

**CHEMISTRY**

Objective, verifiable chemical standards form the foundation of the UP grade. Chemical analysis of EVOO has proven to be a fundamental indicator of sensory quality, predictor of perishability, and authenticity of olive oils. UP is the highest quality standard in the world because it utilizes the broadest array of available tests and enforces the strictest limits on all chemical standards.

Chemical Parameters	Determination	Indicators	Extra Virgin Standard	UP Standard
<b>6.1 Free Fatty Acids (FFA)</b>	Free Fatty Acids are formed due to breakdown of the triacylglycerols in oils during extraction. Fatty acids are "free" when they are no longer bound to any other molecules.	An elevated level of FFA can indicate poor quality or mishandled fruit, too much time between harvesting and extraction, poor storage and/or high temperature during extraction.	Units: % as oleic acid <b>IOC limit <math>\leq 0.8</math></b>	Units: % as oleic acid <b>UP limit <math>\leq 0.3</math></b>
<b>6.2 Oleic Acid</b>	The major fatty acid in olive oil triacylglycerols is Oleic acid making up 55 to 85% of olive oil	The higher the oleic acid monounsaturated fat content translates to increased durability and shelf-life.	Units: % as oleic acid <b>IOC limit <math>\geq 55</math></b>	Units: % as oleic acid <b>UP limit <math>\geq 65</math></b>
<b>6.3 Peroxide Value</b>	Peroxides are primary oxidation products that are formed when oils are exposed to oxygen causing defective flavors and odors	Primary measurement of rancidity in oil. Higher peroxide levels indicate oxidized and/or poor quality oil & give an idea of the freshness & storage conditions.	Units: mEQ O <sub>2</sub> /kg oil <b>IOC limit <math>\leq 20</math></b>	Units: mEQ O <sub>2</sub> /kg oil <b>UP limit <math>\leq 9</math></b>
<b>6.4 UV Absorption</b>	UV spectrophotometric determination Secondary measurement of rancidity in oil. Elevated levels of UV absorption indicate oxidized and/or poor quality oil, possible refining and/or adulteration with refined oil.	Secondary measurement of rancidity in oil. Elevated levels of UV absorption indicate oxidized and/or poor quality oil, possible refining and/or adulteration with refined oil.	Units: K1%/1cm <b>IOC limits</b> <b>K232 <math>\leq 2.5</math>,</b> <b>K270 <math>\leq 0.22</math>,</b> <b>DeltaK <math>\leq 0.01</math></b>	Units: K1%/1cm <b>UP limits</b> <b>K232 <math>\leq 2.0</math>,</b> <b>K270 <math>\leq 0.20</math>,</b> <b>DeltaK <math>\leq 0.01</math></b> (immediately after production)
<b>6.5 Phenolic Content (Polyphenols)</b>	Phenols are healthful anti-oxidant substances in olive oil which aid in slowing down the natural oxidative processes.	Phenolic content decreases over time and is an indicator of freshness, with higher amounts improving shelf-life and oxidative stability.	N/A	Units: (as ppm caffeic acid) <b>UP minimum limit <math>\geq 130</math></b>
<b>6.6 DAGs</b>	Fresh olive oil has a much higher proportion of 1,2-diacylglycerols to Total diacylglycerols while olive oil extracted from poor quality fruits and refined oils have a higher level of 1,3-diacylglycerols	The ratio of 1,2-diacylglycerols to the Total diacylglycerols are a useful indicator of fruit quality and acts as a snapshot of olive oil freshness. Low values can also indicate oxidized oil & sensory defects.	Units: % Total 1,2-diacylglycerols <b>AOA limit <math>\geq 35</math></b>	Units: % Total 1,2-diacylglycerols <b>UP limit <math>\geq 90</math></b> (immediately after production)
<b>6.7 PPP</b>	Upon thermal degradation of olive oil, chlorophyll pigments break down to pheophytins and then to pyropheophytins	The ratio of pyropheophytins to the total pheophytins is useful for distinguishing fresh olive oil from soft column refined, deodorized, or backblended oils.	Units: % Total Pheophytins <b>AOA limit <math>\leq 17</math></b>	Units: % Total Pheophytins <b>UP limit <math>\leq 5</math></b> (immediately after production)

