12 Olive Oil and Health Benefits

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12.1 INTRODUCTION

The olive is a common name for a plant family and its representative genus, and for the fruit of the olive tree. There are approximately 900 species of olives in 24 genera. Most of us are familiar with the olive that is cultivated for its fruit, which are sometimes referred to as drupes. Olives for eating are harvested or picked when they are either unripe or ripe. The unripe olives are green and remain so during pickling. Ripe olives are dark bluish when fresh and turn blackish during pickling.

Olives have been associated with Mediterranean cultures for some time. The cultivated olive is originally native to the eastern Mediterranean region but is cultivated throughout that area and in other parts of the world that have climates like the Mediterranean area. The genus and species of the cultivated olive is *Olea europea*, which is grown between the 30th and 45th parallels. Spain, Italy, and Greece are the major producers of olives, with Spain being the biggest producer, followed by Italy and then Greece. Other producers in the area include Portugal, Turkey, Morocco, Tunisia, and France. More countries and regions of the world (United States, Canada, Japan, Chile, Argentina, New Zealand, and Australia) are cultivating olives because of interest in the health benefits of the Mediterranean diet. In the United States, most of the production is in California due to its more Mediterranean-like climate. Olive trees normally thrive in regions where there are mild winters and hot summers. The trees cannot normally tolerate temperatures below 10°C, but they can withstand hot temperatures and are drought resistant.

12.2 NUTRITIONAL COMPONENTS OF OLIVES

Harvesting of olives may influence their nutrient composition. A point worth noting is to not let them over-ripen, as the acidity level will increase too much. If the harvest is too early, there is limited oil
in the olive. When the olives turn green, it is a good time to pick them. The acidity and oil content will continue to increase as they turn purple and black. For the most part, the nutrient composition of olives shown in Table 12.1 is representative. One large olive will supply 5.1 Kcal. Most of the caloric value is supplied by fat, followed by carbohydrate and protein. Olive oil is derived from the fresh, ripe fruit and makes up about 20% of the olive by weight. One of the most studied aspects of olives is the fatty acid content, with the oil being a good source of the monounsaturated fatty acid oleate. Oleate may range from 56% to 84% of the fatty acid content. Olive oil also contains the saturated fatty acids palmitoleate and stearate in small amounts, the polyunsaturated fatty acids linoleate, and to a small degree linolenate. Linoleate may make up 3%–21% of the fatty acid content.

### Table 12.1

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>1 Large Olive (4.4 g)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Macronutrients</strong></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>3.52 g</td>
</tr>
<tr>
<td>Energy</td>
<td>5.05 Kcal</td>
</tr>
<tr>
<td>Protein</td>
<td>0.037 g</td>
</tr>
<tr>
<td>Total lipid</td>
<td>0.47 g</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>0.28 g</td>
</tr>
<tr>
<td>Total dietary fiber</td>
<td>0.14 g</td>
</tr>
<tr>
<td>Ash (minerals)</td>
<td>0.10 g</td>
</tr>
<tr>
<td><strong>Lipids</strong></td>
<td></td>
</tr>
<tr>
<td>Palmitic acid (16:0)</td>
<td>0.05 g</td>
</tr>
<tr>
<td>Stearic acid (18:0)</td>
<td>0.01 g</td>
</tr>
<tr>
<td>Oleic acid (18:1)</td>
<td>0.34 g</td>
</tr>
<tr>
<td>Linoleic acid (18:2)</td>
<td>0.04 g</td>
</tr>
<tr>
<td>Linolenic acid (18:3)</td>
<td>0.003 g</td>
</tr>
</tbody>
</table>


12.3 OLIVE OIL

The best-quality olive oil is termed *virgin* oil or *extra virgin* olive oil (EVO). This is the oil that is first expressed under light pressure during processing and not further refined. This process is a very significant part of olive oil production. The fact that it has fewer polyunsaturated fatty acids than other oils gives it a better shelf life. Furthermore, it has a mixture of tocopherols, including vitamin E, which can give a protective effect.

