Table olive processing technologies

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Abstract. Olive is one of the most important agricultural products of the countries in the Mediterranean basin. Olive and olive oil play a leading role in the Mediterranean diet, being one of the best and healthiest dietary habits. Olives are processed either as table olives or used for olive oil extraction. Though the processing methods of table olives vary according to the variety, ripeness and consumer habits, they can be classified under three main headlines: (1) Treated green olives (Spanish style green olives); (2) Olives darkened by oxidation (ripe olives); and (3) Natural black olives. Turkey, playing an important role in world table olive production, processes 70% of its production for olive oil production while leaving the rest 30% for table olive processing. 85% of the olives are processed as black table olives and the rest, 15%, is processed as green table olives. Turkish consumer preferences are still in favor of natural green and black olives.

Keywords. Table olive – Production technologies – Treated olives – Natural olives – Turkish table olives.

Technologies de transformation des olives de table

Résumé. *Les olives sont l'un des produits agricoles les plus importants des pays du bassin méditerranéen. Les olives et l'huile d'olive jouent un rôle déterminant dans la Diète Méditerranéenne, car étant l'une des habitudes alimentaires les meilleures et les plus favorables à la santé. Les olives sont soit élaborées sous forme d'olives de table ou utilisées pour l'extraction d'huile d'olive. Bien que les méthodes de traitement des olives de table varient en fonction de la variété, de la maturité et des habitudes des consommateurs, on peut les classifier en trois grands groupes : (1) Olives vertes traitées (olives vertes à l'espagnole) ; (2) Olives noircies par oxydation (olives mûres) ; et (3) Olives noires naturelles. La Turquie, qui joue un rôle important en matière de production mondiale d'olives de table, transforme 70% de sa production en huile d'olive tandis que les 30% restants sont préparés comme olives de table. 85% des olives sont sous forme d'olives de table noires et les 15% restants sont préparés comme olives de table vertes. Les préférences des consommateurs turcs sont encore en faveur des olives et noires vertes naturelles.*

Mots-clés. *Olives de table – Technologies de production – Olives traitées – Olives naturelles – Olives de table turques.*

I – Introduction

Olive tree, the symbol of Mediterranean civilization, has set the foundations of all the civilizations existing in the region, for ages. It is assumed that olive growing dates back to early human and therefore it is said that "olive tree is the first of all trees" and thus claimed to be the tree of "life".

Olive is one of the most important agricultural products of the countries in the Mediterranean basin. With an approximate tree population of 900 million, 90% being in the Mediterranean countries, olive is grown in 35 countries, on 10.6 million hectares in the world.

Olive, is an important product with the vitamins, minerals and protein as well as the oil content. Olive and olive oil has a leading role in Mediterranean diet, being one of the best and healthiest dietary habits. Olive is processed as either table olives or used for olive oil extraction.

Table olive production portrays an increase throughout the world. According to the data

provided by IOC; world's leading table olive producers are Spain, Egypt, Turkey, Argentina and Syria. Table 1 indicates the table olive production data for the countries in last 5 years (IOC, 2012).

Table 1. Table Olive Production (1.000 t)

Production	07/08	08/09	09/10	10/11	11/12
Spain	553.3	485.7	492.6	597.7	482.1
Egypt	432.0	440.0	409.0	200.0	500.0
Turkey	200.0	300.0	390.0	330.0	450.0
Argentina	100.0	95.0	220.0	250.0	200.0
Syria	100.0	120.0	135.0	142.0	165.0
Algeria	91.0	98.0	136.0	128.0	133.0
Greece	95.0	105.0	107.0	135.0	110.0
Morocco	100.0	100.0	90.0	110.0	100.0
World	2151.5	2082.5	2369.0	2440.0	2565.0

Table olive is predominantly consumed by the producer countries with varying consumption habits on country basis. Countries like Turkey, Morocco and Greece generally consume olive for breakfast or before/after meals, Spain, Italy, USA tend to consume as appetizers (Tunalıoglu, 2003). Important countries in terms of table olive consumption are Egypt, Turkey, Spain, USA and Italy. Table 2 indicates the table olive consumption data for countries in the last 5 years (IOC, 2012). Besides, France, Russia, Brazil are also important countries in table olive consumption.

