

Improving the Relationship between Petfood Stability, Nutrition, and Palatability

Presented at CBNA 2015

by

Kemin Industries, Inc.

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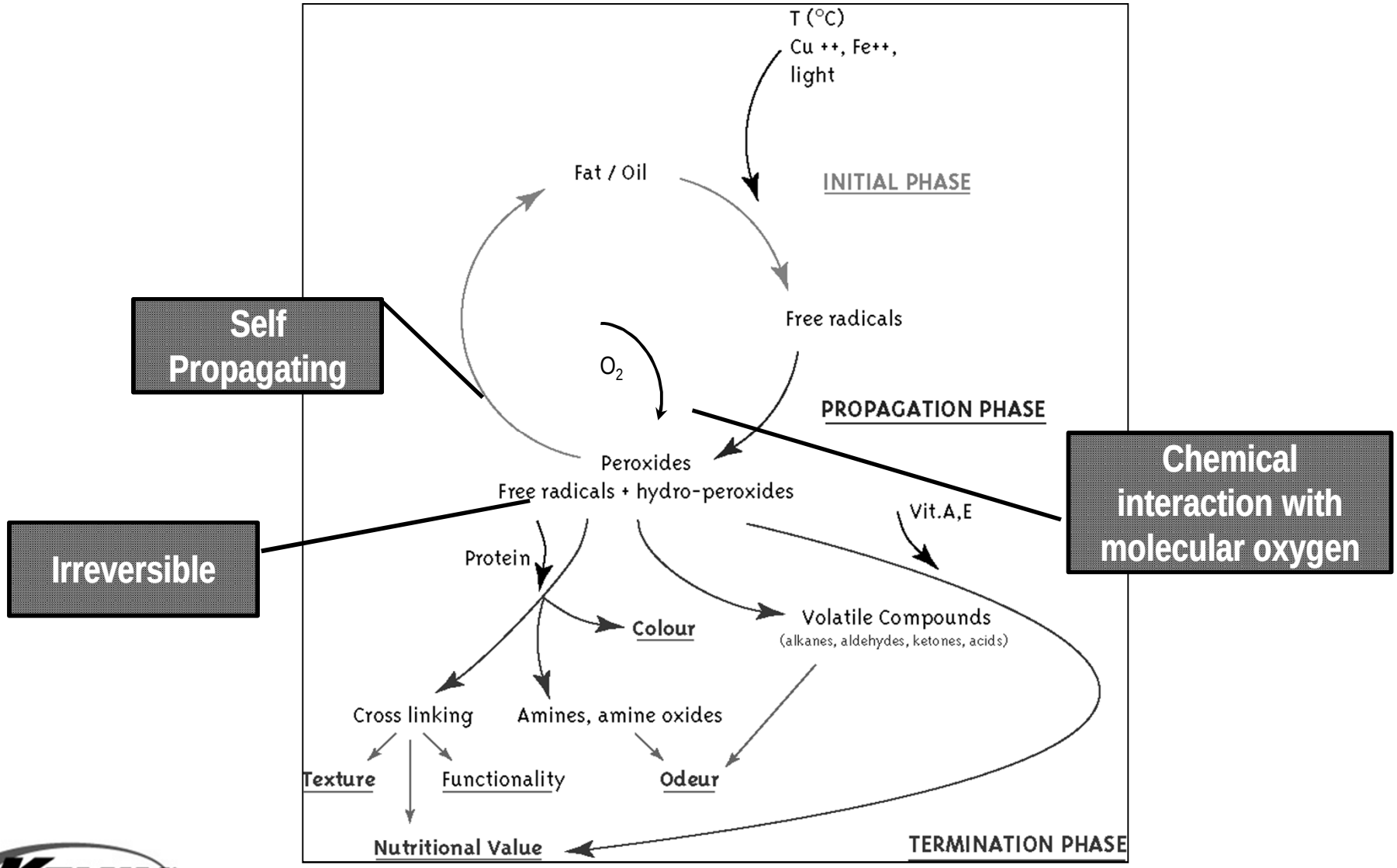
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The Relationship between Petfood Stability, Nutrition and Palatability

- Autoxidation Process
- Impact of Oxidized Diets on Animals
- Stabilization Programs for Petfood Diets
- Managing Palatability and Stability

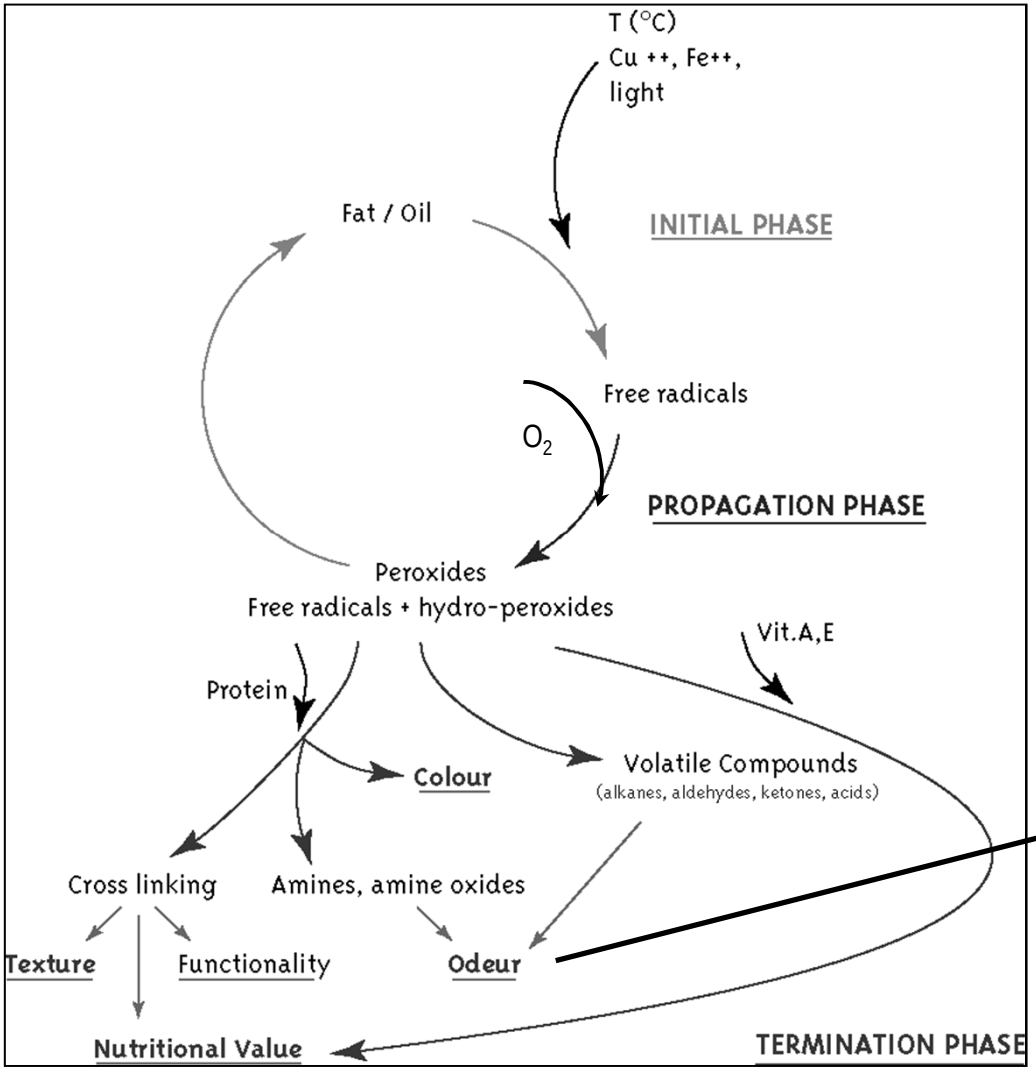
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Autoxidation Process



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Autoxidation Degrades Lipid Quality



Rancidity;
Decreased Nutritional Value,
Undesirable Aesthetic Changes

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Secondary Oxidation Products

- Breakdown products of fat oxidation
- Mostly short chain alchohols, ketones, aldehydes, epoxides
- According to Frankel (1987; Chem Phys Lipids 44:73)

  epoxy-hydroperoxides, oxo-hydroperioxide, hydorperoxy epidioxides, dihydroperioxides, hydroperoxy bis-epidioxides, and hydroperoxy bicycloendoperoxides.