Figure 12.1 illustrates the method commonly used in production of extra virgin olive oil. The olives can be hand-picked from the olive tree, or the trees may be beaten with poles to loosen the olives. Some machines collect the olives into nets as a tractor shakes the branches of the olive trees. Most olive oil on the market is expressed under heavy pressure and undergoes further refinement. Olives should be processed within 24 h of picking, especially if the weather is hot.

They should be processed regardless within 72 h of picking. Typically, olive oil may oxidize easily and produce a strong flavor. Thus, protection from light and heat will increase its shelf life considerably. It is important that during processing no heat or chemicals be used to produce extra
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Virgin olive oil. After the olives are harvested, they are washed and then ground up with the pits into a pulp in a mill made from stainless steel. Before industrialization, granite rocks were used to grind the olives. All the oil is pressed from the pulp and then collected. If the process occurs above 86°C, it is no longer considered “cold press,” which is one of the characteristics of extra virgin olive oil. Using this method, 90% of the oil is extracted from the olives. To obtain the remaining 10% requires heat and/or a chemical process, producing an oil that would not be considered extra virgin olive oil. The three basic grades of olive oils that consumers have access to are: (1) extra virgin, (2) virgin, and (3) olive oils.

The interest in the health benefits of olive oil is due to the low incidence of coronary heart disease and even cancer, particularly breast cancer, in cultures that consume a “Mediterranean diet.” This diet is rather high in fruits, vegetables, grains, and legumes, but low in meat. Much of the evidence that links the Mediterranean diet to a lower incidence of coronary heart disease has centered around the relatively high oleate, but low saturated, fat content. In fact, this diet is associated with a lower incidence of several chronic diseases. Diets in the Mediterranean area are characterized by a high content of oleic acid compared to diets in other Northern European cultures and North America. It is well known that monounsaturated fatty acids may lower blood cholesterol levels and may increase HDL cholesterol levels, which could be a link between olive consumption and the lower incidence of coronary heart disease. With respect to olive oil intake and cancer rate, the mechanisms for such observations are less clear.

This review will focus on two health conditions as affected by olive consumption: Coronary heart disease and cancer—but will also consider generalized health aspects. The components of olives, in addition to fatty acids, will be evaluated, as will other compounds such as polyphenols.

### 12.4 CORONARY HEART DISEASE

#### 12.4.1 FATTY ACIDS IN THE MEDITERRANEAN DIET

Prescription of a Mediterranean diet to patients who have had a myocardial infarct decreases the risk of a second cardiovascular accident, which may be due to several factors. It is commonly accepted that saturated fatty acids are twice as effective at raising blood cholesterol as are polyunsaturated
and monounsaturated fatty acids at lowering blood cholesterol. The consensus appears to be that mono- and polyunsaturated fatty acids are similar in terms of their cholesterol-lowering abilities. Several studies have shown that monounsaturated fatty acids decrease total blood cholesterol, LDL cholesterol, apolipoprotein B, and triglycerides, with no changes in HDL cholesterol and Apo-I plasma levels.\(^8\) Elder and Kirchgessner\(^9\) reported that rats fed linseed oil, as opposed to olive oil, had lower concentrations of cholesterol, triglycerides, and phospholipids in plasma and lipoproteins, but a higher susceptibility of LDL to lipid peroxidation. This latter factor, the susceptibility of low-density lipoprotein cholesterol to oxidation, yields a more potent atherogenic compound and may be more significant. Also, although polyunsaturated fatty acids may lower blood lipids,\(^10,11\) they elevate the oxidative susceptibility of LDL, in contrast to fats that contain elevated saturated and monounsaturated fatty acids.\(^12,13\)

