Olive oil may have to be stored for many months. If specific precautions against deterioration are not taken, this will cause an increase of acidity due to the action of lipases and the development of rancidity.

Tanks or drums for storage should be constructed of material which is impermeable to oil. The interior should be inert so that clearing can be done easily and absorption of odors or other substances (e.g. trace metals), which accelerate oxidation, is prevented. The oil should be protected from air, light, and fluctuation of temperature above 15ºC. Normally the oil should be kept indoors. If, however, the tanks are stored outdoors, they should be coated with an external lining to prevent extreme changes in temperature.

Stainless steel containers are considered ideal for storing. They have a cone shaped bottom to purge sediments periodically. Nitrogen may be added to the air space. Metallic drums can have a significant negative effect on flavor quality and promote deterioration if not lined with epoxy resins. The storage of olive oil in an iron tank and a polyester-glass fiber (PGF) tank was studied by Perez-Cerezal et al. (1977). Measurements of peroxide values, spectrophotometric constants, and organoleptic evaluation after 10 months showed a significantly more rapid deterioration in the quality of oil stored in the iron container.

Packaging

Packing can be designed with the objective to obtain better oxidation stability and to ensure adequate shelf life. Three factors are important for choosing packing materials: impermeability to fat, impermeability to gases, and protection from light. Materials used for bottling and packing of olive oil are plastic, glass, (especially tinted glass), tin plates, ceramics, and plastic-coated cardboard. Tin plates are not transparent and they have excellent impermeability properties. These containers are also resistant to damages from handling and suitable for lithographic labeling. Glass is an inert material and glass bottles are resistant to gas permeation, but their protective effect against
light may vary. Consumers usually prefer transparent glass because the oil is visible, but this is not scientifically advisable since photo-oxidation takes place easily in transparent glass. Green bottles protect oil from light rays in the range 300-500nm. Big glass containers (demijohns) should be covered outside.

Polivinylchloride (PVC) is impermeable to fats and gases, but its ability to protect from light is moderate. Other polymeric materials such as polypropylene (PP) and polyethylene (PE) have average characteristics. Polyethylene terephthalate (PET) is considered to be a better plastic material than PVC, PP, and PE because of its good barrier properties and also its mechanical qualities. The properties of various types of containers used in olive oil were studied by Gutierrez Gonzalez-Quijano and Olias Jimenez (1970). They compared samples stored in tin plates, glass, PVC, and polyethylene bottles in darkness and light at 28-30°C. Spoilage times, as indicated by an increase of peroxide value above acceptable limits, were: polyethylene in light 9-20 days, in dark 120-190 days, all in other packs 225 days. Kiritsakis and Hernandez (1998) have discussed the drawbacks of plastics in relation to migration of oxygen, migration of constituents of the packaging material into the oil, as well as the absorption of the different constituents of the oil by the plastic packaging material (scalping). Mendez and Falque (2002) studied the influence of the container on the quality of commercial mixtures of refined olive mark (orujo) oils with virgin olive oil. They compared plastic containers, glass, tin plate, and carton. The evolution of peroxide values was found to be more rapid in plastic and glass containers and slower in opaque plastic, tin plate, and carton containers. In a recent report, Del Nobile and his collaborators (2003) studied the properties of traditional plastic containers and two innovative materials containing an oxygen scavenger. Their measurements showed that a slower rate of quality decline can be obtained by using an oxygen scavenger or by reducing the concentration of oxygen dissolved in the oil prior to bottling.

The shelf life of extra virgin olive oil stored for 12 months in packages with different oxygen barrier properties was studied by Gambacorta et al. (2004). Five different materials were tested: polyethylene terephthalate (PET), PET containing 1% oxygen barrier, PET containing 3% oxygen barrier, PET coated with high barrier resin containing an oxygen scavenger, and glass (used as a control). Containers having high oxygen barrier properties, (PETC, PET) maintained the initial quality parameters practically unchanged, both at room temperature and at 37°C. High values of the (E)-2-hexenal to hexanal ratio and organoleptic examination indicated only minimum changes and absence of off-flavors.

Psomiadou and Tsimidou (2002) studied the photooxidation of virgin olive oil and the changes in pheophytin, alpha-tocopherol, squalene, and total polar phenols content. They concluded that to preserve the precious characteristics of the oil, it is necessary to change practices of bottling and use dark glass bottles or paper bags as much as possible. If transparent glass bottles are used, these should be protected from light in carton boxes. Factors influencing the shelf life of packaged olive oil were also
studied by Coutelieris and Kanavouras (2005), who used the activation energy concept to estimate reduction of quality of packaged olive oil.

