Nutritional benefits of Olive Oil

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1 What is olive oil ?

Olive oil is the natural oil extracted by pressing, or grinding and then pressing the olives [18]. It has various uses : cooked in a pan, used to prevent food from sticking, used in crepes, drizzled on your salad or your on your pasta to enhance flavor, etc.
There are 3 types of olive oils, regulated by European Union Regulations [1] :

- "Normal" or "Refined" Olive oil
- Virgin olive oil
- Extra virgin olive oil

The method and care with which the oil is pressed, with whether or not it's refined and blended, all contribute to the "grade" and price of the oil [18].

When cooking, the oil acts as a heating medium to the food. When food temperature reaches 100°C, water starts to evaporate from the food. This in turn gives way to the oil being absorbed into the food which modifies the fatty acid composition of the food as it cooks [19].

1.1 Smoke point

All olive oils have smoke points : it's the temperature at which the oil starts emitting smoke. The more virgin the oil, the more it contains various flavorful organic compounds which have lower smoke points than refined (normal) oils because the organic compounds burn [46].
When oils exceed their smoke points, they undergo chemical breakdown, producing volatile compounds, off-flavours, and undesirable odors, including harmful substances like **trans fats** (AKA the worst of the worst in the world of fats, mostly found in ultra-processed foods), small chain fatty acids and more complicated things that I will not remember (acrylamides and polycyclic aromatic hydrocarbons) [38].

1.2 Normal olive oil

"Normal" Olive oil, also called "pure olive oil" or "light olive oil" is **the lower quality oil** (despite the marketing terms "pure" and "light", which by the way **DOES NOT mean "less fat"**) . It can be a mix of virgin olive oil and refined olive oil.
Refined olive oil is the oil made from lampante (defective olive juice) and pomace (residues) [21]. It was extracted using chemical and heat treatments [18][21] to become an edible product.
Normal olive oil should be used for cooking because of its higher smoke point at 199–243°C [27] [45], compared to virgin and extra virgin olive oil which have lower smoke points, c.f. next subsections.

1.3 Virgin olive oil

Virgin Olive Oil, also called "unrefined" olive oil, is the in-between normal olive oil and extra virgin olive oil.
Virgin olive oil does not go through a refining process and is obtained from unspoiled olive juice. [21].
It is lower quality than extra virgin olive oil because it goes through a degradation process when green olives are harvested. It's still a healthy oil, but their acidity levels increase : their beneficial health properties are lower than Extra Virgin Olive Oil [21].
The smoke point of virgin olive oil is approximately 210°C [45].

1.4 Extra virgin olive oil

Extra Virgin Olive Oil (EVOO) is **the highest quality olive oil** as it is taken from 100% natural olive juice using mechanical processes and when cold (it is cold-pressed). This type of oil is difficult to obtain because the olive must be in perfect condition and at this optimum ripening point. [21].

EVOO is **NOT chemically treated**, resulting in a more flavorful oil with a lower smoke point of approximatively 175-212°C [42]. Above the smoke point, the flavor of the oil rapidly deteriorates and a bitter burned taste predominates [18].

EVOO does not deteriorate the coating when using Teflon cookware. On the contrary, it acts as a lubricant to prevent food from sticking to the pans [19].
Quality EVOO, in accordance with relevant olive oil standards, is the best cooking oil for use in the home from a stability and health viewpoint [19]. It has higher concentration in vitamins and antioxidants than the rest of the olive oils.

2 Fats in general

Disclaimer : This subsection is a bit heavy in information but it's worth it to get a bit familiar with the terms for other foods because they come up very frequently.

To the surprise of absolutely no one, olive oil contains fat. So first, let's see what fats are and what are their health benefits and drawbacks.
Fats (Lipides) are one of the main macro-nutrients and give 9 kcal per gram (whereas proteins and carbohydrates (glucides) give 4 kcal per gram).
The benefits of fats are :

- Aiding in the absorption of fat soluble vitamins (like vitamin A, vitamin D, vitamin E and vitamin K [2])
- Maintaining brain and nerves function
- Regulating cholesterol and blood pressure
- Providing energy (the calories)
- Being a major component of cell membranes

So you need (good) fat to live a good life. Now, let's take a very simple look at what "saturated fat" and "unsaturated fat" mean when they're written in a nutrition label.
Fats are a big chain of Carbon, Oxygen and Hydrogen atoms. There are multiple type of fats :

- **Saturated fats** (acides gras saturés) which have NO double bond between carbon atoms