### 12.4.2 Other Olive Constituents and Their Effects

It is not always clear if the resistance to oxidation resulting from the Mediterranean diet is due only to oleic acid or to other non-triglyceride components present in oleic acid-rich oils. The minor constituents of virgin olive oil are nonglycerides such as hydrocarbons, monoglyceride esters, tocopherols, alkanols, flavonoids, anthocyanins, hydroxy and dihydroxyterpenic acids, sterols, polyphenols, and phospholipids.\(^1,14,15\) The Mediterranean diet is high in polyphenolic compounds, and olives have a high amount of these substances. The level of these compounds is variable, with 50–800 mg/kg olive oil reported, and is dependent upon several agronomic factors, including soil, degree of olive ripeness, and cultivar or olive variety.\(^1\) There are a number of phenolic compounds in extra virgin oil (Table 12.2). The simple phenolic compounds are hydroxytyrosol (3,4-dihydroxyphenylethanol), tyrosol, and phenolic acids such as vanillic and caffeic acids. The complex phenolic compounds are tyrosol, hydroxytyrosol esters, oleuropein, and its aglycone. Oleuropein is the phenol that contributes primarily to the bitter taste of olives,\(^1,15\) but other phenolic compounds may contribute some bitterness as well. In addition to the phenolic compounds described, newer information has revealed the presence of the lignan class of phenolics such as (\(+\)-1-acetoxypinoresinol, (\(+\)-pinoresinol, and (\(+\)-1-hydroxypinoriesinol.\(^4\) For extra virgin olive oil, the levels of these lignans can be as high as 100 mg/kg in the oils, but variation does exist.\(^4\)

### 12.4.3 Olives as Sources of Antioxidants

Phenols are very good antioxidants. The greater the phenol content in virgin olive oil, the better the oxidative stability. Hydroxytyrosol can donate a hydrogen to free radicals, thereby neutralizing their potential harmful effects, as demonstrated in Figure 12.2. Another factor is that hydroxytyrosol can chelate metal ions, which are themselves prooxidant agents. However, it is important that metal

<table>
<thead>
<tr>
<th>Phenolic Compounds in Extra Virgin Olive Oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydroxytyrosol</td>
</tr>
<tr>
<td>Tyrosol</td>
</tr>
<tr>
<td>Oleuropein</td>
</tr>
<tr>
<td>Vanillic acid</td>
</tr>
<tr>
<td>Caffeic acid</td>
</tr>
<tr>
<td>Lignans:</td>
</tr>
<tr>
<td>((+)-1-acetoxypinoresinol</td>
</tr>
<tr>
<td>((+)-pinoresinol</td>
</tr>
<tr>
<td>((+)-1-hydroxypinoriesinol</td>
</tr>
</tbody>
</table>
Olive Oil and Health Benefits

With respect to the ability of the various phenolic compounds to protect against LDL cholesterol oxidation, both hydroxytyrosol and oleuropein inhibit \( \text{CuSO}_4 \)-induced oxidation of LDL, and the effect appears to be dose dependent. Luteolin and lutean aglycon are both effective in protecting against LDL oxidation.\(^{17,18}\) Visioli and Galli\(^1\) reported that oleuropein and hydroxytyrosol are equally or more effective than other antioxidants such as butylated hydroxytoluene (BHT), vitamin C, and vitamin E. Incubation of LDL with olive oil phenolics (oleuropein or hydroxytyrosol) reduced the fall in vitamin E levels. Normally, virtually all of the vitamin E would have disappeared in 30 min, but 80% remained in the presence of phenols. A lower number of compounds such as isoprostanes, malonaldehyde, and lipid peroxides were present. The presence of these substances is relatively indicative of free-radical activity. Also, both phenolic compounds prevented the oxidation of linoleic and docosahexaenoic compounds in the LDL phospholipids. Phenols can also inhibit platelet aggregation. Reduced TXB\(_2\) and LTB\(_4\) production by activated leukocytes is a known effect of olive phenolics.\(^{1,15}\) In one study, Nicolaiew et al.\(^{14}\) used 10 normolipidemic subjects in a crossover design in which they received virgin olive oil or sunflower oil for 3 weeks each. Plasma levels of LDL cholesterol did not change in both diets in either the fasting or postprandial states. LDL oxidation, as measured by the formation of conjugated dienes, decreased after the olive oil diet. The results were mixed, in that there was a decrease in the level of conjugated dienes at the beginning and at the end of the oxidation reaction, but the total diene production (maximal-diene at time zero) in the presence of \( \text{CuSO}_4 \) did not differ.

