# Fostering sustainability with shelf-life management solutions for tortillas

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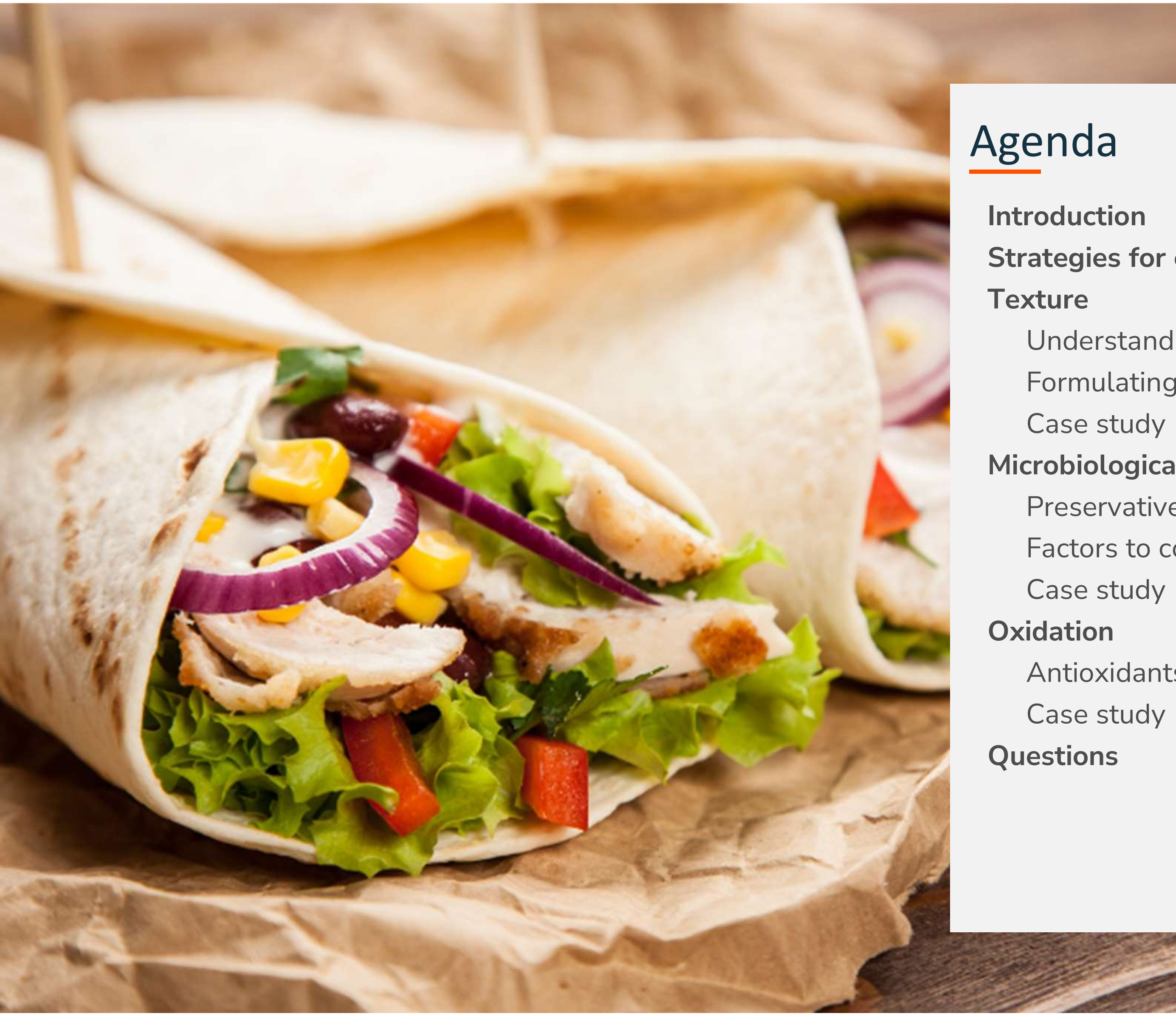
TORTILLA INDUSTRY ASSOCIATION
TIA



## Agenda

**Introduction**

**Strategies for extending shelf life**

**Texture**

- Understanding texture, factors to consider
- Formulating with the right ingredients
- Case study

**Microbiological**

- Preservatives and how they function
- Factors to consider
- Case study

**Oxidation**

- Antioxidants and how they work
- Case study

**Questions**

# Food Waste

Across all food categories, bakery products are the most wasted food group, due to:

- Misunderstanding of best-before dates
- Food spoilage
- Over-purchasing

**1/3** of all food produced globally goes to waste each year

**8%** of global GHG emissions are caused by food loss and waste

**1/4** of all water used by the agriculture sector around the world

If global food waste were a country, it would be the **third largest GHG emitting country** in the world.

**Food waste has become a major environmental and business issue, as consumers, customers and competitors all seek cost savings and enhanced sustainability.**

With 240,000,000 slices discarded so for in 2024, bread is the single largest source of avoidable food waste globally.

Consumers identify preservation as a solution for food waste reduction

**98% of consumers** are actively trying to reduce food waste

Best Before: DD MM YYYY

**74% of consumers** believe preservatives are important in the foods they purchase

**69% of consumers** would purchase a product formulated to help reduce food waste

**1/3 of consumers** will switch to brands or products with longer/better shelf life

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# Strategies for Extending Shelf Life

Maintain Product Texture

Delay Microbial Growth

Delay Oxidation of Fats & Oils

All three aspects of shelf life need to be considered so they don't become limiting factors in determining shelf life


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# Maintaining Texture

## STALING

Chemical and physical process in baked goods resulting to dryness and firming thereby reducing their freshness and palatability.

Associated with starch retrogradation where gelatinized starch molecules, once they start to cool down, recrystallize into their linear structure releasing moisture and start firming up.

