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QUALITY MANAGEMENT GUIDE FOR THE OLIVE OIL INDUSTRY: OLIVE OIL MILLS

1. Scope

This guide is intended for virgin olive oil processing businesses, irrespective of their size or legal status. It provides pertinent advice on quality management from the time the olives enter the mill until virgin olive oil is stored prior to packing for subsequent sale.

2. Purpose

This guide specifies the rules to be followed by olive oil mills as regards hygiene, occupational safety, environmental protection, hazard identification, evaluation of critical control points, traceability and quality assurance, which are aimed at achieving overall quality in order to assure buyers and consumers of the safety (wholesomeness) of the virgin olive oil produced and to provide quality assurance.

3. Definitions

Food hygiene – All the conditions and measures necessary to ensure the safety and suitability of food at all stages of processing.

Good hygiene practice – All the rules recommended to businesses concerning the health conditions and measures necessary throughout the buildings to ensure the safety and suitability of food at all stages of processing.

Good manufacturing practice – All the rules recommended to businesses concerning the conditions necessary in all the processes to ensure the safety and suitability of food at all stages of processing.

Fruit cleaning – The removal of impurities by applying streams of air and water to separate the olive fruits from plant debris, soil, food residues, dirt, grease or other objectionable matter.

Contaminant – Any biological agent, chemical agent, foreign matter or other substances not intentionally added to food which may compromise the safety or suitability of the food for use.

Contamination – The introduction or occurrence of a contaminant in the food, buildings or food environment.

Disinfection – The reduction, by means of chemical agents or physical methods, of the number of micro-organisms present in the environment, processing bays and equipment to a level that does not compromise food safety or suitability.

Hazard – A biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect.

Risk – The probability of a hazard occurring.

HACCP – A system which identifies, evaluates and controls hazards which are significant for food safety.

Hazard analysis – The process of collecting and evaluating information on hazards and conditions leading to their presence to decide which are significant for food safety and therefore should be addressed in the HACCP plan.

HACCP plan – A document prepared in accordance with the principles of HACCP to ensure control of hazards which are significant for food safety along the food chain.

Critical control point (CCP) – A step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level.

Critical limit – A criterion which separates acceptability from unacceptability.

Control (verb) – To take all necessary actions to ensure and maintain compliance with the criteria established in the HACCP plan.

Control (noun) – The state wherein correct procedures are being followed and criteria are being met.

Control measure – Any action and activity that can be used to prevent or eliminate a food safety hazard or reduce it to an acceptable level.

Corrective action – Any action to be taken when the results of monitoring at the CCP indicate a loss of control.

Quality – The totality of characteristics of an entity (which can be individually described and considered – product, process, business) that bear on its ability to satisfy stated and implied needs.

Quality system – The organisational structure of procedural standards, processes and resources needed to implement quality management.

Quality assurance – All the planned and systematic activities implemented within the quality system, and demonstrated as needed, to provide adequate confidence that an entity will fulfil requirements for quality and comply with standards.

Quality control – The operational techniques and activities that are used to fulfil requirements for quality.

Quality management – All the activities that determine the quality policy, objectives and responsibilities, and that are implemented by every means to ensure quality planning, control, assurance and improvement within the quality system.

Quality plan – A document setting out the specific quality practices, resources and sequence of activities relevant to a particular product, project or contract.

Traceability – The ability to trace the history, application or location of an entity by means of recorded identifications.

Audit – A systematic and functionally independent examination to determine whether activities and related results comply with planned objectives.

Certification – The procedure whereby official certification bodies and officially recognised bodies provide written or equivalent assurance that foods or food control systems conform to requirements. Certification of food may be, as appropriate, based on a range of inspection activities which may include continuous on-line inspection, auditing of quality assurance systems, and examination of finished products.

4. Definition of the product obtained at the mill

The product obtained at the mill is virgin olive oil obtained from the fruit of the olive tree (*Olea europaea* L.) solely by mechanical or other physical means under conditions, particularly thermal conditions, that do not lead to deterioration of the oil, and which has not undergone any treatment other than washing, decantation, centrifugation and filtration.

Virgin olive oil is classified in one of the following designations according to its physico–chemical and organoleptic characteristics as defined in the IOC trade standard applying to olive oils and olive-pomace oils:

- Virgin olive oil fit for consumption as it is:

  . Extra virgin olive oil: virgin olive oil which has a free acidity, expressed as oleic acid, of not more than 0.8 grams per 100 grams, and the other characteristics of which correspond to those laid down for this category in the standard.