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{hydroxytyrosol_antioxidant_mechanism.png}
\caption{Hydroxytyrosol’s antioxidant mechanism. Hydrogen is donated from the hydroxyl groups of the phenol ring structure to free radicals to generate stable compounds. Two hydrogen atoms per compound can react, resulting in a carbonyl structure on the phenol ring of the hydroxytyrosol.}
\end{figure}
Many studies on olive oil are linked to studies on the Mediterranean diet where other dietary factors could play a role in the findings. However, recent studies have demonstrated that antioxidant capacity is enhanced by adherence to the Mediterranean diet. The Attica area of Greece studied 3042 male and female adult subjects without evidence of cardiovascular disease. Total antioxidant capacity of the serum samples were obtained. This approach involves determining the extent to which the addition of exogenous hydrogen peroxide reacts with antioxidants already in the serum. Total antioxidant capacity was positively correlated with fruits, vegetables, and olive oil intake as found in a Mediterranean diet, but inversely correlated with consumption of red meat. Furthermore, low oxidized LDL cholesterol levels were reported for those with greater total antioxidant capacity.

### 12.4.4 Olive Oil and Inflammation

Another theory has emerged suggesting olive oil and its phenolic compounds are mediators of inflammation. Miles et al. conducted a systematic study of the different components of olive oil such as vanillic, p-coumaric, syringic, homovanillic and caffeic acids, kaempferol, oleuropein glycoside, and tyrosol to determine the degree to which they were able to inhibit the proinflammatory effects of lipopolysaccharide using diluted human blood cultures. They studied several cytokines, and the results suggested that the phenolic compounds all had differing degrees of inhibiting cytokines at different concentrations. For instance, oleuropein glycoside and caffeic acid decreased the concentration of interleukin-1β. However, oleuropein at a concentration of $10^{-4}$ M inhibited interleukin-1β production by 80%, but caffeic acid only reduced it by 40% at the same concentration. Kaempferol decreased prostaglandin $E_2$ by 95% at a concentration of $10^{-4}$ M. These phenolics did not appear to affect interleukin-6 or tumor necrosis in this in vitro study. Moreover, a study on human subjects who consumed the Mediterranean diet reported that serum levels of tumor-necrosis factor-α and vascular cell adhesion molecule (VCAM)-1 were markedly decreased.

Further, the authors were able to separate out the effects of olive oil vs. other components of the diet and found that both gave similar results. Ruano et al. studied endothelial function in hypercholesterolemic men as a result of an acute response to a meal high in virgin olive oil. Five men and 16 women from Cordoba, Spain, with cholesterol between 200 and 350 mg/100 mL were also studied. In a crossover design, subjects received two fat meals consisting of 60 g of white bread and 40 mL of virgin olive oil with either low or high phenolic acid content. Venous blood was sampled for periods of time after ingestion up to 240 min after consumption. Ischemic reactive hyperemia was measured with a laser-Doppler probe. Subjects on the high phenolic acid olive oil diet had significantly greater increases in ischemic reactive hyperemia starting 120 min after meal ingestion than those on the low phenolic acid diet. This suggested improved endothelial function among these subjects. Further analysis revealed a reduction in oxidative stress and an increase in nitric oxide metabolites.

