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Where the GLOBAL PET FOOD INDUSTRY does business

#petfoodforum

Considerations for supplementing omega-3s (n-3s) in companion animal diets

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University of Guelph, Guelph, ON, Canada

April 28-30, 2025, Kansas City, Missouri, USA

Learning Objectives

1. Understand the **metabolism and physiological roles** of n-3 and n-6 FA in dogs and cats
2. Review **current published recommendations** for these FA and **research investigating the n-6:n-3 ratio** across life stages in dogs and cats
3. Evaluate the **environmental sustainability and practicality** of different n-3 FA sources available to the pet food industry

Importance of fats

Concentrated source of energy

Taste and texture of food

Help absorb vitamins (A, D, E and K)

Source of essential fatty acids

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Fats as a source of essential fatty acids

Dogs and cats can synthesize many fatty acids from:

- Bacterial synthesis
- Amino acids
- Glucose

But cannot:

- Synthesize n-6 and n-3 fatty acids
- Cannot convert between families (n-6  n-3)

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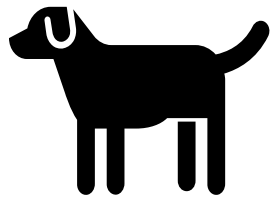
Essential fatty acids



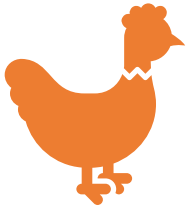
n-6s

Linoleic Acid (LA)

Δ-6 desaturase

Δ-5 desaturase

Arachidonic Acid (AA)



Δ-4 desaturase

Pro-inflammatory signaling molecules

n-3s

Alpha Linolenic Acid (ALA)

Eicosapentaenoic Acid (EPA)

Docosahexaenoic Acid (DHA)

Anti-inflammatory signaling molecules

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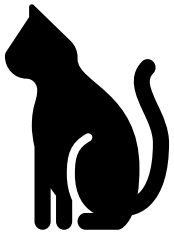
Essential fatty acids



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Arachidonic Acid (AA)

Pro-inflammatory signaling molecules

n-3s

Alpha Linolenic Acid (ALA)

Eicosapentaenoic Acid (EPA)

Δ-4 desaturase

Docosahexaenoic Acid (DHA)

Anti-inflammatory signaling molecules

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Dietary sources of n-6 and n-3 fatty acids

n-6s

Linoleic Acid (LA)

- Corn oil
- Soybean oil
- Sunflower oil

n-3s

Alpha Linolenic Acid (ALA)

- Flaxseed oil
- Camelina oil

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Dietary sources of n-6 and n-3 fatty acids

n-6s

Arachidonic Acid (AA)

- Poultry fats (chicken and duck)
- Beef tallow
- Some fish oils (ie: menhaden)

n-3s

EPA & DHA

- Fish oil (incl. menhaden, herring, salmon etc)
- Algae oil

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Essential fatty acid requirements

AAFCO	Canine		Feline	
	Growth & Reproduction	Adult	Growth & Reproduction	Adult
LA (n-6)	1.3 %	1.1%	0.6%	0.6%
ALA (n-3)	0.08%	--	0.02%	--
AA (n-6)	--	--	0.02%	0.02%
EPA + DHA (n-3s)	0.05%	--	0.012%	--
n-6:n-3 ratio	<30:1	<30:1		

% DM basis, presuming energy density = 4000 kcal ME/kg

DHA and puppies

- DHA necessary for brain and retinal development in-utero and after birth
  - Puppies fed ↑ DHA, or whos moms fed ↑ EPA + DHA during pregnancy and lactation: improved vision, memory and learning ability

(Zicker et al. 2012; Heinemann et al. 2005)

Essential fatty acid requirements

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EPA + DHA (n-3s)	0.05%	--	0.012%	--
n-6:-3 ratio	<30:1	<30:1		

% DM basis, presuming energy density = 4000 kcal ME/kg

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Ratio of n-6 to n-3 fatty acids (n-6:n-3)

- Measure of the balance between these two different families of fatty acids found in the diet
  - Compares quantity of n-6 fatty acids (LA + AA) to the quantity of n-3 fatty acids (ALA, EPA + DHA)

If quantity of n-6 in diet 7 x more than n-3 → **n-6:n-3 = 7:1**

Ratio of n-6 to n-3 fatty acids (n-6:n-3)

- Synthesis of n-6 (AA) and n-3 (EPA + DHA) from plant-derived fatty acids (n-6:LA, n-3:ALA) requires the same enzymes
  - Competition for enzymatic pathways and signal molecule production
- Have opposing effects
  - n-6s: inflammatory
  - n-3s: anti-inflammatory

n-6:n-3 and inflammation

- ↓ dietary n-6:n-3 may help with management of inflammation and inflammatory conditions such as osteoarthritis and dermatitis

Immune response

ELSEVIER

Veterinary Immunology and Immunopathology
69 (1999) 165–183

Veterinary immunology and immunopathology

www.elsevier.com/locate/vetimm

- Healthy young and old dogs both had improved immune response to a dietary n-6:n-3 of 5:1 vs. 25:1

Effect of age, breed and dietary omega-6 (n-6) : omega-3 (n-3) fatty acid ratio on immune function, eicosanoid production, and lipid peroxidation in young and aged dogs

Robert J. Kearns[a,*], Michael G. Hayek[b], John J. Turek[c], Mohsen Meydani[d], John R. Burr[b], Robert J. Greene[b], Craig A. Marshall[b], Scott M. Adams[b], Robert C. Borgert[b], Gregory A. Reinhart[b]

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[b]*The Iams Company, Lewisburg, OH 45338, USA*
[c]*Purdue University, Lafayette, IN 47907, USA*
[d]*Tufts University, Boston, MA 02111, USA*

