



NASC Preferred Supplier Educational Webinar Series



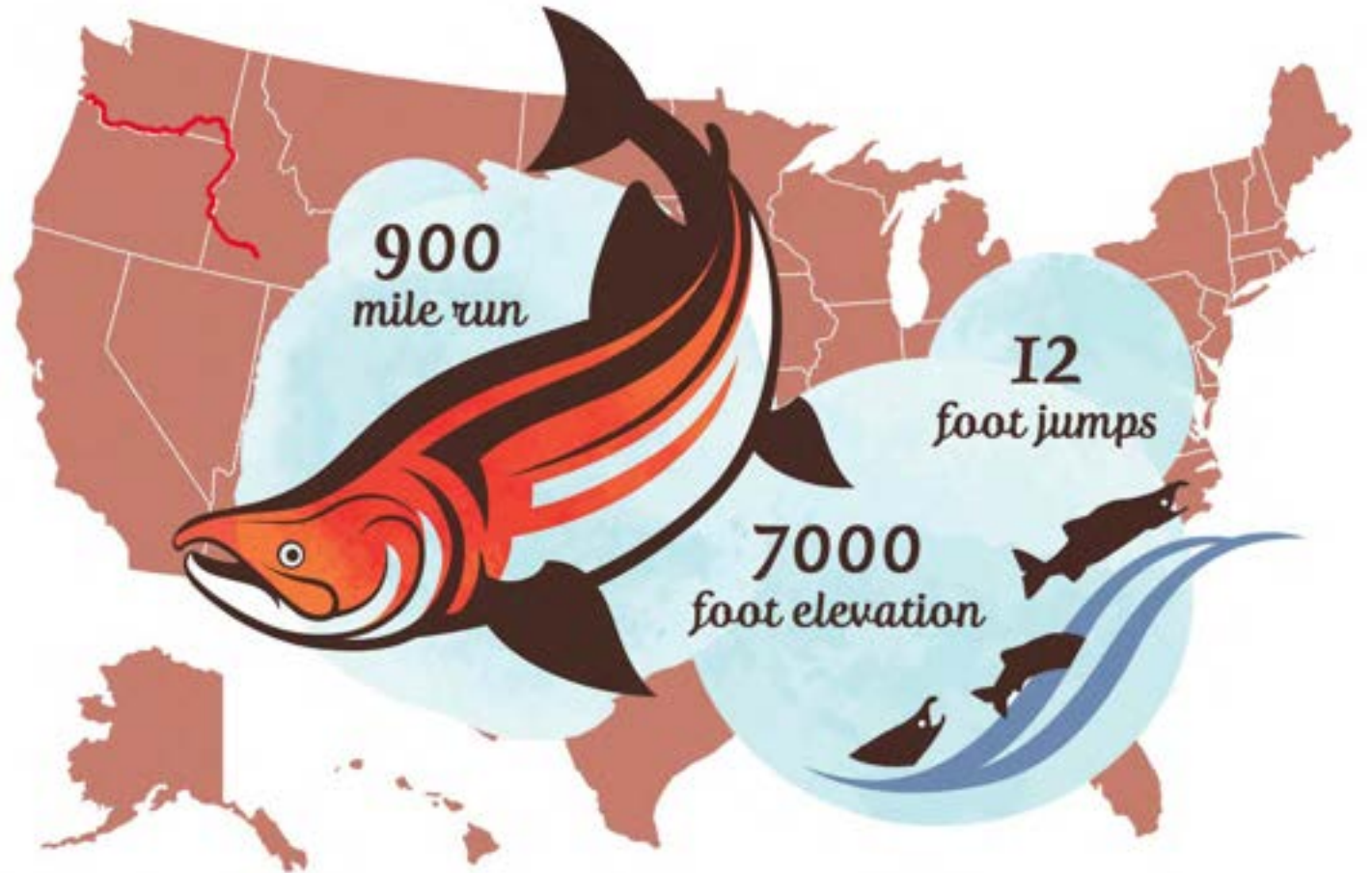


Science-Based Formulations with Natural Astaxanthin for Pets and Their Parents

Karen A. Hecht, Ph.D.

Scientific Affairs Manager, AstaReal Inc.

Natural
Astaxanthin –
Essential
Nutrient for
Salmon



Address the Astaxanthin Diet Gap with Supplementation

Studies show benefits for dogs at
0.1 - 2.2 mg/kg natural astaxanthin.

Mitochondrial support: 2.2 mg/kg
Park et al. 2013

Mobility: 0.08 mg/kg
Zhang et al. 2015

Cardiovascular health: 0.3 mg/kg
Murai et al. 2019

Cognitive function: 0.07 - 0.9 mg/kg
Honda et al. 2014 (US 8,623,434 B2)

Eye health: 0.45 – 0.8 mg/kg
Wang et al. 2016
Destefanis et al. 2016



0.3 mg/day

= 1

wild King
salmon fillet



1 mg/day

= 2

wild King
salmon fillets



3 mg/day

= 6

wild King
salmon fillets



The Power of Natural Astaxanthin

NATURAL ASTAXANTHIN IS:

2.6x STRONGER THAN LUTEIN

4.9x STRONGER THAN BETA-CAROTENE

110x STRONGER THAN VITAMIN E

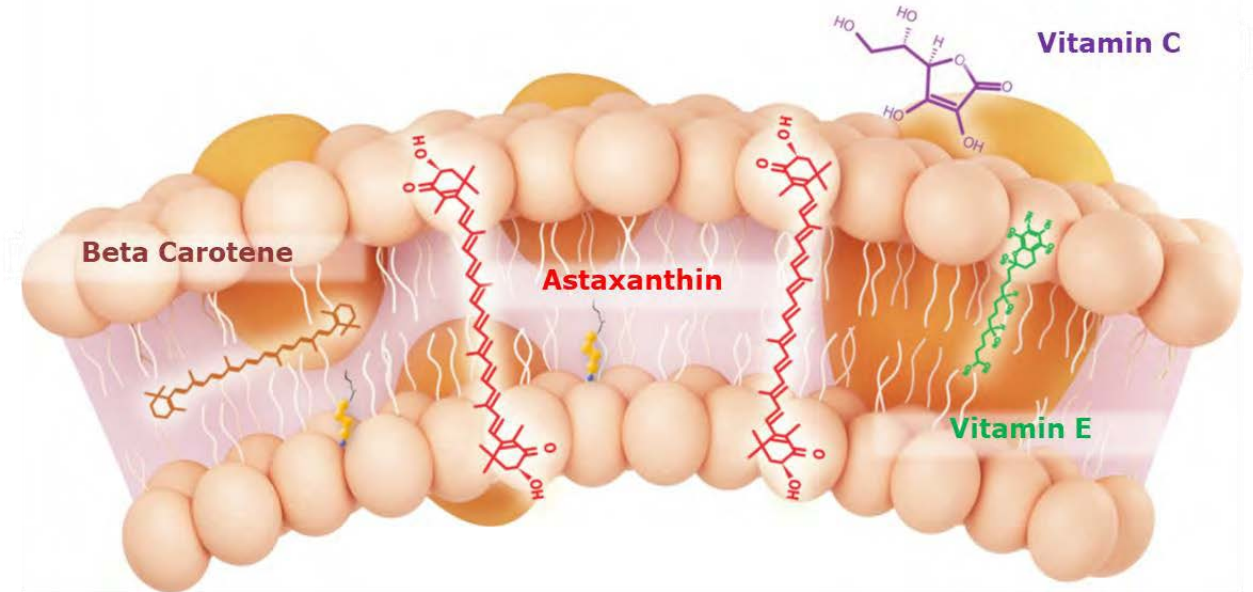
800x STRONGER THAN COQ10

6000x STRONGER THAN VITAMIN C



Head-to-head singlet oxygen quenching capacity *in vitro*

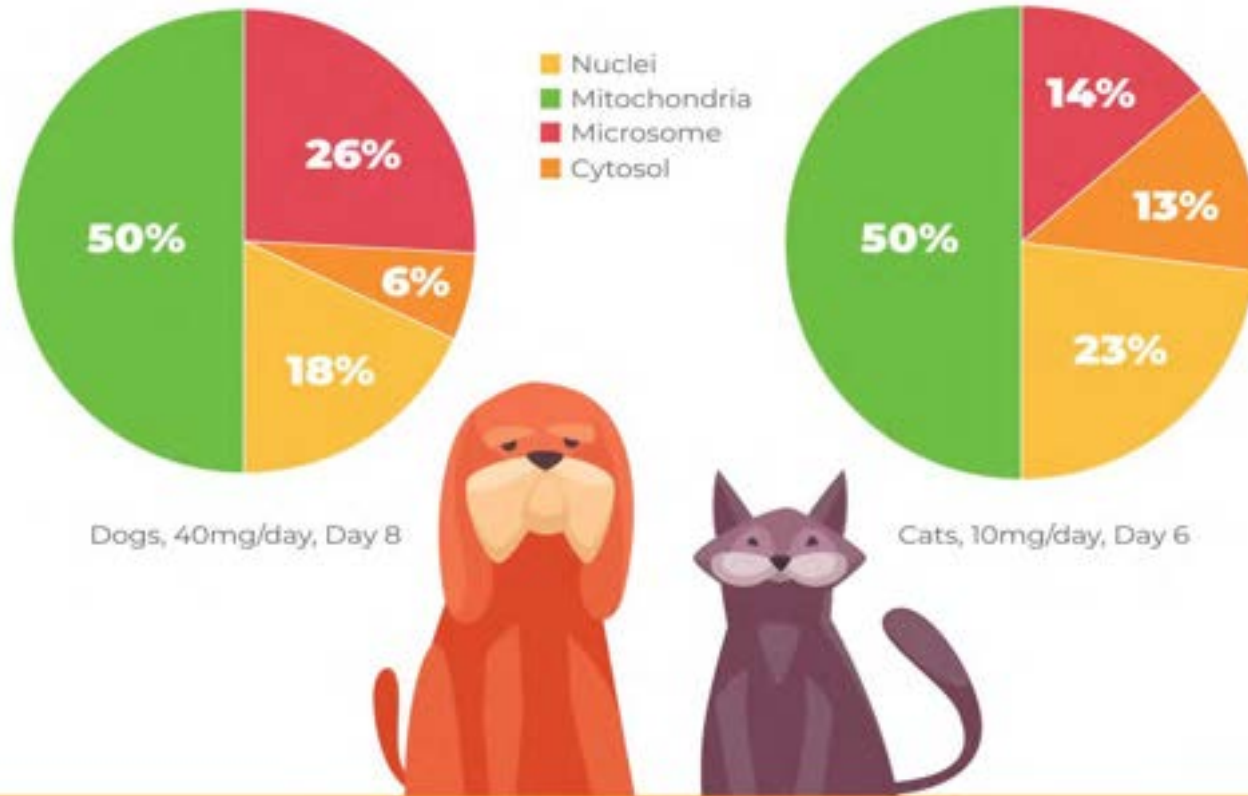
Nishida Y. et. al., Carotenoid Science 2007;11:16-20.
Pashkow FJ, et al. Am J Cardiol 2008;101(suppl):58D-68D.



