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Thore Fritjof
Bertil Henning
Editors

Olive Oil

Sensory Characteristics,
Composition and Importance
in Human Health

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SENSORY CHARACTERISTICS, COMPOSITION AND IMPORTANCE IN HUMAN HEALTH

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**THORE FRITJOF
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Chapter 1

OLIVE OIL: COMPOSITION AND HEALTH BENEFITS

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ABSTRACT

The production of Extra Virgin Olive Oil (EVOO) in Spain is very high, it reached 1 million tonnes in the last olive oil campaign, with over two million hectares planted with olive trees. This crop is distributed in over six different bioclimatic zones and with more than 100 cultivars, many of them native from a pomological point of view.

Among the olive areas of Spain, Andalusia, Extremadura, Catalonia and Valencia stand out, next to the Central Region (Castilla-La Mancha).

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Each one of them is respectively dominated by Picual, Manzanilla, Arbequina and Farga cultivars alongside Cornicabra, all highly diversified.

In response to this diversification of olive groves in Spain, we have studied the composition of the majority of oils of the main five olive areas, both in their saponifiable composition in fatty acids and their unsaponifiable fraction, tocopherols and polyphenols among them.

The characteristics of many of these oils with a high content of oleic acid and antioxidants, make them very suitable as nutrients and healthy products. They also prevent cardiovascular diseases, cancer, and especially diabetes and other diseases that show a significant increase among the population, and more specifically, in child population.

EVOO consumption is considered to be very suitable both in the prenatal period and in childhood, and there are Spanish oils that are especially convenient for these life stages because of their balance, softness and very pleasant aromas.

The current use of EVOOs in food is a very suitable requirement in the face of an increase in nutrition-related diseases, since we really are what we eat and how we eat it, therefore its use is advisable both in hospital diets and catering, and domestically.

Keywords: food, EVOO, health, composition

INTRODUCTION

There is evidence of the consumption of fruits and its liquid extractions in diets already in the Copper Age (6th millennium BC). In the 7th millennium BC, olive oil began to be used as a cosmetic and for basic medical purposes. In the 9th and 8th century BC oil was used for food and also to take care of burnt skin, dermatitis, stomach and intestine problems, as well as sun protection [1].

Hippocrates (460-377 BC) used olive oil as medicine both for burns and all kinds of inflammations and digestive problems.

Pliny (24-71 AB) in his “*Historia Naturalis*” made a list of 48 medicines made from olive oil [2].

Studies on oil and health are and have always been very important. If we read ancient treaties on pharmacology, medicine and agronomy, the role of oil in health is highlighted in many of them, but they also speak of

the virtues of the olive tree, especially of its leaves and fruits, as did Dioscorides, citing its many beneficial actions and its role as a condiment-preservative in many foods [3].

Ancient and modern pharmacopoeias have included numerous preparations based on olive oil, considering its therapeutic use as a remedy for many maladies, with beneficial effects in many of the human organs and systems, and in all phases of life.

In the Spanish pharmacopoeia in a very special way, as well as in other European pharmacopoeias, a broad monograph is dedicated to the remedies that olive oil can provide, even recommending its use in injectables, with a specific role in gynecology, in childhood and old age, but also in youth and adult ages. It has always been considered at least a protector of health.

After speaking of the great longevity of the olive tree and the possibility of its use in marinades [3], Font-Quer describes several marinades and recommends them as food, he indicates that according to various ancient authors, olive tree leaves contain glycoside oleuropein, in a proportion close to 0.75% although according to Power and Tutin it is not a pure substance but a mixture of several bitter principles, including various resins and alcohols. This author mentions that “olive oil takes a long time to turn rancid and for this reason, it is very useful in pharmacy to prepare ointments and creams” as it is still done today, and specifies that the leaves are considered “antipyretic, they lower the blood, this is to reduce the tension of the circulatory system and cause urine,” Quer also indicates that “the effects of olives are usually to stir appetite and fortify the stomach, they make it easier to evacuate the intestine, only overeating causes damages.”

This same author mentions olive oil as food in the Mediterranean countries, an ingredient to prepare ointments for burns, for which he indicates several formulas that are regarded as very good healing agents.

When it comes to the virtues of olive oil, Font-Quer mentions it is a laxative, an emetic in certain preparations and therefore an antivenin, an emollient mixed with mauve which helps avoiding any kind of constipation.

The authors of *A Practical Guide on Medicinal Plants* [4] indicate that olive oil contains very beneficial oleic acid, phytosterina lecithin and enzymes, in addition to a bitter principle and pigments, and they recommend it as a tranquilizer, an anti-inflammatory, a laxative, a stimulant of the biliary secretion and a nutrient. Regarding its leaves, they indicate that they have a bitter principle, certain important oleuropein, flavonoids, organic acids, tannins, carotenoids and evidence of essential oils. Olive tree leaves are attributed a hypotensive, antispasmodic, vasodilator and an astringent effect.

