



Virgin olive oil as a fundamental nutritional component and skin protector

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Abstract Fats are indispensable to life not only as an energy source but also for their structural role in the skin, retina, nervous system, lipoproteins, and biologic membranes. They are also precursors of important hormones and constitute the vehicle for the absorption of liposoluble vitamins. Nutritionists recommend a balanced lipid intake corresponding to a total amount of fats equal to 25% to 30% of total calories with a ratio in monounsaturated and polyunsaturated fatty acids. Thus, olive oil, with its balanced fatty acid composition, is of high nutritional value. Moreover, extra virgin olive oil, extracted from a fruit, has an important value related to the antioxidant power of minor components. Extra virgin olive oil contains 98% to 99% triglycerides and 1% to 2% minor components. In the triglycerides, the main fatty acids are represented by monounsaturates (oleic), with a slight amount of saturates and an adequate amount of polyunsaturates. The minor components are α -tocopherol, phenol compounds, carotenoids, squalene, phytosterols, and chlorophyll. Factors that can influence olive oil's composition, especially in regard to its minor components, are the cultivar, area of production, time of harvesting, and degree of technology used in its production. Therefore, an evaluation of the biologic value of extra virgin olive oil and its use as a topical raw material in cosmetic dermatology is reported.

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Introduction

Fats are not only indispensable to life as an energy source but also for their structural role in the skin, retina, nervous system, lipoproteins, and biologic membranes. Fats are also precursors of important hormones and constitute the vehicle for the absorption of liposoluble vitamins. In view of this, their incorrect use can lead to serious illness such as atherosclerosis and malignancies.

Therefore, an evaluation of the biologic value of fats is called for by examining their makeup in fatty acids and minor components. Following is a list of components that can be considered:

- Fatty acids composition (saturated, monounsaturated, polyunsaturated ω -6, polyunsaturated ω -3)
- Polyunsaturates/saturates ratio
- Omega-6/omega-3 ratio
- Antioxidant content
- Antioxidant/polyunsaturates ratio
- Presence of minor biologically active components

Extra virgin olive oil contains 98% to 99% triglycerides and 1% to 2% minor components. In the triglycerides the main fatty acids are represented by monounsaturates (oleic), with a slight amount of saturates (palmitic, stearic) and an adequate presence of polyunsaturates (linoleic and α -linolenic). The minor components are α -tocopherol, phenol compounds, carotenoids (β -carotene and lutein), squalene, phytosterols, and chlorophyll (in addition to a great number of aromatic substances). Factors that can influence (to a

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degree) the composition of extra virgin olive oil, especially in regard to its minor components, are the type of cultivation (cultivar), area of production, time of harvesting, and degree of technology used in its production.

Some polyunsaturated fatty acids with 18 carbon atoms (linoleic, 18:2 ω -6, and α -linolenic, 18:3 ω -3), although indispensable for cell structure and function, cannot be synthesized by the body and must be consumed preformed in food.

These polyunsaturated fatty acids are therefore referred to as "essential," or essential fatty acids (EFAs). It must be noted, however, that in most cases EFAs do not interact directly in the above-mentioned biologic activity, but only after the chain undergoes an elongation to 20 or 22 carbon atoms and subsequent desaturation. This is brought about (mainly in the liver) by certain enzymes (elongase and desaturase). The long-chain polyunsaturated fatty acids are responsible for the main function attributed to the essential polyunsaturated fatty acids.

Through the above-mentioned enzymatic reaction, linoleic acid gives way for diomo- γ -linolenic acid, 20:3 ω -6 (gamma-linolenic acid), and arachidonic acid, 20:4 ω -6. α -linolenic acid gives way for eicosapentaenoic acid, 20:5 ω -3, and docosahexaenoic acid, 22:6 ω -3.

The long-chain polyunsaturated fatty acids, after being synthesized from EFA by the body in the form of esters (together with a certain amount of EFA), become part of the phospholipid component of the lipoproteins that transport lipids in plasma and structure the cell membranes with the aforementioned structural and functional capacities. At this point, they do not need to be stable because they can be hydrolyzed (by phospholipase A₂) for the subsequent formation of prostaglandins (by cyclooxygenase) and leukotrienes (by lipoxygenase) (Figure 1).

