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Extra virgin olive oil (EVOO) consumption and antioxidant status in healthy institutionalized elderly humans

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ABSTRACT

Recent studies show that the elderly have increased oxidative stress and impaired antioxidant defense systems. Our study aims to evaluate the effects of daily consumption of EVOO in the healthy institutionalized elderly. We studied anthropometric, biochemical and antioxidant parameters in 62 subjects aged 65–96 years after a 6-week daily intake of polyphenol-rich EVOO with high oleuropein derivative contents. Subjects were divided into a control group (CG) who maintained their dietary habits ($n = 39$) and an olive group (OG) who consumed EVOO as the only added fat, plus a daily dose of 50 ml ($n = 23$). We found a significant reduction of total cholesterol (TC), HDL, LDL and TGs in OG subjects and a significant increase of HDL levels. There was no significant variation in the CG parameters. In OG the total antioxidant capacity (TAC) in plasma increased with significant differences over CG. Plasma hydroxytyrosol (OH-Tyr) concentration showed a significant increase after EVOO intervention. Daily consumption of EVOO was found to have positive effects on lipid profiles, OH-Tyr levels and TAC. The results also show a significant increase of catalase (CAT) in erythrocytes and a decrease ($p < 0.05$) in superoxide dismutase (SOD) and glutathione peroxidase (GH-PX) activity after EVOO intake. To our knowledge, no other study has examined the effects of EVOO consumption on biochemical parameters, antioxidant capacity and antioxidant enzyme activity in healthy elderly subjects. In conclusion, our results show that nutritional intervention with EVOO improves antioxidant status in healthy elderly people.

1. Introduction

Many human diseases are associated with increased oxidative stress resulting either from the altered production of free radicals or from altered antioxidant content or activity (Tessier, Khalil, Trottier, & Fülöp, 2009). The main system of antioxidant defense consists of enzymes, SODs, GH-PXs and CATs. There also are several vitamins and micronutrients active in quenching free-radical species or required as cofactors for antioxidant enzymes (Pinzani et al., 2010). The potent antioxidant activity of polyphenolic substances has been widely demonstrated (Giovannelli et al., 2011; Masella et al., 2004; Oliveras-López et al., 2008). Both preventive and chain breaking antioxidants have a role in the limitation of oxidative stress that accompanies aging and disease (Ferrari, 2004; Jacomelli et al., 2010; Pinzani et al., 2010; Pitozzi et al., 2010; Tessier et al., 2009).

Numerous recent studies have shown that the elderly have increased oxidative stress and impaired antioxidant defense systems (Gano et al., 2011; Joseph, Shukitt-Hale, & Casadesus, 2005; Nakamura, Read, Elias, & Omaye, 2006), which appears to be a contributory factor for neurological damage, dementia and depression (Ferrari, 2004; Pitozzi et al., 2010; Sánchez-Villegas et al., 2011; Venkateshappa, Harish, Mahadevan, Srinivas Bharath, & Shankar, 2012) and to be responsible for the initiation and progression of chronic diseases such as diabetes (Atli et al., 2004; Malaguarnera et al., 2009), artherosclerosis (Liu, Yang, Huang, Tan, & Liu, 2012), alteration of circulating lipids (Fabian, Bogner, & Elmadfa, 2012; Malaguarnera et al., 2009) or hypertension (Rybka et al., 2011). Therefore, it has been widely confirmed that there is an age-related pro-oxidant status even in healthy aging people.

While the literature including elderly patients has grown, there are less detailed data about the antioxidant status in healthy people, especially the elderly. The effect of red wine consumption on serum TAC has been evidenced in healthy older adults (Avellone et al., 2006; Hansen et al., 2005) and in healthy elderly subjects (Antonini et al., 2005; Pinzani et al., 2010). The effects of nut consumption on antioxidant status and biomarkers of oxidative

Abbreviations: 3,4-DHPE-EDA, deacetoxy oleuropein aglycone; EVOO, extra virgin olive oil; OH-Tyr, hydroxytyrosol; 3,4-DHPE-EA, oleuropein aglycone; Tyr, tyrosol.

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stress have been reported in a limited number of human intervention studies (Bolling, Chen, McKay, & Blumberg, 2011). In fact, papers reporting intervention with nuts in healthy older adults are scarce (McKay et al., 2010). Numerous authors have assessed the antioxidant effects for healthy adults of drinking tea (Pecorari, Villaño, Testa, Schmid, & Serafini, 2010) or juices such as raspberry (Lee et al., 2011) and orange (Morand et al., 2011), all containing high concentrations of phenolic compounds. However, very few of these trials have been performed with healthy older adults (Crews et al., 2005; Krikorian et al., 2010).

On the other hand, it has been demonstrated that young and middle-aged men and women regularly consuming a moderate amount of EVOO have increased antioxidant status (Ruano et al., 2007; Salvini et al., 2006), so that beneficial changes in biochemical parameters, increased TAC, plasma OH-Tyr or enzyme activities have been described (Castañer et al., 2012; Oliveras-López, Innocenti, Martín Bermudo, López-García de la Serrana, & Mulinacci, 2012; Samaniego-Sánchez, Quesada-Granados, Sánchez-Navarro, López-García de la Serrana, & López-Martínez, 2010). The positive effects of EVOO have been attributed to its high polyphenolic content, especially its composition in secoiridoidic derivatives (Franconi et al., 2006; Jacomelli et al., 2010; Oliveras-López et al., 2007; Weinbrenner et al., 2004).

