

Olive Oil: Nature's Panacea

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Abstract

The differences between the various grades of commercially available olive oil are briefly reviewed together with the chemical characteristics of the major components of olive oil. The health benefits of the important polyphenols present in extra virgin olive oil, namely oleic acid, squalene and tocopherols are discussed.

Keywords: Olive Oil; Health Benefits; Polyphenols; Tocopherols

Introduction

The health benefits arising from the consumption of olives, olive leaves and olive oil have been recognized since the time of Ancient Greece and the writings of the "father" of medicine, Hippocrates (460-370 BC). It is commonplace for health-conscious individuals to consume the "Mediterranean diet" because it comprises plant-based foods, fish and olive oil. These components of this diet are associated with a reduced risk of most age-related diseases including metabolic syndrome¹, cardio-vascular problems and neurodegenerative disorders.

These physiological benefits, notably protection of blood lipids from oxidative stress, were attributed to the polyphenol content of olive oil by the European Food Safety Authority (EFSA) in 2012 [1]. It has become recognized that these bioactive polyphenols or biophenols are the source of the health attributes of fruits and vegetables, and that olive oils with the greatest health benefits are those high in certain minor but highly bioactive components, as discussed below.

Olive oil

Five grades of olive oil are defined by the International Olive Oil Council (IOC). Each grade must satisfy precise production methods, taste and chemical composition for the oil extracted from the olive fruit (*Olea europaea*). Of course, the specific variety of olive tree, where it is grown, and the local environmental and climatic factors obviously will affect the taste and chemical composition of the oil.

There are over 2,000 varieties of olives and about 150 varieties are commonly grown for olive oil and/or consumption. One of the parameters used by the IOC to classify grades of olive oil is called "free acidity" and may be listed on product labels as "acidity"². This term

¹Metabolic syndrome is a cluster of conditions that include elevated blood pressure, high blood sugar, excess body fat around the waist, and abnormal cholesterol or triglyceride levels.

²Acidity is given as the percentage of free fatty acids based on oleic acid, per 100 grams of oil.

is derived from the fact that olive oil naturally contains triglycerides, which are molecules that consist of three fatty acids connected by another molecule, glycerol. If the olive oil is exposed to certain conditions, the glycerol-fatty acid bond can hydrolyze or undergo oxidation which "frees" the fatty acids from the triglyceride and increases the free acidity of resulting olive oil. The presence of free fatty acids are indicators of breakdown in the olives or olive oil. Higher quality olive oils have the lowest levels of free acidity.

1. Organic extra virgin olive oil (OEVOO) is the juice extracted from the first pressing of fresh olives that have been grown using organic farming methods and certified by the USDA. The olives are pressed without the use of heat or chemicals. OEVOO oil has an acidity value $\leq 0.3\%$, is high in antioxidants and must be defect free in aroma and taste.
2. Extra virgin olive oil (EVOO) is the juice extracted from the first pressing of fresh olives that are pressed without the use of heat or chemicals. The oil has an acidity value $\leq 0.8\%$, is high in antioxidants and must be defect free in aroma and taste.
3. Virgin olive oil (VOO) also comes from the first pressing of fresh olives, but it does not meet the sensory or chemical standards of extra virgin olive oil. Virgin olive oil usually has an acidity value $\geq 0.8\%$ but $\leq 2.0\%$ as compared to extra virgin olive oil. It contains a lower percentage of antioxidants than EVOO. The flavor can vary, and the taste is milder than that of extra virgin olive oil.
4. Pure olive oil, sometimes labeled as "olive oil", contains refined olive oil with a small percentage, typically 5 - 10%, of EVOO or VOO. The addition of extra virgin or virgin olive oil confers the color, flavor and aroma otherwise absent in refined olive oil.
5. Refined olive oils are oils that have been refined after solvents and heat are used to extract as much oil as possible from the olive pulp remaining after the first pressing. Generally, this grade of olive oil is fattier, more acidic and has no taste, aroma or antioxidants. The free acidity is $\leq 0.3\%$ because of the refining process rather than because of the quality of growth conditions or oil production method. The refining process generally removes any natural antioxidants present in unrefined oils and also produces artificial trans fats. Because of the absence of color, this grade is sometimes referred to as Extra Light.
6. Olive pomace oil is produced by adding solvents such as hexane to the olive pulp, olive skins, seeds and fruit left over after cold pressing and then heating the mixture. The pomace oil is then refined like pure olive oil. Pomace oils have a free fatty acid or acidity level $\leq 1\%$ and are usually tasteless and contain no antioxidants.