Table 2. Table Olive Consumption (1.000 t)

Consumption	07/08	08/09	09/10	10/11	11/12
Egypt	350.0	360.0	340.0	200.0	300.0
Turkey	190.0	240.0	260.0	260.0	290.0
U.S.A.	240.5	210.0	203.0	240.0	240.0
Spain	183.6	147.7	107.9	150.0	200.0
Italy	122.0	138.5	122.4	125.0	125.0
Algeria	86.0	97.5	134.0	129.0	137.0
Syria	94.0	94.0	116.0	119.0	125.0
World	2130.5	2110.0	2199.0	2205.0	2387.5

II – Olive varieties

Main varieties of olives in the producer countries are listed as below (COI, 2000):

- Spain: Gordal, Manzanilla, Hojiblanca, Cacerena, Verdial, Picual, Lechin, etc.
- Greece: Conservolea, Kalamon, Chalkidiki, Megaritiki, etc.
- Morocco: Picholine Marocaine
- Algeria: Sigoise, Sevillana
- Argentina: Aracuo

- Syria: Jlot, Kaissy, Sourani, etc.

- Egypt: Aggezi Shami, Hamed, Toffahi

- Turkey: main varieties of table olives (Canozer, 1970):

  Gemlik: Widely in Marmara Region, though cultivated in many more regions recently. Approximately 25 % oil content. Mostly processed as black table olives.

  Edremit: Northern Aegean origin. Approximately 24% oil content. Processed as green-pink-black. Widely used for scratched olive production. One of the most important varieties for olive oil.

  Memecik: Cultivated in Aydın, Muğla area. Oil content is approximately around 22%. Processed as pink-green-black table olives or olive oil.

  Domat: Grown in Akhisar and Aydın region. Most important table olive variety. A fleshy variety, mainly processed as green table olives or stuffed.

  Yamalak: Widely cultivated in Aydın region. Mainly processed as spanish style green olives.

  Uslu: Widespread in Akhisar region. Processed as black table olives.

III – Table olive processing

According to International Olive Council' Standard; the term "table olive" means the product prepared from the sound fruits of varieties of the cultivated olive tree that are chosen for their production of olives whose volume, shape, flesh-to-stone ratio, fine flesh, taste, firmness and ease of detachment from the stone make them particularly suitable for processing; treated or remove its bitterness and preserved by natural fermentation, or by heat treatment with or without the addition of preservatives; packed with or without covering liquid (IOC, 2004).

Table olives are classified according to the degree of ripeness of the fresh fruits (green olives, olives turning colour and black olives), trade preparations (treated olives, natural olives, dehydrated and/or shrivelled olives, olives darkened by oxidation, specialities), and styles (whole, pitted, stuffed, salad and other styles).

Harvested olives cannot be consumed directly, because of the oleuropein substance causing a natural bitterness. The olives are fermentated, through different processing methods considering the ripeness, and thus become ready for consumption.

The processing methods of table olives vary according to the variety, ripeness and consumer habits. We can mention about 3 main trade preparations: (1) Treated green olives (Spanish style green olives); (2) Olives darkened by oxidation (ripe olives); and (3) Natural black olives.

1. Treated green olives

This type of production is called "Spanish style". The basis of this production style is to treat the olive with a lactic acid fermentation in brine after removing the bitterness of the olive through an lye treatment. Production stages are shown in Fig. 1 below.

Green olives are harvested when they reach their maximum size and proper ripeness degree (green to yellow). Harvesting time is vitally important in terms of the product quality. Late harvest may end up in olive's either becoming too soft yet early harvest remaining too hard which will cause problems in fermentation stage. To avoid avoid damaging the fruit, olives are picked by hand. Because of the high costs of harvesting by hand, this process is also done mechanically.

After the harvesting, the olives are immediately transported, in perforated plastic containers, to the plant to be size-graded and sorted. Size-grading is exceptionally important for the olives to be treated with lye. Treating with lye is an important stage in Spanish style olive processing. Olives, after classification and calibration are transferred to processing tanks for lye treatment. The alkali process is to remove the natural bitterness deriving from oleuropein.

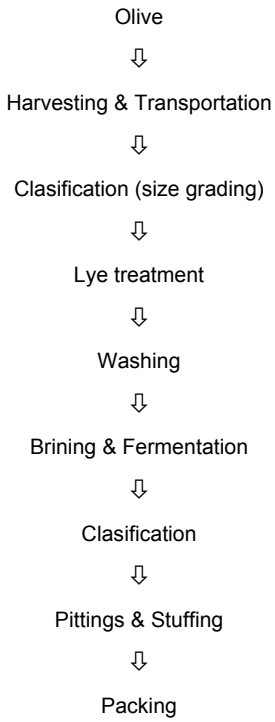

Fig. 1. Treated green olive production.

Oleuropein hydrolysis is maintained through keeping the olives in 1.5-4.5% (w/v) NaOH solution at 15-25ºC and thus the natural bitterness is eliminated. While the concentration of NaOH shows variation according to the variety and the environmental temperature; lye treatment period changes between 6 to 11 hours depending on various factors like the variety, the temperature and the concentration of NaOH.

