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Fat and Animal Protein Quality:

Implications on Pet Food Performance and Stability



Jim Mann
Kemin Nutrisurance

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Agenda

- Introduction
- Impact of Oxidation on Quality
- Impact of Microbial Challenges on Quality
- Managing Risks

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- **29 years experience with Kemin focused on Petfood and Rendering**
- **Primary focus on Antioxidants and Food Safety**
- **10 years Quality, R&D, and CLS experience**
- **10 years Technical Service experience**
- **9 years Antioxidant Product Management experience**

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Pet Food Trends

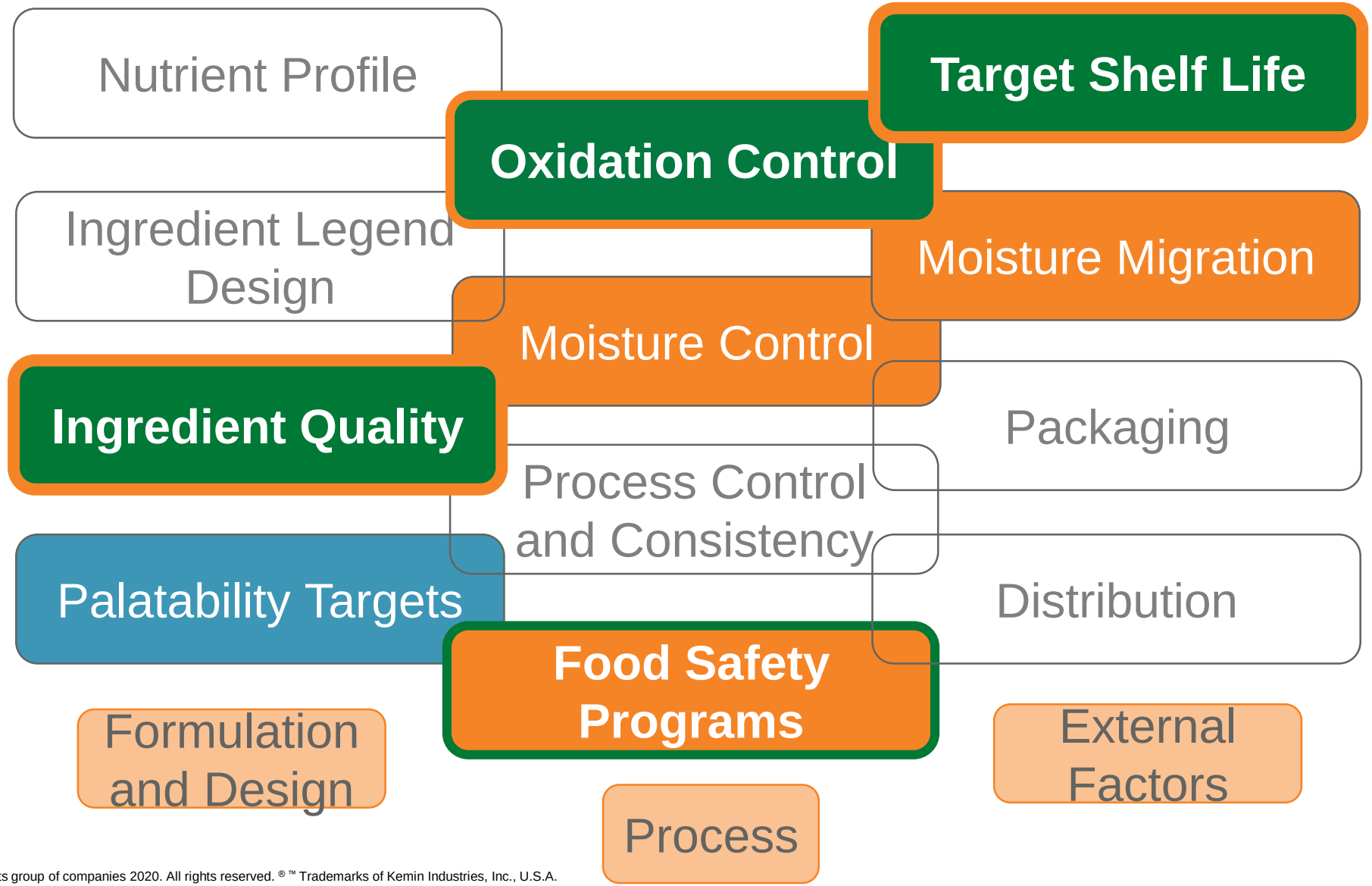
- Diets higher in unsaturated fats
  - Natural, organic, holistic
    - Vegetable oil substitution for animal fats
      - Algal meals and flax as Omega 3 sources
        - Corn alternatives (oat groats, flax, soybean, brown rice, other small grains, etc.)
          - Fresh meats and novel protein sources



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Pet Food & Raw Material Quality



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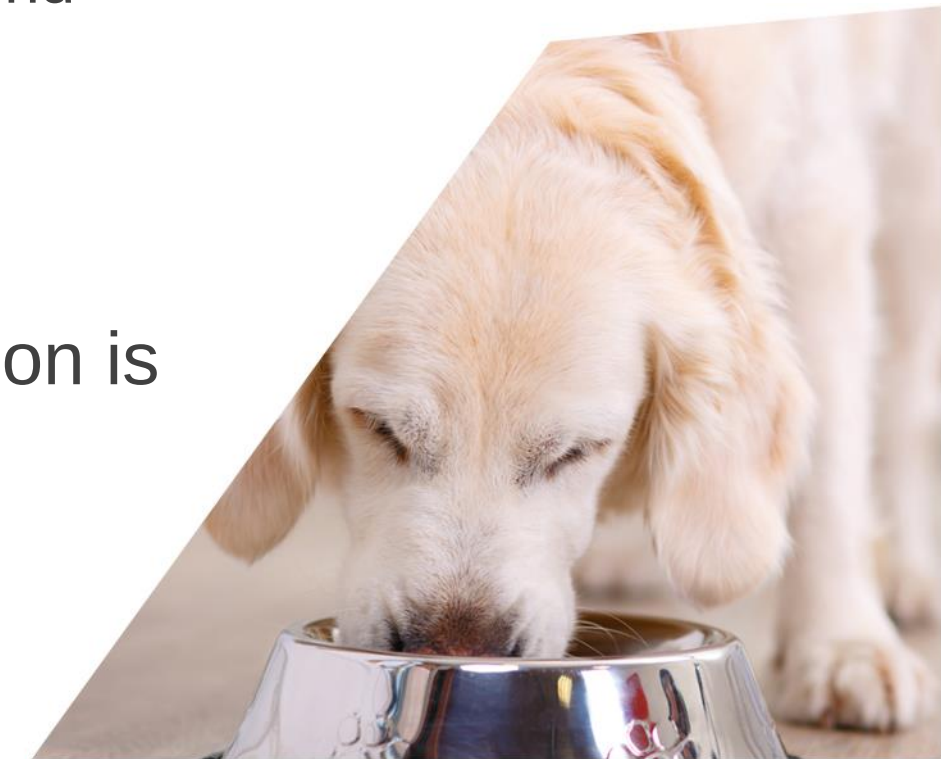
How Oxidation Affects Pet Food and Ingredient Quality



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Image: Shutterstock_230418733

What is Oxidation?

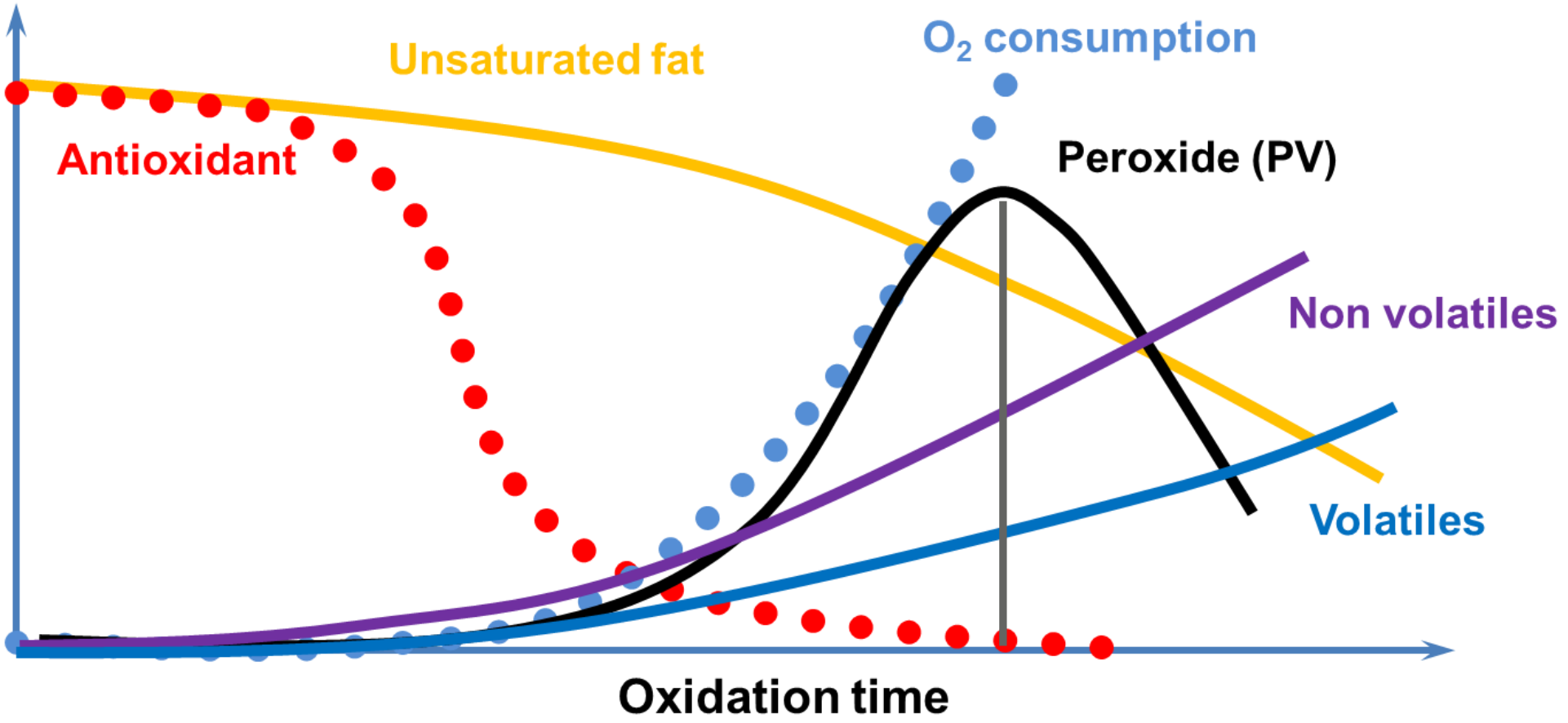
- Autoxidation in pet foods is a chemical process that degrades the nutritional and aesthetic properties of a pet food product or ingredient
  - Oxygen oxidizes molecules with a double bond
  - Initiated by free radicals
  - Oxidation regenerates free radicals
  - Self-propagating (cannot be reversed)
- The most common symptom of autoxidation is ‘rancidity’



