Report of the Scientific Committee of the Spanish Agency for Food Safety and Nutrition (AESAN) on the assessment of olive oil by its nutritional characteristics in the Nutri-Score labelling system

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Working group

Montaña Cámara Hurtado (Coordinadora), Carlos Alonso Calleja, Rosa María Giner Pons, Elena González Fandos, Jordi Mañes Vinuesa, José Alfredo Martínez Hernández, Esther López García, Victoria Moreno Arribas, María del Puy Portillo Baquedano, Magdalena Rafecas Martínez and David Rodríguez Lázaro

Abstract

The Nutri-Score front-of-pack nutritional labelling system uses a code of letters and colours to inform consumers about the nutritional quality of foods and drinks.

However, currently this system does not cover all the positive aspects of foods that possess a specific nutritional quality within the Mediterranean diet, as in the case of olive oil and extra-virgin olive oil.

The AESAN Scientific Committee has suggested different possibilities for a more accurate assessment of olive oil and especially virgin olive oil, in the Nutri-Score front-of-pack labelling system, taking into consideration those compounds that are beneficial to the consumer owing to their nutritional qualities.

These proposals include: differentiating virgin olive oil from other oils in the algorithm's scoring system, establishing a specific category for virgin olive oil; the positive scoring of individual bioactive

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components present in virgin olive oil, and the consideration of authorised nutrition and health claims for all types of olive oils in the algorithm.

The Nutri-Score system is a tool for comparing foods within the same functional category, it is not an indiscriminate system for classifying the nutritional quality of all foods. A better understanding by consumers of the front-of-pack labelling system and its functions would help to improve their consideration of virgin olive oil because of its health and nutritional properties.

In this regard, the corresponding communication campaigns may be conducted in order to provide consumers with clear information on the purpose of this front-of-pack labelling system and the functional categories that may be compared. It may also be worth to consider the inclusion of the food category together with the scoring (A-E, colour) in the front-of-pack labelling in order to facilitate correct interpretation by the consumer, or the inclusion of a disclaimer stating that comparison is only possible between foods that belong to the same category or have the same function.

Finally, it is essential to understand the purpose of this nutritional labelling system and the food categories that may be compared. In order to prevent confusion it may be worth considering the algorithm as a negative characteristic the lack of nutrition value for a specific food.

Key words

Nutri-Score, labelling, olive oil, virgin olive oil.

Suggested citation

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1. Introduction

The current legal framework for food labelling has established compulsory nutritional information from 13 December 2016 onwards, and it plays an important role in providing consumers with the information they need to make healthier choices (Regulation (EU) No. 1169/2011 (EU, 2011)). This regulation includes the possibility of using, additionally and voluntarily, a front-of-pack nutritional labelling to facilitate consumer use and comprehension of the compulsory nutritional information, for healthier choices and to encourage manufacturers to develop products with better nutritional profiles.

The Nutri-Score front-of-pack nutritional labelling system uses a code of letters and colours to inform consumers about the nutritional quality of foods and drinks in a simple and integrated manner (Tables 1 and 2).

For a successful implementation of Nutri-Score in Spain, the Spanish Agency for Food Safety and Nutrition (AESAN) deemed it necessary to consider the unique characteristics of the nutritional recommendations for the Spanish population, in comparison to the original French ones. In this regard, it is worth highlighting the recommendation of olive oil consumption as the main source of monounsaturated fatty acids, especially oleic acid, in the Spanish diet, and the highly different nutritional consideration that must be given to olive oil in comparison with other fats due to its unique chemical composition, and given that it is the principal oil consumed in our country.

Table 1. Table displaying the calculation of **A points or unfavourable** points per 100 g of the product for fatty materials

A points	Calories (kJ)	Sugars (g)	Saturated fatty acids/lipids (%)	Sodium (mg)*
0	≤335	≤4.5	<10	≤90
1	>335	>4.5	<16	>90
2	>670	>9	<22	>180
3	>1005	>13.5	<28	>270
4	>1340	>18	<34	>360
5	>1675	>22.5	<40	>450
6	>2010	>27	<46	>540
7	>2345	>31	<52	>630
8	>2680	>36	<58	>720
9	>3015	>40	<64	>810
10	>3350	>45	≥64	>900

*The sodium content corresponds to the salt content listed in the compulsory declaration divided by 2.5.

A points = calorie points [0-10] + sugar points [0-10] + saturated fatty acid points [0-10] + sodium points [0-10] = [0-40]

With regard to **C points, or favourable points**, in 2019 the *Journal Officiel de la République Française* published the Decree modifying the supplementary presentation of the nutritional declaration recommended by the State (JORF, 2019). Apart from other modifications, the component "Fruits and vegetables, legumes and nuts" includes "rapeseed, walnut and olive oils". Thus when calculating the Nutri-Score, the component "Fruits and vegetables, legumes and nuts, and olive, walnut and rapeseed oils" shall always be considered for the C points according to the scores listed in the following table:

Table 2. C points table with the inclusion of olive oil

Points	Fruits, vegetables, legumes, nuts, and olive, walnut and rapeseed oils (% in weight)	Fibre (g/100g)	Protein (g/100g)
0	≤40	≤0.9	≤1.6
1	>40	>0.9	>1.6
2	>60	>1.9	>3.2
3	-	>2.8	>4.8
4	-	>3.7	>6.4
5	>80	>4.7	>8.0
Subtotal	0-5 (a)	0-5 (b)	0-5 (c)
Total (0-15)	P Points = (a) + (b) + (c)		

Source: (AESAN Scientific Committee, 2020).