Causes:

- Starch retrogradation
- Moisture migration

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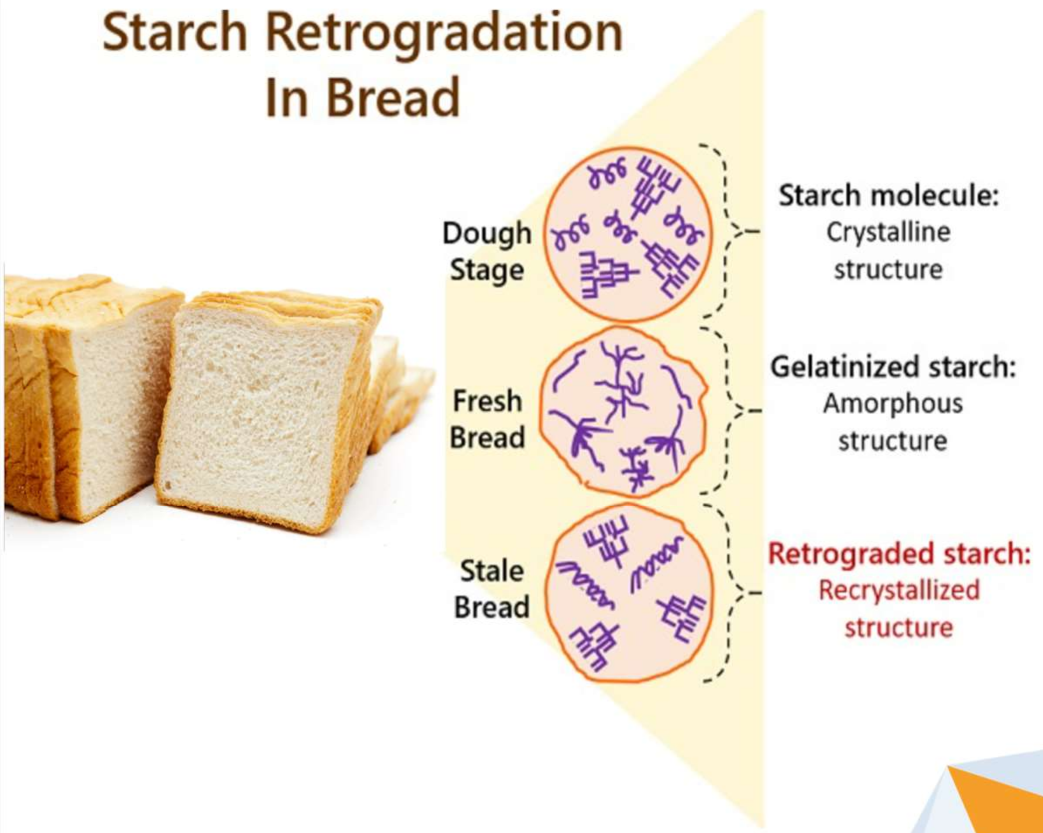
## Maintaining Texture

### Retrogradation

When linear molecules amylose and the linear parts of amylopectin chains in cooked, gelatinized starch realign and return to their original, crystalline structure as the cooked starch granule cools.

As the starch molecules realign, water can be expelled (syneresis) which then evaporates resulting to drier crumb.

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# Maintaining Texture

## How to tackle staling?

Three basic approaches to crumb softness

| Solution | Example |
|---|---|
| Delay starch retrogradation | Emulsifiers (mono and di-glycerides, lecithin) |
| Hydrolyze starch / fat | Enzymes (amylases, lipases) |
| Prevent moisture migration | Water-binding ingredients (fibers, gums)<br>Water activity control (invert sugar, glycerin) |

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# Maintaining Texture - Emulsifiers

Surface active agents containing both fat-loving and water-loving ends

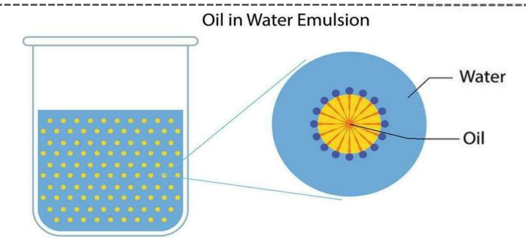
Bring together ingredients that are normally immiscible, like oil & water, reducing surface tension between these interfaces

Complex with starches delaying staling & retrogradation

Create a drier surface giving the dough a waxy-like feel, making it less sticky and easier to sheet/press

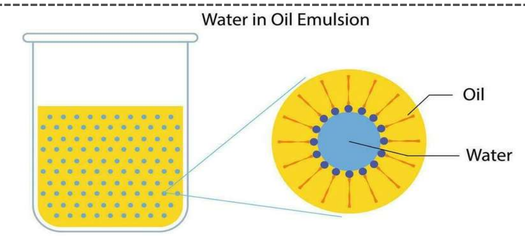
**Mono & diglycerides**

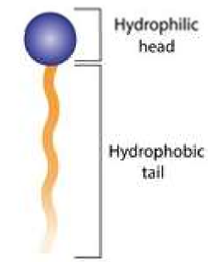
- ✓ Prevents stickiness
- ✓ Provides strength & flexibility




**Lecithin**

- ✓ Label-friendly
- ✓ Liquid or de-oiled

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# Maintaining Texture - Enzymes

**Amylase**

acts on amylose; cleaving certain branches of the starch molecule and preventing the starch structure from re-aligning into a rigid form

**Xylanase**

acts on xylans/hemicellulose
converts insoluble xylans to soluble xylans which help to re-distribute the water in the system

**Lipase**

acts on lipids
converts triglycerides into mono and diglycerides

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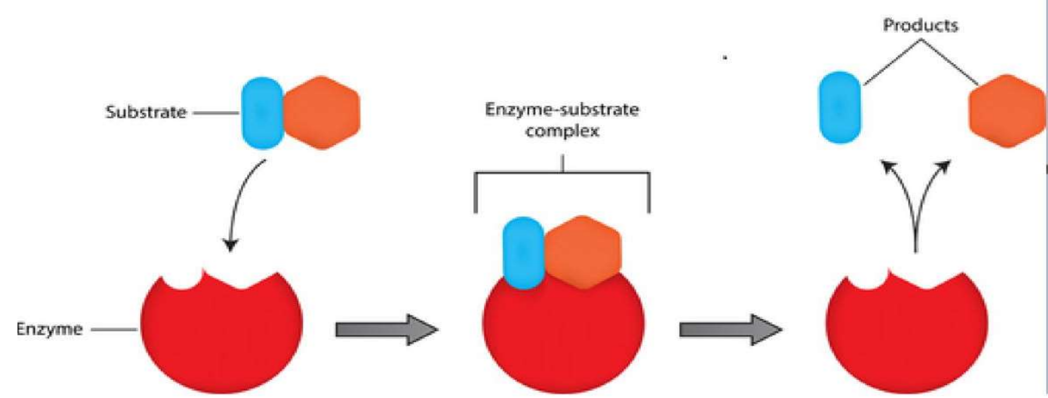
## Enzymes

- Proteins that act as biochemical catalysts
- Very specific in the reaction they affect
- Lock and key mode of reaction – substrate is the key and enzyme is the lock