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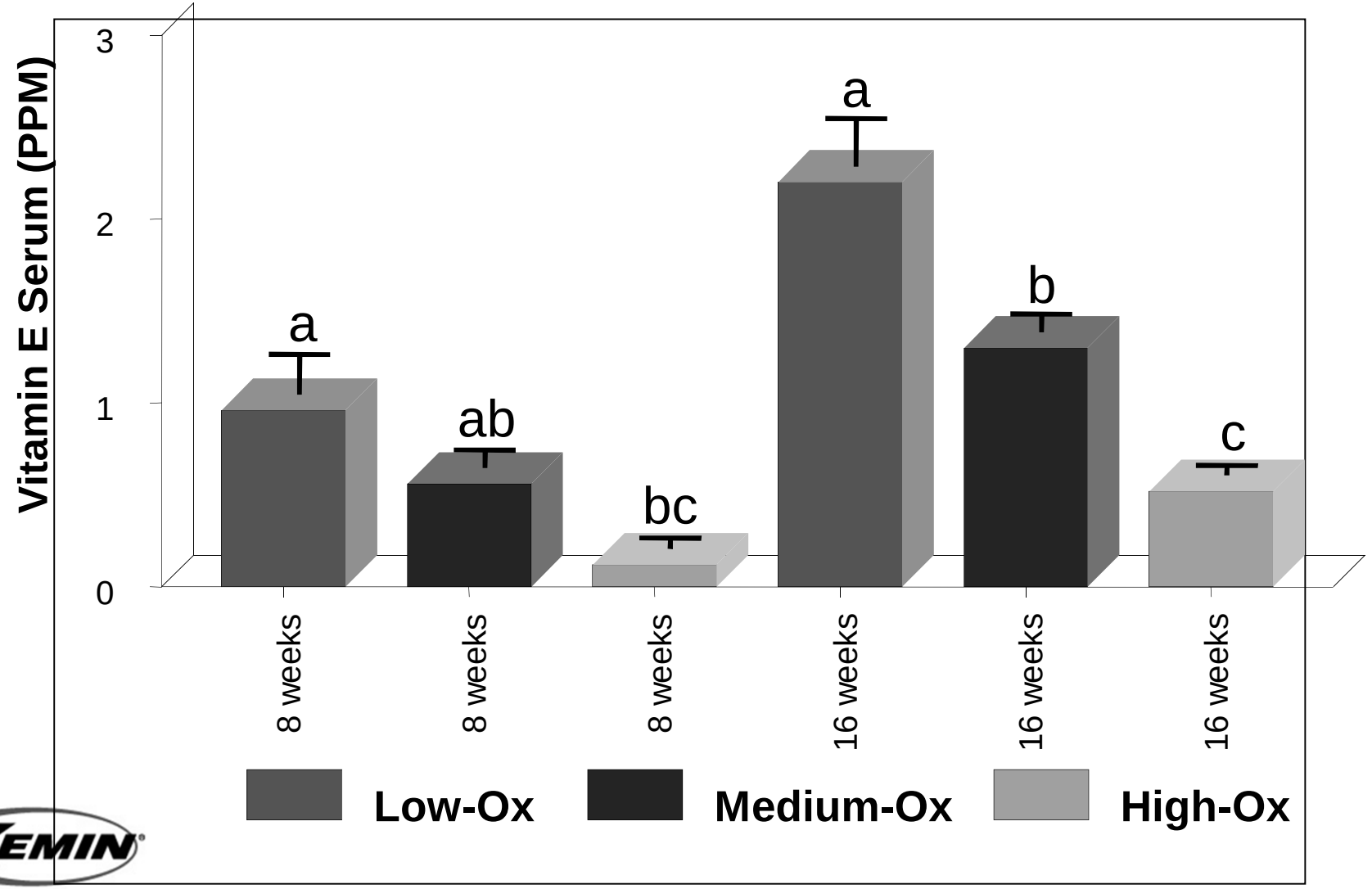
Important Effects of Oxidized Diets on Animals
(list is not comprehensive)

- Reduced nutrient value (Turek et al., 2003 J Nutr Biochem 14:24-31)
- Accumulation of harmful oxidation compounds (Addis, 1986; Food Chem Toxicol 24:1021)
- Loss of flavor / Palatability (Gross, K. L., et al. 1993 Hill's Pet Nutrition, Inc., Topeka, KS.)

(Select examples follow)

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Impact of Oxidized Fat Consumption on Puppy Vitamin E Status



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Turek et al., 2003; J Nutr Bioch 14:24

Impact of Oxidized Fat Consumption on Puppy Tissue Fatty Acid Levels

Variable	Control	Medium	High
18:2n-6, mol/100mol			
Diet	19.34[a]	17.81[b]	15.21[c]
Plasma	24.00[a]	23.44[a]	21.92[b]
Bone	13.71[a]	11.46[b]	9.29[c]

Different superscript letters within a row are statistically different

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Impact of Oxidized Fat Consumption on Puppy Tissue Fatty Acid Levels

