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# Table Olive Production and Processing

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## Abstract

Bitter compounds naturally present in olive fruit can be broken down to produce palatable olives known as "table olives." In this article, we first provide background information on global table olive production and then describe the most common methods of processing table olives. Phenolic compounds in the olive lead to bitterness and pungency and are responsible for many of the health benefits of olives and olive oil through their antioxidant properties. High salt used in many processing methods is critical to provide shelf stability, but it can be unhealthy, especially for those individuals with cardiovascular disease. One sustainable and healthy alternative packaging initiative is described. Some olives are naturally debittered by natural microorganisms and can be eaten directly off the tree and provide a second healthy alternative.

## Keywords
fermentation, food science, molecular and physical gastronomy, olive

## 1. Background

The fruit of the trees *Olea europapea* have been cultivated and harvested by humans for over 8 millennia (Blatchly *et al.,* 2017). While oil can be extracted from the fruit simply by crushing it between one's fingers, pressing fruit with millstones or mortars extracts more oil, and community presses have been discovered dating back to the 6th millennium BCE. Early on, humans learned how to graft strong rootstock with productive fruit-bearing stock. Today, more than 23 million tons of olives are harvested annually from groves that span over 10 million hectares (Cardoni *et al.*, 2023). While Mediterranean countries of Egypt, Türkiye, Spain, and Algeria lead table olive production, South American countries such as Peru and Argentina are not far behind. (International Olive Council-1). While 60 % of the production still occurs in traditional low-density and medium-density groves, high-density and superhigh density modern groves, as shown in Figure 1, are on the rise (DeAndreis, 2020). About 86 % of



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harvested olive fruit is processed for olive oil, and the remaining 14 % is transformed into table olives.
The two streams for processing olive fruit are outlined in Figure 2 (Ordoudi *et al.*, 2018). When the goal is to extract olive oil, the fruit is typically washed and then crushed in a stone mill or ground using a hammer press. Traditionally, the resulting olive paste is pressed to yield olive oil and water. In modern continuous mills, the paste is stirred for about 30 minutes in a process known as malaxation. Once the olive oil collects on the surface, a process called coalescence, the mixture is ready to be separated by centrifugation. In two-phase separation, the oil is separated from the aqueous mixture of solids known as pomace. In three-phase separation, which has been phased out over the last decade due to environmental concerns, the oil is separated from the aqueous black water, and the solid components are separately collected (García-González and Aparicio, 2010).
The focus of this article is not olive oil, but table olives, which, by contrast with the production of olive oil, are traditionally processed by brining with salt or fermenting. After that, they need only to be sorted and packaged with or without de-stoning. Table olive consumption has more than doubled over the last 20 years (Dawson, 2019). According to data from the International Olive Oil Council (IOOC), countries that grow more olives also consume more olives, with Egypt, Türkiye, and Algeria leading in both production and total consumption (International Olive Oil Council, 2015). On a per capita basis, however, Albania is the leader in table olive consumption, most likely due to a combination of a traditional diet that features olives and the climate that is favorable for olive production.
There are good reasons to celebrate and encourage the consumption of table olives. Table olives and olive oil are healthy food choices included within the Mediterranean Diet (Martini, 2019). Table olives provide dietary fibers (1.5 g/100 g), iron, and copper, and are low in cholesterol (Rocha *et al.*, 2020). Most of the 20-38 kJ of energy provided by a single olive is derived from a useful monounsaturated fatty acid residue of triglycerides, known as oleic acid.

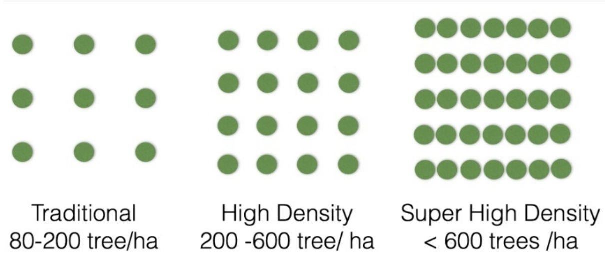


*Figure 1. Olive groves are planted with a tree density described as Traditional, High Density, or Super High Density.*

For olives to be made ready for consumption, it is necessary for them to be processed to break down the phenolic compounds that give rise to their bitter and pungent flavor.
Here, we present the chemical structure of the major phenolic compounds in the olive, highlight their biological relevance to consumers, and discuss the various methods by which the molecules are broken down to make the olive palatable. We will show how we can make table olives even healthier by reducing the sodium content by shifting to a more sustainable, lower salt, and still tasty preservation method, such as the Olivepack project. Finally, we will explore a strategy for processing olives in which naturally occurring microorganisms break down the phenolic compounds in the olive, producing sweet olives that can be eaten directly off the tree.