Hydroxytyrosol, present in olives, is a diphenolic compound common in extra virgin olive oil and may be a potent antioxidant. The superoxide radical ($O_2^-$) and nitric oxide (NO) react rapidly to form peroxynitrite ($ONOO^-$), which is a chemical that is very reactive and can cause tissue damage. Nitric oxide may contribute to inflammatory diseases and cardiovascular disease. Hydroxytyrosol has been shown to be highly protective against the peroxynitrite-dependent nitrination of tyrosine and DNA damage by peroxynitrite in vitro. On the other hand, oleuropein can increase nitric oxide release by cultured macrophages after endothelin challenge by increasing nitric oxide-synthase expression. This may be beneficial in the sense that NO may guard against infectious agents and parasites.

### 12.4.5 Hypertension and Olive Oil Consumption

There is some evidence that olive oil may lower blood pressure. One study reported that a diet enriched with olive oil reduced the mean blood pressure in adult men and women. For those with hypertension, a crossover study in women revealed that olive oil, as opposed to high oleic-acid sunflower oil, significantly reduced both systolic and diastolic blood pressure. This suggests
that constituents of olive oil other than fatty acids may be contributing to these findings. A recent study by Alonso and Martínez-Gonzalez in Spain of 6,863 adults, the Seguimiento Universidad de Navarra (SUN) study, revealed lower blood pressure among men who consumed more olive oil in their diets, but no such relationship was observed among women. Furthermore, Fito et al. reported that extra virgin olive oil, as compared to refined olive oil, lowered systolic blood pressure in hypertensive patients. However, diastolic blood pressure, blood glucose, lipids, and even oxidized LDL cholesterol did not differ between the refined olive oil group and the extra virgin olive oil group.

12.5 CANCER

12.5.1 BREAST CANCER AND OLIVE OIL

In modern cultures, a switch from a low-fat diet that contains a high proportion of monounsaturated fatty acids to a high-fat diet containing a high proportion of saturated fatty acids may be contributing to the increased incidence of cancer, including breast cancer. There is geographic variation in the incidence of breast cancer, and this variation is coincident with the consumption of a high oleic acid intake derived from olive oil, typical of the Mediterranean diet. Case control studies have yielded evidence of a protective association between oleic acid or olive oil consumption and breast cancer. Animal experiments indicate that oleic acid may be protective when ingested in a vehicle both very high in oleic acid and very low in linoleic acid, which is typical of olive oil. Consumption of olive oil has been shown to reduce mammary tumor incidence even when compared with safflower oil, which contains similar amounts of oleic acid but higher levels of linoleic acid. Moreover, experiments with feeding rats a 15% olive oil diet significantly reduced tumor incidence caused by the carcinogenic compound, 9,10-dimethyl-1,2-benzanthracene.

Simonsen et al. hypothesized that an olive oil diet could reduce susceptibility of tissue structures to damage by free radicals, and thus the incidence of breast cancer. This research group used gluteral fat aspirates and measured the fatty-acid profiles of subjects from various European cultures. The study included 291 postmenopausal incident breast cancer patients and 351 control subjects. Oleic acid showed a strong inverse relationship with breast cancer in Spanish cultures, but not among subjects from Berlin, Northern Ireland, the Netherlands, and Switzerland, or non-Spanish residents. One reason for the failure of this study to show any relationship of oleic acid levels to breast cancer in the non-Spanish population could be because olive oil contains other compounds such as phenols and flavonoids, which are good antioxidants. Moreover, the Spanish residents obtained their oleic acid from olive oil, whereas the other residents obtained theirs from other sources, which possibly explains these results.