Skin and coat health

- Dietary n-6:n-3 of 5:1 vs. 20:1 improved fur color, shine and softness
- Reduced skin inflammatory responses to histamine in healthy cats

Contents lists available at ScienceDirect

Veterinary Immunology and Immunopathology

journal homepage: www.elsevier.com/locate/vetimm

Short communication

Dietary fish oil and flaxseed oil suppress inflammation and immunity in cats

Hyun Joo Park[a], Jean Soon Park[a], Michael G. Hayek[b], Gregory A. Reinhart[b], Boon P. Chew[a,*]

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[b] P&G Pet Care, Lewisburg, OH 45338, USA

n-6:n-3 and inflammation

- No clear recommendation on ideal n-6:n-3 for dogs or cats
- Evidence that:
  - n-6:n-3 between 5:1 - 10:1 → effective in altering tissue fatty acid composition and helping with the management of inflammation in healthy animals
  - n-6:n-3 < 5:1 → may be beneficial for animals with inflammatory conditions

Osteoarthritis

Multicenter veterinary practice assessment of the effects of omega-3 fatty acids on osteoarthritis in dogs

James K. Roush, DVM, MS, DACVS; Chadwick E. Dodd, DVM; Dale A. Fritsch, MS; Timothy A. Allen, DVM, DACVIM; Dennis E. Jewell, PhD, DACAN; William D. Schoenherr, PhD; Daniel C. Richardson, DVM, DACVS; Phillip S. Leventhal, PhD; Kevin A. Hahn, DVM, PhD, DACVIM

- Owners of dogs consuming dietary n-6:n-3 of 0.7:1 reported improved ability to rise from a resting position, ability to walk and play vs. dogs consuming n-6:n-3 of 24:1

Risks of excess omega-3 fatty acids

- Delayed wound healing
  - ↓ blood clotting → excess bleeding
  - ↓ skin regeneration
- Altered immune function
  - ↓ white blood cells

New research: EPA & DHA dose-response in adult dogs

- 8-week dose response study with 27 healthy adult dogs
  - Graded inclusions of EPA + DHA (low: 0.03 g/$BW^{0.75}$; mod: 0.45 g/$BW^{0.75}$; high: 0.71 g/$BW^{0.75}$)
- No differences in inflammatory cytokine concentrations between doses
- Dogs fed HIGH: lower α-tocopherol at week 8
  - Indicating that EPA+DHA intake is related to antioxidant depletion


ASAS-CSAS
ANNUAL MEETING
JULY 6-10, 2025
HOLLYWOOD, FLORIDA

Looking ahead: What is the (not so distant) *future* of sustainable fat supply?

