

Common fatty acids and polyphenols in olive oil and its benefits to heart and human health

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ABSTRACT

The health advantages of consuming extra virgin olive oil (EVOO) in the diet are associated with its phenolic compounds which are potentially beneficial and have anti-inflammatory and antioxidant activities. The unsaturated fatty acids in olive oil reduces the risk of cardiovascular disease, obesity, type 2 diabetes, metabolic syndrome and high blood pressure. Spain, Italy and Greece are main source of olive oil creation in the world. Investigations indicate that the probability of the people of these countries to the colon, breast or prostate cancers, as well as Alzheimer's disease is lower than the residents in Northern Europe, and life expectancy has increased. The purpose of this review emphasizes the importance of case-control and cohort studies on the olive oil consumption and its beneficial result on human health.

Keywords: Olive oil, Antioxidants, Disease prevention, Free radicals, Heart, Oxidative stress.

Article type: Review Article.

INTRODUCTION

Edible oils in food are widely used in cooking in all nations of the world. Oils are triglycerides made from an ester of glycerol and fatty acids (FA). The three groups of hydroxyglycerol combine with esterification by saturated or unsaturated fatty acids to create triglycerides. The olive oil consumption is the most demanded among foodstuffs and its market share is about 20% (Wabaidur *et al.* 2016). Olive tree known as "*Olea europaea*", is a small tree species (Foscolou *et al.* 2018) which was the first cultivated by the Mediterranean countries including Italy, Spain and Greece and its main derivative products are olive and olive oil. Olive oil is very popular among people around the world due to its useful effects on human health (Oliveras-López *et al.* 2014). The cultivation of olive trees has spread to different continents and the southern regions of the European Union due to the favorable climate (rainy winters and hot and dry summers) are the important producers of olives (Berg *et al.* 2018). However, the European

Union is in charge of 70% of olive fabrication in the world, leading to the development of the economic, agricultural and industrial parts in these countries (Roselli *et al.* 2018). Also, per capita olive oil consumption in Italy, Spain and Greece in 2011 was reported at 21.3, 13.4 and 10.7 liters, respectively. Investigations displayed that people in the Mediterranean region consume about 25-50 mL extra virgin olive oil (EVOO) daily (Grigg & Olive 2001). There are 19 different kinds of olive oil in the countries and the olive oil fabrication area is very important. Although olive oil is mainly fabricated in Mediterranean countries, it is also fabricated in the parts of the universe, including the United States, Chile, Argentina, and Australia (Fig. 1).



Fig. 1. Olive oil producing countries.

The lifestyle of people such as regular physical activity and proper diet, has been very effective in human health. Results of clinical studies show that people in those areas are healthier than people in Northern Europe. Olive oil has a significant role in human health due to its unsaturated fatty acids and phenolic ingredients. The latter in this oil are potentially beneficial and have anti-inflammatory and antioxidant activities (Cicerale *et al.* 2012). Also, the presence of unsaturated fatty acids and high oleic acid play a significant role in decreasing the risk of chronic diseases including cardiovascular disease, obesity, type 2 diabetes, metabolic syndrome, hypertension, atherosclerosis, Alzheimer's disease and some cancers. Investigations expose which people living in the Mediterranean are less likely to develop colon, breast and prostate cancer due to consuming more olive oil, and that people in these areas are more hopeful and motivated (Covas *et al.* 2015). Therefore, given the compounds in olive oil and its beneficial properties in relation to health, this review was conducted to evaluate the effect of this substance on human health.