There is an additional category of naturally obtained olive oil, *Lampante* Olive Oil, that is created from poor or inferior quality olives or through poor processing practices. Its sensory qualities and product defects are so severe that it is unfit for human consumption without further processing. In Italian, *olio Lampante* means "lamp oil" and in the old days, this was one use for this grade of olive oil. The free acidity level of *Lampante* olive oil is generally $\geq 2\%$.

Phenolics in olive oil

Extra virgin olive oil (EVOO) contains approximately 36 phenolic compounds including tyrosol, hydroxytyrosol, oleocanthal, oleuropein and various carotenes. Although both VOO and EVOO contain similar phenolic compounds, the carboxylic ester oleocanthal is found only in extra virgin olive oil. As with VOO, the biophenol content of EVOO, and notably that of oleocanthal, will vary from oil to oil.

Interestingly, the bitterness, pungency and astringency characteristic of Extra Virgin Olive Oils (EVOO) and which causes the familiar "throat burn" sensation was only ascribed to the compound decarboxymethyl ligstroside aglycon in 1993 [2]. After researchers at the University of Pennsylvania determined the absolute stereochemistry of the compound in 2005 [3], it was given the more convenient name of oleocanthal.

The idea that bitterness is often associated with pharmacological activity led researchers to predict that oleocanthal might have anti-inflammatory effects comparable to those of ibuprofen [4-6], which, in turn, led to the development of the synthesis of the compound [3]. The health benefits of oleocanthal are discussed elsewhere [6,7].

Numerous natural phenolic compounds are found in virgin olive oil (VOO) and these compounds significantly affect the stability and flavor of the oil. The major constituents are tyrosol and hydroxytyrosol³ together with a number of other phenolics such as caffeic acid, *o*-coumaric acid, *p*-coumaric acid, gallic acid, homovanillic acid, oleuropein, oleocanthal, lignans as well as various flavonoids. Apparently, hydroxytyrosol and caffeic acid are reported to be the most potent antioxidants in VOO. Interestingly, hydroxytyrosol is similar in bioactivity to the phenolic compounds found in green tea and in red wine.

The content of phenolic compounds, expressed as caffeic acid, differs from oil to oil and depends on the growth conditions, harvesting, etc. and can range from a few mg to over 400 mg per kilogram of oil. When the level exceeds 300 mg.kg⁻¹, the oil may have a bitter taste, but this high polyphenol content is beneficial with regard to the oil shelf-life.

Bioactives in olive oil

A variety of bioactive compounds have been identified in olive oil as well as in olives and olive leaves, table 1.

Hydroxytyrosol
Oleacein Oleocanthal
Oleuropein
Oleic acid
Phytosterols
Squalene
Tocopherols
Tyrosol

Table 1: Bioactive compounds in olive oil, olives and olive leaves.

Biophenols is the comprehensive term referring to the polyphenols present in olive oil, the most important with regard to human health are considered to be hydroxytyrosol, tyrosol, oleuropein and oleocanthal. Despite the relatively low content of these compounds in olive oil, they are thought to markedly contribute to the health-providing characteristics of olive oil by exhibiting antiatherogenic, cardioprotective, anticancer, neuroprotective and endocrine effects [8]. In fact, all of these bioactive compounds are recognized as potent antioxidants that provide protection against oxidative stress. The latter can cause DNA mutations which eventually lead to cancer, diabetes, cardiovascular disease and neurodegenerative disorders such as Alzheimer’s disease.

³Tyrosol is 4-hydroxyphenethyl alcohol whereas hydroxytyrosol is 3,4-dihydroxyphenethyl alcohol.

