CALIFORNIA EST. 1992 Olive Oil COUNCIL

Oxidation in olives will produce oxidized oil
Storage vessels must not interact with the oil
Storage must limit oxidation of the oil

Best Practices:
Storage Challenges and Solutions

But, we need to understand some chemistry

Chris Calvert, Ciarlo Fruit and Nut, LLC.

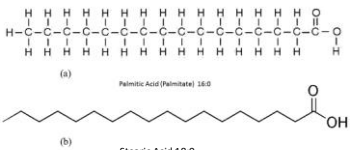
A QUICK
OVERVIEW

- **Fatty Acid Structure**
- **What is Oil (FAT)**
- **How Does Oil Oxidize**
- **How Do We Limit Oxidation**

Fatty Acids

1. Carbon chains of 2 to 29 carbons
2. Saturated or Unsaturated with Hydrogen
3. *Cis versus Trans Unsaturated Fatty Acids*

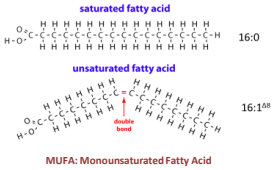
Fatty Acid Structure



Stearic Acid 18:0

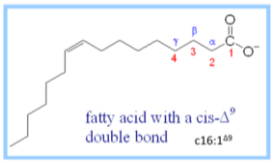
3 Dimensional (3D – 4D)

Saturated vs Unsaturated Fatty Acid

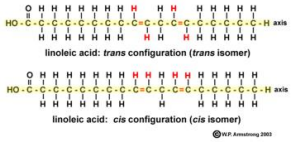


MUFA: Monounsaturated Fatty Acid

Unsaturated 16:1$^{\Delta 9}$ Fatty Acid (Palmitolic)

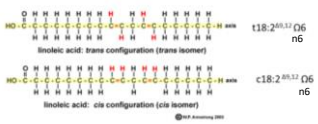


Cis vs Trans Fatty Acids



18:2$^{\Delta 9,12}$
18:2 Ω6
n6

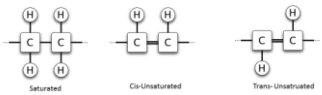
Cis vs Trans Fatty Acids



t18:2$^{\Delta 9,12}$ Ω6
n6

c18:2$^{\Delta 9,12}$ Ω6
n6

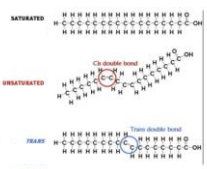
Cis vs Trans Fatty Acids



Natural

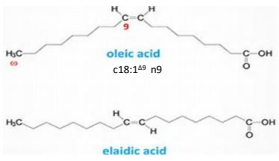
Hydrogenation & Microbes

Cis vs Trans Fatty Acids



3-D

Cis vs Trans Fatty Acids

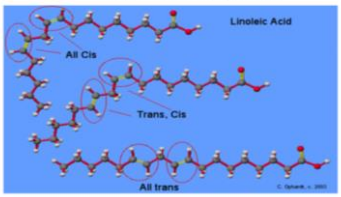


c18:1$^{\Delta 9}$ n9

t18:1$^{\Delta 9}$ n9

3-D

Cis vs Trans Fatty Acids

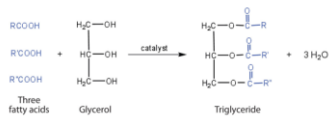


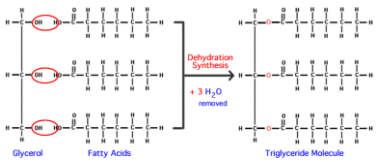
A QUICK

OVERVIEW

- Fatty Acid Structure
- **What is Oil (Fat)**
- How Does Oil Oxidize
- How Do We Limit Oxidation

Fat and Oil – Triacylglycerol





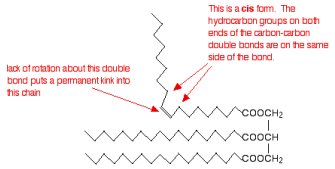
3-D
&
Attraction Between Fatty Acids

Fats: Esters of fatty acids with glycerol.
Oils: Fats in the liquid state.

Two Primary Determinants of Fat vs Oil

1. Length of fatty acids (↑ Melting Point)
2. More saturated (↑ Melting Point)

Saturated vs Unsaturated in a TAG



Saturated vs Unsaturated in a TAG

In a **trans** form, the two hydrocarbon groups are on opposite sides of the carbon-carbon double bond. This doesn't cause quite so much distortion (although more than this simplified diagram shows).

Similar to a saturated fatty acid

With Fatty Acids –
You Are What You Eat

A QUICK

OVERVIEW

- Fatty Acid Structure
- What is Oil (FAT)
- **How Does Oil Oxidize**
- **How Do We Limit Oxidation**

What is Rancidity?

