How does olive oil protect our DNA in front of oxidative damage?

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INTRODUCTION

Olive oil, a product of the mechanical extraction from the fruit of *Olea europeae* L., is an important component in the Mediterranean diet due to its valuable source of natural phenolic antioxidants. The power of olive oil is given by its fatty acid composition (characterized by a low composition of tryacylglycerol) and by its content of many minor compounds (phenolic components) with potential antioxidant activity.

Objective The aim of this work is to describe the protective effects that olive oil provides in front of oxidative damage that occur on DNA.

OLIVE OIL COMPONENTS

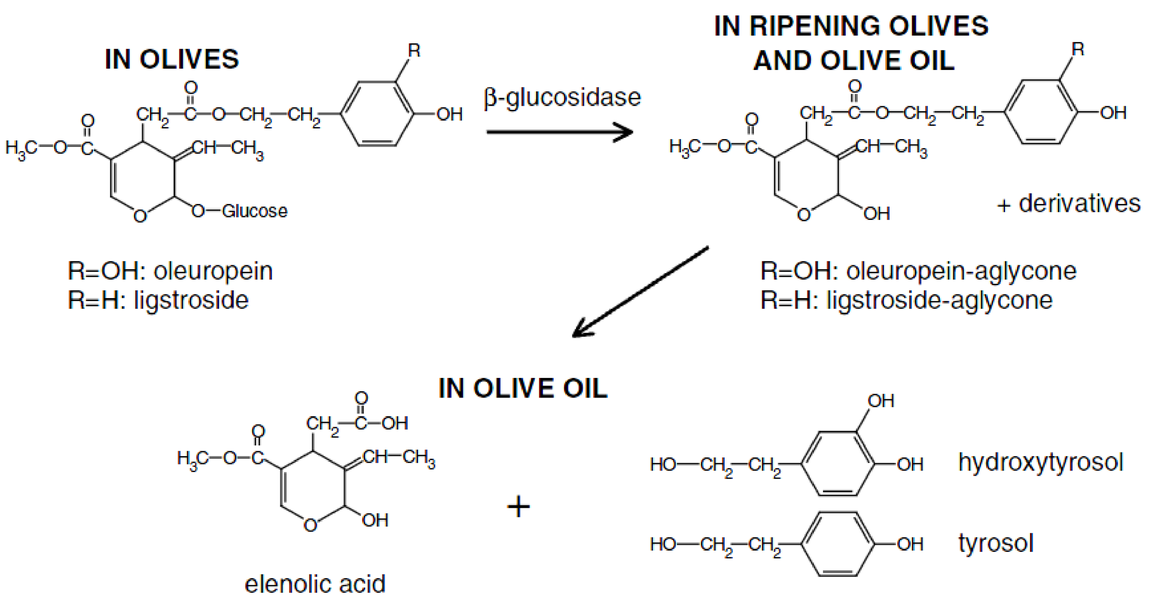

Figure 1. Structures of phenols present in olives and olive oil (Vissers et al., 2004)

Virgin Olive Oil (**VOO**) is produced by direct press or centrifugation methods. It is submitted to a refining process in which around 80% of phenolic compounds are lost.

Extra Virgin Olive Oil (**EVOO**) is the first-pressed olive oil and it contains an abundance of phenolic antioxidants.

The olive oil phenolic compounds (**OOPC**) are responsible of the antioxidant activity that impact to the DNA; concretely they have a protective effect on DNA oxidation.

MECHANISM OF ACTION

Molecules with *o*-dihydroxyl structures possess high antioxidant activity because they form intramolecular hydrogen bonds during the reaction with free radicals. Electron-donating substituents in the ortho position tend to weaken the O-H bond of phenol and provide extra stability to the phenoxyl radical.

Exposure of DNA to peroxynitrite leads to modifications in purine and pyrimidine bases. Levels of xanthine (deamination product of guanine) and hypoxanthine (deamination product of adenine) increase with $ONOO^-$. **Hydroxytyrosol** (HT) decrease the yield of xanthine and hypoxanthine by scavenging $ONOO^-$.

HT reacts with $ONOO^-$ to inhibit the formation of DNA oxidation products.

$$^{\bullet}NO + O_2^{\bullet-} \rightarrow O{=}NOO^-$$

This poster is made by a bibliography search in various databases

MATERIALS AND METHODS

Changes in markers of oxidative damage

The subjects from distinct populations were divided into different groups; each one received a dose of phenolic content. The oxidative DNA and RNA damage was assessed by measuring 8oxoGua, 8oxoGuo and 8oxodG by using HPLC/tandem mass spectrometry.

