Hot Topics in Nutrition: Copper and Grain free – Myths and Facts!

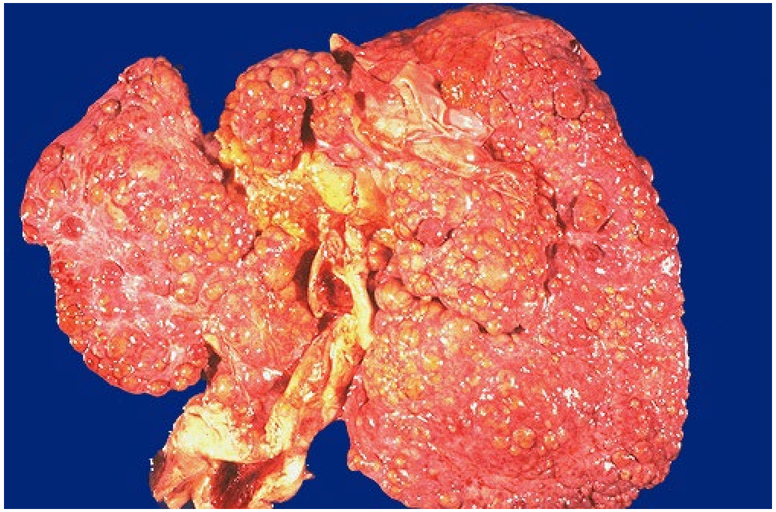
Joseph Wakshlag – DVM, PhD, DACVIM (nutrition), DACVSMR

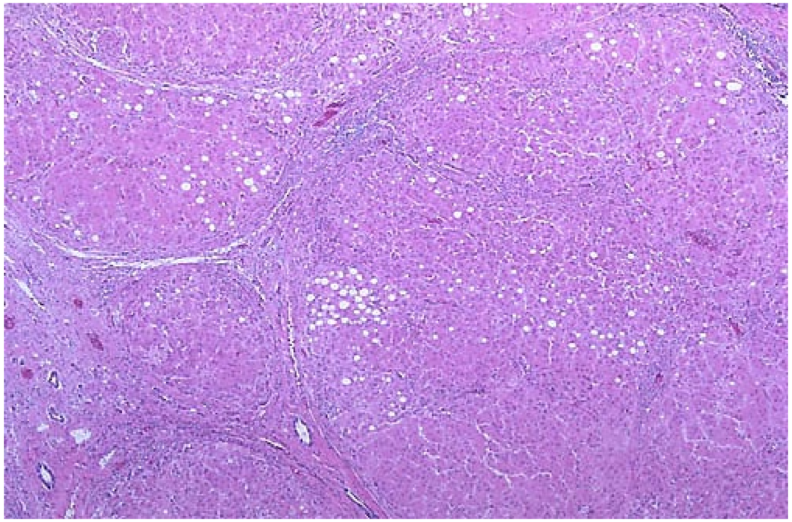
Today’s topics

- The Chronic Cirrhotic
  - Manganese – a sidebar about diet - can it play a role?
- Copper the primary or secondary hepatotoxin
  - Requirements in dogs and cats.
  - Why all the copper in dog food?
  - What to do when they won’t eat the limited options?
  - The quaqmire between vet med and industry
- Cardiac Disease and Diet
  - DCM and the grain free craze
  - Taurine? Carnitine?
  - Why can’t it be reproduced?
  - Not a convincing argument regarding GF diets as cause
  - The real problem with Grain free – IMHO

Cirrhosis/Bridging Fibrosis

- Most hepatobiliary disorders result in global or zonal degeneration.
- Regardless of the pathogenesis the dietary recomms. are similar.
  - Autoimmune, genetic, toxic and idiopathic degeneration
  - Congenital shunts and acquired shunting





Dietary Recomm. in non-complicated hepatobiliary disease

- Easily digestible
- Highly palatable
- Calorically dense
- Small frequent feeding
  - Moderate protein (20-40% DM; 50-100 g/1000 kcals)
  - Moderate Fat (20% DM; 20 plus g/1000 kcals)
  - Moderate CHO (30-40% DM; 75-100 g/1000 kcals)

Protein and Hepatobiliary Disorders

- Goals
  - Prevent hepatic encephalopathy
    - Protein titration is important
    - Minimally start with 2.5 g/kg in dogs (Ideal BW)
    - Minimally start with 3.5 g/kg in cats (Ideal BW)
    - Add 0.5 gm more per week.
  - Prevent catabolism of lean mass
    - Positive nitrogen balance
    - Studies from the 70's suggest proper amino acids can alleviate encephalopathy

