Benefits of the lactic acid fermentation of table olives on human health: Fermented table olives as a functional food
Table olives since ancient times

- The table olive has been popular in Mediterranean countries for centuries, as the source of olive oil and as one of the basic elements of the Mediterranean diet.
Table Olive in the Mediterranean diet

In particular in rural areas, it represented a substantial part of the diet, at least for some periods of the year, as it was eaten in substantial quantities at certain mealtimes, such as breakfast.

Olives were also the basic food in periods of religious fasting
Table
Olives in the Mediterranean Diet today

Table olives
Consumption of table olives in thousands tones (IOOC Nov. 2010)

<table>
<thead>
<tr>
<th>Countries</th>
<th>1990/91</th>
<th>1999/00</th>
<th>2009/10</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU</td>
<td>346,5</td>
<td>421,5</td>
<td>558,0</td>
</tr>
<tr>
<td>World</td>
<td>957,0</td>
<td>1241,5</td>
<td>2136,5</td>
</tr>
</tbody>
</table>
Table Olives: Types in the market

According to their degree of maturation and way of preparation the following types can be defined:

1. Natural

*Green olives in brine:* They are harvested before the fruit takes on the golden or reddish colour which marks the onset of ripening.

*Black olives in brine:* The fruit is harvested when fully ripe or slightly before. It may be a reddish or greenish black, or have purple or dark brown tones.

*Changing colour olives in brine:* Obtained from olives with a pink, claret or chestnut colour, harvested before they fully mature.

The 3 types above are placed in brine where debittering and fermentation occurs.

*Dry salted black olives (shrunk):* They are harvested black and may be shrunk from the tree and treated usually with dry salt or heating with prior brining or not.

*Black olives shrunk:* They are placed in brine and then dried by heating or any other proper technological process.
## Table Olives: Types in the market

### 2. Treated with alkali

*Green olives in brine:* They are harvested green, treated with an alkaline solution to be partially or totally de-bittered and then placed in brine where they undergo a total or partial lactic fermentation.

### 3. Blackened with oxidation

*Black oxidized in brine:* They are harvested green or changing colour, preserved in brine and blackened with oxidation in alkaline environment. They have to be preserved and transported in hermetically sealed containers (max 5 kg) thermally sterilized. Their color is uniform black or dark brown.
### Table Olives: Forms in the market

- **Whole** (with stone).
- **Pitted**

<table>
<thead>
<tr>
<th>Image</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Whole" /></td>
<td>Whole olives with stones.</td>
</tr>
<tr>
<td><img src="image" alt="Pitted" /></td>
<td>Pitted green olives.</td>
</tr>
</tbody>
</table>

**Stuffed**: These are pitted green olives stuffed with one or more ingredients. The filling normally comprises red pepper or anchovy.

**Speciality**: These are pitted green olives with a hand-made filling, using nuts such as almonds, hazelnuts and/or other ingredients including capers, onion and orange or lemon rind.

**Slices**: Pitted olives cut into slices across the middle.

**Olive Paste**
Diet and health

“Let food be your medicine and medicine be your food”, Hippocrates (460-377 B.C.)

- Humans for centuries have attributed to diet and foods a functional role in health. What is new, is the scientific evidence as well as the terminology.
Functional foods (terminology)

- The term **functional foods** was first introduced in Japan in the mid-1980s where there is a government approval process for functional foods called Foods for Specified Health Use (FOSHU).

- A **functional food** is similar to, or may be, a conventional food that is consumed as part of a usual diet, and is demonstrated to have physiological benefits and/or reduce the risk of chronic disease beyond basic nutritional functions, i.e. they contain bioactive compound.