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Lipid Oxidation Summary



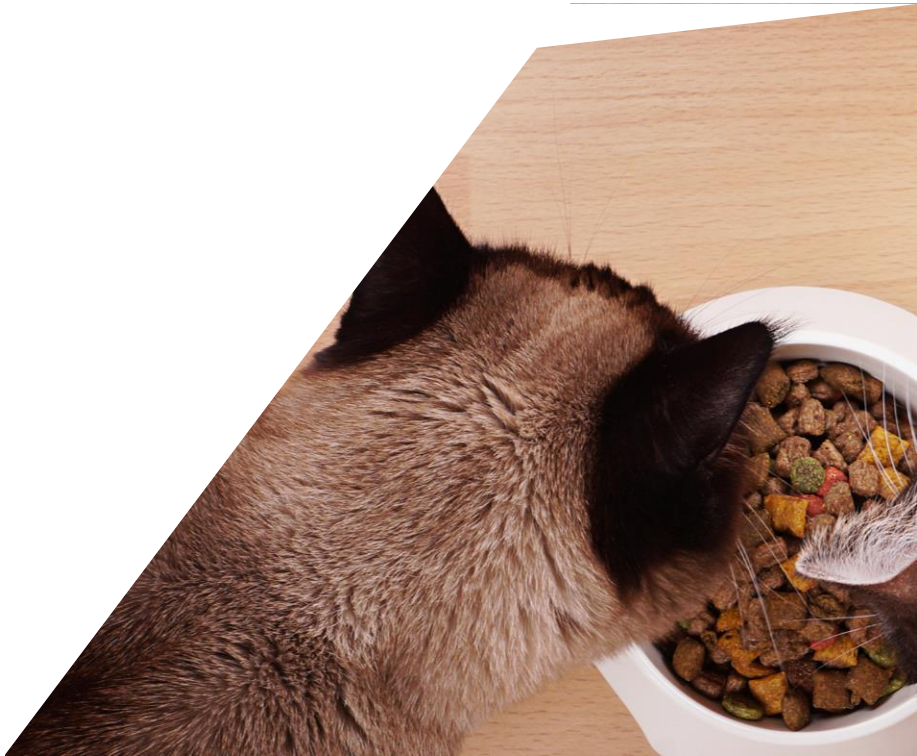
Initiation	Propagation	Termination

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Lubuza, T. P. Kinetics of Lipid Oxidation in Foods, *CRC Crit. Rev. Food Technol.* 1971. 2, 355-405.

Negative Effects of Oxidation

- Quality loss
  - Negative color and texture changes
  - Warmed-over flavor, negative palatability
- Economic loss
  - Consumer acceptance, loss of shelf-life
  - Brand loyalty
- Nutritional losses
  - Destruction of essential fatty acids
  - Vitamin loss
  - Toxicity



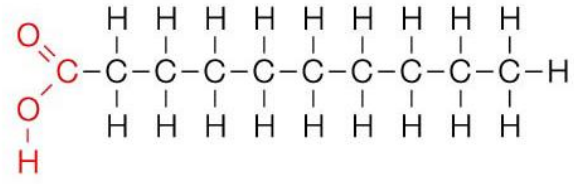
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Types of Fats

Saturated

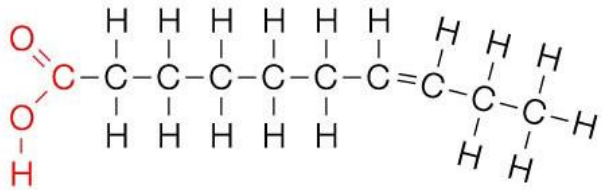




Less susceptible to oxidation

Unsaturated

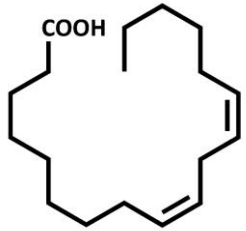




More susceptible to oxidation

Polyunsaturated





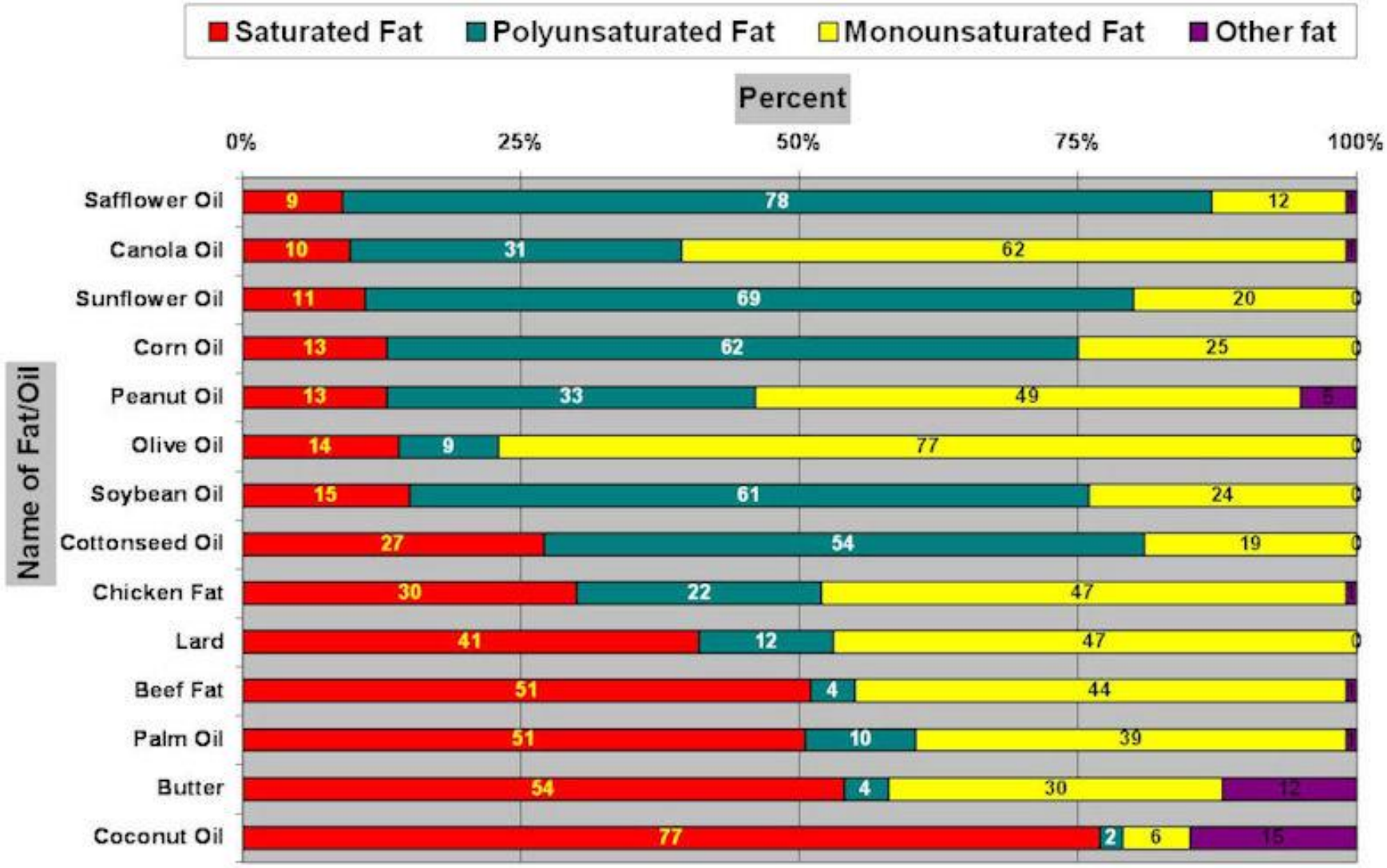
Very susceptible to oxidation

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Fatty Acid Composition



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Source: J.B. Reeves and J.L Weihrauch, Composition of Foods, Argricultural Handbook. 1992.

Reaction Rate per Double Bond

	Fatty acids	Relative rates	
	18:1 n9	1	
PUFA	18:2 n6	50	1
PUFA	18:3 n3	100	2
PUFA	18:4 n3,20:4 n6		3
PUFA	20:5 n3 (EPA)		4
PUFA	22:6 n3 (DHA)		5

Activation Energy decreases



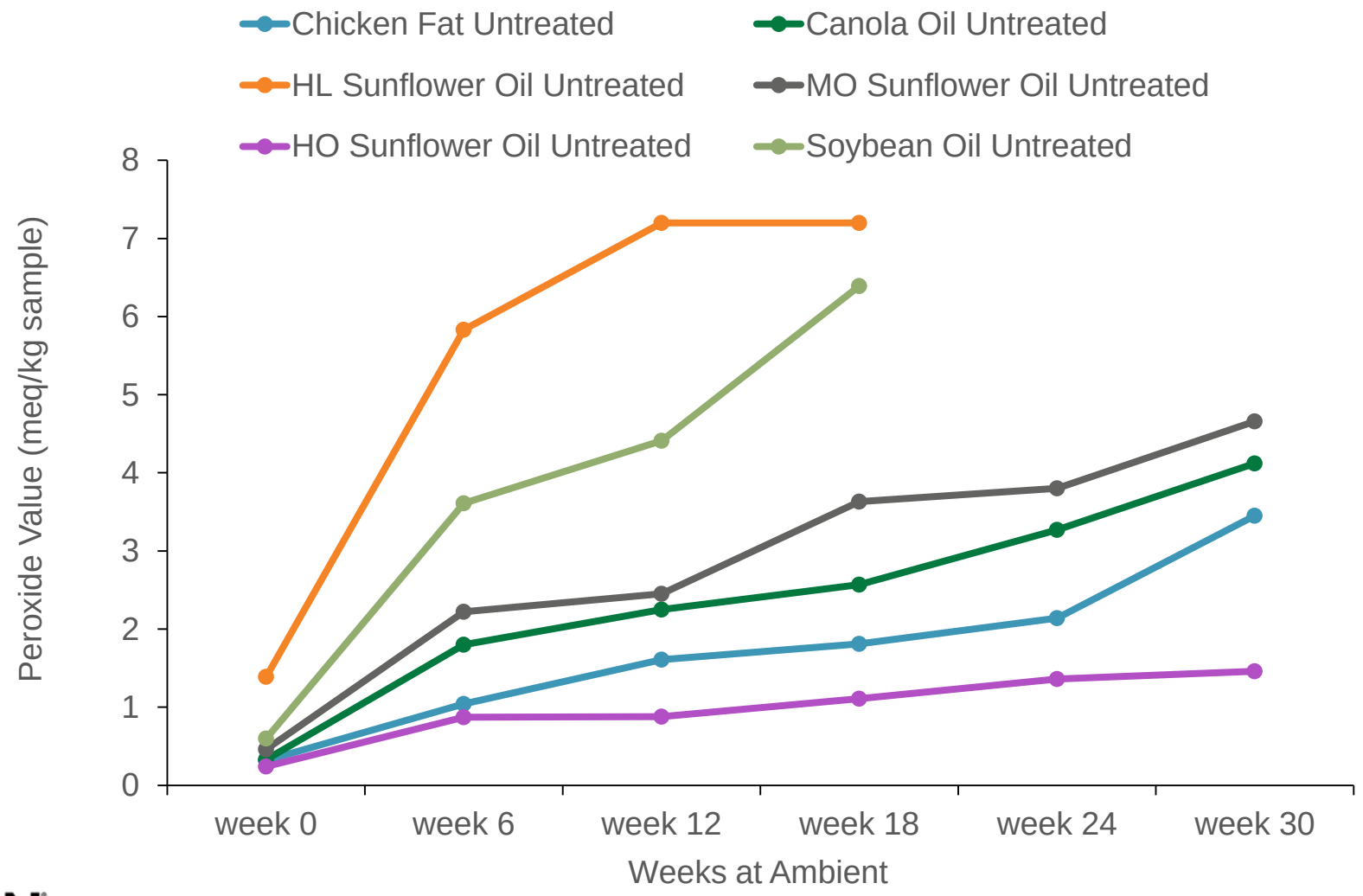
Increasing Oxidation Risk

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Reference: ***Lipid Oxidation, Second Edition,*** **E. N. Frankel The Oily Press, Bridgewater, England, 2005**

