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Brief communication

Caffeine ingestion effects on oxidative stress in a steady-state test at 75%$V_{O_2\,max}$

Effets de l'ingestion de la caféine sur le stress oxydatif après la réalisation d'un test stable à 75 % $V_{O_2\,max}$

G.J. Olcina [a,*], R. Timón [a], D. Muñoz [a], J.I. Maynar [b], M.J. Caballero [c], M. Maynar [a]

[a] *Sport Science Faculty, University of Extremadura, Avenida de la Universidad s/n, 10071 Cáceres, Spain*
[b] *Sciences Faculty, University of Extremadura, Badajoz, Spain*
[c] *Faculty of Medicine, University of Extremadura, Badajoz, Spain*

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Summary

Introduction. – Caffeine is a commonly used ergogenic aid in endurance sports. However, its role is not well known on oxidative stress during exercise: pro-oxidative or antioxidant substance?

Synthesis of facts. – In a randomized double-blind study involving 20 active males, we examined plasma lactate, oxidative stress markers (malondialdehyde), antioxidative systems (vitamins A, E, C), and ergospirometric response before and after steady 30 min steady-state tests 75% $V_{O_2\,max}$ (placebo and caffeine).

Conclusions. – We concluded that 5 mg/kg of caffeine ingestion could increase the oxidative stress whereas its consumption may not have a clear metabolic advantage in certain aerobic activities.

Résumé

Introduction. – La caféine est une aide ergogénétique utilisée dans les sports de résistance. Cependant on ne connaît pas le rôle de la caféine sur le stress oxydatif : antioxydant ou pro-oxydant ?

Synthèse de faits. – Dans une recherche en double insu sur 20 personnes non entraînées, on a évalué le lactate, la réponse ergospirométrique, les marqueurs de stress oxydatif (malondialdéhyde) et les systèmes antioxydants dans le plasma (vitamines A, E, C) avant et après quelques tests d'état stable d'une durée de 30 minutes à 75 % du $V_{O_2\,max}$, en conditions de placebo après absorption de caféine.

Conclusion. – Nous pensons que l'ingestion d'une dose de 5 mg/kg de caféine peut augmenter le stress oxydatif tandis que son usage n'aurait pas un avantage métabolique clair dans certaines activités aérobiques.

Keywords: Caffeine; Oxidative stress; Haematocrite; Aerobic exercises

Mots clés : Caféine ; Stress oxydatif ; Hématocrite ; Exercices aérobie

1. Introduction

Caffeine is a trimethilxanthine easily found in our diet or in some medications and used to increase athletic performance. The optimal caffeine dose is reported to be about 5 mg/kg body weight (BW) ingested 1 h prior to exercise [1].

One of the theories about caffeine actuation mechanism suggests that caffeine increases adrenaline concentrations during physical efforts [2]. From this point of view, a greater plasma adrenaline concentration may induce an oxidative stress because catecholamine metabolic inactivation is a recognized source of free radicals [3], as well as a higher aerobic metabolism [4],

* Corresponding author.
E-mail address: golcina@unex.es (G.J. Olcina).

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therefore the antioxidant systems may be unable to offset completely this proposed increase in oxidative stress. In this case, caffeine could act as a pro-oxidant substance.

On the other hand, some research may indicate that caffeine could conduct itself, under certain conditions, as an antioxidant substance [5]. As a result, it is possible that caffeine's ergogenic benefit may be related to its antioxidant properties. However, it is unknown whether caffeine actually conducts itself as an antioxidant during physical activity.

So, could caffeine ingestion improve aerobic performance due to its antioxidant properties or could its consumption generate side effects by increasing oxidative stress? Therefore, the aim of this study is to determine the role of caffeine as antioxidant or pro-oxidant agent during aerobic submaximal exercise.

2. Materials and methods

2.1. Subjects

Participants were 20 males who reported no caffeine consumption and who were not regularly performing exercise. Participants' characteristics were calculated using cineanthropometric techniques: age (years) 20.91 ± 1.31; height (cm) 175.27 ± 6.10; weight (kg) 71.00 ± 5.52; fat weight (% BW) 10.11 ± 1.09; muscle weight (% BW) 53.52 ± 1.51; BMI 23.10 ± 1.90.