- **Functional food** is also a food where a new ingredient(s) (or more of an existing ingredient) has been added to it and the new product has a new function (often related to health-promotion or disease prevention).
# Functional food components and their potential benefits

<table>
<thead>
<tr>
<th>Functional food components</th>
<th>Potential benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carotenoids</td>
<td>Neutralise free radicals which may cause damage to cells, reduce the risk of prostate cancer (lycopene)</td>
</tr>
<tr>
<td>Dietary fibre</td>
<td>Reduce risk of cardiovascular disease, Protect against heart disease and some cancers; lower LDL and total cholesterol, Reduce risk of breast or colon cancer</td>
</tr>
<tr>
<td>Fatty acids (ω3 - ω6)</td>
<td>Reduce risk of cardiovascular disease, Improve mental, visual functions</td>
</tr>
<tr>
<td>Phenolics</td>
<td>Neutralise free radicals; Reduce risk of cancer</td>
</tr>
<tr>
<td>Plant sterols</td>
<td>Lower blood cholesterol levels by inhibiting cholesterol absorption</td>
</tr>
<tr>
<td>Prebiotics/Probiotics</td>
<td>Improve quality of intestinal microflora; gastrointestinal health</td>
</tr>
<tr>
<td>Soy Phytoestrogens</td>
<td>Protect against heart disease and some cancers; lower LDL and total cholesterol, Menopause symptoms</td>
</tr>
</tbody>
</table>
Categories of functional foods

- **Basic Foods (containing a functional component)**
  - Carrots (containing the natural level of the anti-oxidant beta-carotene)
  - Processed foods - oat bran cereal (containing the natural level of beta-glucan)

- **Processed Foods with Added Ingredients**
  - Calcium-enriched fruit juice
  - Vitamin enriched foods

- **Foods enhanced to have more of a functional component (via traditional breeding, special livestock feeding or genetic engineering)**
  - Tomatoes with higher levels of lycopene (an antioxidant carotenoid)
  - Oat bran with higher levels of beta glucan
  - Eggs with omega-3 fatty acids

- **Fermented foods with live cultures that are considered functional foods.**
The functional food industry, consisting of food, beverage and supplement sectors, is one of the areas of the food industry that is experiencing fast growth in recent years.
Fermented table olives as a functional food

- Table olives are a highly nutritious food that provide essential fatty acids, fibre, vitamins and minerals.

- They contain a far higher proportion of unsaturated fatty acids, and in particular oleic acid

- The table olive is highly digestible, with a lignin/cellulose ratio of less than 0.5, making its fibre easy for the body to digest.

- It also has a notable mineral content, in particular calcium, iron, potassium, magnesium, phosphorus and iodine.

- They also contain polyphenols and flavonoids which have anti-inflammatory properties.
Table olives: Specific Nutritional Characteristics

Energy & Fibre:

Olives are mainly made up of water, with an energy content of around 150 Kcal per 100 g.

Black olives generally have fewer calories, some varieties containing only 79 kcal/100 g as opposed to green olives, which on average contain 150-177 Kcal/100g.

The fibre content of the table olive is around 2.6 g/100 g edible portion, which means that in accordance with labelling rules of EU Regulation 1924/2006, it may be deemed a Source of Fibre.

Table olives help towards meeting the RDA (Recommended Daily Amount) of fibre, which is 30 g.
Table olives: Specific Nutritional Characteristics

Fat*:

They contain a far higher proportion of unsaturated fatty acids, and in particular monounsaturated oleic acid.

- As for fat, the proportion is generally 20-30%.
- The most abundant fatty acid is oleic acid: 82%
- Followed by palmitic acid: 13%
- Linoleic (Omega-6): 5%
- Stearic: 3%
- Linolenic (Omega-3): 1%
- Palmitoleic: 1%.

*depending on the ripeness of the olive.
Table olives: Specific Nutritional Characteristics

- Olives also provide small quantities of carbohydrates (1%) and protein (0.8%).
- 25 g of olives (7 olives) provide approximately 0.28 g of sodium.
- They also contain a small proportion of other minerals, such as calcium, potassium, magnesium, iron, phosphorus and iodine.
- Black olives contain less salt and more iron.
- As for vitamins, table olives provide liposoluble vitamins of group B such as provitamin A and vitamins E & C, having an antioxidant effect.
- They also contain polyphenols and flavonoids which have anti-inflammatory properties.
### Nutritional Composition

[Average for Green Olive and Black Olive (100 g edible portion)]

