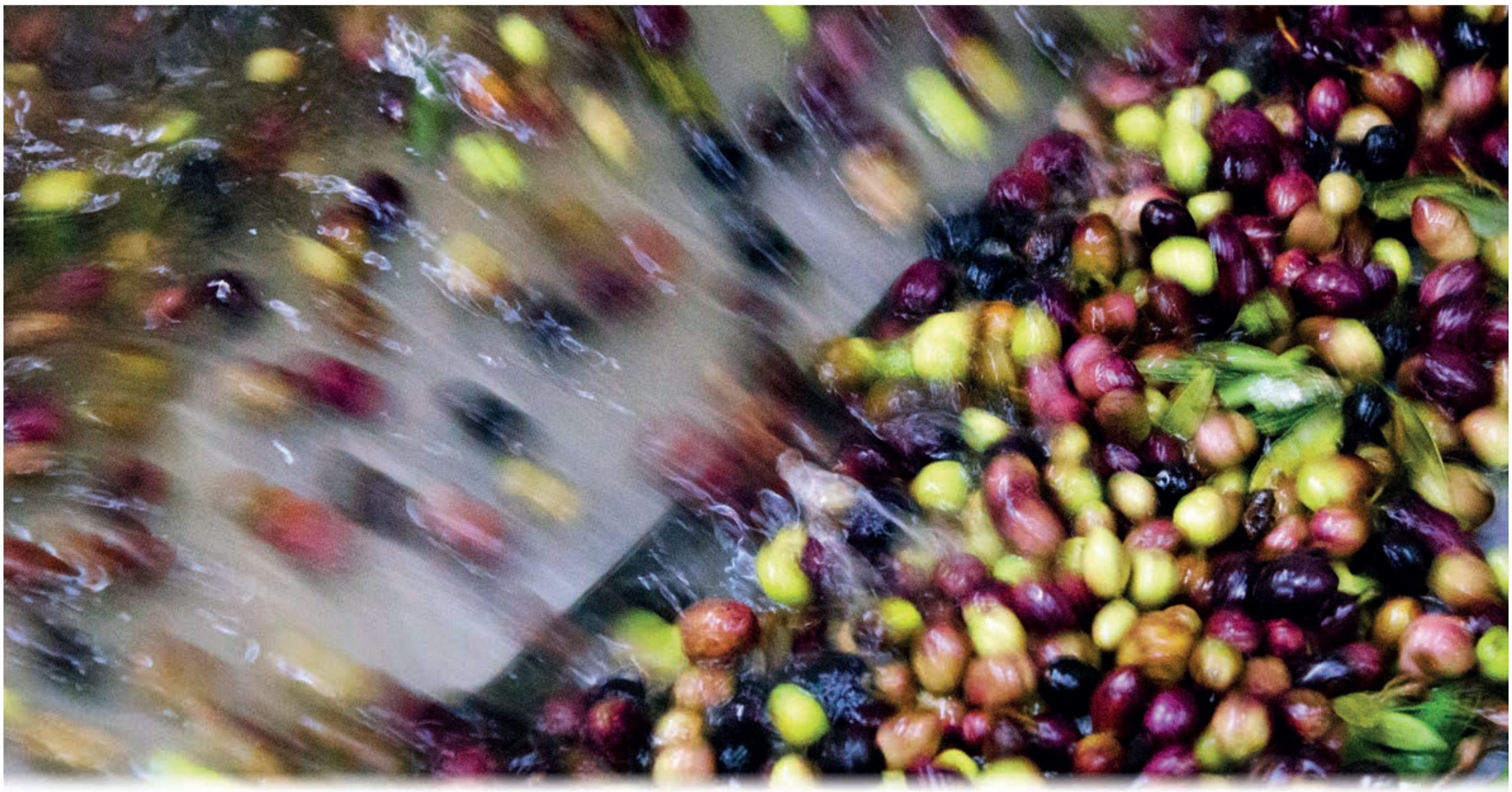

Processing for quality

Many processing factors affect the quality of olive oil including harvesting and transport conditions, crushing speed, sieve grid size, malaxation time and temperature and storage conditions *Christoph Sippel*

The olive tree is one of the oldest plants to be cultivated and is believed to have originated in Iran and Syria around 6,000 years ago. From there, it spread around the whole Mediterranean and, today, the olive tree can be found all over the world.

Great developments and changes have taken place in the production of olive oil during the centuries.

The first techniques developed for the extraction of olive oil were based on crushing the fruits, breaking the structure, using compression systems like the 'molae' and extracting the oil with a wedge or screw press.

The modern extraction process to produce extra virgin olive oil (EVOO), the highest olive oil category, generally involves the following steps:

- Harvest and transport of olives to the mill
- Belt elevator with deleafer
- Washing
- Crushing
- Malaxation
- Decanter process
- Centrifugal olive oil separator ('polishing')
- Filtration
- Bulk storage
- Bottling

General aspects

In order to determine processing steps, the olive fruits' condition, maturity and moisture content must be determined to decide on the most appropriate strategy for paste preparation and oil separation. The fruit condition and water content will also determine if the operator should use processing aids such as talcum powder or enzymes to improve oil extractability and decanter working capacity.