The guide to *Medicinal Plants and Flowers* [5] does not speak of the properties of oil, but indicates that the bark is antipyretic and astringent. The leaves are considered to be one of the best vasodilator agents, they are diuretic, antipyretic and anti diarrheal. They are prescribed in cases of hypertension, arteriosclerosis and diabetes. They prevent chest angina and kidney damage, they facilitate the non-formation of bladder stones, and they are regarded as sources of active principles with a protective hepatic function.

Much has been discussed about the position and importance of oil and in particular of EVOO (Extra Virgin Olive Oil) in the Mediterranean diet [6, 7, 8] and in food pyramids, at least about the recognition of this diet as appropriate [9, 10]. It reduces deaths due to cardiovascular diseases [11] and has shown excellent results in inflammatory processes treatments [12].

It is important to establish the level of polyphenols and monounsaturated fatty acids as antioxidants and anti-inflammatories [13] along with their nutritional properties and their ability to maintain the oxidative stability of oils for longer. Also their interesting content in carotenoids and chlorophyll [14].

Many other authors have boosted the search and development of new analytical techniques by HPLC-DAD of hydroalcoholic extracts that coupled to a mass spectrometer improve and facilitate the study of these compounds, and especially of tyrosol and hydroxytyrosol [15], in order to know their content in different oils either from different cultivars or the same cultivar in different regions.

Currently, it is very important to know the composition of varietal oils in detail [16] and to know what is the concrete role played by their most noble components in health, the role of the predominant monounsaturated fatty acid (oleic acid) [17] and its proportion in relation to the saturated and polyunsaturated fatty acids, the role of polyphenols, tocopherols and phytosterols. Extra virgin olive oil (EVOO) also contains other components whose biological properties cannot be forgotten, such as chlorophyll, which plays a stimulating part in many organs and accelerates the healing process, vitamin A and magnesium, both with a possible anti-cancer action, etc.

For a long time, food was one of the main control resources for many diseases. In the Mediterranean culture, olive oil has always been an important resource, it remains so to this day and therefore its therapeutic function on diabetes mellitus, systolic pressure decrease and as a diastolic pressure moderator, in the prevention of cardiovascular diseases, etc.

The regular consumption of EVOO is considered suitable [18] for mothers in prenatal periods, children, adolescents and especially the elderly and in hospital diets [19].

The role of olive oil in preventive medicine is presently expanding, and it is always associated with healthy habits of behavior. For this reason, together with food and activities, olive oil plays an important role in the pyramid of the Mediterranean diet, which is nowadays regarded as a powerful support in the prevention of cancer [8, 20]. Interest in olive oil has reemerged [21], especially EVOO in its own right [22] and there is also a greater interest in its specific compounds [23], especially monounsaturated fatty acids, polyphenols, tocopherols [24], etc. It is still very important to continue to deepen in their specific role and that of other components not only as antioxidants [25, 26], but also in the control of chronic diseases such as arteriosclerosis, heart diseases [27], Parkinson's disease [28], the regulation of cholesterol plasma level, obesity, and hypertension control [29], etc. Therefore, the active component characterization of monovarietal oils is essential [30, 31, 32].

At the moment, there is a clear need to replace the current industrial pastries made with different types of oils and fats, with EVOO products and the daily consumption of between 5 and 10 fruits or vegetables.

Olive oil, in addition to being rich in polyphenols and other antioxidant compounds [33, 34, 35, 36], has a superb balance between monounsaturated and polyunsaturated fatty acids. It is rich in the minor components related to the main current pathologies and it has a cellular anti-proliferation effect [37].

EVOO's antioxidant activity is attributable to phenolic compounds, tyrosol and hydroxytyrosol, lignans, flavonoids, carotenoids and chlorophyll and their derivatives, and squalene, a triterpene present in olive oils [22].

The high content in monounsaturated and in particular in oleic acid is now considered to be, without a doubt, very positive from a healthy, dietary perspective. In the studies carried out in the west of the Mediterranean, the following oils contain more than 80% of oleic acid: Arbequina, Carrasqueña, Cornicabra, Del Pomet, Hojiblanca, Llumero, Picudo, Seniero, Serrana and some Villalonga [38].

In nutrition, lipids are essential foods provided they do not exceed 30% of the total energy intake and this intake should be consistent with age, weight, and possible sensitivities to pathologies of the consumer, thus it is recommended that out of this total amount, between 12 and 20 per cent should be monounsaturated fats.

The general functions of fats, as well as being part of the cell membrane, are metabolic functions, they also facilitate the absorption of fat-soluble compounds, the synthesis of several hormones and secretions, etc.