The final score is obtained by subtracting the C points from the A points, except when the score A is higher than, or equal to, 11 and the score of the fruit and vegetable content is less than 5 (except for cheese), then the protein content points shall not be considered when calculating the C points. Depending on the final score obtained, the food products are classified into five categories, each of them represented by a colour and a letter according to the following Table:

Table 3. Classification of food products according to the Nutri-Score system

Solid foods (points)	Drinks (points)	Nutri-Score
-15 to -1	Water	A
0 to 2	≤1	B
3 to 10	2 to 5	C
11 to 18	6 to 9	D
19 - 40	≥10	E

With this modified Nutri-Score, olive oil, rapeseed oil and walnut oil pass from a Nutri-Score value of D to a C score (the most favourable score for an oil). This may also benefit products that contain olive oil, when their fruit, vegetable, legume, nut, and olive, walnut or rapeseed oil content is higher than 40 % (AESAN Scientific Committee, 2020).

The AESAN Scientific Committee (2020) issued a report on the suitability of adapting the Nutri-Score system to include olive oil content in its calculation, and concluded that the AESAN's proposal to adapt the Nutri-Score system so that olive oil is included within the group of "Fruits, vegetables, legumes and nuts" and counts positively towards the Nutri-Score calculation, improves the consideration of a product that provides nutritional benefits based on its oleic acid content, and is an improvement to said system of front-of-pack nutritional labelling. In its conclusions, the Scientific Committee considered that the correct wording to be applied to the included oils would be: "olive oil, walnut oil and rapeseed oil" and under no circumstance should reference be made to "olive oils". It also suggested that, without prejudice to the numerical calculation, it should be listed in an independent section/column and not as part of the current category of fruits and vegetables.

In spite of this improvement however, currently this system does not cover all the positive aspects of foods that have a specific nutritional quality within the Mediterranean diet such as olive oil, and especially virgin and extra-virgin olive oil. Therefore, AESAN has requested the Scientific Committee's opinion for a more accurate assessment of olive oil within the Nutri-Score system of front-of-pack nutritional labelling, based on the available scientific evidence of its nutritional characteristics.

2. Olive oil

Although the origins of olive oil and when it was first cultivated and produced for consumption are not known for certain, the history of the olive and olive oil is linked to the *Mare Nostrum*. Legend has it that the goddess Pallas Athena, the protector of Athens, gave the olive to the city to improve the lives of its citizens. Today, we know that olive oil was produced between the 13th and 15th centuries BCE around the Aegean Sea, specifically in Crete, Cyprus and Sparta. Phoenicia, Greece and Rome expanded its cultivation across the entire Mediterranean basin for more than 1000 years and it continued into the Middle Ages, both under Islamic reign in Northern Africa and Spain, as well as under the Christian monasteries.

The olive tree has been the basis of dry farming in countries of the Mediterranean basin for more than 1000 years, along with cereals, legumes and vineyard rotations. It is a production system that depends on the plant's excellent adaptation to the dry conditions in its area of cultivation. Mediterranean countries are the principal producers and consumers of olive oil, and it is indeed the most characteristic food in the Mediterranean diet. The European Union produces approximately 67 % of all olive oil in the world. Around 4 million hectares, mainly in the Mediterranean states of the European Union, are dedicated to olive cultivation in traditional and intensive plantations. Italy and Spain are the biggest consumers of olive oil in the European Union, with an annual consumption of approximately 500 000 tons each year, while Greece has the largest per capita consumption of olive oil in the European Union, at 12 kg per person per year. Overall, the European Union accounts for approximately 53 % of the global consumption[1]. Olive oil is one of the most important products of the Spanish food industry, as our country is the largest exporter of olive oil in the world (Fernández, 2015).

2.1 Process of obtaining olive oil

Virgin olive oil is defined as oil obtained from the fruit of the olive tree solely by mechanical or other physical means under conditions that do not lead to alterations in the oil, which have not undergone any treatment other than washing, decantation, centrifugation or filtration, to the exclusion of oils obtained using solvents or using adjuvants having a chemical or biochemical action, or by re-esterification process and any mixture with oils of other kinds (EU, 2013).

In mills, virgin olive oil and pomace are obtained from olives. The pomace is the solid part of the olive paste that remains during pressing or during the centrifugation of the mass which contains most of the skin, the drained pulp and fragments of olive pit, retaining some oil (5-10 %). From virgin olive oil we obtain extra-virgin olive oil, virgin olive oil and virgin lampante olive oil. The last oil is not suitable for direct consumption due to its high acidity and must be refined. As it loses its minor compounds when refined, it is topped up with virgin olive oil, thus creating an oil that is known as olive oil. From the pomace we obtain olive-pomace oil or crude pomace oil. This oil is refined to produce a refined pomace oil. This oil is also topped with virgin olive oil, thus creating olive-pomace oil (Sánchez-Muniz, 2009).

1 https://ec.europa.eu/info/food-farming-fisheries/plants-and-plant-products/plant-products/olive-oil_es

2.2 Regulations and legal definitions

The classification of the commercial qualities of olive oil is conducted in accordance with European regulations (Regulation (EEC) No. 2568/91, and its later modifications) (EU, 1991).