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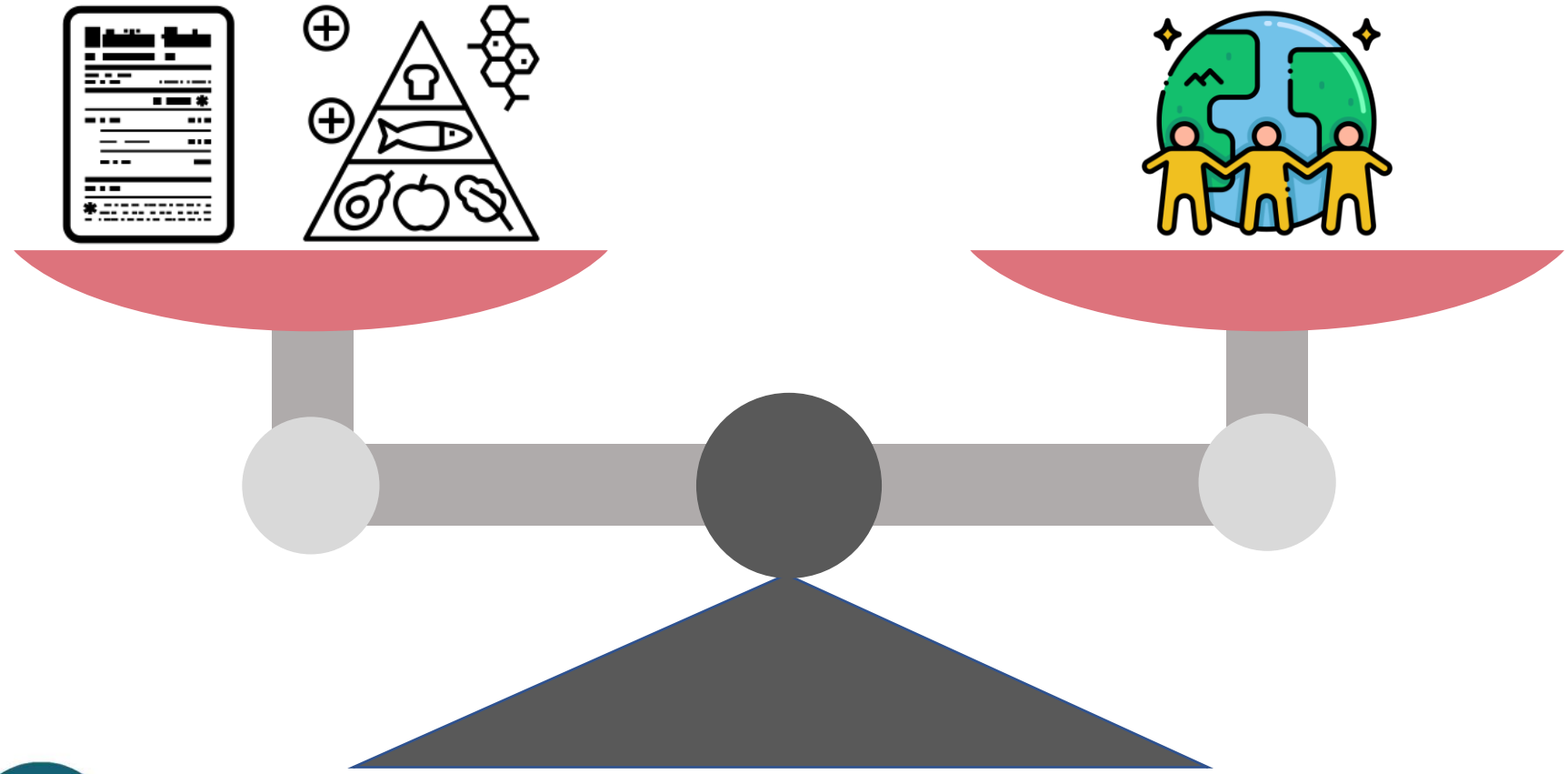
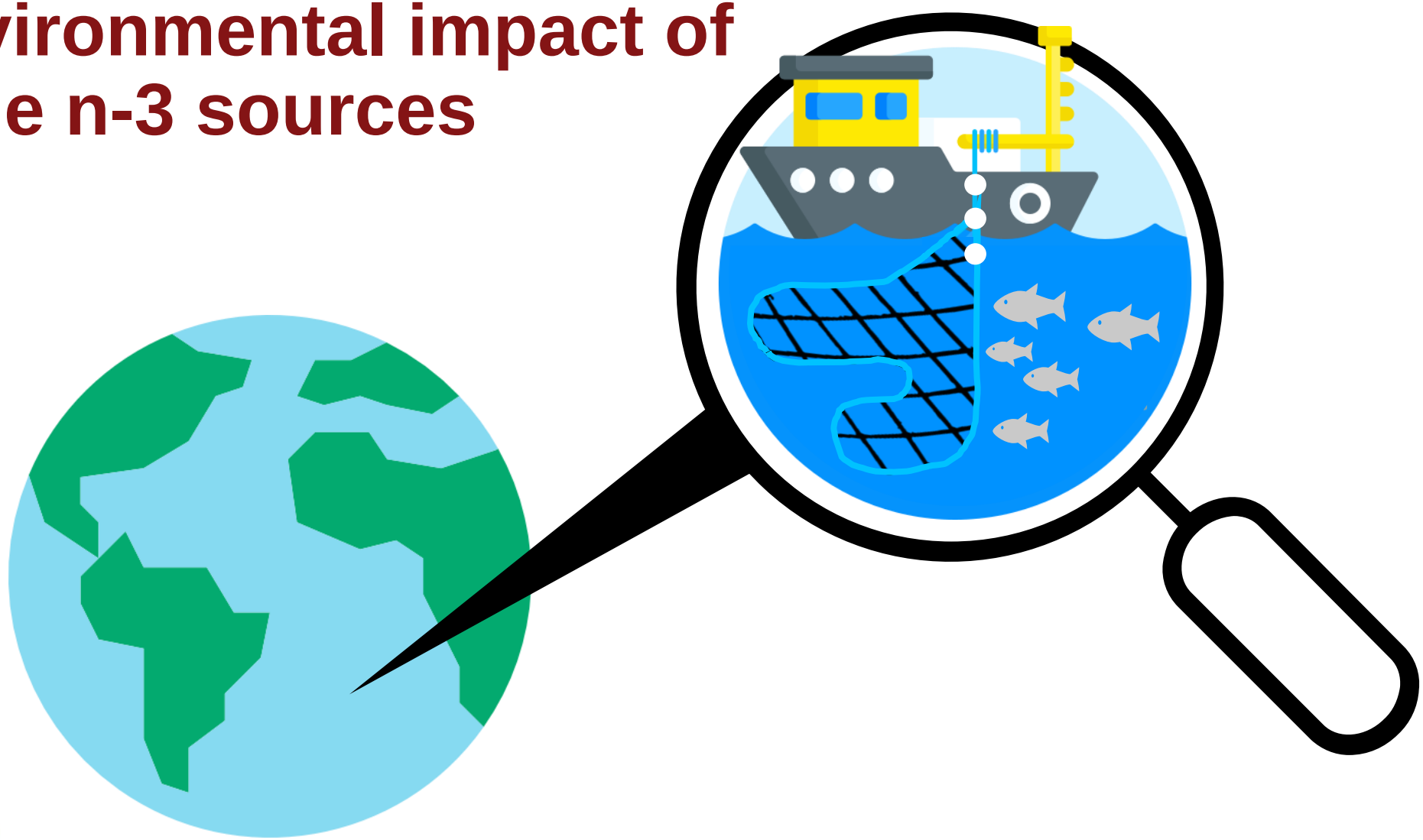
Ingredient choices are a balancing act