The role of plasma amino acids in hepatic encephalopathy

Josef E. Fischer, M.D., Josef, M. Funovics, M.D., Alfonso Aguirre, M.D., J. Howard James, B.S., Jane M. Keane, B.A., Robert I. C. Wesdorp, M.D., Norman Yoshimura, Ph.D., *and* Thomas Westman, Ph.D., *Boston, Mass., and Glendale, Calif.*

Sulfur-containing amino acids in experimental hepatic coma in the dog and the monkey

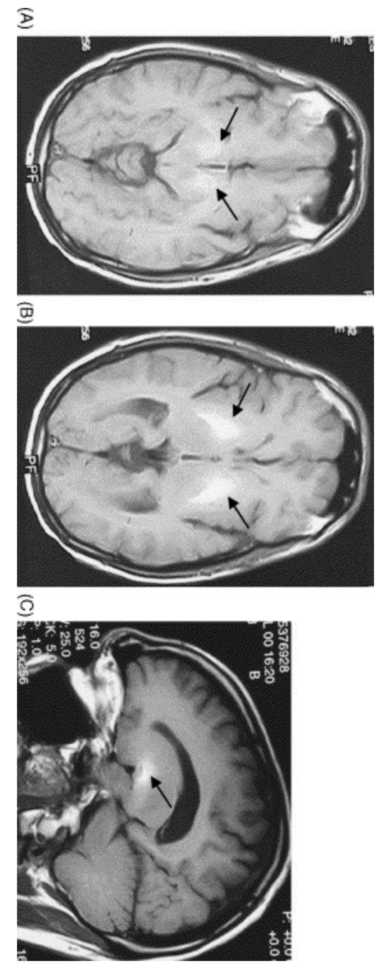
Arlan R. Smith, M.D., Filippo Rossi-Fanelli, M.D., Herbert Freund, M.D., *and* Josef E. Fischer, M.D., *Boston, Mass.*

Hepatic Encephalopathy

- Dogs
  - If intolerant go to minimum NRC 1.33 g/kg/BW.
- Cats
  - If intolerant go to NRC minimum 2.5 g/kg/BW
- Puppies (3 months) - usually a shunt scenario
  - If intolerant start at 6.5 g/kg/BW and titrate downwards 1 g/kg each month. At 6 months of age you can be at 2.5g/kg/BW if covering amino acid needs
- Monitor albumin, BUN, and CK
- Ammonia levels if available.

Manganese and Encephalopathy

- Many human studies have found that manganese accumulation occurs in various nuclei
- Manganese has been associated with encephalopathic behavior
- Manganese accumulation in astrocytes is associated with dysfunction
- Primary manganism occurs with certain professions
  - Welders.
  - Parkinsonian signs, irritability, depression and cognitive deficits.



Dogs, PSS and Manganese

- Primary means of elimination is enterohepatic.
- Do PSS dogs have higher serum Mn?
- Fasting serum
  - 18 PSS Dogs
  - 14 Healthy
  - 26 other illness

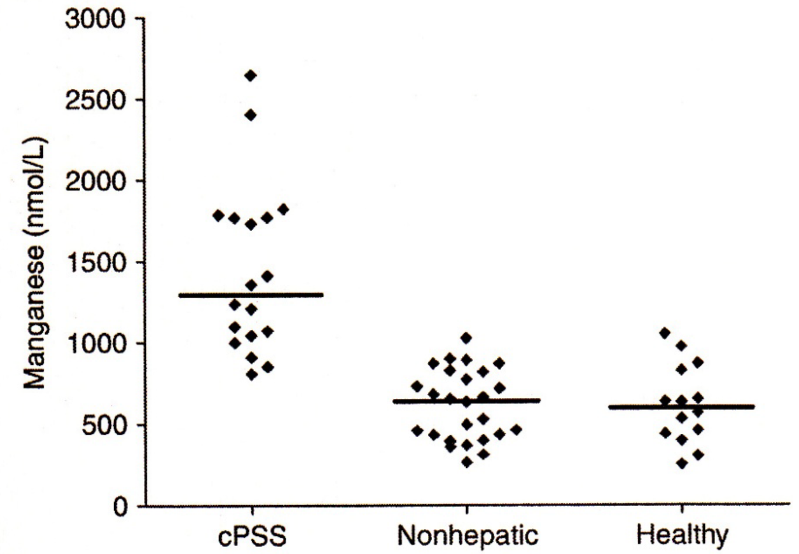


Fig 2. Whole blood manganese (Mn) concentrations in dogs with congenital portosystemic shunts (cPSS) (n = 18), dogs with nonhepatic illnesses (nonhepatic) (n = 26), and healthy dogs (healthy) (n = 14). The line indicates the median value. Mn concentrations are significantly increased in dogs with cPSS compared with dogs with nonhepatic illnesses and healthy dogs.

