SIDI MOHAMED BEN ABDELLAH
UNIVERSITY
POLYDISCIPLINARY FACULTY OF TAZA
PROGRAM: AGRI-FOOD ENGINEERING/ S6

COURSE MODULE:
AGRO-RESOURCE PROCESSING AND VALORIZATION

PRACTICAL WORK
MANUAL

Olive Oil Extraction and Quality Assessment

ACADEMIC YEAR: 2025-2026

Pr. RHARRABTI

PRACTICAL WORK:
OLIVE OIL EXTRACTION AND QUALITY ASSESSMENT

1. INTRODUCTION

Olive oil is one of the most widely recognized vegetable oils. It is obtained exclusively from olives through mechanical processes or other physical methods, excluding any chemical treatment or solvent extraction. The oil undergoes only washing, malaxation, centrifugation, decantation, and filtration. No chemical additives are used, and no mixing with oils of other origins is allowed.

The quality of olive oil is influenced by several factors, particularly the olive cultivar, environmental conditions, harvesting methods, and extraction processes.

Olive Oil Extraction Process

The primary objective of olive cultivation is olive oil production. Although extraction technology has evolved considerably, the fundamental principles remain unchanged. The main stages of olive oil production are as follows:

Leaf Removal

This step consists of removing leaves, wood fragments, and foreign matter remaining in olive containers after harvesting. It is generally carried out by aspiration.

Washing

Washing is an essential operation to eliminate dust and soil that may affect oil color and organoleptic properties, and to prevent damage to metallic grinding equipment.

Grinding

Grinding consists of breaking olive cell walls and releasing cellular contents. It is performed either using millstones in traditional extraction systems or hammer crushers in continuous two-phase or three-phase systems.

Malaxation

Malaxation is a fundamental step involving slow and continuous mixing of the olive paste after slight heating. Its purpose is to break the oil/water emulsion and facilitate the aggregation of small oil droplets into larger droplets.

Phase Separation

The phase separation step is carried out to isolate the oil from the other components of the olive paste. After malaxation, the paste is introduced into a centrifugation system, where separation occurs based on differences in density between the phases. Under the effect of centrifugal force, the mixture is divided into three fractions: the oil phase, the aqueous phase (olive mill wastewater), and the solid residues (pomace). In modern installations, a horizontal decanter centrifuge is commonly used for the initial separation, followed by a vertical centrifuge to remove residual water and fine particles, ensuring better clarity of the oil.

Olive Oil Extraction Technologies

Olive oil extraction is mainly performed using three systems:

Discontinuous (Press) Systems

Traditional and semi-modern extraction systems rely on the mechanical pressing of olive paste obtained after crushing and malaxation, typically using hydraulic presses in conjunction with millstones. These systems are characterized as discontinuous processes, as they operate through successive batches or sequential pressing cycles. The separation of the solid (pomace) and liquid phases is achieved through the application of pressure, whereas the subsequent separation of oil from the aqueous phase (olive mill wastewater) occurs by natural decantation.

Continuous Three-Phase Centrifugation System

Olive oil extraction is carried out through successive stages, in contrast to discontinuous processes. The olives are first washed, then crushed, mixed with hot water, and malaxed. The separation of the oil from the solid-liquid mixture is achieved by centrifugation using a horizontal centrifuge, known as a “decanter,” which operates continuously. The outcome of this operation yields three products: oil, olive mill wastewater, and pomace.

Continuous Two-Phase Centrifugation System

It is a variant of the previous system with the advantage of extracting oil without the need to add water to the decanter. The latter separates the oil while combining the pomace and vegetation water into a single phase with a pasty consistency, known as “wet pomace.”.

Composition and Quality of Olive Oil

Olive oil contains approximately 98% lipids, mainly triglycerides and 2% minor compounds, including phenolic compounds (antioxidants), vitamins (A, D, E, K), alcohols, and pigments. Oleic acid is the predominant fatty acid, representing up to 83% of total fatty acids.

The quality of olive oil is mainly evaluated using three criteria:

- Free acidity
- Peroxide value
- Sensory characteristics

Classification of Olive Oil Quality

Type of Olive Oil	Free Acidity	Peroxide Value	Organoleptic Score Me (median)
Extra Virgin Olive Oil	≤ 0.8%	< 20 meq O_2/kg	> 6.5
Virgin Olive Oil	≤ 2%	< 20 meq O_2/kg	5.6 < Me < 6.5
Ordinary Virgin Olive Oil	≤ 3.3%	< 20 meq O_2/kg	> 3.5
Lampante Virgin Olive Oil	< 3.3%	Not limited	< 3.5
Refined Olive Oil	≤ 0.3%	≤ 5 meq O_2/kg	—

2. MANIPULATION

Objectives

The aim of this practical work is to:

- Extract olive oil from two olive samples at different maturity stages
- Calculate oil yield
- Determine the category of each olive oil sample
- Compare their quality through physicochemical analysis

Calculation of Olive Maturity Index (MI)

The maturity index is determined by evaluating the coloration of 100 olives randomly selected from a 1 kg sample.