## 2. Major phenolic compounds in the olive

Phenolic compounds that give rise to both the bitterness and pungency of the olive are shown in Figure 3. First to consider are the natural phenolic compounds that give rise to the bitter



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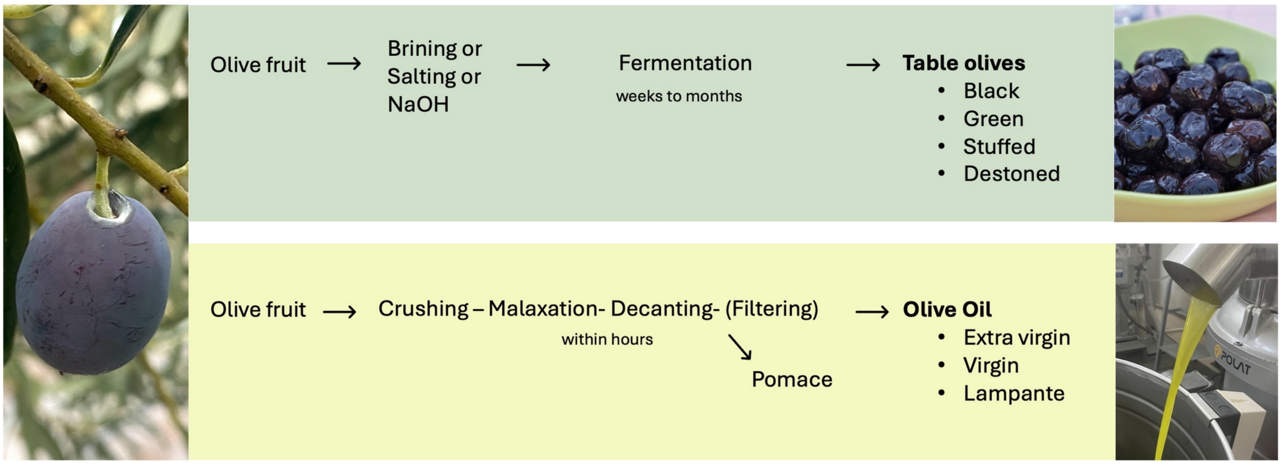


*Figure 2. Olive fruit can be processed into table olives or olive oil.*

flavor of the olive. Oleuropein, luteolin, and apigenin are three of the hundreds of different phenolic compounds in the olive (Romani, 2019). IUPAC names for these compounds are included in the references (PubChem, 2025) (Figure 3). The exact identity and amount of the bitter compounds are determined by the olive varietal, the terroir in which it is grown, the seasonal growing conditions, and the maturation level of the olive itself when harvested. The earlier in the growing season, the higher the level of phenolic compounds. These compounds have at least one aromatic ring with two hydroxyl groups. The most prevalent of these is oleuropein, two images of which are shown in Figure 4. The line drawing shows the positions and bonds of the non-hydrogen atoms, while the surface electron density image more clearly reveals the shape and charges that would cause this molecule to be recognized by its bitter receptor proteins on the taste bud sensory cell.

Oleuropein binds to receptors known as TAS2R1, TAS2R8, and TAS2R14 (Cui, 2021). The chemical structures of these phenolic compounds facilitate their acting as antioxidants: they are oxidized to stable semiquinones or quinones, transferring electrons to reactive oxygen species (ROS), thus deactivating the ROS and preventing them from wreaking havoc in the cell (Barbero *et al.*, 2014). The oxidized phenolic compounds exist as stable nonreactive radicals. Antioxidants minimize risks from diseases that involve reactant oxygen species and are thought to be a major factor in the healthiness of the Mediterranean diet, which includes olives and olive oil.

Next to consider is oleocanthal, a particularly special monophenol (one hydroxyl group), which gives rise to the olive's pungency. Pungency is different than bitterness, with sensory aspects of a slightly burning sensation, and is often accompanied by a cough. Oleocanthal has been found to bind to a particular receptor in the back of the throat that also binds to anti-inflammatory drugs such as ibuprofen (Peyrot des Gachons *et al.*, 2011). The receptor, known as TRPA1, is a gated cation channel protein that opens to permit the passage of positive ions through the membrane of a sensory cell whenever oleocanthal is bound. The cellular signal created by the passage of these ions results in an anti-inflammatory response. The oleocanthal is responsible for the health benefits of olives by providing protection against inflammatory diseases such as cardiovascular disease and cancer.

