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Consumption of extra-virgin olive oil rich in phenolic compounds has beneficial antioxidant effects in healthy human adults

María-Jesús Oliveras-López [a,*], *Genoveva Berná* [a,b], *Enrique Jurado-Ruiz* [a,b], *Herminia López-García de la Serrana* [c], *Franz Martín* [a,b]

[a] *Department of Molecular Biology and Biochemistry Engineering, Andalusian Center of Molecular Biology and Regenerative Medicine, University Pablo Olavide, Avda. Americo Vespucio s/n, 41092 Seville, Spain*

[b] *Centro de Investigación Biomédica en Red de Diabetes y Enfermedades Metabólicas Asociadas (CIBERDEM), Seville, Spain*

[c] *Department of Nutrition and Food Science, School of Pharmacy, University of Granada, Campus Universitario de Cartuja, 18071 Granada, Spain*

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ABSTRACT

Extra-virgin olive oil (EVOO) possesses beneficial health effects due to its antioxidant activity. In a controlled before-and-after supplementation trial (45 healthy adults), we examined the effects of daily consumption (30 days (d), 50 mL/d) of EVOO rich in phenolic compounds, antioxidant activity and antioxidant enzymes (catalase (CAT), superoxide dismutase (SOD), glutathione peroxidase (GPX)). Participants completed for 30 d a 24-h dietary record. Anthropometric characteristics, body composition, glycemia, plasma lipid profile, plasma polyphenols, total antioxidant capacity, erythrocyte antioxidant enzyme activity, peripheral blood mononuclear cells (PBMC) gene expression were recorded. EVOO supplementation did not modify the first four parameters. Significant increases in plasma antioxidant capacity and antioxidant enzyme activity (CAT, GPX) were observed. Significant increase in SOD and decrease in CAT gene expression were detected. Daily consumption of EVOO rich in phenolic compounds by healthy adults improved their antioxidant status and modified their antioxidant gene expression levels without affecting metabolic parameters.

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1. Introduction

Extra-virgin oil (EVOO) has remarkable antioxidant potential derived from its high level of phenolic compounds, α-tocopherol, monounsaturated fatty acids (MUFA) and other minor compounds (Quiles, Ochoa, Ramirez-Tortosa, Huertas, & Mataix, 2006). Several bioavailability studies have confirmed that EVOO antioxidants, such as polyphenols, are dose-dependently absorbed (Marrugat et al., 2004; Vissers, Zock, & Katan, 2004; Zbakh & El Abbassi, 2012) and cooperate to increase plasma antioxidant capacity (Covas, 2007; Covas et al., 2006; Franconi et al., 2006; Perona, Cabello-Moruno, & Ruiz-Gutierrez, 2006). In addition, it has been shown that high intake of olive oil phenols increases their plasma concentrations (Covas et al., 2006; Miró-Casas et al., 2003; Perona et al.,

* *Corresponding author.* Tel.: +34-954-977943; fax: +34-954-349813.
E-mail address: mjolilop@upo.es (M.-J. Oliveras-López).
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2006) and excretion (Bazoti, Gikas, & Tsarbopoulos, 2010; Covas et al., 2006; Marrugat et al., 2004; Ruano et al., 2007; Suárez et al., 2011).

Several clinical trials have measured oxidation and endothelial injury markers after intake of MUFA-rich diets, and these trials suggest a modest improvement in oxidative status (Cotrim et al., 2012; Covas, 2007; Salvini et al., 2006). In addition, diets containing phenol-rich EVOO reduce oxidized LDL level (Covas, 2007; Covas et al., 2006; Masella et al., 2004; Ros, 2009), inflammatory biomarkers (Konstantinidou et al., 2010; Weinbrenner et al., 2004) and prothrombotic profile (Covas, 2007; Priora et al., 2008; Ruano et al., 2007).