The two series ω -6 and ω -3 are, however, in contrast with each other in many aspects. Therefore, it seems important that they be present in a correct ratio in the diet, because an excess of linoleic acid can inhibit the endogenous synthesis of the long chains of α -linolenic acid (eicosapentaenoic acid and docosahexaenoic acid) with

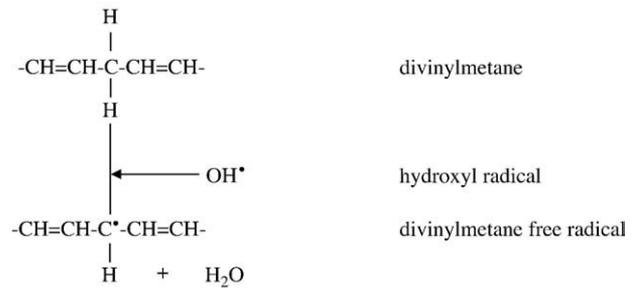


Fig. 2 Oxidative activity of the oxygen free radical at level of the methylene group.

consequent damage to the body. The ratio between the ω -6 and the ω -3 series should never be less 10:1, especially during growth because the long-chain ω -3 series are fundamental for brain and retina development. They also have other important functions: anti-cancer, antiplatelet aggregation, anti-inflammatory, and protection against dryness of the skin.

The recommended ratio is found in olive oil, whereas the same cannot be said for other vegetable oils, with the exception of linseed and soy oils. It should also be noted that Δ -6-desaturase (a key enzyme in the synthesis of long-chain polyunsaturated fatty acids) can be inhibited by the peroxidative action of oxygen free radicals with particular limitation of the formation of diomo- γ -linolenic acid (20:3 ω -6), which has an important protective activity in the skin, especially in atopic dermatitis.

The recognition of the essentiality of polyunsaturated fatty acids, together with the fact that their consumption decreases cholesterol plasma levels, gave rise to great interest in them (particularly in regard to linoleic acid, 18:2 ω -6) to the point of recommending a high intake in the diet mainly through the use of seed oils. At the present time, however, doubts have arisen in regard to these recommendations because of the easy peroxidation that polyunsaturates can undergo.

During the normal production of energy, it is inevitable that the body forms some oxygen free radicals that can be dangerous, in particular, the hydroxyl radical (OH \bullet). If the free radicals produced are not neutralized, they can damage some macromolecules as deoxyribonucleic acid (DNA), proteins, and especially polyunsaturated fatty acids component of phospholipids in the biologic membranes and the lipoproteins, causing even serious and irreversible damage.

The body defends itself against peroxidative damage with antioxidants, some of which are naturally present (eg, certain enzymes, α -1-antitrypsin, uric acid, and ferritin) and some of which are in the form of foods (tocopherols, carotenoids, and polyphenols). In the event of imbalance between prooxidant and antioxidant factors, the body undergoes *oxidative stress*, which causes modifications in cell function that when totally compromised can cause cell death.

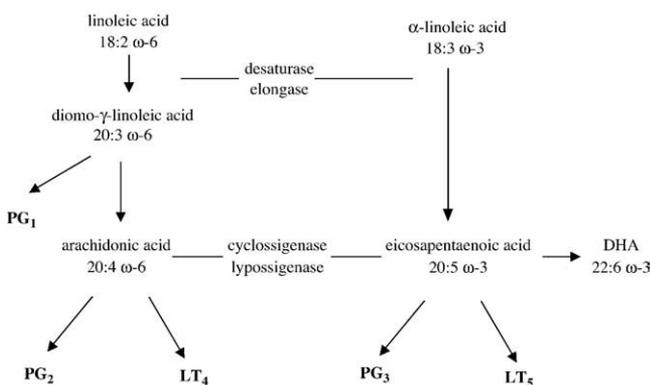


Fig. 1 Omega-6 and omega-3 metabolic pathways.

Table 1 Fatty acid composition of some dietary fats

	Saturates	Monounsaturates	Polyunsaturates Omega-6	Polyunsaturates Omega-3
Butter	45–55	35–55	1.5–2.5	0.5
Lard	40–46	42–44	6–8	0.5–0.9
Olive oil	8–14	65–83	6–15	0.2–1.5
Peanut oil	17–21	40–70	13–28	—
Maize oil	12–28	32–35	40–62	0.1–0.5
Soya oil	10–18	18–30	35–52	6.5–9
Sunflower oil	5–13	21–35	56–66	—

Polyunsaturates, although indispensable, constitute a mark for oxygen free radicals because the methylene positioned between the two double links (divinylmethane group) constitutes a vulnerable point that allows the subtraction of a hydrogen atom through a homolytic scission and subsequent formation of a lipid peroxide that will in turn try to stabilize itself, creating a chain reaction (Figure 2).

