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Effect of a carbohydrate mouth rinse on maximal sprint performance in competitive male cyclists

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Abstract

There is evidence that rinsing the mouth with a carbohydrate (CHO) solution can improve endurance performance. The goal of this study was to investigate whether a CHO mouth rinse can improve the performance of a maximal sprint effort. Fourteen competitive male cyclists ($64.0 \pm 5.6\,mL\,kg^{-1}\,min^{-1}$ (mean ± SD)) each completed the following 5-s mouth rinse trials in a randomised counter-balanced order; (a) 6.4% maltodextrin solution [Mal], (b) 7.1% glucose solution [Glu], (c) water [Wa] and (d) a control trial with no rinse [Con]. Each participant then performed a 30-s maximal sprint effort on a cycle ergometer. Glu, Mal and Wa trials were not significantly different from Con across all indicators of sprint performance (maximal power output, mean power output over 0–30, 0–10, 10–20, and 20–30 s), nausea or fatigue level ($p > 0.05$). These findings suggest that the use of a 5-s mouth rinse with an isoenergetic amount of either maltodextrin or glucose is not beneficial for maximal sprint performance.

Keywords: Mouthwash; Supramaximal exercise; Glucose; Power output; Nausea; Bicycle ergometry test

1. Introduction

It is well recognised that carbohydrate (CHO) ingestion before and during exercise can improve performance in prolonged endurance events.[1] This ergogenic effect may be due to glycogen 'sparing',[2] or delayed onset of fatigue by maintaining euglycemia and high rates of blood glucose oxidation late in exercise.[1] However, these proposed mechanisms do not explain the ergogenic effect of CHO ingestion for events lasting 1 h or less. Furthermore, the improved exercise performance under these conditions cannot be explained by the small rate at which exogenous CHO is oxidised compared to the total CHO oxidation rate.[3] These observations have led to the view that the effect of CHO ingestion on short duration endurance events may be related to a non-metabolic central influence on the brain.

In order to investigate the possibility of a non-metabolic central effect of CHO on short-term endurance performance, Carter et al.[4] examined the effect of rinsing the mouth repeatedly with a CHO solution on cycle time trial performance. Compared to rinsing the mouth with a water placebo, the CHO mouth rinse resulted in a significant 2.9% improvement in performance. Others have also reported that a CHO mouth rinse improves both cycling and running performance compared to a similar tasting placebo.[5–7] However, it is important to acknowledge that some have found no improvement in performance with a CHO mouth rinse compared to placebo.[8,9]

Part of the benefit of a CHO mouth rinse on endurance performance may result from the stimulation of CHO taste receptors in the oral cavity leading to an increase in central drive or motivation.[4] In support of this view, it has been suggested that the sweet taste of CHO affects central reward systems in the brain.[10] More recently, Chambers et al.[5] provided fMRI-based evidence that the observed ergogenic effect of both sweet and non-sweet CHO mouth rinses on performance may be due to the activation of brain areas associated with reward and the regulation of motor activity. This raises the intriguing, but untested possibility, that a CHO mouth rinse might also improve performance in the types of activities that could benefit from enhanced central drive and motivation such as those involving a maximal sprint effort.

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Given that the activation of muscle fibres may be inhibited to some extent even in a maximal effort,[11] it is possible that there is scope for improvement in maximal exercise performance with the appropriate ergogenic aid. This possibility is further supported by a recent study reporting that the presence of CHO in the mouth facilitates corticomotor output to both fresh and fatigue muscle, independent of endogenous glycogen reserves.[12] For these reasons, the purpose of the present study was to investigate the effect of a CHO mouth rinse on maximal sprint performance and several indicators of central discomfort associated with a maximal effort.

2. Methods

Fourteen trained male cyclists (mean ± SD age: 28.7 ± 4.0 years, height: 178.3 ± 6.4 cm, mass: 74.8 ± 6.9 kg, peak rate of oxygen consumption ($\dot{V}O_{2peak}$) 64.0 ± 5.6 mL kg^{-1} min^{-1}, sum of eight skinfolds: 82.1 ± 37.1 mm) were recruited for this study. Participants were fully informed of the testing procedures before their written informed consent was obtained. However, in order to minimise the possibility of a placebo effect, they were deceived about the true aims of the study and were initially told that the purpose of the study was to determine the effect of a CHO mouth rinse on pH and blood lactate levels during recovery from a maximal sprint effort. After completing all trials, participants were debriefed of the true aims of the study. The procedures were approved by the Human Research Ethics Committee of The University of Western Australia.

