

Article

# Acute Effects of Hesperidin in Oxidant/Antioxidant State Markers and Performance in Amateur Cyclists

Francisco Javier Martínez-Noguera <sup>1</sup>, Cristian Marín-Pagán <sup>1,\*</sup>, Jorge Carlos-Vivas <sup>1</sup>,  
Jacobo A. Rubio-Arias <sup>2</sup> and Pedro E. Alcaraz <sup>3</sup>

<sup>1</sup> Research Center for High Performance Sport, Catholic University of Murcia, 30107 Murcia, Spain

<sup>2</sup> Faculty of Sport, Catholic University of Murcia, 30107 Murcia, Spain

<sup>3</sup> Faculty of Sport, Research Center for High Performance Sport, Catholic University of Murcia Catholic University of Murcia, 30107 Murcia, Spain

\* Correspondence: cmarin@ucam.edu; Tel.: +34-968-278-566

Received: 16 July 2019; Accepted: 13 August 2019; Published: 14 August 2019



**Abstract:** Human and animal studies have shown that Hesperidin has the ability to modulate antioxidant and inflammatory state and to improve aerobic performance. The main objective of this study was to assess whether the acute intake of 500 mg of 2S-Hesperidin (Cardiose<sup>®</sup>) improves antioxidant status, metabolism, and athletic performance, during and after a rectangular test (aerobic and anaerobic effort). For this, a crossover design was used in 15 cyclists (>1 year of training), with one week of washout between placebo and Cardiose<sup>®</sup> supplementation. After the intervention, significant differences in average power (+2.27%,  $p = 0.023$ ), maximum speed (+3.23%,  $p = 0.043$ ) and total energy ( $\Sigma$  4 sprint test) (+2.64%,  $p = 0.028$ ) between Cardiose<sup>®</sup> and placebo were found in the best data of the repeated sprint test. Small changes were also observed in the activity of catalase, superoxide dismutase, reduced glutathione concentration and oxidized/reduced glutathione (GSSG/GSH) ratio, as well as the lipoperoxidation products (thiobarbituric acid reactive substances; TBARS), at different points of the rectangular test, although not significant. Our findings showed improvements in anaerobic performance after Cardiose<sup>®</sup> intake, but not in placebo, suggesting the potential benefits of using Cardiose<sup>®</sup> in sports with a high anaerobic component.

**Keywords:** hesperidin; hesperitin; antioxidants; catalase; superoxide dismutase; reduced glutathione; oxidized glutathione; performance and exercise

## 1. Introduction

The use of ergogenic aids in sports has increased considerably in recent years [1]. This growing interest is driven by the emergence of studies that have shown how ergogenic aid intake can contribute to improvement in athletic performance, post-exercise recovery, or antioxidant capacity enhancement, as well as changes in body composition (e.g., body fat loss or increase in lean muscle mass), by a stimulation of fatty acids mobilization [2–6]. Within the ergogenic aids, there exist several categories based on the degrees of evidence shown in scientific literature. For instance, category A refers to the highest level of evidence and includes proteins, amino acids, creatine, beta-alanine, carbohydrates, etc. [7]

One potentially promising group that can serve as an ergogenic aid is polyphenols [8]. Polyphenols are bioactive compounds which are widely distributed in plant and plant-based foods, such as vegetables, fruit, cocoa, tea, coffee, and wine [9]. Polyphenols are a very diverse group of compounds, with over 500 different molecules identified in foods, which can be divided into four main categories, according to their chemical structure: flavonoids (e.g., hesperidin, hesperitin, etc.), phenolic acids, stilbenes, and lignans [10]. In addition, polyphenols are of the most studied compounds for their