COMET ASSAY

Cells were submitted to phenolic supplementation treatments for 24h and then were exposed to H_2O_2 during 10 min. It is measured the degree of migration of nuclear DNA upon electrophoresis in alkaline buffer. The comet-like "tail" were placed into five arbitrary classes according to its extension. The oxidation of purines and pirimidines can be studied by the addition of endonucleases cleaving DNA at damage sites.

Effect of HT, OO-PE and WW-PE

Cells were treated with 40µmol/L H_2O_2 during 30 min of incubation at 37ºC. Each group of cells were incubated in enriched mediums with increasing concentrations of 3,4-DHPEA , phenols from virgin olive oil (OO-PE) and from olive mill wastewater (WW-PE).

RESULTS

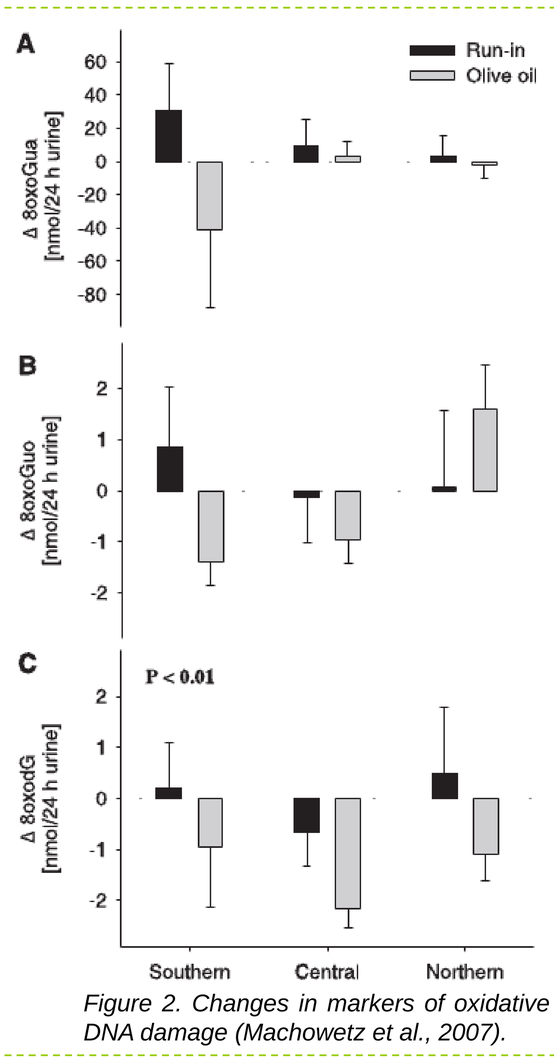

Figure 2. Changes in markers of oxidative DNA damage (Machowetz et al., 2007).

There is a significantly urinary 8oxodG decrease after oil consumption in the third group. The effect of OO-PE phenolic content on urinary oxidation products of guanine demonstrate its protection to DNA against oxidative damage by the reduction of 8oxodG as a marker of DNA oxidation.

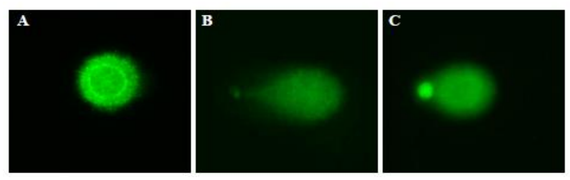

*Figure 4. Images of Comet assay analysis of MCF10A cells (breast cell line). (**A**) Untreated cells, showing a circular shape → absence of damage; (**B**) 10 min. H_2O_2 exposed cell, exhibiting a long tail indicating DNA strand breaks → DNA oxidative damage; (**C**) 10 min. H_2O_2 exposed cell after 24h of 100 µM HT pretreatment showing the reduction of tail lenght → reduced DNA damage (Warleta et al., 2011).*

The extend of migration is proportional to the DNA break frequency.