The importance of EVOO in health is increasingly recognized, which is why a lot has been studied on polyphenols [39] oleuropein [40], hydroxytyrosol [41], all capable of partially inhibiting platelet aggregation [42, 43] and other compounds that are also present in the leaf of the olive tree [44, 45, 46] by insisting on their bactericidal properties [47], especially in cases of colitis and diarrhea, due to the high content of polyphenols in its leaves [48] which show an important antioxidant activity [49]. Nowadays, the extraction of polyphenols with an anticancer effect [44] and

the oleanoic acid [50] of the leaves has become habitual, since they are considered to be a potential treatment for various cancers [35, 51, 52].

We shouldn't forget the oleuropein olive content [53], it is really an excellent antioxidant and an ancient food, an antioxidant and antimicrobial [54], although the excessive salt content of some preparations can lead to hypertensive disorders.

Monounsaturated fatty acids are particularly interesting, olive oil is rich in two of them: oleic acid (cis-9 octadecanoic) and palmitoleic acid (9cis-hexadecanoic) which are always beneficial to health and especially in people who have diabetes or other metabolic syndromes. These fatty acids act by decreasing the total cholesterol and LDL cholesterol when they replace saturated fatty acids, reducing triglycerides and increasing or maintaining the level of HDL cholesterol. They are also antihypertensive, antithrombotic, anti-inflammatory and contribute to the improvement of the endothelial functions.

BIOACTIVE EVOO AND VOO COMPONENTS AND HEALTH BENEFITS

The high content in monounsaturated fatty acids (MUFAs), especially oleic acid, which plays very clear role in nutrition, and the richness in polyphenols, tocopherols and phytosterols, which are important antioxidants, have risen the already very high interest on olive oil as an essential component and a symbol of the Mediterranean diet [55]. The nutraceutical industry is working with extra virgin olive oil (EVOO) [56] because it acts as a cardiovascular and cerebral-vascular protector, it prevents neurodegenerative disorders (Parkinson's Disease and Alzheimer's Disease), it is an anti-inflammatory and it plays an important role in some types of cancer. It also intervenes in certain syndromes of the human metabolism and is a general detoxifier. All these characteristics make EVOO an essential food component for health.

Monounsaturated fatty acids, of which olive oil is the richest fat, are now considered to be valuable compounds in the prevention of cardiovascular pathologies and various types of cancer [57, 58]. They are also important in the maintenance of a normal cholesterol level in blood, which has made many nutraceutical industries decide to use olive oil or some of its components in their products [59] and thus they study different methods of extraction [60] of these fatty acids, particularly polyphenols, as antioxidants, in different fruits of the forest as well as in some nuts, even in other organs of the olive tree and other species that are rich in these components.

Oleic acid is an oil that is associated with the ability to reduce the effects of oxidative stress in the human body, the control of the levels of LDL-cholesterol without altering HDL-cholesterol and it therefore reduces the risk of heart attacks and other cardiac pathologies.

This acid contributes to a better control of the formation of foamy cells and the control of the accumulation of macrophages in the circulatory system, it minimizes the formation of atheromas [61, 62], which explains its role in the reduction of heart problems, along with other minority components in EVOO and VOO. The proportion of monounsaturated, polyunsaturated and saturated fatty acids consumed in our diet is also involved in the prevention of death or complications from cardiac problems.

Currently, the high oleic acid content of an oil is associated with its ability to act as an antitumour agent [57], and it is specifically attributed an important role in the decline of the possibility of colorectal or prostate cancer.

It is necessary to consider that the content of oleic acid and these relationships have a mainly varietal genetic component, but are influenced by weather conditions and the state of maturation of the olive in the harvest stage. The origin of olive oil and its oleic acid content as well as the composition of the oil of wild olive trees [66] have been studied [63, 64, 65] in different Mediterranean countries.

Polyunsaturated omega-3 fatty acids from fish have been considered to be very significant for some time now, due to their antilipidemic,

antiarrhythmic and anti-inflammatory effects, they decrease the incidence of coronary events and cardiac diseases. Without losing its importance, this fatty acid has given way to the great benefits provided by monounsaturated omega-9 acid (oleic acid) major in olive oil, along with omega-6, as parts of olive oil and have been given a lot of publicity in the food sector. A number of authors [67, 68] have recently stated the need to deepen our knowledge on the role of the different fatty acids present in EVOO and VOO and the relationships between them [69] in order to clarify in the deepest possible way, their role as dietary supplements that are favorable to the reduction of cardiovascular pathologies [69] and in the treatment of various pathologies of the nervous system and even multiple sclerosis [70].

Some time ago, it was stated that [71] monounsaturated fatty acids contribute to the delay of cognitive faculty loss in older people as they avoid, among other things, neuronal damage produced by free radicals [72].