**6000X stronger than
Vitamin C**

Astaxanthin Primarily Found in Mitochondria

Mitochondria are the
Powerhouses of the Cell



© AstaReal 2022

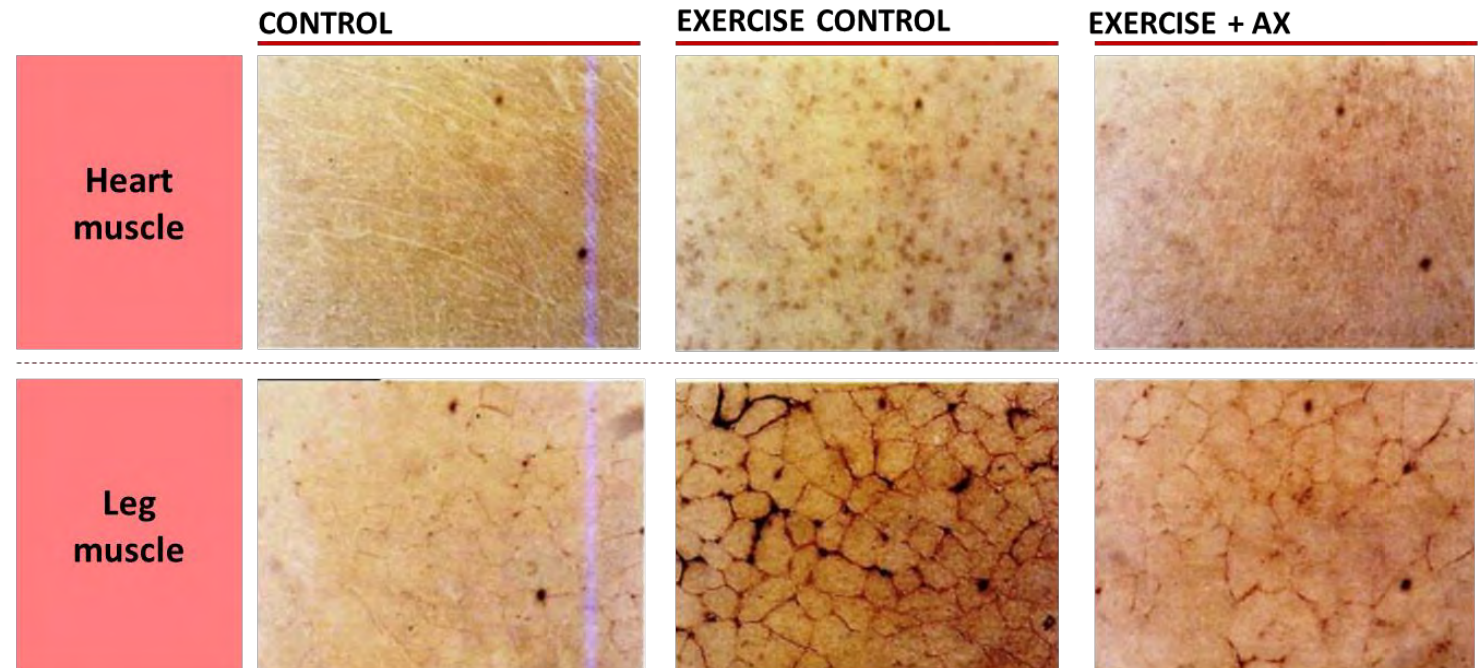
Astaxanthin Neutralizes Free Radicals at Their Source

**Free Radicals are
Mitochondrial Byproducts**



Fat oxidation during exercise

0.02% astaxanthin for 3 weeks



Source: Aoi et al. (2003) Antioxidants & Redox Signalling, 5:(1) 139-144.

Improved Mitochondrial Function in Dogs

Female beagle dogs

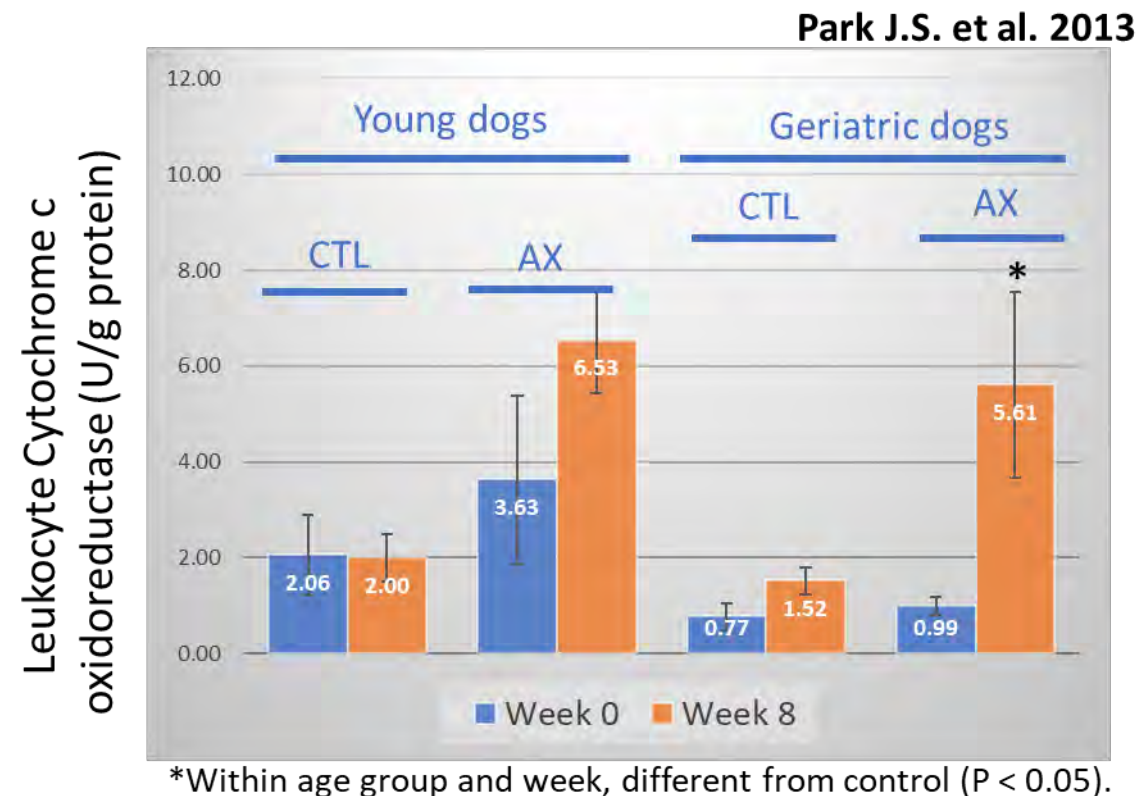
14 young individuals (average 2.97 yr old)

14 geriatric individuals (average 10.71 yr old)

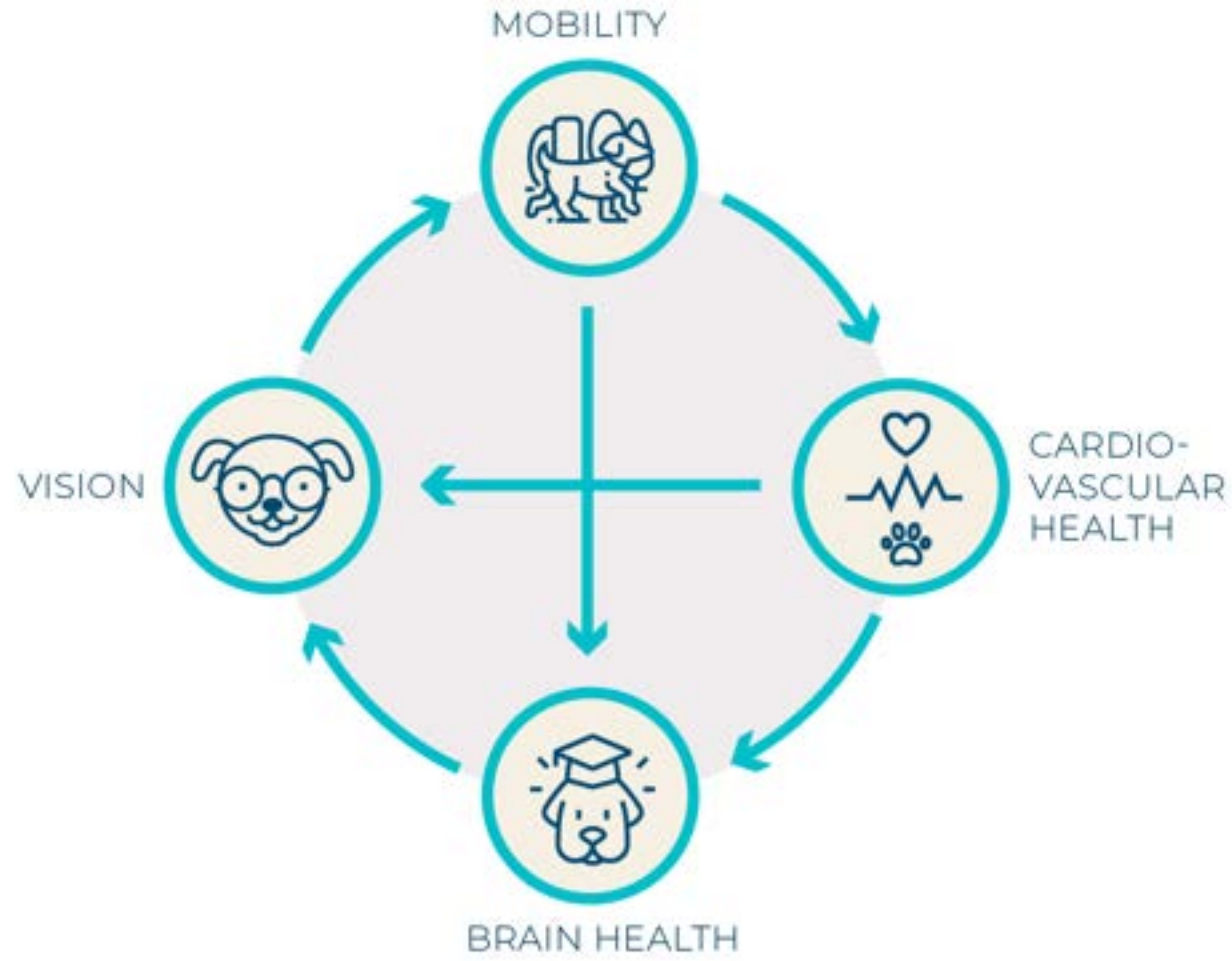
Fed 0mg or 20mg astaxanthin kibble daily for 16 weeks