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Finished Diet Design- Enrobing Fat





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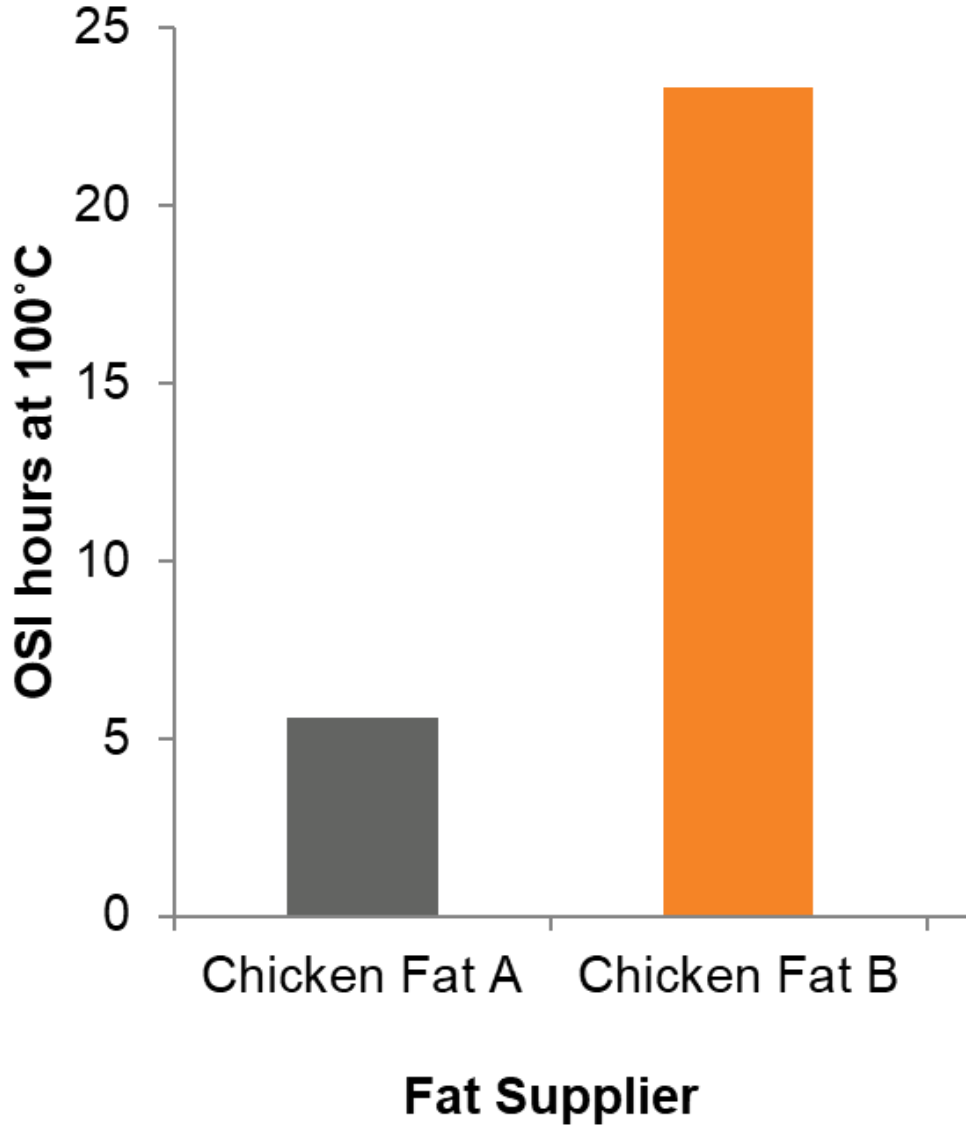
Impact of Supplier

- Appearance, fatty acid profile and oxidative stability can vary by supplier
  - Can have seasonal variation
  - Can vary with changing diet composition
    - Processing and origin of materials contribute to differences
      - Monitoring suppliers via vendor assurance assists in consistent quality



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Impact of Supplier

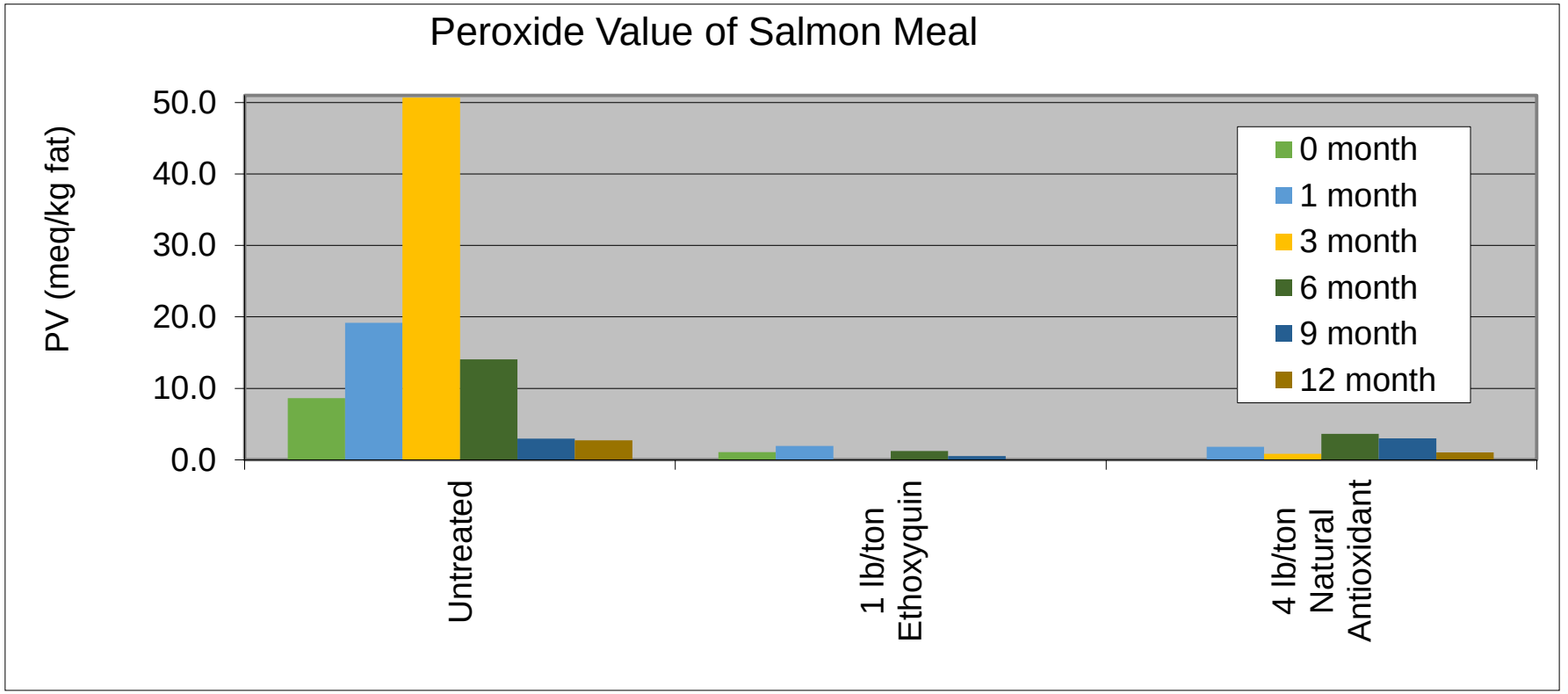




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Peroxide Values in Salmon Meal



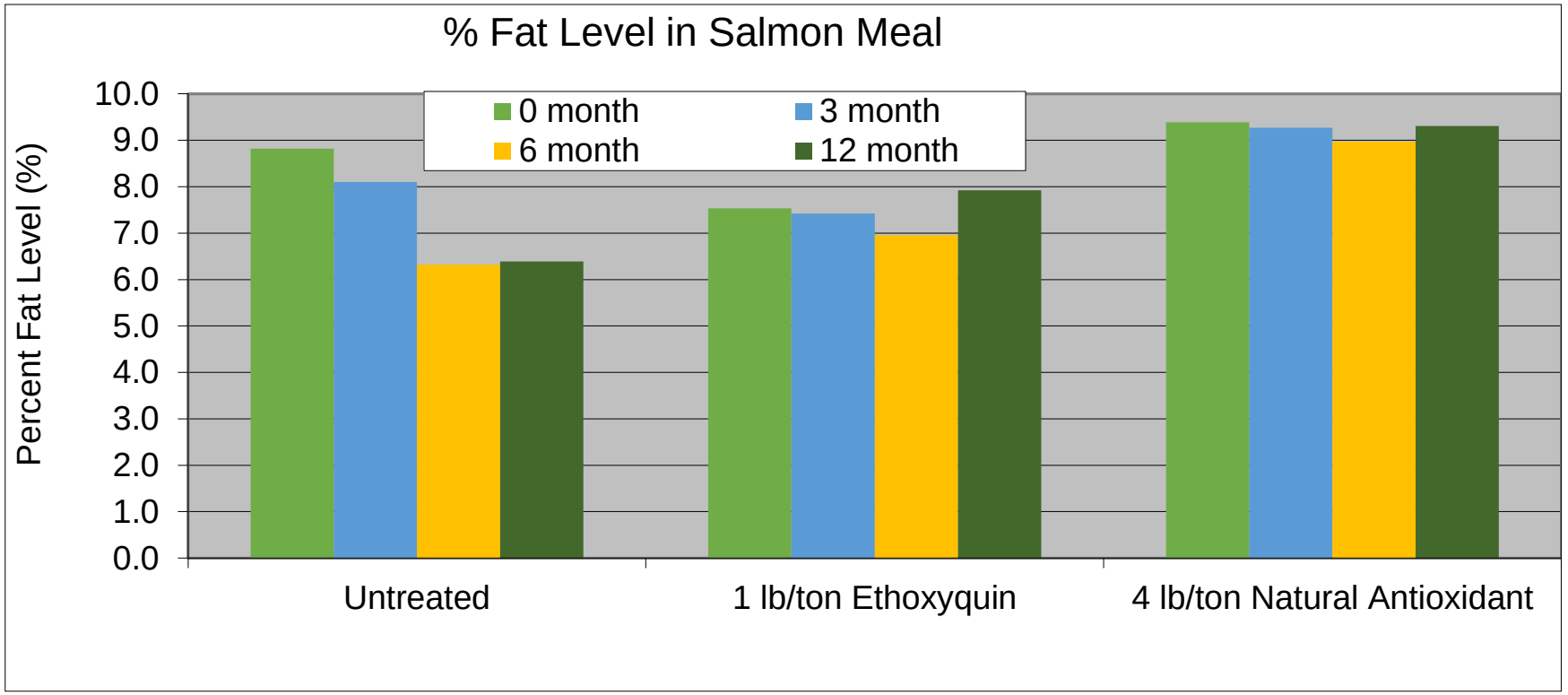


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Percent Fat Levels in Salmon Meal