Olives are classified into 8 categories (0 to 7) according to skin and pulp color:

- Class 0: intense green skin
- Class 1: yellowish green skin
- Class 2: green skin with reddish spots on less than half of the fruit
- Class 3: reddish or violet skin on more than half of the fruit
- Class 4: black skin and white pulp
- Class 5: black skin and violet pulp not reaching the center
- Class 6: black skin and violet pulp not reaching the pit
- Class 7: black skin and violet pulp extending to the pit

Stages of Olive Maturation

The maturity index (MI) is calculated using the following formula:

$$MI = \frac{(0 \times A) + (1 \times B) + (2 \times C) + (3 \times D) + (4 \times E) + (5 \times F) + (6 \times G) + (7 \times H)}{A + B + C + D + E + F + G + H}$$

Where A, B, C, D, E, F, G, and H represent the number of fruits in classes 0 to 7, respectively.

Olive Oil Extraction Procedure

- Weigh the olive sample
- Grind until a homogeneous paste is obtained
- Manually malax after adding hot water
- Centrifuge at 4000 rpm for 10 minutes
- Recover the oil phase
- Measure the extracted oil volume

Oil Yield Calculation

The oil yield represents the amount of oil extracted relative to the mass of olives used.

$$\boldsymbol{Oil\ Yield}(\%) = \frac{m_{\text{oil}}}{m_{\text{olives}}} \times 100$$

Where:

m_{oil} = mass of extracted oil (g) = volume of oil (mL) × density of olive oil (≈ 0.91 g/mL)

m_{olives} = mass of olives used (g)

Determination of Free Acidity

Free acidity in olive oil refers to the proportion of free fatty acids, which are generated because of the hydrolysis of triglycerides. The presence and increase of free fatty acids are commonly regarded as an indicator of oil degradation and are used as a key parameter in assessing the quality and freshness of olive oil.

Protocol

- Weigh 2.5 g of olive oil
- Add 50 mL absolute ethanol
- Add 3 drops of 1% phenolphthalein
- Titrate with 0.1 N alcoholic KOH until a persistent pink color appears for at least 10 seconds
- Perform a blank test

The acidity expressed as % oleic acid is calculated by:

$$\boldsymbol{Acidity}\ (\%\ \boldsymbol{oleic\ acid}) = \frac{(V_{\text{sample}} - V_{\text{blank}}) \times N \times 28.2}{m}$$

Where:

V_{sample} = volume of KOH used for the sample titration (in mL).

V_{blank} = volume of KOH used for the blank titration (in mL).

N = KOH normality (= 0.1 N)

m = mass of the oil sample (g).

28.2 = constant derived from the molar mass of oleic acid

Determination of Peroxide Value

The peroxide value (PV) is considered a highly relevant and sensitive indicator for evaluating the early stages of oxidative degradation in lipids. It provides an estimate of the concentration of primary oxidation products, namely hydroperoxides, and is widely used as a key parameter for assessing the initial oxidative status and overall quality of olive oil.

Protocol

- Weigh 2.5 g of olive oil
- Add 30 mL of the acetic acid/chloroform mixture (3/2 v/v)
- Add 0.5 mL of the saturated potassium iodide (KI) solution (approximately 14 g per 10 mL).
- Keep in darkness for 1 minute
- Add 30 mL of distilled water
- Add 1 mL of 1% starch solution (color indicator: violet).
- Titrate under stirring (agitation) with a 0.01 N sodium thiosulfate solution until disappearance of violet coloration

Peroxide value is calculated as:

$$\boldsymbol{PV\ (meq\ O_2/kg)} = \frac{V_{\text{sample}} - V_{\text{blank}} \times N \times 1000}{m}$$

Where:

V_{sample} = volume of sodium thiosulfate used for the sample titration (in mL).

V_{blank} = volume of sodium thiosulfate used for the blank titration (in mL).

N = normality of sodium thiosulfate (= 0.1 N)

m = mass of the oil sample (g).

3. REPORT

The report should include:

a. Calculation of the maturity index for both olive samples
b. Identification of the extraction process used during the practical session
c. Determination and comparison of oil yield between the two olive samples
d. Determination of free acidity and peroxide value for each sample
e. Comparison of olive oil quality according to standards