Astaxanthin fed dogs increased **ATP production** in both young and geriatric groups by **12-14%** after 16 weeks compared to no astaxanthin control groups ($p < 0.05$)

Leukocyte Cytochrome c oxidoreductase increased 570-600% by week 8 in geriatric AX group ($p < 0.001$).



STAYING HEALTHY EVERYWHERE, ALL AT ONCE





Astaxanthin as a Tool for Maintaining Mobility Later in Life

Geriatric animals account for half of the pet population in the United States

Frye et al. 2022

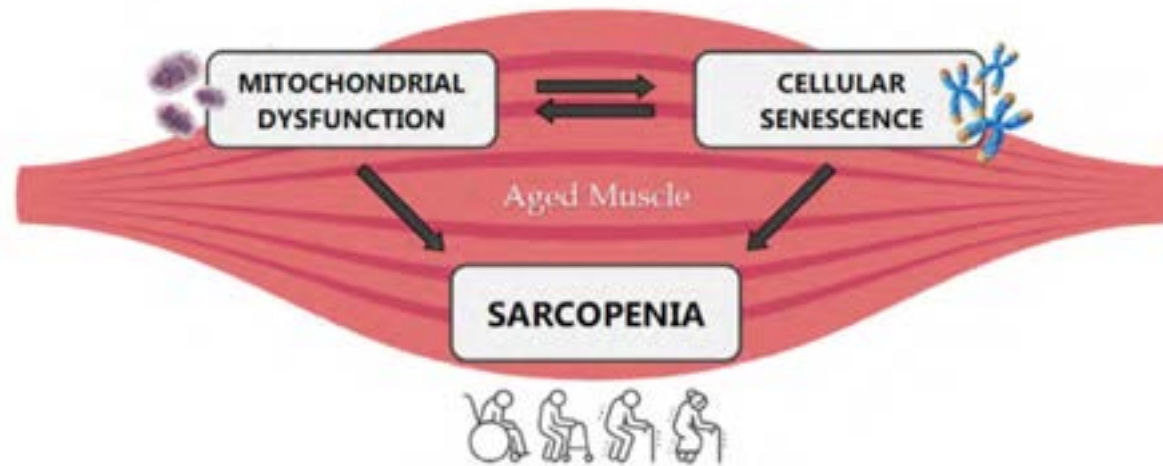
Sarcopenia: Progressive Muscle Loss

Muscle mass declines at $\sim 1\%$ / year after age 30.

Kirk-Sanchez and McGough. Clinical Interventions in Aging 2014:9

↑Oxidative stress
↑ ROS accumulation
↑ mtDNA damage

↓ATP production
↓Bioenergetics
↓Biogenesis

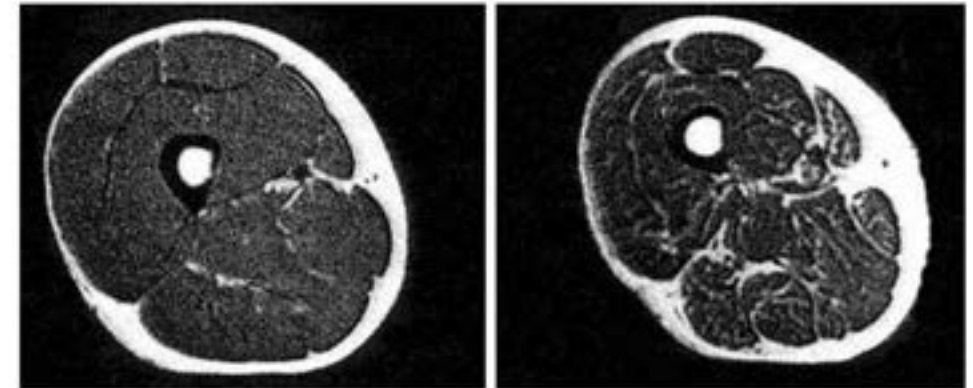


Modified from Figure 1: Ferri, E. et al. Role of Age-Related Mitochondrial Dysfunction in Sarcopenia. *Int J Mol Sci.* 2020;21(15):5236.

MRI Cross-Section of Human Thigh

25-year-old

65-year-old



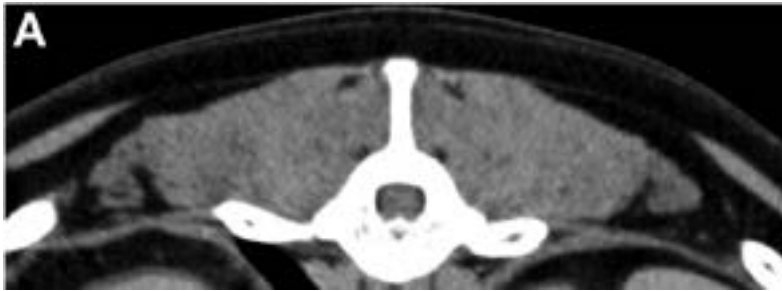
Right: Sarcopenic loss of muscle fiber, fat infiltration

Sergi G., et al. Imaging of sarcopenia. *Eur J Radiol.* 2016;85(8):1519-1524.

Greater Muscle Loss in Older Dogs

Sarcopenia in humans is identified by measuring the cross-sectional area of the thigh or epaxial (paraspinal) muscle via CT.

10-year-old Golden Retriever



4-year-old Golden Retriever



Reduced Muscle Radiodensity

Mean CT attenuation values for the left epaxial muscles significantly lower in old dogs (mean \pm SD, 47.1 \pm 6.5 HU) than in young dogs (55.5 \pm 4.4 HU; $p = 0.005$).

Reduced Muscle Condition Score

Greater muscle loss in old dogs based on MCS ($p < 0.001$)

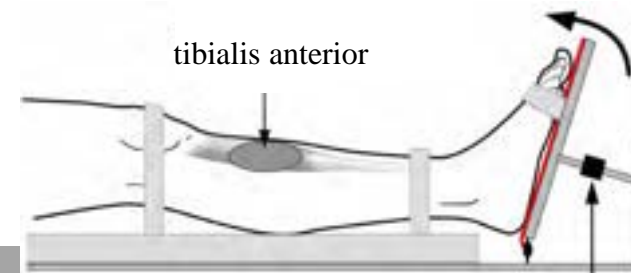
- Older dogs median MCS = 1.3 [range, 0.5 - 2.0], $n=10$
- Young dogs (0 for all, $n=9$)

Muscle Condition Score (MCS) to each dog on a scale:

- 0 is no muscle loss
- 1 is mild muscle loss
- 2 is moderate muscle loss
- 3 is severe muscle loss.

Study Combined Astaxanthin with Functional Training

- Randomized, double-blind, placebo-controlled study
- 65-85 years old
- Astaxanthin 12mg, Tocotrienol 10mg, Zinc 6mg vs placebo
- Enrollment n=58, (Ax=32, Pl=26), 41 completed the study.
- Exercise Intervention: Treadmill 9-12% incline,
- Recovery: Treadmill 5-7% incline



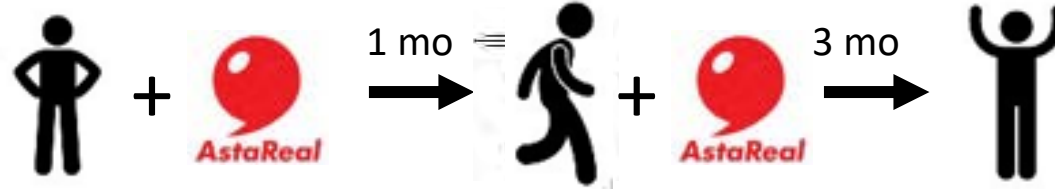
Phase	Week	Exercise time	Recovery
No intervention (Only Ax intake)	1 Month		
Familiarization	Week 1-2	1 min	8-10 intervals 2 min recovery
Base Line	Week 3-7	1-1.5 min 70-80% HRmax	8-10 intervals 2-3 min recovery
Ramping up	Week 8-12	1.5 – 2min 80-85% HRmax	10-12 intervals 0.5 – 1min recovery

▶ Exercise

▶ Post



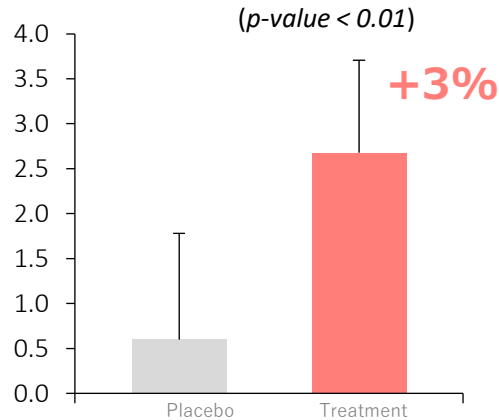
Astaxanthin Improved Results of Functional Training



Astaxanthin intervention increased muscle mass as well as muscle strength, while exercise alone did not.