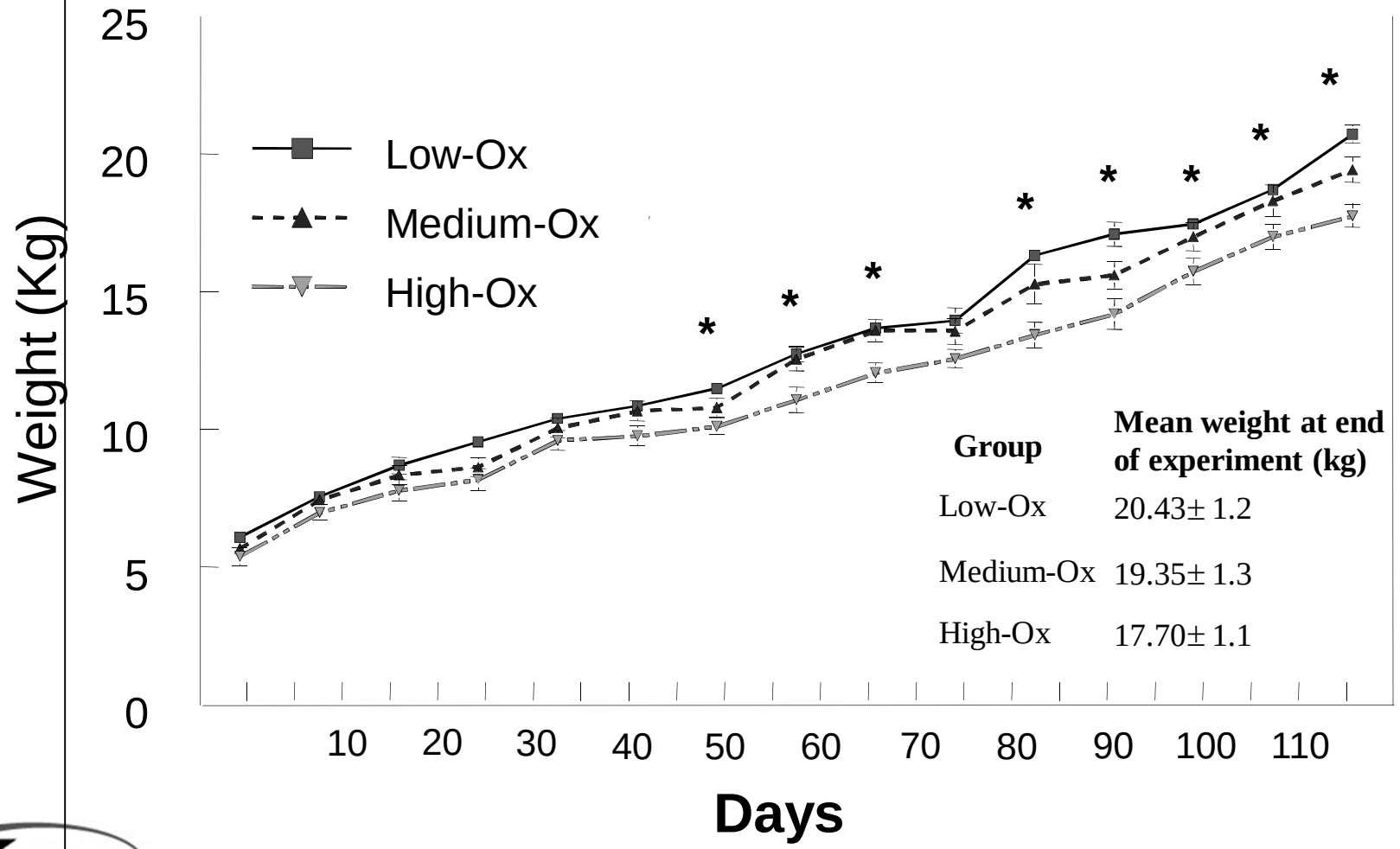
Variable	Control	Medium	High
18:3n-3, mol/100mol			
Diet	1.27[a]	1.21[b]	1.05[b]
Plasma	ND	ND	ND
Bone	0.57[a]	0.43[b]	0.38[c]
22:6n-3, mol/100mol			
Diet	0.496[a]	0.556[b]	0.67[c]
Plasma	2.62[a]	3.28[ab]	3.98[a]
Bone	0.45[a]	0.45[a]	0.42[a]

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Turek et al., 2003; J Nutr Bioch 14:24

Oxidized Dietary Lipids Depress Puppy Growth and Development



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Turek et al., 2003; J Nutr Bioch 14:24

Impact of Oxidized Fat Consumption on Metabolism

- Dietary oxidized lipids make a major contribution to the level of oxidized lipids in circulating lipoproteins in rats
  (Staprāns et al., 1996 . J Lipid Res 37:420-430)

- Feeding oxidation products of Linoleic Acid reduced fatty acid synthesis, and actetyl-CoA carboxylase
  (Minamoto et al., 1988; Biochim Biophys Acta 958:199)

- Oxidized Linoleic Acid:
  - incorporated into hepatic mitochondrial and microsomal lipids,
  - metabolized to neutral lipids and phsopholipids,
  - lipid peroxides were injurious to rat liver
    (Kanazawa et al., 1986 Biochim Biophys Acta 879:36)

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Consumption of Oxidized Fats has Negative Physiological Effects in Animals

- Suppresses growth and development (Lin et al., 1989 Br Poult Sci 30:855-864; Calabotta and Shermer, 1985; Eder et al., 2002; J Nutr 132:1275; DeRouchey et al., 2004; J Anim Sci 82:2937; Turek et al., 2003; J Nutr Bioch 14:24)

- Has a broad impact on metabolism via gut, liver, pancreas (Ozimek et al., 1995 Z Ernährungswiss 34:224; Kanazawa et al., 1988 J Nutr Sci Vitaminol 34:363; Hayam et al., 1993 J Nutr Biochem 4:563; Dibner et al., 1996 Anim Feed Sci Technol 62:1-13; Staprāns et al., 1996; Arterioscler Thromb Vasc Biol 16:533; Staprāns et al., 1996 . J Lipid Res 37:420-430; Kanazawa et al., 1986 Biochim Biophys Acta 879:36; Minamoto et al., 1988; Biochim Biophys Acta 958:199; Ashida et al., 1987 Arch Biochem Biophys 1:114; Eder et al., 2003; Lipids 38:31)

- Affects immune response and inflammatory mediators (Turek et al., 2003; J Nutr Bioch 14:24)

- May lead to life-threatening diseases in extreme cases (Bhat et al., 1995; Clin Toxicol 33:219; Kanazawa et al., 1988; J Nutr Sci Vitaminol 34:363; Alexander et al.., 1987; J Toxicol Env Health 21:295; Budowski et al., 1979; Yang et al., 1998; Nutrition & Cancer 30:69)

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Relationship between Stability and Palatability

Oxidation, indicated by Peroxide Value, reduced Dog Palatability

Effect of Peroxide Value on Palatability of Chicken Based Dog Diets		
Storage Conditions	**Peroxide Value (meq / kg fat)**	**Consumption Ratio**
16 weeks at 48.8°C	9	2.7
16 weeks at 48.8°C	28	1.0

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Gross, K. L., et al. (1993) "Effect of three different preservative systems on the stability and palatability of extruded pet food subjected to ambient and high temperature storage", Hill's Pet Nutrition, Inc., Topeka, KS.

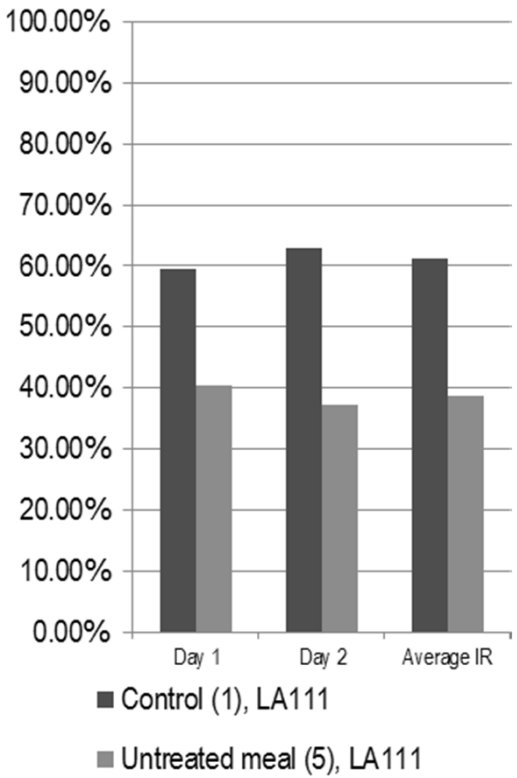
Relationship between Stability and Palatability

An increase in oxidation, indicated by Peroxide Value, reduced Cat Palatability over time

Effect of BHA + BHT Treatment of Meat Meals on Palatability of Chicken / Tallow Cat Diets Containing the Meals			
Time	**Meal Treatment**	**Peroxide Value (meq / kg fat)**	**Consumption Ratio**
Initial	BHA + BHT	4.7	1.9
Initial	Untreated	7.3	1.0
3 months at 35°C	BHA + BHT	7.7	3.6
3 months at 35°C	Untreated	19.0	1.0