Nutritional attributes of olive oil

Based on the United States Department of Agriculture (USDA) reports, one tablespoon of olive oil includes 119 kcal, fat (13.5 g), unsaturated fat (10 g), 0 g carbohydrates, fiber and protein, vitamin E (1.9 mg), and vitamin K (8.1 µg; Jimenez-Lopez *et al.* 2020). In addition, Olive oil contains monounsaturated fatty acids (MUFA; Table 1) and also 7-15.5% polyunsaturated fatty acids (PUFA; Borges *et al.* 2017), along with other fats including diacylglycerols, monoacylglycerols and total sterol content amounting to 1-2.8%, 0.25% and 1000 – 3040 mg kg⁻¹ respectively (S Boskou *et al.* 2006; rigley *et al.* 2016; Alu'datt *et al.* 2017). Moreover, olive oil comprises tocopherols such as α -, β and γ - tocopherol amounting to 10.2-208, 0.75-1.05 and 0.7-2.1 mg kg⁻¹, respectively (Mapelli-Brahm *et al.* 2018), Tocopherols are fat-soluble compounds known for their vitamin E and antioxidant activity. Olive oil also contains 200-8260 mg kg⁻¹ carbohydrates such as Squalene (Mapelli-Brahm *et al.* 2018). The pigments such as total chlorophylls, Pheophytin-a, total carotenoids, β – carotene and lutein have been found in olive oil (Mapelli-Brahm *et al.* 2018). Other compounds including total phenolic compounds e.g. triterpene dialcohols and β - sitosterol are the main compounds in olive oil (Ambra *et al.* 2017). Distinctive profiles of polyphenol are identified even among different kinds produced in the country. In Italy, for instance, the Busana

area produces olive oil containing more polyphenol, though, the Tagiasca region produces oil with a corresponding low content. In addition, certain areas of various countries (such as Picval in Spain, Coroniki in Greece, and Kuratina in Italy) were in favour such that the highest amount of polyphenols was obtained in olive oil. Thus, the specific region of production, rather than the country, seems to be more indicative of the quality and nutritional content of olive oil (Vossen 2007).

Table 1. Common fatty acids in olive oil (Boskou *et al.* 2006).

Fatty Acid	Chemical formula	Codex Alimentarius		IOOC
Lauric acid	C12:0	Not present in discernible amounts	Not	specified
Myristic acid	C14:0	7.5-20		<0.05
Palmitic acid	C16:0	0.3-3.5		7.5-20
Palmitoleic acid	C16:1	<0.5		0.3-3.5
Heptadecanoic acid	C17:0	<0.6		≤0.3
Heptadecenoic acid	C17:1	0.5-5		≤0.3
Stearic acid	C18:0	0.5-5		0.5-5
Oleic acid	C18:1	55-83		55-83
Linoleic acid	C18:2	3.5-21		3.5-21
Linolenic acid	C18:3	**		≤0.1
Arachidic acid	C20:0	0.8		≤0.6
Eicosenoic acid	C20:1	Not specified		≤0.4
Behenic acid	C22:0	<0.3		≤0.2***
Erucic acid	C22:1	Not present		
Lignoceric acid	C24:0	<1		≤0.2

* The determined limits include the exact values of the recommended technique; **pending the results of IOOC review and further consideration by the Committee on Fats and Oils, national limits may remain in place; ***Limit increased to < 0.3 for olive-pomace oils.

Olive oil consumption and human health

The chemical composition of olive oil depends on the technology and how it is extracted (Fig. 2). To produce olive oil, the fruits of olive were crushed, squeezed and pressed it again with or without hot water to get a powerful color, a feeble aroma, and a more content of free fatty acid (Gökçebağ *et al.* 2013). Fig. 2 depicts the amount of polyphenols in olive oil which depends on the olive oil production procedure. Unrefined EVOO has a higher polarity polyphenol content, which is usually released with small amounts of water after refining. As a result, due to the several technological procedures, the polyphenols content in olive oil is different. Oil from chemical extraction by solvents should be refined before use to remove solvents and other impurities which is called refined olive oil containing vitamins, polyphenols and phytosterols. While low yielding EVOO has been much more expensive and has the highest level of polyphenols, EVOO has a better flavor and lighter color owing to the elimination of free fatty acids (Kalogeropoulos & Tsimidou 2014).