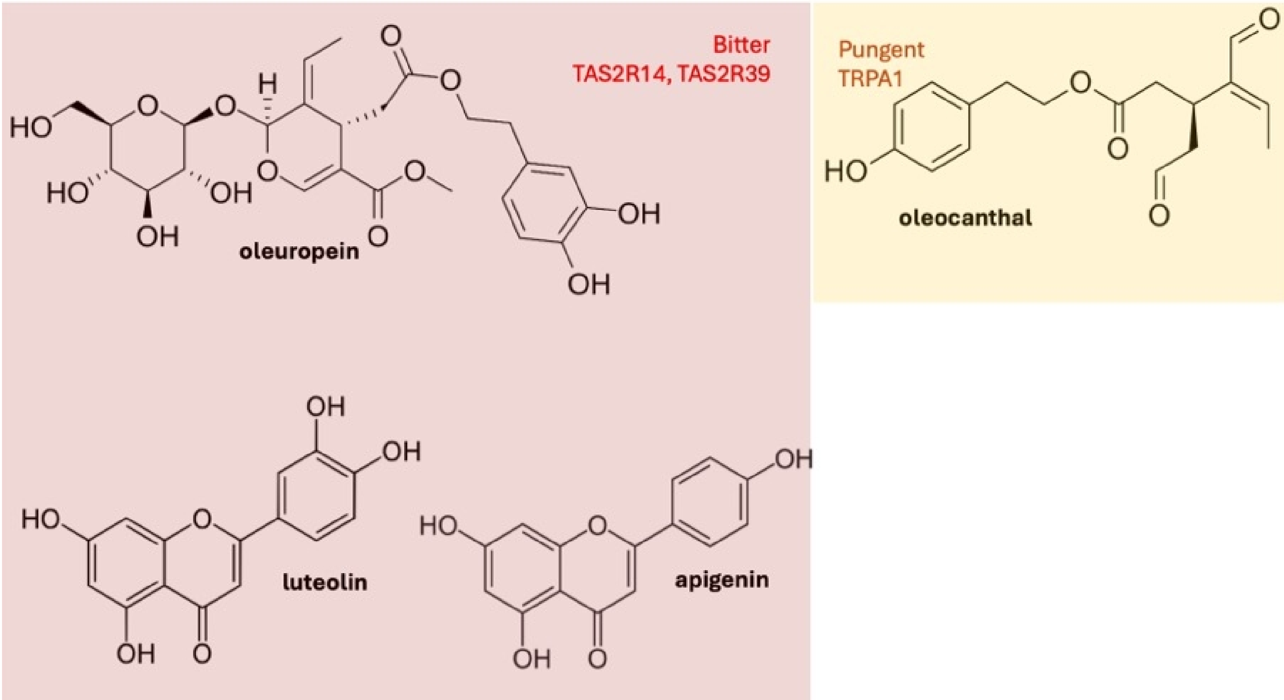


*Figure 3. Four representative phenolic compounds in olives that give rise to their pungency or bitterness. Oleocanthal creates a pungent response in the back of the throat that is often manifested in a cough. It binds to the TRPA1 ion channel protein, which also binds NSAID compounds such as ibuprofen, and may be one reason why olive consumption has anti-inflammatory effects. Oleuropein, apigenin, and luteolin give rise to a bitter flavor and bind to TAS2R1, TAS2R8, and TAS2R14 receptors. All are antioxidants (modified from Glauser and Goodman, 2016).IUPAC Names of oleoeuropein: methyl (4S,5E,6S)-4-[2-[2-(3,4-dihydroxy-phenyl)ethoxy]-2-oxoethyl]-5-ethylidene-6-[(2S,3R,4S,5S,6R)-3,4,5-trihydroxy-6-(hydroxymethyl) oxan-2-yl]oxy-4H-pyran-3-carboxylate; luteolin: 2-(3,4-dihydroxyphenyl)-5,7-dihydroxy chromen-4-one); apigenin: 5,7-dihydroxy-2-(4-hydroxyphenyl)chromen-4-one.*

## 3. New and conventional methods for processing table olives

An olive off a tree is extremely bitter and few would choose to consume it voluntarily. The phenolic compounds must be broken down to make the olive palatable. Two methods for doing this are shown in Figure 5.