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Relationship between Stability and Palatability



- Chicken By-Product Meal Treatment
  - 1200 ppm Naturox® TX applied after the fat press (Control)
  - Untreated
- Cat Diet Palatability
  - Control Intake Ratio = 0.61 (p = 0.001)
- Stability of Cat Diets made with the meals
  - No difference in Peroxide Values (oxidative stability)
  - Minimal differences in Protein Oxidation By-Products
  - Cats very sensitive to stability, perhaps more so than analytical parameters

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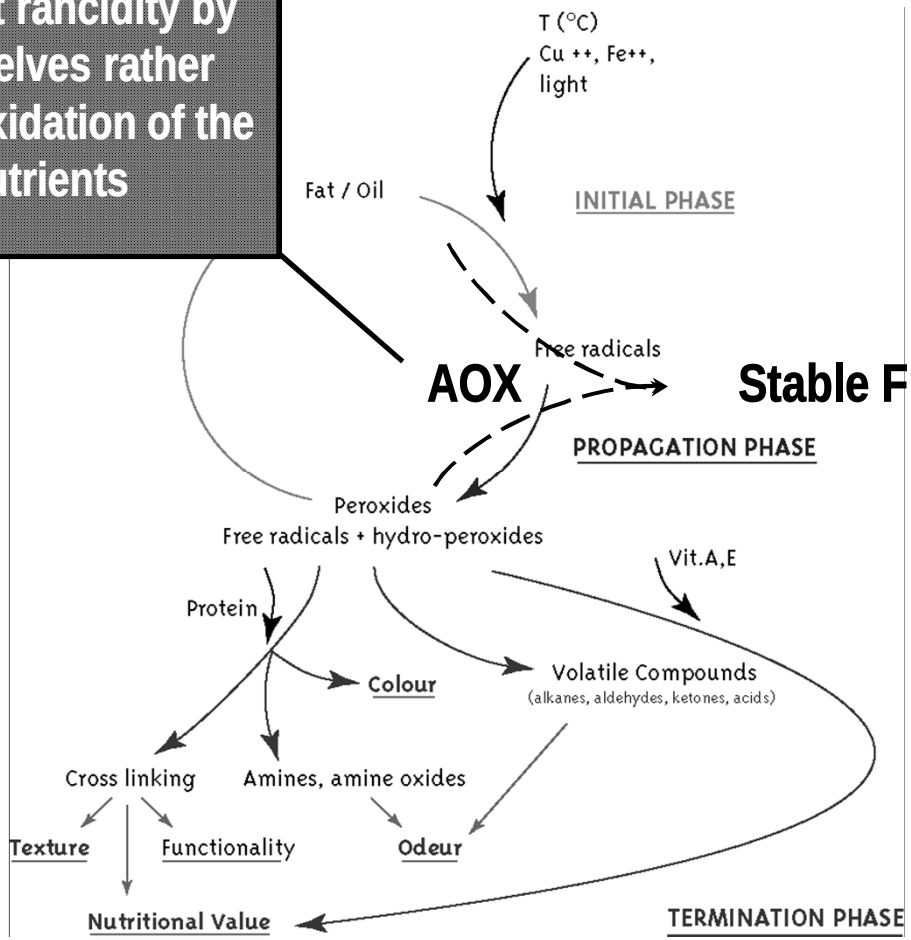
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Role of Antioxidants

Antioxidants arrest rancidity by sacrificing themselves rather than allowing the oxidation of the fat or food nutrients



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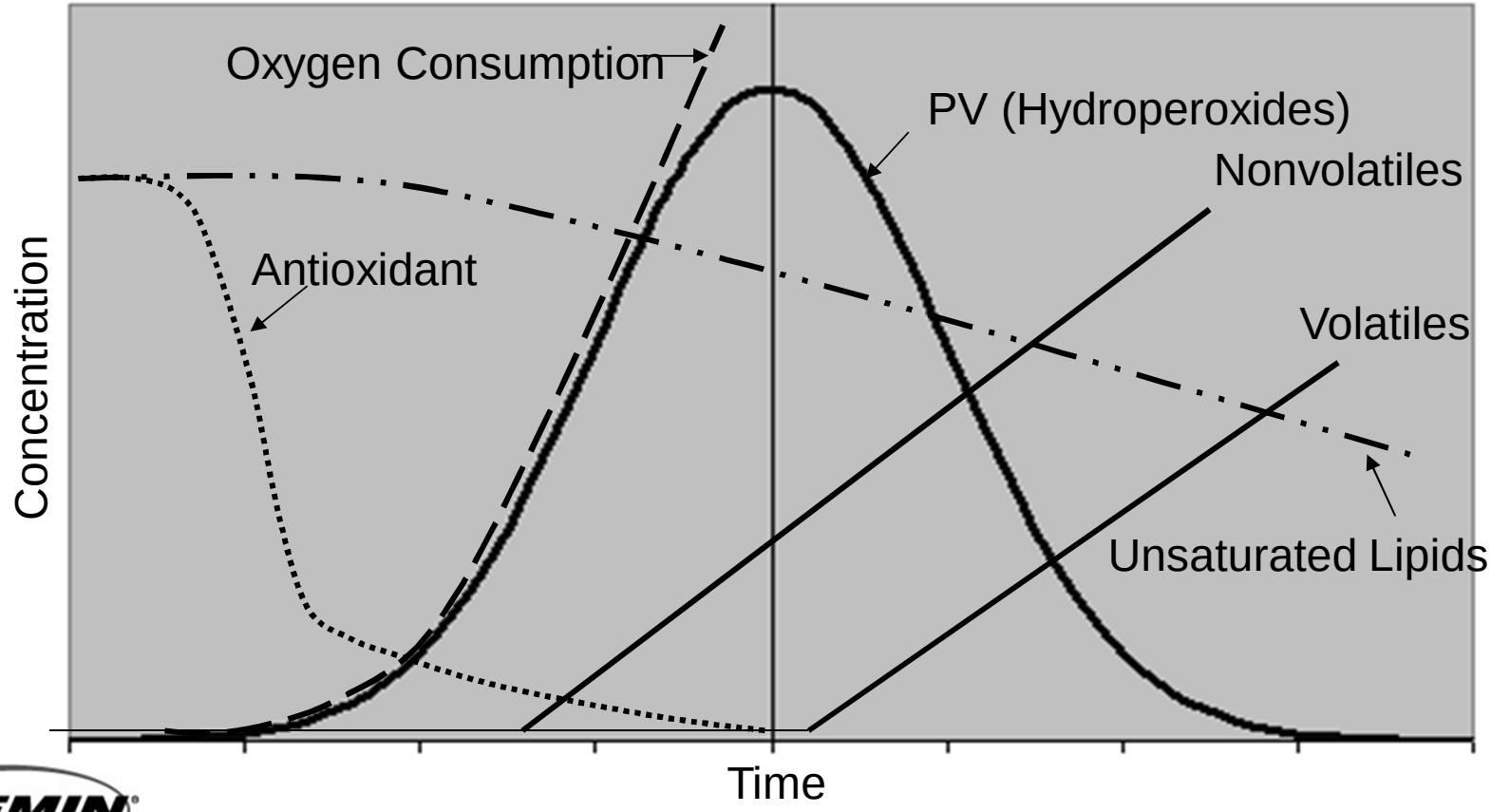
Role of Antioxidants

- Protect fat and fat containing ingredients from autoxidation
- Reduce formation of “off” odors
- Reduce formation of toxic compounds
- Maintain energy value
- Protect nutrient stability, including vitamins and proteins

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Role of Antioxidants

Delay rancidity by being preferentially oxidized (sacrificed) rather than allowing oxidation of the food nutrients.