2.2. Experimental design

This was a double-blind, randomized study where all participants performed two submaximal steady-state tests under different conditions: (i) placebo (PLA) or (ii) caffeine (CAF). The participants ingested capsules that contained placebo with water or caffeine (5 mg/kg body weight) 60 min prior to effort. Each subject performed the cycling test with an interval of three days in order to favour recovery and to remove exercise adaptations.

Exercise trials consisted of pedalling during 30 min on a cycloergometer (Ergo-metrics 900, Ergo-line®) at 70–80% $V_{O_2\,max}$ after 15 min progressive warming-up. Individual loads to generate mentioned intensity which were previously calculated, using an incremental maximum-exercise protocol on the same cycloergometer.

Physiological response was assessed by a gas analyser (MGC, model 762014-102) evaluating respiratory quotient, and relative oxygen consumption (ml kg/min). Heart rate was measured using a heart rate monitor (Polar® S 720) with interface (Polar® Interface). Values were registered during the entire test and recovery, though they were chosen for their analysis every 5 min during exercise and at minutes 1 and 3 during recovery.

2.3. Measurements

A blood sample was obtained from the anticubital vein in repose conditions before caffeine (or placebo) ingestion and immediately after the exercise. Haematocrite determination was made by microcentrifugation (Microcentrifugue Alresa) of 25 μl of blood contained in heparinised capillars, in order to correct blood parameters due to a possible hemoconcentration. Plasma was obtained by centrifugation and was stored at −20 °C until use, which was not longer than one week.

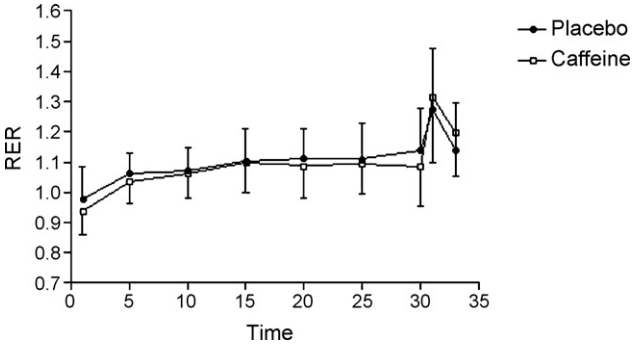

Fig. 1. Respiratory exchange ratio during submaximal trials. Quotient respiratoire pendant l'exercice sous-maximal.

Plasma lactate concentration was determined by photospectrometry (Unicam 5625 UV/VIS) with Sigma commercial kit. HPLC was used to determine (i) plasma concentrations of vitamins A and E [6] to estimate antioxidant ability in lipid moieties; (ii) vitamin C [7] as an antioxidant in watery moieties, and (iii) malondialdehyde [8], as a final product from lipid peroxidation. The experiments carried out in this study are governed by the Spanish legal norms of investigation.

2.4. Statistics

Statistical analysis was performed on SPSS version 11.0, using ANOVA test. Values are presented as mean ± standard deviation. Statistical significance was accepted at $P < 0.05$.

3. Results

Ergospirometric tests results are shown in Fig. 1 (respiratory quotient) and Fig. 2 (relative oxygen consumption, (ml kg/min)).

As related, respiratory quotient, as indicator of metabolic substrate utilization, presents slightly lower values during initial and final phases related to effort following caffeine ingestion, increasing during recovery (Fig. 1), whilst there were no differences in relative oxygen consumption between both trials (Fig. 2), caffeine or placebo.

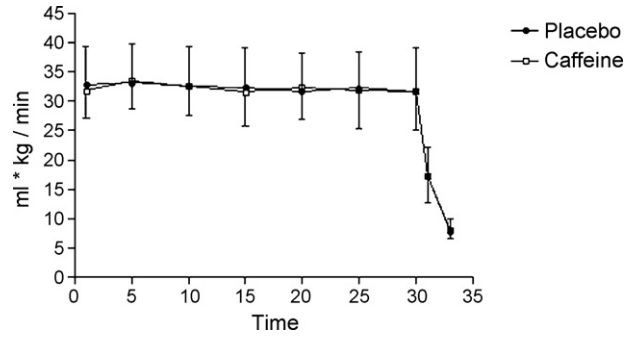

Fig. 2. Oxygen consumption during submaximal trials. Consommation d'oxygène pendant l'exercice sous-maximal.