  . Virgin olive oil: virgin olive oil which has a free acidity, expressed as oleic acid, of not more than 2 grams per 100 grams and the other characteristics of which correspond to those laid down for this category in the standard.

  . Ordinary virgin olive oil: virgin olive oil which has a free acidity, expressed as oleic acid, of not more than 3.3 grams per 100 grams and the other characteristics of which correspond to those laid down for this category in the standard.

- Virgin olive oil not fit for consumption as it is, designated lampante virgin olive oil, is virgin olive oil which has a free acidity, expressed as oleic acid, of more than 3.3 grams per 100 grams and/or the organoleptic characteristics and other characteristics of which correspond to those laid down for this category in the standard. It is intended for refining or for technical purposes.

The following by-products are obtained on processing virgin olive oil:

- Pomace, the residual olive paste left after processing which still contains a variable percentage of water and oil depending on whether pressing, two-phase centrifugation or three-phase centrifugation is the processing method employed. Pomace is usually used by the extraction industry to obtain crude olive-pomace oil, or for other purposes.

- Wastewater, which comprises the vegetation water of the olives and the water added during oil processing. It contains a variable percentage of solid matter from the paste depending on whether pressing or centrifugation is the processing method employed. The minor water-soluble constituents in wastewater may be extracted by the industry for use in accordance with domestic or international legislation.

- Debris from leaf removal and fruit washing such as leaves, shoots, stones, soil and dust.

- Water used to wash the oil during liquid–liquid centrifugation.

5. General principles of food hygiene: practical application and control

5.1. Mill location

- Mills should be located away from environmentally polluted areas or areas where industrial activities are carried out that pose a serious threat of contaminating the olives and olive oils.

- Mills should be located away from areas subject to flooding unless sufficient safeguards are provided.

- Mills should be located away from areas prone to infestations of pests.

- Mills should be established in an area that is sufficiently large and suitably located to ensure proper storage and/or treatment of wastewater and pomace in order to avoid soil infiltration and discharge of these by-products into water courses.

5.2. Buildings and facilities

- Buildings should be made of durable material and should be of sound construction such as to prevent any deterioration caused by weather, soil or other conditions.

- Buildings should be designed to ensure adequate natural light for daytime work inside the plant and to ensure adequate ventilation in each handling area.

- The internal distribution of the premises should be such as to differentiate clearly between each handling area of the mill:

    . Delivery area: this area should be properly ventilated, covered and dry and should be directly connected to the leaf removal, washing, weighing and fruit sampling systems and hoppers.

. Processing area or mill proper (crusher–mixer–press, decanter and upright centrifuge): this area should be well lit, ventilated and free from extraneous odours and fumes; it should be equipped with a forced air outlet system. If possible, the crusher should be located in a separate area between the delivery area and the processing area in order to reduce noise and dirt.

. Oil storage and handling area: this area should be kept at a stable ambient temperature (12–22 ^{o}C) and should have minimal lighting and ventilation.

. Water boiler area: this area should be separate in order to eliminate smells and fumes.

. Area for sample delivery and for laboratory testing of fruit quality and physico–chemical and organoleptic analysis of the olive oils for subsequent storage in uniform lots: this area should be completely separate from the mill and should be well lit and well ventilated.

. Storage area for authorised auxiliary products: this area should be completely separate from the mill; it should be dry, properly shut and easy to keep and to clean.

- Equipment should be suited to each operation and should work properly and efficiently. Means of transport shall be of food-grade quality and in flawless condition.

- The moving parts of machinery should be protected by safety devices.

- Buildings should be fitted with a fire system.

- Mills should have an adequate supply of potable water and suitable facilities for its storage, distribution and temperature control. Potable water should comply with the guidelines issued by the WHO for the quality of drinking water, or should be of a higher standard. Non-potable water (used for fire control and for producing hot water for heating the mixer) should have a separate system. Non-potable water systems should be identified and should not connect with, or allow reflux into, potable water systems.

- Sanitary facilities should be located separate from handling areas and should ensure adequate personal hygiene: facilities for hygienic washing and drying of hands (washbasins with a supply of hot and cold water), lavatories of appropriate hygienic design, showers, adequate changing facilities for personnel and canteens.

5.3. Premises

- Walls and partitions should have a smooth surface made of impervious materials that are easy to clean and disinfect; angles should be rounded.

- Floors should be made of heavy-duty, impervious, non-slip material. They should have rounded angles, be easy to clean and disinfect, and they should ensure good drainage.