Gow AG et al, JVIM, 2010

Dogs and Manganese

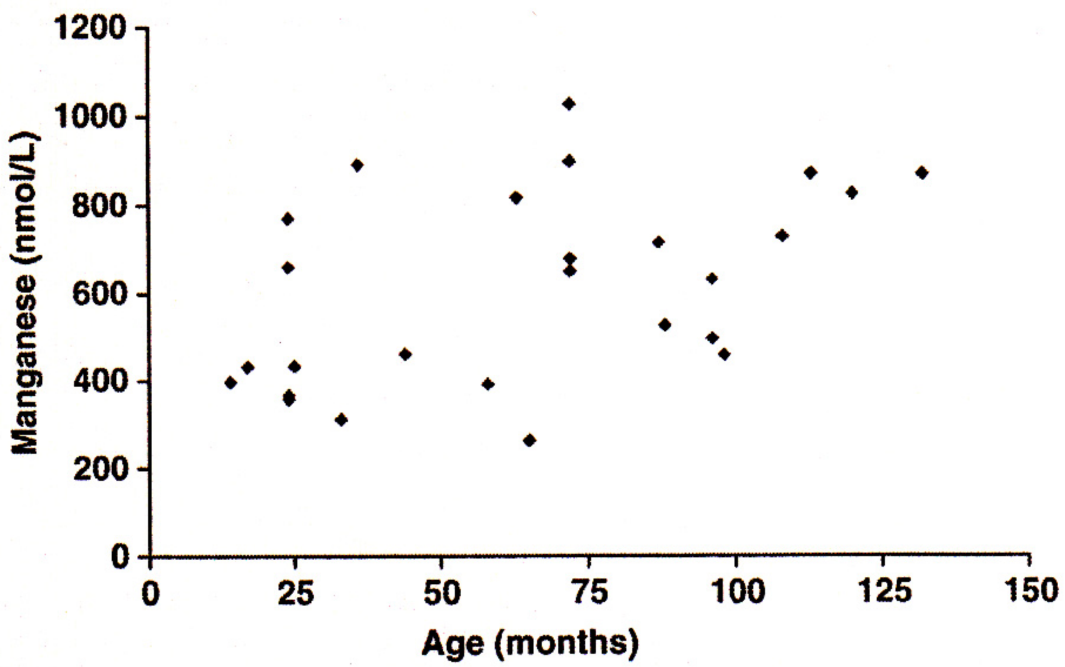


Fig 3. Whole blood manganese (Mn) concentrations versus age in months of the dogs with nonhepatic illnesses (n = 26). There was a significant positive correlation between Mn concentration and age.

Dogs and Manganese

- 13 dogs with PSS
  - 10 of 13 with lentiform nucleus lesions
  - All had some degree of cortical atrophy in frontal and parietal lobes
  - One showed resolution After post ligation
- 3 cats with PSS
  - One of 3 had lesion in lentiform

Before ligation

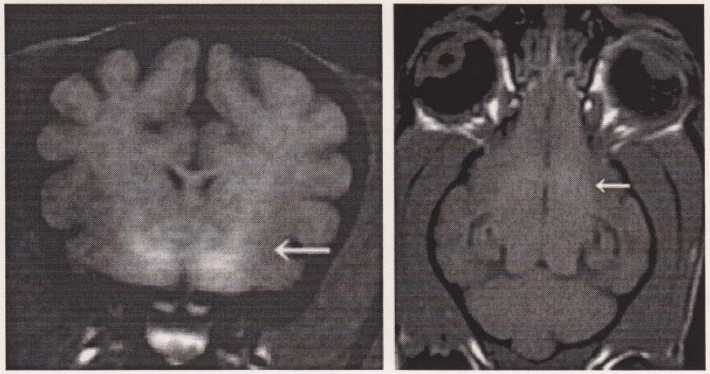


FIG. 4. Dog with a portosystemic shunt. Note the lentiform nucleus hyperintensity on the T1-weighted image (left side, transverse; right side, dorsal plane section).