Harvest and transport

It is absolutely necessary to treat olives very carefully during harvest as any damage to the fruits leads to fermentation, which begins after fruits are harvested from the trees. During internal fermentation, enzymes are activated to destroy the fruit to set the pit free.

Therefore, storing olives in the grove over several hours or days should be avoided. The best storage conditions are cold and in shade. Olives should ideally be processed immediately after delivery to the mill or their storage time kept to a minimum.

Deleafing and washing

In the mill, processing starts with the deleafer to get rid of leaves, stems and little twigs. If these are not removed, they may influence the taste of the olive oil. Normally, after the deleafing, the leaves are cut into pieces and used as fertiliser.

After deleafing, olives should be washed with clear, cold water to remove dirt and other debris or additives used during the year. Sand can cause serious damage to the hammer mill or quickly wear out a decanter or the separator, reducing their life span.

For the cleaning process, it is important to use fresh water and not to use the water already in long circulation as fermentation may already have taken place, impacting the quality of the oil.

Crushing

The next step is crushing the olives into ▶

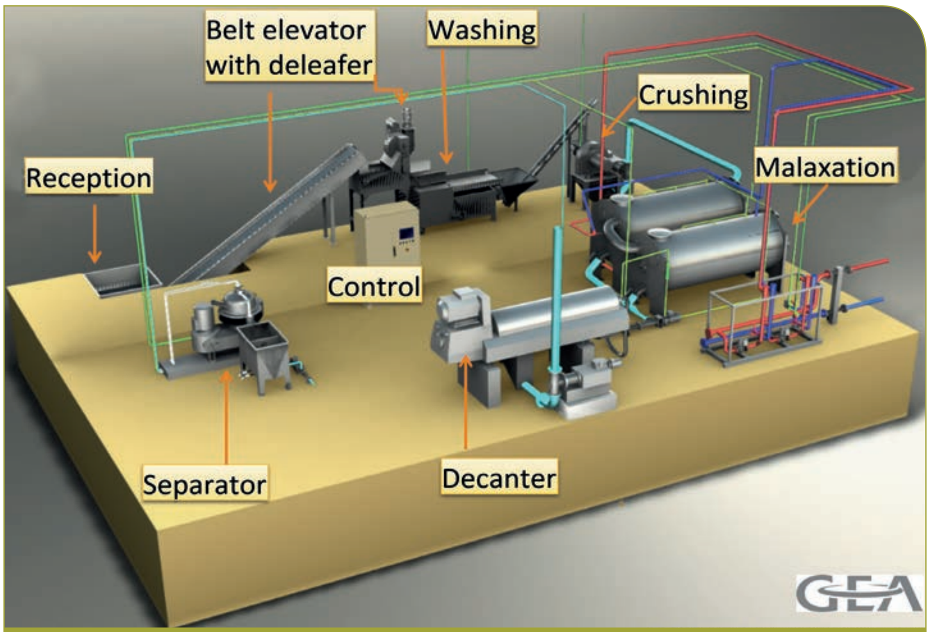

Figure 1: Olive oil processing steps

pieces, which can be carried out with stone mills, metal tooth grinders, or various kinds of hammer mills.

The crusher is the most important machine during the process. If the hammers are worn or not in the right position, lubricating effects that cause emulsions may result, which cannot be separated properly during further processing.

To reduce this effect, the right speed of the mill must be set and the correct grid size chosen. Normally low-maturity fruits will characteristically require a coarse crushing degree (6-7mm) and, therefore, a wider grid size in the crusher to maximise oil extractability. Riper fruits with softer cell tissues as well as high-moisture fruits are best prepared with smaller grid sizes (4-5mm) to maximize extraction efficiency. High maturity fruits require a larger grid size (6-7mm).

The purpose of crushing is to tear the flesh cells apart to facilitate the release of the oil from the vacuoles.

De-pitting olives prior to crushing can modify the aromatic profile and phenolic composition of the oil. This practice also reduces extraction efficiency.

The aromas produced from de-pitted olives are milder and not so strong. Normally the ground pits are needed as a kind of 'sandpaper' during malaxation to facilitate the release of the oils in combination with the fruit enzymes.

Malaxation

Malaxing or mixing the olive paste is the next step, with time and temperature being the most important, and controversial, factors.

Many oil producers believe that the longer the malaxation time, the more oil can be extracted. The same opinion is also common for temperature.

With higher temperatures, the oil becomes more fluid. However, a long malaxation time and high temperature above 27°C causes a loss of aroma and stability. International Olive Council (IOC) guidelines and EU regulations set a limit of 27°C for the production process of the highest quality EVOO.

Lower malaxation temperatures tend to generate more aromatic and complex oils but also reduce extraction efficiency. However, a modern decanter minimises the loss of efficiency.