The intake of polyunsaturates is necessary, but not in high quantities (only 6%–8% of calories from fats [2%–3% of total calorie intake]). At the same time, saturated fatty acids consumption should be moderate (approximately the same amount as polyunsaturates, with a ratio of 1:1). The saturates increase plasma cholesterol levels and act as “promoters” on certain cancer growths (colon, breast, and perhaps uterus and prostate).

Nutritionists recommend a balanced lipid intake corresponding to a total amount of fats equal to 25% to 30% of total calories with a ratio in fatty acids:

- Saturates (6%–8%)
- Monounsaturates (12%–14%)
- Polyunsaturates ω -6 (6%–7%)
- Polyunsaturates ω -3 (0.5%–1.5%)

Olive oil’s balanced acid composition gives it a high value (necessary and adequate EFA content with a balanced ratio between the two series), but extra virgin olive oil, extracted from a fruit, has an important value related to the antioxidant power of minor components (Table 1).

Antioxidants in olive oil

Virgin olive oil contains 150 to 200 mg/kg α -tocopherol with an optimum E/polyunsaturated fatty acid ratio (milligrams of vitamin E per gram of polyunsaturates). This ratio, which should never be less than 0.5, is hardly ever found in seed oils, but in extra virgin oil it is 1.5 to 2. In seed oils, the tocopherols present are mainly of β , γ , and δ types scarcely used by the body. The body at the intestinal level absorbs all tocopherol types equally well, but after the liver identifies them, it eliminates the β , γ ,

and δ types with the bile, keeping only the α form, the true vitamin E.^{1,2}

In addition to α -tocopherol, extra virgin olive oil contains some carotenoids as β -carotene and lutein (responsible for the yellow color), and especially numerous phenol compounds, which are presently attracting the attention of many researchers. The most important of these are hydroxytyrosol and oleuropein, with the ability to decrease cholesterol levels, platelet aggregation, and tumor risk. Other phenol compounds present, in lesser amounts, are caffeic acid, vanillic acid, and ferulic acid, which exert an α -tocopherol-saving action, in addition to the lignanes, a class of phenols able to provide protection from colon and breast cancers.

Currently, there is considerable interest in olive oil’s squalene content, a triterpene hydrocarbon that exerts antioxidant properties at the cutaneous level against solar rays, behaving as a biologic filter of singlet oxygen.^{3,4} Squalene seems to have immune-stimulating properties and an anti-neoplastic influence on the colon, breast, and prostate.

The presence of numerous and varied antioxidants agents is of importance because diverse antioxidants act synergistically, whereby when only one antioxidant is present, even in high amounts, it is not effective and can even have adverse effects.

Most researchers are primarily interested in phenol compounds, which seem to have numerous properties, in addition to antioxidant, and this puts phenol-rich extra virgin olive oil in first place. It is also important to consider that although carotenoids and tocopherols are found in other animal and vegetable foods, the most important water-soluble phenol substances can be found exclusively in extra virgin olive oil.

Biologic activity of phenol compounds

- Direct antioxidant activity
- Increased vitamin A and β -carotene activity
- Protection and recharge of vitamin E (α -tocopherol)
- Binding of metal ions that catalyze free radical formation

- Protection of Δ -desaturase activity
- Inhibition of phospholipase A₂, concealing arachidonic acid release
- Inhibition of platelet aggregation
- Inhibition of cyclooxygenase and lipoxygenase
- Reduction of plasma cholesterol level
- Inhibition of low-density lipoprotein (LDL) oxidation
- Inhibition of some cancer-forming chemicals
- Decreased cancer growth
- Increased immune activity
- Anti-inflammatory activity
- Anti-allergic activity
- Skin protection

Olive oil and atherosclerosis

A high plasma cholesterol level plays an important role in the pathogenesis of atherosclerosis. The plasma cholesterol level depends not only on a high dietary intake, but also from the saturated fatty acid activity that inhibits the cell's receptors for LDL (the lipoproteins that transport cholesterol, which if not taken up by the cell will remain in the blood, determining the increase in cholesterolemia).