Oxidative stress is characterized by an increased production of cellular oxidants (i.e., superoxide anion and hydrogen peroxide) and a decreased concentration of circulating antioxidants (Fang, Yang, & Wu, 2002). EVOO consumption increases antioxidant activities of enzymes such as catalase (CAT), superoxide dismutase (SOD) and glutathione peroxidase (GPX) (Masella et al., 2004; Oliveras-López et al., 2008a; Weinbrenner et al., 2004). These enzymes are some of the most important biological antioxidant defenses against free radical production and directly neutralize radical oxygen species (ROS) (Haskins et al., 2003; Puiggrós et al., 2005). Reports suggest that consuming EVOO as the main dietary fat can be important because of its action in preventing oxidative stress (Covas, 2007; Covas et al., 2006; Marrugat et al., 2004; Perona et al., 2006; Vissers et al., 2004). Therefore, growing evidence suggests that dietary polyphenols from EVOO, tea, cocoa, wine, fruits and nuts have beneficial effects for health, mediated by their action on antioxidant defenses (De la Rosa et al., 2014; Fuentes & Palomo, 2014; Gorelik, Kanner, Schurr, & Kohen, 2013; Lopez de Lerma, Peinado, & Peinado, 2013). However, at present, little data exist on EVOO consumption effects on antioxidant enzymes, particularly in healthy subjects (Konstantinidou et al., 2010). It would be interesting to test if EVOO ingestion, in healthy people, could modulate the responses against oxidative stress, throughout antioxidant enzymes. This is important because EVOO consumption could help to prevent oxidative stress and consequently its associated illnesses. Thus, in this study, we aimed to investigate the phenolic composition of EVOO, plasma polyphenols and the effects of polyphenol-rich EVOO in healthy subjects. Moreover, we tested whether a 30-day (d) supplementation could regulate antioxidant enzyme activity and related gene expression.

2. Materials and methods

This study was a controlled before-and-after supplementation trial to assess the effects of EVOO consumption.

2.1. Participants

We recruited volunteer participants through local general practices. The intervention study involved 45 subjects (11 men and 34 women), aged between 21 and 45 years. One week after starting the trial, four women dropped out of the study due to different reasons. Individual appointments for the baseline visit were established, and the subjects were examined. The exclusion criteria were the presence of any previous or actual cardiovascular, hepatic, gastrointestinal, renal or other chronic diseases. We required them not to smoke, drink alcoholic beverages or consume drugs, mineral supplements or antioxidant vitamins. Health questionnaires to check exclusion criteria were completed by all recruited individuals.

Ethical approval for the study was obtained from the Bioethical Research Committee of the University Pablo de Olavide of Seville (Spain), and procedures followed were in accordance with the Helsinki Declaration. All subjects signed a written informed consent prior to their participation in the study. Finally, the privacy rights of participants have been observed.

2.2. Study design and dietary intervention

At the first visit, the subjects were informed of the experimental design and received the EVOO. In addition, the participants were instructed to avoid polyphenol-rich foods (tea, chocolate, coffee, fruits or juices, soya, EVOO, beer, wine, or some alcoholic drinks) for the duration of the study and to maintain their exercise habits that were checked. All of the participants completed a 24-h diet record each day for the duration of the study to evaluate their diet during the trial and to record any differences before and after EVOO intake.

The EVOO used in the study came from an Andalusian (Spain) olive variety called Picual. The EVOO was obtained at 18–22 °C in a two-phase centrifugation system. All of the subjects consumed 50 mL of raw EVOO each day for 30 d at breakfast (30 mL) and lunch (20 mL). Previously published studies also divided the EVOO intake into several doses (Covas, 2007; Salvini et al., 2006; Weinbrenner et al., 2004). Apart from the fat supplementation and polyphenol-rich foods restriction, the subjects were instructed to continue with their dietary habits, including oil used for cooking.

Dietary information for nutrient composition was analyzed using Dietsource 1.2 (Novartis, Madrid, Spain) software, which was modified to also include the composition of the EVOO used in the trial, allowing us to estimate the daily intake of monounsaturated acid and α-tocopherol during the intervention period.

2.3. Measurements of anthropometric, body composition and blood pressure

At first and last visits, the participants were weighed in light clothing without shoes. A digital scale with a talli meter included was used to measure height and weight (SECA 710, TMA Medica, Madrid, Spain). A Holtain flexible metric belt was used to measure body circumference (waist and hip) (Holtain Ltd., Crymych, UK). Waist circumference was measured at the minimum circumference between the iliac crest and the rib cage. Hip circumference was measured at the maximum protuberance of the buttocks. Both circumferences were measured in duplicate. Body composition was assayed by bioelectrical impedance analysis (BIA) using a single frequency Bioelectrical Impedance Body Composition Analyzer (TANITA TBF-300A, Tokyo, Japan). Blood pressure was measured weekly following the method authorized by international guidelines using a digital automatic sphygmomanometer (M3 Intellisense,