Lye treatment parameters in the Gordal de Sevilla, being one of the most important Spanish varieties, is 9-11 hours in 2% (w/v) NaOH solution at 25ºC and it is 6-7 hours for Manzanilla de Sevilla variety at 20ºC, in 2.5% (w/v) NaOH solution. (Rejano and Garrido, 2004).

To complete the alkaline treatment, samples are taken at certain times, from the tanks to see the amount of penetration. Lye should penetrate into the flesh to a depth of 2/3 for Spanish style processing. After this treatment, draining the solution, olives are washed with water, 4 times, to eliminate the alkali.

After this process, the olives are transferred to fermentation tanks to be brined.(appx. 10%). The alkali treatment increases the skin permeability thus resulting in the fermentable compounds' easy flow into the brine. This is important to speed up the fermentation. During the fermentation process, sugars in the olives are converted to lactic acid. The fermentation in olive is a lactic acid fermentation.

While at the first stages of the fermentation, as the gram-negative bacteria are dominant in the brine, the increasing acidity and salt results the elimination of them, leading to the growth of lactic acid bacteria population. For a good fermentation process, controlled microbial population temperature, pH, acidity level, flesh of the olive and salt concentration are vitally important. Fermentation ends in 1-2 months. The final product has an acidity of 0.7-1% (lactic acid) with pH 3.8-4 and 5-6% salt concentration. When the fermentation has finished, olives are sorted/graded and packed as whole, pitted, or stuffed, finally becoming ready for the market.

2. Olives darkened by oxidation

The optimum harvesting time of the olives to be processed with this method is when the colour turns to pink from green. Yet, the olives can be picked when they are green and processed, too. The olives, size-graded and sorted, are transferred to tanks to be kept in brine (4-6% salt concentration) till further processing (Fig. 2).

Salt concentration may be increased to 8-9% depending on the varying the climatic conditions and condition of the olive. To avoid the unwanted microbial activity in brine, 1.5-3.0%. acetic acid concentration is added. To prevent the deterioration of the texture $CaCl_2$ (0.1-0.3%) is added (Brenes *et al*., 1994).

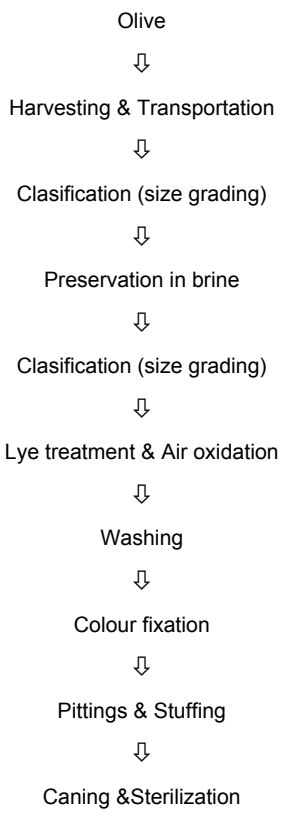

Fig. 2. Treated black olive production.

This processing type requires the highest technologies and the production is done in horizontal, cylindrical, steel, polyester or fiber glass tanks. Here, the important thing is the functionality of

the tank, rather than the shape, allowing the equal amount of lye exposure and aeration. The tank should be designed to be equally and efficiently aerated (Aktan and Kalkan, 1999). In the production stage, olives in the brine are transferred to oxidation tanks. Oxidation is a process to remove the natural bitterness of the olive and to darken the colour through lye treatment, CO_2 and air.

The number of lye treatments is generally between 2 and 5. Penetration into the skin is obtained at the first stage and at the final stage, the treatment reaches the stone. The number of the treatment depends on depends on the ripeness and the variety of the fruit, as well as the environmental temperature. After lye treatment, the olives are washed. During both lye treatment and washing, air-bubbling is used to attain oxidation.

At the last stage of oxidation process, to preserve the black color obtained, ferrous-gluconate is added to the oxidation tank and thus colour fixation is maintained. After the color fixation, the olives are ready for packing. Olives are packed in brine (ferrous-gluconate and 2-4% salt concentration) and sterilized. The pH of the fruit's flesh is around 7. In case of lowering the pH below 4.6, through adding acid into the brine, pasteurization alone is enough.

3. Natural black olives

It is the traditional Turkish and/or Greek style olive processing method. The olives are placed into brine with a high salt content. The fermentation process takes longer time as the olives have not been treated previously with NaOH and thus, oleuropein is removed slowly. Figure 3 portrays the production stages.