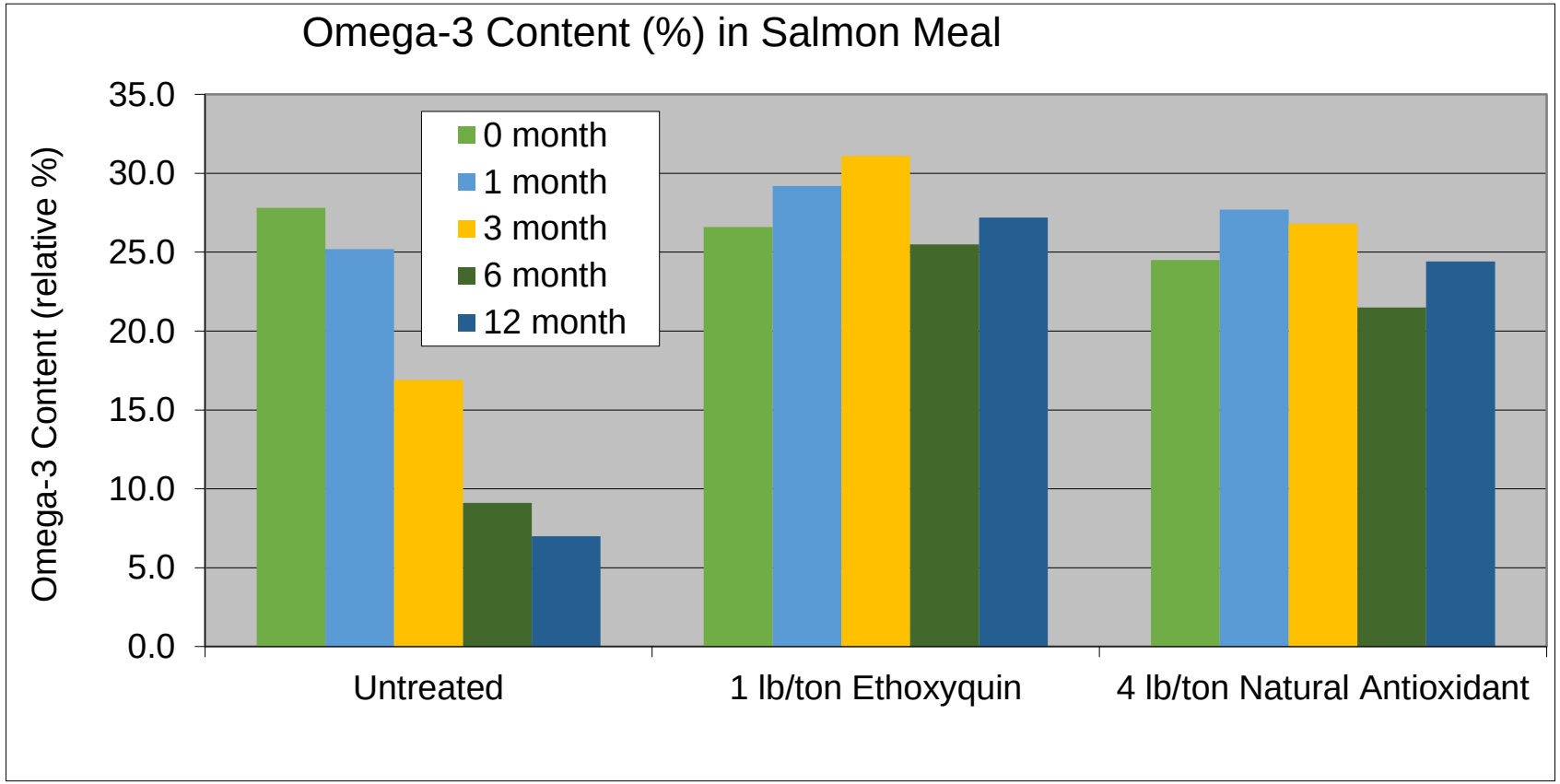


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Omega-3 Content (Relative %) in Salmon Meal





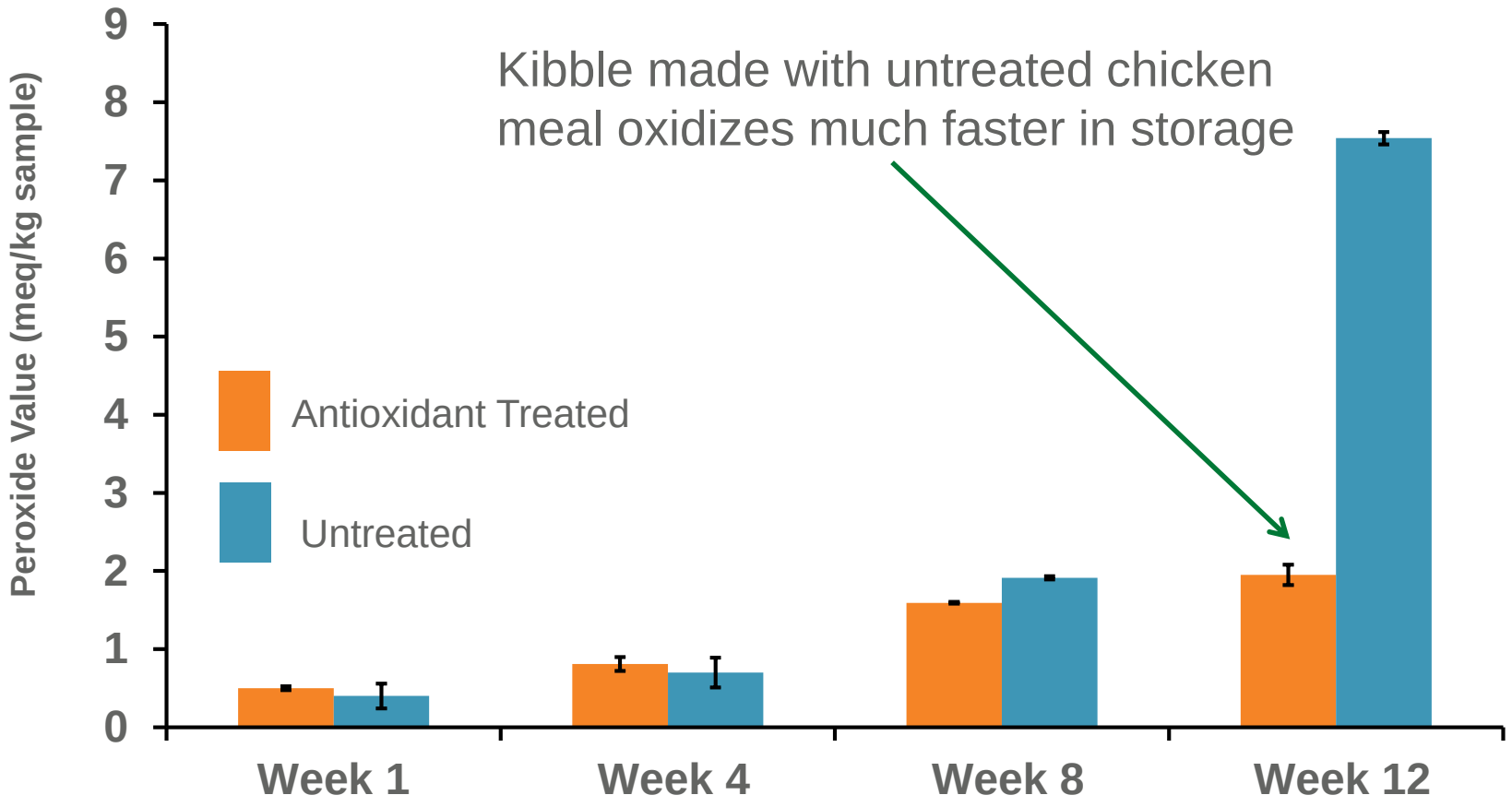
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Raw Material Antioxidant Treatment

