially available transdermal sodium bicarbonate lotion.

ACKNOWLEDGMENTS

Ampersand Biopharmaceuticals, LLC (DBA AmpHP), the manufacturers of Topical Edge PR sodium bicarbonate sports lotion, provided an unrestricted research grant and placebo and active products for testing.