In the Turkish/Greek style, salt, or salt and water, is added to the olives and left to naturally ferment for periods of weeks to months. In the Spanish style, a solution of sodium hydroxide (NaOH) (1.3–2.6 % w/v) is added to hydrolyze the bonds, and then the olive is preserved with a solution of sodium chloride (NaCl) (6–8 % w/v) (Rocha *et al.*, 2020). The one downside to table olive consumption is the high salt levels (> 10 %) that are important for extending shelf life. Consumers are urged to try to limit sodium consumption to below 1.5 g per day, which is about ½ cup of green olives (American Medical Association, 2022). Consumers with hypertension should

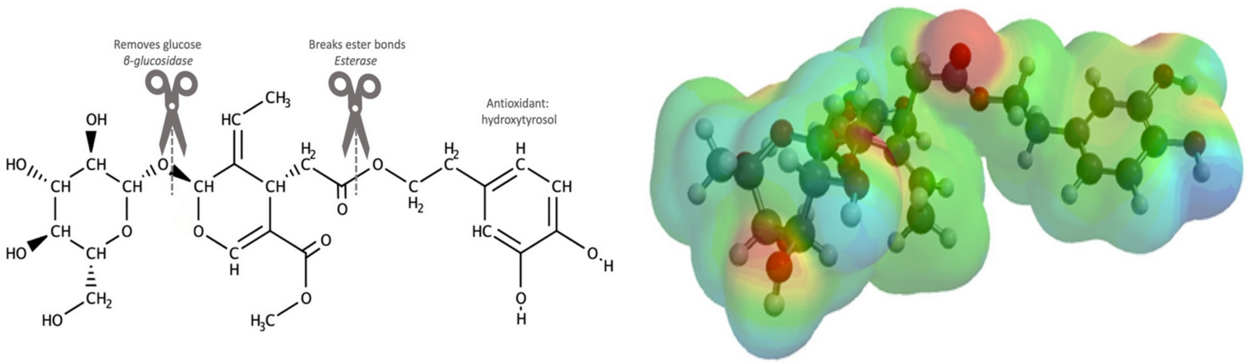


*Figure 4. Oleuropein in olives gives rise to its antioxidant properties and bitter flavor. The left panel shows a stick drawing of the molecule and the bonds that are broken during the debittering process. The right image shows the surface electron density that highlights the shape and surface charge of the molecule, key factors in its binding to its receptor protein. Here, a red color indicates a region of high electron density, a blue color indicates a region of low electron density, and a green color indicates a region of neutral electron density.*

strive for a daily intake of sodium to be less than 500 mg.
New innovative research, funded by the European Union's Partnership for Research and Innovation in the Mediterranean (PRIMA) has supported the Olivepack project in research conducted by a consortium of four Mediterranean countries. Participants in the Olivepack Program: Hayriye Ünal & Zeynep Delen Nircan Sabanci U. Nanotechnology, Research Center (SUNUM), Türkiye; Şahnur Irmak Bornova Olive Research Institute (ORI), Türkiye; Mohamed Bouaziz University of Sfax (USFAX), Tunisia; Elsa Ramalhosa Polytechnic Institute of Bragan.a (IPB) Portugal; Joaquin Bautista-Gallego University of Extremadura (UEX) Spain
The aim is to reduce the amount of sodium used in table olive production. As shown in Figure 6, Olivepack aims to develop an integrated process for extending the shelf life of the olive without the need for artificial preservatives such as sodium sorbate and sodium benzoate. The process uses a biobased, biodegradable, bio-nanocomposite foam composed of cellulose polymer matrix obtained from olive wood waste, impregnates it with a natural antioxidant with antimicrobial activity extracted from olive waste water. The foam is expected to release the antimicrobial agent into the packaging environment over time and act as a preservative to extend the shelf life without adding salt. The project's objectives are to develop the bio-based nanocomposite foam, evaluate its antimicrobial activity as well as the physicochemical, nutritional and organoleptic properties of low salt olives. Finally, to monitor the implementation of acceptance of innovative technological solutions to the Mediterranean diet.