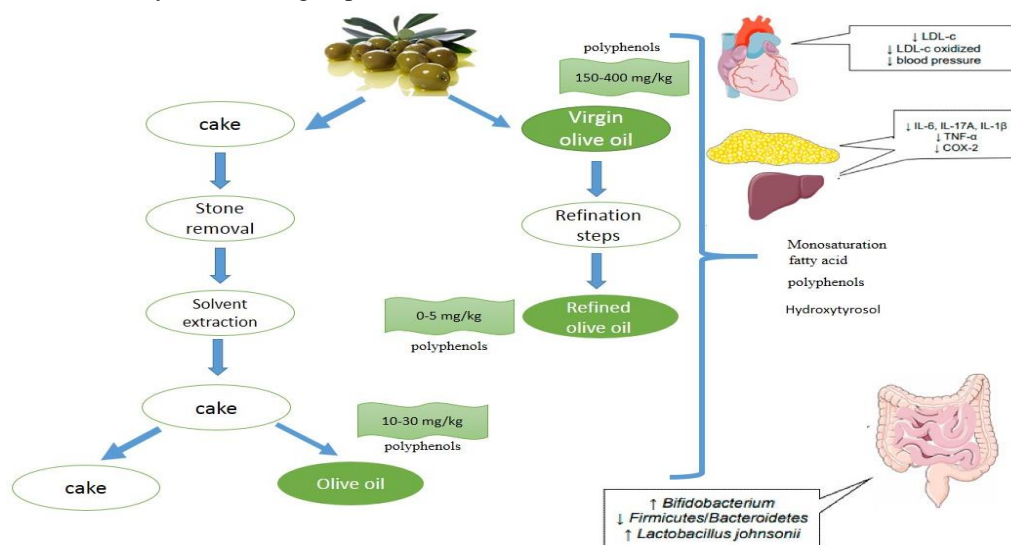


Fig. 2. The polyphenols content in different types of olive oil dependent on technological procedure of the oil extraction. Tumor necrosis factor (TNF- α); interleukin-6 (IL-6); interleukin-17A (IL-17A); interleukin-1 β (IL-1 β); cyclooxygenase-2 (COX-2); low-density lipoprotein cholesterol (LDL-c).

Based on experimental studies, olive oil compounds have biological activities including anti-inflammatory, antioxidant, antiarrhythmic and vasodilator effects. Investigations have exhibited that consuming olive oil with different phenolic compounds reduces the risk factors for cardiovascular disease, serum triglyceride, oxidized glutathione and increases high-density lipoprotein (Rodrigues *et al.* 2020). The nutritional characteristics of different types of olive oils may differ from each other. Olive oil uses as a nutritious food, medicine, and cosmetic and has been the focus of many authors in recent decades (Rasheed *et al.* 2020). Also, its biological, therapeutic, and nutritional uses have been confirmed in some studies. Currently, based on scientific evidence and numerous experimental epidemiological and clinical studies, olive oil is recognized as a reliable food and medicinal source (Caramia *et al.* 2012). The antioxidant, antimicrobial, anti-inflammatory, anti-cancer, etc. effects of olive oil have made it an interesting, important and necessary subject for further studies. Studies show that the occurrence of chronic diseases is increasing worldwide. One of the causes of these chronic diseases is poor diet among the people of the world (Wagner & Brath 2012). Phenolic compounds and unsaturated fatty acids are abundant in olive oil, exhibiting its antibacterial properties. Olive oil also contains antioxidants that have anti-cancer, anti-inflammatory and countless cardiovascular health benefits (Table 2; Schwingshackl *et al.* 2015). Other benefits of olive oil include lowering blood pressure, reducing coronary heart disease, as well as preventing diabetes and reducing the risk of Alzheimer's disease (Guasch-Ferré *et al.* 2015).