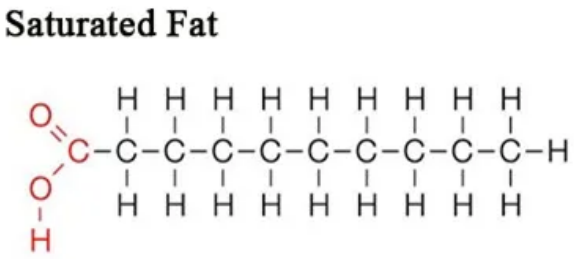

Figure 1: Saturated fat : no double bond between carbon atoms

This structure makes saturated fats usually straight and compact at room temperature (example : butter, coconut oil, fried foods, fatty animal meat, etc.).
In moderation, saturated fats are shown to be good for the brain [39] [3], the nervous system [39], heart health [3], the bones [28] [3] and the immune health [3].
In excess, saturated fats are associated with cholesterol and heart issues, increase risk of bone disease [22]. The general recommendation is to limit your intake of saturated fats [22] to 10% of your daily calories [35], but there is no need to cut off completely saturated fats (butter tastes good).
In fact, there is a lot of conflicting research on that topic. For instance some say saturated fats cause cardiovascular diseases [35] and others say that they have no effect on cardiovascular diseases [43]. It's a pretty complicated topic, as even the daily recommendation intake is being questionned.

- **Unsaturated fats** (acides gras insaturés) which have AT LEAST one double bond between carbon atoms. The double bond makes them less compact and often liquid at room temperature (example : **olive oil**, avocado oil etc.).

Unsaturated fats are shown to be **essential** in cholesterol regulation, heart health [2], fighting inflammation, the brain [2] and the nervous function [40].

Unsaturated fats can be split up into two groups :

- **Monounsaturated fats** (AKA acides gras monoinsaturés) have only 1 double bond (hence the "mono" prefix)

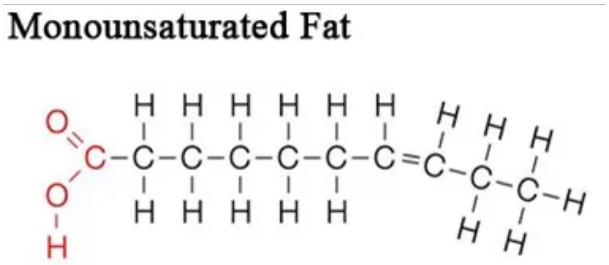

Figure 2: Monounsaturated fat : one double bond between carbon atoms

They are widely accepted to be healthy, especially for the heart.
Monounsaturated fats can be found in avocados (one of the best source actually), **olive oil**, peanuts, almonds, dark chocolate, etc.

- **Polyunsaturated fats** (AKA acides gras polyinsaturés) have multiple double bonds (hence the "poly" prefix)

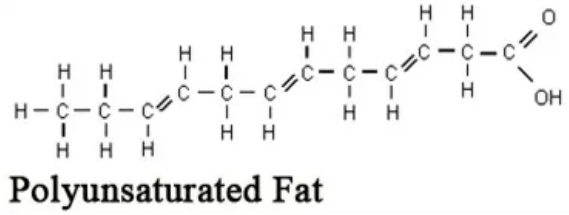

Figure 3: Polyunsaturated fat : multiple double bonds between carbon atoms

Omega-3 and Omega-6 are polyunsaturated fats that deserve their own document. They are considered essential : the body needs them but it cannot create them on its own thus you must consume foods that contain them (especially Omega-3 which is way harder to seek than Omega-6). Polyunsaturated fats can be found in salmon, olive oil, soybeans, etc.

For ease of notations let's abbreviate all of these fats into :

- SF = Saturated Fat
- MUF = MonoUnsaturated Fat
- PUF = PolyUnsaturated Fat

Also, fats are often named "something + acid", for example : oleic acid, linoleic acid, palmatic acid, stearic acid etc., which is why in French they are called "**acides** gras (in)saturés".
98-99% of the total weight of EVOO is represented by fatty acids, especially MUF acids such as oleic acid (subsection 3.1) [36]. The benefits of olive oil have been related to its high content of MUF acids and its richness in polyphenols, abundant in VOO and EVOO but not in ordinary olive oil. [36].

3 Nutritional contents and health benefits

3.1 Oleic acid

Oleic acid (a MUF Omega-9) accounts for up to 70% - 80% of EVOO [34].
Oleic acid manages cholesterol : it raises **HDL** (High Density Lipoprotein, AKA **the good cholesterol**) [47] and lowers **LDL** (Low Density Lipoprotein, AKA **the bad cholesterol**) [32].
It also lowers blood pressure level* [44] and the risk of cardiovascular disease [34].