Polyunsaturates, in contrast with saturates, promote LDL cell cholesterol entry, decreasing plasma cholesterol levels. LDLs, with their high polyunsaturate percentage, are at high risk of peroxidation, which can modify apoprotein B-100 (the LDL component that recognizes the cell receptor allowing the cell uptake of cholesterol). In this manner, the oxidized LDL loses the ability to recognize the receptors and stagnates in the blood, at the same time exerting a toxic effect on the endothelia and promoting atherogenesis instead of inhibiting it.

It is known that a negative cholesterol effect is not the result of normal LDL, but of LDL modified during oxidation. Oxidized LDLs, in addition to causing microlesions to cell endothelia (with the consequent production of thromboxane, which promotes platelet aggregation), exert a proliferative stimulus on the muscle cells of arterial walls (leading to arterial stenosis). They also lose their ability to recognize normal cell receptors while they are avidly taken up by the scavenger receptors of macrocytes and macrophages, which are transformed into the foam cells at the basis of atherosclerotic plaque formation.

LDLs are rich in polyunsaturated fatty acids and are particularly exposed to peroxidative risk. They are normally protected by antioxidant substances, especially α -tocopherol, which can be insufficient in an incorrect diet with an excess of polyunsaturates or deficient in antioxidant factors. In this regard, a striking protection against LDL peroxidation has been shown with hydroxytyrosol and oleuropein,^{5,6} polyphenols contained in virgin olive oil in high amounts. Oleuropein seems to exert a favorable action on platelet aggregation, blocking thromboxane formation from arachidonic acid via an anti-cyclooxygenase action similar to aspirin's mechanism.

In atherosclerosis prevention, animal fats, high in saturated fatty acids and cholesterol, should be reduced, and oils high in polyunsaturates (ω -6 series) must be limited because of the high peroxidative risk they represent. These recommendations come from classic international studies, both American (Cholesterol Lowering Atherosclerotic Study) and European (EURAMIC Study), showing that ischemic cardiopathy risk increases with the increase of linoleic acid intake because of its susceptibility to peroxidative phenomena.⁷⁻⁹

Oleic acid, 80% of the fatty acids present in olive oil, not only avoids the insurgence of peroxidation by oxygen free radicals but also has a favorable effect on atherosclerotic disease via the action of LDL receptors (similar to polyunsaturates) and can increase HDL concentration and inhibit the adhesive molecules (vascular cell adhesion molecule-1) implicated in atherosclerotic plaque pathogenesis.^{10,11}

Extra virgin olive oil, with its adequate polyunsaturate content, being poor in saturates, high in monounsaturates, and rich in antioxidant agents, is seen to be the dietary fat suitable to prevent atherosclerotic disease and ischemic cardiopathy.

Neoplasms

The incidence of breast and colon cancer in Southern Italy, Spain, and Greece, where olive oil is widely used, is lower than in other European nations and North America, but in southern Italy this protective effect extends to all forms of cancer.

In addition to epidemiologic data, there are experimental data that document olive oil's protective anticancer effect. Numerous animal studies have shown that olive oil decreases the risk of neoplastic development induced by exposure to cancerous agents, because it reduces the production time of the cancer-forming cheto-derivatives in rat intestines.

The protective action seems to be connected to olive oils high monounsaturated fatty acid content. To confirm this epidemiologic aspect, we cite an experimental study¹² conducted on two groups of rats fed olive oil or safflower oil and then exposed to tumoral induction with 7,12-dimethylbenz(a)anthracene. The incidence of breast cancer was less in the group fed olive oil than in the group fed safflower oil. According to researchers, this result could be in relation to the lesser amount of linoleic acid (8%–10% in olive oil vs 65%–72% in safflower oil), taking into consideration the possible "promoter" effect of peroxidation on the neoplastic process.^{13,14} An increased biosynthesis of leukotrienes was also hypothesized, but a damaging effect tied to the peroxidation of linoleic acid is more probable.

At this point it is mandatory to underline the protective action exerted by antioxidant agents, such as carotenoids, squalene,^{14,15} and especially polyphenols, of which olive oil is particularly rich (eg, hydroxytyrosol¹² and lignans¹³).