There are eight different categories of olive and olive-pomace oils[2]:

- extra-virgin olive oil,
- virgin olive oil,
- virgin lampante olive oil,
- refined olive oil,
- olive oil composed of refined olive oil and virgin olive oils,
- olive-pomace oil,
- crude olive-pomace oil,
- refined olive-pomace oil.

Not all categories can be sold to consumers. Only extra-virgin olive oil, virgin olive oil, olive oil composed of refined olive oils and virgin olive oils, and olive pomace oil may be directly purchased from retailers.

There are three different categories of virgin olive oils:

- Extra-virgin olive oil: it is the category with the highest quality. From an organoleptic point of view, it has no defects and is fruity. Its acidity level must not exceed 0.8 %.
- Virgin olive oil: it may have some sensory defects, but these are slight. Its acidity level must not exceed 2 %.
- Virgin lampante olive oil: it is an olive oil of lower quality, with an acidity exceeding 2 %. It is not fruity, and has substantial sensory defects. Lampante olive oil is not intended for retail sale to consumers. It is refined and used for industrial purposes.

Other categories of olive oil:

- Refined olive oil: it is obtained after refining a defective virgin olive oil. It is not intended for retail sale. It has a acidity of up to 0.3 %.
- Olive oil composed of refined olive oil and virgin olive oils: is an oil obtained by mixing refined olive oil with extra virgin and/or virgin olive oil. It has a acidity of up to 1 %.
- Crude olive-pomace oil: olive pomace is the residual paste obtained after the oil is extracted from the olives, with organic solvents. The oil obtained from this paste is crude olive-pomace oil.
- Refined olive-pomace oil: crude olive-pomace oil can be refined and mixed with virgin olive oils. The result of this mixture is called refined olive-pomace oil. It may have an acidity of up to 1 %.

2 https://ec.europa.eu/info/food-farming-fisheries/plants-and-plant-products/plant-products/olive-oil_es

Apart from its physical and chemical properties, as mentioned, olive oil is also classified according to its organoleptic qualities. The terms used to describe the positive attributes used for the organoleptic assessment of virgin olive oil are the following (Regulation (EU) No. 640/2008 (EU, 2008)):

- Fruity: range of smells (dependent on variety) characteristic of oil from healthy fresh fruit, green or ripe, perceived directly and/or retronasally.
  - Fruitiness is qualified as green if the range of smells is reminiscent of green fruit and is characteristic of oil from green fruit.
  - Fruitiness is qualified as ripe if the range of smells is reminiscent of ripe fruit and is characteristic of oil from green and ripe fruit.
- Bitter: characteristic primary taste of oil from green olives or olives turning colour. It is detected by the circumvallate papillae in the "V" region of the tongue.
- Pungent: tingling sensation characteristic of oil made at the beginning of the season mainly from olives that are still green. It can be perceived throughout the mouth cavity, particularly in the throat.

Based on these considerations, and in accordance with Regulation (EC) No. 640/2008, olive oil is classified based on the median of the defects and the median for "fruity" (EU, 2008). The median of the defects is defined as the median of the defect perceived with the greatest intensity. The median of the defects and the median for "fruity" are expressed to one decimal place, and the value of the robust variation coefficient which defines them must be no greater than 20 %.

- Extra-virgin olive oil: the median of the defects is 0 and the median for "fruity" is above 0;
- Virgin olive oil: the median of the defects is above 0 but not above 3.5 and the median for "fruity" is above 0;
- Lampante olive oil: the median of the defects is above 3.5; or the median of the defects is below or equal to 3.5 and the median for "fruity" is 0.

2.3 Differentiated commercial quality

Several international organisations regulate the quality and purity of extra-virgin olive oil (EVOO), namely, the European Union, the International Olive Council (IOC), and the *Codex Alimentarius.*

The commercial quality of virgin olive oil (VOO) is determined by chemical parameters such as free acidity and the state of oxidation (peroxide value, K232, K270 and ΔK) that serve to assess the deterioration of the product, while other markers of analytical chemistry such as waxes, sterols, aliphatic and triterpenic alcohols, trans isomers of fatty acids, the composition of fatty acids and triglycerides, erythrodiol and uvaol and stigmastadienes, are considered in order to prevent oil adulteration and fraud, according to the considered purity criteria (Regulation (EEC) No. 2568/91 (EU, 1991)).

Commercial parameters do not consider the markers responsible for the health properties and some sensory aspects of EVOO, although these are an important part of the exclusive composition of EVOO which differentiates it from other vegetable oils regularly consumed all over the world. Additionally, these markers are not displayed in current EVOO labelling, thus consumers are not informed about the health properties of the product, which may be due principally to its high content of oleic acid, squalene, and natural antioxidants such as phenolic compounds, tocopherols and carotenoids (López-Miranda et al., 2010) (Bach-Faig et al., 2011) (Fernández, 2015).

In general, the quality criteria for olive oil and the methods to determine these analytical parameters have been approved by the International Olive Council and adopted by the European Union and the *Codex Alimentarius* (Table 4).

Table 4. Commercial quality criteria for EVOO according to European legislation

Acidity (% of oleic acid)	≤0.8
Peroxide value (milliequivalents of active oxygen per kilogram of oil)	≤20
K indexes K270 ΔK K232	 ≤0.22 ≤0.01 ≤2.50
Organoleptic assessment	Fruity median > 0 Median of defect = 0

Source: (EU, 1991).

