



# INFLUENCIA DE LOS COMPONENTES DE LA SALMUERA EN LAS PROPIEDADES NUTRICIONALES Y CALIDAD DE LAS ACEITUNAS

## INFLUENCE OF BRINE COMPONENTS AND NUTRITIONAL ON THE QUALITY PROPERTIES OF OLIVES

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### RESUMEN

El presente estudio presenta una revisión bibliográfica, de la aceituna de mesa ya que ha mostrado una importante expansión en los últimos años, a nivel nacional e internacional, por lo que para su importación y exportación es clave conocer estos parámetros. El objetivo principal es determinar cómo los diferentes componentes de la salmuera, como la concentración de sal, el pH y la presencia de otros aditivos, afectan la calidad y las propiedades nutricionales. La metodología de investigación empleada en este estudio es de naturaleza cualitativa y documental. Los resultados indican que la calidad nutricional de las aceitunas de mesa está estrechamente relacionada con la salmuera utilizada en su procesamiento. La salmuera incluye la presencia de NaCl en este caso el mejor resultado de textura se obtuvo con una concentración al 10 % y el 0.1 de ácido acético. Además, actúa como agente conservante y, durante la fermentación ácido-láctica, contribuyendo al sabor, textura y vida útil de las aceitunas. Esta concentración se puede determinar mediante varios métodos, como la fotometría de llama y el uso de electrodos selectivos de iones cloruro o sodio. En conclusión, la composición de la salmuera influye significativamente en el perfil nutricional de las aceitunas, reduciendo la grasa y la vitamina C mientras aumenta la proteína y la fibra. Estos ajustes en la salmuera permiten modificar el equilibrio de nutrientes para alcanzar las propiedades nutricionales deseadas en el producto final.

**PALABRAS CLAVE** Aceitunas, salmuera, componentes, calidad, fermentación, textura

### ABSTRACT

This study presents a bibliographic review of table olives, since they have shown significant expansion in recent years, both nationally and internationally, so that for their import and export it is key to know these parameters. The main objective is to determine how the different components of the brine, such as salt concentration, pH and the presence of other additives, affect the quality and nutritional properties. The research methodology used in this study is qualitative and documentary in nature. The results indicate that the nutritional quality of table olives is closely related to the brine



used in their processing. The brine includes the presence of NaCl in this case the best texture result was obtained with a concentration of 10% and 0.1% of acetic acid. In addition, it acts as a preservative agent and, during lactic acid fermentation, contributes to the flavor, texture and shelf life of the olives. This concentration can be determined by several methods, such as flame photometry and the use of chloride or sodium ion selective electrodes. In conclusion, The composition of the brine significantly influences the nutritional profile of olives, reducing fat and vitamin C while increasing protein and fiber. These adjustments to the brine allow the nutrient balance to be modified to achieve the desired nutritional properties in the final product.

**KEYWORDS** Olives, brine, components, quality, fermentation, texture

## INTRODUCTION

World production of table olives is around 1,000,000 tonnes. The majority corresponds to green olives of the Spanish or Sevillian style, and to a lesser extent natural black olives and coloured olives. The olive industry is of great importance both in the food sector and in the economic sphere of several countries, among them Spain, which is the world's leading exporter of olive oil.

The conservation of olives by means of lactic acid fermentation has been practised since ancient times in Egypt. The purpose of preserving olives in brine is to maintain the fruits under the best conditions, not the achievement of a true fermentation. During this process, the development of a complex microbial flora occurs, whose evolution is crucial for adequate conservation or the appearance of alterations in the physicochemical or microbiological processes in the olives.

The olive is a food of notable nutritional value, offering an optimal proportion of all essential amino acids, although its protein content is relatively low. However, its high fibre content contributes to efficient digestion. Mainly composed of water, olives provide the following nutrients per 100 grams: 1 gram of carbohydrates, 0.8 grams of proteins, 150 calories, and 2.6 grams of fibre. The fibre density is 1.73 grams per 100 calories, allowing them, in accordance with Regulation No 1924/2006 of the European Parliament and of the Council of 20 December 2006, to be classified as a source of fibre (1).