**The Lock and Key Mechanism**



# Maintaining Texture - Hydrocolloids

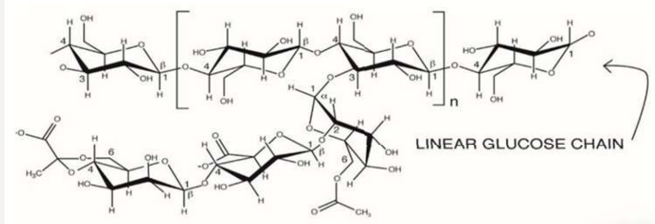
Used in tortillas for moisture management and water binding delivering better texture over shelf life

Provide strength and flexibility both at dough stage and after bake

Help with freeze-thaw stability minimizing moisture release during thawing stage thus reducing stickiness

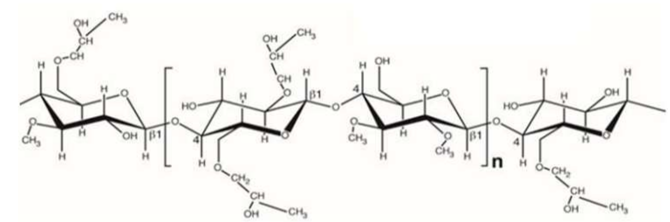
**Xanthan Gum**

- ✓ Functions in a wide range of temps & pH
- ✓ Synergistic with other gums
- ✓ Binds moisture, gives strength & flexibility



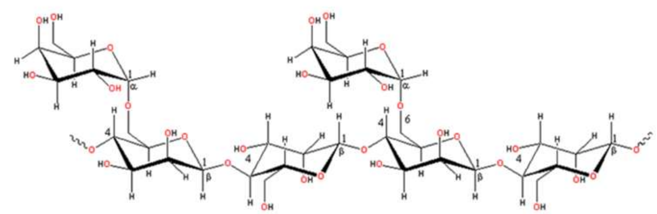

**Cellulose Gum**

- ✓ Wide range of viscosities
- ✓ Contributes to freeze-thaw stability



**Guar Gum**

- ✓ Provides cohesion, dough strength for improved machinability
- ✓ Binds moisture



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# Case Study - Texture

**Objective**

- Evaluate effect of enzyme, gums and emulsifier in extending flour tortilla texture over shelf life
- Determine if synergy exists when combined

**Study Design**

- Flour tortillas were prepared
- Performance benchmarked against negative
  control (no texture additive)
- 5 tests samples prepared
- Tortillas were frozen and then stored at ambient temperature
- Organoleptic evaluation (roll test) daily

| | Negative Control | Test 1 | Test 2 | Test 3 | Test 4 | Test 5 |
|---|---|---|---|---|---|---|
| Treatment | No additives | Emulsifier | Gum | Enzyme | Emulsifier + Enzyme | Gum + Enzyme |
| Day 0 |  |  |  |  |  |  |

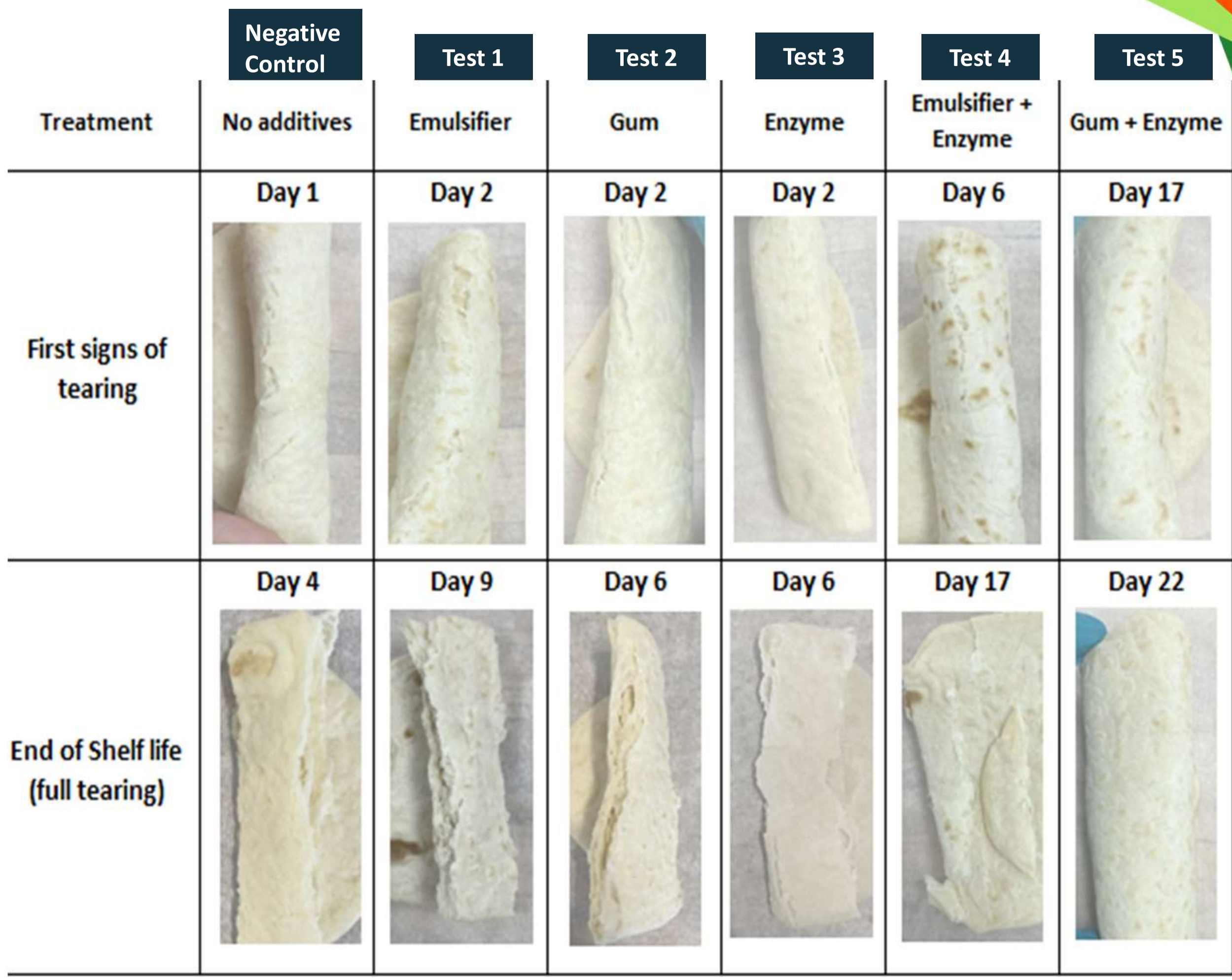
# Case Study - Texture

**Results**

- All 3 ingredients (emulsifier, gum and enzyme) used on their own extends the flexibility of tortillas for couple of days
- Test 4 & Test 5 (with combined ingredients) extended flexibility longer with T5 performing significantly better