Consider environmental impact of marine n-3 sources



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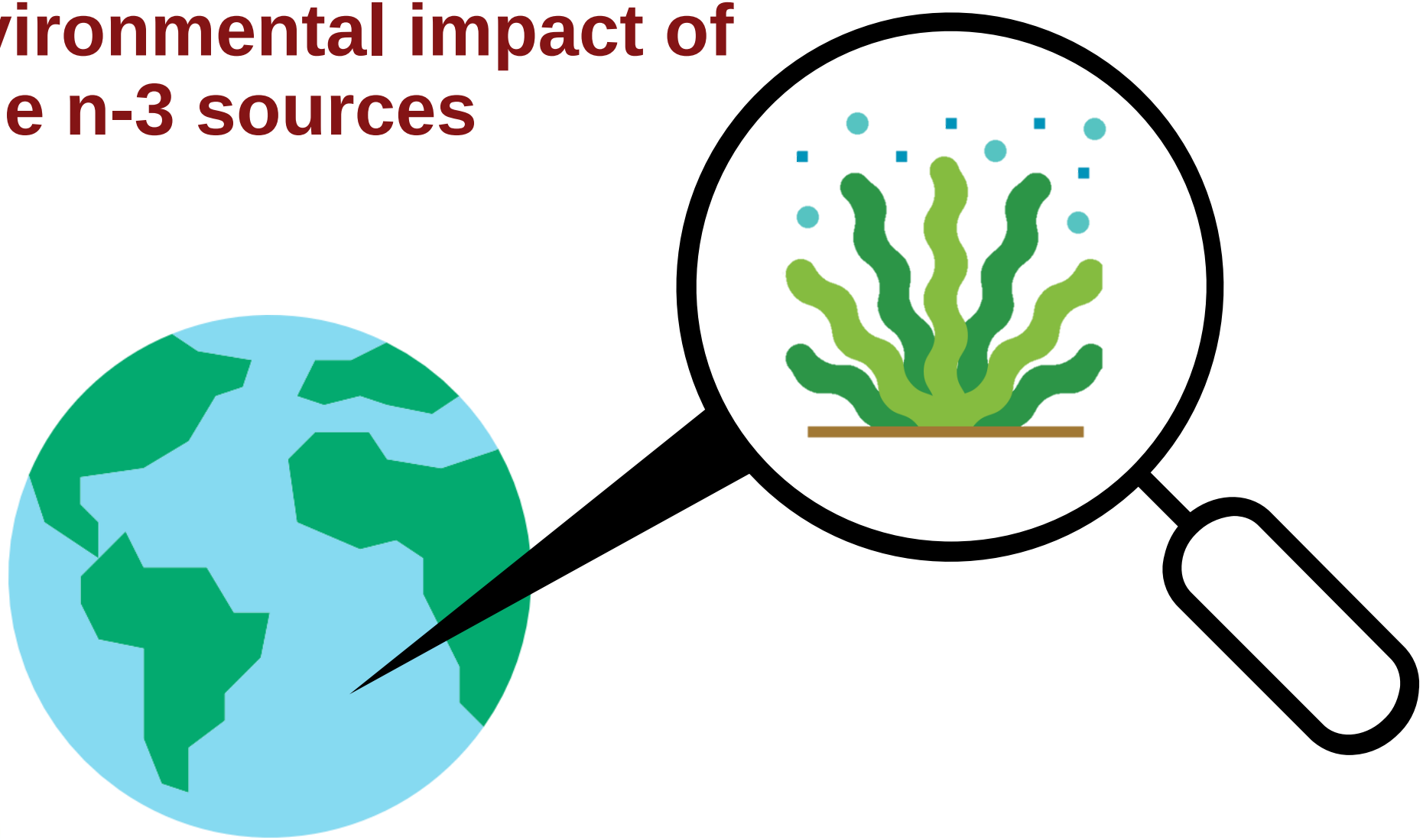

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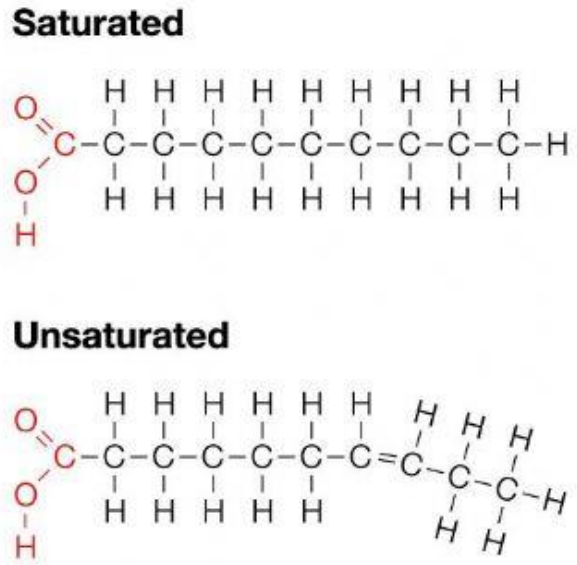
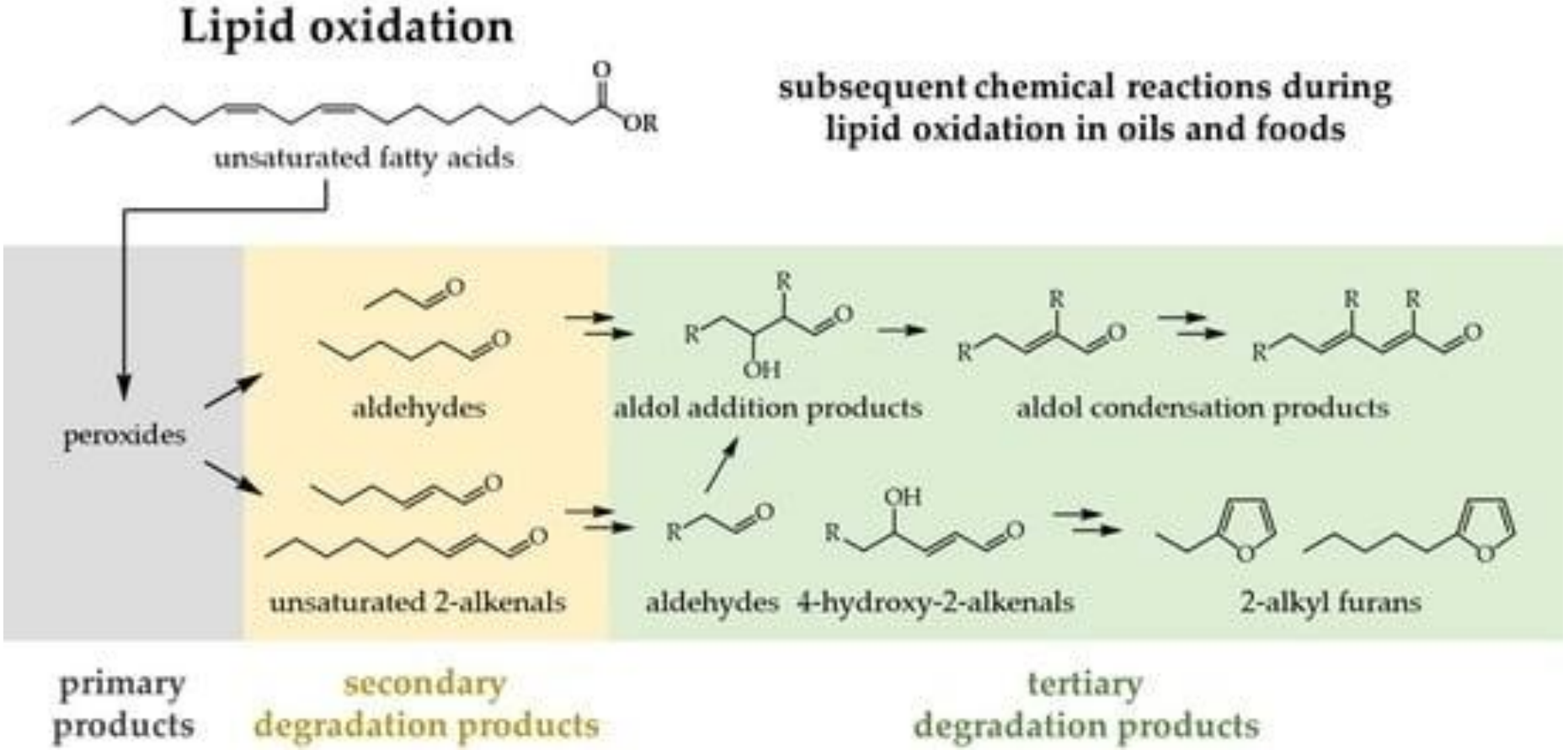
Must also consider lipid oxidation and shelf life