After ligation

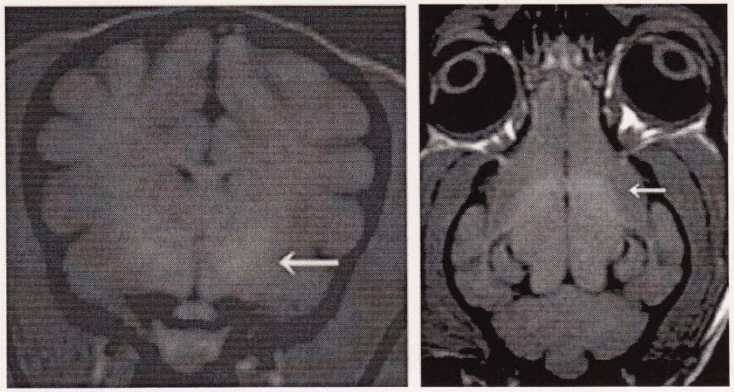
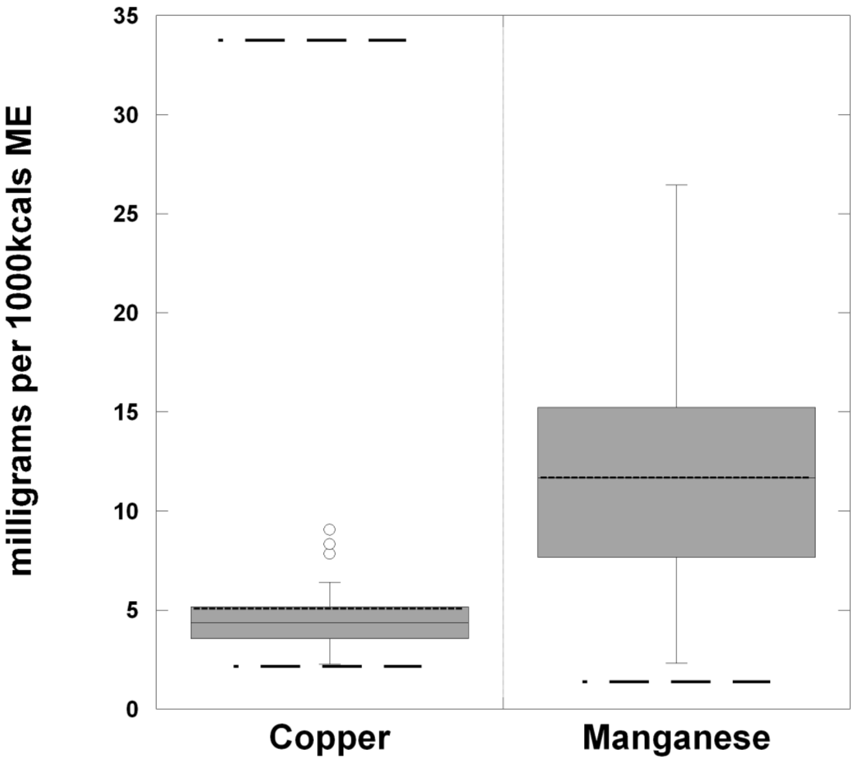


FIG. 5. Same dog as in Fig. 4, 1 month after surgery to correct the portosystemic shunt.

Torisu et al, Vet Rad & US, 2005.

Manganese in food

- 45 over the counter brands
  (Gagne et al, 2013)
- Minimum AAFCO
  - 1.25 mg/1000 kcals
- Royal Canin Hepatic
  - 18 mg/1000 kcals (dry)
  - 7 mg/1000 kcals (wet)
- Hill's LD diet
  - 8 mg/1000 kcals (dry)
  - 2 mg/1000 kcals (wet)



What about Copper toxicity?

- Bedlington, Doberman, Labs, Dalamation, Westie
  - See accumulation in some cirrhotic hepatobiliary disorders –secondary vs. Primary?
  - Increasing numbers of breeds are being affected as primary disease
  - Is there really a problem with foods?
  - Opinion: Far worse of a problem than the “DCM crisis” – yet getting little attention.
- Interventions?
  - D-Penicillamine → the go to for the internist (trientine)
  - Low Copper Diet → Few choices
  - Zinc chelates → decrease copper absorption

What happened in the mid 1990's

- Cupric oxide was banned as a feed ingredient in animal feed due to agricultural deficiency problems.
- Most of industry decided to use copper sulfate or organic/amino acid chelates.

Issues and Opinions in Nutrition

Cupric Oxide Should Not Be Used As a Copper Supplement for Either Animals or Humans

David H. Baker

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Manufacturers of vitamin-mineral supplements should discontinue use of CuO as a source of Cu. Other Cu compounds are available that provide utilizable forms of Cu. Among these, Cu_2O (88% Cu), CuCl (64.2% Cu), $CuCO_3 \cdot Cu(OH)_2$, known as alkaline Cu carbonate (57% Cu), $CuCl_2$ (47.3% Cu), cupric acetate (35.0% Cu) and $CuSO_4 \cdot 5H_2O$ (25.5% Cu) would be good choices. Clearly, chemical, physical and organoleptic properties of Cu salts must be considered. The resulting pill or tablet may be larger, but at least it will furnish Cu in a form that can be utilized.

