

# **Lipid oxidation in foods and its implications on proteins**

## **Introduction – Why should we be interested in the oxidation of lipids and proteins?**

### **Scientific background**

- Food undergoes many chemical transformations during its production, transport and storage.
- Lipids and proteins are particularly vulnerable to oxidation, which can alter their nutritional, sensory and functional quality.

### **Issues**

- Lipid oxidation generates free radicals that attack proteins, causing them to oxidize and aggregate.
- These phenomena reduce the digestibility, stability, texture and shelf life of food.

### **Objectives of the article**

- Describe the mechanisms of lipid oxidation.
  - Investigate its effects on dietary proteins.
  - Present methods for evaluating oxidation and protein aggregation.
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## Mechanisms of lipid oxidation – How lipids break down

### Types of oxidation

- **Auto-oxidation** : a chain reaction triggered by light, heat or metals.
- **Photooxidation** : activation by light and singlet oxygen.
- **Enzymatic oxidation** : catalyzed by enzymes such as lipoxygenases.

### Steps of auto-oxidation

1. **Initiation** : formation of free radicals from unsaturated fatty acids.
2. **Spread** : Radicals react with oxygen to form peroxides.
3. **Termination** : formation of stable compounds or lipid polymers.

### Formed Products

- **Hydroperoxides** : primary indicators of oxidation.
  - **Volatile compounds** : aldehydes, ketones, alcohols responsible for the loss of aroma and taste.
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## **Consequences of lipid oxidation – Impact on food and protein**

### **Effects on food**

- Appearance of rancidity, loss of taste and aroma.
- Deterioration of colour (e.g., meat turning brown).
- Reduction of nutritional value (loss of vitamins, essential fatty acids).

### **Effects on proteins**

- Oxidation of sensitive amino acids (Cys, Met, Lys, Trp).
- Formation of disulfide bonds and hydrogen bonds → aggregation.
- Modification of the secondary structure ( $\alpha$ -helix → random winding).

### **Examples**

- In rice: loss of viscosity and whiteness.
- In meat: loss of tenderness, juiciness and colour.

## **Oxidation Assessment Methods – How to Measure Damage**

### **Lipids**

- **Primary Products :**
  - Peroxide (PV) value: iodometry, ferrithiocyanate.
  - Infrared spectroscopy, chromatography (GC, HPLC).
- **Secondary products :**
  - MDA, TBARS: rancidity indicators.
  - Anisidine value, oxidation stability index (OSI).

### **Protein**

- **Chemical markers :**
  - Carbonyl groups, sulfhydryls, di-tyrosine.
- **Physical methods :**
  - UV spectroscopy, fluorescence, X-ray diffraction.
  - Analysis of the secondary structure (CD, FTIR).

### **Sensory evaluation**

- Used to judge aroma, texture and colour.
  - Complementary to chemical methods.
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## **Protein aggregation – When oxidation changes the structure**

### **Mechanisms**

- Oxidation causes changes in the amino acid side chains.
- Formation of disulfide bridges, covalent bonds and hydrophobic interactions.
- The result: protein aggregation → loss of solubility and functionality.

### **Functional consequences**

- Decreased digestibility (e.g., pepsin, trypsin).
- Loss of foaming and emulsification capacity.
- Alteration of texture (e.g., harder gel, less tender meat).

### **Examples**

- Rice: aggregation of proteins from its → loss of digestibility.
  - Meat: oxidation of myoglobin → brownish colour, loss of juiciness.
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## **Conclusion and outlook – What to remember and where to go**

### **Synthesis**

- Lipid oxidation is a major factor in food degradation.
- It directly affects proteins, changing their structure and functions.
- Evaluation methods allow for a better understanding and control of these phenomena.

### **Research perspectives**

- Better understand lipid-protein interactions.
- Develop natural antioxidant strategies (e.g., polyphenols, active packaging).
- Extend studies to plant foods, which are often neglected.