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Average Green Olive</th>
<th>Average Black Olive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (kcal)</td>
<td>154</td>
<td>143</td>
</tr>
<tr>
<td>Protein (g.)</td>
<td>1.1</td>
<td>0.6</td>
</tr>
<tr>
<td>Carbohydrates (g.)</td>
<td>0</td>
<td>0.075</td>
</tr>
<tr>
<td>Total Fat (g.)</td>
<td>16.3</td>
<td>15.4</td>
</tr>
<tr>
<td>Saturated Fat (g.)</td>
<td>3.23</td>
<td>2.7</td>
</tr>
<tr>
<td>Monounsaturated Fat (g.)</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Polyunsaturated Fat (g.)</td>
<td>1.4</td>
<td>0.85</td>
</tr>
<tr>
<td>Cholesterol (g.)</td>
<td>0.2</td>
<td>0.25</td>
</tr>
<tr>
<td>Fibre (g.)</td>
<td>2.6</td>
<td>2.6</td>
</tr>
<tr>
<td>Sodium (g.)</td>
<td>1.5</td>
<td>0.77</td>
</tr>
<tr>
<td>Vitamin A (Retinol)</td>
<td>6 (% RDA)</td>
<td>4 (% RDA)</td>
</tr>
<tr>
<td>Vitamin E (Tocopherol)</td>
<td>33 (% RDA)</td>
<td>35.75 (% RDA)</td>
</tr>
<tr>
<td>Vitamin C (Ascorbic Acid)</td>
<td>6.7 (% RDA)</td>
<td>6 (% RDA)</td>
</tr>
<tr>
<td>Calcium</td>
<td>6 (% RDA)</td>
<td>6.5 (% RDA)</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>1 (% RDA)</td>
<td>1 (% RDA)</td>
</tr>
<tr>
<td>Iron</td>
<td>4 (% RDA)</td>
<td>45.5 (% RDA)</td>
</tr>
<tr>
<td>Magnesium</td>
<td>4.3 (% RDA)</td>
<td>2.5 (% RDA)</td>
</tr>
<tr>
<td>Zinc</td>
<td>1.6 (% RDA)</td>
<td>2 (% RDA)</td>
</tr>
</tbody>
</table>

Seville Fat Institute. Advanced Scientific Research Council (Green and Black Olive).
## Antioxidant potential of table olives compared to other fruits

Table 2: Ferric reducing-antioxidant power (FRAP), total radical-trapping antioxidant parameter (TRAP) and Trolox equivalent antioxidant capacity (TEAC) of fruit extracts.

