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Characteristics of the Olive Tree and Olive Fruit

Dimitrios Boskou
Laboratory of Food Chemistry and Technology School of Chemistry, Aristotle University of Thessaloniki University Campus, Thessaloniki, 54124, Hellas, Greece Tel. 0030 3210 997791 Fax 0030 2310 997779

History of the Olive Tree

Olive is the common name for about 35 species of evergreen shrubs and trees of the genus *Olea* in the olive family, the *Oleaceae,* native to tropical and warm temperate regions. The name is especially used for *Olea Europaea*, the well-known olive which is grown for its edible fruits.

Olive trees are native to Greece, Italy, Palestine, and Syria, but different species are native to different areas. It is believed that cultivation of olives started around the fourth millennium B.C. in the area which is today Syria and Palestine. The inhabitants of Crete during the Minoan civilization cultivated olives as early as 2500 B.C. Pottery items such as jars found in Knossos Palace were probably intended for storing olive oil.

The botanical origin of the tree and the beginning of its cultivation have been a subject of dispute (Anon, 1983, Loukas and Krimbas, 1983, Blazquez,1996). Archeologists tend to believe that the transformation to the cultivated tree should be placed in the early Bronze Age. During this period management of olive populations consisting of intentional and selective pruning have been probably applied by man to rejuvenate olive tree in order to favor flowering and fruit production.

From the 35 known species of the genus *olea* the one that is considered to be the ancestor of olive oil is *O. Chrysophylla*, found in Asia and Africa. There is, however, another theory according to which the progenitor is the Mediterranean wild olive, *olea oleaster* (Loukas and Krimbas, 1983). Others consider *olea oleaster* as an intermediate in the development from the wild olive tree *olea chrysophylla* to *olea europaea* (Blazquez,1996, Lavee,1996).

The spread of the olive tree to western places is due to Phoenicians who traded with other maritime centers. From the sixteenth century B.C., the tree began to reach the Greek islands and also Libya and Carthage. The Greeks extended olive farming and spread it through their colonies and routes taken by their seamen. The island of Samos was called "Elaeophytos," which means "planted with olives." The first significant improvement of olive cultivation and a better organization occurred in the seventh century B.C. (Fiorino and Nizzi Griffi, 1992).

Later, the Romans discovered olive trees through their contacts with the Greek colonies in Italy. Although they were not admirers of olives and olive oil, the Romans expanded the tree throughout the huge empire. They used olive oil in their baths and as a fuel, but, for edible purposes, they considered it as a commodity of moderate quality. The rise of the Roman Empire and the conquest of Greece, Asia Minor, and Egypt increased the trading channels around the Mediterranean Sea and olive oil became far more important, not only as a staple food, but also as a pharmaceutical and a source of energy (Chazau-Gilling, 1994).

Expansion of olive growing continued until the fifth century A.D. and revived again when maritime cities began to grow. Between the twelfth and sixteenth century A.D., an impressive advance of olive oil orchards was observed in Italy (Fiorino and Nizzi-Griffi, 1992).

When America was discovered, missionaries and early settlers introduced wine and olive trees to the New World. Wine spread everywhere, but olive trees were cultivated only in restricted areas in Chile, Argentina, and California.

During the nineteenth century, olive farming reached a peak because lighting was still based on fatty substances, and oil seeds were not known enough to be exploited as sources of edible oils as they are today. The cultivation of the olive tree has now been extended to many regions of the world where climatic and other conditions are as favorable as those prevailing in the Mediterranean countries.

Until the advent of present-day propagation and cultivation techniques, olive trees usually began to crop after their eighth year. They could live to an age of several centuries and there are claims that olive trees exist with an age of more than one thousand years. One explanation for this longevity is its characteristic ability to send out shoots and roots from temporary buds which are abundant at the lower part of the trunk. The root system of the tree tends to spread horizontally rather than downwards. The tree is resistant to adverse conditions and adapts to all kinds of soils (even poor soils that cannot be used for other crops). It can sprout even if the part above the soil is seriously wounded. It can also tolerate dryness and lack of treatment better than most other fruit trees.