(*)Having a high blood pressure (also called hypertension) can damage your arteries over time, which can lead to :

- heart failure : the heart can't properly pump blood to your body
- a stroke (un AVC en français)
- a heart attack
- (chronic) kidney disease (i.e. the kidneys stop filtering waste from your blood) that cannot be cured [4] [5]
- or even dementia [6]

3.2 Omega-3

Omega-3's are an essential nutrient that you have to actively seek in order to get a good daily intake.

Fortunately, olive oil has some ALA (it's something that you should remember as it will often come up) Omega-3's. ALA (Alpha-Linoleic Acid) is exclusively found in plant based food and is the "weak form" of Omega-3 and your body uses it for energy.
I call it "weak form" because ALA can be converted by your body into other forms to be truly useful, however the conversion rate is low (less than 1% is converted into DHA, c.f. next sentence)[20] [25]. The other forms are called EPA (for Eicosapentaneoic Acid) and DHA (for Docosahexaenoic Acid) which are the active form of Omega-3 (and should also be remembered) and are primarly found in marine food like salmon or algae and some are found in grass fed animal meat and their byproducts (like eggs).

There is not that much Omega-3 compared to Omega-6's : the ALA content of EVOO is between 0.4% to 1% , which decreases slightly as we lower the quality of the oil [7].
Omega-3's are a vital part of your cells [8] and are shown to lower cardiovascular diseases [41], lower LDL levels, protect our eyes (especially DHA) [41] and assist the brain [8] and the nervous system.

3.3 Omega-6

Olive oil contains much more Omega-6's than Omega-3's, particularly linoleic acid. EVOO is composed of approximately 3.5 % to 12 % of Omega-6's [7]. The lower the quality of the oil, the more linoleic acid you have (10 % to 21 % for normal olive oil [7]).

Linoleic acid lowers the risk of cardiovascular diseases, lowers LDL levels, raises HDL levels and improve the body sensitivity to insulin [9] (a hormone that turns food into energy and keeps blood sugar levels in check).

Omega-6's are much much more common than Omega-3's. They are so common that the average ratio of Omega-6's to Omega-3's is 15:1 in a typical western diet [10] [41] (this reference has been quoted more than 5800 times), whereas the recommended ratio is 4:1 or 5:1. In fact, consuming too much of Omega-6's can have the exact opposite of the sought benefits. Indeed, consuming too much Omega-6's can lead to inflammatory diseases, autoimmune diseases, cardiovascular diseases and cancer. [41]. For women, the lower the ratio, the lower the risk of breast cancer [41].

Now you see why Omega-3's and Omega-6's might need their own standalone document.

3.4 Vitamin E

Olive oil contains Vitamin E, an antioxidant that protect your body from reactive oxygen species that damage cells by taking tiny parts of them, which will make your cells weaker in the long run [11] . It also supports the well-being of your eyes and your skin [11]. In addition, vitamin E may increase skeletal muscle repair [26].

3.5 Vitamin K

Olive oil contains vitamin K which helps for blood clotting/coagulation i.e. your blood stacks at a location to become a compact mass. Thus, it helps in healing wounds and stops hemorrhage [12].
Also, vitamin K helps in bone formation and mineral association. For example it helps calcium to associate to the bone structure.
A lack in vitamin K can lead to nose bleeding, abundant period blood and osteoporosis [13] (your bones becomes weak and brittle).

3.6 Polyphenols

Polyphenols are molecules that plants produce to defend themselves, which also act as antioxidants for us.
Polyphenols were determined to reduce morbidity (a word to mean "measure of diseased people in a population") and slow down the progression of cardiovascular, neurodegenerative, and cancer diseases[29].
EVOO contains the highest level of polyphenols compared to virgin and normal olive oil [29].
Some important polyphenols in olive oil are **HT** (hydroxytyrosol) and **OL** (oleuropein).

3.7 Type 2 diabetes risk reduction

HT can reduce risk of developping type 2 diabetes [29].

3.8 Cardiovascular events reduction

An observational study on 7216 men and women aged 55-80 found that baseline total olive oil consumption, especially EVOO variety, was associated with a significant reduced risk of cardiovascular events and cardiovascular mortality in a Mediterranean population at high cardiovascular risk [30].