The fatty acid composition of a newly obtained oil that meets the specifications to be considered an EVOO (IOOC, 2013) clearly depends on the cultivar at issue, its genetics, but also the state of maturation of the olive and the ecological-geographic conditions in which it is cultivated [73, 74, 75, 76]. In the data reported in Figure 1, we always sought the same state of colorimetric maturation [77, 78, 79, 80], although collection has always been early, it has not been simultaneous [81]. This collection has always been carried out in experimental plots and traditional growings located next to the West of the Mediterranean, in the Levantine area of the Iberian Peninsula, although some cultivars do not originate nor are common in commercial plantations in these areas. The analyses have been carried out according to the rules and techniques indicated by AOCS (1998), CODEX and [82], evidently [14] the quantitative values of the components may slightly vary according to the area of origin of the EVOO. The oleic acid content, just like other components, may slightly decrease or increase depending on the cultivar [76] the data shows the average values of 16 olive trees for five olive oil year campaigns.

Table 1. Monounsaturated fatty acid composition and percentages of SFAs, PUFAs, MUFAs in the main oils studied

Variety	C18:1 (oleic ac.) %	C16:1 (palmitoleic ac.) %	ΣSFAs %	ΣPUFAs %	ΣMUFAs %
Aguilar	79,21 ± 0,88	1,42 ± 0,02	16,29	4,56	80,63
Blanqueta Enguera	61,95 ± 0,74	1,52 ± 0,06	21,35	17,51	63,47
Borriolenca	77,89 ± 0,51	0,77 ± 0,02	13,52	6,98	78,66
Cabaret	76,77 ± 0,91	1,95 ± 0,02	13,35	10,23	78,72
Callosina	76,06 ± 1,85	1,18 ± 0,34	17,42	9,12	77,27
Carrasqueña	83,98 ± 0,80	0,52 ± 0,02	11,52	4,46	84,51
Cuquillo	75,87 ± 0,54	1,31 ± 0,01	16,22	6,73	77,19
Changlot Real	77,06 ± 1,77	0,51 ± 0,05	14,36	7,45	77,57
Del Patró	72,60 ± 0,27	1,87 ± 0,04	15,77	9,94	74,47
Del Pomet	79,45 ± 0,36	1,24 ± 0,02	14,81	3,98	80,69
Figuereta	79,38 ± 0,58	0,42 ± 0,01	10,91	9,61	79,81
Genovesa	77,53 ± 2,34	0,62 ± 0,15	14,53	7,24	78,15
Gileta	69,68 ± 0,96	1,14 ± 0,04	12,98	13,49	70,82
Grossal	71,75 ± 0,05	0,58 ± 0,01	15,64	11,79	72,33
Lloma	83,84 ± 0,26	0,40 ± 0,03	10,66	5,64	84,24
Llumero	80,52 ± 1,24	0,60 ± 0,20	12,91	6,42	81,12
Marfil	78,94 ± 0,75	0,59 ± 0,01	13,23	6,89	79,53
Mas Blanc	74,79 ± 0,76	1,19 ± 0,02	12,65	11,92	75,99
Millareja	70,57 ± 0,48	0,97 ± 0,05	16,45	12,22	71,54

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Variety	C18:1 (oleic ac.) %	C16:1 (palmitoleic ac.) %	ΣSFAs %	ΣPUFAs %	ΣMUFAs %
Monteaguda	71,53 ± 1,04	1,23 ± 0,01	19,74	7,66	72,76
Morons	73,75 ± 1,49	0,65 ± 0,02	11,95	14,19	74,40
Morruda	72,81 ± 1,34	0,85 ± 0,02	15,76	10,9	73,66
Negra	73,32 ± 1,10	0,46 ± 0,01	15,23	11,57	73,79
Piñonera	69,15 ± 0,71	1,49 ± 0,02	17,72	11,72	70,64
Romana	68,53 ± 0,34	2,04 ± 0,02	20,68	8,82	70,58
Rotja	66,84 ± 0,90	1,08 ± 0,02	17,50	9,85	67,93
Rufina	76,82 ± 0,19	1,15 ± 0,01	16,22	6,07	77,97
Seniero	82,76 ± 0,44	0,76 ± 0,01	11,02	6,39	83,53
Valentins	82,29 ± 0,46	0,716 ± 0,01	11,28	5,00	83,00
Vallesa	73,60 ± 0,11	0,45 ± 0,07	14,35	11,76	74,05
Vera	74,19 ± 0,75	0,97 ± 0,02	15,54	6,57	75,16

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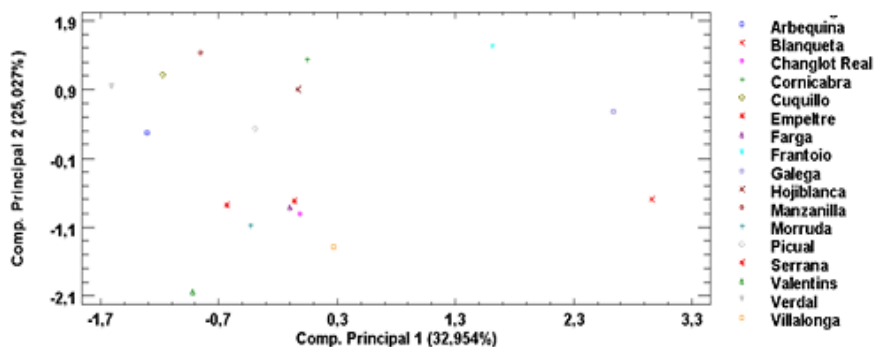


Figure 1. Tocopherol and polyphenol PCA in the main varieties.