The participants attended the laboratory on five separate occasions, each separated by at least 1 week. The initial visit involved a familiarisation session during which anthropometric data (height, body mass and sum of eight skinfolds) and $\dot{V}O_{2peak}$ were obtained. The $\dot{V}O_{2peak}$ was determined using a graded exercise test on an air-braked cycle ergometer (Repco Cycle Company, Huntingdale, Victoria). The test commenced at 200 W, after which the workload was increased by 30 W every 3 min following a 1-min rest period until volitional exhaustion. Following the $\dot{V}O_{2peak}$ test, the participants were familiarised with the "all-out" sprint protocol to be used in the experimental trials. This involved the performance of 3 practice starts that required the participants to pedal at maximal intensity for 2–3 s interspersed with 20 s of slow pedalling. The participants were then allowed to rest for 5 min before performing a 30-s 'all-out' cycling effort. Before leaving the laboratory, the participants were provided with a log book and asked to record their food intake and physical activity for 48 h prior to the first experimental trial. Each participant was asked to replicate the same diet and activity pattern before all subsequent trials. They were also instructed to avoid strenuous activity, alcohol and caffeine for 24-h prior to each trial.

Each of the subsequent four trials involved one of the following mouth rinse treatments for a duration of 5 s; (a) 25 mL of 6.4% (w/v) maltodextrin solution (Mal; Polycose, Ross Laboratory, Columbus, OH), (b) 25 mL of 7.1% (w/v) glucose solution (Glu; equivalent energy content to the maltodextrin solution; Glucodin, Boots Healthcare, NSW, Australia), (c) 25 mL of water (Wa; as a tasteless and aroma-less control to mimic the somatosensory effects induced by the presence of a liquid in the mouth[13]; Direct-Q 5 Ultrapure Water System, Millipore, MA, USA), and (d) no mouth rinse prior to exercise (Con). The trials were administered following a randomised, partially double blind (Con treatment could not be blinded to participants or the tester), counter-balanced design, with each visit separated by 1 week and conducted at the same time of morning after an overnight fast.

Prior to each experimental trial, participants performed a 4-min light cycling warm up followed by one practice start during which they pedalled close to maximal intensity for 2–3 s followed by a 10-min rest. After the fifth minute of rest, participants provided a rating of perceived exertion (RPE[14]), nausea (NP[15]) and fatigue[16] since sweet taste may decrease pain[17] through a release of β-endorphin in the brain.[18] An additional assessment of nausea was obtained using a 100 mm visual analogue scale (VAS), anchored by the descriptors 'no nausea' and 'extreme nausea' at each end. Approximately 2 min before exercise, a capillary blood sample (125 μL) was taken from a hyperaemic earlobe. Then, immediately before exercise, the participants rinsed their mouth with the assigned mouth rinse for 5 s before expelling the fluid into a plastic container to be weighed to evaluate any possible ingestion of fluid.

Thereafter each participant performed a 30-s maximal sprint cycling effort. The cycle ergometer was interfaced with a customised program (Cyclemax, School of Sport Science, Exercise and Health, The University of Western Australia) to allow for the measurement of maximal power output (P_{max}), mean power output over 0–30 s ($P_{0–30}$), 0–10 s ($P_{0–10}$), 10–20 s ($P_{10–20}$), and 20–30 s ($P_{20–30}$) of the sprint. Fatigue index, which reflects the power decline during each trial expressed as a percentage of peak power, was also determined.[19] All maximal sprint efforts were initiated in a standing position, with the preferred foot starting at the "two o'clock" position. Participants were instructed to cycle in an 'all-out' manner for 30 s without pacing themselves. At 7th min post-exercise, capillary blood (125 μL) was sampled and analysed for blood pH and concentrations of lactate and glucose (ABL 735 blood gas analyser, Radiometer, Copenhagen, Denmark). In addition, participants were asked to rate their RPE, nausea and fatigue.

The effects of the mouth rinse treatment on each performance variable were compared with the Con treatment trial using one-way repeated measures ANOVA followed by Dunnett *post hoc* tests and differences accepted at $p < 0.05$. All other variables measured pre- and post-exercise were compared using two-way repeated measure ANOVA followed by Bonferroni *post hoc* tests (Statistical Package for the Social Sciences Version 17.0 for Windows software, Chicago, IL). Cohen's effect sizes (ES) were also used to highlight any