**Conclusion**

Combining emulsifier or gum with enzyme extends the flexibility of tortillas longer than when these ingredients are used alone.



| | Negative Control | Test 1 | Test 2 | Test 3 | Test 4 | Test 5 |
|---|---|---|---|---|---|---|
| Treatment | No additives | Emulsifier | Gum | Enzyme | Emulsifier + Enzyme | Gum + Enzyme |
| First signs of tearing | Day 1 | Day 2 | Day 2 | Day 2 | Day 6 | Day 17 |
| End of Shelf life (full tearing) | Day 4 | Day 9 | Day 6 | Day 6 | Day 17 | Day 22 |

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# Microbiological Shelf Life

Length of time the product stays microbiologically safe for consumption.

- Molds – main cause of spoilage in foods
- Baked products susceptible to mold growth due to high moisture content and high water-activity

**Factors to consider to help inhibit mold growth:**

**Water Activity (Aw)** – partial vapor pressure of water in the product over the partial vapor pressure of pure water at the same temperature

Aw of water = 1

- High Aw products support more microorganism
- Below certain Aw, mold growth can be inhibited = longer SL
- Aw also helps limit moisture migration within a baked product with multiple components (e.g. pies, filled cookies)

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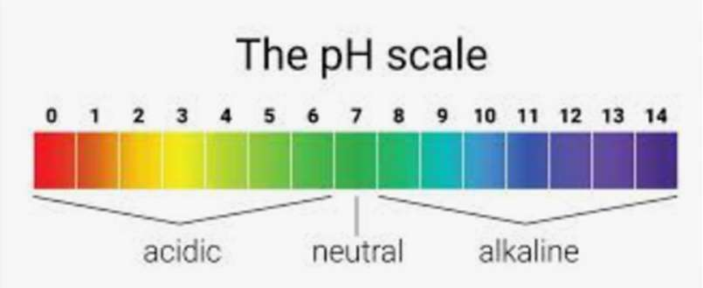
| Group of Micro-Organisms | Minimum $a_W$ required for growth |
|---|---|
| most gram-negative bacteria | 0.97 |
| Staphylococcal toxin production (by Staphylococcus aureus) | 0.93 |
| most gram-positive bacteria | 0.90 |
| most yeasts | 0.88 |
| Staphylococcus aureus | 0.86 |
| most moulds | 0.80 |
| Halophilic bacteria (grow best at high salt concentrations) | 0.75 |
| Xerophillic moulds (can grow on dry foods) and Osmophillic yeasts (can grow in high concentrations of organic compounds, ex: sugars) | 0.62-0.60 |

| Product | Water Activity | Moisture Content(%) |
|---|---|---|
| Flour tortilla | 0.922 | 30.8 |
| Pepperoni | 0.878 | 31.6 |
| Cream cheese | 0.991 | 53.4 |
| Butter | 0.894 | 15.9 |
| Oreo cookies | 0.309 | 1.40 |
| Potato chips | 0.182 | 1.30 |

# Microbiological Shelf Life




**Factors to consider to help inhibit mold growth:**

**pH** – concentration of hydrogen ions in solution

- pH below 7 has a high concentration of hydrogen ions and referred to as "acidic"
- pH greater than 7 has low concentration of hydrogen ions and referred to as "basic"
- Pure water has pH = 7
- Acidic environment can limit the growth of some molds

**Temperature** – room temperature with high humidity is optimal for most molds to grow.

**Post-bake contamination**
Handling
Environment
Packaging
Storage conditions

# Microbiological Shelf Life

**Ingredients to help inhibit mold growth:**

**Mold inhibitors (preservatives)** – additives that are effective in controlling mold growth on their own or in combination.

## Chemical Preservatives

Works most effectively/optimally at lower pH ranges (below pH 6), commonly regulated in dosage levels.

**Propionates**

Calcium propionate

Sodium propionate

**Sorbates**

Potassium sorbate

**Benzoates**

Sodium benzoate

## Clean-label Mold Inhibitors

Typically, products of fermentation that create natural sources of organic acids to prevent mold growth.

- Cultured carbohydrates (starches, flours, or sugars)
- Effective at pH <6
- Best used in combination with acid e.g. fumaric acid, vinegar
- Have impact on color and flavor depending on dosage

# Consumer Demand Rising for Cleaner Label Preservatives

## There's Potassium Sorbate in My Food — Is That Safe?

- **Potassium Sorbate:** A preservative used to suppress formation of molds and yeasts in foods, wines and personal care products. In-vitro studies suggest that it is toxic to DNA and has a negative affect on immunity.

CBS EVENING NEWS ›

**U.S. food additives banned in Europe: Expert says what Americans eat is "almost certainly" making them sick**


- Rising consumer concerns around chemical preservatives
- Online misinformation still impacts consumer perceptions
- "Preservative-free" or "free-from artificial ingredients" product launches have been trending for years, with major CPG and restaurant brands participating

International Food Information Council — 64% of consumers "try to choose foods made with clean ingredients"

MINTEL — 84% of Americans buy "free-from" foods because they believe them to be more natural or less processed

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## New clean label alternative

Natural fermented ingredient replacing conventional chemical preservatives

**Features**

- ✓ Naturally-derived from fermentation, clean label ingredient
- ✓ Gluten-free and non-gmo option is available
- ✓ Inhibits mold growth
- ✓ Replaces chemical preservatives and works optimally up to **pH 6.5**
- ✓ Suitable for both flour and corn tortilla
- ✓ **No impact on color, flavor and texture**

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# Case Study – new clean-label option

Shelf-life study in flour tortilla

**Treatments:**

- Negative Control (no preservative)
- Positive Control (calcium propionate + potassium sorbate)
- Test – new clean label option

*Fumaric acid added to all samples to adjust tortilla pH

| Parameters | Negative Control | Positive Control | Test (new clean label option) |
| --- | --- | --- | --- |
| pH | 5.43 | 5.61 | 5.49 |
| No of days SL | 5 | >56 | >56 |
| Sensory | Reference | Similar to neg Control, no off | Clean-tasting, comparable to Control (taste & color) |