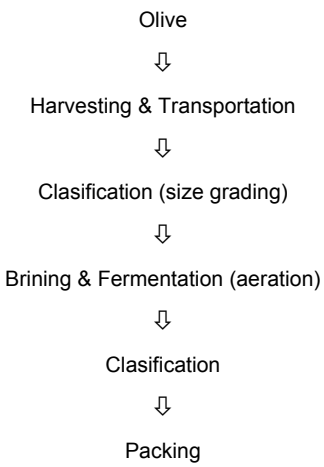

Fig. 3. Natural black olive production.

Olives are harvested when the flesh of the fruit turns purple 2 mm deep to the stone. The harvesting time is vitally important. The desired fruit colour may not be obtained at an early harvest, yet a late harvest may result in the olive's becoming too soft. The olives harvested are immediately transported to the plant in perforated plastic containers, to be size-graded and sorted. They are placed into the brine (8-10% salt concentration) for fermentation. The fermentation period takes around 8-12 months (Sánchez *et al.*, 2006).

Fermentation process may take place under aerobic or anaerobic conditions. As the salt concentration will decrease during the fermentation process, the brine should be controlled and salt should be added. Yeasts are the dominant microorganisms in the fermentation, yet an

increase in the population of gram-negative bacteria and lactic acid bacteria can also be observed.

During the fermentation of the olives in anaerobic conditions, microorganisms may increase the CO_2 in the environment, causing "gas-pocket" (fish eye) spoilage. Therefore, it is important to place air columns in the fermenters to obtain air-bubbling and thus get rid of the CO_2 in the environment (Sánchez *et al.,* 2006). Besides, aeration can reduce the fermentation period to 4-5 months. Following the fermentation process, the olives are packed and are ready for consumption.

IV – Table olive production in Turkey

Turkey, playing an important role in world table olive production, processes 70% of its production for olive oil production while leaving the rest 30% for table olive processing. 85% of the olives are processed as black table olives and the rest 15% is processed as green table olives. Table olives are a culturally important part of Turkish style breakfast. Despite the increase in the production of Spanish style green and olives darkened by oxidation. Turkish consumer preferences are still in favor of natural green and black olives.

1. Natural black olive production

Olives, harvested when the flesh of the fruit turns purple 2 mm deep to the stone, are transferred to the processing facility. After size-grading and sorting, the olives are widely put in concrete pools or polyethylene, polyester or fiberglass tanks. Certain amount of pressure -20-25% of the original weight of the olives- is applied on the olives and they are put in brine. The goal of this application is to attain the shape that is called "yanaklı" which is specially preferred by the consumer.

Brine salt concentration is around 10-12% and this ration can be around 14-15% at times. The high salt content may slow down the fermentation process and it may take 6 to 10 months. During the fermentation, circulating the brine, salt and pH controls are done. The bitterness does not disappear completely from final product and residual reducing sugars may also remain at a high level after fermentation period which may cause secondary fermentation during the preservation of the olives. After fermentation, the olives are packed, with or without brine, for the market, according to the preference.

The olives produced by traditional methods are consumed locally or exported to ethnic markets because of high salt concentration. The disadvantages of this production method are the stock cost due to the long fermentation period, the loss of weight around 20% and the lack of exportability except ethnic markets (Fındık, 2011).

The aerated fermentation has been widely used to speed up the fermentation process, shortening the fermentation period. Through this, the fermentation period takes around 5 months.

Lately, natural black olives with low salt content has become popular in Turkish markets, gaining the appreciation of Turkish consumers who especially want to consume diet products.

Besides black olive processing, dehydrated in dry salt, without brine is also popular. Most widely consumed variety is Gemlik, yet Edremit (Ayvalık), Memecik and Uslu varieties are also widespread.

2. Natural green olive production

Scratched and cracked green olives are highly appreciated by the Turkish consumers. Edremit (Ayvalık) variety is widely preferred for scratched green olives. It can be processed whether pink or green. Domat, Memecik and Yamalak varieties are considered to be processed as scratched

as well. Soon after the olives are transported to the plant, they are size-graded, sorted and scratched on 2 or 3 sides and put into water. The water is changed every other day to obtain the deserved taste.

The olives transferred to the fermentation tanks. The brine's salt ratio is increased progressively and reaches to 5-6%. After the fermentation, the olives, being ready for consumption, are packed. Although, cracked olives are highly preferred by the Turkish customers, they find limited place in the market due to the short shelf life. The production method for cracked olives is the same as scratched ones, yet the olive is cracked instead of being scratched. Because of the possible storage problems, the product is processed as Spanish style green olives and then cracked to be packed.

V – Conclusions

Table olive and olive oil consumption tend to portray a worldwide increase. Table olive production technologies are determined by the consumption habits and tastes of the consumer and thus varies from country to country. The important thing is to provide high quality products to the market and therefore, the researches carried out should aim to attain decrease in production cost and increase in product quality.

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