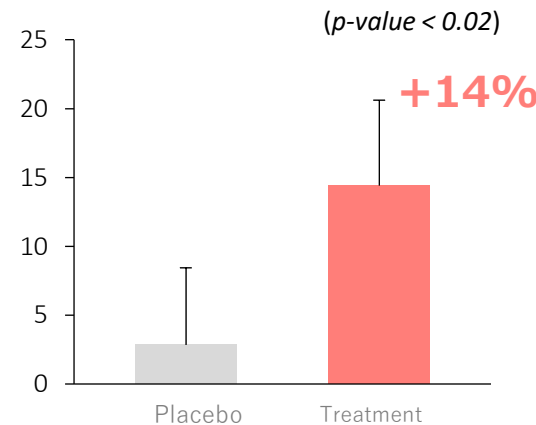
Increase in tibialis anterior cross-sectional area (CSA)

Muscle Mass
CSA (%)



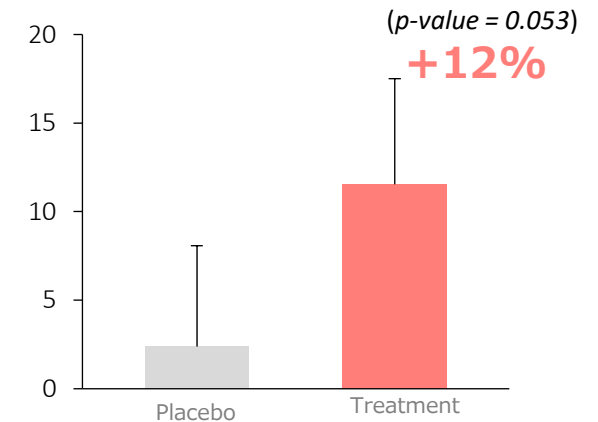
Increase in maximum voluntary contraction (MVC)

Muscle Strength
MVC (%)



Increase in specific force (MVC/CSA)

Specific Force Increase(%)
MVC/CSA



CSA by 2.7% ($\pm 1.0\%$, $P < 0.01$)

MVC by 14.4% ($\pm 6.2\%$, $P < 0.02$)

specific force by 11.6% ($\pm 6.0\%$, $P = 0.05$)

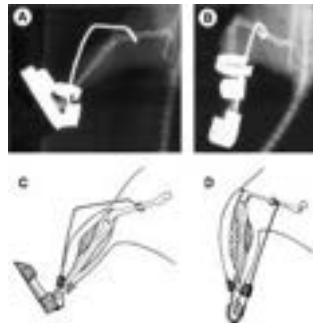
Placebo: (MVC, 2.9% \pm 5.6%; CSA, 0.6% \pm 1.2%; MVC/CSA, 2.4 \pm 5.7%; $P > 0.6$ for all).

Astaxanthin Inhibited Muscle Capillary Regression from Disuse

Muscle atrophy and capillary regression worsened in the soleus muscle with longer periods of hindlimb unloading (HU).

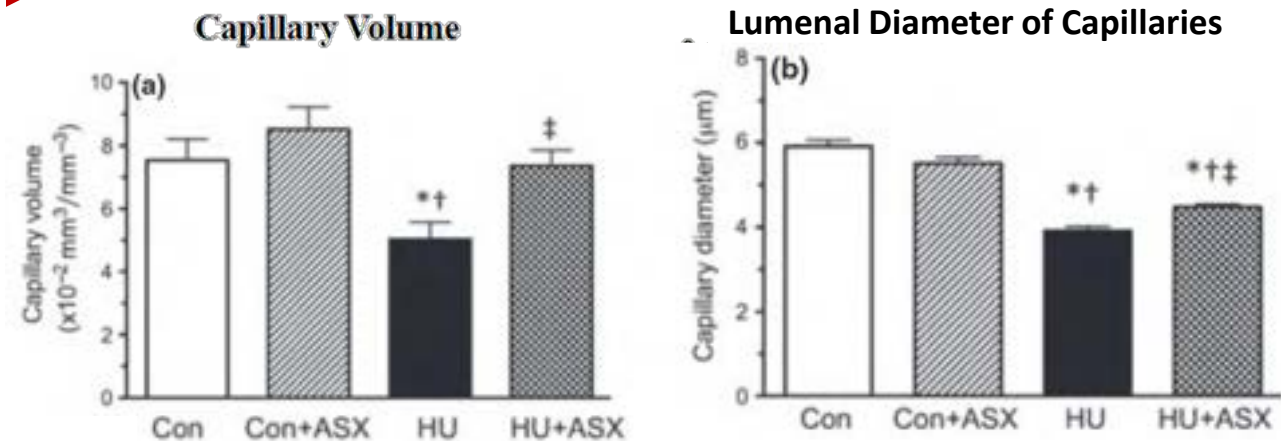
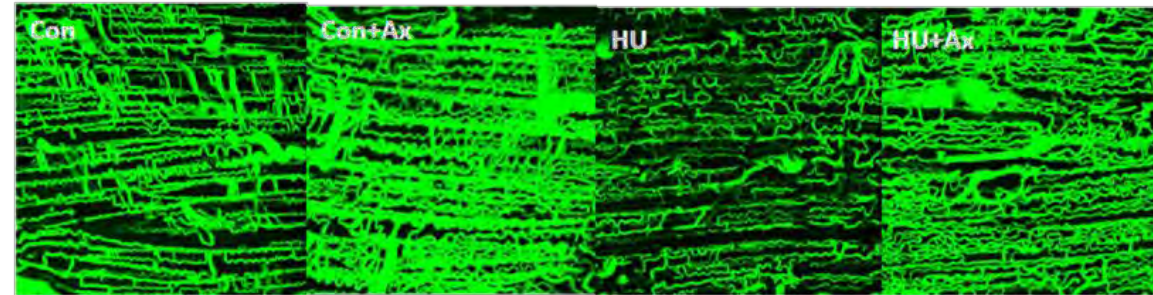
Study summary

- Oral administration of astaxanthin daily (50mg) followed by 7 days immobilization (hindlimb unloading)
- **HU**- hindlimb unloading



Result

3-D capillarity in skeletal muscle



Mean (\pm SEM) capillary volume (a) and diameter (b) of the Con, Con + ASX, HU and HU + ASX groups determined using confocal laser microscopy. Both mean capillary volume and diameter were lower in the HU than all other groups. Capillary volume, but not diameter, in the HU + ASX group was not different from Con levels. *, † and ‡ denote a significant difference from the Con, Con + ASX and HU groups, respectively, at $P < 0.05$.



Supporting Cardiovascular Health
with Astaxanthin

Astaxanthin Slowed Down LDL Oxidation

Ex vivo study 24 volunteers (mean age 28.2 [SD 7.8] years) consumed astaxanthin at doses of 1.8, 3.6, 14.4 and 21.6 mg per day for 14 days.

Fasting venous blood samples were taken at days 0, +14. LDL lag time was longer (5.0, 26.2, 42.3 and 30.7% respectively) compared with day 0 after consuming astaxanthin at doses of 1.8, 3.6, 14.4 and 21.6 mg for 14 days compared with day 0, but there was no difference in oxidation of LDL between day 0 (lag time 59.9 ± 7.2 min) and day 14 (57.2 ± 6.0 min) in the control group.