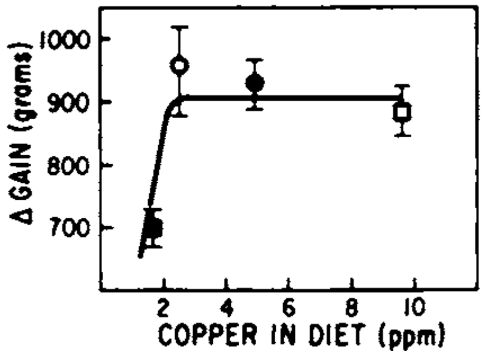
It was a nail in the coffin for oxides!

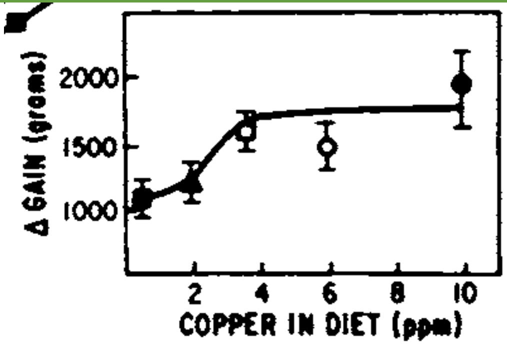
1769

COPPER BIOAVAILABILITY AND REQUIREMENT IN THE DOG: COMPARISON OF COPPER OXIDE AND COPPER SULFATE. G.L. Czarnecki-Maulden, R.C. Rudnick and D.G. Chausow. Friskies Research, Nestec Ltd., St. Joseph, MO 64506.

While copper oxide is the most common source of supplemental copper in pet foods, its bioavailability has never been assessed in the dog. The purpose of this research was to further define the copper requirement of the growing dog and to determine the ability of the dog to utilize copper oxide as a source of copper. Growing puppies were fed a canned diet containing either 1.1, 1.9, or 2.7 mg copper/1000 kcal ME from copper sulfate, or 1.7 or 4.7 mg copper/1000 kcal ME from feed grade copper oxide. Serum copper concentration rapidly decreased in puppies fed 1.7 mg copper from copper oxide. Rate of decline was slightly lower in dogs fed the higher level of copper oxide indicating that copper bioavailability in copper oxide is minimal, but not zero. At 16 weeks, blood hemoglobin was lower in puppies fed the lower level of copper oxide than in puppies fed copper sulfate or the higher level of copper oxide. When copper was supplied by copper sulfate, 2.7 mg copper/1000 kcal was required to maintain serum copper at initial levels. However, 1.9 mg/1000 kcal was required to prevent anemia. This clearly demonstrates that the copper requirement of the dog is above the National Research Council recommendation of 0.8 mg bioavailable copper/1000 kcal ME.

Dogs and Cats





- Cat Data
  - Kitten – Goong et al; growth rate supported by 3 ppm in diet of copper sulfate.
  - Fascetti et al; Gestation in queens – depleted and then provided varying copper levels from sulfate or oxide
  - oxide caused further depletion based on single cat biopsies from each group
  - May affect conception between 3-6 ppm in diet.
  - Adult Cats – no data
- **NRC – kittens 1.1 mg/1000 kcals; adults 1.2 mg/1000 kcals**