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

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Controlling the Autoxidation Process

- Antioxidants can control oxidation as long as active, residual levels are present (antioxidants cannot reverse oxidation)
- The higher the Initial Peroxide Value (IPV) the greater the chemical demand on the antioxidant
- Consumption of the antioxidant by a pro-oxidant effect leaves the material susceptible to oxidation

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Stability Evaluation in Petfood Diets

- Ideal evaluation of pet food shelf life stability is real time stability, 12 – 24 months.
- Accelerated storage at an elevated storage temperature provides an estimate
  - 1 week at 37°C ≈ 3 – 4 weeks ambient

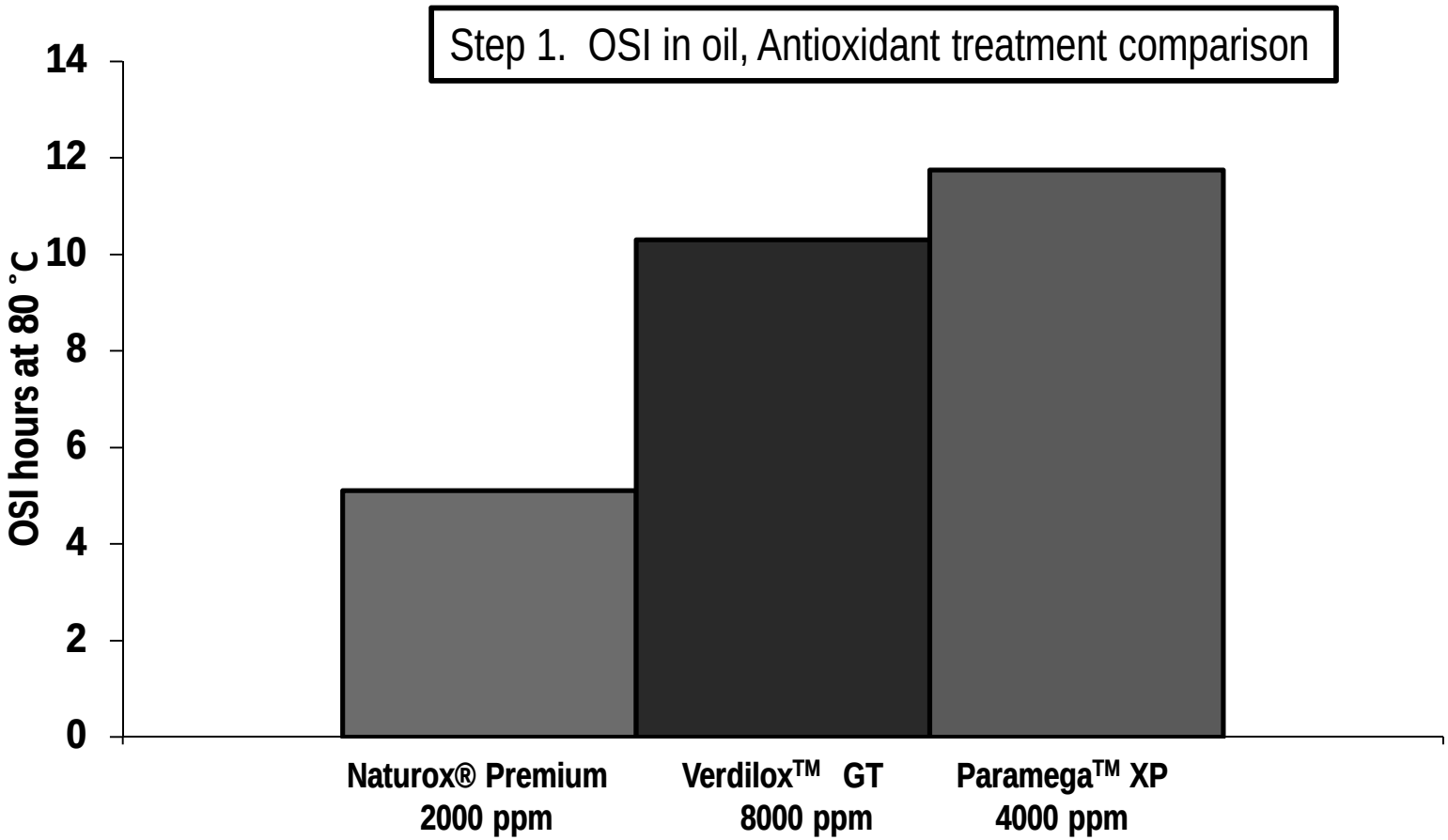
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Shelf Life Case Study

- Challenging diet
  - High marine content
- Evaluation of raw materials
  - Meals were in good condition, oil was under treated
- Oil stability study
  - OSI with treatment options
- Kibble study with oil treatments
  - PV, oxidatives, antioxidant loss

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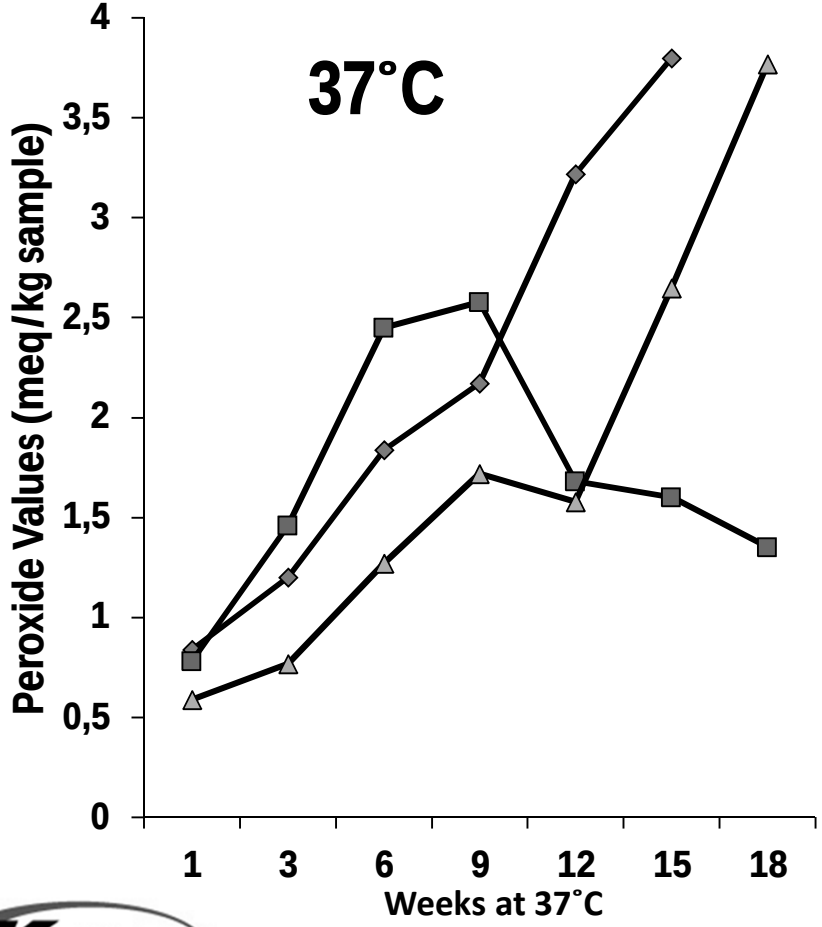
Shelf Life Case Study