Aging

The most accredited theory to explain aging is free radical peroxidation.¹⁶ In addition to modifying DNA replication, oxygen free radicals cause progressive damage to biologic membranes and subcellular organelles, impairing their functionality.

With aging, biologic membrane sensitivity to peroxidative phenomena increases with a progressive loss of functionality, with increased activity of phospholipase A₂ enzyme, which hydrolyzes phospholipids releasing arachidonic acid. This, by the action of cyclooxygenase, leads to an increased synthesis of thromboxane with consequent vasoconstriction, increased platelet aggregability, and hypertension, and the subsequent reduction of nutrients and oxygen reaching the tissues. At the same time, lipoxygenase action increases leukotriene production with a reduction in immunity.¹⁷

It should not be forgotten that the brain has an elevated concentration of long-chain polyunsaturated fatty acids (especially ω -3) necessary for neuron function. Because the brain's weight is 2% of the body's total weight and its oxygen consumption is high, equal to 20% of the body's total oxygen consumption, it is understandable that it is particularly exposed to lipid peroxidative risk. The brain therefore needs high antioxidant protection to avoid degenerative processes, keeping in mind that a damaged brain irradiates the aging phenomena to all other organs.

The skin represents the mirror of the aging process, but in this area, next to the general physiologic processes, an important role is played by photoaging caused by solar rays, in which oxygen free radicals also play an important role. After lipoperoxidation, the skin forms lipofuscin (an indicator of skin aging) and cancer risk is increased. It should not be forgotten that the inhibitory role played by free radicals on Δ -6-desaturase, which limits the formation of long-chain polyunsaturated fatty acids (in particular diomo- γ -linolenic acid, which is important in skin protection). It seems evident that a balanced diet with fatty acids and rich in antioxidant agents can act favorably to combat, both generally and locally, degenerative processes tied to both aging and solar radiation, a balanced diet that, if precise, should be followed for the entire life span.

It is important to ensure an adequate intake of dietary antioxidants, which can be accomplished by eating fruits and vegetables, but also using extra virgin olive oil for its high polyphenol content (as well as carotenoids and α -tocopherol). Olive oil has a balanced fatty acid makeup that provides an adequate amount of polyunsaturates, without deficiencies but also without excesses and with an adequate ω -6/ ω -3 ratio.

The longevity of Italy's population is one of the world's highest, and it seems natural to ascribe it mainly to the Mediterranean diet, which more precisely should be called the Greco-Latin diet, rich in fruits and vegetables but also in virgin olive oil.

Skin protection

Since remote times, olive oil has been used as a cosmetic and skin protector. The ancient Egyptians used it to make creams and perfumes, and it is said that the first anti-wrinkle cream was invented by Cleopatra. It seems she used olive oil mixed with milk, incense, and juniper berries, spreading its fame as a basic ingredient for beauty products. Romans used it to oil their bodies after bathing to keep the skin elastic, and this belief has survived to this day with the widespread use of olive oil to prevent wrinkles.

We will not give a description of the lipid composition of the skin, but it is noteworthy that most lipids are different from those of other tissues in that they are synthesized in loco from glucose. In regard to EFAs, the skin does not contain desaturase and therefore cannot make, starting from linoleic and α -linolenic acids, the long-chain diomo- γ -linolenic (20:3 ω -6), arachidonic (20:4 ω -6), eicosapentaenoic (20:5 ω -3), and docosahexaenoic (22:6 ω -3) acids that must be consumed directly preformed. The skin instead contains cyclooxygenase and lipoxygenase so it can form prostaglandins and leukotrienes. Even for this tissue, it is important that an adequate ratio exists between the ω -6 and ω -3 series in that the long-chain ω -3 (eicosapentaenoic and docosahexaenoic acids) has local anti-inflammatory and immunoprotective effects.¹⁸

Much has been written on the necessity to ensure a sufficient intake of EFAs to maintain skin homeostasis in that these fatty acids play an important role in the skin barrier. They keep the skin well hydrated and prevent various conditions, such as atopic dermatitis, psoriasis, acne, and eczema. There is no doubt that in serious and prolonged deficiency (<1% of total calories), notable alterations occur, for example, hemorrhagic spots, erythemas, and an increase in "perspiratio insensibilis" with hypoelastic, dry, and dehydrated skin. Also seen is an increase in DNA synthesis with epidermal proliferation and consequent desquamation. However, although it is important to have a sufficient intake of these fats to maintain healthy skin, and to use them topically to treat the above-mentioned pathologies, a prolonged, excess dietary intake of polyunsaturates and their accumulation in the skin can set off a free-radical reaction favoring aging, sun damage, and the insurgence of cancers even in healthy subjects.