In addition, the European Union protects the denominations of certain specific products that are associated with a territory or a method of production and assigns them a distinctive quality mention that differentiates them from the rest of the products in the same commercial category. This translates into quality logos for identification, and by means of specific controls, which also ensures their authenticity (Fernández, 2015). Some of the most important quality seals are Protected Designation of Origin or PDO, Protected Geographical Indication or PGI and Traditional Speciality Guaranteed or TSG (Regulation (EU) No. 1151/2012 (EU, 2012a)).

3. Nutrients and bioactive compounds present in olive oil

The composition of olive oil varies greatly according to various factors of which the variety of the olive grove, the olive ripening stage at the time of harvesting, the latitude/longitude of the place of cultivation, soil type and climate, are the most important, regardless of the process of preparation and the resulting type of olive oil. This is why each component is always referred to within a wide range, whether saponifiable or unsaponifiable.

Advanced analytical techniques such as high-resolution liquid chromatography coupled with a mass spectrometer, have played an important role in the identification and quantification of the bioactive compounds found in EVOO, and which are responsible for its beneficial effects.

The *Codex Alimentarius* (2017, 2019) and the International Olive Council (IOC, 2019) are taken as references.

3.1 Fat fraction: oleic acid and polyunsaturated fatty acids

The triglycerides in olive oil represent approximately 99 % of the total content. Regarding the position of fatty acids in the triglycerides, we find that 40-59 % are OOO (triolein), 12.5-20 % are OOL (diolein), 12-20 % are POO (diolein), 5.5-7 % are POL, and 3-7 % are SOO, along with trace amounts of LOL, OLnL. POP and POS, among others. Where O: oleic acid, L: linoleic acid, P: palmitic acid, S: stearic acid.

The presence of diglycerides and monoglycerides is due to the hydrolysis of triglycerides or an incomplete synthesis. Diglycerides may be found in olive oil in a proportion of 1-2.8 % and monoglycerides in proportions under 0.25 %.

Table 5. Fatty acid composition in olive oil, rapeseed oil and walnut oil

Fatty acids		Olive oil*	Rapeseed <5 % of erucic acid**	Walnut oil**
Palmitic acid	C16:0	7.5-20.0	5.6 (5-6)	7.3 (6-8)
Palmitoleic acid	C16:1	0.3-3.5	0.4 (<3)	0.2
Stearic acid	C18:0	0.5-5.0	1.4 (1-3)	2.2 (1-3)
Oleic acid	C18:1	55.0-83.0	58.3 (55-70)	17.5 (13-21)
Linoleic acid	C18:2	3.5-21.0	22.2 (11-30)	59.4 (54-65)
Linolenic acid	C18:3	Trace amounts	8.9 (9-10)	12.8 (12-14)
Arachidic acid	C20:0	0.8	0.6 (2-3)	0.1
Gadoleic acid	C20:1	Not specified	1.9 (1-2)	0.2
Behenic acid	C22:0	<0.3	1.1	0.1
Erucic acid	C22:1	-	0.2-0.9	-

*(IOC, 2019).
**(INRA, 1987).

With regard to oleic acid, the fatty acid profile of rapeseed oil is quite similar to that of olive oil, however its elevated proportion of linoleic acid in comparison to olive oil depending on the varieties makes the w-6/w-3 ratio more favourable in olive oil. As it contains erucic acid, albeit in amounts below the limit set by the European Union (0.2 %) (Regulation (EU) 2019/1870 (EU, 2019)), it may pose a potential hazard for infants and children who consume it on a regular basis, given that the tolerable daily intake is 7 mg/kg b.w./day and it is principally based on the myocardial lipolytic effect in young pigs and rats. It must be considered that erucic acid may be found in other foods that contain rapeseed oil such as cake and biscuit products, which also contribute to people's daily intake.

The most obvious case is that of walnut oil, which has almost 60 % w-6 linoleic acid, therefore the w-6/w-3 ratio: 59.4/12.8 means that the w-6 intake is increased beyond the appropriate ratio of 4:1 omega-6/omega-3 (Feimberg et al., 1987).

3.2 Unsaponifiable fraction

The hydrocarbons largely present in olive oil are squalene and carotenoids. Squalene accounts for more than 90 % of the total, with values ranging between 200 and 7500 ppm. β-carotene and lutein are the main carotenoids, although different xanthophylls may also be present.

α-tocopherol in virgin olive oil represents approximately 90 % of all tocopherols. The average values are around 120 ppm, although different authors have listed quantities ranging between 50 and 300 ppm.

The pigments present in virgin olive oil are chlorophylls and carotenoids, therefore its colour which ranges from green to yellow. Among chlorophylls, α-pheophytin is the most prevalent.

Long-chain fatty alcohols are present in olive oil in amounts of approximately 250 ppm, principally tetracosanol and hexacosanol. The presence of esters of these alcohols with fatty acids is also characteristic, mainly oleic and palmitic acids.

Wax is present in amounts of 150 ppm in olive oil, although in pomace oil, this value may reach 2000 ppm.

Among diterpenes, we find phytol at concentrations of 25-600 ppm either free or esterified with oleic acid, and in some olive varieties, geranilgeraniol may be present in quantities below 50 ppm. Sterol content in virgin olive oil ranges between 1000 and 2000 ppm, and in larger amounts in pomace oil. β-sitosterol accounts for 70-90 % of all sterols, followed by Δ5-avenasterol, campesterol and stigmasterol. Of all sterols 10-40 % are found forming esters with stearic, oleic and linoleic acids.