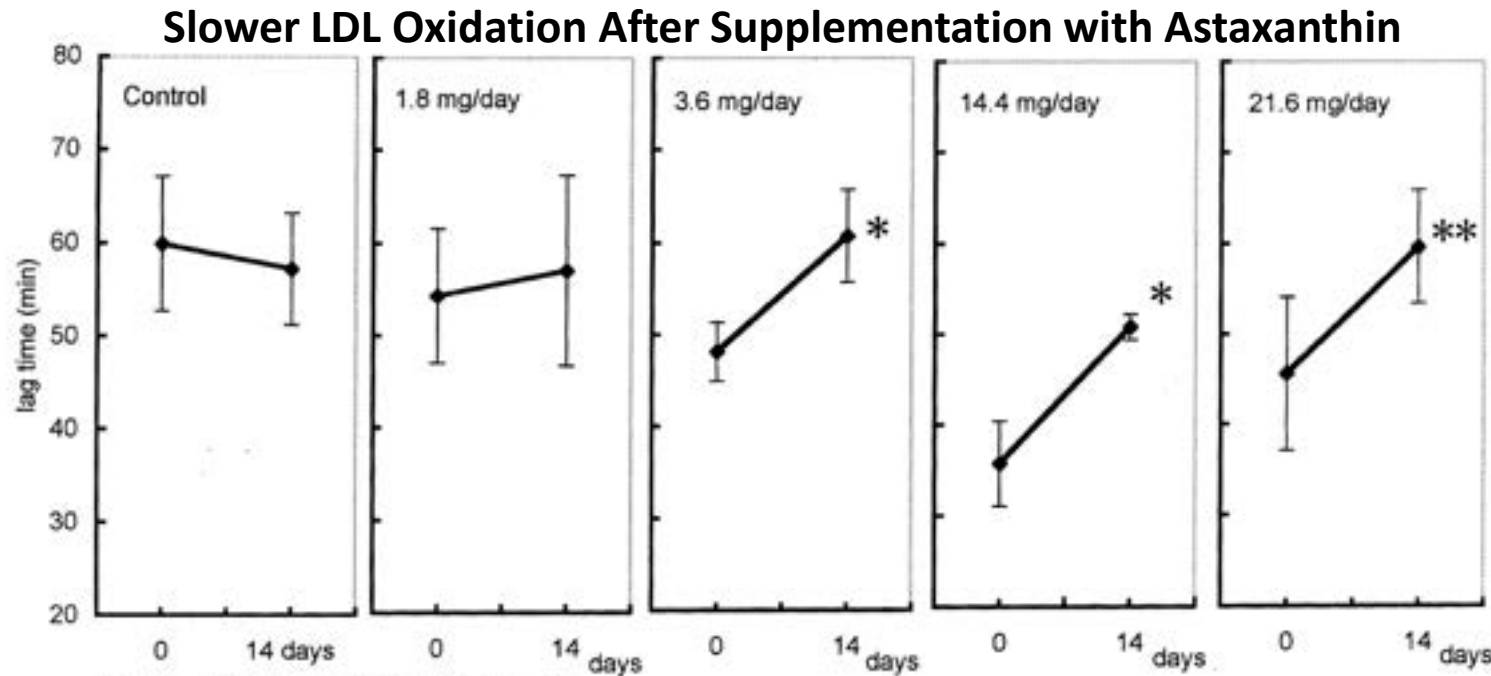
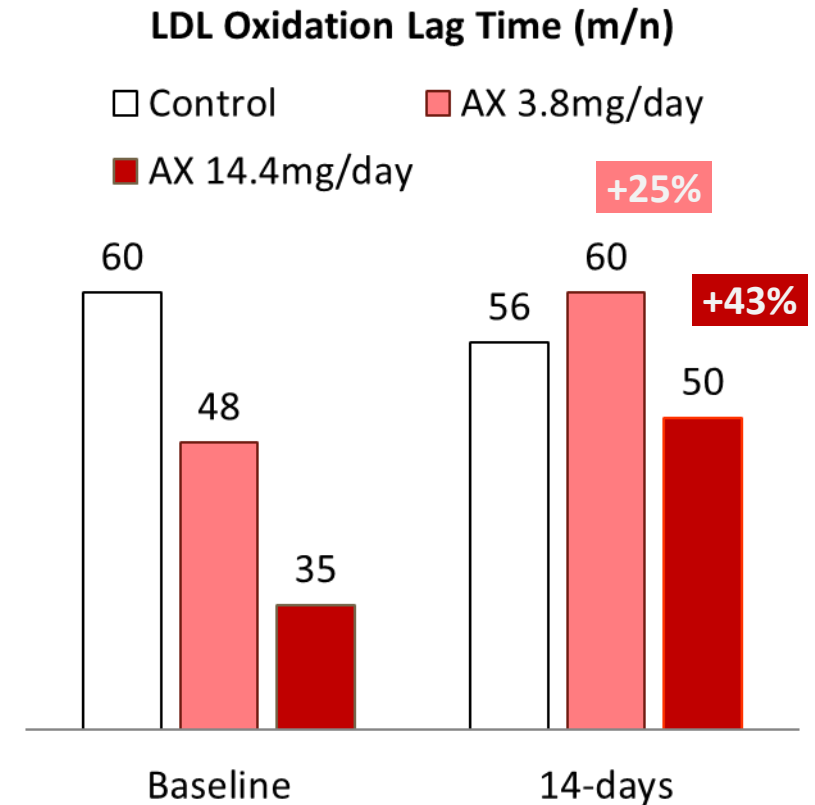


Fig. 3. Values indicate mean \pm SD. Changes in LDL lag time after 14 days consumption of astaxanthin (1.8, 3.6, 14.4, 21.6 mg/day). * $p < 0.05$, ** $p < 0.01$ vs. before experiment (0).

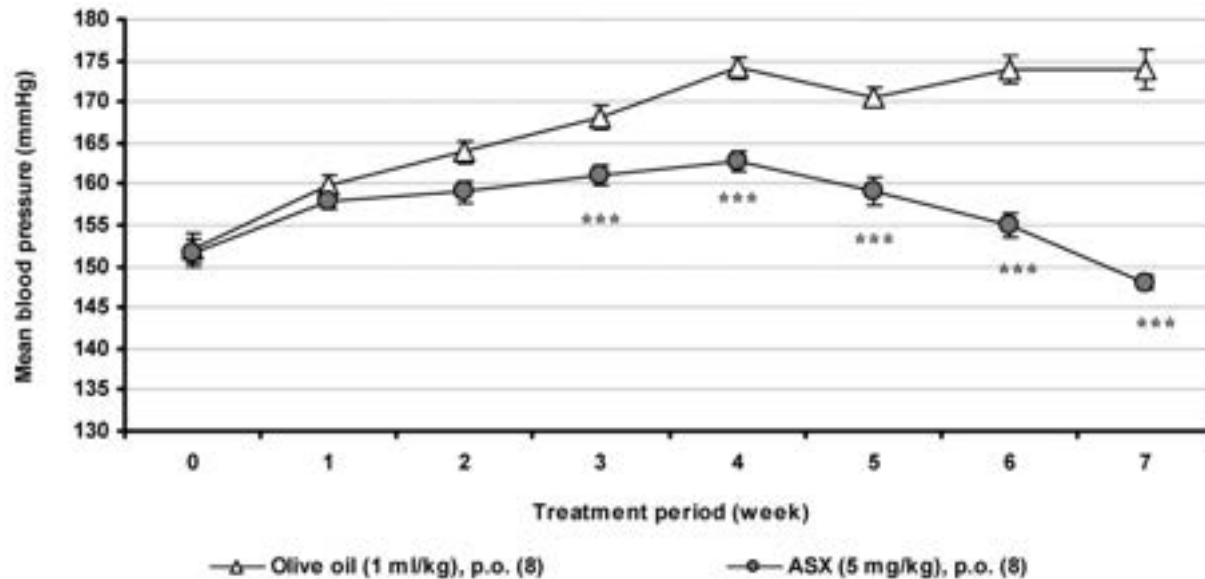


Iwamoto et al. 2000.

Astaxanthin Promoted Healthy Blood Pressure in Rats

Hypertensive Rats ingested 5mg astaxanthin daily for 7 weeks

Significantly Lower Mean Blood Pressure with Astaxanthin



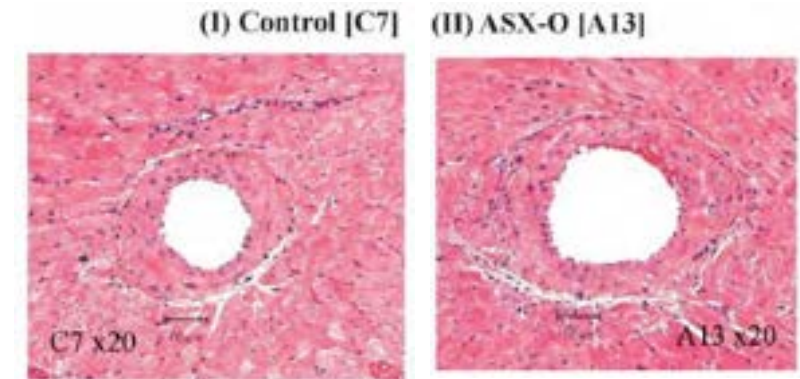
Each data point represents the mean \pm S.E.M. of 8 rats per group.
*** p=0.001 vs. the vehicle control group (t-test).

Hussein, G., et al. Biol. Pharm. Bull. 28(6) 967—971 (2005)

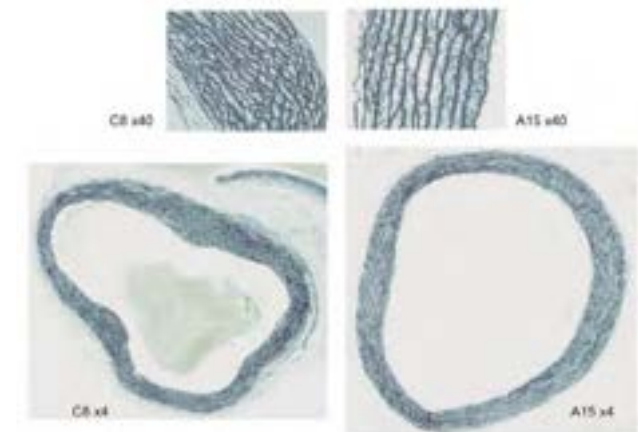
Thinner Coronary Artery Wall, and Wider Lumen

olive oil (1 ml/kg)

ASX (5 mg/kg/d)



Arterial Elastin Layers disrupted in Hypertensive Rats



Hussein, G., et al. Biol. Pharm. Bull. 29(4)684-688 (2006).

Astaxanthin Improved Results of Functional Training

10 healthy Beagle dogs (1-3 y.o.) randomly divided into

1. Control group (n=5)
2. 0.3 mg/kg of AstaReal® Astaxanthin group (n=5)

Treatment period was 6 weeks

Astaxanthin vs. Baseline:

- **Triglycerides (TG)** ↓ 37% from baseline ($p < 0.05$)
- **Malondialdehyde (MDA)** ↓ 40% from baseline ($p < 0.01$)
- **Lactate dehydrogenase (LDH; indicator of inflammation)** ↓ 36% from baseline ($p < 0.01$)

Astaxanthin vs. Control:

- **Malondialdehyde (MDA)** ↓ 40% at 6 weeks vs control ($p < 0.01$)
- **Lactate dehydrogenase (LDH)** ↓ 50% vs control ($p < 0.01$)

Parameter	without ASX (n=5)	
	0 week	6 weeks
Triglyceride (mg/dL)	30.6 ± 1.3	38.0 ± 6.6
Malondialdehyde ($\mu\text{mol/L}$)	1.5 ± 0.2	1.5 ± 0.1
LDH (IU/L)	83.4 ± 5.7	113.6 ± 12.6

Parameter	with ASX (n=5)	
	0 week	6 weeks
Triglyceride (mg/dL)	37.2 ± 1.3	23.6 ± 4.1 *
Malondialdehyde ($\mu\text{mol/L}$)	1.5 ± 0.2	0.9 ± 0.0 **,***
LDH (IU/L)	89.4 ± 6.3	57.4 ± 2.4 **,***