On the other hand, different authors indicate that the geographical, agronomic and technological conditions influence the quality and sometimes the composition of the oil [64], especially in their phenolic compounds [65].

The diversity among EVOO is therefore important and it is related to the specific campaign to which they belong, due to the influence of the different temperatures and rainfall or irrigation. By using MRI we can differentiate the area of origin of the oils [74] and secure the area of cultivation which in our case is homogeneous. The techniques of cultivation can also influence the composition of the oils [75], which are also the same, or very similar and always in conditions of low water availability in counties with a rainfall average between 300 and 420 mm per year.

One of the most interesting components for health of EVOO and VOO are phenolic compounds, whose activity was controversial for a period of time [83, 84], but after being revised [13] it was concluded their great importance and, in particular, the fact that they are bearers of ortho diphenolic groups [85].

Nowadays, polyphenol analysis techniques [15, 86] have been greatly developed, as well as the valuation of its antioxidant properties [85]. Many authors refer to this very important effect of polyphenols in olive oil [87], since they are considered to be efficient in the treatment and prevention of the inflammations [88] involved in numerous diseases and that in different

formulations have applications as nutraceuticals (pharmaceutical accessories), cosmetics, and in the food industry. At the Paris International Conference on Polyphenols (2015) it was stated that “economically feasible approaches are still needed for the exploitation of biophenols by products arising from processing of plant derived raw materials.” Polyphenols also have clear antioxidant properties [89, 90, 91], since they block the oxidation process in its initiation stage, they oxidize themselves forming peroxide compounds of a more stable nature or act on the radicals already formed by avoiding the cascade formation of new radicals (CODEX SJAN 33-1981 of 1989). They also take active part in the prevention of certain types of cancer [92, 93] (including prostate and colorectal cancer [94] and colorectal [95]) in cardiovascular diseases, since they are considered vasodilators [96] and antiaterogens, specifically inhibitors of leukocyte-5-lipoxygenase [97]. All of them play an important role as neuroprotectives [98].

Polyphenols are antioxidants due to their role as free radicals and they are considered to be anti-inflammatory [99], antihepatotoxic, anti-diarrheal, anti-ulcerous in the digestive system [100], anti-allergic, anthelmintic and also have certain antiviral effects. Furthermore, polyphenols are highly valuable for their protective effects from cardiovascular diseases, an important effect capable of reducing neurodegenerative processes [18], these great expectations have helped achieve a greater progress in the evaluation of the antioxidant power of these compounds.

They are also considered preventive of cerebral ischemia problems and others related to neurotransmission [101] such as Alzheimer's disease [28], Huntington's disease [102], Parkinson's disease, certain peripheral neuropathologies, problems in the spinal nervous system and even multiple sclerosis.

In the wild olive tree [33] we mentioned contents between 23.6-25 and 81-92.4 mg/kg, in the oils studied in the west of the Mediterranean [31] we have obtained total values between 462.81 and $126.83 \pm 0.94 \pm 3.18$.

We must remember that all EVOOs and VOOs for commercial use do not have the same polyphenol content [103, 104] and we understand that this content should be specified on labels today.

The most important phenolic compounds in olive oil and leaves of the olive tree are polyphenols, especially oleuropein, which is an heteroside of elenoic acid, and hydrocortisols. They are both basically very powerful chelating agents of metal ions and abductors of free radicals[105].

Anyway, we must remember [106] that the place of origin of oil, the agronomic management of the olive trees and especially the extraction technologies, will greatly influence the total polyphenol content of the extra virgin olive oil [64].

Currently, talking about the global role of the components of EVOO is important, but we should focus even more on the specific role of each of its components like hydrocortisol, oleuropein, fatty acids, especially monounsaturated, phytosterols, tocopherols, almost all of them play a proven antioxidant role.

Hydrocortisol shows a high antioxidant activity [107] and it is considered to be very important because it prevents various neurodegenerative problemsa and it protects against brain synapses [108] [109, 110]. In addition, many authors [111, 112, 113] studied the mechanisms that interlink hydrocortisol to the activity of monocytes and their action on inflammation [114] and especially its role as a superoxides blocker [115] and its importance in adenylate cyclase control.