Table olives are useful for reaching the Recommended Daily Amounts (RDA) of fibre, established at 30 grams. In addition, they contain 20% fat, predominantly oleic acid at 82%, followed by palmitic acid (13%), linoleic acid (Omega-6) (5%), stearic acid (3%), linolenic acid (Omega-3) (1%), and palmitoleic acid (1%), with variations depending on the degree of ripeness of the olive (1).

The composition of the brine, which includes specific concentrations of salt, 0.1% acetic acid, and sometimes herbs and spices, plays a crucial role in the development of the nutritional properties and sensory quality of the olives. These components not only act as preservative agents, but also affect the texture, flavour and nutritional profile of the final product. The interaction between these elements and the natural components of



the olives during the curing process largely determines their chemical profile and the sensory response upon human consumption (2).

Olives must undergo washing, which in most cases lowers the pH, generating in all cases Gram-negative bacteria, a certain quantity of which passes into the brine process because it is adhered to the olive; this process is not related to any direct reaction with the product in abundance, for which reason this study focuses on conservation in brine, where effects may occur according to the quantities treated, given that brine concentrations range between 5 and 8% NaCl but vary according to the type of olive (3).

Before initiating the fermentation process, it is essential to prepare a brine with a density of between 8 and 10 °Baumé using sodium chloride, which must be acidified with a 0.1% solution of acetic acid or lactic acid. In addition, it is crucial to maintain the ambient temperature during fermentation in a range of 25 to 28 °C, as this favours the growth of beneficial lactic bacteria and minimises the proliferation of undesirable microorganisms (3).

Immediately after the olives are placed in brine, the fermentative process begins. However, it is quite slow given the difficulty with which the different substrates reach the brine, because in these fruits the skin and the pulp remain intact and offer high resistance to the diffusion of said compounds. The abundant initial release of gases is due not only to the growth of Gram-negative bacilli but also to the carbon dioxide originating from the respiration of the fruits, in a manner similar to what occurs in natural black olives in brine (4).

It is fundamental to bear in mind that the salt concentration in the solution is reduced to half the initial value because the olives, once washed, absorb a significant quantity of water. This absorption dilutes the original brine and decreases its concentration. This reduction occurs mainly during the first six days of fermentation and, if not adjusted, may allow the growth of undesirable microorganisms that could alter the process. To correct this decrease, sodium chloride solutions must be added to the tanks until an equilibrium concentration of 7–8% is reached (2).

The analysis of sodium chloride in olive brines is currently performed by means of the Volhard method, which consists of the titration of the brine, once suitably diluted, with silver nitrate, using potassium chromate as indicator. The normality of the silver nitrate solution is fixed so that the volumes consumed in the reaction correspond to the percentages of NaCl (5).

The objective of this review is to determine how the different components of the brine, such as salt concentration, pH and the presence of other additives, affect the quality and nutritional properties of the olives. This is achieved through the evaluation of parameters such as texture, flavour, nutrient content and microbiological stability of the olives under different brine conditions and the concentration of NaCl in the same. The results of this research may help to improve the quality and food safety of olives and to develop more efficient and sustainable production processes.



## MATERIALS AND METHODS

The present bibliographic review article is based on the compilation and description of information covering the influence of brine components on the quality and nutritional properties of olives. Given that it is a narrative review, a specific study population or sample is not defined; rather, a general synthesis is presented according to the topic under consideration. Therefore, a review of 40 documents was carried out, based on observational and experimental studies performed on different olives, which address the analysis of brine components from an inductive and deductive approach. The information is obtained from databases such as PubMed, Scopus and Web of Science, where updated articles related to the topic are taken into account.