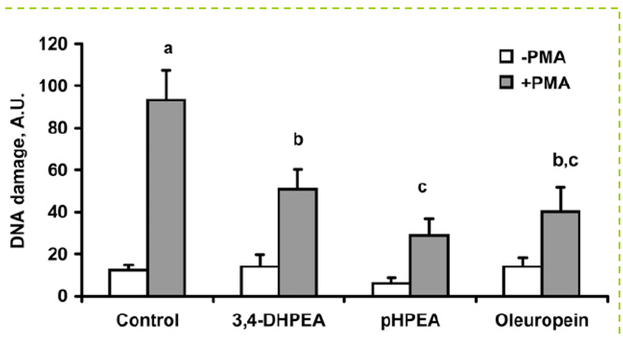

Figure 3. Effect of 3,4-DHPEA, p-HPEA, and oleuropein (10 µmol/L) on DNA damage of lymphocytes incubated with monocytes either untreated or stimulated with PMA (phorbole-myristate-acetate) for 1h (Machowetz et al., 2007).

Fig.3 shows the DNA damage reduction, due to phenols presence, in front of the oxidative stress induced by PMA-activated lymphocytes.

Fig 5. shows the protective effect of 3,4-DHPEA, phenols extract OO-PE and WW-PE in front of the DNA damage caused by H_2O_2. There is a reduction of the damage as the phenolic components concentrations increase.

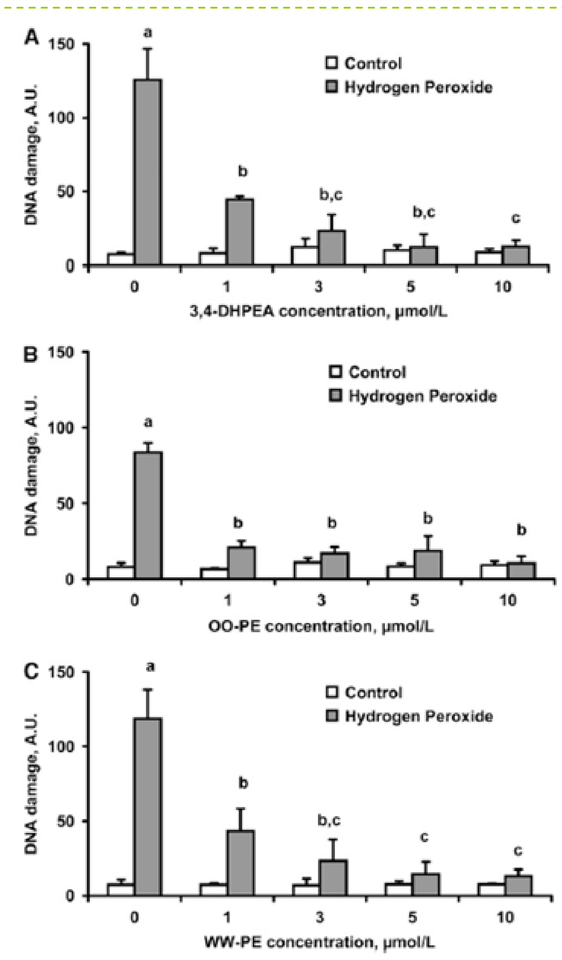

*Figure 5. Effect of increasing concentrations of 3,4-DHPEA (**A**), OO-PE (**B**), and WW-PE (**C**) on DNA damage of HL60 cells (Fabiani et al., 2008).*

CONCLUSIONS

ROS (reactive oxygen species) can be originated from metabolic processes and from environmental factors that can be lead to oxidative damage of biomolecules such as DNA. Olive oil can protect our DNA in front of oxidative damage due to its phenolic compounds. Concretely, hydroxytyrosol and oleuropein possess the antioxidant potential. Its antioxidant activity depends on the number of reactive OH groups in their structure.

Cells use enzymatic and non-enzymatic antioxidants and DNA repair systems in order to defend themselves. Therefore a diet including EVOO is important because it can decreases oxidative DNA damage. It is important to consider that olive oil contains a high level of MUFA (monounsaturated fatty acid); consequently, the healthy recommended quantity of olive oil taken is about 3 to 5 spoonfuls per day.

Olive oil can reduce the levels of 8-oxo-dG (hydroxylation of guanine in the 8-position) as a biomarker for DNA oxidation.

It is demonstrated by the Comet assay that hydroxytyrosol can reduce DNA damage.

Hydroxytyrosol (3,4-DHPEA), virgin olive oil (OO-PE) and olive mill wastewater (WW-PE) reduce DNA damage. 3,4-DHPEA (orto-diphenols) are more effective antioxidants than simple phenols (p-HPEA).

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