The olive tree is a broad evergreen tree. Depending on the subspecies and environmental conditions, its height may vary from 3 to 20 meters. The cost of modern cultivation and harvesting has made low shapes (4-5 meters in height) very popular to farmers in many olive-producing countries.

The trunk of the young tree is smooth with a green color, but later it becomes uneven and tends to twine and often hollow with the passing of time. The bark, greenish-gray in young trees, becomes dark gray as the tree grows older. The flowers are small, yellow-white, and appear in erect clusters. The leaves are narrow, lanceloate, leatherish, and persistent (they stay on the tree for 3 years). Their color is green above and silky white beneath.

The olive is widespread in many arid and semi-arid regions. It is traditionally dry-farmed but it can benefit from irrigation. In the Mediterranean area, climate conditions are favorable because rainfalls are frequent in the period from autumn to early spring. Thus, luck of humidity during the period of flower cluster formation is not normally observed. However, in dry years watering before blossoming is needed.

The olive tree has some tolerance to saline water. Researchers are experimenting with various cultivars to study the genotype response to sodium chloride salinity (Therios and Misopolinos, 1988) or to explore the potential use of brackish water for crop production (Briccoli et al,1994).

The cultivation of the olive tree is heterogenous and varietal uniformity, even within restricted areas, is sometimes lacking. Thus, it is not always easy to develop cultural techniques to regulate production and quality of orchard harvests.

Normally the olive tree is very resistant to unfavorable conditions, but it is also a demanding crop if it is to produce well. Therefore, a suitable environment and proper cultural care (irrigation, control of harvesting, good nutritional conditions, pruning, and pest control) are necessary for the full development of the agronomic characteristics of the tree. Besides cultural care, other measures suggested to ensure a more steady fruit production are identity of cultivars (Sweeney, 2003) and pollinators. New cultivars can be used which have a reduced biennial bearing. Pollinators are suggested when the chief variety is incompatible or when an orchard is set up with a cultivar not widespread in the area. Foliar fertilization has also been tested as a means to encourage shoot growth, reduce alternate bearing and increase plant production (Cimato, 1994, Inglese, 2002, Connell, 2002). Recently, deficit irrigation strategies have been proposed in order to save water without reducing yields or modifying unfavorably color characteristics and phenolic composition (Fontanazza, 1996, Romero, 2002, Alegre, 2002).

Due to modern techniques of propagation and cultivation today's olive trees usually begin to crop after the 3rd year. Full productivity is developed between 11th and 12th year in dry groves and 7th and 8th year in irrigated groves (Fontanazza, 1996).

The oils produced in Tunisia often have a linoleic acid content higher than the level suggested in the olive oil norms and the European Union Regulations. To overcome this problem a lot of research work has been carried out (Fourati et al, 2002, Kamoun et al, 2002, Khlif et al., 2002) for better identification of varieties, cloning and genetic amelioration by crossing. Such techniques are expected to result in better chemical characteristics of the produced oil (less linoleic acid, better stability, higher phenolics content). Crossbreeding has also been applied in China for the creation of cultivars better adapted to local conditions (Fontanazza, 1996).

Varieties

The olive tree has many varieties which exhibit major or minor phenotypical and genetic differences. Today, most of the differences in size, color, oil content, fatty acid composition, and other properties have been recorded in the main olive growing countries. The most important varieties have been discussed by Fontanazza (1996).

Some of them are only of local interest, others are more widely distributed. The same olive cultivars can be used for table olives and oil production but generally olives for oil production have a lower pulp to kernel ratio (4:1-7:1) in relation to the same ratio of olives for the preparation of table olives (7:1-10:1). As emphasized by Essadki and Ouazzani (2003), the task of identifying and classifying olive varieties is very complex.

The Olive Fruit. The fruit of the Olea europea is an oval-shaped drupe. It consists of a pericarp and endocarp (kernel, pit). It weighs from 2-12 g, although some varieties may weigh as much as 20g. The pericarp has two parts: the epicarp (skin) and the mesocarp (flesh, pulp) which accounts for about 65-83% of the total weight. The endocarp (kernel pit) may vary from 13% to 30%. The epicarp is covered with wax and turns from light green to black as the fruit ripens.