A search strategy is developed that includes keywords such as olives, brine, brine components, quality, nutritional properties, conservation, curing, polyphenols, tocopherols, fatty acids, antioxidants, fermentation and microbiology.

An exhaustive and critical bibliographic review is carried out on the influence of brine components on the quality and nutritional properties of olives, with the aim of compiling and synthesising the existing information in the scientific literature, identifying some inconsistencies and areas that require further research, and providing a general overview of knowledge in this field.

## RESULTS

The olive fermentation process is complex and varies significantly in comparison with green or natural black olives. In the initial stages of fermentation, the microbial flora is diverse and includes a mixture of Gram-negative and Gram-positive bacilli, moulds and other microorganisms. After approximately one week, the appearance of fermentative yeasts is observed, which persist throughout the brine period. These yeasts play a crucial role in the formation of a slight acidity in the olives.

When the salt concentration in the brine does not exceed 5%, the development of lactic bacteria begins around the fourth or fifth day of immersion. Table 1 shows the yeast species isolated on the surface of the olives after the washing process with sodium hydroxide.

**Table 1. Yeast species isolated on the surface of olives**

|                           |
|---------------------------|
| Candida boidinii          |
| Diddensiae                |
| Krusei                    |
| Cryptococcus melibiosum   |
| Rhodotorula glutinis      |
| Minuta                    |
| Debaryomyces hansenii     |
| Hansenula anomala         |
| Metschnikowia pulcherrima |



### Saccharomyces cerevisiae

Table 1 shows the yeast species that were isolated from the surface of the olives after washing with sodium hydroxide. Among the yeasts identified are *Candida boidinii*, *Diddensiae*, *Krusei*, *Cryptococcus melibiosum*, *Rhodotorula glutinis*, *Minuta*, *Debaryomyces hansenii*, *Hansenula anomala*, *Metschnikowia pulcherrima*, and *Saccharomyces cerevisiae* (6).

The presence of these yeasts indicates an active and varied fermentation. Specifically, species such as *Saccharomyces cerevisiae* and *Debaryomyces hansenii* are known for their capacity to ferment sugars and contribute to the development of characteristic flavours and aromas in the olives. On the other hand, yeasts such as *Cryptococcus melibiosum* and *Rhodotorula glutinis* may influence the texture and the acid profile of the final product (6).

Salt concentrations in the brine play a crucial role in the selection of the microbial species that can thrive in the fermentation environment. Table 2 illustrates how different salt concentrations affect the texture of the olives, providing a texture score based on a scale of 1 to 10.

**Table 2. Influence of salt concentration on olive texture**

| Brine concentration (%) | Texture (score 1 to 10) |
|-------------------------|-------------------------|
| 5                       | 7.2                     |
| 7.5                     | 8.5                     |
| 10                      | 9.3                     |
| 12.5                    | 8.8                     |
| 15                      | 7.6                     |

Analysis of the table reveals that olives in brine with a 10% salt concentration present the best texture, with a score of 9.3. This indicates that a higher salt concentration improves the firmness and consistency of the olives, which is desirable for the quality of the final product. However, very high salt concentrations, such as 15%, result in a less ideal texture (7).

It should be noted that a higher salt concentration in the brine favours the formation of a firmer texture in the olives, although an adequate balance must be found to avoid adverse effects on flavour and texture. The optimal texture is achieved at moderate salt concentrations, such as 10%, which coincides with the highest texture score in the table. These results provide a detailed understanding of how the components of the brine and the fermentation conditions influence the final quality of the olives (8).

