MALTODEXTRIN’S EFFECT ON THE PERFORMANCE OF ELITE MOUNTAIN BIKING ATHLETES DURING SIMULATED COMPETITION AND ON POWER OUTPUT AT THE VENTILATORY THRESHOLD

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ABSTRACT

Purpose. To aim of this study was to analyze the effects of maltodextrin supplementation on cardiovascular and performance parameters during simulated Mountain Biking (MTB) competition as well as the cardiorespiratory and blood glucose (BG) response to a maximal test performed in a laboratory on elite MTB athletes. Methods. A total of eight male bikers [age: 28.4 ± 10.6 years; body fat: 9.46 ± 3.76 %; VO2max: 55.31 ± 4.7 mL/kg/min], participated in a double-blind study. The athletes received maltodextrin supplementation (1g/kg) or a placebo (light tangerine juice) 20 min before competition (seven 2 km laps) or before a laboratory maximal test. An incremental exercise test on a cycloergometer was performed to find any alterations in maximal HR, Watts max, VO2max, VEmax, and VO2 at the ventilatory threshold (VT), using a gas exchange analyzer. Comparisons between the simulated competition and laboratory variables (maltodextrin vs. placebo) were made using ANOVA and a two-tailed paired Student’s t-test, where \( p < 0.05 \) was considered statistically significant. Results. Maltodextrin supplementation reduced 26 s in the mean time spent on completing all laps (Maltodextrin: 9 min and 16 s vs. placebo: 9 min and 35 s; \( p < 0.05 \)). In laboratory testing, maltodextrin raised BG during exercise (Maltodextrin: 104.1 ± 20.9 mg/dL vs. placebo: 88.2 ± 5.3 mg/dL; \( p < 0.05 \)), power output at the ventilatory threshold (Maltodextrin: 260.8 ± 12.9 vs. placebo: 150.5 ± 8.7; \( p < 0.05 \)) but had no effect on cardiorespiratory variables. Conclusion. Maltodextrin was found to enhance athletic performance during MTB competition, showing that it can play an important role in supplementation strategies for these competitors.

Key words: supplementation, maltodextrin, cyclist, performance

Introduction

Mountain biking cross-country cycling (MTB) is a popular alpine outdoor recreational activity and an Olympic sport since 1996, [1] characterized by off-road circuits with continuous climbs and descents on gravel and field paths. The International Cycling Union (UCI) suggests an optimal competition winning time of 105 to 135 minutes and is performed at an average heart rate close to 90% of the maximum, corresponding to 84% of maximum oxygen uptake (VO2max) [1, 2]

Mountain bikers’ physiological characteristics indicate that aerobic power and the ability to sustain high work rates for prolonged periods of time are prerequisites for competing at a high level in off-road cycling events [2].

However, there are other factors than aerobic power and capacity that might influence off-road cycling performance and therefore, require further investigation. These include off-road cycling economy, anaerobic power and capacity, technical ability and pre-exercise nutritional strategies. The importance of proper nutrition, such as carbohydrate (CHO) supplementation pre-, during and post-exercise, has been shown to increase the amount of work that can be performed [3–5] as well as the duration of aerobic exercise [6, 7]. The elevation of blood glucose (BG) associated with supplementation is suggested to improve aerobic performance through the reduction of muscle glycogen use [7–10] or through the use of BG as a predominant fuel source as glycogen becomes depleted [4, 9, 11].

CHO provides most of the energy for high-intensity endurance exercise (85% to 100% VO2max) when compared with other nutrients. Consequently, a high-CHO diet could be more appropriate for athletes competing in endurance events because of greater pre-exercise muscle-glycogen availability in heavily recruited
muscle fibers and due to an enhanced glycolytic metabolism [12].

One frequent way of delivering CHO pre-, during and post-exercise is through the use of sports beverages. However, one of the disadvantages of such sports beverages is their monosaccharide and disaccharide composition, making the beverage very sweet. One alternative is the use of hydrolized soluble starch (maltodextrin), which has a major advantage when compared to mono- and disaccharides as it is not as sweet and, therefore, allows for solutions with concentrations of 10 g per 100 ml or more (10% m/V). Such a concentration is more acceptable than glucose, sucrose or fructose solutions, which are far sweeter. Although being a complex carbohydrate, maltodextrin is considered to be a carbohydrate with a high glycemic index, capable of retaining the glycemic levels of glucose, but with the advantage of preventing the fast accumulation of glucose at the beginning of exercise, which could result in hypoglycemia as a consequence of high insulin secretion [13].