- Windows should be fitted with screens to prevent the entry of insects and rodents, and they should be easy to clean.

- Doors should have smooth, non-absorbent surfaces and should be easy to clean and disinfect. Outer doors should open outwards or be sliding and should be easy to open from the inside. They should be adequately close-fitting to prevent the entry of pests or any other small animals.

- Floor openings for lines or pipes should be adequately protected to prevent any contamination.

- Authorised, non-contaminating systems should be installed for the control of insects, rodents and other animals.

- Adequate space should be left between equipment to enable staff to move without risk.

- The minimum height of ceilings should be sufficient to meet requirements and to ensure proper ventilation.

- Each worker should have a minimum space of two square metres.

- Artificial lighting should be adapted to handling areas. Light bulbs should be protected to prevent contamination in the event of breakage.

5.4. Staff hygiene

- Any person known or suspected to be suffering from, or to be a carrier of, a disease likely to be transmitted through food should not be permitted to enter the mill if there is any likelihood of such a person contaminating the oil.

- No person known or suspected to be suffering from, or to be a carrier of, a disease likely to be transmitted through food may be authorised to work in any of the production areas if there is any direct or indirect likelihood of product contamination.

- Persons working in the mill should maintain a high standard of personal cleanliness. They should always wash their hands before handling the olive paste or oil and immediately after using the toilet.

- Persons working in the mill should avoid any behaviour that could result in contamination of the olive paste or oil, such as smoking, spitting, chewing or eating, sneezing or coughing nearby.

- Persons working in the mill should wear clothes that are suited to their tasks and that do not represent a risk.

- Persons working in areas where there is a high, continuous level of noise should wear suitable ear protection.

- Processing personnel should be trained food handlers.

5.5. Responsibilities – recording of inspections

The management of the business shall be responsible for implementing and monitoring the application of the hygiene rules.

6. Description of the processes involved in the production of virgin olive oil

Delivery of raw materials

- Delivery of olives:

In bulk; in solid or vented crates of varying capacity made of plastic or other authorised food-grade material.

- Operations:

Inspection of the means of conveyance for transporting the olives to the mill: recording of container cleanliness, of the certificate stating the previous load and of the cleaning system in the case of bulk transportation.

Analysis and recording: date of delivery, owner, variety, lot number, weight, fruit soundness and type, presence of contaminants and parasites, fruit oil content.

- Delivery of other products:

Water intended for use in the various stages of processing and cleaning operations, as well as in the sanitary facilities and laboratory.

Detergents, lubricants, processing aids and oil packing containers: recording of date of delivery, suppliers, quantities, conformity of the delivery to order specifications and certificate of fitness for use in the food industry.

- In-mill fruit conveyor system:

Conveyor belts (type and condition of belts), augers (manufacturing material), centrifugal water pump.

Fruit storage and placement

Unloading of the olives into suitable containers or stores for crushing as quickly as possible.

Placement of the olives in shallow layers on racks ensuring adequate ventilation, in solid or vented crates, or on smooth, washable flooring.

Leaf removal and fruit washing

Elimination of leaves, twigs, other plant matter and mineral matter such as soil, dust, pebbles and stones using equipment incorporating air stream, vibration and screening facilities.

Fruit washing by systems entailing pressurised circulation of potable, clean water to eliminate water-soluble substances, mud, soil and stones.

Olive crushing

This process is designed to rupture the plant structure of the olives and to release the droplets of oil from the vacuoles.

It is carried out by granite stone mills, or by metal crushers equipped with screens for regulating the particle size of the olive paste or removing the olive stones.

Mixing of the olive paste

This process is designed to amalgamate the droplets of oil dispersed in the crushed olive paste into larger-sized drops and to separate them from the other solid and aqueous liquid phases.

It is carried out by mixers, also known as malaxators, equipped with a system permitting suitable, regulated heating of the olive paste as it undergoes slow, continuous kneading for a given length of time.

Solid–liquid separation of phases: oil, pomace and aqueous phase

This process can be carried out by the following systems:

- Percolation: process whereby the oil is separated from the kneaded olive paste as a result of the effect exerted by the interfacial tension of the oil on a stainless steel blade or mesh.

- Pressing: process whereby the oily juice (oil and vegetation water) is separated from the solid fraction as a result of the force exerted by a hydraulic press on pressing mats on which the kneaded paste has been spread beforehand either manually or mechanically.