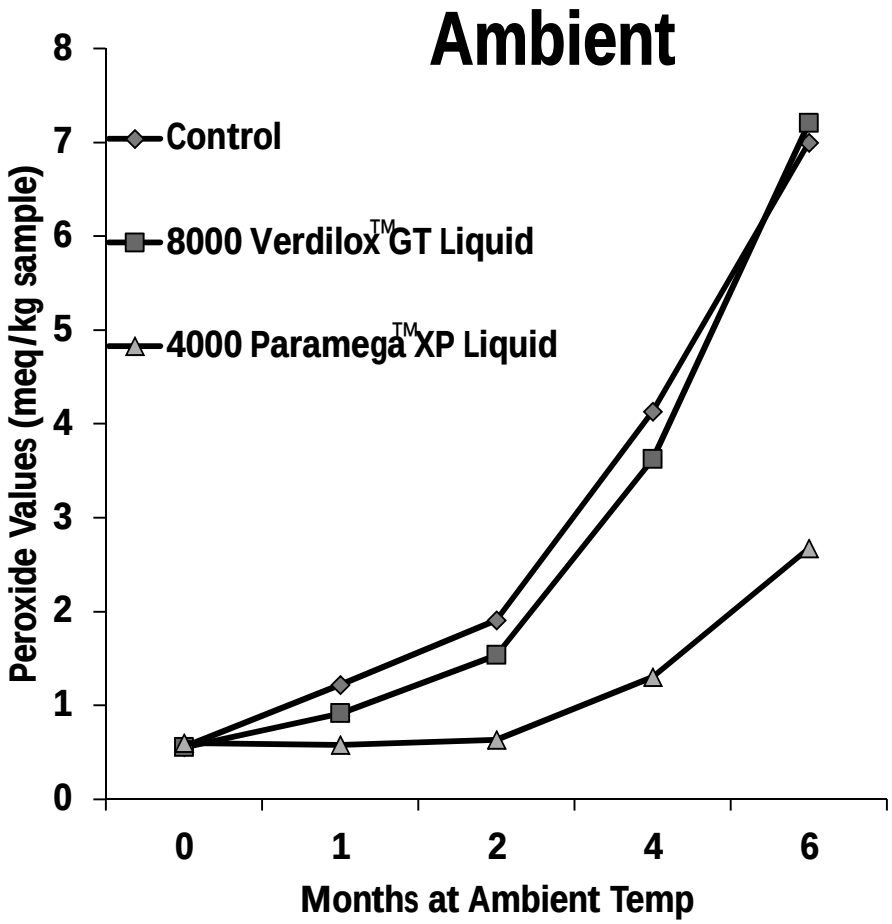


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Shelf Life Case Study

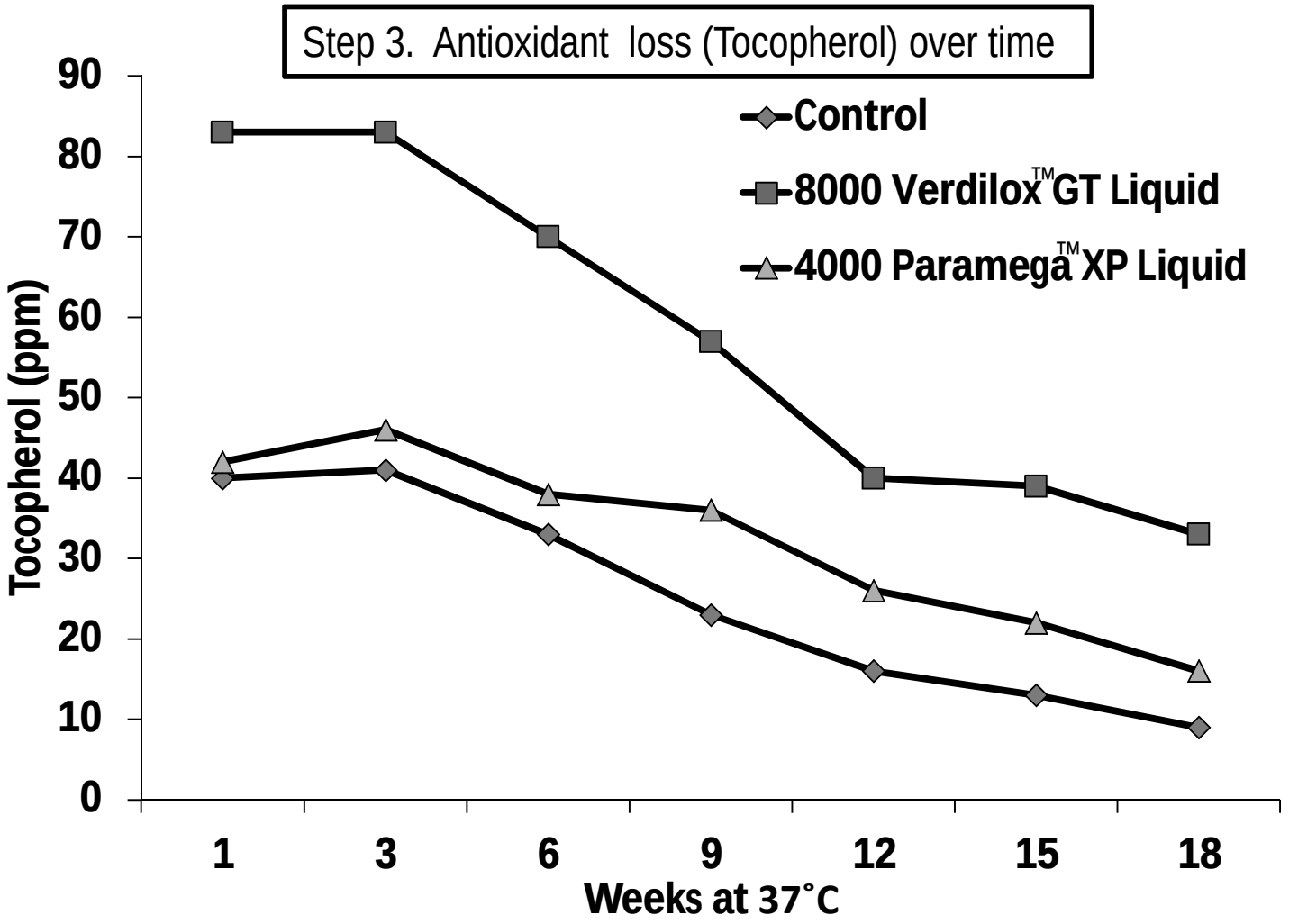
Step 2. Peroxide Value comparison for diet at two storage temperatures





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Shelf Life Case Study



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The Program Approach to Controlling Autoxidation

- Pet food diets are a complex matrix of fat, starch, and protein contributed by many ingredients
- Antioxidant treatment is needed at multiple points
  - All susceptible ingredients
  - At susceptible points in the process
  - Sufficient dosage required to protect the diet throughout the full shelf life
- Antioxidants may need to include:
  - Water and oil soluble components
  - Chelators to chelate pro-oxidant metals
  - Components that withstand and function at hot and cold temperatures
  - Dry and Liquid forms for optimum application