Emerging Studies on Astaxanthin and Brain Health

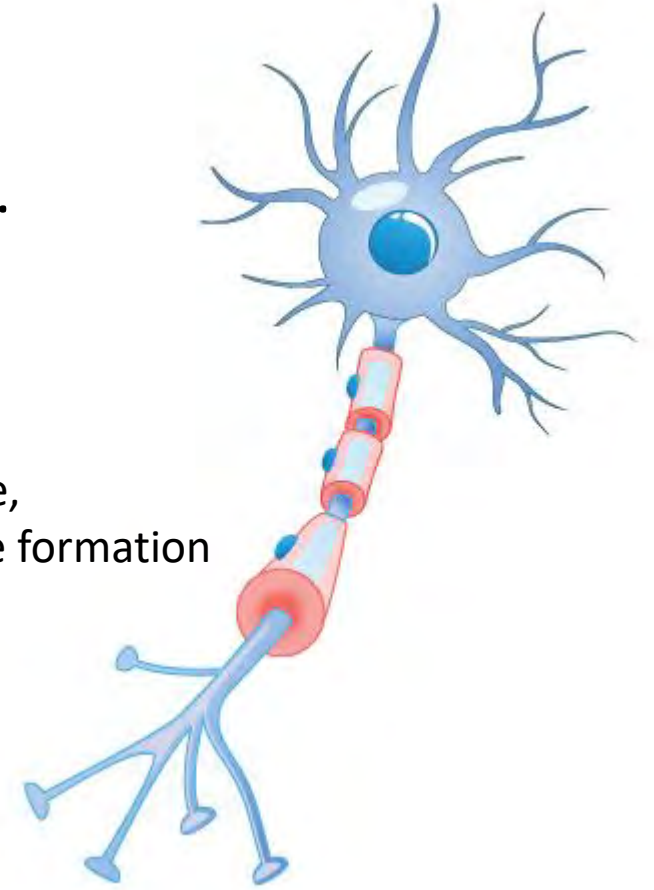
LEARNING AND MEMORY IN ADULTS

Neurogenesis in adulthood supports learning and memory

Development of new neurons in the hippocampus
is linked to improved memory retention and synaptic function.

In adult humans, the process can be described in four stages:

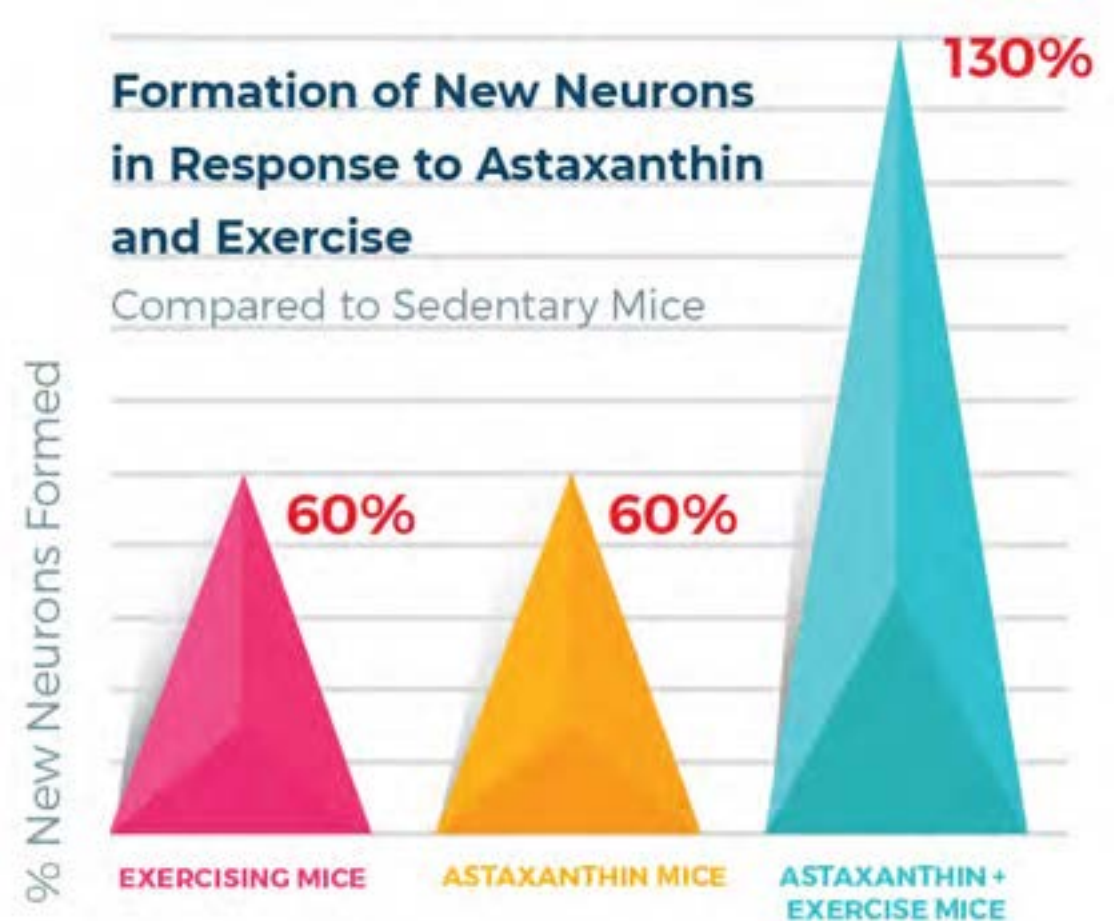
- (1) a precursor cell phase where “newborn” neurons multiply,
- (2) an early survival phase marks the exit of “newborn” neurons from the cell cycle,
- (3) a postmitotic maturation phase allows growth of axons, dendrites, and synapse formation
- (4) a late survival phase allows for fine-tuning of the maturing neurons.



ASTAXANTHIN + EXERCISE BOOSTS NEUROGENESIS

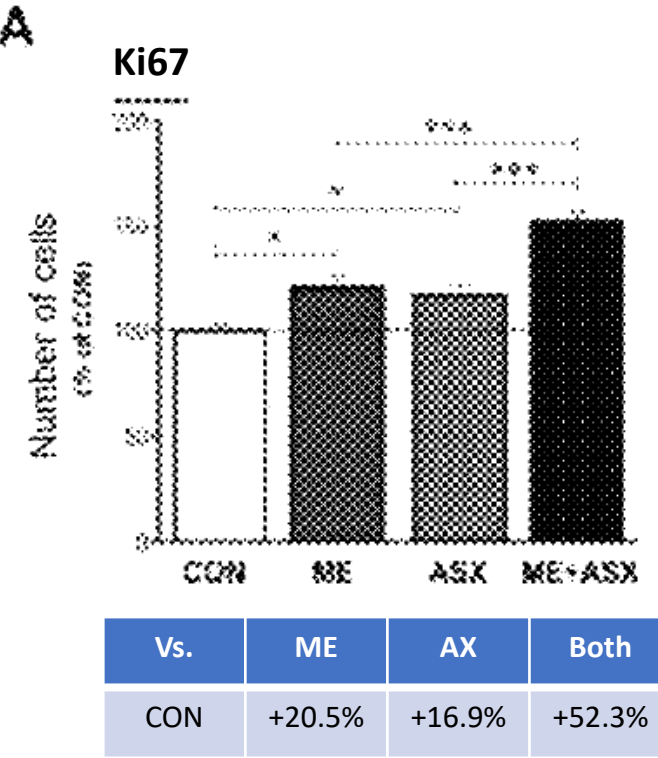
Exercising mice experienced more neurogenesis than sedentary mice.

Exercising mice taking Natural Astaxanthin showed a further increase in “newborn” neurons in the hippocampus compared to both exercising and sedentary mice without astaxanthin.