Table 3 offers an overview of how different brine components affect the colour, texture and antioxidant content of the olives. Each component has a distinctive impact on the final characteristics of the olives, as detailed below:

**Table 3. Influence of brine components on olives**

| https://vitalyscience.com Vol. 1, No.2, PP.8-19 |                             |                       |                             |
|-------------------------------------------------|-----------------------------|-----------------------|-----------------------------|
| Brine component                                 | Olive colour (Colour Index) | Olive texture (Score) | Antioxidant content (mg/kg) |
| Common salt (NaCl)                              | 5.2                         | 8.5                   | 120                         |
| Citric acid                                     | 4.8                         | 9.2                   | 150                         |
| Garlic in the brine                             | 6.0                         | 7.8                   | 110                         |
| Olive oil in the brine                          | 5.5                         | 8.0                   | 180                         |

The use of common salt in the brine results in a colour index of 5.2, indicating a relatively pale colour in the olives. Texture is quite good, with a score of 8.5, and antioxidant content is moderate, at 120 mg/kg. Common salt, being the basic component of many brines, provides a good base for texture, but does not influence antioxidant content as much.

The addition of citric acid improves the colour index to 4.8, suggesting a brighter colour compared with common salt. In addition, better texture is observed, with a score of 9.2, which suggests that citric acid contributes to greater firmness of the olives. Antioxidant content is the highest among the components evaluated, at 150 mg/kg, which may be related to the capacity of citric acid to preserve antioxidants during fermentation (9).

The inclusion of garlic in the brine gives rise to a colour index of 6.0, indicating a more intense colour in the olives. However, texture is the lowest, with a score of 7.8. Antioxidant content is also the lowest, at 110 mg/kg, which may be due to the fact that garlic does not have a significant effect on the conservation of antioxidants compared with other components (3).

Olive oil in the brine presents a colour index of 5.5, slightly better than common salt, and a texture of 8.0, which is good but not as firm as with citric acid. Antioxidant content is the highest, at 180 mg/kg, which may be attributable to the inherent antioxidant properties of olive oil. This suggests that olive oil not only improves sensory quality, but also contributes significantly to the conservation of antioxidants (9).

Table 4 presents a comprehensive overview of the impact of salt concentration on the nutritional composition of olives. The relationship between salt concentration and the key nutrients—fat, protein, fibre and vitamin C—provides valuable information on how variations in the brine affect the nutritional quality of the final product.

**Table 4. Nutritional content of olives according to brine composition**

| Brine components (%)      | Fat (%) | Protein (%) | Fibre (%) | Vitamin C (mg/100g) |
|---------------------------|---------|-------------|-----------|---------------------|
| Low salt concentration    | 15.2    | 1.8         | 2.5       | 12.4                |
| Medium salt concentration | 14.5    | 2.2         | 3.0       | 10.8                |
| High salt concentration   | 13.8    | 2.5         | 3.5       | 9.5                 |



Salt concentration has an inverse effect on the fat content of the olives. As the salt concentration in the brine increases, the percentage of fat decreases. Olives with low salt concentration have the highest fat content (15.2%), while olives with high salt concentration present the lowest fat content (13.8%). This may be attributed to the capacity of salt to extract and eliminate part of the fats during the fermentation process.

The protein content in the olives increases with salt concentration. Olives with high salt concentration have the highest protein percentage (2.5%), compared with olives of low salt concentration (1.8%). This trend may be related to the effect of salt on the concentration of proteins as water content decreases and nutrients become more concentrated (10).

Fibre content also increases with salt concentration. Olives with high salt concentration show the highest fibre content (3.5%), while those with low concentration have the lowest fibre content (2.5%). This increase may be due to the reduction of water content and the concentration of fibre in the final product. Finally, vitamin C content decreases with salt concentration. Olives with low salt concentration have the highest vitamin C content (12.4 mg/100g), while those with high concentration have the lowest content (9.5 mg/100g). The decrease in vitamin C may be caused by the degradation of this nutrient during the fermentation process and exposure to high salt levels (10).

Salt concentration in the brine has a notable impact on the nutritional profile of the olives. Olives with high salt concentration present a higher concentration of proteins and fibre, but a lower content of fat and vitamin C. These changes reflect the effect of salt on the concentration of nutrients and the overall balance of the product. To optimise the nutritional profile of the olives, it is crucial to adjust the salt concentration according to the desired objectives regarding fat, protein, fibre and vitamin content.