- Polyunsaturated fatty acid (PUFA)-rich oils more susceptible to oxidation vs. fats rich in saturated fatty acids (SFA)
- Oxidation influenced by:
  - Internal factors (ie: nutrient profile)
  - External factors (ie: heat, light)



Must also consider lipid oxidation and shelf life

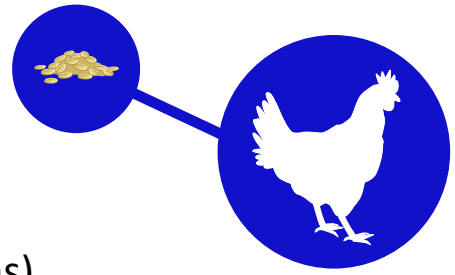


(Grebenteuch et al. 2021)

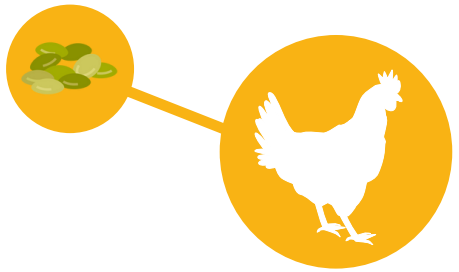
Research investigating lipid oxidation and shelf life

- Objectives:
  - To assess how the oxidative stability of kibble differs in ambient storage conditions based on the degree of saturation of oil it is enrobed in

2 Kibble Formulas
(with and without grains)

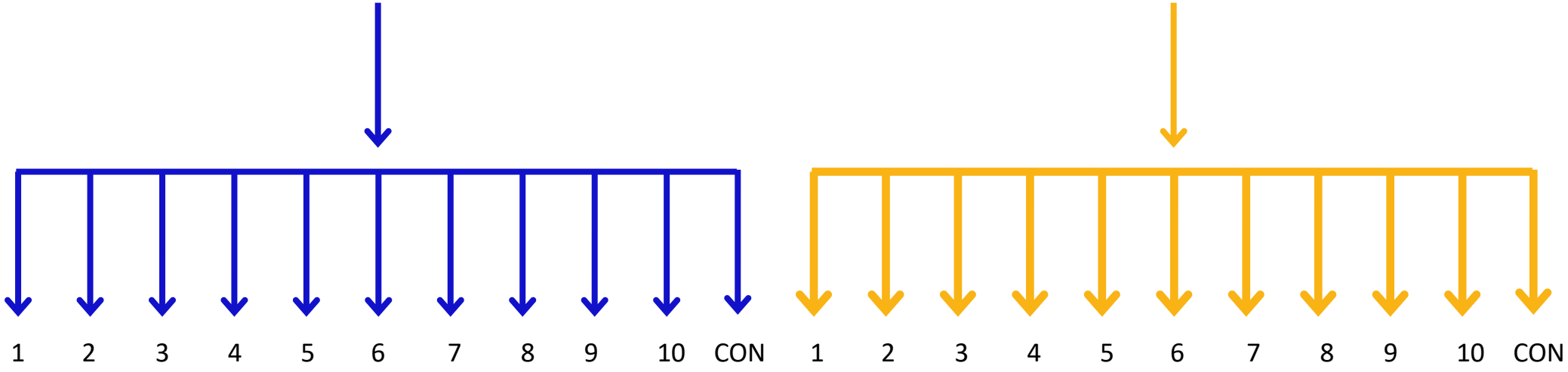


Grains



Pulses

10 oil/fat treatments + uncoated control



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2 Kibble Formulas
(with and without grains)