The effect of hydrocortisol at an endoplasmic reticulum level has now been confirmed in the attenuation of hepatocarcinoma [116] and the preparation of new drugs for cancer control and prevention [117].

Oleuropein is a sericoid with clear pharmacological properties [118]. It is an antibacterial, an antioxidant, an abductor and inhibitor in the formation of free radicals [90], it is anti-inflammatory, it has shown an effect in obesity control, it is antiaterogenic and therefore plays a cardioprotective and regulating role on hypertension [119]. It is even antiviral [87].

Oleuropein of the leaves of the olive tree and olive oil has more recently been tested as a cell anti-proliferation agent [120, 121], also in breast and ovarian tumors with an inhibitory action of their metastases [122], with action on certain kinases and the mitochondria of cells in rapid growth [123].

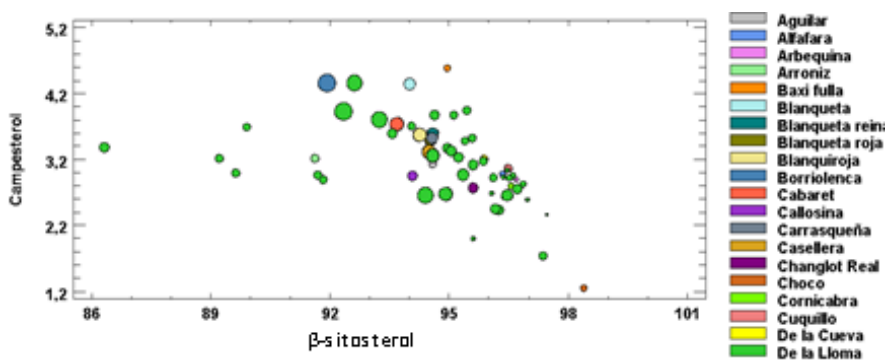


Figure 2. Majoritarian composition of the three major sterols according to cultivars.

On oleic acid, whose content varies according to the varietal origin of the olive oil, and which is also known as Omega 9, among other basic features, we know that it reduces the risk of atherosclerosis and thrombosis.

Polyunsaturated fatty acids generated great excitement in the past due to their beneficial health effects, especially when they were shown to decrease the risk of atherosclerosis. Nowadays, although they are still considered important, at least series omega 6 and omega 3, it has been proven [22] that monounsaturated fatty acids have the same effect and they are more complete.

We should mention as fatty acids in olive oil of the series Omega 3, linolenic acid (6C9C12C) with 18 carbon atoms and 3 double links and arachidonic acid (5C8C11C14C eicosatetraenoic) with 20 carbon atoms and 4 double links. The most important in the series Omega 6, is linoleic acid (estearidonic 6C9C12C15C octadecatetranoic) with 18 carbons with 4 double links which, among other things, reduce the risk of atherosclerosis.

Olive oil contains linoleic acid, which is defined as an essential fatty acid for the human being and the lack of which today is associated with skin problems (scaly skin, eczema and abnormally pale skin), imbalances in prostaglandins, poor control of inflammation and blood pressure associated with thrombotic and vasoconstriction problems, especially in the peripheral circulatory system. On the other hand, linoleic acid is key in the control and metabolic regulation of diabetes, so the high content of

linoleic acid in olive oil compared to other oils makes it appropriate to consider EVOO as a nutrient whose limited but constant consumption should be regarded as a true pillar in an adequate nutrition for health maintenance.

Phytosterols are [124, 125] components that positively support health, but certain authors indicate that the stigmasterol content must always be well below the content in campesterol.

The relative values between these compounds are the basis for the detection of mixtures of EVOO and seed oils, which allows to clearly differentiate between oil as a natural juice of the olive and other extraction oils, differentiating also refined olive from the VOO and EVOO, though their content in these oils very much depends on the cultivar [126].

There are more than 200 types of sterols in different vegetables. The main sterols in olive oil are β -sitosterol and campesterol, and stigmasterol to a much lesser extent. All of them play outstanding roles in maintaining human health. This is due to their hypocholesterolemic effect, they reduce both total cholesterol and LDL cholesterol, acting not only in the intestinal absorption of cholesterol, but also in its synthesis in eliminating systems.

In this regard, we find particularly interesting the role of sterols as an anti-inflammatory and their anticancer effects, with their action on the immune system [127].

Phytosterols [124], both from EVOO and other products, have significant effects on health. They are antibacterial, antifungal, they prevent the appearance of ulcers in the digestive system, they have anti-inflammatory properties, they are antioxidants and therefore preventers and modulators of tumor growth, especially in breast cancer [128] and they play an interesting role in the minimization of degenerative processes associated with age, and in particular in the prevention of macular eye degeneration in people of advanced age.