<table>
<thead>
<tr>
<th>Fruit</th>
<th>FRAP Value (mmol Fe²⁺/kg FW)</th>
<th>FRAP Rank</th>
<th>TRAP Value (mmol Trolox/kg FW)</th>
<th>TRAP Rank</th>
<th>TEAC Value (mmol Trolox/kg FW)</th>
<th>TEAC Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple (red Delicious)</td>
<td>3.84</td>
<td>24</td>
<td>2.23</td>
<td>20</td>
<td>1.59</td>
<td>22</td>
</tr>
<tr>
<td>Apple (yellow Golden)</td>
<td>3.23</td>
<td>26</td>
<td>1.54</td>
<td>24</td>
<td>1.31</td>
<td>25</td>
</tr>
<tr>
<td>Apricot</td>
<td>4.02</td>
<td>23</td>
<td>2.29</td>
<td>19</td>
<td>1.44</td>
<td>24</td>
</tr>
<tr>
<td>Banana</td>
<td>2.28</td>
<td>28</td>
<td>1.05</td>
<td>27</td>
<td>0.64</td>
<td>30</td>
</tr>
<tr>
<td>Blackberry</td>
<td>51.53</td>
<td>1</td>
<td>21.01</td>
<td>1</td>
<td>20.24</td>
<td>1</td>
</tr>
<tr>
<td>Blueberry</td>
<td>18.61</td>
<td>9</td>
<td>9.30</td>
<td>7</td>
<td>7.43</td>
<td>10</td>
</tr>
<tr>
<td>Cherry</td>
<td>8.10</td>
<td>16</td>
<td>4.17</td>
<td>12</td>
<td>2.69</td>
<td>16</td>
</tr>
<tr>
<td>Clementine</td>
<td>8.88</td>
<td>15</td>
<td>2.74</td>
<td>16</td>
<td>3.10</td>
<td>14</td>
</tr>
<tr>
<td>Fig</td>
<td>5.82</td>
<td>20</td>
<td>2.06</td>
<td>21</td>
<td>2.47</td>
<td>18</td>
</tr>
<tr>
<td>Grape (black)</td>
<td>11.09</td>
<td>12</td>
<td>2.50</td>
<td>17</td>
<td>3.85</td>
<td>13</td>
</tr>
<tr>
<td>Grape (white)</td>
<td>3.25</td>
<td>25</td>
<td>1.59</td>
<td>23</td>
<td>2.48</td>
<td>17</td>
</tr>
<tr>
<td>Grapefruit (yellow)</td>
<td>10.20</td>
<td>13</td>
<td>4.04</td>
<td>13</td>
<td>3.05</td>
<td>15</td>
</tr>
<tr>
<td>Kiwi fruit</td>
<td>7.41</td>
<td>17</td>
<td>2.30</td>
<td>18</td>
<td>2.28</td>
<td>19</td>
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<tr>
<td>Loquat</td>
<td>2.70</td>
<td>27</td>
<td>1.73</td>
<td>22</td>
<td>0.75</td>
<td>27</td>
</tr>
<tr>
<td>Melon (cantaloupe)</td>
<td>5.73</td>
<td>21</td>
<td>0.95</td>
<td>28</td>
<td>1.20</td>
<td>26</td>
</tr>
<tr>
<td>Melon (honeydew)</td>
<td>2.27</td>
<td>29</td>
<td>1.12</td>
<td>26</td>
<td>0.65</td>
<td>29</td>
</tr>
<tr>
<td>Olive (black)</td>
<td>39.99</td>
<td>4</td>
<td>18.08</td>
<td>2</td>
<td>14.73</td>
<td>3</td>
</tr>
<tr>
<td>Olive (green)</td>
<td>24.59</td>
<td>6</td>
<td>14.64</td>
<td>3</td>
<td>10.43</td>
<td>7</td>
</tr>
<tr>
<td>Orange</td>
<td>20.50</td>
<td>8</td>
<td>5.65</td>
<td>11</td>
<td>8.74</td>
<td>9</td>
</tr>
<tr>
<td>Peach (yellow)</td>
<td>6.57</td>
<td>19</td>
<td>1.49</td>
<td>25</td>
<td>1.67</td>
<td>21</td>
</tr>
<tr>
<td>Pear</td>
<td>3.00</td>
<td>22</td>
<td>3.87</td>
<td>14</td>
<td>2.19</td>
<td>20</td>
</tr>
<tr>
<td>Pineapple</td>
<td>15.73</td>
<td>10</td>
<td>5.92</td>
<td>10</td>
<td>9.91</td>
<td>8</td>
</tr>
<tr>
<td>Plum (red)</td>
<td>12.79</td>
<td>11</td>
<td>8.09</td>
<td>9</td>
<td>5.11</td>
<td>11</td>
</tr>
<tr>
<td>Prickly pear</td>
<td>6.97</td>
<td>18</td>
<td>2.06</td>
<td>21</td>
<td>1.46</td>
<td>23</td>
</tr>
<tr>
<td>Raspberry</td>
<td>43.03</td>
<td>3</td>
<td>10.48</td>
<td>5</td>
<td>16.79</td>
<td>2</td>
</tr>
<tr>
<td>Redcurrant</td>
<td>44.86</td>
<td>2</td>
<td>12.14</td>
<td>4</td>
<td>14.05</td>
<td>4</td>
</tr>
<tr>
<td>Strawberry (cultivated)</td>
<td>22.74</td>
<td>7</td>
<td>8.56</td>
<td>8</td>
<td>10.94</td>
<td>6</td>
</tr>
<tr>
<td>Strawberry (wild)</td>
<td>28.00</td>
<td>5</td>
<td>10.34</td>
<td>6</td>
<td>11.34</td>
<td>5</td>
</tr>
<tr>
<td>Tangerine</td>
<td>9.60</td>
<td>14</td>
<td>2.76</td>
<td>15</td>
<td>4.16</td>
<td>12</td>
</tr>
<tr>
<td>Watermelon</td>
<td>1.13</td>
<td>30</td>
<td>0.46</td>
<td>29</td>
<td>0.69</td>
<td>28</td>
</tr>
</tbody>
</table>
Concentration of polyphenols in Greek table olives varieties*