However, the effect of maltodextrin supplementation on athletes’ heart rate intensity and performance at different moments of MTB competition has not yet been reported. Therefore, the aim of this study was to analyze the effects of maltodextrin supplementation on heart rate intensity and lap times during competition, as well as power output, and cardiorespiratory and BG response during a maximal laboratory test performed on elite Brazilian MTB athletes.

Material and methods

A total of eight elite Brazilian MTB athletes [age: 28.4 ± 10.6 years; body fat: 9.46 ± 3.76%; VO₂max: 55.31 ± 4.7 mL/kg/min], participated in the double-blind study. Informed consent was obtained for the study in accordance with Resolution 196/96 of the National Health Council in Brazil, which was approved by the local Ethics Committee (prot. n. 03454/2008).

One week prior to competition, the cyclists were evaluated in a laboratory to obtain their physiological and physical parameters. Body mass and height were measured using anthropometrical devices (Welmy Corp., Brazil). Body fat was measured by means of the skinfold technique [14, 15], using a skinfold caliper (Cescorf Corp., Brazil).

For the first simulated competition (based on a Olympic Cross Country competition), the athletes received oral supplementation with a placebo (dose: 1g/kg; light tangerine juice). For the second simulated competition, they received maltodextrin (dose: 1g/kg; DNA Design Nutrition Advanced) dissolved in distilled water 20 min before the competition (seven 2 km laps). Similarly, this procedure was used for the laboratory maximal test, held during a seven-day interval between the two competitions.

The athletes were advised not to train 24-hours before the maximal laboratory test. The maximal laboratory test was performed on a Biotec-1800 cycloergometer (CEFISE, Brazil), at 60 rpm, with an initial resistance set at 50 W, where each 3 min stage was increased by 25 W until the athletes reached exhaustion. Maltodextrin or placebo supplementation was used to verify alterations in maximal heart rate, Wattsmax, VO₂max, VEmax, VO₂ at the ventilatory threshold (VT) using a TrueOne 2400 gas exchange analyzer (ParvoMedics, USA). The heart rate was monitored every 5 s from the beginning to the end of the competition by means of a cardiac monitor (Polar Team System, Finland).

Exhaustion was defined as the point when an athlete was no longer capable of maintaining an appropriate pedaling rate of 55–60 rpm. The highest VO₂ value obtained during the last minute of exercise was considered the VO₂max [16].

The ventilatory threshold was determined by plotting ventilation (Vₐ) vs. oxygen consumption (VO₂) values [17]. Two linear regression lines were fit to the lower and upper portions of the Vₐ vs. VO₂ curve before and after the break points, respectively. The intersection of these two lines was defined as the VT.

Open circuit spirometry was used to analyze the gas exchange data using the TrueOne 2400 Metabolic Measurement System (ParvoMedics, USA). Oxygen and carbon dioxide were analyzed through a sampling line after the gases passed through a heated pneumotach and mixing chamber. The data were averaged over 15-second intervals. The highest average VO₂ value during the test was recorded as the VO₂max if it coincided with at least two of the following criteria: (a) a plateau in the heart rate (HR) or with HR values within 10% of the age-predicted HRmax, (b) a plateau in VO₂ (defined as an increase of no more than 150 ml · min⁻¹), and/or (c) a respiratory exchange rate (RER) value greater than 1.15 [16].

Capillary blood samples were used to determine glucose concentrations using an ACCU–CHEK Performa digital glucose meter (Roche, Australia), and an ACCU-CHEK Multiclix lancetator (Roche, Australia), performed at grade 5 on the distal phalange on the right hand’s third finger prior to testing (basal), twenty minutes after maltodextrin or placebo consumption and immediately after the end of the maximal test in laboratory. The subjects abstained from food 6 hours before all experiments.

All data are expressed as means ± SEM. The statistical analyses of BG at rest (maltodextrin vs. placebo) and immediately at the end of exercise (maltodextrin vs. placebo) were carried out by one-way ANOVA. The physiological parameters (maltodextrin vs. placebo) analyzed in the laboratory were carried out by the two-tailed paired Student’s t-test. Comparisons between each lap (total of 7 laps) during competition and the laboratory variables comparisons (maltodextrin vs. pla-
Results

During the simulated competition, the athletes recorded heart rates of 180 to 190 bpm, which represents a predominant intensity at 80–90% of HRmax (Fig. 1). This intensity is in accordance with recent publications showing the cardiovascular demands during competition for elite mountain biking competitors [1, 2, 18].