## 4. Microorganisms can debitter olives on the tree

Several microorganisms, most likely fungi, are capable of naturally debittering olives so they can be consumed directly off the tree (Heperkan, 2013). To date, at least three varietals of olive trees have been identified as providing a host to the microorganisms: in Greece, the Thrubolea, in Tunisia, the Dhokar, and in Turkey, the Erkence. The Turkish sweet olive, named "Hurma olive," is shown in Figure 7. Originally, a fungus named



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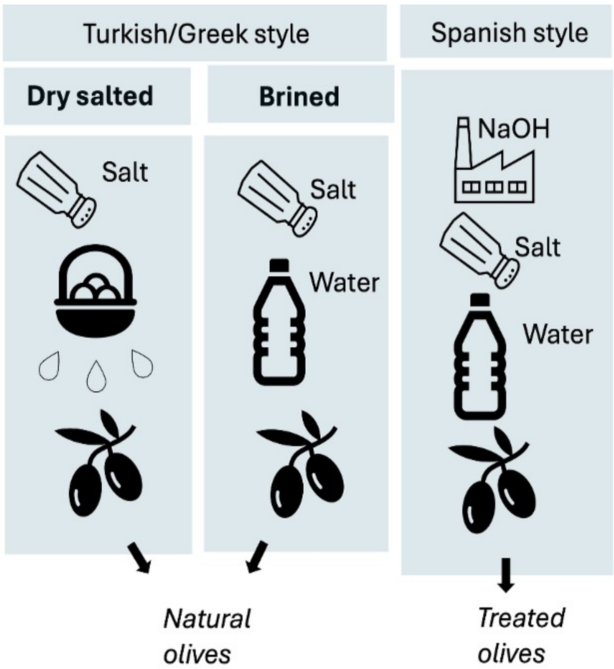


*Figure 5. Conventional methods for processing olives into table olives. Whereas the Turkish and Greek method only uses salt for debittering, the Spanish uses sodium hydroxide.*


*Figure 6. The Olivepack method uses a recycled cellulose polymer foam from olive trees that has been impregnated with natural antioxidant.*

*Phoma oleae* was thought to be the debittering agent. *Phoma multistrata* was identified as a fungus responsible for the debittering in 2014 (Abacı-Günyar, 2014). Previous work showed *P. oleae* to be a pathogen and not responsible for breaking down phenols (Borema, 2004). In 2016, *Phoma oleae* was renamed *Dothiora oleae*, but the literature still contains references to it as the debittering agent (Species Fungoforum, 2025).
The culprit or culprits have yet to be convincingly identified. Several candidates have been suggested, and this is still an active area of research (Aktas *et al.*, 2014). Even with the right olive and the right microorganism, this natural process is extremely sensitive to wind patterns, rainfall, and pollution. Identification and perhaps genetic manipulation of the microorganism to make it more robust might, in the future, lead to a program of natural debittering and avoid the need for harsh chemical treatments.

## 5. Conclusion

Table olives are a healthy energy energy-dense food that must be processed before it is palatable. This processing involves breaking down the bitter and pungent phenolic compounds by chemical or natural fermentation processes. The phenolic antioxidants, such as oleuropein and the anti-inflammatory monophenol oleocanthal, are at least two of the many compounds that provide health benefits. The healthy benefits can be enhanced by



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*Figure 7. Hurma Olives or date olives in Türkiye. The olive varietal in this case is the Erkence olive, and the microorganism responsible for the debittering has yet to be definitively identified (permission by Selin Tunçer in Karaburun İzmir Türkiye).*

lowering the salt necessary for preserving the fruit using Olivepack processing introduced here. The long-term and chemical processing methods can be bypassed completely by natural microorganisms.

## Dedication

This paper is dedicated to the late Professor Richard Blatchly, who inspired both of us with his curiosity and intelligence.

## Acknowledgement

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## References:

Abacı-Günyar O, Haliki-Uztan A, Ölmez HA, Ozkarakas I, Karaburun I, Olgunlaşan YD. 2014. Hurma zeytinlerden phoma multirostrata'nın izolasyonu ve tanılanması: olea europaea (oleaceae)'dan ilk kayıt, *Elektronik Mikrobiyoloji Dergisi* TR, 12(2), 20-27. http://www.mikrobiyoloji.org/TR/Genel/DosyaGoster.aspx?DIL=1&BELGEANAH=2999&DOSYAISIM=02%20Phoma.pdf, last access: 2025/06/09

Aktas AB, Ozen B, Tokatli F, Sen I. 2014 Phenolics profile of a naturally debittering olive in comparison to regular olive varieties, *Journal Science Food Agriculture,* 94, 691-698. DOI 10.1002/jsfa.6308, https://gcris.iyte.edu.tr/bitstream/11147/5534/1/5534.pdf

American Medical Association. 2022. https://www.ama-assn.org/public-health/prevention-wellness/what-doctors-wish-patients-knew-about-sodium-consumption, last access 2025/08/05

DeAndreis P. 2020. Olive Oil Times. https://www.oliveoiltimes.com/world/modern-olive-growing-starting-to-overtake-traditional-methods/88625, last access 2025-12-01.