*Concentration of polyphenols (mg gallic acid/g olive) in natural Black olives, Green olives, and Dry salted (Thassos) olives.

*Panagou et al. (unpublished data)
Antioxidant potential of Greek table olives varieties*

Method FRAP (Ferric Reducing Antioxidant Power)  
*Panagou et al. (unpublished data)
Health benefits of table olives

The combination of these health elements allows olives to:

- **Protect the heart against diseases.** Antioxidants and the “good fat” eradicate the free radicals that are responsible in oxidizing cholesterol.

- **Protect cells from free radicals.** Vitamin E together with the monounsaturated fat protects cells and fights off free radicals produced during cellular energy production.

- **Reduce inflammation due to arthritis.** Both green and black olives contain polyphenols and flavonoids that have anti-inflammatory properties. These can help in lowering the inflammation caused by arthritis.

- **Prevent colon cancer.** The combination of monounsaturated fat and Vitamin E is make it a great health benefit. High intake of these nutrients lowers the risk for colon cancer.

- **Reduce menopause symptoms.** Olives can help reduce the intensity and frequency of menopausal symptoms for women.
Daily recommendation

The daily recommendation for a healthy adult is around 25 g of olives per day, or about 7 olives.

175 g / week 49 olives / week
25 g / day 7 olives per day

This quantity could be reduced in the case of overweight or high blood pressure, or increased if energy and mineral demands are higher, as in the case of athletes.
Probiotics are live microorganisms thought to be beneficial to the host organism.

According to the definition by FAO/WHO probiotics are: "Live microorganisms which when administered in adequate amounts confer a health benefit to the host".

Lactic acid bacteria (LAB) and bifidobacteria are the most common types of microbes used as probiotics; but certain yeasts and bacilli may also be helpful.

Probiotics are commonly consumed as part of fermented foods with specially added active live cultures; such as in yogurt, or as dietary supplements.
Health benefits from probiotics

✓ Intake of probiotics stimulates the growth of beneficial microorganisms, reduces the amount of pathogens and can help boost the immune system (lowering thus the risk of gastro-intestinal diseases).

✓ To deliver the health benefits, probiotics need to contain an adequate amount of live bacteria (at least $10^6$-$10^7$ cfu/g)
Mode of action of probiotics

**Probiotic Benefits**

ACIDOPHILUS AND OTHER PROBIOTIC BACTERIA SECRETE:
ANTIVIRAL ANTIBACTERIAL AND ANTIFUNGAL CHEMICALS.

PROBIOTICS FORM A PHYSICAL BARRIER TO HINDER INVASION OF BACTERIA AND YEASTS

PROBIOTICS LIKE ACIDOPHILUS CREATE AN ACIDIC MICROENVIRONMENT WHICH PROMOTES IRON AND OTHER MINERAL ABSORPTION.
Health benefits from probiotics

The role of probiotics in the prevention of food allergies and intolerances has been also reported.

Probiotic bacteria can also help relieve the symptoms of:

- inflammatory bowel diseases,
- irritable bowel syndrome,
- colitis, alcoholic liver disease,
- constipation

and reduce the risk for colon, liver and breast cancers.
Probiotic foods as functional foods

- Most probiotic bacteria are lactic acid bacteria and, among them, lactobacilli represent certainly one of the fundamental microbial groups.

- They have been introduced in a wide range of food products. Many studies have reported that the best matrices to deliver probiotics are dairy fermented products such as fermented milks and yogurt.