We hypothesized that a nutritional intervention program with EVOO would improve the antioxidant status of healthy institutionalized elderly people and that this would have an impact on their well-being, preventing the occurrence of diseases. We investigated biochemical parameters, plasma OH-Tyr levels, TAC in plasma, and CAT, SOD and gluthation peroxidase activity in erythrocytes from healthy elderly subjects, after replacement of added diet fat by a selected EVOO. The aims of this study were to determine the antioxidant status in healthy institutionalized elderly subjects and to evaluate the effects of the daily consumption of EVOO.

2. Subjects and methods

2.1. Subjects

The present study was a randomized double-blind interventional trial and involved 62 healthy elderly subjects of both sexes (15 men and 47 women), of the 65–96 year age range. All participants were institutionalized in a private geriatric center in Malaga (Spain). Subjects were selected by the medical staff of the center, which performed a full life style and medical history and a physical examination for each person. They were mentally competent, with no cognitive impairment, able to give oral and written informed consent and to take part in the study. Ethical approval for the study was obtained from the Bioethical Research Committee of the University of Granada (Spain). Study was also authorized by the geriatric center supervisor. All procedures involving subjects complied with the Declaration of Helsinki, as revised in 2000. Volunteers were selected on the basis of their health status according to the criteria of the Eurage Senieur Protocol. Subjects had correct functional and cognitive capacity, were non-smoking and non-vegetarian. None of the subjects consumed any alcohol nor took drugs, antioxidants or dietary supplements for 4 weeks prior to being recruited for the study. Subjects with acute and chronic infection, diabetes, hypertension, hyperlipidaemia, hyperglycaemia, renal disease, tumors, cardiovascular or any disease involving digestion or assimilation of nutrients were excluded.

The study initially enrolled 71 elderly volunteers (24 men and 47 women), but 4 subjects objected to raw EVOO ingestion and abandoned the study, 2 subjects presented health problems during the trial and also dropped out and 3 subjects died. The 62 remaining subjects were divided into two groups: (i) CG who maintained their dietary habits throughout the study ($n = 39$, 7 males, 32 females); (ii) OG, who maintained their dietary habits and with the single modification of replacing the ingestion of fats with a selected EVOO during the intervention period ($n = 23$, 8 males, 15 females).

2.2. Procedure

The aim of this research was to study the effects of replacing fats added to the diet of healthy elderly subjects, with EVOO. The study lasted 7 weeks, divided into a period of 1 week followed by an intervention period of 6 weeks, starting at baseline. Subjects did not modify their usual life habits, physical activities or diet over the 7-week study, except for the substitution of fats by EVOO in the OG during the intervention period.

The medical staff of the geriatric center and the nutritionists interviewed and informed each subject about the study and were responsible for controlling the subjects' diet and food intake. During the first 1-week period the diet was not modified, in fact, the usual added oils and fats were consumed. Dietary habits and dietary records from this 1-week period were collected at baseline by the nutritionists. Dietetic characteristics were assessed by a semi-quantitative food frequency questionnaire (FFQ) of 136 items validated in Spain (Martin-Moreno et al., 1993). In addition, nutritionists also compiled an individual 7-day weighed food diary of the consumed diet. Average nutrient intakes were calculated with Dietsource 3.0 software (Novartis-Spain).

During the second 6-week period of the study, CG subjects did not modify their diet, including the oil or fat intake. OG subjects stayed on their usual diet, except for the consumption of oil. The EVOO selected for the study was used for cooking all meals of OG subjects and was also used for dressing OG food, in place of all the habitually consumed fats and oils. In addition, OG subjects consumed 50 ml per day of the chosen EVOO in raw form, as provided in unit bottles containing the said dose. This quantity was equally distributed between meals (25 ml at breakfast and lunch). Nutritionists individually controlled oil intake and ensured the completion of the intervention procedure. During the intervention period dietetic characteristics were also assessed in the validated FFQ (Martin-Moreno et al., 1993) and an individual 7-day weighed food diary was compiled as before. The cooked oil consumed in meals was estimated by the portion size served. Nutrient intakes for both CG and OG were evaluated after the 6-week intervention period.

2.3. Anthropometric and biochemical parameters measurements

Anthropometric and biochemical characteristics of the elderly volunteers were measured at baseline and after the 6-week intervention period. The anthropometric measurements were performed in the same place by the same trained researcher, following all the considerations of the International Society for the Advancement of Kinanthopometry (ISAK) (11). The measurements were performed by a level II anthropometrist certified by the ISAK using the following instruments: GPM Stadiometer with $\pm$1 mm precision; Tefal scale with $\pm$50 g precision.; Holtain skinfold compass with $\pm$1 mm precision; Holtain flexible metallic metric belt with $\pm$1 mm precision. The anthropometric measurements taken were height, weight, skinfold triceps, and waist, hip and relaxed biceps perimeters. The body mass index (BMI) was calculated from height and weight.

2.4. Blood collection and processing and biochemical determinations

The medical staff of the geriatric center performed the blood extractions by venipuncture early in the morning, after overnight