The skin has a high metabolic activity and therefore a high risk of undergoing oxidative stress that can be brought on by internal and external conditions.

Internal disorders, in addition to an incorrect diet (protein deficiency, polyunsaturates deficiency or excess, antioxidant deficiency, and alcoholism), hormone disorders, and other factors (eg, smoking) are in this category.

External influence, in addition to atmosphere pollution, can be represented by ultraviolet (UV) rays that can cause a type of energy transfer at the skin level where a photosensitized molecule absorbs photons that enter an excited state. This leads to the formation of free radicals that

have the ability to penetrate the epithelia, disarranging its structure and functioning, and favoring cell aging and cancer risk.

UV rays cause skin tissue damage with the possibility of tumor transformation because UVA induces free radical formations that target DNA, aromatic amines, and polyunsaturated fatty acids.²² Consequently, lysosome rupture occurs with the release of enzymes and formation of typical sunburn cells.

On the other hand, UVB causes direct damage to DNA, provoking photoproducts (eg, 8-OH deoxyguanine) that induce transverse bonds between nucleotides during DNA replication.²³

However, great importance is given to the formation of oxygen free radicals produced inside the epidermal cell, not only by solar rays but also by the oxide-reduction reactions that take place inside the cell. This modifies the phospholipids in the membrane that undergo the peroxidation of their polyunsaturates, with cell destruction that can lead to cell death. The skin's susceptibility to peroxidative initiation is strictly connected to the presence or absence of an adequate antioxidant system, represented by the enzymes superoxide-dismutase and glutathione peroxidase; α -tocopherol, β -carotene, and squalene; and the phenol compounds.

In addition to ensuring an adequate intake of antioxidants, it seems opportune to provide an optimum amount of polyunsaturated fatty acids, avoiding deficiency but also avoiding excesses, because of their high susceptibility to peroxidative initiation, which can favor the damaging effects of solar rays. The peroxidation of EFA leads to polymer formation with cyclic compost formation, which causes ulcerative-type lesions that accumulate pigments of lipofuscin and ceroids (brown spots) and a tendency to cancer.

As a confirmation of this hypothesis, we cite Harman's study,¹⁹ which involved two groups of rats with diets rich in polyunsaturated fatty acids (safflower oil) or monounsaturates (olive oil). The rats were then exposed to radiation, and from the measurement taken it was noted that the rats fed olive oil had less severe lesions than those of the rats fed safflower oil. Harman noted that UV light induces alterations in the skin that mimic those of normal aging, which led us to think that those who habitually consume olive oil should have younger-looking skin than those who habitually consume oil high in polyunsaturates, such as corn oil or safflower oil.

Further support to this hypothesis is given by Pinckney,²⁰ who observed that 78% of subjects who consumed a diet containing more than 10% of polyunsaturates presented striking signs of early aging and had an older appearance than their chronologic age. In this group, 6% had undergone removal of one or more skin lesions of suspected malignancy.

Therefore, to prevent skin damage it is advisable to consume an adequate amount of polyunsaturates, being careful not to exceed the body's physiologic need (respecting the correct ω -6/ ω -3 ratio) to limit the peroxidizable substrate, and most of all to ensure an adequate intake of antioxidant

agents. This can be accomplished by the regular intake of fruits and vegetables with extra virgin olive oil. Exposure to solar rays determines a serious loss of antioxidant factors in the skin. It has been observed that after 30 minutes of UV exposure, the level of α -tocopherol in the skin is reduced by 50% to 60%. The topical application of α -tocopherol clearly reduces damage, and the same positive effect, although to a lesser degree, is seen when the α -tocopherol is taken orally.²¹ It should be remembered that UV rays exert a negative effect on all antioxidants, especially on carotenoids, decreasing their concentration both at the skin level and in the plasma.²² An adequate intake of carotenoids (with vegetables, but also with extra virgin olive oil, which contains β -carotene and lutein) can be decisively recommended as an important protective skin factor. Lutein has a direct effect as an antioxidant and works synergetically with other another carotenoid, lycopene, a highly active agent against skin photoaging and cancer risk, not only of the skin, but of other tissues as well.²³ Olive oil also promotes the intestinal absorption of carotenoids, particularly lycopene.