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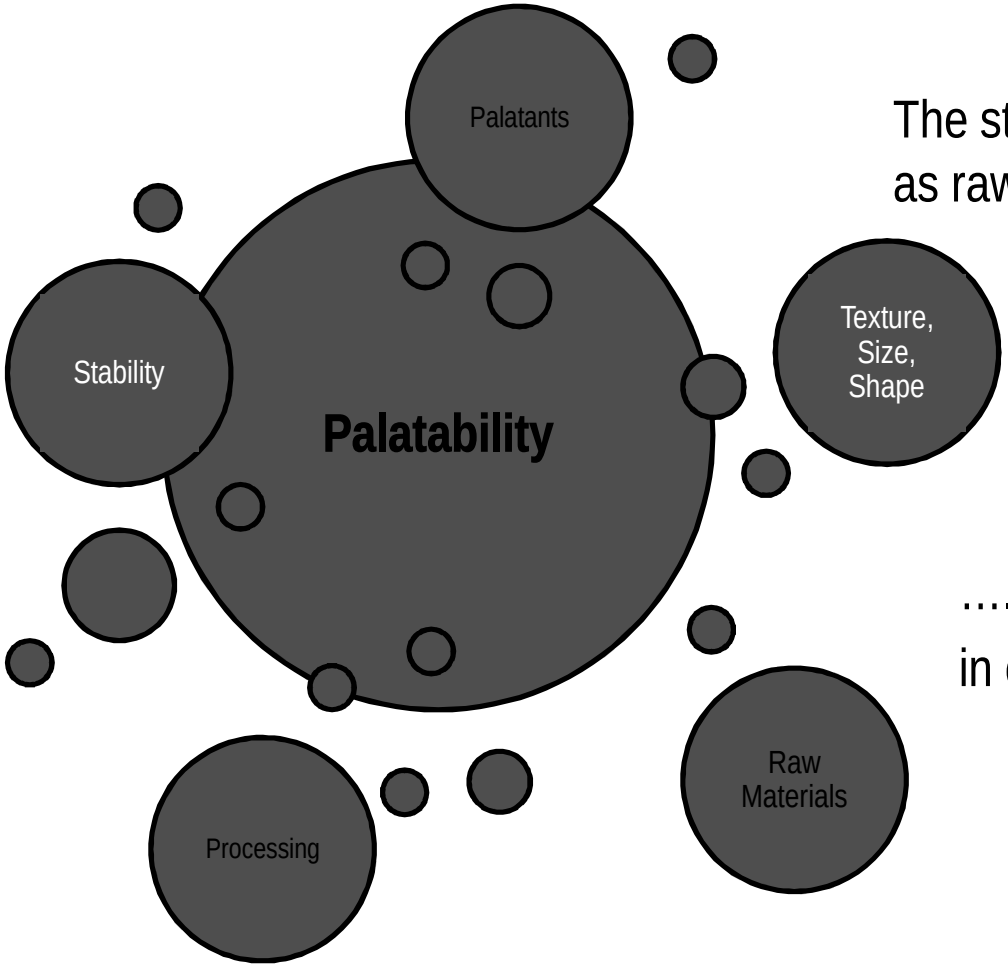
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Palatability is a Bellwether Parameter

….or changes in factors such as stability….



The status of a pet food such as raw materials or texture….

….will be reflected in overall palatability.

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Managing Palatability and Stability

- PALFRESH™ technology provides another Stabilization Tool
  - Improving stability improves palatability
- This technology leverages the interaction between stability and palataiblity which **protects palatability**



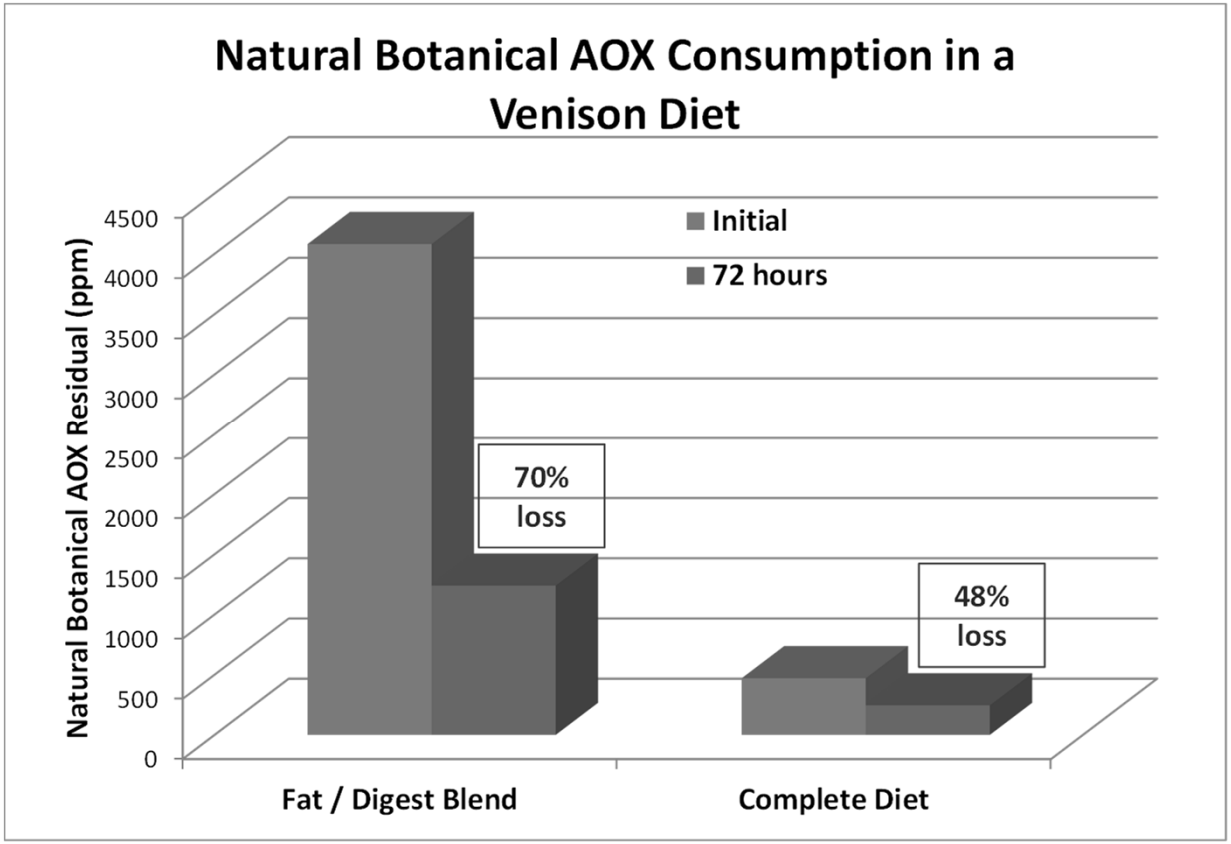
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Managing Palatability and Stability

- Hard to Stabilize Diets
  - Challenging or Pro-Oxidant ingredients and formulations
  - Low Fat diets that are subject to under-dosing and uneven coating
  - ➢ Increased levels of antioxidants may not result in incremental increase in shelf life
- Palatability Decline
  - Although initial stability may obtained with a standard antioxidant program, palatability may decrease within the first three months of shelf life
  - ➢ Antioxidant systems need to be optimized to preserve the palatant profile both pre- and post-coating

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Managing Palatability and Stability



- Pro-oxidant palatants sacrifice antioxidant needed for long term shelf life of the diet