Table 2. Effects of olive oil on human health (Yubero-Serrano *et al.* 2019; Tzekaki *et al.* 2020)

Antimicrobial properties	Reduction of the microbial activity
Lipid metabolism	LDL, total cholesterol and triglycerides
Prevent platelet aggregation	Improves blood circulation
Antitumor properties	Breast, prostate, endometrium, digestive tract, etc.
Prevention oxidative stress	Prevents the development of certain types of skin cancer
Digestive system	Inhabits gastric motility, stimulates the digestion of lipids and prevents the onset of gallstones
Anti-inflammatory properties	Decreasing creactive proteins and pro inflammatory genes
Reduction of the risk of neurodegenerative diseases	Preventing age- related cognitive decline, memory loss, dementia and Alzheimer's disease
Osteoporosis	Favorable effect on bone calcification and bone mineralization
Lowering immunological parameters	Proliferation of lymphocytes induced by specific mitogens of B- and T- cells
Glucose metabolism	Prevention and treatment of diabetes type 2
Blood pressure	Diminish the risk of hypertension, vasodilator capacity

It has been proven that consumption of olive oil containing higher content of phenolic compounds is more efficient in reducing systolic blood pressure than that containing lower content (Fitó *et al.* 2005). It has been demonstrated that there was a significant relationship among the consumption of unsaturated fatty acids derived from olive oil and heel ultrasound bone density (Rivas *et al.* 2009). It has been found that consumption of virgin olive oil increases omega-3 unsaturated fatty acids in the diet have valuable synergistic impacts on fat metabolism and oxidative stress in patients with metabolic syndrome (Venturini *et al.* 2015). Giner *et al.* (2016) have been reported that consumption of olive oil with oleuropein content as a dietary supplement can be a promising protective factor against colon cancer. Besides, some studies have been shown that there is a link between olive oil consumption and cardiovascular disease. On the other hands, adding EVOO in the diet can play a significant role, including antioxidants, anti-inflammatory and prevention of atherosclerosis in the human body, since EVOO includes unsaturated fatty acids, oleic acid, tocopherol, and polyphenols. Therefore, all these nutrients influence reducing heart attacks and cardiovascular disease (Nocella *et al.* 2018). In addition, the bioactive extract of olive oil reduces the inhibitory result of chronic subclinical inflammation of animal growth via a mechanism which appears to improve intestinal integrity unrelated to alterations in intestinal ecology and microbial function (Bahmani *et al.* 2019). Also, another study has been released that numerous efficient impacts of olive oil, including prevention of cardiovascular disease, 62% reduction in breast cancer of women, the 40% decreased Alzheimer's disease, reduction in type 2 diabetes and strengthening the immune system (Liehr *et al.* 2017; Ebrahimi *et al.* 2019). The antioxidant compounds of olive oil improve skin tumors. In other words, olive extract due to its antioxidant compounds has a significant role in reinforcing skin health and skin protection and also exhibits a positive effect on skin aging, which led to the reduced oxidative stress and inflammatory responses. Moreover, EVOO influences the nervous system and is a potential treatment for Alzheimer's patients (Liehr *et al.* 2017; Ebrahimi *et al.* 2019), as well as controlling blood pressure. The reduced intestinal inflammation is another

beneficial effect of phenolic compounds which protect intestinal cells against oxidative stress (Liehr *et al.* 2017; Ebrahimi *et al.* 2019; AL- Ethawi *et al.* 2022). Many medicinal plants have long been used to treat many physical and mental diseases, since they are rich in antioxidants and medicinal substances (Zarei *et al.* 2017; Hasanvand *et al.* 2019; Abbasi *et al.* 2020; Vladimirovna Demina *et al.* 2020; Bahmani *et al.* 2020; Solati *et al.* 2021; Obaid *et al.* 2022).

CONCLUSION

Over the past decades, there has been an enhancing trend in the using healthy consumable oils including virgin olive oil which is full of energy sources and fat-soluble vitamins and can play a significant role in supplying some of the nutrients for the humans. Olive oil is known as 'liquid gold'. It is a valuable product that has many benefits for human health owing to the polyphenolic compounds and abundant unsaturated fatty acids. Polyphenolic compounds that are abundantly found in this oil include oleuropein, hydroxytyrosol and other valuable compounds which exhibit anti-cancer, anti-angiogenic and anti-inflammatory properties, capable of declining the risk of chronic diseases. So, the consumption of olive oil is suggested not only due to the characteristics of its healthy fatty acids, but also because of its valuable active ingredients that can have beneficial results on health of human.

Conflict of interest

No potential conflicts of interest were reported by the authors.

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