Epidemiological studies have yielded consistent results on the association of monounsaturated fatty acids or olive oil consumption and the incidence of breast cancer. Omega-6 fatty acids enhance carcinogenesis promotion, but omega-3 fatty acids from fish inhibit this phase. The impact of omega-6 fatty acid-rich diets is thought to be related to eicosanoid products, such as prostaglandins E₂ and F₂α, and thromboxane B₂, which are elevated in N-nitrosomethylurea-induced rat mammary cancer. On the other hand, there have been epidemiology studies reporting a higher risk from increased polyunsaturated fat consumption for breast cancer. Landa et al. studied 100 breast cancer subjects and 100 controls using a food-frequency instrument. Those with breast cancer reported lower intakes of fish, fruits, and vegetables compared to controls. Those with breast cancer also had lower intakes of vitamin C and monounsaturated fatty acids. Martin-Moreno et al. used a case-control study in Spain and examined specific nutrient intakes using a food-frequency questionnaire in 762 newly diagnosed breast cancer women and compared this to 988 randomly selected control females. Both total fat and type of fat intake were not associated with breast cancer in either pre- or postmenopausal women, after adjustment for energy intake. However, a lower risk of breast cancer was reported in those who consumed higher amounts of olive oil. Trichopoulou et al. used a semi-quantitative food-frequency instrument administered to 820 women with breast cancer and 1548 control women from Greece to estimate the intakes of olive oil, margarine, and other food items. After adjustment for some other
potential confounding factors, increased olive oil consumption was associated with a significantly reduced risk for breast cancer. Margarine consumption was associated with a greater risk of breast cancer. They also reported that fruit and vegetable consumption was inversely related to breast cancer in the same study. In a much larger study in Italy, 2564 women hospitalized with breast cancer were compared to 2588 women admitted to the same hospital for other health conditions not related to breast cancer, hormone problems, or gastric disorders. Using a food-frequency questionnaire, this study demonstrated an inverse relationship with olive oil and other vegetable oil consumption and the incidence of breast cancer. No relationship for butter or margarine were reported.

### 12.5.2 Prostate Cancer and Olive Oil

Olive oil may protect against prostate cancer. Southern European populations of Greece, Italy, Portugal, and Spain have lower rates of prostate cancer, and perhaps the Mediterranean diet that is high in olive oil may be a factor. Studies have suggested that diets high in olive oil may afford protection against prostate cancer. Hodge et al. reported in a case-controlled study of 858 men below 70 years of age with prostate cancer, compared to 905 age-frequency-matched men in Australia, that diets with high levels of olive oil, tomatoes, and allium-containing vegetables reduce the risk of prostate cancer. However, the association with olive oil in that study was weak. It was also unclear whether the fatty acids or the antioxidants in olive oil were the responsible factor. Many studies on prostate cancer have reported inconsistent results for the effect of fatty acid intake on prostate cancer. However, margarine consumption was related to an increased risk of prostate cancer. A New Zealand study revealed that diet patterns high in monounsaturated fatty acid-rich vegetable oils reduced the risk of prostate cancer in 317 prostate cancer cases compared to 480 controls. However, the association was with the foods high in monounsaturated fatty acids and not the fatty acids per se. This suggested that other components in these foods (e.g., phenolic compounds) could be contributing factors.

### 12.5.3 Other Cancers and Olive Oil

In addition to the role of olive oil in lowering the incidence of breast tumors, later studies have suggested that other cancer types may benefit from a diet high in olive oil. Franceschi et al. examined cases of 512 men and 86 women from Northeastern Italy who had cancer of the oral cavity and pharynx and compared them to 1008 men and 483 women controls who had been admitted to area hospitals for ailments other than neoplastic conditions. Subjects were administered a dietary questionnaire to evaluate fat intake and other lifestyle aspects. Risk for these cancers was reduced by at least 50% in subjects with the highest intakes of several food items, including poultry, fish, raw and cooked vegetables, citrus fruits, and olive oil.

### 12.5.4 Summary and Future Need for Cancer Research and Olive Oil

While much of the work on olive oil intake and cancer has focused upon the monounsaturated fatty acid content, the antioxidant compounds present may play an important role in its benefits as it apparently does for heart disease, as reviewed in earlier text. Furthermore, studies examining the antioxidant effects of olive oil on various cancers are surprisingly limited and thus afford more opportunity for investigation.