- Centrifugation: process whereby the constituent parts of the mixed olive paste are separated according to their density as a result of the effect of the centrifugal force generated by the horizontal centrifuge (decanter). Decanters are of two types, depending on the products discharged during centrifuging. They are known as three-phase or triple-outlet decanters when separation is intermittent and the three constituent parts – oil, pomace and wastewater – are discharged. When the three constituent parts are separated internally and only two products are discharged – oil, and pomace containing vegetation water – the decanters are known as two-phase or twin-outlet decanters.

Liquid–liquid separation: oil and aqueous phase

- Natural settling: process whereby the constituent parts of the oily juice – oil, water and fragments of solids – separate in the decanting vats owing to their immiscibility and difference in density.

- Centrifugation: process whereby an upright centrifugal separator applies centrifugal force to separate the oil from the aqueous fraction.

Decanting and grading prior to warehouse storage

- The oil produced in a given period of time (lot, shift, day) should be decanted to homogenise the quantity produced, to eliminate the fraction of air trapped during centrifuging, to bring the oil to the right temperature and to enable removal of the supernatant foam and lees; it should then be graded according to its physico–chemical and organoleptic characteristics.

In-mill storage and handling of virgin olive oil

- The oil storage area should be physically separate from the processing area. It should be constructed of material that attenuates to a maximum or eliminates the impact of oscillations in temperature and light and that is easy to keep in hygienic condition.

The tanks where the oil is to be kept after grading should be made of inert, non-absorbent material and should have a conical or sloping bottom. They should be airtight and equipped with auxiliary systems for tank filling and emptying from the bottom, as well as with bleeder and sampling valves; if possible, they should also be fitted with an efficient internal inerting and cleaning system.

Optional oil transfer

Operation whereby the oil is transferred from one tank to another to avoid the risk of organoleptic alterations caused by fermentation of the muddy sediment which collects on the bottom of the tank.

Oil filtration prior to packing for sale

Operation whereby devices or equipment separate the oil from any solid or liquid particles; filters (metal, paper or fabric mesh) using authorised aids (diatomaceous earth and cellulose) are employed for this purpose.

7. Health hazard identification, analysis and control

7.1. Delivery of the olives and other raw materials

Hazards:

- Biological: presence of micro-organisms or parasites.
- Chemical: residues of phytosanitary products, fertilisers, herbicides, contaminants from previous loads carried in the means of transport, detergents and halogenated compounds in the water.

Preventative measures:

- Training of olive growers, compilation of raw material specifications, training of inspection staff.

Critical control points (CCP):

- Visual inspection and assessment of the presence of micro-organisms and parasites in the olives.

- Analysis of the content of residues of phytosanitary products and other contaminants in the fruit.

- Analysis of water quality.

Critical limits:

- Maximum content of phytosanitary product residues.

- Maximum content of micro-organisms and of halogenated compounds in the water.

Control system for each CCP:

- Methods for testing for residues of phytosanitary products and contaminants.

Corrective action:

- Sorting of the olives according to quality, cleanness and soundness for separate processing.

- Adaptation of storage time to fruit quality and soundness.

7.2. Fruit delivery and handling

Hazards:

No hazard should be identified if good hygiene practice is observed during this stage of oil processing.

7.3. Leaf removal and fruit washing

Hazards:

- Biological and chemical: contamination, especially of olives bruised by dirty or contaminated wash water.

Preventative measures:

- Control of water quality and cleanness.

Critical control points (CCP):

- Analysis of the contaminant content of the water.

Critical limits:

- Limits for potable water in compliance with legislation.

Control system for each CCP:

- Control of the potability of the water.

Corrective action:

- Rewashing the olives in clean water.

7.4. Olive crushing

Hazards:

No hazard should be identified if good hygiene practice is observed during this stage of oil processing.

7.5. Mixing of the olive paste

Hazards:

No hazard should be identified if good hygiene practice is observed during this stage of oil processing.

7.6. Solid–liquid separation: oil, pomace, aqueous phase

Hazards:

- Chemical: presence of halogenated solvents from the water.

Preventative measures:

- Control of proper cleaning of equipment and facilities.

- Control of water quality.

Critical control points (CCP):

- Analysis of halogenated solvent content.

Critical limits:

- Critical limits for water.

Control system for each CCP:

- Control of the potability of the water.

Corrective action:

- Action to ensure the water is potable.

Liquid–liquid separation

Hazards:

- Chemical: presence of halogenated solvents from the water.

7.7. In-mill storage and handling of the oil

Hazards:

- Chemical: residues of impurities and detergents.

Preventative measures:

- Adequate washing of the tanks with potable water.