If properly stored in a dark place and a temperature below 15°C, the shelf life of olive oil can be extended to almost 2 years, especially when the container remains unopened. Even 20°C may work well, provided there are no big fluctuations. The ideal spot would be a cabinet far from the stove, like a wine cellar, where the temperature is low and it is dark. Storing in a refrigerator may extend the life of certain grades without any serious harm in the quality. The oil becomes cloudy but when warmed at room temperature it easily returns in its original form. Of course, such practices should be avoided in the case of expensive extra virgin olive oils intended for gourmet palates.

**Defects Due to Bad Storing**

Rancidity (heat, time, light)
Metallic-plastic (depending on the container)
Dirty (no proper removal of sediment)
Putrid (long period of storage)

**International Olive Oil Council Standards**

According to International Olive Oil Council trade standards (IOOC, COI / T 15/NC no 3/1,2003) olive oil and olive pomace oil intended for trade shall be packed in containers which comply with basic principles of food hygiene recommended by the Codex Alimentarius Commission (CAC/RP 1-1969, Rev.3 -1997). These containers may be:

- Tanks, containers, vats, which permit transportation in bulk of olive oils and olive-pomace oils.
- Metal drums, in good condition, hermetically-sealed, which should be internally covered with a suitable varnish.
- Metal tins and cans, lithographed, new, hermetically-sealed, which should be internally covered with a suitable varnish.
- Demi-johns, glass bottles or bottles made of suitable macromolecular material.

**Container Filling Tolerance**

The volume occupied by the contents shall under no circumstances be less than 90% of the capacity of the container, except in the case of tin containers with a capacity of, or less than, 1 L in which the volume occupied shall under no circumstances be less than 80% of the capacity of the container; this capacity is equal to the volume of distilled water at 20°C which the container can hold when full.
Container Labeling

In addition to sections 2, 3, 7, and 8 of the Codex General Standard for the Labeling of Prepacked Foods (CODEX STAN 1-1985, Rev.1-1991) and the guidelines applying to food not intended for direct sale to consumers, the specific provisions providing the filling information shall be applied:

1. On Containers Intended for Direct Sale to Consumers

1.1 Name of the product
   The labeling on each container shall indicate the specific designation of the product contained, complying in every way with the relevant provision of this standard.

1.1.1 Designation of olive oils:
   Extra virgin olive oil
   Virgin olive oil
   Ordinary virgin olive oil1
   Refined olive oil1
   Olive oil2

1.1.2 Designation of olive-pomace

   Refined olive-pomace oil1
   Olive-pomace oil2

1 This product may only be sold direct to the consumer if permitted in the country of retail sale.
2 The country of retail sale may require a more specific designation.

1.2 Net contents
   The net contents shall be declared by volume in the metric system (“System International” units)

1.3 Name and address
   The name and address of the manufacturer, packer, distributor, importer, exporter, or seller shall be declared.

1.4 Country of origin
   The name of the country of origin shall be declared. When the product undergoes substantial processing in a second country, the country in which such processing is carried out shall be considered as the country of origin for labeling purposes.

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1.5 Indication of source and appellation of origin.

1.5.1 Indication of source
The labels of virgin olive oil may indicate their source (country, region, or locality) when they have been empowered to do so by their country of origin and when such virgin olive oils have been produced, packed, and originate exclusively in the country, region, or locality mentioned.

1.5.2 Appellations of origin
The labels of extra virgin olive oil may indicate their appellation of origin (country, region, or locality) when they have been awarded such an appellation in accordance with the terms provided under the regulation of their country of origin and when such extra virgin olive oil has been produced, packed, and originates exclusively in the country, region, or locality mentioned.

1.6 Lot identification
Each container shall be embossed or otherwise permanently marked in code or in clear to identify the producing factory and the lot.

1.7 Date marking and storage conditions

1.7.1 Date of minimum durability
In the case of pre-packaged products intended for the end consumer, the date of minimum durability (preceded by the words “best before end”) shall be declared by the month and year in uncoded numerical sequence. The month may be indicated by letters in those countries where such use will not confuse the consumer; if the shelf life of the product is valid to December, the expression “end (stated year)” may be used as an alternative.

1.7.2 Storage instructions
Any special conditions for storage shall be declared on the label if the validity of the date of minimum durability depends thereon.