*ISSN 2431-0859*

Barbaro B, Toietta G, Maggio R, Aricello M, Tarrocchi M, Galli A, Balsano C. 2014. Effects of the olive-derived polyphenol oleuropein on human health, *International Journal of Molecular Sciences*, 15(10), 18508. https://doi.org/10.3390/ijms151018508

Blatchly RA, Nircan ZD, O'Hara, PB. 2017. The chemical story of olive oil: from grove to table, *Royal Society Chemistry*, ISBN: 978-1-78262-856-9. https://doi.org/10.1039/9781782628569-FP001.

Boerema GH, de Gruyter J, Noodeloos ME, Hamers MEC. 2024. *Phoma Identification Manual: Differentiation of Specific and Infra-specific Taxa in Culture,* CABI Publishing.

Cardoni M, Mercado-Blanco J. 2023. Confronting stresses affecting olive cultivation from the holobiont perspective, *Frontiers in Plant Science*, 14, 1261754. https://doi.org/10.3389/fpls.2023.1261754.

Cui M, Chen B, Xu K, Rogakou A, Diamantakos P, Melliou E, Logothetis D, Magiatis P. 2021. Activation of specific bitter taste receptors by olive oil phenolics and secoiridoids, *Scientific Reports*, 11, 22340. https://doi.org/10.1038/s41598-021-01752-y.

Dawson D. 2019. *Table Olive Consumption Doubled Since 1999.* https://www.oliveoiltimes.com/business/table-olives-consumption-has-doubled-since-1990/67213, last access 2025/06/09.

García-González DL, Aparicio R. 2010. Research in olive oil: challenges for the near future, *Journal of Agricultural and Food Chemistry*, 58, 12569-12577. DOI: 10.1021/jf102735n.

Glauser DA, Goodman MB. 2016. Molecules empowering animals to sense and respond to temperature in changing environments, *Current Opinion in Neurobiology*, 41, 92-98. DOI: 10.1016/j.conb.2016.09.006.

Heperkan D. 2013. Microbiota of table olive fermentations and criteria of selection for their use as starters, *Frontiers in Microbiology*, 4, 143. https://doi.org/10.3389/fmicb.2013.00143.

International Olive Oil Council. 2024. IOC-1, World Olive Oil and Table Olive Figures, https://www.internationaloliveoil.org/wp-content/uploads/2024/12/HO-W901-15-12-2024-P.pdf last access 2025/12/01.

International Olive Oil Council. 2015. IOC-2, Market Newsletter No 92. https://www.internationaloliveoil.org/wp-content/uploads/2019/12/NEWSLETTER_MARCH-2015_ENGLISH.pdf, last access 2025/06/09.

Martini D. 2019. Health benefits of mediterranean diet, *Nutrients*, 11.8, 1802. DOI: 10.3390/nu11081802.

Ordoudi S, Bakirtzi C, Tsimidou MZ. 2018. The potential of tree fruit stone and seed wastes in greece as sources of bioactive ingredients, *Recycling*, 3, 9. DOI: 10.3390/recycling3010009.

Peyrot des Gachons C, Uchida K, Bryant B, Shima A, Sperry JB, Dankulich-Nagrudny L, Tominaga M, Smith AB 3rd, Beauchamp GK, Breslin PA. 2011. Unusual pungency from extra-virgin olive oil is attributable to restricted spatial expression of the receptor of oleocanthal, *Journal of Neuroscience*, 31(3), 999-1009.

PubChem. 2025. https://pubchem.ncbi.nlm.nih.gov, last access 2025/08/09.

Rocha J, Borges N, Pino O. 2020. Table olives



*ISSN 2431-0859*

and health: a review, *Journal of Nutritional Science*, 9, e57.
DOI: 10.1017/jns.2020.50.

Romani A, Ieri F, Urciuoli S, Noce A, Marrone G, Nediani C, Bernini R. 2019. Health effects of phenolic compounds found in extra-virgin olive oil, by-products, and leaf of *Olea europaea, Nutrients*, 11.8, 1776.
DOI: 10.3390/nu11081776.

Species Fungoforum, 2025.
https://www.speciesfungorum.org/Names/GSDSpecies.asp?RecordID=816140, last access 2025/08/05

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