\*IOC= International Olive Council, AOA= Australian Olive Association

*Extra virgin olive oil decreases in flavor and health benefits over time. Fresh crushed olive oil is like fresh squeezed fruit juice in that it contains the most flavor and nutrients. Old, poorly made and improperly stored extra virgin olive oil yields fewer if any health benefits and undesirable flavor. Becoming intimately familiar with a particular extra virgin olive oil's flavor characteristics and chemistry i.e. antioxidant content, oleic acid, FFA, and crush date will help you make an educated decision about which olive oil is right for you.*

### **CRUCIAL OLIVE OIL CHEMISTRY DEFINITION KEY**

**Oleic Acid:** is a monounsaturated omega-9 fatty acid found in olive oil. Olive oil is generally higher in oleic acid than other vegetable fats. The range found in extra virgin olive oil is between 55-85%. **Extra virgin olive oil high in oleic acid has greater resistance to oxidation.**

**FFA:** Based on IOOC standards the maximum limit for free fatty acid in extra virgin olive oil is 0.8g per 100g or (.8%). **A low FFA is desirable. Free fatty acid speaks to the condition of the fruit at the time of crush.** The higher the FFA the greater the indication of poor quality fruit such as damaged, overripe, insect infestation, overheating during production or too much of a delay between harvest and crush.

**Peroxide Value:** Based on IOOC Standards the maximum peroxide value for extra virgin olive oil is 20. **A very low peroxide value is desirable.** Unsaturated free fatty acids react with oxygen and form peroxides, which create a series of chain reactions that generate volatile substances **responsible for a typical musty/rancid oil smell.** These reactions are accelerated by high temperature, light, and oxygen exposure.

**Polyphenol Count:** Polyphenols are a class of **antioxidants** found in a variety of foods. Polyphenols such as Oleuropein, Oleocanthal, and hydroxytyrosol impart intensity **connected with pepper, bitterness and other desirable flavor characteristics.** Recent studies indicate that these potent phenols are responsible for many of the health benefits associated with consuming fresh, high quality extra virgin olive oil. Phenols in olive oil decrease over time or when exposed to heat, oxygen and light. **Consuming fresh, well made olive oil with high polyphenol content is crucial when looking to obtain the maximum health benefit commonly associated with consuming extra virgin olive oil.**

### **NEW TESTING METHODS BASED ON OLIVE OIL CHEMISTRY**

**DAGs Test/Score:** Measures the proportion of two forms of diacylglycerol: 1,2 and 1,3. In oil freshly made from sound olives of good quality, the prevalent form of DAG is the 1,2 form where the fatty acids are bonded to a glycerol molecule in the 1 and 2 positions. The bond on the 2 position is weak and easily broken, leading to the migration of that 2 position fatty acid to the 3 position. This results in the much more stable 1,3 DAG. This makes the ration of 1,2 DAGs to the total DAG's a good indicator of the quality of the olive fruit and the processing. It is also an **indicator of the age of an oil**, since the migration from 1,2 to 1,3 DAGs takes place naturally as the oil ages. Warmer storage temperatures, and higher free fatty acid levels will both accelerate this process, but DAGs are not affected by the short exposure to high heat that is characteristic of deodorizing (refining).

**PPP Test/Score:** This test was developed to measure the degradation of chlorophyll in olive oil. This degradation of chlorophylls to pyropheophytin was found to take place at a predictable pace, making it possible to gain information about the age of an olive oil. The rate at which the degradation occurs can be accelerated by even short periods of high temperatures – such as that which is utilized during the deodorizing or soft column refining process – making it a **useful indicator of the presence of deodorized olive oil as well as the age of the oil.**