2. On Forwarding Packs of Oils Intended for Human Consumption
In addition to the details noted under section 1., the following inscription shall appear:
-number and type of containers held in pack.
3. On Containers Allowing the Transportation in Bulk of Olive Oils and Olive-pomace Oils

The labeling on each container shall include:

3.1 Name of the product.
The name shall indicate the specific designation of the product contained, complying in every way with the provisions of this standard.

3.2 Net contents
The net contents shall be declared by weight or volume in the metric system (System International units).

3.3 Name and address
The name and address of the manufacturer, distributor or exporter shall be declared.

3.4 Country of origin
The name of the exporting country shall be declared.

Figure 11.1
Storage and Packing

Nutrition Labeling

A model for nutritional labeling of packed oils based on existing Food and Drug Administration nutritional labeling rules is given in Figure 11.1.

Cloudy and Unfiltered Olive Oil

Virgin olive oil is produced in a form of emulsion-dispersion, which can persist for several months before full deposition of a residue. Small quantities of cloudy (veiled) oil (the fresh olive juice) are sold to consumers who consider this type more "green," not over-processed, and richer in flavor. Many chefs also prefer this natural slight cloudiness in salads or in gourmet dishes. The oil is usually sold in bulk to the consumers directly from the mills, but it is also available in bottles. Unfiltered oils are virgin olive oils not filtered through filter paper or diatomaceous earth, but bottled only after settling. There are many firms specializing in the trade of packed unfiltered raw olive oil with varying flavoring characteristics (e.g. sweet and fruity, peppery etc.), but the usual practice is with oils of early harvest from green olives. Very often the oils are advertised as "stone made" or "cold pressed" to emphasize that a traditional process has been used. The term "cold pressed" means that the temperature during the production is kept at 35°C. The product is considered ideal for use in tavernas, restaurants, and other "fine-eating" establishments.

Freshly pressed extra virgin oil has been recently found to contain oleocanthal, a tyrosol derivative (see chapter "Polar Phenolic Compounds"). This compound has the same pharmacological properties as the drug Ibuprofen, a nonsteroidal anti-inflammatory compound and this is attributed to some structural similarities. The presence of oleocanthal is also related to the stinging sensation in the back of the throat ("a throaty bite"). This finding adds to the healthful effects of the Mediterranean diet and olive oil, especially of the freshly prepared virgin olive oil.

Veiled oils were found to have longer induction periods compared to filtered ones (Lercker et al., 1994). It appears that the material in suspension-dispersion that "veils" the oil plays a significant role against oxidation, although there is little evidence concerning the chemical nature of the compounds participating in the stable dispersion system. In a recent report Tsimidou et al. (2005) found a higher total phenolic compounds content in veiled oils in relation to the filtered and this may partly explain the higher stability.

One other possible explanation might be the presence of emulsifiers. There are compounds in the oil which may act as tensioactive solutes, e.g. traces of phosphatides or partial glycerides (Kiosseoglou and Kouzounas, 1993). Bianco and his co-workers (1998) identified two galactosyl glycosides in freshly produced oils, the a-1,6 digalactosyl derivative of the 1,2 diglyceride of linolenic acid and the a-1,6 digalactosyl derivative of the glycerol linolate-oleate diester. The physicochemical characteristics of such compounds and the stable emulsions formed may allow an increase in the
transfer of hydrophilic compounds, such as phenols, which are strong antioxidants. It has also been suggested that small quantities of proteins may contribute to the higher oxidative stability of unfiltered olive oil (Zamora et al., 2001). There is a discrepancy in the literature concerning the level of proteins and values varying from 0.1 to 400 mg / Kg have been reported (Georgalaki, 1998, Hidalgo, 2002). In a recent report (Koidis and Boskou 2005) it was demonstrated that the level of proteins in cloudy olive oil is very low, not exceeding 2.5 mg/ Kg oil. This indicates that a significant antioxidant activity cannot be expected from proteins in the presence of strong antioxidants (α-tocopherol, o-diophenols) at much higher concentrations.

A lipoxygenase activity has been detected in freshly prepared olive oil (Georgalaki et al., 1998). In spite of the presence of a small quantity of water in the non-filtered oils (a favorable condition for an enzymic activity), these oils have higher oxidative stabilities. It can be postulated that the polar phenolic compounds present not only act as primary antioxidants, but also as inhibitors of oxidizing enzymes.

References