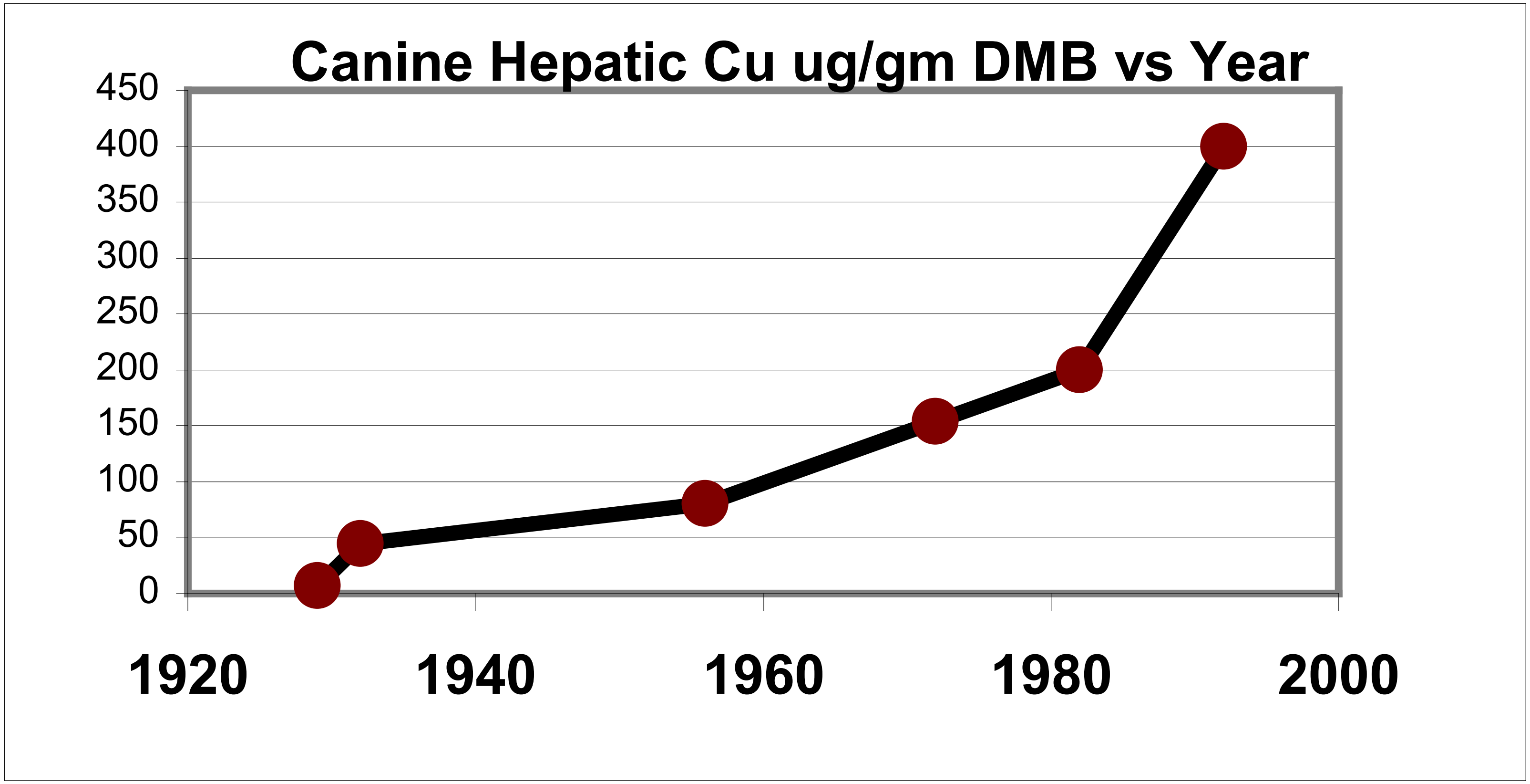
- Dog Data
  - Puppies – Baxter et al, 1953 - 1 ppm in diet (unknown source) showed deficiency in soy and milk diets –collagen deficits and anemia
  - Puppies – Czarnecki Maulden et al, 2007 supports 2.7 mg/1000 kcals supports RBC's
  - Adult dogs – no data
- **NRC – pups -2.7 mg/1000 kcals; Adults 1.7 mg/1000 kcals**

Current AAFCO and FEDIAF Guidelines

- AAFCO – 2.7 mg/1000 kcals in pups; 1.7 mg/1000 kcals in Adults; No SUL
- FEDIAF – 2.75 mg/1000 kcals in pups; 1.8 mg/1000 kcals in Adults; SUL – about 7 mg/1000 kcals
  - What's the SUL difference – FEDIAF did this due to environmental exposure.
  - AAFCO (CVM-FDA) and EPA – do not work hand in hand
- Both FEDIAF and AAFCO suggest that adult minimums and SUL must be established based in science – not arbitrary.

Mean Hepatic Copper in Dogs from Publications

What about dogs?



Data from Dr. Sharon Center

Labradors who are predisposed # 2 breed

1980-2020 Data Update: n=1,094

Hepatic copper concentrations in Labrador Retrievers with and without chronic hepatitis: 72 cases (1980–2010)

Andrea N. Johnston, DVM; Sharon A. Center, DVM; Sean P. McDonough, DVM, PhD; Joseph J. Wakshlag, DVM, PhD; Karen L. Warner

Objective—To evaluate differences in hepatic copper concentrations in Labrador Retrievers with and without chronic hepatitis.