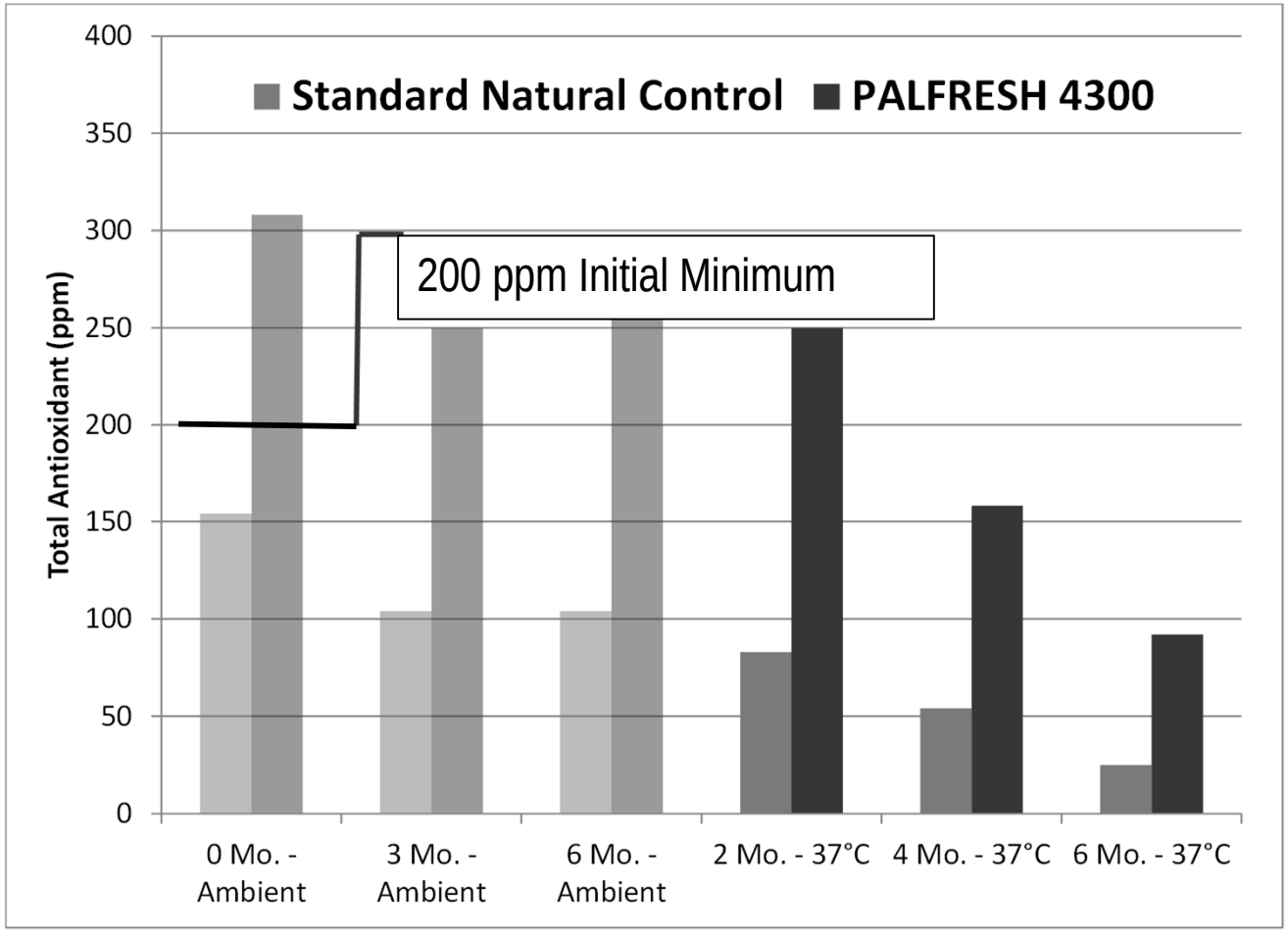
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Managing Palatability and Stability with PALFRESH™ Palatants

✓ ***PALFRESH™ palatants are formulated to not have a pro-oxidant effect***

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Managing Palatability and Stability:
PALFRESH™ 4300 for Dogs



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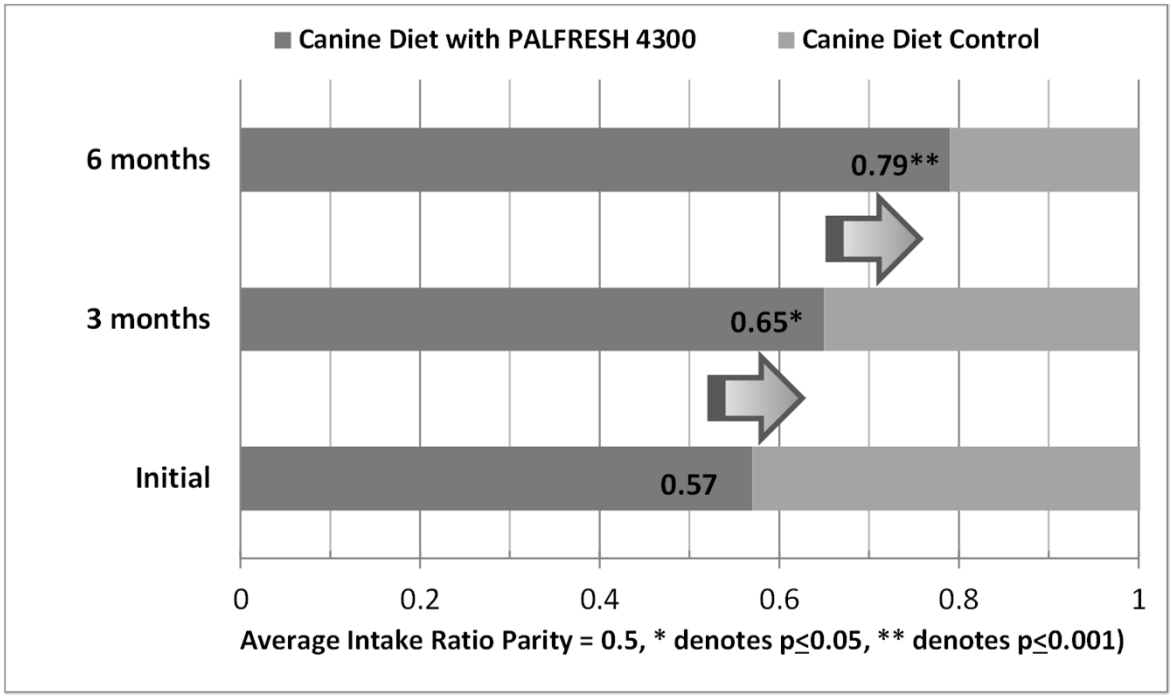
Managing Palatability and Stability with PALFRESH™ Palatants

✓ ***PALFRESH™ palatants are formulated to not have a pro-oxidant effect***

✓ ***PALFRESH palatants deliver target antioxidant effect to the diet at a uniform 3% application rate***

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Managing Palatability and Stability:
PALFRESH™ 4300 for Dogs



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Managing Palatability and Stability with PALFRESH™ Palatants

✓ ***PALFRESH palatants are formulated to not have a pro-oxidant effect***

✓ ***PALFRESH palatants deliver target antioxidant effect to the diet at a uniform 3% application rate***

✓ ***PALFRESH palatants retain preferred pet acceptance through coated diet shelf life***

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Managing Palatability and Stability

- Polar botanical antioxidant systems are compatible and efficacious in aqueous palatants
- These unique liquid palatants contribute antioxidants to the finished diet
- Patent pending technology that reinforces the relationship between stability and palatability

PALFRESH™ Technology that protects palatability

PALFRESH™ brand palatants

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THANK YOU

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