The two marked areas in Figure 1 found that maltodextrin induced minor cardiovascular demand in the first thirty minutes, allowing the athletes to finish faster in the competition (see end exercise). In relation to the time spent on each lap, maltodextrin supplementation enhanced performance during the simulated competition, reducing ~20 s in mean lap time (CHO: 9 min and 16 s vs. placebo: 9 min and 35 s; p < 0.05; Fig. 2), finishing the competition approximately ~3 min faster.

In laboratory tests, maltodextrin increased the BG level when at rest (CHO: 109.7 ± 7.7 vs. placebo: 84.1 ± 2.1 mg/dL; p < 0.05) and during exercise (CHO: 104.1 ± 7.4 mg/dL vs. placebo: 88.2 ± 1.9 mg/dL; p < 0.05; Fig. 3). In addition, maltodextrin increased the power output at the ventilatory threshold (CHO: 260.8 ± 12.9 W vs. placebo: 150.5 ± 8.7 W; p < 0.0001; Tab. 1), but did not increase maximal power output or other physiological variables, such as maximal HR during laboratory tests, maximal HR during competition; the mean percent of reserve HR during competition; VO2max at the ventilatory threshold; VO2max – maximal oxygen uptake.

Discussion

A substantial number of scientific papers have been published describing the relationship exercise intensity and the effects of various CHO supplements during road cycling [19–25], but there are few scientific papers focused on the effect of maltodextrin supplementation in pre-competition or laboratory testing nor how it modifies off-road cycling performance parameters. Recent studies have found that carbohydrate drinks (glucose, maltose and sucrose administrated at 0.65 g/kg before a performance test and then 0.2 g/kg every 15 min during every 1 h of testing), when compared to a placebo (maltodextrin in low doses), increased plasma glucose levels but did not enhance performance during the test (a 1 h test) after glycogen-depletion protocol initiated [26]. The data suggested that although carbohydrate drinks help maintain plasma glucose at a higher level, they have no effects on performance after the glycogen-depleting exercise. In fact, the optimal reserve of pre-exercise glycogen is very important.
during an endurance competition. In other studies, carbohydrate supplementation has been shown to increase the amount of work that can be performed [3–5] as well as increase the duration of aerobic exercises [6, 7]. The elevation of blood glucose, found in the laboratory test, can be associated with improved aerobic performance through the reduction of muscle glycogen use [7, 27, 28] or through the use of blood glucose as a predominant fuel source as glycogen becomes depleted [4, 9, 11].

As was found in this study, maltodextrin supplementation induced better velocity during competition and increased the power output at the ventilatory threshold during laboratory test. The better performance observed during the competition suggests, but does not prove that maltodextrin supplementation can induce minor glycogen depletion during such mountain biking competitions [4, 9, 11].

The simulated off-road competition used in the present study consisted of highly intensive exercise, where the athletes achieved a cardiac rate from 80% to 90% of HR reserve during approximately 100 min of the competition. This model of simulated competition is in accordance with a previous study, in which a similar test protocol was used, with the aim of depleting glycogen (60 min at 70% of VO2max). In that same study, supplementation with high concentrations of carbohydrates (500 g−1), such as maltodextrin with fructose or maltodextrin with glucose, were not able to enhance performance, but improved the pre-competition muscle glycogen levels and plasmatic glucose concentrations [29].

A wide array of articles show the benefits of supplementation with CHO, where many of these papers use glucose and other CHOs before exercise [30, 31]. However, this study found novel data with maltodextrin supplementation used before exercise, which has a smaller glycemic index when compared to glucose solutions and can avoid rebound hypoglycemia and, as such, decrease endurance performance. In a study conducted by the authors of this paper with rats, plasmatic glucose concentration, insulin responses and fatty acid mobilization (analyzed by blood glycerol concentration) were not statistically different when the difference between a glucose polymer (maltodextrin) and a placebo was analyzed [8].

In the laboratory maximal test, maltodextrin induced an increase in power output at the ventilatory threshold but not in VO2max (at the ventilatory threshold) or maximal oxygen uptake. These data suggest that maltodextrin induced positive effects in performance predominately during sub-maximal intensities and can be used as part of a nutritional strategy for an athlete’s optimized performance during different training phases at sub-maximal intensities as well as during competitions.

**Conclusion**

Maltodextrin enhanced performance during Mountain Biking competition, showing that maltodextrin supplementation can be used as part of nutritional strategy for competing athletes. The results from this study suggest further research is needed in analyzing different dosing of maltodextrin and the consequent glycogen levels and their relation to performance and physiological markers during laboratory simulated mountain biking competition.

**References**

C.R. Maneck Malfatti et al., Maltodextrin enhanced performance of cyclists


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