3.9 Immune system boost

Polyphenols encourage the production of white blood cells (they protect your body from infection and respond to injuries and illness [14]) and cytokines (proteins that function as chemical messengers in the immune system [15]).

3.10 Anti-atherogenic

An atheroma (or plaque) is a fatty material composed of cholesterol, proteins, calcium, inflamatory cells and other substances that builds up in the arteries, which means atheroma clogs your artery. The disease associated with that is called **atherosclerosis**.
Atheroma grows over time and can result in coronary artery disease (the main individual cause of death and morbidity in industrialized countries [23]), peripheral artery disease (condition in which narrowed arteries reduce blood flow to the arms or legs), heart attack or stroke [16].
OL and HT present in olive oil have anti-atherogenic properties [29].

3.11 Blood pressure regulation

Several factors, such as blood pressure, contribute to the development of atherosclerosis [36] (c.f. subsection 3.10). Olive oil rich-diet induced a significant reduction of blood pressure [23].

3.12 Free radicals

Because polyphenolic compounds are antioxidants, they are capable of scavenging free radicals (molecules that damage our cells) thanks to HT.
Also, FYI, exercise may increase the generation of oxygen free radicals that can cause skeletal damage for untrained people and older people [26].

3.13 Effectiveness against organisms

Olive oil contains OL. It was found to be effective against various strains of bacteria, viruses, fungi and also molds or even parasites [29].

3.14 Anti-inflammatory properties

Inflammatory response is part and parcel of many diseases. It may lead to the production of excessive amounts of substances promoting the production of reactive oxygen species, which can damage cell structures and lead to long-term disruption in the functioning of the body as a whole, as well as playing signalling functions promoting inflammation [31].
Reactive oxygen species are created during stressful situations : environmental pollution, cigarette smoke, improper diet, chronic psychological stress, very intense and prolonged physical exertion, UV radiations from the sun etc.
Consequences include illnesses such as diabetes, atherosclerosis, neoplastic disease (abnormal mass of tissue that forms when cells grow and divide more than they should or do not die when they should [17]), neurodegenerative diseases or the aging of the organism [31].
Polyphenols are capable of scavenging these reactive oxygen species.
Furthermore, oleocanthal shares anti-inflammatory characteristics with Ibuprofen [37].

3.15 Prevention against Alzheimer's disease

EVOO and VOO both contain oleocanthal, a phenolic compound that can disrupt the formation of Alzheimer's [37] [33].

3.16 Anti-cancer

Polyphenols of olive oil (including and especially OL) have been confirmed to have anti-cancer potential on proliferation and cell deaths on number of cancers (breast cancer, osteoarcoma, neuroblastoma [29], colorectal cancer and prostate cancer [33]).

3.17 Anti-thrombotic properties

A thrombus is the scientific word for "blood clot" ("caillot de sang" en français).
Phenolic compounds in olive oil have been shown to have anti-thrombotic properties, which means olive oil can reduce the formation of blood clots [33].

3.18 Anti-angiogenic

Angiogenesis is the formation of blood cells from existing blood cells. Angiogenesis can help with healing your wounds. However, the blood cells may feed a growing tumor with nutrients and oxygen, which can lead to cancers such as breast cancer.
Olive oil can be an angiogenesis inhibitor [29]. It does not kill cancer cells but it can to slow down the growth of blood cells, thus slowing down the development of the tumor.

3.19 Apoptosis induction

Apoptosis is the normal and planned death of the cells in the body.
OL and oleocanthal [37] induce the apoptosis of cancer cells, especially breast cancer cells. This means that OL may have a great therapeutic potential for breast cancer treatment [29]. It inhibits (i.e. "slows down") aromatase which is a target in breast cancer treatment.

3.20 DNA synthesis

HT protects mitochondria (which is, of course, the powerhouse of the cell) against the reduction of mitochondrial DNA synthesis [29]. This process is crucial for cellular energy production and overall cell health (Google AI).
Mitochondrial dysfunction, in conjunction with altered mitochondrial dynamics, is a major driving force behind aging and age-related diseases [24].

4 Conclusion

Olive oil is one banger of a food, displaying a ton of health benefits and versality in cooking.
The "go to" olive oil should be Extra Virgin Olive Oil, which has been shown to have more benefits than Virgin Olive Oil and Normal Olive Oil, but EVOO tends to cost more money than the latter and might not be the best oil to use for **intense** heat cooking due to its lower smoke point.
Nevertheless, EVOO is a very good enhancement to your food, health wise and flavor wise, and should be consumed regularly as its benefits are way too good to be missing out.

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