- However, it has been found that traditional fermented foods may constitute a good working base for the development of probiotic-type of functional foods.
The EU funded project: Research for the benefit of SMEs

The idea:
“to offer to SME associations the possibility to fund the research institutions for the benefit of their members”

“PROBIOLIVES”
Table olive fermentation with selected strains of probiotic lactic acid bacteria. Towards a new functional food.

FP7-SME-2008-2-243471
Duration 3 years (1/3/10 – 28/2/13)
Total budget: 2 MEuros
The consortium

**NAGREF - ITAP:** National Agricultural Research Foundation - Institute of Technology of Agricultural products ([www.nagref.gr](http://www.nagref.gr), [www.itap-nagref.gr](http://www.itap-nagref.gr))

**PEMETE:** Panhellenic association of Table Olives Processors, Packers and Exporters ([www.pemete.gr](http://www.pemete.gr))

**OLYMPS:** Konstantopoulos S.A., 3rd klm. Katerini-Larissa, Pieria, ([www.konstolymp.gr](http://www.konstolymp.gr))

**AUA:** Agricultural University of Athens ([www.aua.gr](http://www.aua.gr)), Food Science & Technology Dept., Lab. of Microbiology & Biotechnology
The consortium

**ASEMESA**: Association of Producers and Exporters of Table Olives, Spain, [www.asemesa.es](http://www.asemesa.es),

**JOLCA, S.A.**: Autovía Sevilla-Huelva 22,5 km, [www.jolca.es](http://www.jolca.es)

**CSIC**: Instituto de la Grasa (Consejo Superior de Investig. Científicas), Madrid 28006, Spain, [www.csic.es](http://www.csic.es),
The consortium

**APABI:** Associação de Produtores de Azeite da Beira Interior, Portugal, [www.apabi.pt](http://www.apabi.pt),

**PROBEIRA:** Produtos Alimentares da Beira Lda., Portugal

**INRB:** Instituto Nacional de Recursos Biológicos (INRB)/L-INIA [www.inrb.min-agricultura.pt](http://www.inrb.min-agricultura.pt), in cooperation with Instituto de Tecnologia Química e Biológica/ITQB [www.itqb.unl.pt](http://www.itqb.unl.pt)
The consortium

**AIFO**: Associazione Frantoiani Oleari Italiani, Roma, Italy, [http://www.associazionefrantoiani.it/](http://www.associazionefrantoiani.it/)

**AZAGAP**: Azienda Agricola Arcoria Pietro, Gravina di Catania, Italy, aarcobio@hotmail.it

**UNITO**: University of Turin, Italy, Torino [http://www.divapra.unito.it](http://www.divapra.unito.it)

**INSAT**: Institut National des Sciences Appliquées et de Technologie, Tunis [http://www.insat.rnu.tn](http://www.insat.rnu.tn)
Project's workplan

WP1 Project Management

WP2 Isolation & characterization of probiotic LAB as starter cultures in olive fermentation

WP3 Application of the selected probiotic LAB in small scale controlled fermentations

WP4 Evaluation of shelf life of the final product under different Storage conditions

WP5 Modelling the fermentation kinetic and survival during storage of the probiotic LAB

WP6 Risk assessment and Predictive Modelling of potential pathogenic bacteria on the final product

WP7 Consumers acceptance studies

WP8 Test Field

WP9 Exploitation Dissemination & Training
Table olives fermented with probiotic bacteria from olive microbiota.
The project is running its 2nd year. A great number of lactic acid bacteria has been isolated from different cultivars in Greece, Spain, Portugal, Italy and Tunisia.

The tests that have been performed in vitro for their probiotic potential have indicated that certain lactic acid bacteria have shown probiotic properties.

The most promising ones have been used as starters in olive fermentations in each participating country. The fermentations have been monitored successfully with microbiological and physicochemical analyses performed at regular intervals. (2 patents have been applied in Spain & Greece).

Molecular techniques have also been used to detect the survival rate of the potential probiotic strains in the final fermented product. Packaging and safety studies are also in progress.
For more information visit the website: http://www.probiolives.eu
Thank you