Phytosterols and specifically different sterols and squalene are considered powerful bioactive substances present in olive oil, because they reduce intestinal absorption of cholesterol and therefore help maintain low levels of cholesterol in blood and clearly contribute to the prevention of heart attacks [129].

β -sitosterol, which is the majoritarian phytosterol in olive oil, reduces the absorption of compounds with nitrogen (nitrites, nitrosourea, etc) which induce digestive tumors and especially colon tumours [124], it also reduces the amount of cholesterol, especially LDL cholesterol by interfering with its absorption [130], reducing LDL cholesterol and not affecting the serum levels of HDL-cholesterol. On the other hand, β -sitosterol has for a while been considered suitable for the treatment of prostatic hyperplasia [55, 131] and breast cancer control [132]. In general, the increase in the consumption of phytosterols and the reduction of cholesterol, clearly reduce the incidence of different types of cancer. Campesterol is considered today a chemical health parameter of olive oil.

Tocopherols are relevant in the discrimination of the stable isotope analysis [133], they take a strong antioxidant action, α -tocopherol is the most active biologically speaking [134], which is the one studied in our chapters and reflected, by varieties, in the table above. Its contents are also considered. It very useful in the detection of possible tampering in oils and it is important in cancer prevention [135]. It must be borne in mind that temperatures in the process of oil extraction can significantly reduce the tocopherol content.

α -tocopherol has a clearly defined role as an antioxidant and a free radical, it has been very much biochemically studied in the integrity maintenance of cell membranes against chemical contaminants, tobacco, alcohol, excessive exposure to sun and heat, application of radiotherapy, etc.

We must remember that the presence of free radicals, in addition to damaging fatty acids in cell membranes that they deteriorate, forces the rupture of fatty acids that form new free radicals (superoxides and hydroxides) and can form very toxic aldehydes at a cellular level by acting on the double links of polyunsaturated fatty acids and lipoproteins, forming peroxidized and malon-dialdehyde fragments (MDA) that have been proven to widely increase (up to 20-25 times) in the acute phase of myocardial infarction and 20-25 hours after a stroke. This progressive cascade of peroxides is associated with certain types of infections, allergies and chronic inflammation. In addition, MAD is considered to be one of the

compounds that cause most damage to DNA structures that constitute genes, it being the cause of numerous genomic alterations associated with cellular or even organic pathologies.

Cancer and other numerous diseases such as atherosclerosis, cataracts, neurovegetative diseases (Parkinson's and Alzheimer's) are currently associated with the oxidation of specific structures such as the eye lens and the neural formations.

So we can summarize [134] that tocopherols (provitamin E) which are very much present in EVOO, are involved in:

- The cardiovascular system, avoiding or mitigating thrombus formation. They reduce platelet activity and decrease the possibility of forming atheromas and thrombus by reducing the risk of heart attack, angina pectoris, strokes, but also avoiding cramps, especially in the legs, in people with venous return problems.
- They stimulate the reparative power of a physical injury, by encouraging the formation of elastin fibers and collagen in the conjunctive tissue.
- They promote the formation of cellular responses in specific infections and damages by extra organic invasions, and stimulate the cellular immune system and they possibly have an effect throughout the immune system.
- Tocopherols are essential for the proper functioning of the reproductive system and fertility, although in this sense its deficiency is rare, in chronic patients who lack fat assimilation, the role of this olive oil component is more easily assimilated, it is the case of its role in preventing vitamin E deficiencies, in patients with cystic fibrosis and Crohn's disease, in both children and the elderly who are more vulnerable to this deficiency. In these cases they show weakness and muscle atrophy, jaundice, they are also involved in coagulation processes because they can alter the adhesion of platelets.

- Tocopherols and several tocotrienols present in olive oil [136] clearly contribute to the protection of cells against oxidative stress.

Tocopherols, vitamin E precursors, can be found in significant quantities in green leaves and in the germ of cereals and olive oil, in this case, preferably in the form of α -tocopherol, which contains, according to various authors, between 125 and 200 g/kg [30], between 97 and 224 mg/kg and between 150 and 430 mg/kg [137]. In our studies, the content in α -tocopherol has varied between 86.84 ± 0.56 and 343.01 ± 6.98 , depending especially on the variety it is obtained from and thus taking a chemotaxonomic high value in oils and an undoubted value in the election of the oil, always EVOO.

Terpenes are also a set of organic compounds derived from an isoprene compound with five carbon atoms (2methyl-1,3-butadiene) that are also called terpenoids when they are reorganized in their hydrocarbon structure. Within the existing terpenes in olive oil, we should basically mention tetraterpenos or carotenoids, vitamin A precursors, but also triterpene squalene, and certain diterpenes, Vitamin A or retinol formers, from base tocopherols of vitamin K. Olive oil is considered to be essential in food, among other things due to its contribution in these three vitamins.