Critical control points (CCP):

- Control of tanks to check they are airtight, truncated conical in shape, easy-to-clean, etc.

Critical limits:

- Standards specified for tanks.

Control system for each CCP:

- Control of compliance with such standards.

Corrective action:

- Implementation of the action identified in the control system.

7.8. Oil transfer

Hazards:

No hazard should be identified if good hygiene practice is observed during this stage of oil processing and the hoppers and pumps undergo thorough inspection.

7.9. Optional oil filtering

Hazards:

No hazard should be identified if good hygiene practice is observed during this stage of oil processing.

8. Quality control points in the processing of virgin olive oil

Delivery of raw materials:

- Olives:

Control point	Good practice measure, preventative or corrective
Cleaning of means of transport of olives to mill	Controlling and recording cleanness and the certificate of the previous load
Fruit cleaning	Controlling and recording for separate processing of the olives
Proportion of extraneous matter: twigs, leaves, stones, soil	Recording the percentage of extraneous matter to determine the intensity of leaf removal and washing before or after storing the olives
Proportion of damaged olives (parasites or bruises)	Recording for separate processing
Oil content	Analysing and recording the content at the laboratory mill
Free acidity of oil	Analysing and recording the acidity at the laboratory mill

- Other raw materials:

Control point	Good practice measure, preventative or corrective
Water	Controlling the sanitary standard
Aids	Certifying the suppliers
Cleaning and maintenance products	Certifying the suppliers
Lubricants	

Fruit storage and placement:

Control point	Good practice measure, preventative or corrective
- Storage:	
Container and place	Complying with hygiene standards
Duration	Ensuring storage is as short as possible
- Placement:	
Container and place	Complying with hygiene standards
Control of changes in olive quality: fermentation	Avoiding fruit storage
Presence of mould	Analysing the free acidity

Leaf removal and fruit washing:

Control point	Good practice measure, preventative or corrective
Proportion of leaves, twigs	Maximum %
Other mineral matter	Continuing leaf removal until fully eliminated
Cleanness of wash water	Changing the water as often as possible (at least once a day) and optionally giving the olives a final rinse with clean, potable water

Olive crushing:

Control point	Good practice measure, preventative or corrective
Olive paste grain size	Adjusting the size according to the variety, fruit ripeness and processing method
Crushing speed	
Maximum duration	

Mixing of paste:

Control point	Good practice measure, preventative or corrective
Olive paste temperature	Checking the temperature is right
Mixer speed	Adjusting the speed to the type of olive paste
Maximum duration	Making sure mixing lasts the required time according to the olive paste, variety and fruit ripeness
Processing aids	Adding processing aids only to difficult-to-extract olive pastes and in accordance with domestic legislation

Separation of phases:

Control point	Good practice measure, preventative or corrective
- Percolation:	Checking percolation is done properly
Duration	
- Pressing:	Checking pressing is done properly
Control of press load formation	Cleanness of the pressing mats Thickness of olive paste Number of pressing mats
Adjustment of pressure	According to manufacturing characteristics and not more than 400 atm
Quantity and temperature of water	Minimum amount of water at not more 30^{o}C for washing the load

- Three-phase centrifugation:

Temperature of water added	Not more than 35 ºC
Quantity of water added	Maximum of 1 litre/kg mass
Speed of centrifugation	According to manufacturing characteristics

- Two-phase centrifugation:

Speed of centrifugation	According to decanter characteristics

- Natural settling

Time kept in vats	Minimum required to ensure good separation and to prevent the oil entering into contact with the centrifugal water

- Oil centrifugation:

Speed of centrifugation characteristics	According to centrifuge
Water added for washing	According to the moisture and impurity content

Oil storage:

Control point	Good practice measure, preventative or corrective
Tank filling and sealing	Avoiding contact with the air and the entry of extraneous bodies
Distribution of oils according to physico–chemical and organoleptic quality	Sensory analysis Analysis of free acidity and peroxide value
Identification of oil contained in each tank	Recording the origin and analytical characteristics of the oil on the tanks and in the records, and the date of placement in the tanks
Temperature inside tank	Between 12 and 22 ºC

Optional oil filtering:

Control point	Good practice measure, preventative or corrective
Type of filter: cotton, paper	Certifying suppliers

9. Training

- Food handling and inspection course.
- Environmental and occupational safety.
- HCCP and critical control points.

10. References

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ISO 9002 – Quality systems – Model for quality assurance in production, installation and servicing.

ISO 9003 – Quality systems – Model for quality assurance in final inspection and tests.

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