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# Case Study – new clean-label option

Shelf-life study in corn tortilla

**Treatments:**

- Negative Control (no preservative)
- Positive Control (calcium propionate + potassium sorbate)
- Test – new clean label option

*Fumaric acid added to all samples to adjust tortilla pH

| Parameters | Negative Control | Positive Control | Test (new clean label option) |
|---|---|---|---|
| pH | 5.02 | 5.31 | 5.40 |
| No of days SL | 3 | >35 | >35 |
| Sensory | Reference, clean corn flavor | Similar to neg Control | Clean-tasting, no off smell, comparable to Control |

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# Delaying oxidation of fats and oils

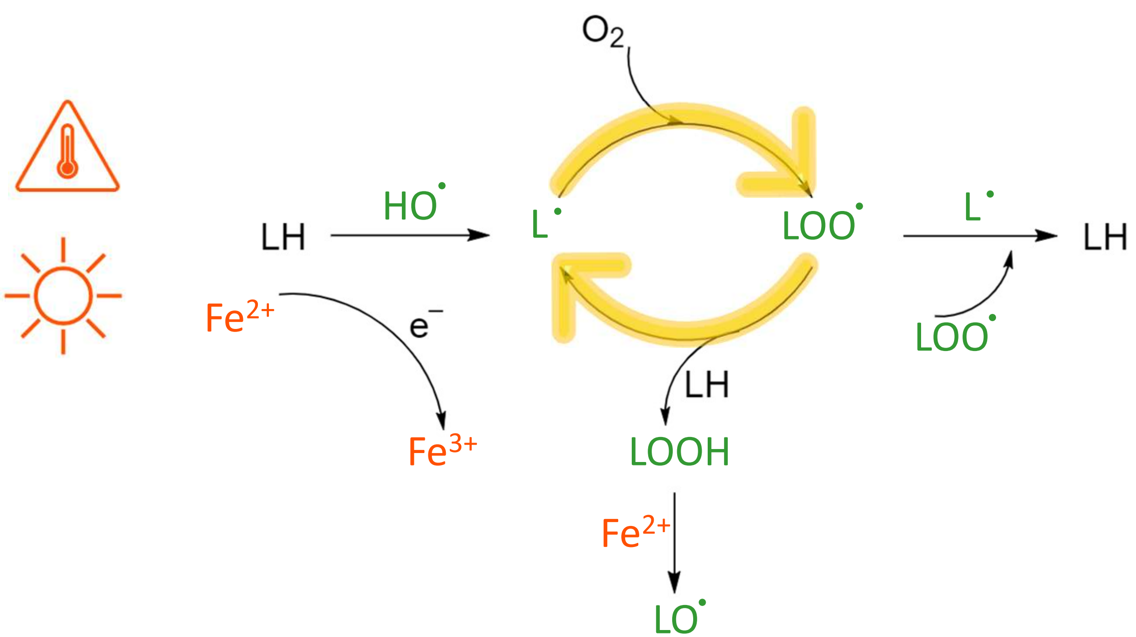
- Oxidation of fats/oils leads to rancidity
- Preservation of fats and oils in products during and through-out shelf life:
  Important for **taste**, **texture**, and overall **consumer experience** as well as in keeping the **nutritional value** of unsaturated fats

**Oxidation**

- Chemical reaction that occurs with fats or oils interacting with air leading to the degradation of unsaturated fats
- Results to rancidity in oil with accompanying off flavor and smell
- Accelerated by heat, light, presence of moisture/water, metal ions (e.g. iron)
- Contributing factors lead to generation of free radicals which create primary and secondary oxidation species
- Antioxidants protect fats and oils from these free radicals

# Fats & oil oxidation – complex and multi-faceted

Initiation | Propagation | Termination




LH Unsaturated Fatty Acid

HO• Hydroxyl Radical

LOO• Lipid Peroxyl Radical

LOOH Lipid Hydroperoxide

LO• Lipid Oxyl Radical

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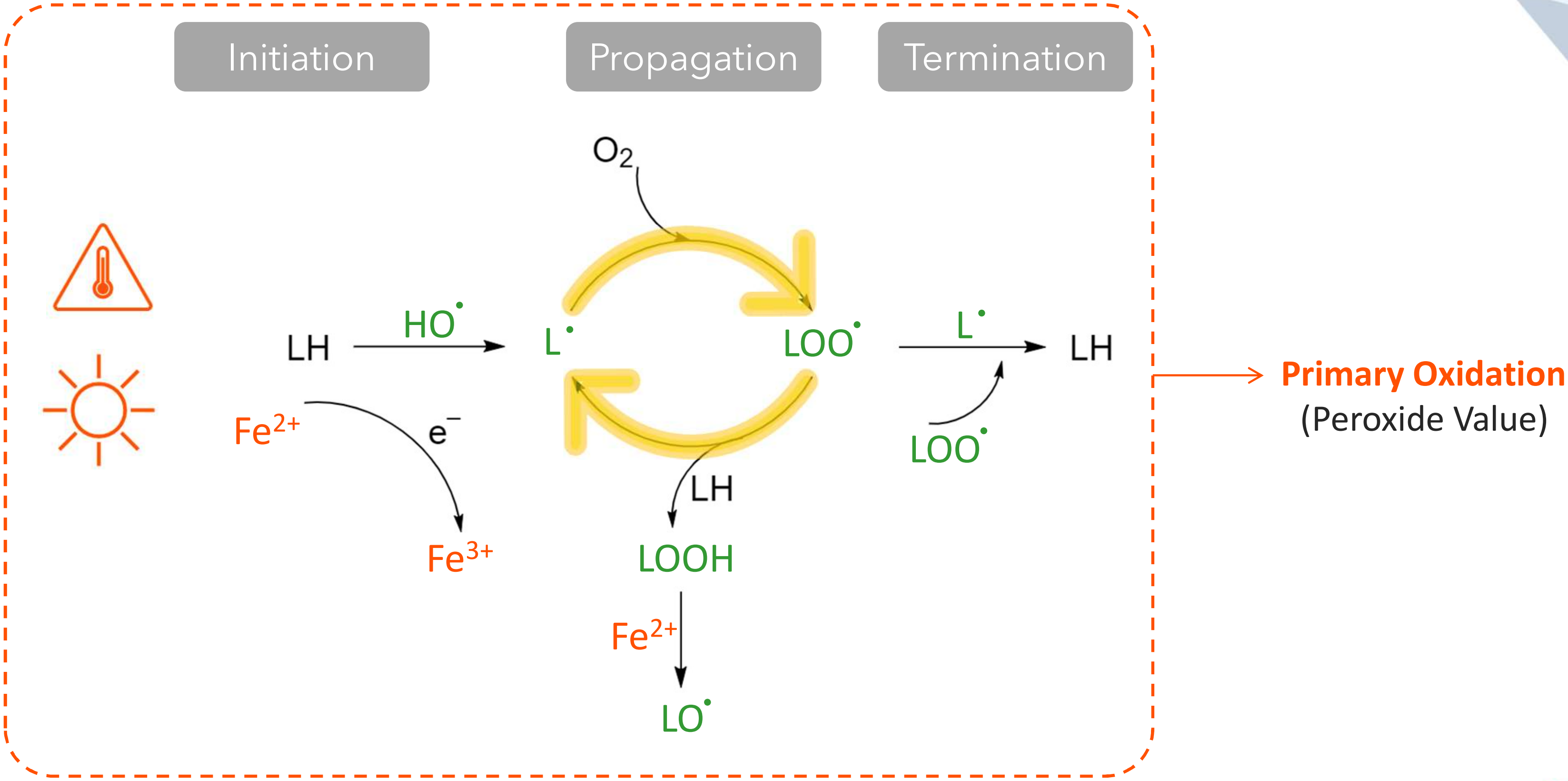
# Fats & oil oxidation – complex and multi-faceted