The carotenoids contained in oil accumulate in many tissues, plasma lipoproteins are the mean of transport to the different organs for which they are essential, they are precursors of vitamin A and responsible for the yellowing in olive oils, in which they are present in their three isomers α , β , and γ , related by their antioxidant role in the protection of nucleic acids, therefore they possess antiatherogenic and anti cancer effects (efficient against certain types of cancer), they maintain normality in the ocular system, skin and mucous, strengthen the immune system and protect our body against cardiovascular diseases.

We must remember that the process of discoloration in the refining of oils, including olive oil, will eliminate a large part of these pigments, especially β -carotene, which is the most abundant in EVOO, and whose content typically varies between 0.03 mg and 0.5 mg/100 g depending on the altimetry of the crop, the forcing of productions by excessive addition

of nitrogen, the ripening index, the management of the olive from harvest to the mill and obviously the system itself, speed of extraction and proper preservation of the oil.

The consumption of squalene [138] is considered to be an oxygenic radical receiver and therefore a protector of the lipid peroxidation attributed, at least in the skin, to an excessive exposure to ultraviolet and other ionizing radiation, so that its high content in EVOO, since the process of refining olive oil reduces the contents of this valuable compound by more than 70%, causes that in diets in which EVOO is used, the squalene content is multiplied by 10, compared to other diets without this type of oil. Squalene consumption within the Mediterranean diet, rich in EVOO, can reach 200-450 mg/day. This is considered very suitable as a complement and a statin booster, an active hypocholesteromiant principle, because it makes a very efficient contribution to lowering blood levels of cholesterol and triglycerides in blood [134].

The chlorophyll content in olive oil, as a non-oily component, clearly determines the color of the oils that are obviously lost in the refining process. We must not forget its role as a facilitator of cell growth, and its part in the stimulation of the formation of blood cells (hematopoiesis).

The chlorophyll content is highly dependent on the concrete variety of olive tree from which olive oil is obtained and mainly from its state of maturation. For this reason and for the higher content in aromas and balance of the different components of olive oil, and therefore of its organoleptic quality, some early olive collections are thus recommended nowadays in order to enhance the quality and suitability for health of EVOO.

We should mention cultivars Picual and Koroneiki [31] among the oils with a higher chlorophyll content, if they are harvested properly as well as some wild olive trees.

One of the most serious problems for human health are high blood pressure and other cardiovascular pathologies, we must understand that normal averages between systolic pressure BP >140 mm Hg and the diastolic BP is >90 mm Hg in hypertension control components like

phytosterols (β -sitosterol), triterpenes and especially phenolic compounds are essential.

Arteriosclerosis is a serious problem present in human population, it is a disease related to ageing and the natural wear of the circulatory system, identified sometimes with age itself, what is true is that a man is as old the vessels of his circulatory system [139].

Atherosclerosis is a progressive process of functionality loss in the circulatory system as a result of the accumulation of platelets and monocytes in its walls, which results in the loss of elasticity and partial obstruction, very problematic when it happens in vital arteries. The different variants of arteriosclerosis are the main origin of various diseases associated with old age, for example, lens, heart and locomotor apparatus damages and the cause of numerous deaths.

This disease has very variable extension and locations, affecting the aorta, the peripheral circulatory system, the vessels of the brain, the coronary arteries, the irrigation of the pancreas and kidney, etc.

Some time ago, an escalation in the consumption of animal fats and some other fats of vegetable origin was associated with an increase of coronary thrombosis. In addition, a clear increment in the possibility of unexpected blood clotting, which was associated with an increase in the content of saturated fats in plasma, which stimulate the formation of thromboplastin, when they exceed certain levels, they promote blood clotting and predisposition to the formation of atheromas.

The major role in the regeneration of vascular endothelial cells is studied by numerous authors [96] who insist on the role of the abundant polyphenols in EVOO and the Mediterranean diet in general, in the prevention and treatment of atherosclerosis, and even in the evolutionary processes of different types of cancer.

The beneficial effects of EVOO in hypertension control, as a consequence of the endothelial activity of vessels in response to different stimuli and substances such as nitric oxide, have been proven both in hypertensive and in normotensive individuals. Moreover, this is a result of the interaction of polyphenols, hidroxytirosol and some fatty acids present

in olive oil, noting a greater antihypertensive effect in EVOOs which are richer in polyphenols.

Knowledge of the adequacy of nutrient intake is still considered insufficient and it is stated that “between 20-25% of the total calories consumed should come from fats that include essential unsaturated fatty acids, at least 1-2% in relation to the total calories, especially in highly active people, children and adolescents, this is ensured by a regular consumption of olive oil” [140].

We must remember that neither olive oil nor its components are drugs but only, and this is already quite something, preventives and nutraceuticals [56] that can clearly help improve the state of human health.

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