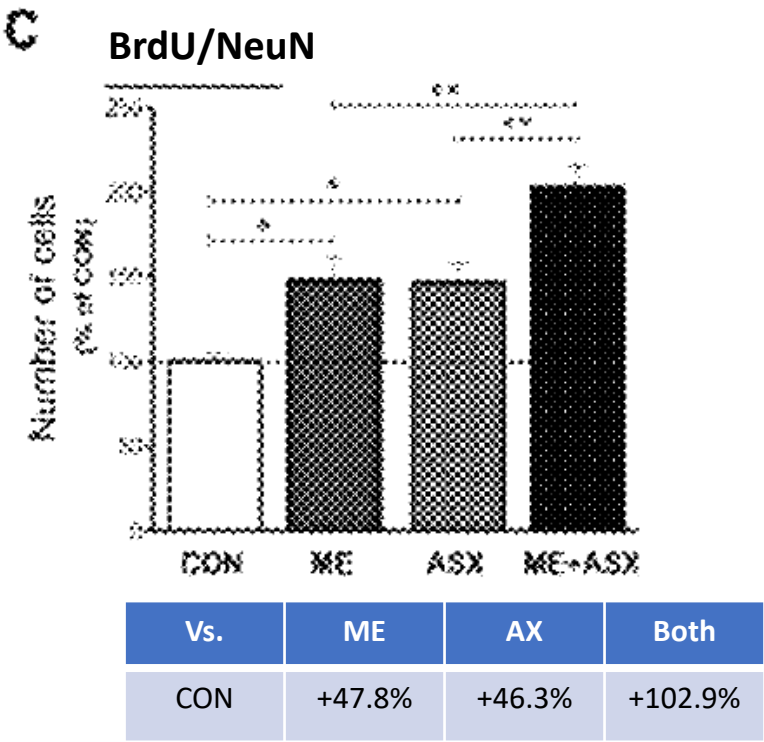


ASTAXANTHIN INCREASED AHN IN RESPONSE TO MILD EXERCISE

Actively Proliferating Brain Cells

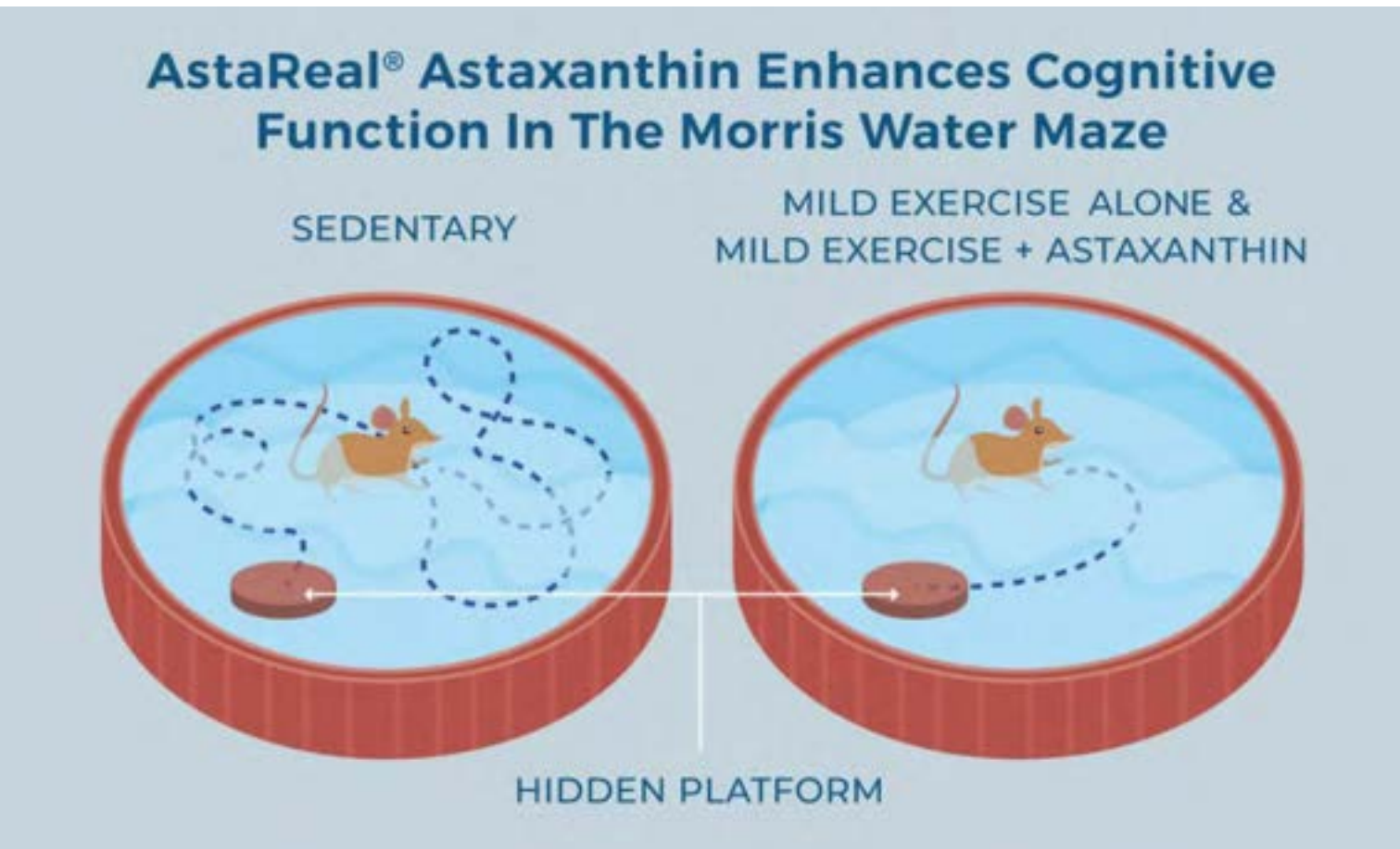


Newborn Neurons



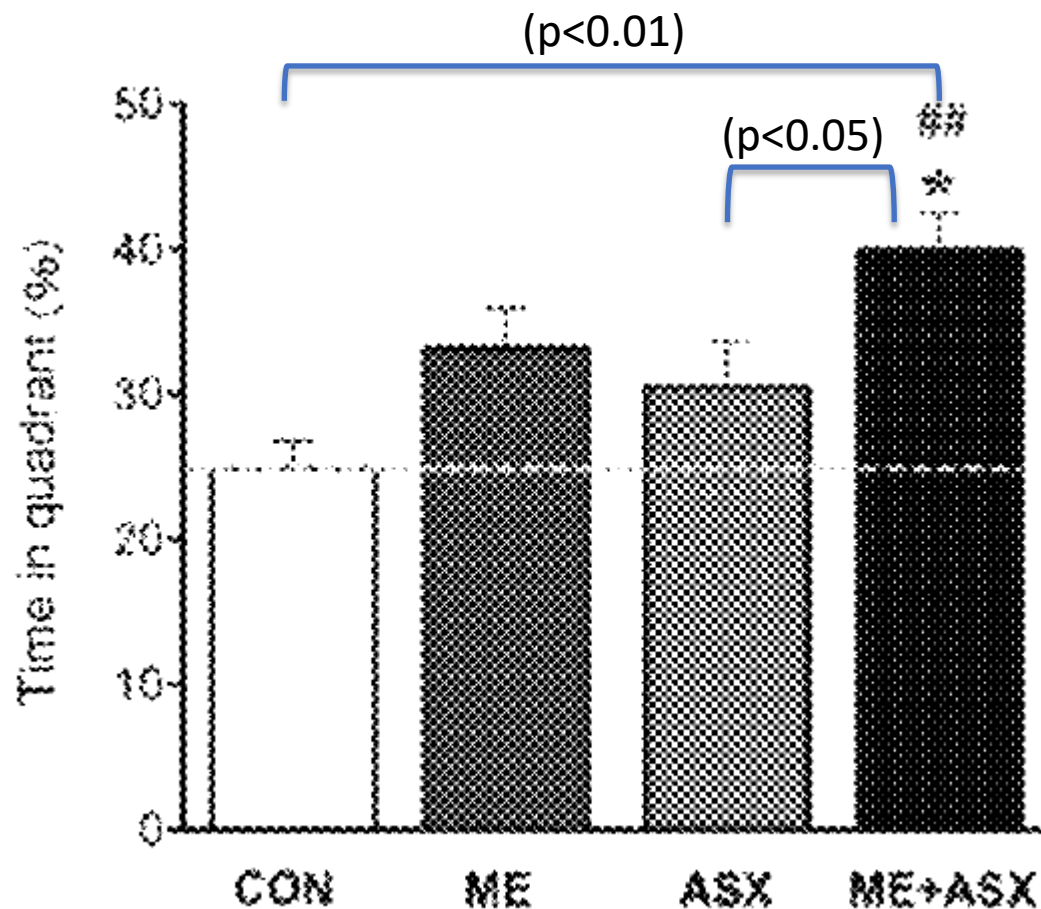
Mice were fed 0.5% astaxanthin by weight in chow for 4 weeks
n=8 per treatment group

MORRIS WATER MAZE: SPATIAL MEMORY AND LEARNING



The Morris Water Maze, (MWM), is a pool of water with a submerged platform. A mouse swimming in the pool can rest when it reaches the platform, which provides an incentive for the mouse to learn how to locate the platform quickly.

SPATIAL MEMORY: REMEMBERING WHERE THE PLATFORM IS



Mice with ME + ASX took a less random path to the platform. Spending more time in the platform quadrant means that the mice remembered the location of the platform.

ME + ASX group spent 24.8% more time in the platform quadrant than the control group ($p<0.01$)

ME+ASX group spent 39.9% of their total swim time in the platform quadrant.

ASX group spend 30.5% of their total swim time in the platform quadrant.

ME+ AX group spent a significantly greater proportion of their swim time in the platform quadrant compared to the AX group ($p<0.05$)



Maintaining Healthy Eyes with Astaxanthin

Changes in the Eye of an Aging Dog

Cloudy Lens (nuclear sclerosis)

- a normal effect of aging in dogs
- affects depth perception and near vision
- causes worsening refractive error (visual acuity)
- Unlike cataracts, does not lead to blindness



Eye changes with aging: hardening and clouding of the lens and accumulated oxidative damage.

Dogs become more near-sighted as they age and the lens becomes less flexible.

“It is often common for dogs who have nuclear sclerosis to also develop cataracts,” says Dr. Jerry Klein, AKC chief veterinary officer.

<https://www.akc.org/expert-advice/health/cloudy-eyes-in-dogs/>

prevalence of lenticular sclerosis or cataracts is 50% in dogs over nine years of age and ~100% in dogs over the age of thirteen.

<https://vcahospitals.com/know-your-pet/lenticular-sclerosis-in-dogs>

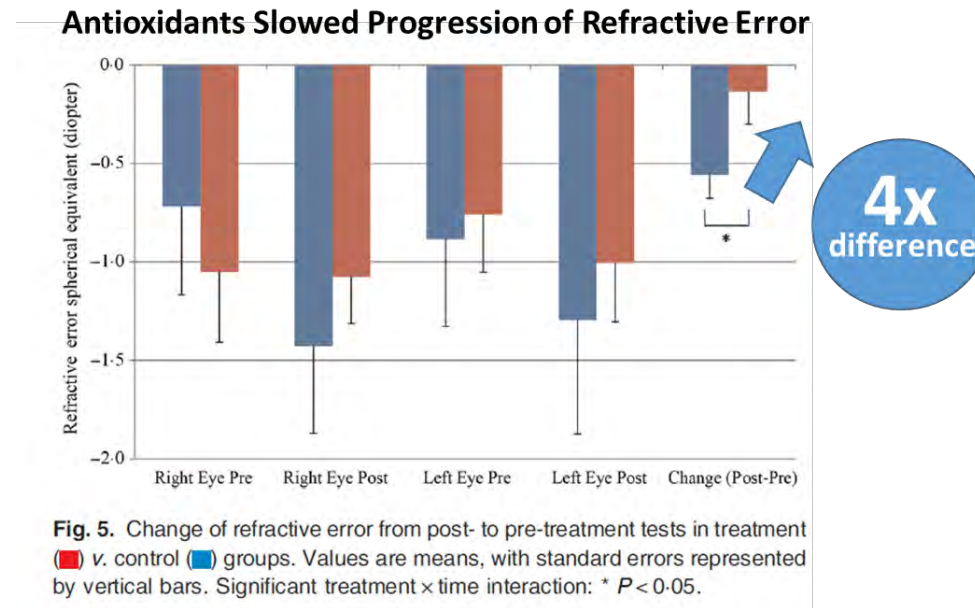
Hernandez J, et al. 2016. Aging Dogs Manifest Myopia as Measured by Autorefractor. PLoS One. 11(2):e0148436.