3.2.1 Polyphenols

Of the polar polyphenols present in virgin olive oil, the major ones are tyrosol and hydroxytyrosol, both free and in their various forms. Although it is also worth mentioning oleuropein and its aglycone. The average values of total polyphenols generally range between 300-600 ppm (Phenol-Explorer, 2021). The minor polar compounds include the following sub-classes:

- Secoiridoids (dialdehydic form of decarboxymethyl elenolic acid linked to ortho-phenolic and/or ortho-diphenolic alcohols): oleuropein aglycone, oleacein, oleocanthal, and ligstroside aglycone.
- Phenolic alcohols: hydroxytyrosol, tyrosol and hydroxytyrosol glycol.
- Phenolic acids: gallic acid, protocatechuic acid, *p*-hydroxybenzoic acid, vanillic acid, caffeic acid, syringic acid, p- and o-coumaric acids, ferulic acid and cinnamic acid.
- Flavonoids: luteolin and apigenin
- Lignans: pinoresinol and acetoxypinoresinol.

Among the minor polar compounds, oleuropein aglycone and hydroxytyrosol are widely studied, in addition to oleocanthal, which has been recently studied for its anti-inflammatory properties. Concretely, oleuropein aglycone and hydroxytyrosol are highly interesting compounds owing to their antioxidant activity and their ability to chelate metals and trap free radicals. Both molecules contain an *ortho-diphenolic* group, with a significant role in EVOO. Their high antioxidant activity is due to their capacity to eliminate reactive oxygen species (ROS) and to stabilise oxygen radicals by forming an intramolecular hydrogen bond. The previously described lignans, pinoresinol and acetoxypinoresinol, also demonstrate antioxidant activity.

During the ripening of the fruit and olive oil production, the enzyme systems present in the fruit can hydrolise oleoeuropein first in its aglycone and later in hydroxytyrosol together with glucose and elenolic acid. Due to its hydrophilic nature, hydroxytyrosol is abundant in the by-products of olive oil and especially, in wastewater from olive oil, which is a valuable source of this compound.

Table 6 displays the average values of some compounds of interest that are present in olive oil, in comparison to other oils.

Table 6. Average values of compounds of interest present in olive oil in comparison to other oils

Oil	Polyphenols* (mg/kg)	Tyrosols* (mg/kg)	Hidroxytyrosol* (mg/kg)	Vitamin E** (mg/kg)
Refined olive oil	371	336	6.8	Lost on refining
Extra-virgin olive oil	624	595	7.7	183
Sunflower oil	10	-	-	Lost on refining
Rapeseed oil	167	-	-	Lost on refining
Walnut oil	360	-	-	108

*Polyphenols, tyrosol and hydroxytyrosol individually quantified by liquid chromatography. **Source**: (Phenol-Explorer, 2021).

Vitamin E: alpha-tocopherol equivalents of Vitamin E vitamer activity. **Source: (BEDCA, 2021).

4. Beneficial effects of nutrients and bioactive compounds of olive oil

The cardioprotective properties of the Mediterranean diet, primarily linked to the beneficial effects of EVOO were first demonstrated in the Seven Countries Study on cardiovascular disease (SCSCD) in 1986 (Keys et al., 1986) (Romani et al., 2019).

The Mediterranean diet consists of a balanced consumption of fruits, vegetables, legumes, and cereals, along with fatty fish and EVOO (the latter being the main source of fats), low consumption of red meats and dairy products. The Mediterranean diet has an important effect on health and increased longevity, according to the statement of the United Nations Educational, Scientific and Cultural Organization (UNESCO) in 2010 (Xavier Medina, 2009) (Di Daniele et al., 2017).

The beneficial effects on human health that may be attributed to the consumption of olive oil, the main oil in the Mediterranean diet, are linked to its composition of nutrients and bioactive compounds, specifically to the fatty acid composition, the presence of minor components such as squalene and phytosterols, and to the antioxidant properties of phenolic compounds (Owen et al., 2000) (Fernández, 2015).

In the last decades, numerous epidemiological studies and meta-analysis, as well as intervention trials, have confirmed this observation, highlighting the protective role of the Mediterranean diet in primary and secondary prevention of cardiovascular diseases (CVD).

The PREDIMED study researched the protective effect of the Mediterranean diet with EVOO or walnuts on 7477 subjects at high risk of cardiovascular diseases such as stroke, myocardial infarction or death due to cardiovascular causes (Guasch-Ferré, 2014). The authors pointed out that the incidence of serious cardiovascular diseases decreased significantly in subjects who followed a Mediterranean diet with EVOO or walnuts, in comparison to those who followed a diet low in fats, confirming the beneficial effects of the Mediterranean diet in the primary prevention of cardiovascular disease (Estruch et al., 2018).

