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The Effects of Carbohydrate, Caffeine, L-Menthol, and Combination (Carbohydrate + Caffeine + L-Menthol) Mouth Rinsing on Intense Intermittent Exercise Performance

Nur Irdina Farhani, Adam Linoby*, Muhammad Azizi Shah, Azwa Suraya Mohd Dan, Harris Kamal Kamaruddin, Reshandi Nugraha, and Marco Machado.

Abstract | Mouth rinsing with solutions containing carbohydrates (CHO), caffeine (CAF) and L-menthol (MEN), has been suggested to enhance exercise performance by providing ergogenic effects through various mechanisms such as oral sensing and improved perceptual responses. However, the individual and combined impacts of these substances on high-intensity intermittent exercise remain unclear. This study aimed to address this research gap by examining the effects of CHO, CAF, MEN, and their combination (CHO+CAF+MEN; MIX) on exercise performance, heart rate (HR), and rating of perceived exertion (RPE) in recreationally active young men. Eighteen participants (mean ± SD: (mean ± SD: age 22 ± 2 years, body mass 62 ± 7 kg, height 168 ± 0.06 cm, VO2 max 48 ± 3 mL/kg/min) underwent a randomized, double-blind, placebo-controlled crossover study involving six trials with different mouth rinse conditions. Results indicated that CHO mouth rinsing significantly enhanced performance in the Yo-Yo intermittent recovery level 1 (Yo-Yo IR1) test compared to placebo (PLA) and control (CON) (CHO: 1440 ± 288 m vs. PLA: 1383 ± 282 m, and vs. CON: 1373 ± 282 m; both $p < 0.05$), but not when compared to other rinses. RPE values for the CHO condition were significantly lower than PLA and CON during the Yo-Yo IR1 tests ($p < 0.05$). No significant differences in HR were observed among the conditions. These findings suggest that CHO mouth rinsing can enhance intermittent exercise performance, possibly by reducing perceptual effort, offering a practical strategy for athletes and active individuals.

Keywords: *Mouth rinsing, carbohydrate, caffeine, L-menthol, exercise performance.*

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I. INTRODUCTION

Recent research suggests that mouth rinsing with carbohydrate (CHO), caffeine (CAF), or L-menthol (MEN) solutions can enhance exercise performance and affect physiological responses [1]. However, the independent and combined effects of these substances on high-intensity intermittent exercise remain unclear [2]. This study aims to assess the separate and combined impacts of mouth rinses containing CHO, CAF, MEN, and CHO+CAF+MEN (MIX) on performance during high-intensity intermittent exercise. The study will also examine changes in heart rate (HR) [3] and rating of perceived exertion (RPE) [4].

II. METHODS

Eighteen participants (mean ± SD: age 22 ± 2 years, body mass 62 ± 7 kg, height 168 ± 0.06 cm, $\dot{V}o_{2max}$ 48 ± 3 mL·kg·min^{-1}) underwent a randomized, double-blind, placebo-controlled crossover study involving 6 trials with different mouth rinse conditions, together with placebo (PLA) and control (CON).

III. RESULTS AND DISCUSSION

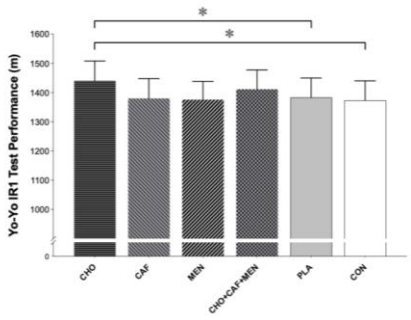

Fig. 1. The distance covered in the Yo-Yo IR1 between six different solutions (mean ± SEM).

Results indicated that CHO group significantly enhanced performance in the Yo-Yo intermittent recovery level 1 (Yo-Yo IR1) test [5] compared to PLA and CON (CHO: 1440 ± 288 m vs. PLA: 1383 ± 282 m, and vs. CON: 1373 ± 282 m; both $p < 0.05$), but not when compared to other rinses (Fig. 1). RPE for the CHO condition were significantly lower than PLA and CON during the Yo-Yo IR1 ($p < 0.05$) (Table 1). No significant differences in HR were observed among the conditions. The results support the previous study by [6], demonstrating that CHO enhances high intensity interval exercise. Additionally, CHO lowered RPE, consistent with previous findings by [7].

TABLE 1
RATING OF PERCEIVED EXERTION (RPE) DURING YO–YO IR1 BETWEEN SIX DIFFERENT SOLUTIONS (MEAN ± SD).

	CHO	CAF	MEN	CHO+CAF+MEN	PLA	CON
Warm-up	6.56 ± 0.7	7.22 ± 1.17	6.61 ± 1.09	7.06 ± 1.3	7.67 ± 1.37	7.17 ± 1.11
Level 5	6.78 ± 0.65	7.11 ± 1.08	7.28 ± 1.02	6.61 ± 0.78†	7.39 ± 0.92	7.02 ± 0.84
Level 9	6.44 ± 0.51*	7.22 ± 1.01	7.61 ± 1.54	7.94 ± 1.21	7.94 ± 1.59	7.22 ± 1.01
Level 11	7.56 ± 0.62†*	8.39 ± 1.15	8.67 ± 1.57	7.17 ± 1.47†*	8.94 ± 2.15	8.03 ± 0.59
Level 12	8.56 ± 0.77†*	9.17 ± 1.47	9.44 ± 2.18	9.28 ± 1.32	9.67 ± 2.11	9.72 ± 1.18
Level 13	10.56 ± 0.98†	11.11 ± 1.45	10.94 ± 1.73	11.39 ± 1.69	11.89 ± 2.25	10.67 ± 1.28
Level 14	11.67 ± 1.14†*	12.72 ± 1.53	13.1 ± 2.09	13.33 ± 1.88	13.17 ± 1.95	12.56 ± 1.46
80%max	18.1 ± 2.03†	18.22 ± 1.26	17.94 ± 1.63	18.67 ± 1.53	18.28 ± 1.56	18.44 ± 1.25
Exhaustion	18.39 ± 1.69†*	18.94 ± 1.63	19.5 ± 0.92	18.28 ± 2.22	18.22 ± 1.26	19.21 ± 0.94

Values are means ± SD. †Different from PLA, $p < 0.05$.
**Different from CON, $p < 0.05$.*

IV. Conclusion

CHO mouth rinses enhance exercise performance, possibly due to the lowering of perceptual effort during the intense intermittent exercise. CHO mouth rinsing could offer a convenient and effective strategy to enhance intermittent exercise performance and lower perceptual effort (i.e., central fatigue), making it a useful tool for athletes and active individuals.

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