Astaxanthin Support Visual Function

12 adult Beagles (ages 6-8 y.o., 8 males, 4 females) with cloudy lenses (nuclear sclerosis)

6 months daily antioxidant supplement blend (lutein 20 mg, zeaxanthin 5 mg, beta-carotene 20 mg, **natural astaxanthin 5 mg (0.45mg/kg bw)**, vitamin C 180 mg, and vitamin E 336 mg)

With all eyes combined, the change in refractive error in the control group (-0.56 D) was more than 4 times greater than in the treatment group (-0.13 D; $p < 0.05$).



Keratoconjunctivitis Sicca (Dry Eye) in Dogs

Dry eye symptoms:

- Cloudy eyes
- Mucous discharge
- Redness around the whites of the eye
- Swelling of the tissue on the surface of the eye and eyelids
- Squinting or excessive blinking

Dry eye is often associated with an autoimmune inflammation of the tear glands and can be a chronic, lifelong condition.

- Prevalence of dry eye in dogs is estimated at 4% (with Schirmer test I values < 10 mm/min).
- Thought to be more common but undiagnosed
- Prevalence in male crossbred dogs 6-9 years old is 64%

Destefanis S, et al. *BMC Vet Res.* 2016;12(1):214.



<https://todaysveterinarypractice.com/diagnosis-treatment-of-keratoconjunctivitis-sicca-in-dogs/>

Antioxidants Support Eye Hydration and Comfort

50 dogs (19 females, 31 males; avg 6.5 y.o.) of different breeds

25 dogs were fed a standard control diet

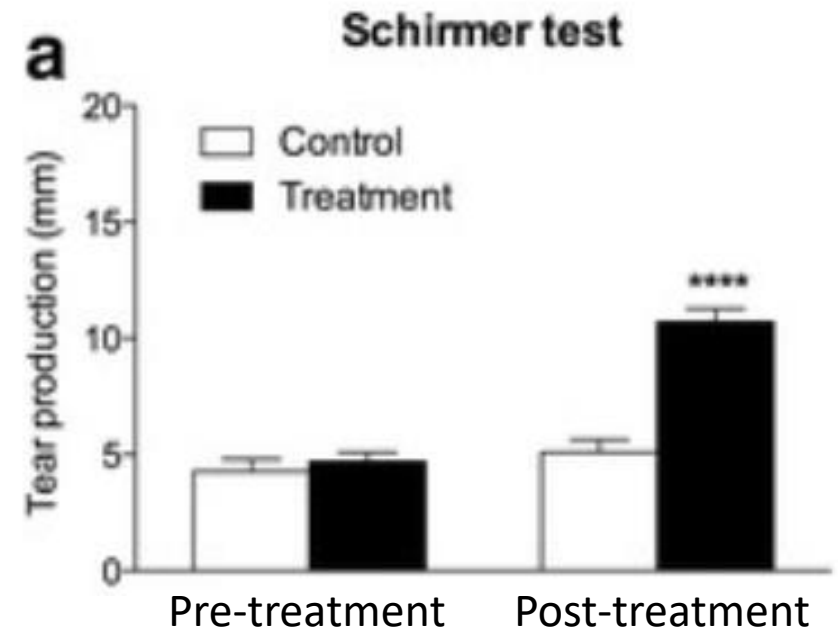
25 dogs were fed tablets containing an antioxidant mix including astaxanthin for 60 days.

Tablets contained: *Ascophyllum nodosum*, *Cucumis melo*, *Carica papaya*, *Aloe vera*, **Astaxanthin from *Haematococcus pluvialis* (0.8 mg/kg bw)**, *Curcuma longa*, *Camellia sinensis*, *Punica granatum*, *Piper nigrum*, *Poligonum spp*, *Echinacea purpurea*, *Grifola frondosa*, *Glycine max*, omega 3 and omega 6 from fish oil.

Dry eye-induced **inflammation decreased by 72%** only in the antioxidant group ($p < 0.0001$).

Tear production more than doubled in the antioxidant group over 60 days ($p < 0.0001$), with no change in tear production of the control group.

Mucous discharge scores decreased 83% in the antioxidant group after 60 days ($p < 0.0001$), with no change in the control group.



**** $P < 0.0001$



NASC Preferred Supplier
Educational Webinar Series



Market Trends for Use of Astaxanthin in Companion Animal Supplements

54% of USA households are dog owners

2021-2022 APPA National Pet Owners Survey

Geriatric animals account for half of the pet population in the United States

Frye *et al.* 2022

Pet ownership has increased by 250% in the first half of 2020

Veterinary Humanities and Social Sciences

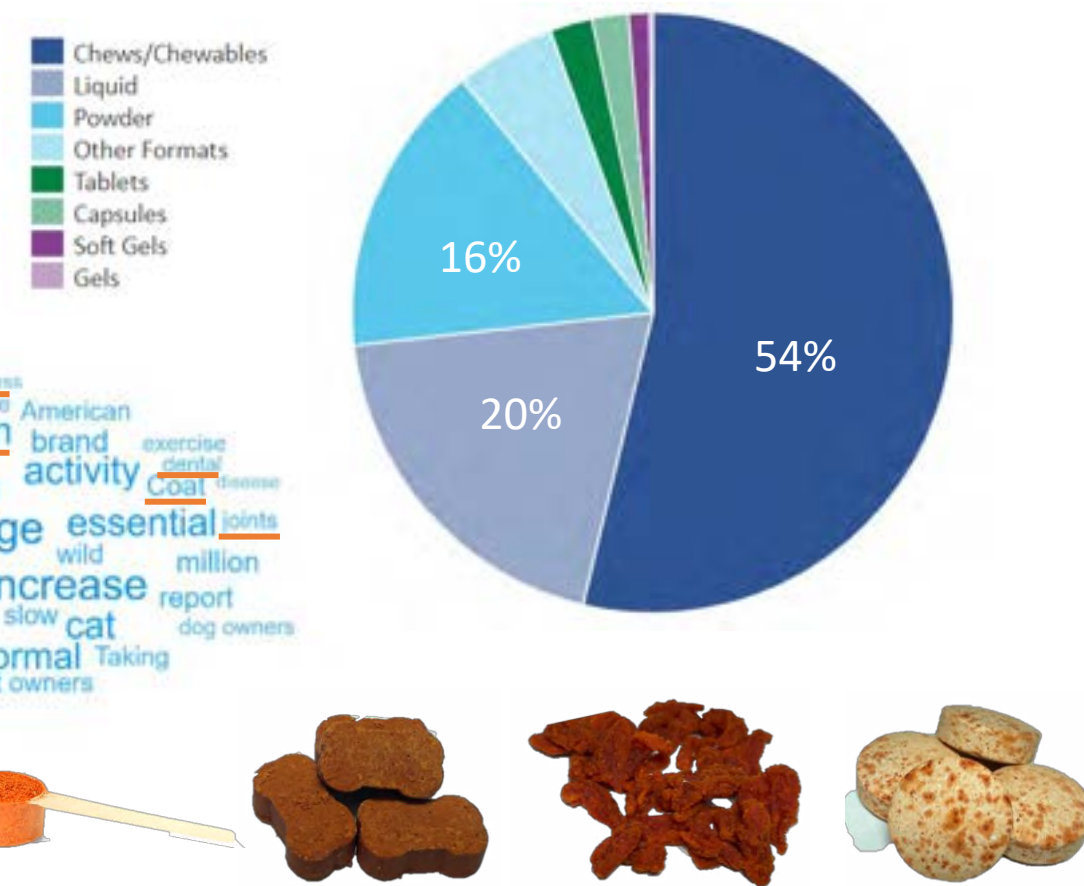
16% of new Dog/Cat Supplement Launches had functional antioxidant claims (US, Jan 2017 – May 2022)

Innova Market Insights

USA Supplement Formats

Jan 2017 – Apr 2022

Innova Market Insights



Astaxanthin Benefits

Studies show benefits for dogs at
0.1 - 2.2 mg/kg natural astaxanthin.

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Park et al. 2013

Mobility: 0.08 mg/kg
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Cardiovascular health: 0.3 mg/kg
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Eye health: 0.45 – 0.8 mg/kg
Wang et al. 2016
Destefanis et al. 2016

To Get Minimum Beneficial Dose...



0.3 mg/day

= 1

wild King
salmon fillet



1 mg/day

= 2

wild King
salmon fillets



3 mg/day

= 6

wild King
salmon fillets



An Insider Look At Astareal[®] Astaxanthin

Astaxanthin Done the AstaReal[®] Way:

We take care of our algae and they take care of us by making healthier and long-lasting natural astaxanthin.



Hand-Picked Algal
Cells are Prepared



Algae Grown in Indoor
Photobioreactors



Mature Cells Harvested



Stringent Quality
Control Practiced



Clinically Proven

The
AstaReal®
Difference



ASTAREAL BIOMASS
4.5% WHOLE ALGAE

ASTAREAL L10
10% ASTAXANTHIN OIL

**ASTAREAL
CUSTOM SOFTGELS**

ASTAREAL P2AF
2% ASTAXANTHIN POWDER

ASTAREAL P4AF
4% ASTAXANTHIN POWDER

ASTAREAL CWS25
2.5% COLD WATER SOLUBLE
ASTAXANTHIN POWDER

**ASTAREAL
CLEAR 100**
1% WATER SOLUBLE LIQUID

**ASTAREAL
PECTIN AND
GELATIN GUMMIES**



Thank you!

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khecht@astarealusa.com