Over the years, many of these compounds have been thoroughly studied although others, notably oleocanthal and oleuropein⁴, have received intense research interest only in recent years. The literature regarding the health benefits, i.e. the bioactivity, of the important polyphenols in extra virgin olive oil will be discussed in a subsequent review.

Oleic acid

Oleic acid is a monounsaturated omega-9 fatty acid that can comprise up to 83% of olive oil, a level far exceeding that of any other oil. Research studies indicate that oleic acid reduces blood pressure and possesses anti-inflammatory and anticancer properties [9-11]. In the latter case, oleic acid apparently can suppress or inhibit certain genes associated with breast cancer and those involved in cancers of the brain. The antineoplastic function of extra virgin olive oil may be the result of protection of cells from oxidative stress due to its high content of oleic acid. In fact, olive oil has a higher polyphenol and polyunsaturated fatty acids content than other edible oils such as palm, peanut, soybean and sunflower. Consequently, olive oil is less susceptible to oxidation than other edible oils.

The antineoplastic activity of EVOO and oleic acid may also be ascribed to the content of antioxidant components such as hydroxytyrosol and oleuropein, both of which are potent reactive oxygen species (ROS) scavengers, as discussed later.

Oleic acid has also been shown to effect reductions in blood lipids, notably overall cholesterol levels, LDL cholesterol and triglycerides. There are also indications that oleic acid can protect against insulin resistance, a principal cause of type 2 diabetes as well as assist in balancing serum glucose levels.

Phytosterols

Phytosterols are present in olive oil and various other plant foods, including nuts and whole grains. The principal phytosterols in olive oil are β -sitosterol and campesterol and these have many health benefits [12-14]. Because phytosterols are similar in composition to cholesterol, their contribution to heart health appears to be the result of their ability to block absorption of cholesterol.

There is growing evidence of the inhibitory action of phytosterols on lung, stomach as well as ovarian and breast cancer [15]. This antineoplastic activity of phytosterols apparently involves multiple mechanisms, including inhibition of carcinogen production, cancer-cell growth, angiogenesis, invasion and metastasis, and through the promotion of apoptosis of cancerous cells. Phytosterol consumption may also increase the activity of antioxidant enzymes and thereby reduce oxidative stress.

Squalene

Squalene is a triterpene present at a level of ~0.7% in olive oil, a content exceeding that in virtually every other food. Squalene has an overall antioxidant effect through its ability to scavenge reactive oxygen species, including free radicals present in the body [16,17]. There are also indications that the squalene present olive oil may be partly responsible for the lower incidence of skin cancer observed with people in the Mediterranean region [18].

Tocopherols

Tocopherol is the chemical name for vitamin E, and a teaspoon of olive oil contains about 10% of the daily requirement of the vitamin. This dietary ingredient is essential to health [19,20] and there is increasing evidence that vitamin E (primarily α - and γ -tocopherol) may

⁴Oleuropein is a glycosylated seco-iridoid, a type of phenolic compound found in green olive skin, flesh, seeds and leaves as well as in argan oil.

reduce the risk of cardiovascular disease and some cancers [21,22]. Tocopherols have a beneficial effect on blood lipids and are very effective in helping prevent lipid oxidation, a bioprocess that can trigger widespread inflammation. Further, there is increasing evidence that tocopherols assist in preventing atherosclerosis-related cardiovascular disease [23]. Finally, the beneficial presence of vitamin E in skin creams is well known and it appears that ingestion of tocopherols may help alleviate certain dermatological issues such as eczema from the inside out.

Conclusion

This overview of the scientific literature clearly demonstrates that olive oil and especially extra virgin olive oil (EVOO) may have a remarkably beneficial effect on human health. In particular, EVOO may possess therapeutic potential for addressing several severely debilitating and potentially fatal diseases. The question remains, however, if the individual biophenols are therapeutic in their own right or whether the bioefficacy is improved by or perhaps is reliant upon the other conjoint polyphenols and minor bioactives present in the oil, the fruit and the leaves of the remarkable olive tree.

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