The study by Romani et al. (2019) describes the health effects of the Italian Mediterranean diet (IMD) and the Italian Mediterranean organic diet (IMOD) in healthy subjects and patients with stage II-III chronic kidney disease (CKD), classified according to the Kidney Disease Outcomes Quality Initiative (Kopple, 2001). Concretely, there was a significant reduction of phosphorus, total homocysteine, and albuminuria, as well as a decrease in fat mass both in kg and in percentage, after 2 weeks of IMOD treatment. The improvement of all of these clinical parameters is associated with lower cardiovascular risk, highlighting the role of the IMOD in preventing CVDs. The IMOD would seem to induce a slowing down of CKD progression. Additionally, it was confirmed that the IMOD in CKD patients on conservative therapy represents a useful tool for CVD prevention, by inducing a significant reduction of total serum homocysteine influenced by the methylenetetrahydrofolate reductase genotype (Di Daniele et al., 2014). Homocysteine causes endothelial dysfunction through ROS production, which occurs during the autoxidation process, accelerating atherosclerosis (Zhang et al., 2000) (Pastore et al., 2015).

Numerous studies have been published on the possible beneficial effects of the Mediterranean diet on diabetes mellitus. The meta-analysis by Guasch-Ferré et al. (2015) looks at the results of the 22-year monitoring of two cohorts, that of the "Nurses' Health Study (NHS)" which included 59 930 women between the ages of 37 and 65, and that of the NHS II study, which included 85 157 women between the ages of 26 and 45. In both studies, the participants were free of diabetes, cardiovascular disease, and cancer at the start of the study. The dietary intake was assessed by validated food-frequency questionnaires with the data updated every 4 years, and incident cases of diabetes were identified through self-report and questionnaires. Olive oil intake was categorised into four groups: a) no intake, b) intake of up to 4g/day, c) intake between 4 and 8 g/day, and d) intake of 8 g/day. The conclusions reached by the meta-analysis are that a higher olive oil intake is associated with decreased risk of developing Type 2 diabetes mellitus and that substituting other fats (mayonnaise, margarine, butter) with olive oil is inversely associated with Type 2 diabetes mellitus. Even when these associations were attenuated by adjusting for body mass index, they remained significant.

Subsequently, Schwingshackl et al. (2017) published another meta-analysis that reflected the results of 4 cohort studies and 29 clinical trials, with a total of 15 748 individuals, including the PREDIMED and EPIC studies. The clinical trials used different control groups (low fat diet, diet rich in polyunsaturated fatty acids, diet rich in fish oil). Some studies used extra-virgin olive oil while others, mainly those that used fish oil in the control group, did not provide information in this regard. The number of participants ranged between 6 and 215 and the studies lasted between 2 weeks and 4.1 years. This meta-analysis concluded that olive oil intake is associated with reduced risk of developing Type 2 diabetes mellitus and improved glucose metabolism. These effects are of great interest as a reduction of only 0.1 % in glycated haemoglobin (HbA1c) translates into a reduction of vascular pathology by approximately 7 % (Di Angelantonio et al., 2014). Nevertheless, it must be mentioned that a limitation of the meta-analysis is that it is based solely on fasting glucose values and HbA1c values, which may not reflect glycaemic variability, an independent predictor of diabetic complications, accurately (Gorst et al., 2015).

4.1 Beneficial effects of olive oil polyphenols

Among the minor components, phenolic compounds are significant with regard to health effects attributed to EVOO. Especially, epidemiological studies indicate that the dietary intake of EVOO rich in phenolic compounds has a cardioprotective effect on the Mediterranean population.

Visioli et al. (2000) demonstrated that the phenolic compounds of olive oil are absorbed in human beings and excreted in urine as glucuronides. Methylated polyphenolic metabolites, sulfonates and glucuronides have been detected after EVOO intake. Different studies have demonstrated that these metabolic modifications do not reduce their activity in human beings. Additionally, the original compounds and metabolites derived from EVOO may reach a tissue concentration (mainly in gastrointestinal and cardiovascular systems) that can perform antioxidant and anti-inflammatory actions, modulating intracellular signalling (Serreli and Deiana, 2018).

With regard to the biological activity of olive oil, a review by Covas (2007) examined 15 studies on human beings, and most of them indicated that (phenol-rich) olive oil is superior to seed oils and oils with low phenolic content. This superiority was attributed to the decrease in cardiovascular risk factors such as plasma LDL, improved endothelial function and reduced prothrombotic conditions.

Phenolic compounds appear to have cardioprotective and chemopreventive potential. The phenolic content of EVOO improves oxidative stress and lipid profiles. A study by Franconi et al. (2006) demonstrated that hydroxytyrosol and oleuropein aglycone may inhibit LDL oxidation induced by low concentrations of copper similar to those detected in human plasma after EVOO intake. Another study demonstrated the protective role against oxidative damage in post-menopausal healthy women after the daily intake of 50 g of EVOO with high phenolic content (592 mg of total phenols/kg) for 8 weeks (Salvini et al., 2006). The biomarkers of oxidative stress (malonaldehyde, superoxide dismutase or glutathione) decreased in proportion to the phenolic content of the EVOO while HDL cholesterol increased directly, in healthy males who consumed 25 ml of EVOO every day with different phenolic content for 3 weeks (Covas et al., 2006).

The close relation between inflammation, endothelial dysfunction and CVD is well-known. Several studies have demonstrated that a regular consumption of EVOO is associated with a reduction in the mediators involved in inflammatory processes linked to atherosclerosis, through the negative regulation of NF-kB (Brunell Souza et al., 2017). Oleuropein aglycone has been shown to significantly increase NO production induced by bacterial lipopolysaccharide, leading to improved macrophage function (Visioli and Galli, 1998).