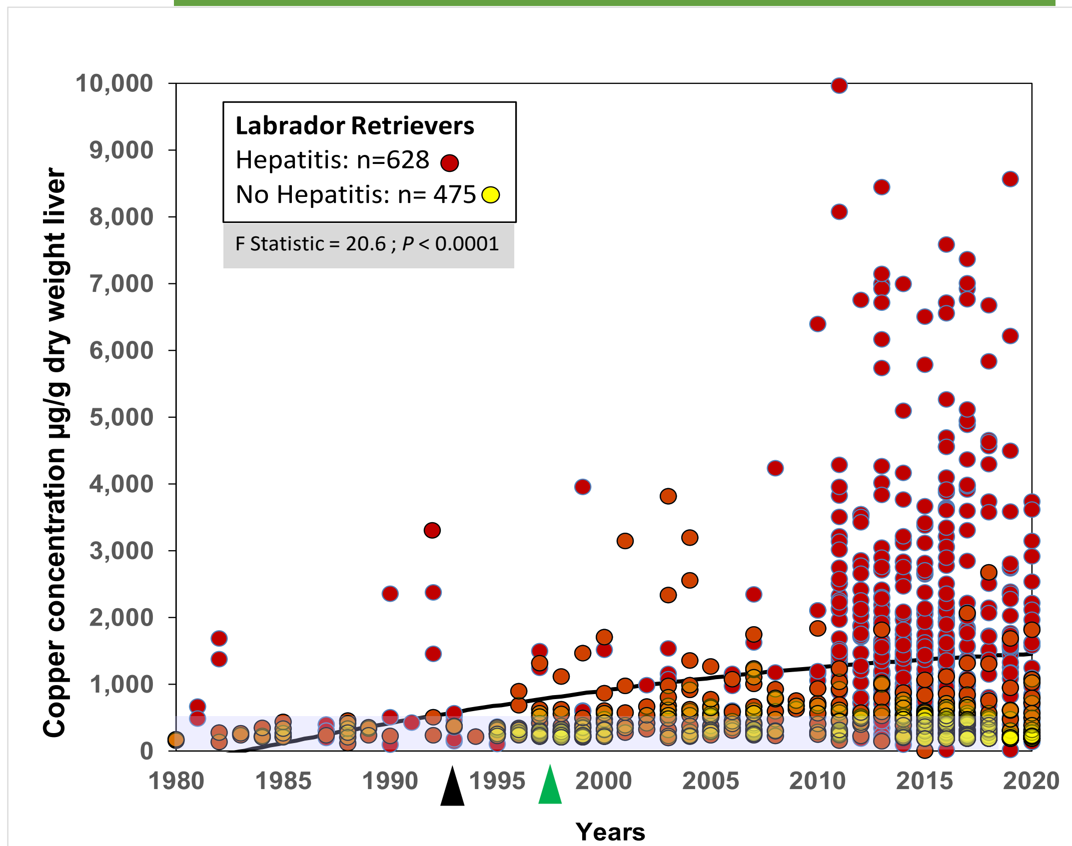
Design—Retrospective case-control study.

Sample—Liver tissue specimens from 36 Labrador Retrievers with chronic hepatitis and 36 age- and sex-matched Labrador Retrievers without chronic hepatitis (control dogs).

Procedures—Liver tissue specimens were obtained during 2 study periods (1980 to 1997 and 1998 to 2010). For each tissue specimen, a histologic score was assigned independently by each of 2 interpreters, and the hepatic copper concentration was qualitatively determined via rhodanine staining and quantitatively determined via atomic absorption spectroscopy.

Results—Mean hepatic copper concentration was significantly higher in dogs with chronic hepatitis (614 µg/g of dry weight [range, 104 to 4,234 µg/g of dry weight]), compared with that in control dogs (299 µg/g of dry weight [range, 93 to 3,810 µg/g of dry weight]), and increased significantly over time. A higher proportion of liver tissue specimens collected during the 1998–2010 study period had hepatic copper concentrations > 400 µg/g of dry weight (the upper limit of the reference range), compared with the proportion of liver tissue specimens collected during the 1980–1997 study period. The qualitative copper score did not accurately predict quantitative hepatic copper concentration in 33% of study dogs.

Conclusions and Clinical Relevance—Results suggested that the increase in hepatic copper concentrations in Labrador Retrievers with and without chronic hepatitis over time may be the result of increased exposure of dogs to environmental copper, most likely via the diet. (*J Am Vet Med Assoc* 2013;242:372–380)



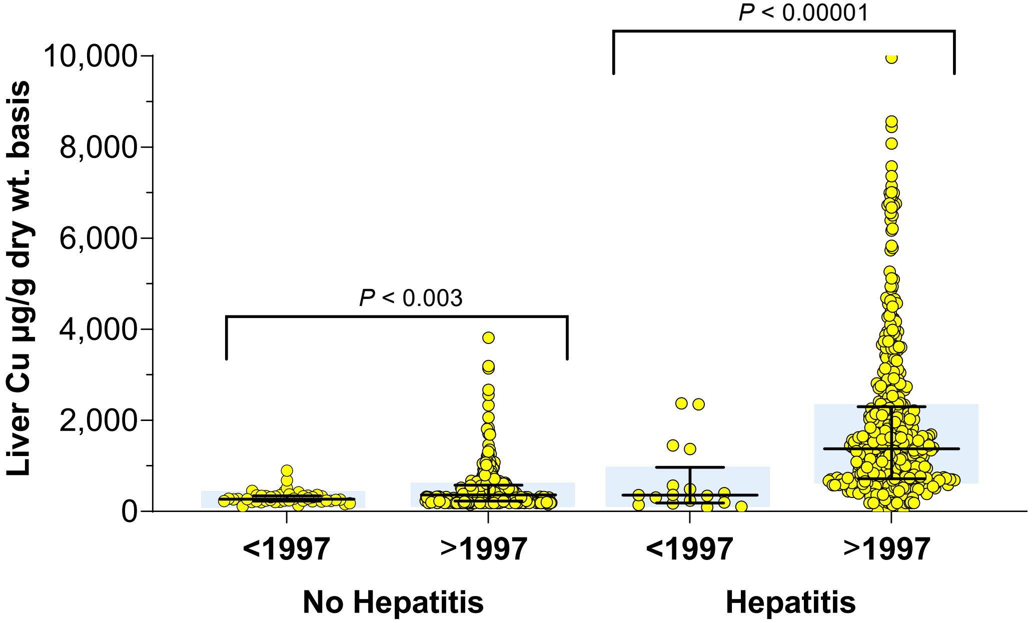
Labrador Retrievers: n=1,094 (Hepatitis: 619; No-Hepatitis: 475)