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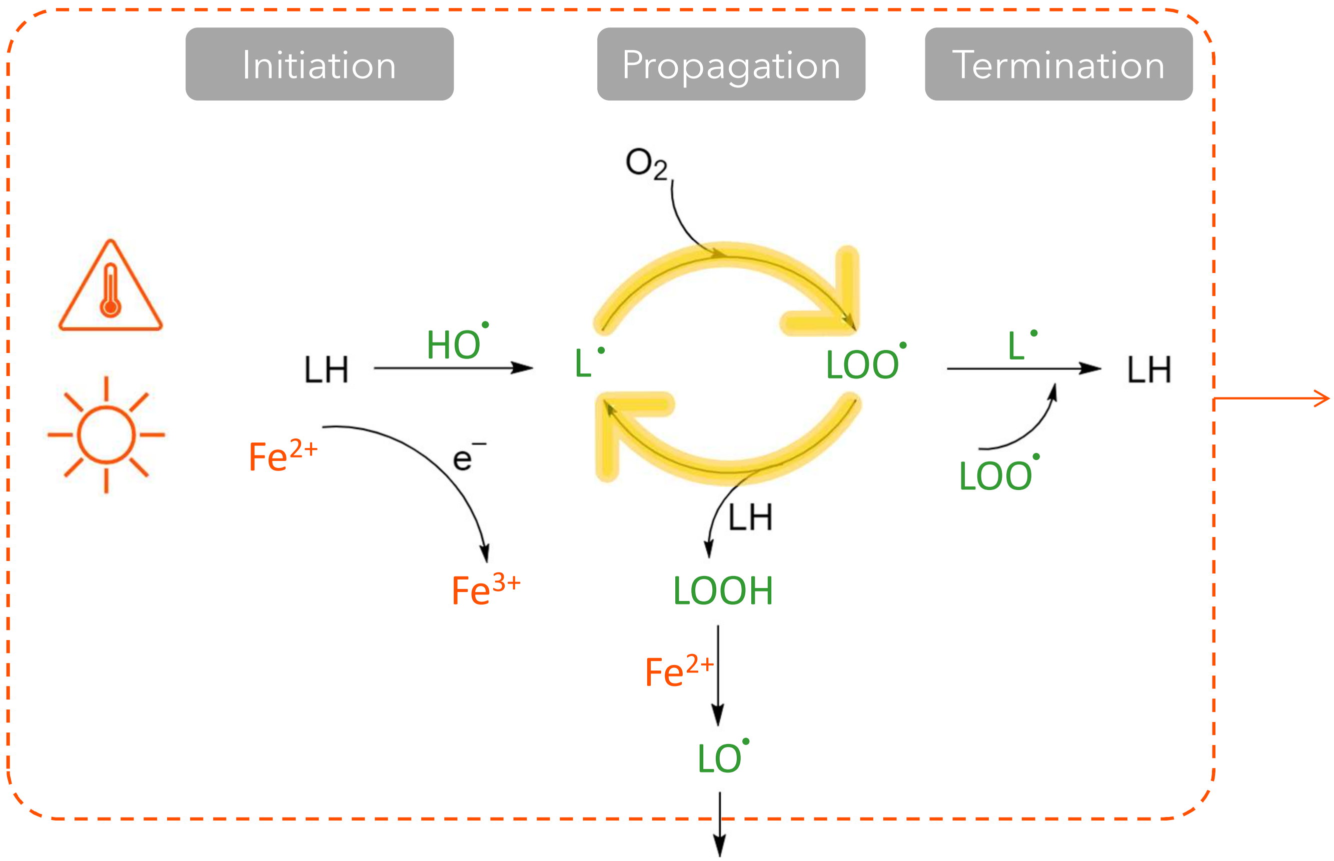


**Primary Oxidation**
(Peroxide Value)

**Secondary Oxidation**
Volatile Compounds – Off Flavor – Rancid Odor
(*p*-anisidine Value)

| | |
|---|---|
| LH | Unsaturated Fatty Acid |
| $HO^{\bullet}$ | Hydroxyl Radical |
| $LOO^{\bullet}$ | Lipid Peroxyl Radical |
| LOOH | Lipid Hydroperoxide |
| $LO^{\bullet}$ | Lipid Oxyl Radical |

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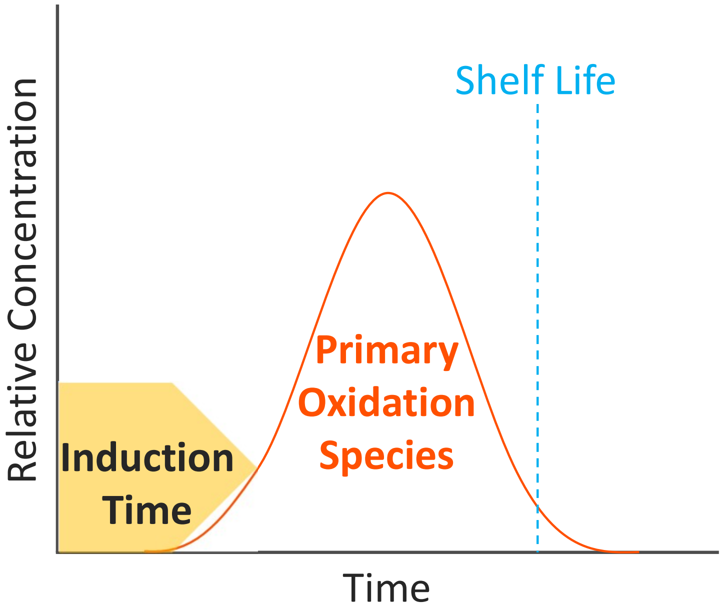
# Antioxidants – extension of induction time