The phenol components of olive oil have been shown to have a direct antioxidant action on skin, especially oleuropeine, which acts as a free radical scavenger at the skin level.²⁵ Particular attention must be directed to squalene, present in notable concentration in virgin olive oil in nonsaponifiable fraction, which makes it similar to the composition of sebum. Squalene is found in high amounts in sebum (~12% of its composition) and acts as a potent scavenger of singlet oxygen, inhibiting the lipoperoxidation induced by UVA.^{3,4} When taken orally, olive oil has been shown to give photoprotection to the skin.^{26,27}

Also present in high concentration in olive oil is β -sitosterol, a phytosterol that has an action similar to azelaic acid, inhibiting the transformation of testosterone into dihydrotestosterone with a consequent regulatory effect on sebum.²⁸

Topical uses of olive oil

Another interesting aspect of virgin olive oil is its use in cosmetic and dermo-protective creams. The similarity of virgin oil's composition to sebum, given by its high content of squalene, β -sitosterol content, optimum fatty acids content (the presence of oleic acid, which acts as a skin softener), and wealth of antioxidant substances, makes it particularly able to directly protect the skin. When applied to the skin after sun exposure, olive oil has an inhibitory effect on sun-induced cancer development. This is accomplished by the activation of enzyme p53, the substance that prevents and repairs skin damage caused by exposure to UVA.²⁴

On the whole, virgin olive oil seems indicated for use directly on the skin and in creams and salves used in cosmetics. However, it should not be forgotten that if the topical use of olive oil alone or as an ingredient in dermo-

cosmetology shows therapeutic effects (anti-inflammatory, anti-neoplastic, and anti-aging), its daily dietary use contributes to reinforce these effects and prevent the alterations physiologically caused by time and diverse external irritating factors.

Conclusions

Olive oil, used since 4000 B.C. by the Mediterranean populations as a food, drug, and cosmetic, has been the object of numerous epidemiologic, clinical, and experimental studies in the last few decades, confirming its protective action and demonstrating how the intuition of ancient Mediterranean populations now has scientific backing.

Because of increased scientific research, the recognition of virgin olive oil's biologic value has notably increased. Currently, we know that in addition to olive oil's preventive action in the physiologic aging process in atherosclerosis and neoplastic development, it exerts protective action toward the skin with topical and dietary use.

The Mediterranean diet, which favors the use of fruits, vegetables, bread, pasta, fish, and olive oil, has an effective value in the dermo-cosmetology sector, making ancient Mediterranean customs more comprehensible, such as the use of olive oil on the body after bathing to protect the skin and keep it fresh.