## DISCUSSION

Brine allows olives to be conserved for a longer time in a healthy manner and enhances their flavour throughout the fermentation and curing process. The aqueous solution becomes a medium that permits lactic fermentation, which contributes to the transformation of the olives and their conservation. Brine, being a solution of water and salt, creates a favourable environment for the development of microorganisms that participate in the fermentation process, which in turn influences the organoleptic and nutritional properties of the olives. Therefore, brine not only affects the fermentation process of the olives, but is also a determining element in the curing stage. Once fermented, the olives are placed in brine, which allows them to complete their curing process. Brine, being a highly concentrated salt solution, affects the texture, flavour and conservation of the olives, which in turn influences their final quality and nutritional value (1).

Conservation of olives in brine, especially in acidified brine, may cause a loss of the original green colour of the olives. A study observed that the use of acidified brine caused greater deterioration of the green colour in all the varieties studied. The most



common method for debittering green table olives is the alkaline hydrolysis of polyphenols. This method is widely used to make olives more palatable by eliminating the bitter components (8).

Regarding existing studies, relevant information has been found on the fermentative process of green olives in brine, as well as on the importance of brine in food conservation. In addition, studies have been carried out on the influence of salt concentration on the texture and flavour of olives, as well as on the presence of other components in the brine, such as citric acid and vinegar, and their impact on the organoleptic properties of the olives (2).

In the study carried out by Durán, it is reported that the brine was suitably diluted until a NaCl concentration of 5% was achieved. To this brine, acetic or lactic acid was added until pH values of 4.0 and 3.5 were reached, as well as NaCl to achieve salt levels of 8%. The content of organic acids and residual sugars (11).

The components of the brine, such as sodium chloride (salt) and lactic acidity, influence the quality and nutritional properties of the olives in the following ways:

- Flavour and texture: The brine, which contains sodium chloride, contributes to the characteristic flavour and firmness of the olives. An adequate balance of salt in the brine is crucial to achieve the desired flavour and optimal texture of the olives.
- Conservation: The brine acts as a preservative agent, helping to preserve the olives and prolong their shelf life. This is important for maintaining the quality of the olives during storage and packaging (12).
- Sodium chloride is an important component of the brine, and its presence in the brine solution may affect the sodium content of the olives. The duration of the curing process may decrease if the olives are first immersed in a 2 to 4% sodium hydroxide (NaOH) solution. The caustic soda solution rapidly removes phenolic compounds before the olives enter the brine (13).

In summary, the composition of the brine exerts a decisive influence on both the sensory quality and the nutritional profile of table olives. Careful adjustment of salt concentration, acidity and optional additives allows producers to optimise texture, colour, antioxidant retention and the balance of macronutrients and micronutrients according to the desired commercial and nutritional objectives.

## CONCLUSIONS

1. The composition of the brine, particularly the concentration of sodium chloride and the presence of acidifying agents such as acetic or lactic acid, significantly influences the texture, colour, antioxidant content and nutritional profile of table olives.
2. A salt concentration of approximately 10% yields the optimal texture score (9.3 on a 1–10 scale). Higher concentrations improve firmness up to a point, beyond which texture deteriorates and sensory quality declines.



3. Increasing salt concentration reduces fat and vitamin C content while increasing protein and fibre content. These changes allow the nutritional balance of the final product to be modulated according to specific dietary or commercial objectives.
4. The addition of citric acid or olive oil to the brine enhances antioxidant retention and can improve colour and firmness, offering additional tools for quality optimisation.
5. Proper control of brine composition, temperature (25–28 °C) and microbial succession is essential for obtaining a safe, high-quality product with the desired nutritional and organoleptic characteristics. Further research is recommended to refine process parameters for different olive cultivars and market requirements.

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