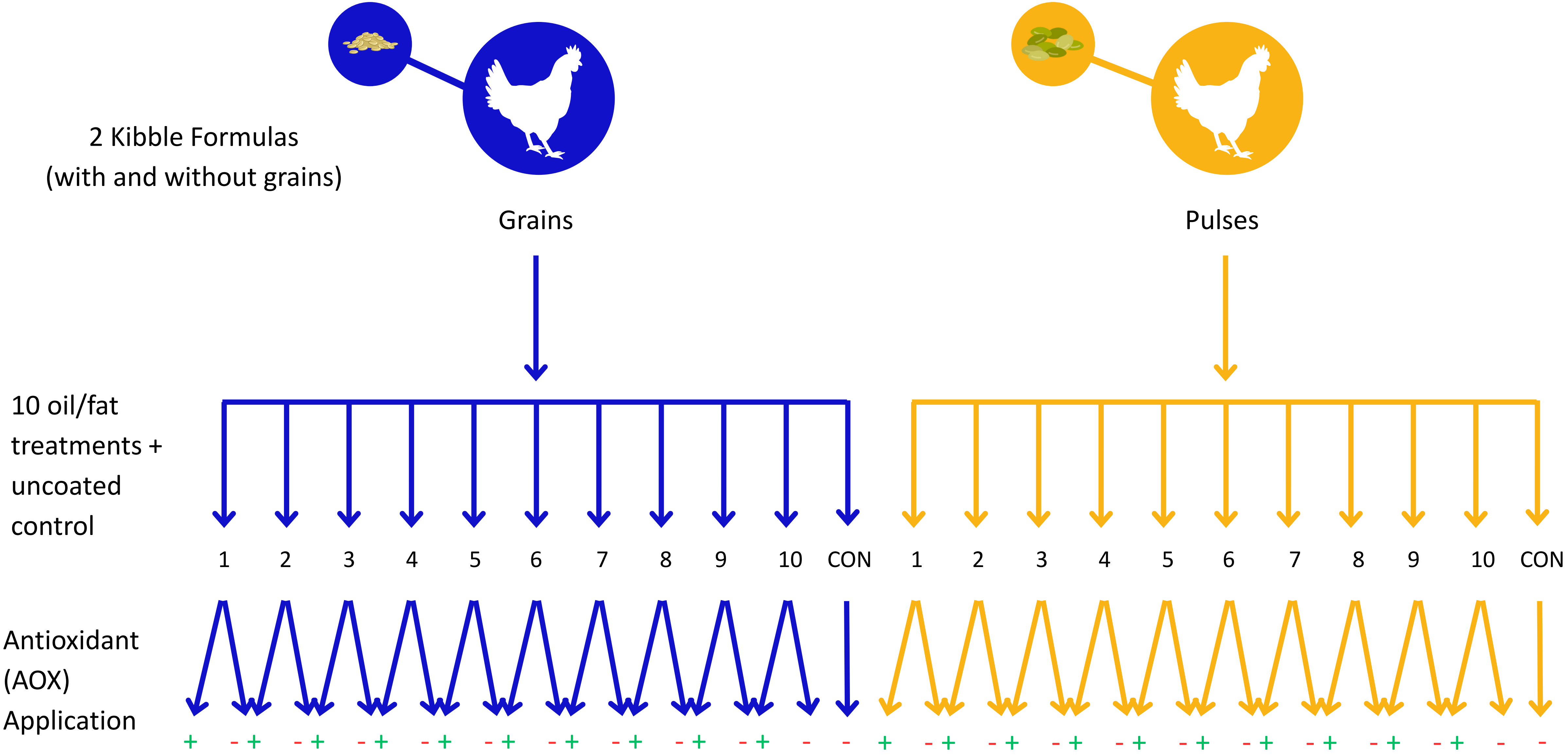
Grains

Pulses

10 oil/fat treatments + uncoated control

FA profile rich in	Oil/Fat Treatments	
PUFA - EPA/DHA (n-3)	Fish (Pollock) Oil	Algae Oil
PUFA - ALA (n-3)	Flax Oil	Camelina Oil
PUFA – LA (n-6)	Sunflower Oil	Canola Oil
SFA	Chicken Fat	Duck Fat
SFA + medium chain FA	Coconut Oil	Black Soldier Fly Larvae (BSFL) oil

CON



Antioxidant: Mixed tocopherols + rosemary oil (NATUROX R30, Kemin Industries) applied to external coating at 200 ppm diet

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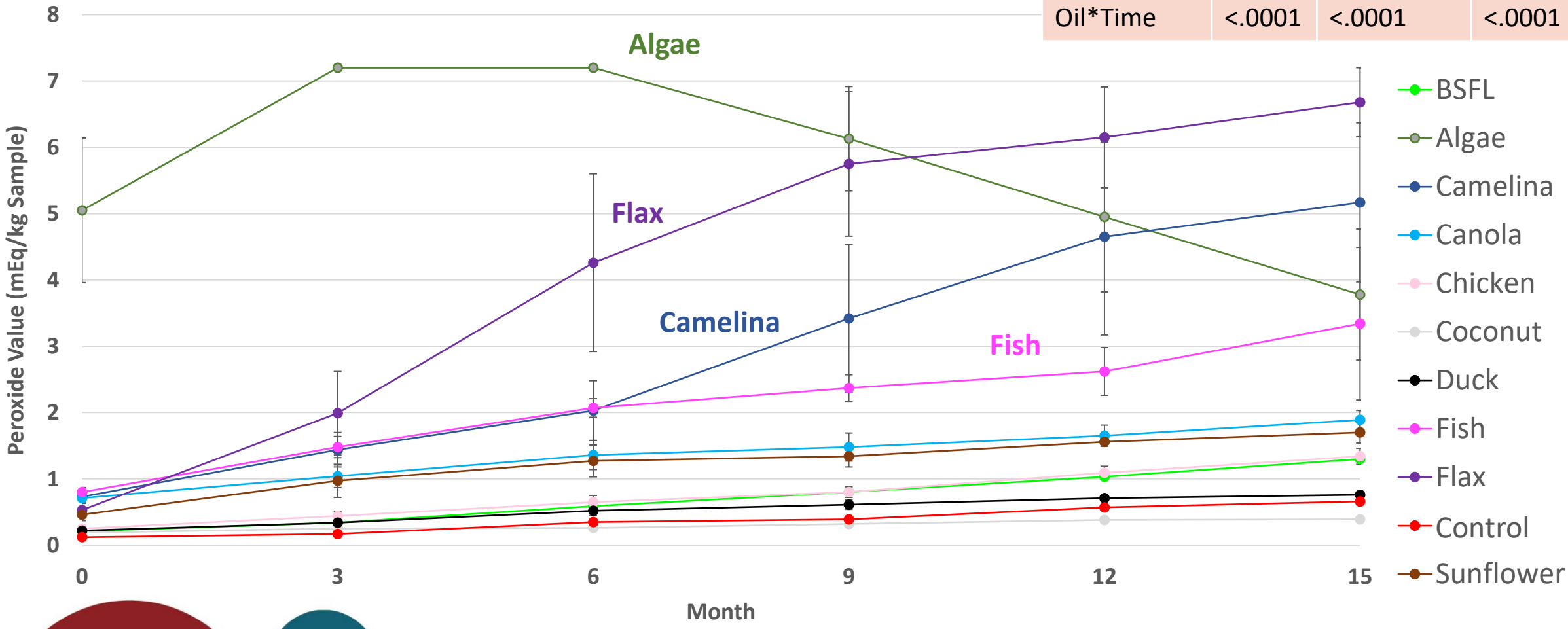
Ambient Storage and Testing