In batch processing, the malaxation time comprises three steps – the time for filling the malaxer, the mixing time of the paste and the time for draining the malaxer. In several publications, a malaxation time of about 75 minutes is standard. However, this is too long for an aromatic and highly graduated oil and adjusting malaxation parameters is absolutely necessary.

Higher malaxation times maximise paste extractability but reduce the complexity of the oil. Frequently inspecting the paste in the malaxer and looking for the presence of free oil being released from the paste should be performed.

The most common mixer is horizontal with spiral mixing blades but vertical types also exist.

In summary, malaxing is carried out to soften the cell wall (via native enzymes), improve breaking of the cell walls (utilising pits as cutters) and agglomerate oil droplets from 1µm to >30µm (continuous oil phase).

During the malaxing process, the activated enzymes destroy the cells and allow small oil droplets to combine into bigger ones. However, it is important that the paste is homogenous and no free oil is visible at the surface. The shorter the process time, the less oxidation takes place.

Processing aids should be considered when required. Talcum powder and pectinase enzymes can help in improving the physical condition of the paste for better oil extractability.

Talcum powder can be added to the paste in the malaxer if the fruits are excessively wet (moisture content >58%) or if the paste looks emulsified in the malaxer. Pectinase enzymes can be added, according to different regulations, to the paste when the fruit is of low maturity (green or turning green).

These products usually have a synergetic action when used together and can be added at the same time in the malaxer. However, under normal circumstances, the use of pectinase is not necessary.

Separation (decanter)

During separation, oil becomes separated from the rest of the olive components. There are three fractions which are separated – the water, the oil and the solid fraction.

Separation used to be carried out in former times with presses (hence the now somewhat obsolete terms, 'first press' and 'cold press'), but is now done by centrifugation with decanters, except in old facilities still using hydraulic presses.

Some decanters are called three-phase because they separate the oil, the water (containing fruit and added water), and the solids separately. Two-phase decanters separate the oil from a wet paste.

Using the two-phase process, no water for the decanter is needed, but the pomace still contains the fruit water. The two-phase extraction represents the most modern process.

When the paste is processed, it is important to ensure that the oil emerging from the decanter is not too 'dirty' with paste as this could mean that the paste feeding-speed is excessively high or that the oil outlets are excessively open.

The waste needs to be checked regularly to determine the extent of oil losses, as well as whether paste-preparation decisions were correct and whether to slow down the feeding rate of paste into the decanter.

Centrifugal 'polishing'

In most cases, the oil coming out of the first centrifuge is further processed to eliminate any remaining water and solids by a second centrifuge that rotates faster. ▶

The condition of the oil should be continually inspected. The optimum oil appears clean with a slight milky aspect and low foam content. The foam should look bright with beige aspects but not brown. If it looks like this, the oil contains more proteins and enzymes.

If the oil has a shiny aspect, it may mean that there are excessive temperatures in the malaxer, or that excessively warm water was added into the decanter or the vertical centrifuge.

The vertical centrifuge has to be visually checked to ensure that no oil is coming out from the water outlet, or water from the oil outlet. It is safe to add a small amount of water to the centrifuge with a similar temperature to the oil, or 2-4°C higher, to improve the cleaning operation.

Filtration and storage

It is good practice to let the oil settle before filtration as it is necessary to separate the oil from fine water droplets and particles in suspension. The settling process will also help release most of the air bubbles contained in the oil. This is called racking the oil.

Settling tanks should be drained regularly to remove sediments and water. After one to a maximum of three days, the oil should be filtered. This is the best way to keep the aroma and increase the stability of the oil. Several studies show that an unfiltered oil has no long-term stability and, therefore, has a reduced shelf life. This is caused by still active enzyme activity, which firstly causes loss of aroma, and then damages the oil.

Relatively often, only decantation is used to clear the oil but the best route is filtration a short time after processing.

After filtration, an in-house sensory analysis should be carried out, as well as testing of free fatty acids and peroxide value to decide on the final destination of the oil in the tank storage facility.

The best storage conditions involve the use of stainless steel tanks, nitrogen blanketing and temperature control in the storage room to minimise oxidation processes in the oil to maximise the shelf life of the product. The oil is best stored at temperatures ranging between 14-19°C.

Conclusions

Many factors influence the sensory quality of olive oil including:

- Harvesting and fruit transport method
- Fruit condition (including any pest infection from the olive fruit fly, *dacus oleae*) and diseases
- Crushing speed, sieve grid size, malaxation time and temperature
- Good Manufacturing Practices (GMP)
- Exposure to oxygen and light
- Filtration
- Cleanliness of tanks, piping and bottling machines
- Oil storage temperature

The condition and treatment of olives and their production parameters are directly linked to oil quality. Factors influencing an olive oil's character, aroma profile and style include:

- Irrigation practices, fertilisation, cutting of trees
- Climate/weather conditions
- Olive variety
- Fruit maturity related to time of harvesting
- Oil extraction or pressing system

Any issue in the production and distribution chain of extra virgin olive oil can negatively impact oil quality. ●

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