Rancidity is a term generally used to denote a condition of unpleasant odours and flavours in foods resulting from deterioration in the fat or oil portion of a food.

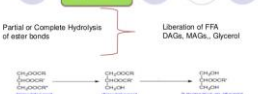
https://www.slideshare.net/snp_ptl/oxidative-rancidity-in-fats-and-oils-causes-and-prevention

HYDROLYTIC RANCIDITY

Enzyme action, Heat, Moisture

Partial or Complete Hydrolysis of ester bonds

Liberation of FFA DAGs, MAGs., Glycerol



EX:
Development of rancid flavour in milk
Deep fat frying

https://www.slideshare.net/snp_ptl/oxidative-rancidity-in-fats-and-oils-causes-and-prevention

OXIDATIVE RANCIDITY

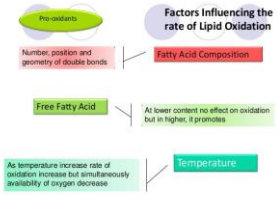
Major causes of food spoilage

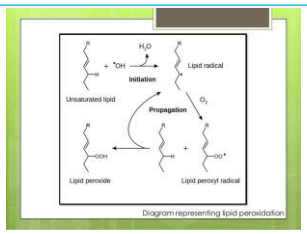
Extensive research have done, yet to be discovered

.....extremely complex subject because

1. Sensitivity of Intermediates Isolation separation and identification
2. Effect of catalyst Pro & anti-oxidants
3. Influence of photo-oxidation and auto-oxidation simultaneously
4. Relation between oxidation rate and stability

https://www.slideshare.net/snp_ptl/oxidative-rancidity-in-fats-and-oils-causes-and-prevention





https://www.slideshare.net/presh_g/rancidity-lipid-peroxidation

Factors Influencing Fat Oxidation

1. Temperature:
2. Oxygen:
3. Type of fat:
4. Light:
5. Metals:
6. Products from fat oxidation:

TEMPERATURE

A. Rate of fat oxidation highly dependent on temperature.

B. Improve storage stability by lowering the storage temperature.

C. Olive oil stored at room temperature. OK (<75° F)
Stored in the wine cellar. Better (maybe) (55° - 65° F)

D. Decreasing temperature slows oxidation
It does not eliminate it.

OXYGEN

A. Use of packaging materials with low oxygen permeability. **Stainless Steel – Glass**

B. Replace air with an inert gas.
air may be displaced by an inert gas.
Argon, Nitrogen, Carbon Dioxide

C. Pack under vacuum
Not practical with olive oil, don't use plastic.
Olive oil is not like wine.

Metals

A. Metals increase rate of fat oxidation.
copper, iron, manganese, and chromium dramatically increase rate of fat oxidation, plus they impart metallic flavors.

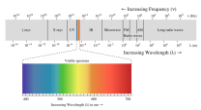
B. Preferred storage containers are steel drums and glass bottles.Stainless steel is used in processing plants

C. Water with trace metal is often a cause of rancidity in food products.

Light

A. Exclude light.
Stainless Steel and dark bottles.
Light is energy – it works as a "pro-oxidant".

Process in "low energy light"?



Type of Fat

A. Unsaturated fats are more susceptible oxidation and oxidative rancidity.

B. Natural antioxidants in fat protect against oxidation vegetable fats, although more unsaturated, are usually more stable than animal fats because they contain natural antioxidants.

Olive varieties vary in concentration of natural antioxidants

Products from fat oxidation

A. Traces of oxidized fat in ingredients accelerate oxidative rancidity.

Olives oxidize! If they initiate oxidation prior to milling, there will be products of oxidation in the processed oil. Those products of Oxidation increase oxidation rate in the processed oil.

A QUICK

OVERVIEW

- **Fatty Acid Structure**
- **What is Oil (FAT)**
- **How Does Oil Oxidize**
- **How Do We Limit Oxidation**

START IN THE ORCHARD

1. Olive Variety
   Differ in antioxidant concentrations
   Phenolics, Chlorophylls, Carotenoids, Sterols
2. Health of the Olives
   Olive Fly!
3. Health of the Trees
4. Harvesting Time and System
   Maturity (water content) – Mechanical vs Hand Harvest
5. Time to Milling (Conditions from picking to milling)
6. Milling System and Miller

Oil Processing and Bottling

1. Cleanliness – Steam!
   Stainless Steel and Glass
   Cannot effectively clean plastic
2. Time to Racking
   Sediment contains water and organics – microbial activity, fermentation, enzymatic activity, minerals
3. Storage
   dark, cool and in stainless steel or glass – under Nitrogen or Argon
4. Educate your consumer!