

Muhamad Noor Mohamed . Raja Nurul Jannat Raja Hussain .
Mardiana Mazaulan . Noor Azila Azreen Md Radzi .
Nurul Ain Abu Kasim . Nur Hani Syazwani Bakri .
Umami Khaltum Mohd Mokhtar . Mohd Aizzat Adnan .

Editors

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Independent and Synergistic Impact of Mouth Rinsing with L-Menthol, Carbohydrate, Caffeine, and Combination L-Menthol + Carbohydrate + Caffeine on Intermittent Performance in Recreationally Active Young Men

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

Abstract | This study examined the hypothesis that mouth rinsing with carbohydrate (CHO), caffeine (CAF), L-menthol (MEN), and their combination (CHO+CAF+MEN; MIX) would improve performance during high-intensity intermittent exercise. Eighteen recreationally active young men (*mean* \pm *SD*: age 22 ± 2 years, body mass 62 ± 7 kg, height 168 ± 0.06 cm) participated in a randomized, double-blind, placebo-controlled crossover study. Participants completed six trials involving mouth rinsing with CHO, CAF, MEN, MIX, a placebo (PLA), and a control (CON; plain water). The CHO mouth rinse (1440 ± 288 m) significantly enhanced exercise performance in the Yo-Yo intermittent recovery level 1 (Yo-Yo IR1) test compared to PLA (1383 ± 282 m) and CON (1373 ± 282 m) (both $p < 0.05$), but not when compared to other rinses. There were no significant differences in heart rate (HR), muscle oxygenation (SmO₂), blood lactate, or blood glucose levels between the different mouth rinse conditions. These results suggest that CHO mouth rinsing can improve intermittent exercise performance without affecting physiological markers such as HR, SmO₂, lactate, or glucose. Further research should explore the mechanisms behind these performance improvement effects and the potential benefits for different athletic populations.

Keywords: Mouth rinsing, carbohydrate, caffeine, L-menthol, muscle oxygenation, blood glucose.

M.A., Shah, A., Linoby* (✉), N.I., Farhani, and A.S., Mohd Dan.

Faculty of Sports Science and Recreation, Universiti Teknologi MARA Negeri Sembilan Branch, Seremban Campus, Malaysia.

*Corresponding author: linoby@uitm.edu.my

H.K., Kamaruddin.

Department of Physiology, School of Pharmaceutical Sciences, University Sains Malaysia, Penang, Malaysia.

R., Nugraha.

Institute of Medical Science Technology, Universiti Kuala Lumpur, Kajang, Selangor, Malaysia.

M., Machado.

Department of Biochemistry, Keio University School of Pharmaceutical Sciences, Shibakoen, Minato-ku, Tokyo, Japan.

I. INTRODUCTION

Mouth rinsing with carbohydrate (CHO) [1], caffeine (CAF) [2], or L-menthol (MEN) [3] solutions may improve exercise performance. However, the combined effects on high-intensity intermittent exercise are not fully understood. This study examines the separate and combined impacts of CHO, CAF, MEN, and CHO+CAF+MEN mouth rinses on performance, muscle oxygenation, and metabolic indicators during high-intensity intermittent exercise.

II. METHODS

Eighteen recreationally active young men (22 ± 2 yrs; 58 ± 7 kg; 170 ± 0.06 cm) participated in a randomized, double-blind, placebo-controlled crossover study. Participants underwent six tests with different mouth rinse conditions (CHO, CAF, MEN, CHO+CAF+MEN, PLA, and CON) and a 5-day washout period. Performance was measured using the Yo-Yo Intermittent Recovery Test Level 1 (Yo-Yo IR1) [4], muscle oxygenation (SmO₂) with the MOXY Muscle Oxygen Monitor [5], and blood glucose [6] and blood lactate [7] levels were recorded.

III. RESULTS AND DISCUSSION

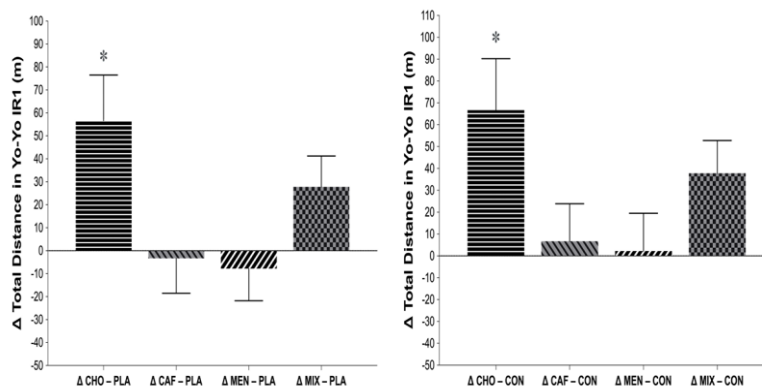


Fig. 1 Change Δ in total distance covered in the Yo-Yo IR1 test compared to placebo (PLA) and control (CON) (mean \pm SEM).

CHO mouth rinsing significantly improved performance in the Yo-Yo IR1 test compared to PLA and CON ($p < 0.05$, Fig. 1). No significant differences were found in SmO₂% (Fig. 2). The analysis also revealed significant increases in blood lactate with exercise intensity, but there were no significant differences between mouth rinse conditions ($p > 0.05$). Notably, there is a trend of higher glucose levels in the CHO and CHO+CAF+MEN conditions, though these differences were also not statistically significant ($p = 0.95$).

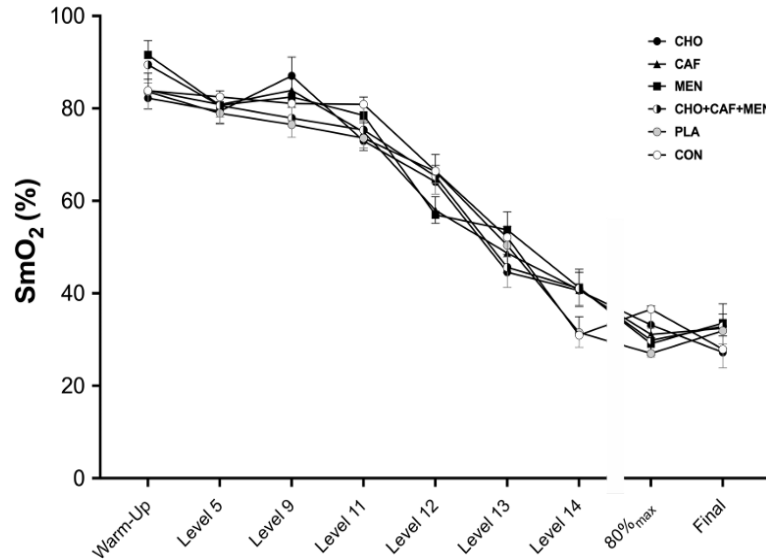


Fig. 2 Change Δ muscle oxygenation during Yo-Yo IR1. (mean \pm SD)

The results support the previous study by [1], demonstrating that CHO enhances high intensity interval exercise. Accordingly, previous studies also suggest that CHO mouth rinse could attenuate the decrease in blood glucose during exercise [7] [8].

IV. CONCLUSIONS

CHO mouth rinses may enhance exercise performance, though the exact mechanism remains unclear in this research. Future research should investigate the underlying mechanism, as well as the long-term effects and potential benefits across different athletic populations and exercise types.

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