The fruit contains water (up to 70%) which is called “vegetable” water. The average chemical composition of the olive fruit is: water, 50%; protein, 1.6%; oil 22%; carbohydrates, 19%; cellulose, 5.8%; minerals (ash) 1.5%. Other important constituents are pectins, organic acids, pigments, and glycosides of phenols. Some of the components or their hydrolysis products are found in the vegetable water which is squeezed with the oil during processing and is separated by centrifugation.

Fruit weight increases in various phases until October or mid-November. Then, it begins to decrease, basically through loss of moisture. As a result, a rise in oil content is observed, usually from October to December. The oil accumulation starts in the period from late July to beginning of August. Through the autumn and winter, the fruit becomes black and the oil content reaches its maximum. Oil is mainly concentrated in the pericarp (96-98%). The formation and concentration of oil in the drupe, a rich reservoir of many classes of lipids, is possibly the reason why the oil has a unique flavor and fragrance.

The maturation of the olive is a slow and long process which lasts several months and varies according to the latitude of the growing area, variety, water availability, temperature, and cultural practices. In order to obtain a characteristically fragrant but delicately flavored oil, it is imperative that it is properly extracted from mature, undamaged olives. Therefore, the degree of ripeness is an important quality factor. From a scientific point of view, it is difficult to measure and express in mathematical terms the contribution of each factor to overall quality of the extracted oil. According to Montedoro and his co-workers (1986), the stage of maturity has a 30% contribution. Other factors contribute according to the following percentage: variety 20%; harvest 5%; transportation and pre-milling storage 15%; system of extraction 30%.

The first stage of ripening is known as the “green” stage. This corresponds to green mature fruits which have reached their final dimensions. Afterwards chlorophylls in the skin are gradually replaced by anthocyanins. This is the transition to a “spotted,” ”purple” and “black” stage. At the stage between the yellow green and purple skin (veraison) the olives have the highest phenolic compounds content.

Various methods have been proposed for determining the stage of maturity of olives. Among them, the ratio of spectrophotometric absorbance of the olive paste in the visible region at two different wavelengths (665 nm and 525 nm). The assessment of volatiles, and the ratio maleic/citric acid are often reported. The International Olive Oil Council (1984) has suggested a simple technique which is based on the assessment of the color of 100 olives which are randomly drawn from 1 Kg of the sample. To calculate the maturation index the following formula is used:

$$\text{Maturation} = \frac{(0 \times n_0) + (1 \times n_1) + (2 \times n_2)\ldots\ldots + (7 \times n_7)}{100}$$

where n_0, n_1, n_2, ……n_7, are the number of olives belonging to each of the following eight categories.

0 = Olives the skin of which is a deep or dark green color.
1 = Olives the skin of which is a yellow or yellowish-green color.
2 = Olives the skin of which is a yellowish color with reddish spots.
3 = Olives the skin of which is a reddish or light violet color.
4 = Olives the skin of which is black and the flesh is still completely green.
5 = Olives the skin of which is black and the flesh is a violet color halfway through.
6 = Olives the skin of which is black and the flesh is a violet color almost right through the stone.
7 = Olives the skin of which is black and the flesh is completely dark.

According to this approach, the best harvesting period is when the maturity value is 5. This index has a relative value and its use cannot be generalized because olive variety, growing area, climatic conditions and other minor parameters significantly affect the ripening index. Thus, the index has to be calculated in various producing countries on a case by case basis, by correlating the maturation value of olives from certain areas to quality of the oil that is produced and the level of phenolic compounds. Generally, the fruit polyphenols level reaches its peak at the turn point yellow-green-purple skin. Consequently, the decision to produce a more mellow product with a higher oil content or a more pungent oil, is highly dependent on harvest time, which is the most significant factor for the variations in composition and sensory qualities. The decision to produce highly pungent oil or alternatively, a mellow product is based on harvest time.

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