- Samples stored in plastic bags at ambient conditions for 15 months
- Baseline + testing every 3 months of samples for:
  - Peroxide Value (PV)
  - Secondary Aldehydes: Hexanal and 2.4-Decadienal

PUFA-rich oils oxidized more than SFA-rich fats

	PV	Hexanal	Decadienal
Oil	<.0001	<.0001	<.0001
Time	<.0001	<.0001	<.0001
Oil*Time	<.0001	<.0001	<.0001



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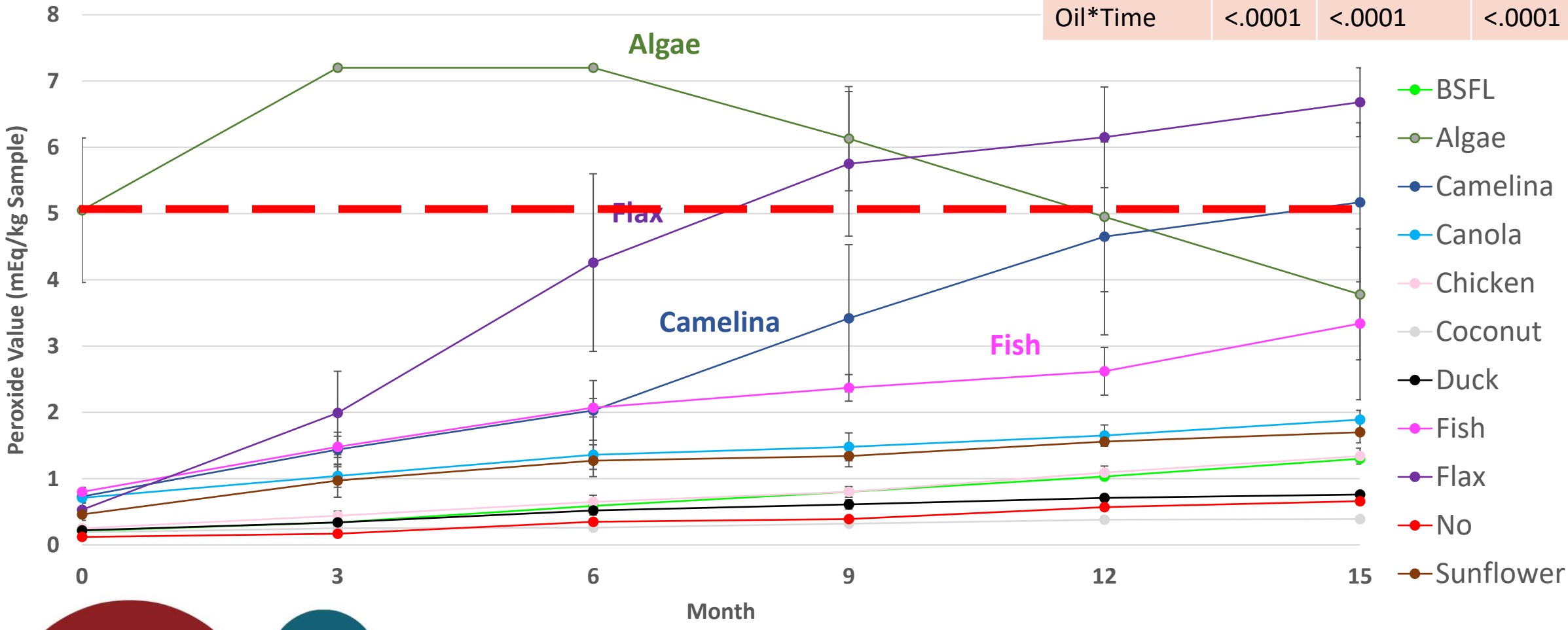
PUFA-rich oils oxidized more than SFA-rich fats

	PV	Hexanal	Decadienal
Oil	<.0001	<.0001	<.0001
Time	<.0001	<.0001	<.0001
Oil*Time	<.0001	<.0001	<.0001



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Ingredient choices are a balancing act

- Algae oil considered more environmentally sustainable option for providing EPA and DHA vs. fish oil
  - However, oxidative stability must be considered
  - Lipid oxidation = especially important consideration for immunocompromised pets

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Considerations for ALA

- ALA will support the endogenous production of EPA in dogs
  - Additional EPA/DHA supplementation only needed during certain life stages, such as growth/reproduction or in certain disease states
- Beneficial effects of ALA on inflammation independent of its conversion to EPA and DHA (Anderson and Ma, 2009)

Considerations for ALA

- Inclusion of EPA or DHA-rich ingredients in excess is not warranted

  given the:

  - Practical limitations in terms of **sustainability**
  - **Lack of requirements** in healthy adult animals
  - **Potential to create a problem: lipid oxidation**

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Considerations for ALA

- Reliance on a single fat source may not be sufficient in meeting the essential and conditionally essential FA recommendations of a dog or cat
- **Need more oil/fat options for a sustainable supply chain**
  - Limited choices currently

Acknowledgements

NSERC
CRSNG

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Thank you!