Impact on Shelf-Life



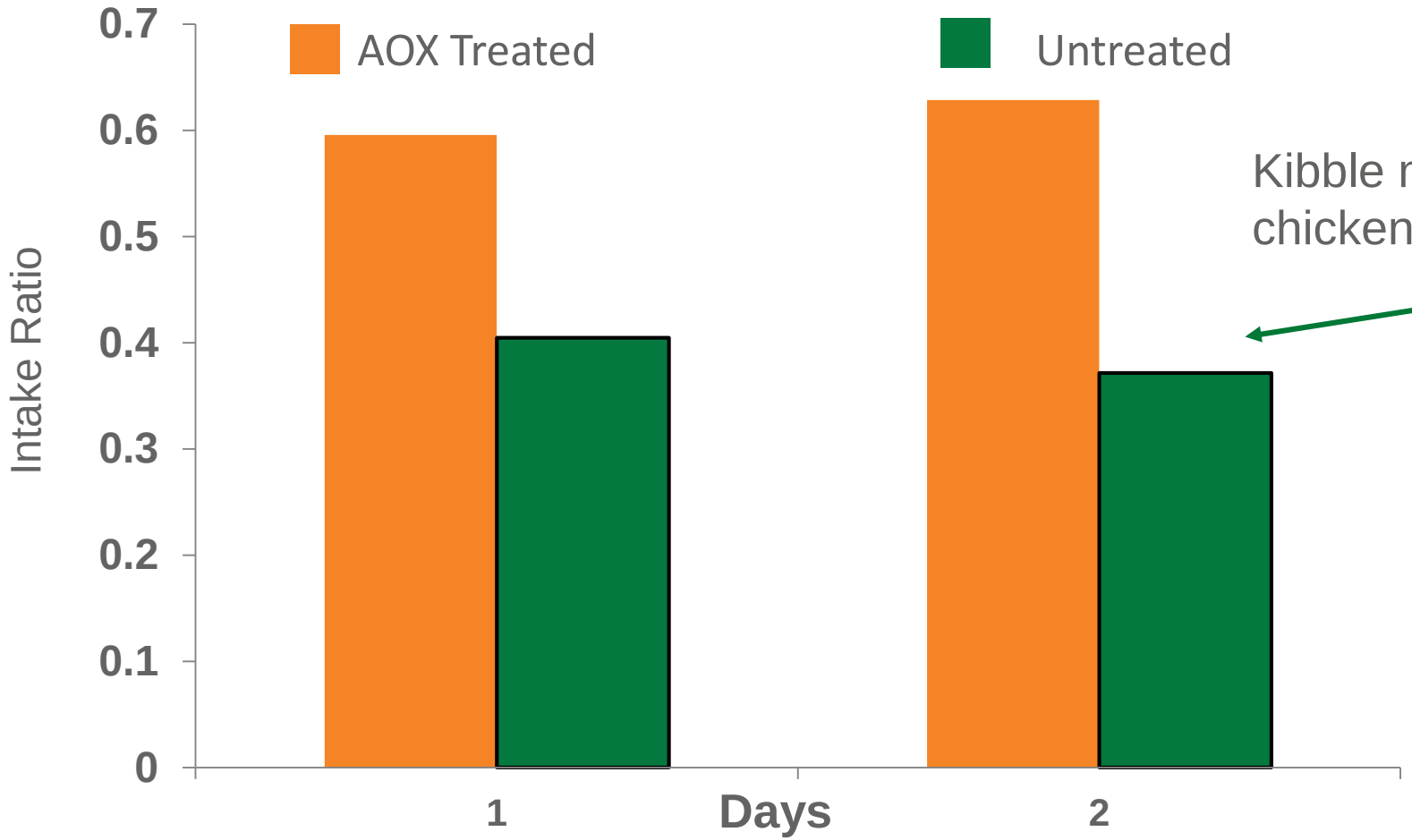


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Cat Diet Palatability Study

Protein Meal Oxidation



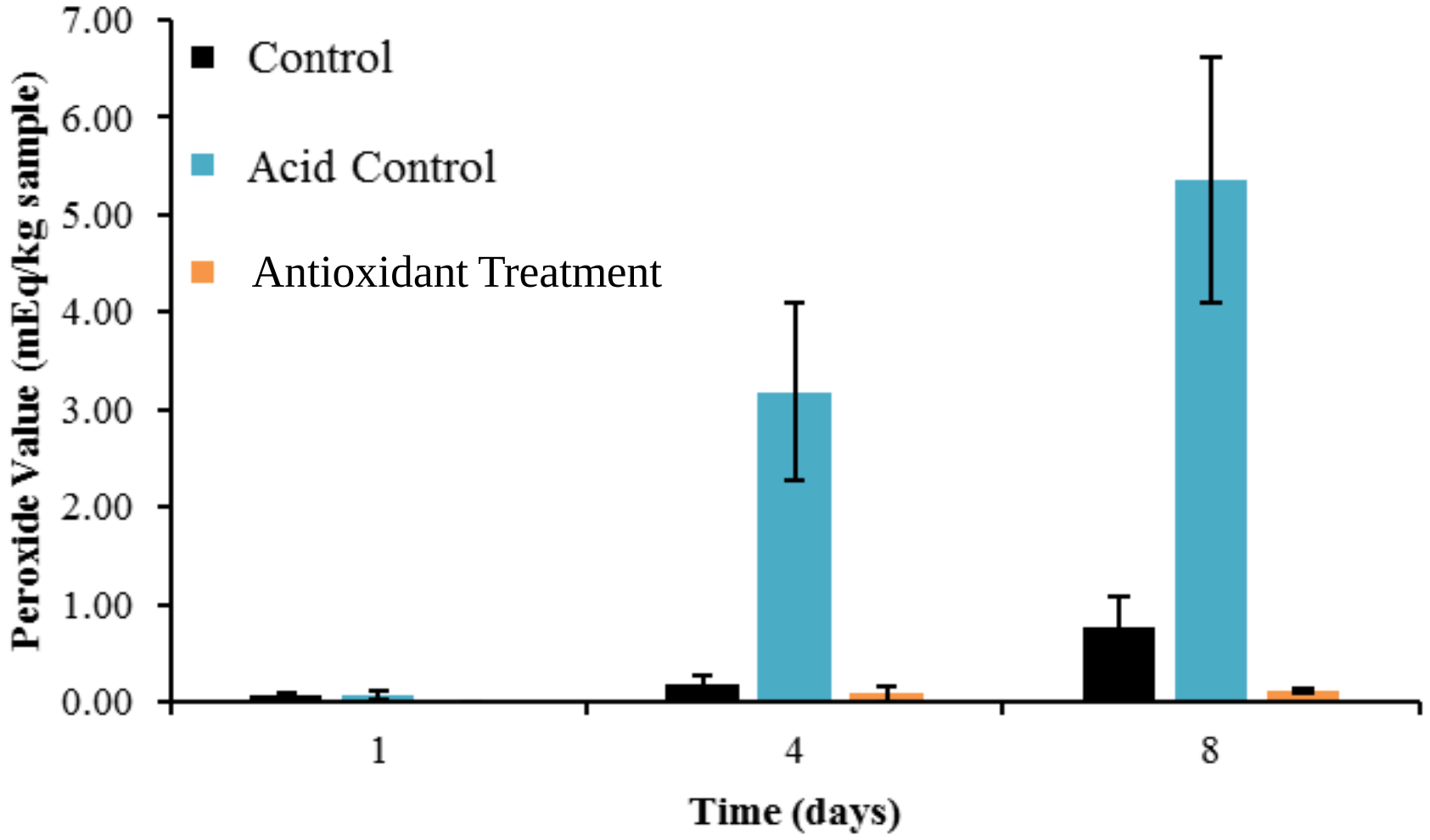
Kibble made with untreated chicken meal is less palatable



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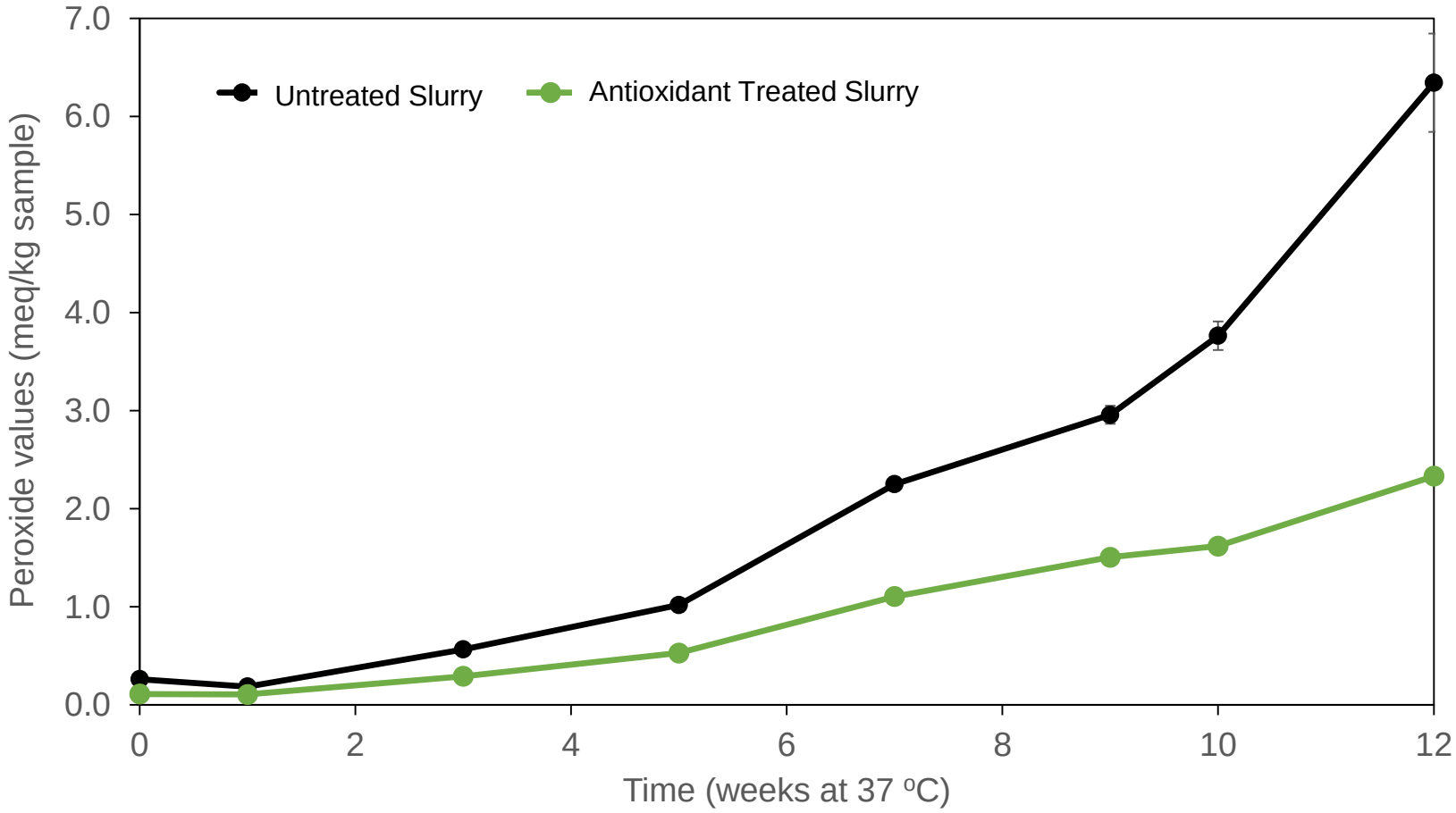
Meat Slurry Preservation- Oxidation



- Fresh chicken slurry stored at 4°C

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Impact of Meat Slurry Preservation On Diet Shelf Life



Untreated product:

- 23.5% chicken slurry
- 16% crude fat
- 500 ppm Antioxidant in core

Treated product additions:

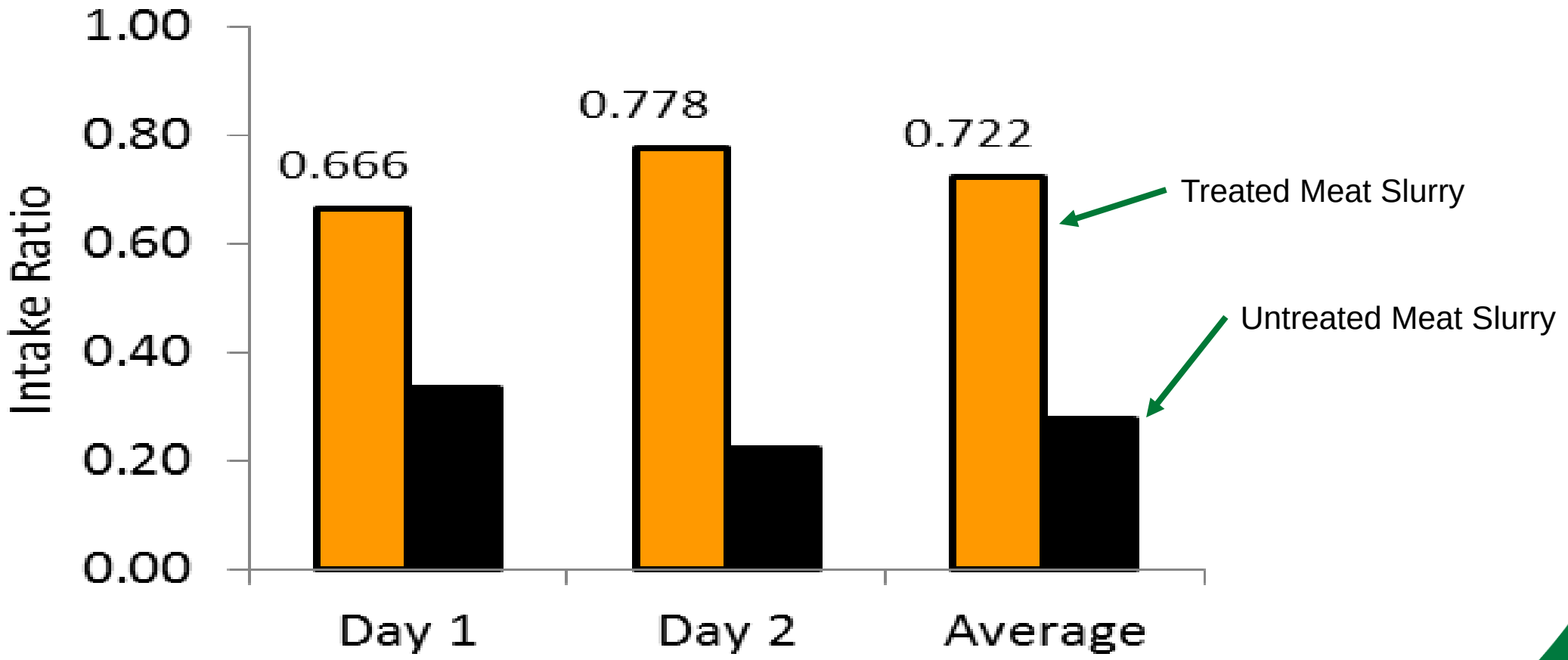
- Antioxidant added to slurry

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Source: Internal Kemin CLS project.

Aged Meat Slurry Preservation
Dog Palatability

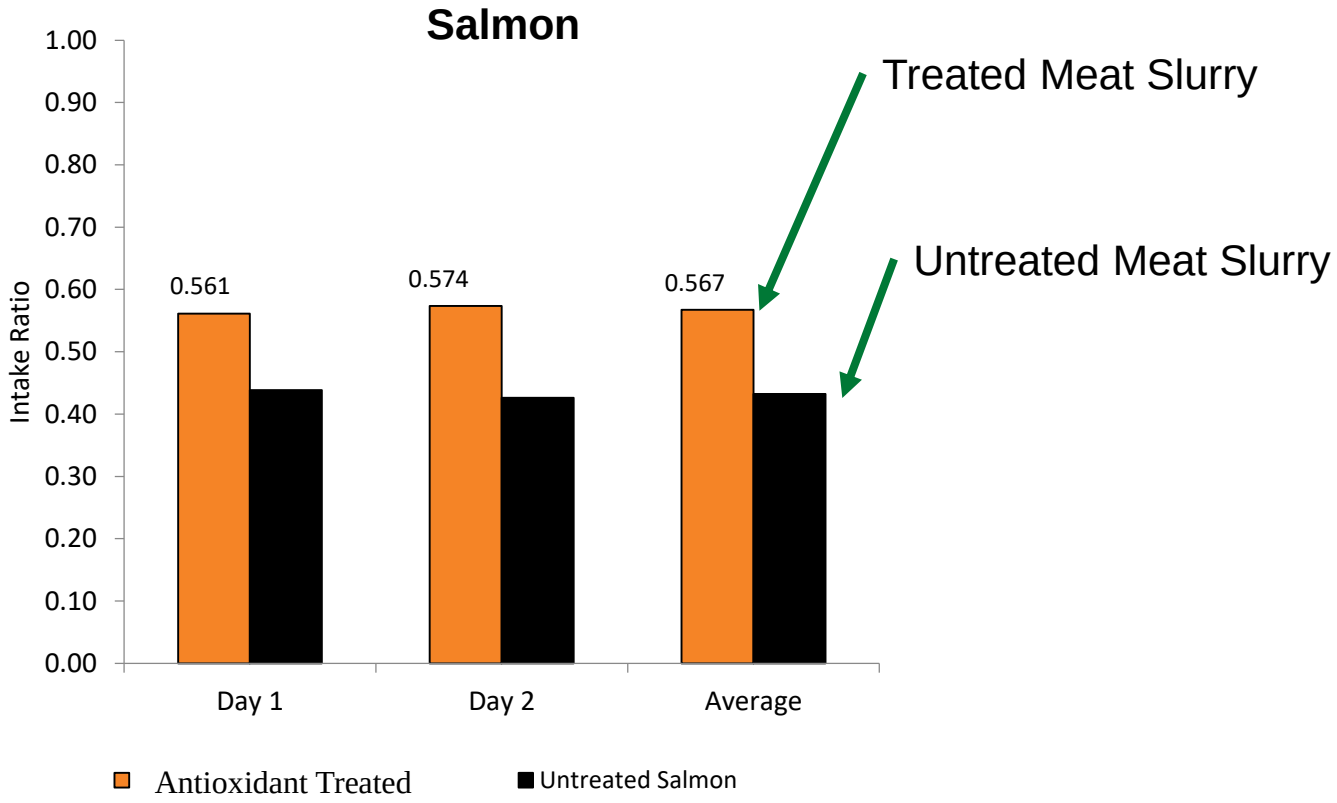


- Palatability of aged, untreated meat slurry compared to aged (4 days @ 4 ºC), Antioxidant treated meat slurry
- Dogs (N=20) showed preference toward kibbles made with treated meat slurry.

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Aged Meat Slurry Preservation
Cat Palatability



- 25% Meat Slurry in recipe
- Palatability of aged, untreated meat slurry compared to aged, Antioxidant Dry treated meat slurry
- Meat slurry refrigerated (4 ^{o}C) with either treatment 4 days prior to extrusion
- Cats (N=20) showed no statistical preference toward untreated meat

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Aldehyde Testing

- Aldehydes create the characteristic smell of oxidation
- Aldehydes continue to rise over time (unlike PVs)
- Dog palatability is sensitive to the presence of oxidation by-products, such as aldehydes
- Significant reduction in palatability when 20 ppm of synthetic Total Aldehydes (Hexanal + 2,4-Decadienal) were added to petfood

Source: Internal Kemin CLS project.

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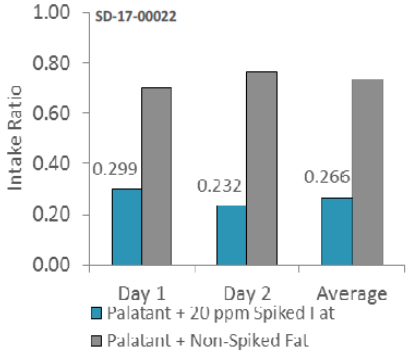
Aldehyde Sensory Impact in Diets

Variable A

- 2.0% Palatant
- 6.5% Chicken Fat with 3000 ppm Natural Antioxidant + 20 ppm combined oxidatives

Variable B

- 2.0% Palatant
- 6.5% Chicken Fat with 3000 ppm Natural Antioxidant



Results

Analysis	A	B
2,4-Decadienal (ppm)	11	6
Hexanal (ppm)	5	3
Peroxide Value (mEq/kg)	0.47	0.51

Average IR-A= 0.266
p= 0.00340

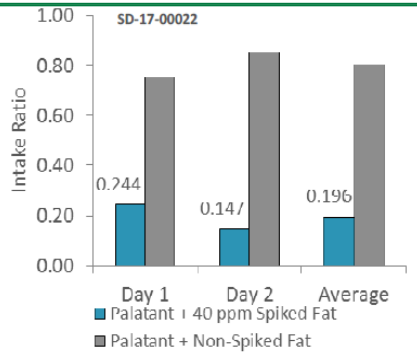
20 ppm

Variable A

- 2.0% Palatant
- 6.5% Chicken Fat with 3000 ppm Natural AOX + 40 ppm combined oxidatives

Variable B

- 2.0% Palatant
- 6.5% Chicken Fat with 3000 ppm Natural AOX



Results

Analysis	A	B
2,4-Decadienal (ppm)	17	6
Hexanal (ppm)	6	3
Peroxide Value (mEq/kg)	0.52	0.51

Average IR-A= 0.196
p= 1.36E-08

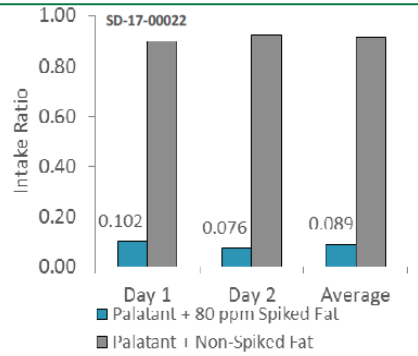
40 ppm

Variable A

- 2.0% Palatant
- 6.5% Chicken Fat with 3000 ppm Natural AOX + 80 ppm combined oxidatives

Variable B

- 2.0% Palatant
- 6.5% Chicken Fat with 3000 ppm Natural AOX



Results

Analysis	A	B
2,4-Decadienal (ppm)	30	6
Hexanal (ppm)	12	3
Peroxide Value (mEq/kg)	0.49	0.52

Average IR-A= 0.089
p= 1.10E-14

80 ppm

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CLS Project #17N002234, 17N002235, 17N002236, 17N002237

How Microbial Degradation Affects Pet Food and Ingredient Quality



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Impact of Raw Material Degradation

- Oxidative Deterioration
  - Shelf-life reduction
- Microbial Degradation
  - Free Fatty Acids (FFA), Biogenic Amines (BA)
- Impact on Plant Operations
  - FFA increases energy costs
    - Longer cook times due to decreased heat transfer
  - Reduced efficiency
    - Increased fines
    - Reduced fat yield
  - Increased plant odor
- Reduction in nutritive value