The incidence of chronic diseases linked to ageing and unhealthy lifestyles is increasing, but there are also increased amounts of data that show how the intake of EVOO rich in secoiridoids may help to prevent some chronic diseases where the inflammatory component is directly involved in its appearance and progression. Recent studies have suggested that oleocanthal, another secoiridoid present in EVOO, which is responsible for its pungency, has a beneficial effect on inflammation, oxidative stress, specific types of cancer, as well as neurodegenerative and rheumatic diseases. This perception appears to be due to a specific receptor present in the oropharyngeal region. The cardioprotective action of oleocanthal in atherosclerotic cardiovascular disease, a chronic inflammatory process that begins with endothelial damage and affects vessel walls and platelets, has been assessed (Segura-Carretero and Curiel, 2018). Agrawal et al. (2017) showed that the weekly intake of 40 ml of EVOO rich in oleocanthals could modify platelet aggregation in healthy adult males. Currently, the methods for analysing oleocanthal are not standardised and not all studies that describe the minor polar components of EVOO indicate this data. Oleocanthal concentration in recently pressed EVOO tends to be low and it increases when EVOO is stored, due to increased hydroxytyrosol by secoiridoid hydrolysis (Serreli and Deiana, 2018). More recently, the regular consumption of olive oil has been associated with a lower risk of cardiovascular disease in the American (Guasch-Ferré et al., 2020), Greek (Kouli et al., 2019), as well as the Spanish population at high cardiovascular risk (Guasch-Ferré et al., 2014).

Regarding lignans, a study by Carrasco-Pancorbo et al. (2005) showed the antioxidant activity of pinoresinol and acetoxypinoresinol in the DPPH model (2,2-diphenyl-1-picrylhydrazyl) and noted that the absence of the acetyl group in pinoresinol was relevant to the activity. Another study demonstrated the ability of pinoresinol, in synergy with other phenolic compounds present in olive oil, to reduce proliferation and induce apoptosis of colorectal cancer cells (Fini et al., 2008).

A limited number of randomised controlled trials have demonstrated the effect of EVOO on the secondary prevention of diseases linked to atherosclerosis, but the minimum EVOO intake required to produce the anti-inflammatory effect and a cardioprotective action has not been assessed (Wongwarawipat et al., 2018). The evidence indicates that the regular consumption of EVOO is associated with a lower risk of developing chronic non-transmissible diseases such as cancer, chronic kidney disease, high blood pressure and metabolic syndrome (Santangelo et al., 2018).

In the Spanish cohort of the EPIC study (Buckland et al., 2012), which had 40 622 participants, the association between olive oil consumption and risk of death was studied and after 13 years, it was found that an increase of 10 g/2000 kcal/day of consumption was associated with a 7 % decrease in mortality from any cause, and with a 13 % decrease in cardiovascular mortality.

The EPICOR study (long-term monitoring of patterns of antithrombotic management in patients with acute coronary syndrome) studied 29 689 Italian women, evaluating the possible associations between the consumption of EVOO, vegetables and fruits, and the incidence of coronary heart disease (CHD). The average monitoring period was 7.85 years. It showed that women who consumed vegetables and olive oil in the highest quartile had a lower risk of developing coronary heart disease. This study confirmed the protective effect of the consumption of vegetables and olive oil in the primary and secondary prevention of CVD (Bendinelli et al., 2011).

In a study, Martín-Peláez et al. (2016) observed that the daily consumption of 25 ml of olive oil with a high content of phenolic compounds (500 mg/kg) for 3 weeks stimulated the intestinal immune system in hypercholesterolemic patients.

For all of the above-mentioned reasons, we may state that the consumption of virgin olive oil is closely linked to the reduced risk of certain diseases that are currently present in developed societies, such as cardiovascular disease and cancer. This beneficial action is related, as we have seen, to its nutrient composition, especially with reference to oleic acid and bioactive components, especially phenolic compounds.

5. Nutrition and health claims applicable to olive oil

The general rules on food labelling ensure that consumers are not misled about the characteristics of the oils (composition, quality, origin, category, method of production), and that olive oil labelling is in line with general rules on food labelling, established in Regulation (EU) No. 1169/2011 (EU, 2011).

On 19 January 2006, the European Union established the European regulation on nutrition and health claims in labelling (Regulation (EC) No. 1924/2006) which prohibits the promotion of a food as possessing therapeutic or curative properties, and establishes the following categories of declarations: "nutrition claims" or "content", "health claims" and "reduction of disease risk claim" (EU, 2006). Health claims are expressions that describe a relationship between a food substance and a disease or other health condition (that is to say, a "risk reduction" relation). They are defined as any message or voluntary commercial representation in any format such as text, claim, image, logo, etc. that states, suggests or implies that there is a link between the food alleged to, consumer health, and the type of claim subject to assessment.

In 2011, the European Food Safety Authority (EFSA) approved some claims listed in Regulation (EC) No. 432/2012 (EU, 2012b) on the benefits of the bioactive compounds found in foods, including EVOO phenols and especially, hydroxytyrosol and oleuropein, supporting its important role in human health (EFSA, 2011a). The health effects include preventing LDL oxidation, maintaining HDL blood content, stabilising normal blood pressure, anti-inflammatory properties, normal upper respiratory tract function and gastrointestinal tract function, and contribution to the body's defences against external agents. These beneficial effects are obtained with a daily intake of 20 g of EVOO, which contains 5 mg of hydroxytyrosol and its derivatives (EFSA, 2011a). In fact, the oxidated LDLs (OxLDL) bonded to the lectin-like OxLDL receptor similar to receptor-1, stimulate endothelial expression and secretion of proatherogenic enzymes. This bonding induces superoxide production and decreases the local concentration of nitric oxide (NO). This receptor is involved in the initial process of atherosclerotic plaque formation.