References

- Traber MG, Kajden HI. Preferential incorporation of α -tocopherol vs γ -tocopherol in human lipoproteins. *Am J Clin Nutr* 1989;49:517-26.
- Traber MG, Burton GW, Ingold KU, et al. RRR- and SRR- α -tocopherol are secreted without discrimination in human chylomicrons, but RRR- α -tocopherol is preferentially secreted in very low lipoproteins. *J Lipid Res* 1989;119:1252-8.
- Kohn Y, Egawa S, Itoh S, et al. Kinetic study of quenching reaction of singlet oxygen and scavenging reaction of free radical by squalene in n-butanol. *Biochim Biophys Acta* 1995;22:778-84.
- Dennis KJ, Shimamoto T. Production of malonyldialdehyde from squalene, a major skin surface lipid, during UV irradiation. *Photochem Photobiol* 1989;49:711-9.
- Visioli F, Galli C. Natural antioxidants and prevention of coronary heart disease: the potential role of olive oil and its minor constituents. *Nutr Metab Cardiovasc Dis* 1998;5:306-14.
- Visioli F, Petroni A, Galli C. Phenolic compounds extracted from olive oil prevent oxidation of LDL and inhibit platelet function and platelet and leukocyte eicosanoid production in vitro. In: Paoletti R, et al, editor. *Oxidative processes and antioxidants*. New York: Raven Press Ltd; 1994.
- Kramshar DM, Sevanian A, Blakenhorn DH. Limit of current therapy in coronary heart disease. In: Ursini F, Cadenas E, editors. *The importance of fat composition on progression and regression of atherosclerosis*. Dietary Lipids, Antioxidants, and the Prevention of Atherosclerosis. Asolo, Italy: CLEUP Publ; 1992.
- Kardinaal AFM, Aro A, Kark JD. Association between β -carotene and acute myocardial infarction depends on polyunsaturated fatty acids status. The EURAMIC Study. *Arterioscl Thromb Vasc Biol* 1995;15:726-32.
- Cohen L. *Dieta e Cancro*. Le Scienze 1988;21:15-21.
- De Caterina R. Fasi iniziali dell'aterogenesi e punti d'attacco per la prevenzione. *Dieta Mediterranea e cardioprotezione*. Dalle evidenze epidemiologiche ai meccanismi di azione molecolare. Pisa, Italy: Primula Multimedia Publ; 2002. p. 60-72.
- Bellido C, Lopez-Miranda J, Perez-Martinez J, et al. The Mediterranean and CHO diets decrease VCAM-1 and E-selectin expression induce by low density lipoprotein in HUVECs. *Nutr Metab Cardiovasc Dis* 2006;16:524-30.
- Lasekan JB, Clayton MK, Gendron-Fitzpatrick A, Ney DM. Dietary olive and safflower oils in promotion of DMBA induced mammary carcinogenesis in rats. *Nutr Cancer* 1990;13:156-63.
- Morozzi G, DeBartolomeo A, Fabiani R, et al. Effetti antitumorali "in vitro" dei polifenoli dell'olio extravergine di oliva. Symposium on "Gli antiossidanti degli oli vergini di oliva con particolare riferimento ai composti fenolici."; 2005. Spoleto, Italy.
- Owen RW, Giacosa A, Hull WE, et al. The antioxidant anticancer potential of phenolic compounds isolated from olive oil. *Eur J Cancer* 2000;36:1235-47.
- Desai KN, Wei H, Lamartiniere CA. The preventive and therapeutic potential of squalene containing compounds on tumour promotion and regression. *Cancer Lett* 1996;101:93-6.
- Harman D. The free radical theory of aging. Effect of the amount and degree of unsaturation on mortality rate. *J Gerontol* 1971;26:451-60.
- Viola P, Audisio M. Lipidi alimentari e invecchiamento—enciclopedia mondiale dell'olivo. Madrid, Spain: Consiglio Oleicolo Internazionale Publ; 1997. p. 378-80.
- Soiland E, Drevon CA. The effect of very long-chain n-3 fatty acids on immune function-related skin disease. *Eur J Chim Nutr* 1993;47:381-8.
- Harman D. Swiss male mice: effect of dietary fats on skin damage by ultraviolet light—olive oil in medicine. Madrid, Spain: COI Publ; 1996.
- Pinckney ER. The potential toxicity of excessive polyunsaturates. Do not let patients harm himself. *Am Heart J* 1973;25:723-8.
- Tavakkol A, Nabi Z, Soliman N, et al. Delivery of vitamin E to the skin by a novel liquid cleaner: comparison of topical versus oral supplementation. *J Cosmetic Sci* 2004;55:177-87.
- Mathews Roth M. Photoprotection by carotenoids. *Fed Proc* 1987;46:1890-987.
- Bernstein EF. Reactive oxygen species activate the Human elastin promoter in a transgenic model of cutaneous photoaging. *Dermatol Surg* 2002;28:132-5.
- Arief B, Nazim UA, An W, et al. Protective effect of topically applied olive oil against photo-carcinogenesis following UVB exposure of mice. *Carcinogenesis* 2000;21:2085-90.
- Ancora C, Roma C, Vettor M. Evaluation of cosmetic efficacy of oleoeuropein. Symposium on the New Frontiers of Dermo-cosmetology: Efficacy, Stability and Safety. Rome, Italy, November 4-6; 2004.
- Kelly G. Squalene and its potential clinical uses. *Altern Med Rev* 1999;4:29-36.
- Cornelli U. The antioxidant defence system in skin. International Congress on Nutricosmeceutical, a Challenge for the Future; 2002. Rome, Italy.
- Castellani L, Zumiani G. L'oleosità cutanea. *La Pelle* 2000;8:41-3.