No Antioxidant or Poorly Stabilized



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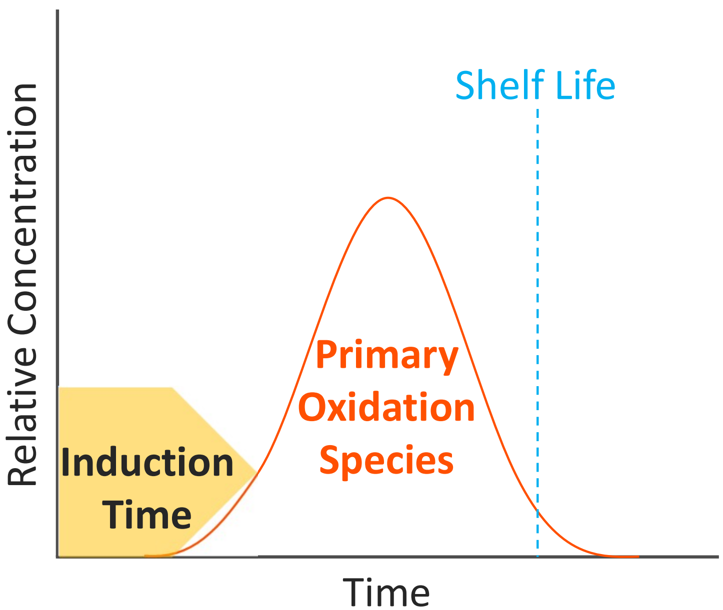
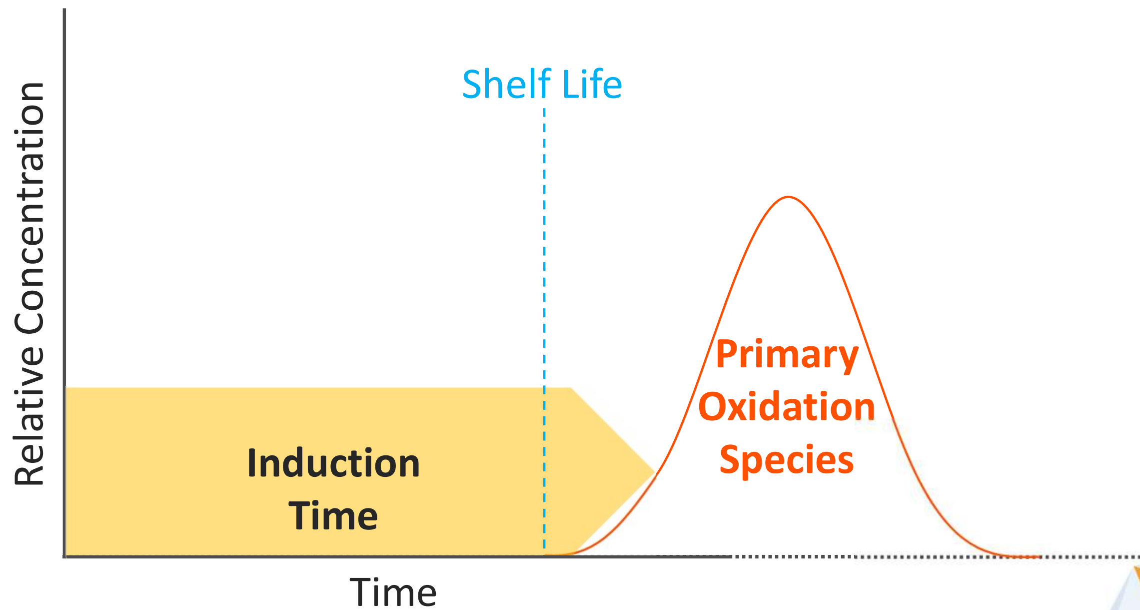



Adequately Protected with **Sufficient Quantity** of the **Appropriate Antioxidant**

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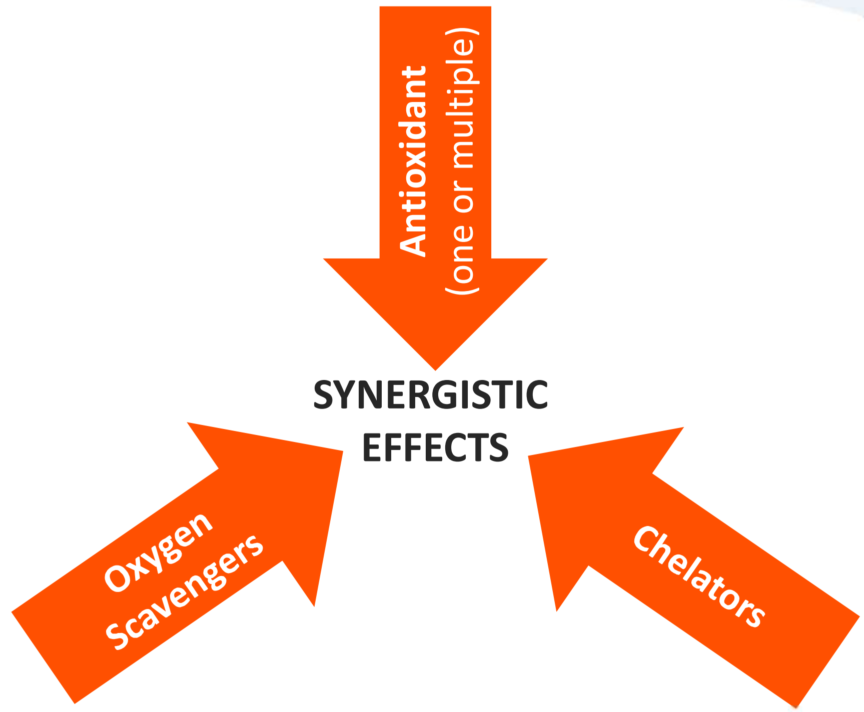
# Antioxidant systems