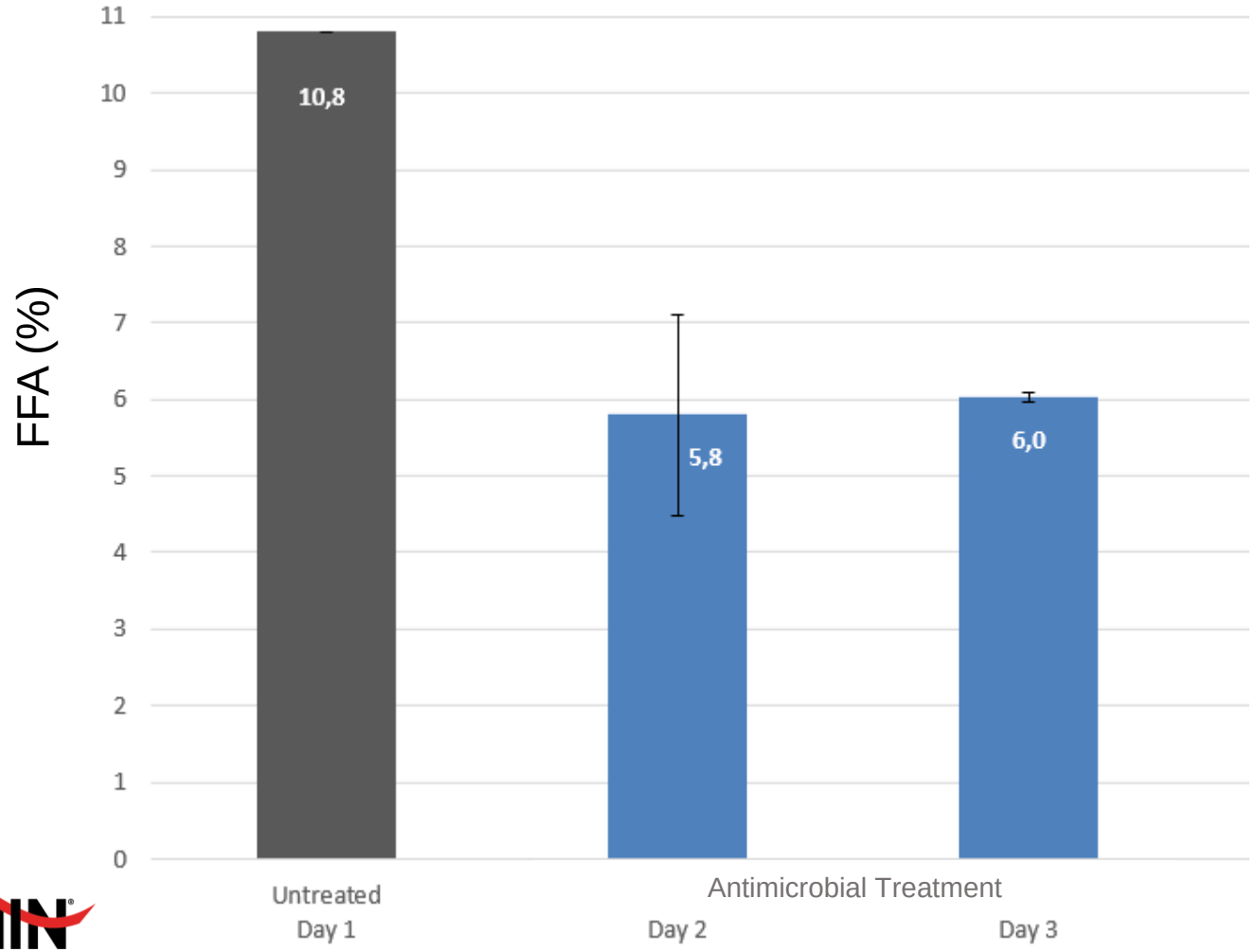
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1) “Batch dry rendering: The influence of controlled processing conditions on the quality of meat meal prepared from sheep stomachs”, Bremner, A.H., April 1976, Journal of Science of Food and Agriculture, pp 307-314