### 12.6 Other Disease Conditions and Olive Oil

Heart disease and cancer are the two diseases that show a reduction in risk with increased olive oil intake as found in the Mediterranean diet. Recently it has been suggested that metabolic syndrome can be prevented by adherence to the Mediterranean diet. Metabolic syndrome consists of a combination of conditions, including hypertension, abdominal obesity, increased fibrinogen, insulin resistance, increased blood viscosity, and uric acid levels. These conditions predispose the individuals to be
at high risk for cardiovascular disease. Esposito et al.\textsuperscript{52} conducted a randomized clinical trial among 90 men and women with metabolic syndrome. The intervention group followed a Mediterranean diet and the control group followed the prudent diet where carbohydrates provided 50\%–60\%, protein 15\%–20\%, and total fat less than 30\%. Two years later, serum C-reactive protein levels, whose elevation indicates metabolic syndrome, were significantly reduced. Furthermore, insulin resistance, interleukin-6, and improved endothelial function were found in those on the Mediterranean diet.

Interestingly, some recent studies have suggested that a combination of fish oil with olive oil may prove beneficial in treatments of inflammation-related conditions. The omega-3 fatty acids present in fish oils have a well-known impact upon attenuating the inflammatory response. Berbert et al.\textsuperscript{53} reported that treatment of rheumatoid arthritis patients with fish oil plus olive oil resulted in superior relief of clinical arthritic symptoms as opposed to those supplemented with fish oil only. The control group received soy oil. Subjects consuming both supplements of fish and olive oils were better able to withstand pain on handgrip tests, had reduced duration of morning stiffness, and increased time before fatigue became apparent. Camuesco et al.\textsuperscript{54} reported that fish oil and olive oil were superior in reducing inflammation in the colons of rats that were induced to develop colitis with dextran sodium sulfate (DSS). Tumor necrosis factor-\(\alpha\) and LTB\(_4\) levels were reduced in rats treated with both fish and olive oils.

12.7 REVIEWS AND CONSENSUS REPORTS

Several reviews and international conference consensus reports exist for the health benefits of virgin olive oil.\textsuperscript{55–59} In addition to the influence of extra virgin olive oil upon cardiovascular disease and cancer, the report goes further to suggest that EVO may be protective against age-related cognitive decline and Alzheimer’s disease. They further recommended that olive oil intake is especially important during the first decades of life and particularly that EVO intake should begin before puberty and continue throughout life. The most relevant molecular effects of EVOO involved in the prevention or resolution of liver damage are: (1) activation of the nuclear transcription factor erythroid-derived 2-like 2 (Nfr2), inducing the cellular antioxidant response; (2) inactivation of the nuclear transcription factor-\(\kappa\)B (NF-\(\kappa\)B), preventing the cellular inflammatory response; and (3) inhibition of the PERK pathway, preventing endoplasmic reticulum stress, autophagy, and lipogenic response.

12.8 SUMMARY

Clearly, the monounsaturated content of the Mediterranean diet, with respect to the intake of olive oil, plays a significant role in the lower incidence of both coronary heart disease and cancer, particularly breast cancer. The antioxidant compounds present in extra virgin olive oil allow for protection against LDL cholesterol oxidation and thus spare other antioxidant nutrients. The role of these same antioxidants in protecting against various cancers should be pursued. Therefore, further examination of olive oil intake and other cancer types may also yield beneficial information. The health benefits of olive oil due to its active compounds should focus more on those agronomic factors that optimize their content. Additionally, further knowledge on the genetic regulation of the production of antioxidant phenolic compounds would be worthwhile. Increasing the content of these valuable nutrients to protect against both coronary heart disease and cancers is a good example of functional food for health. Furthermore, extraction of these compounds from olives and concentrating them for clinical trials, both animal and human, may provide better insights into their utility as nutraceuticals for the future.

REFERENCES

220 Handbook of Nutraceuticals and Functional Foods