- **ANTIOXIDANTS**
  - Natural: Tocopherols, Rosemary, Green Tea
  - Synthetic: BHA, BHT, TBHQ, Propyl Gallate
- **CHELATORS**
  - Citric Acid
- **OXYGEN SCAVENGERS**
  - Ascorbic Acid




- **Antioxidant Systems**
  - Multi-component (may provide synergistic effects)
- **Different Oil, Different Matrix, Different Antioxidant System!**
  - **ONE SYSTEM DOES NOT FIT ALL!**

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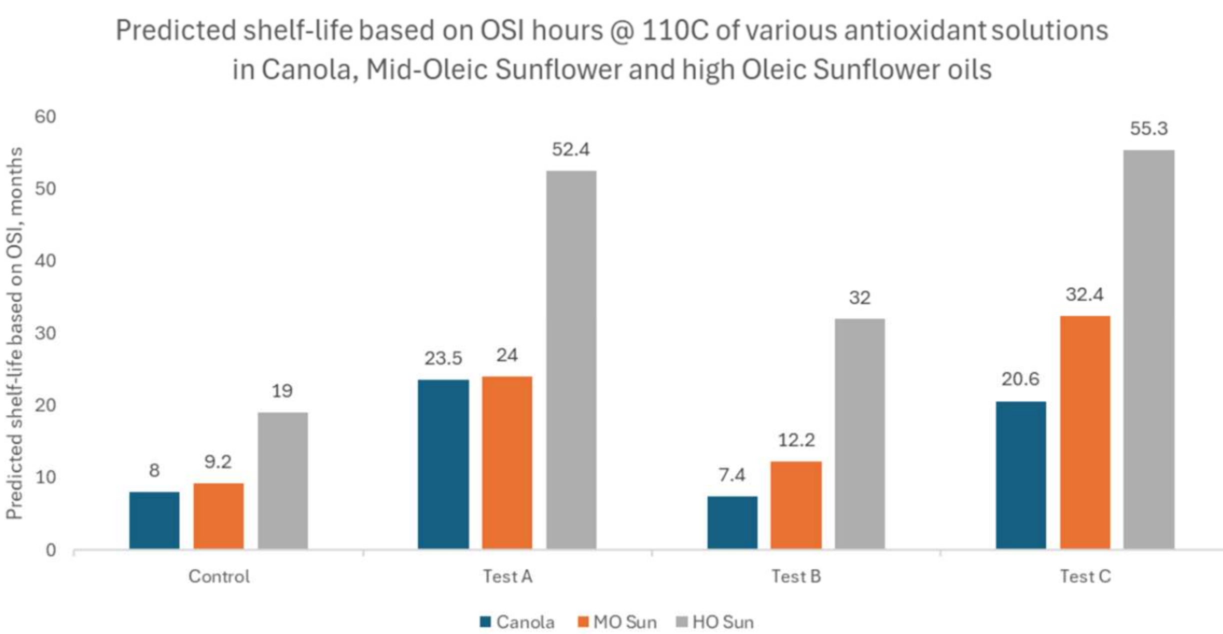
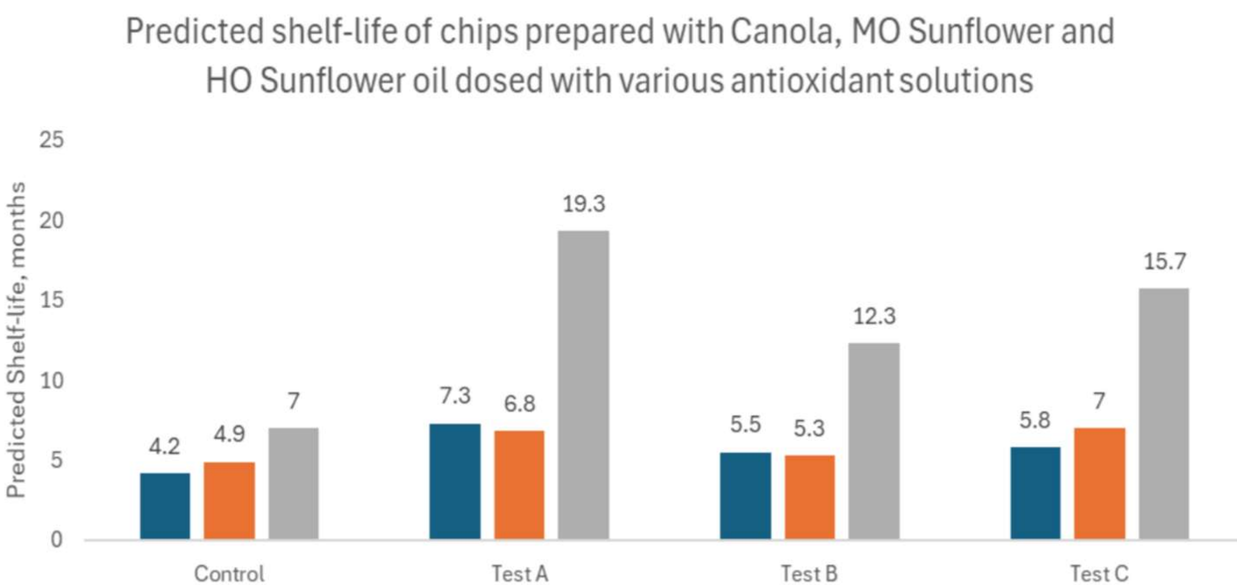
# Case Study 1 – Antioxidants In Oils




**Case Study: Antioxidant systems in different oils**

- Canola, MO Sun and HO Sun with different antioxidants:
  A - natural blend
  B – natural blend
  C - synthetic
- Measured projected shelf life using accelerated OSI testing

# Case Study 2 - Antioxidants in Oil for Fried Chips




**Case Study: Fried chips in different oils with different antioxidant systems**

- Canola, MO Sun and HO Sun with different antioxidants:
  A - natural blend
  B – natural blend
  C - synthetic
- Measured projected shelf life using oxygen bomb testing

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## Summary

- Food waste is a major concern contributing to total global gas emission and that it can be avoided
- When looking at managing or extending shelf life, have to take into account several aspects including: texture, microbiological shelf life and also fat oxidation, in the case of fried products
- With texture improvers, combining ingredients can create synergy effect resulting to even results
- For frying oils, protecting the oil early on in the process is key
- For antioxidant systems, no one solution fits all; have to find the combination of active ingredients depending on the type of substrate and matrix

# Thank You

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