In relation to olive oil and considering Regulation (EC) No. 1924/2006, there are two aspects to consider in its possible claims, the benefit of its fatty fraction mostly consisting of oleic acid and that of its minor components, especially polyphenols. Companies marketing olive oil provided they fulfil the scientific requirements for the corresponding declaration and, according to Regulation (EC) No. 1924/2006 may use the authorised claims, they are the following:

- Oleic acid: *"Replacing saturated fats in the diet with unsaturated fats contributes to the maintenance of normal blood cholesterol levels"* (EFSA, 2011b). This claim may be used only for food which is high in unsaturated fatty acids, as referred to in the claim "high unsaturated fat" as listed in the Regulation (EC) No. 1924/2006 and Regulation (EC) No. 116/2010 (EU, 2006, 2010). Although olive oil mostly contains oleic acid, it also has other unsaturated fatty acids such as linolenic acid and linoleic acid, both of which are polyunsaturated fatty acids.

- Monounsaturated and polyunsaturated fatty acids: *"Replacing saturated fats with unsaturated fats in the diet contributes to the maintenance of normal blood cholesterol levels"* (EFSA, 2011c). This claim may be used only for food which is high in unsaturated fatty acids, as referred to in the claim "high unsaturated fat" as listed in the Annex to the Regulation (EU) No. 116/2010 (EU, 2010): "A claim that a food is high in unsaturated fat may only be made where at least 70 % of the fatty acids present in the product derive from unsaturated fat under the condition that unsaturated fat provides more than 20 % of energy of the product".
- Polyphenols: *"Olive oil polyphenols contribute to the protection of blood lipids from oxidative stress"* (EFSA, 2011d). The claim may be used only for olive oil that contains at least 5 mg of hydroxytyrosol and its derivatives (e.g. oleuropein complex and tyrosol) per 20 g of olive oil.

Conclusions of the Scientific Committee: proposals for the improved assessment of olive oil in the Nutri-Score system of information on the nutritional quality of foods

As mentioned before, the composition of olive oil and especially virgin olive oil (VOO) has nutritional and health benefits.

VOO is known for its nutritional and health properties, especially in fighting against CVD. These properties are due to its high content of oleic acid and the weighted content of polyunsaturated acids, as well as other compounds of interest such as phenolic compounds, phytosterols, tocopherols and squalene, in spite of the lower percentage in which they are found (1-2 %). Only VOO and not seed oils possess minor polar and apolar compounds, of an antioxidant nature.

Currently, after the modification of the Nutri-Score system, olive oil has the highest possible score (C) for a fat.

A more appropriate assessment of the nutritional properties of olive oil in the Nutri-Score system must consider those compounds that present beneficial effects for the consumer owing to their nutritional properties.

In this regard, there are different possibilities:

- **Differentiating virgin olive oil** from the rest of the oils in the algorithm's score, given that virgin olive oil contains, in addition to oleic acid and Vitamin E (α-tocopherol and α-tocotrienol), other bioactive compounds such as tyrosols that are determining factors with regard to the nutritional properties of virgin olive oil. This would entail the establishment of a specific category for virgin olive oil, similar to the separation of water from other drinks.
- **The positive scoring of individual bioactive components present in virgin olive oil** due to their health properties in accordance with the available scientific evidence, which is not included in the labelling.
- **The consideration by the algorithm of the nutrition and health claims authorised for any type of**

olive oil. The Nutri-Score labelling system only considers those parameters of composition that are listed in the compulsory nutritional labelling. The health properties of some components of foods in general and especially of olive oil, have been approved by the European Union and when displayed in the labelling, information on the content of these substances must be added to the nutritional information. With regard to olive oil, and considering Regulation (EC) No. 1924/2006 on nutrition and health claims in foods, there are two aspects to be considered in the labelling and the algorithm which are: the benefit of its fatty fraction which consists mainly of oleic acid, as well as its content of minor components.

It must always be considered that the Nutri-Score system is a tool for comparing foods within the same functional category, not an indiscriminate system for classifying the nutritional quality of all foods. A better understanding by consumers of the front-of-pack labelling system and its function would help to improve their consideration of virgin olive oil on the basis of its health and nutritional properties. In this regard, different actions may be taken:

- Conducting the corresponding awareness campaigns for clear consumer information regarding the purpose of this front-of-pack labelling, the functional categories where this front-of-pack labelling may be compared, and that these categories are well-defined in order to prevent products such as olive oil which have a high energy content and a specific culinary function as ingredient, dressing or frying fat, from being compared with other products with a different culinary function, lower energy contribution and low nutritional value.
- Consider the inclusion in the front-of-pack labelling along with the score (A-E, colour), of the category to which the food belongs, in order to enable its correct interpretation by the consumer.
- To include an advisory regarding comparisons, that they are only feasible between foods within the same category or with the same function, in order to enable correct interpretation by the consumer.
- Although it is essential to understand the purpose of this nutritional labelling system and the food categories that may be compared, it may be worth considering the negative labelling of the lack of nutrition intake for a specific food in this system's algorithm, in order to prevent confusion.

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