Free Fatty Acid Control

Poultry Fat

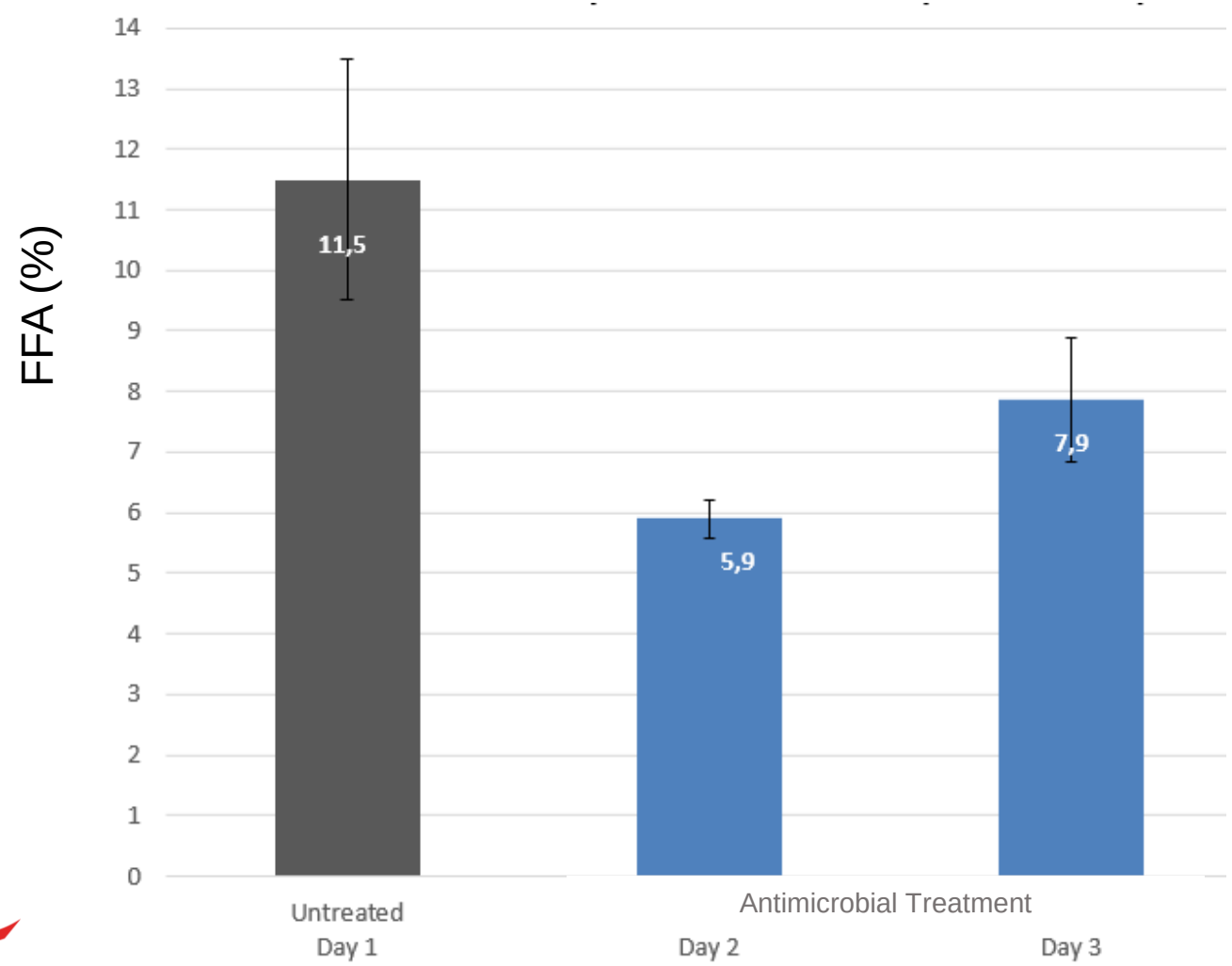




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Free Fatty Acid Control

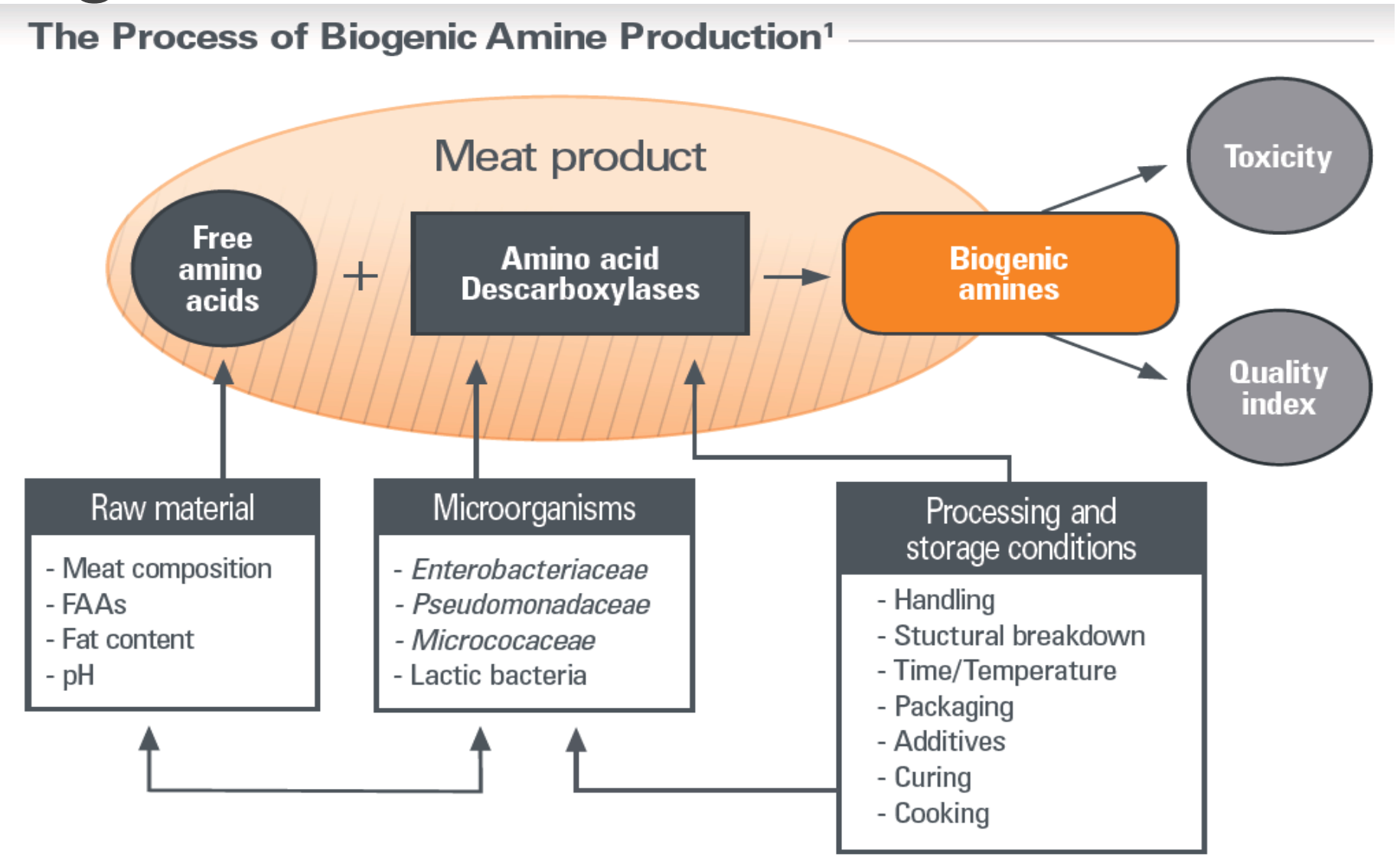
Poultry Meal





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Biogenic Amines



Ruiz –Capillas. 2004

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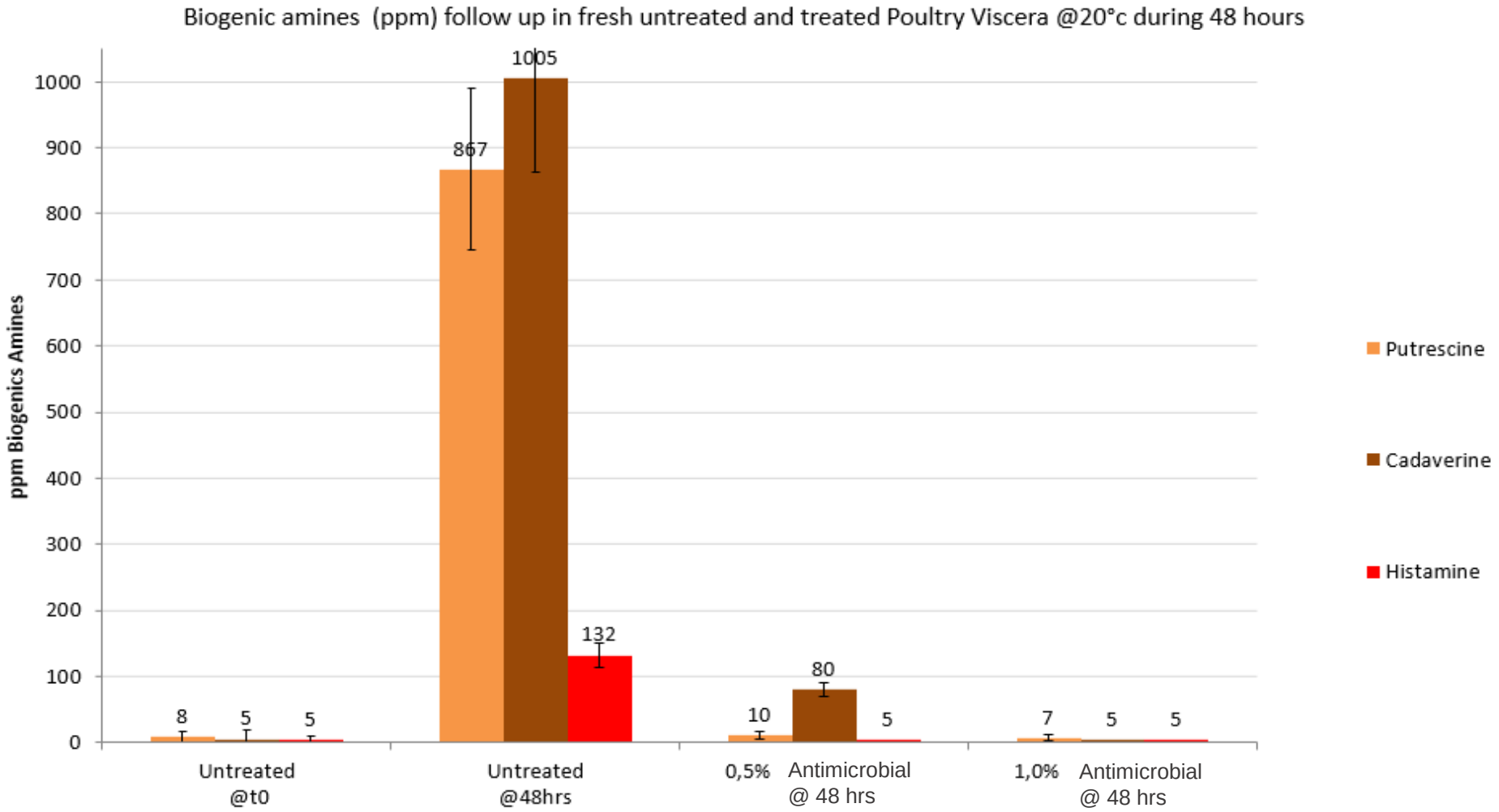
Biogenic Amines in Chilled (4º C) Chicken Viscera

Biogenic Amine	Washed Viscera (ppm)		Unwashed Viscera (ppm)	
(ppm)	Day 0	Day 3	Day 0	Day 5
Tyramine	6	148	3	537
Putrescine	2	6	4	203
Cadaverine	1	96	18	280
Histamine	6	12	3	32
Spermidine	42	47	49	139
$Subtotal_1$	57	309	77	1191
Agmatine	13	9	17	2
Spermine	20	18	33	27
$Subtotal_2 + 1$	34	28	51	30
Total BA	90	336	127	1220
pH	6.2	5.8	5.8	5.3
TPC (cfu/g)	6×10^4	2×10^7	2×10^6	6×10^8

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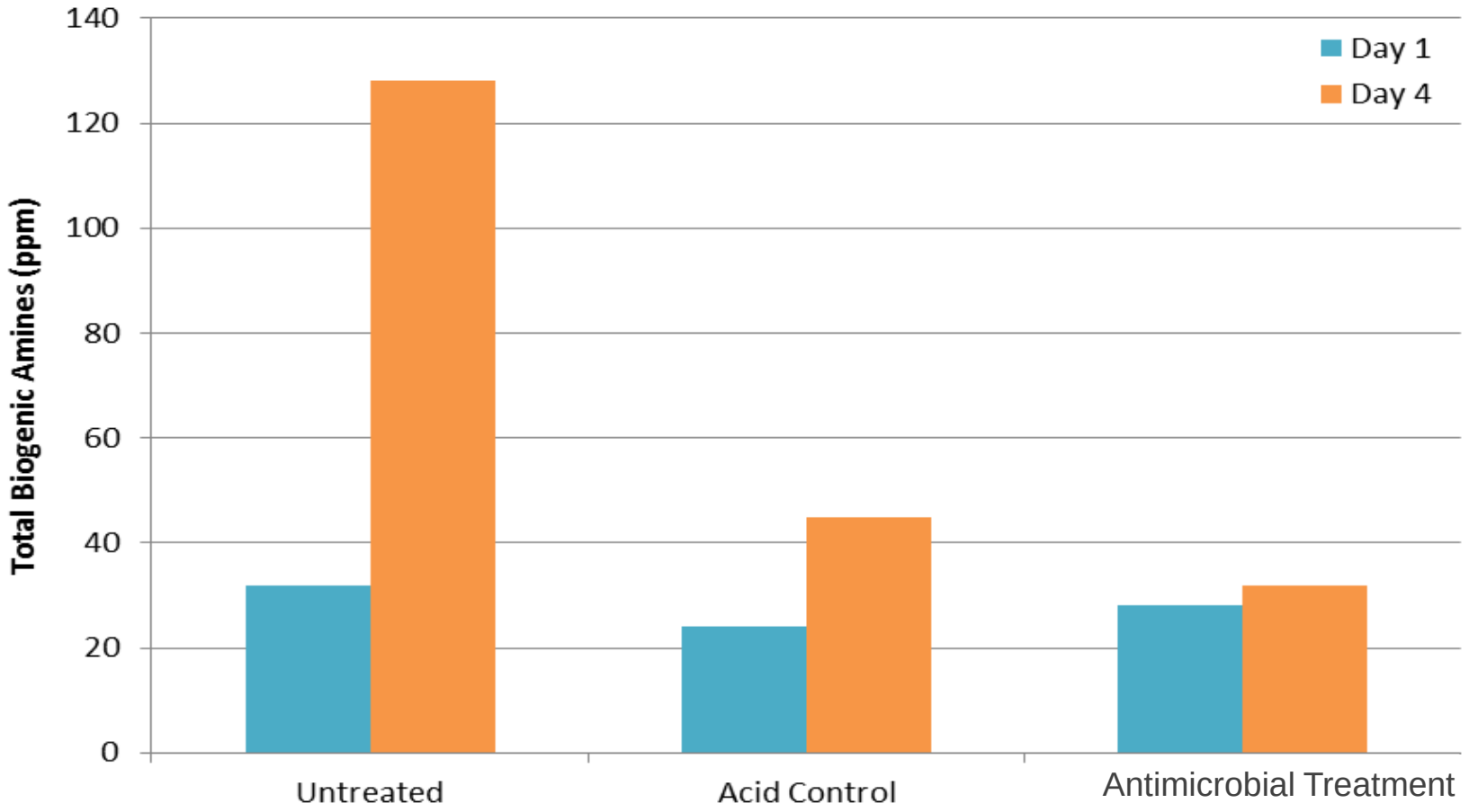
Biogenic Amine Control in Poultry Viscera



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Meat Slurry Preservation

Biogenic Amines



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Biogenic Amines in Various Meals

Mean concentration of putrescine, cadaverine, and histamine in Australian by-product meals between 1994-1997

Sample type	No. of samples	Putrescine (range) (mg/kg)	Cadaverine (range) (mg/kg)	Histamine (range) (mg/kg)
Fish meal	78	102 (7-102)	220 (11-1340)	570 (<5-1620)
Poultry meal	387	82 (7-1320)	121 (<5-1350)	19(<5-167)
Meat meal	835	21 (<5-695)	29 (<5-680)	10(<5-258)
Feather meal	120	31 (5-267)	42 (<5-159)	5(<5-90)
Blood meal	25	13 (<5-223)	7 (<5-280)	4(<5-36)

Source: den Brinker et al, 2003

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Biogenic Amines Found in Retail Pet Food

- Finished diets that were returned from consumer were monitored for biogenic amines and rancidity over 16 months
- Categorized as:
  - Complaint – consumer complaint related to animal illness or lack of consumption
  - Non-complaint – no associated illness or consumption issues
- No diets in either group showed any signs of oxidation

	PV (meq/kg sample)	Hexanal (ppm)	2,4-decadienal (ppm)	Total Biogenic Amine (ppm)	
Complaint - Average	0.16	3.40	3.27	301	58 % > 300ppm
Complaint - Std Dev	0.10	0.96	1.58	107	
Non-Complaint - Average	0.18	3.60	3.26	136	8% > 300ppm
Non-Complaint - Std Dev	0.14	1.18	2.03	31	

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Factors Impacting Antioxidant Application and Selection

The value of controlling oxidation risks and microbial growth is well recognized

- Processes
  - Substrate being stabilized
    - Where to apply antioxidant
      - Type of fat utilized
        - Product formulation
          - New suppliers
            - Packaging



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Rules to Respect

- Use Fresh Raw Materials!
- Decrease Risk Factors & High Risk Ingredients!
- Protect as Soon as Possible!
- Select the Right Antioxidant and Dosage!
- Evaluate Microbial Risk and Implement Hurdles!
- Understand Methods and Testing Needed!



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Thank You !



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