Questions?

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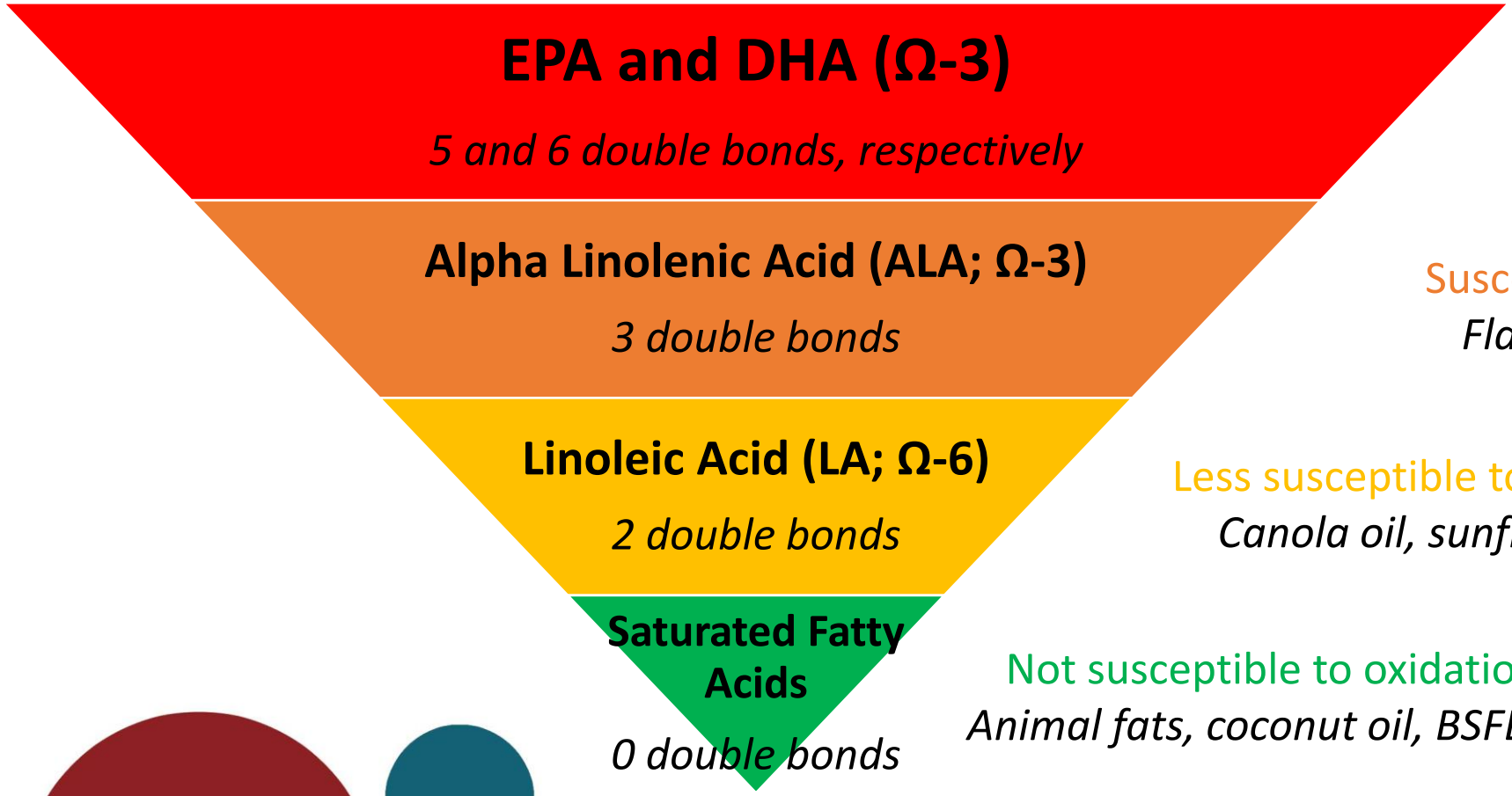
Oxidation related to degree of unsaturation (# double bonds)

Ingredients rich in:



Most susceptible to oxidation
Fish oil, algae oil

Susceptible to oxidation
Flax oil, camelina oil

Less susceptible to oxidation
Canola oil, sunflower oil

Not susceptible to oxidation
Animal fats, coconut oil, BSFL oil

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n-6s

Linoleic Acid (LA)

↓

γ-Linoleic Acid (GLA)

↓

Arachidonic Acid (AA)

n-3s

Alpha Linolenic Acid (ALA)

↓

Stearidonic Acid (SDA)

↓

Eicosapentaenoic Acid (EPA)

↓

Docosapentaenoic Acid (DPA)

↓

Docosahexaenoic Acid (DHA)

Safety of Dietary Camelina Oil Supplementation in Healthy, Adult Dogs

by Scarlett Burron [1], Taylor Richards [1], Keely Patterson [1], Caitlin Grant [2], Nadeem Akhtar [1], Luciano Trevizan [3], Wendy Pearson [1] and Anna Kate Shoveller [1,*]

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Animals **2021**, *11*(9), 2603; https://doi.org/10.3390/ani11092603