< 1997: n=65
Hepatitis= 18; No-Hepatitis=47

≥ 1997: n=1,029
Hepatitis= 601; No-Hepatitis= 428

1993:Cu Oxide abstract

≥ 1997: full compliance



More Copper in Dogs

STANDARD ARTICLE

Hepatic copper concentrations in 546 dogs (1982–2015)

Jaimie M. Strickland DVM[1] | John P. Buchweitz PhD[1] |
Rebecca C. Smedley DVM, MS, DACVP[2] | Katherine J. Olstad DVM, DACVP[1#] |
Ryan S. Schultz DVM[3#] | N. Bari Oliver DVM, PhD, DACVIM[3] |
Daniel K. Langlois DVM, DACVIM[3]

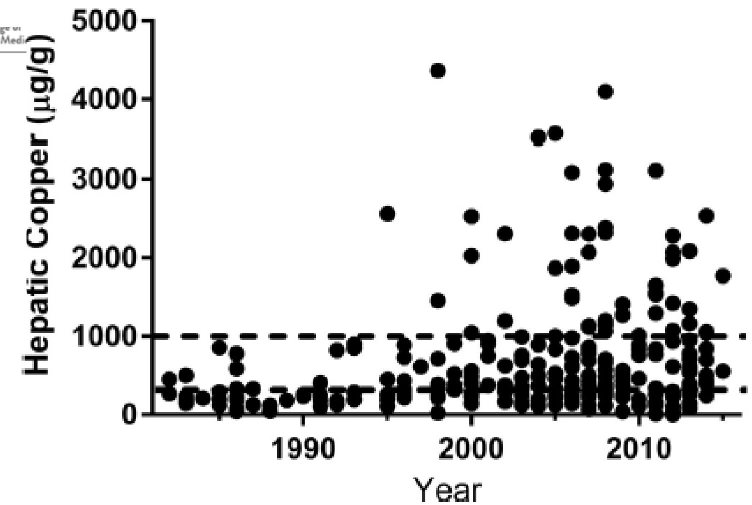


TABLE 3 Hepatic copper concentrations in dogs with and without hepatitis

		1982–1988	2009–2015	P-value
PB dogs	Non-hepatitis	249.2 μg/g (154.8–429.0) n = 40	381.6 μg/g (250.3–763.5) n = 66	.004
	Hepatitis	404.2 μg/g (191.4–821.1) n = 45	1274.0 μg/g (563.0–1773.0) n = 39	< .001
NPB dogs	Non-hepatitis	170.0 μg/g (104.3–310.3) n = 64	262.5 μg/g (166.0–398.8) n = 84	.013
	Hepatitis	181.1 μg/g (129.8–346.1) n = 27	542.2 μg/g (270.3–862.3) n = 22	.004

What about SUL?

- None in cat and dogs as prior data was acute tox so removed from SUL by AAFCO
- No chronic consumption data or minimal.
- Well there is one study from 1972 that AAFCO cites as a means to not establish a SUL

Dog

A 1-year chronic study was conducted with male and female beagle dogs to evaluate the potential oral toxicity of copper gluconate administered at levels of 0.012, 0.06 and 0.24% of the diet. These levels were equivalent to 3, 15 and 60 mg/kg bw per day. After 6 months of ingesting such diets, 2 animals of each sex were sacrificed and necropsied. Weight gains and food consumption values were similar for the control and treated groups. Overall health, haematology and urinalysis were comparable to controls. After 1 year, minimal liver function changes were observed in 1 of 12 dogs receiving the 0.24% copper gluconate diet, a change that was reversed following a 12-week withdrawal period. Accumulation of copper in liver, kidneys and spleen was seen at the high dose. No compound-related effects were seen at the lowest dose and there were no compound-related deaths or gross or microscopic pathological lesions in any dog (Shanaman et al., 1972).

A little Math

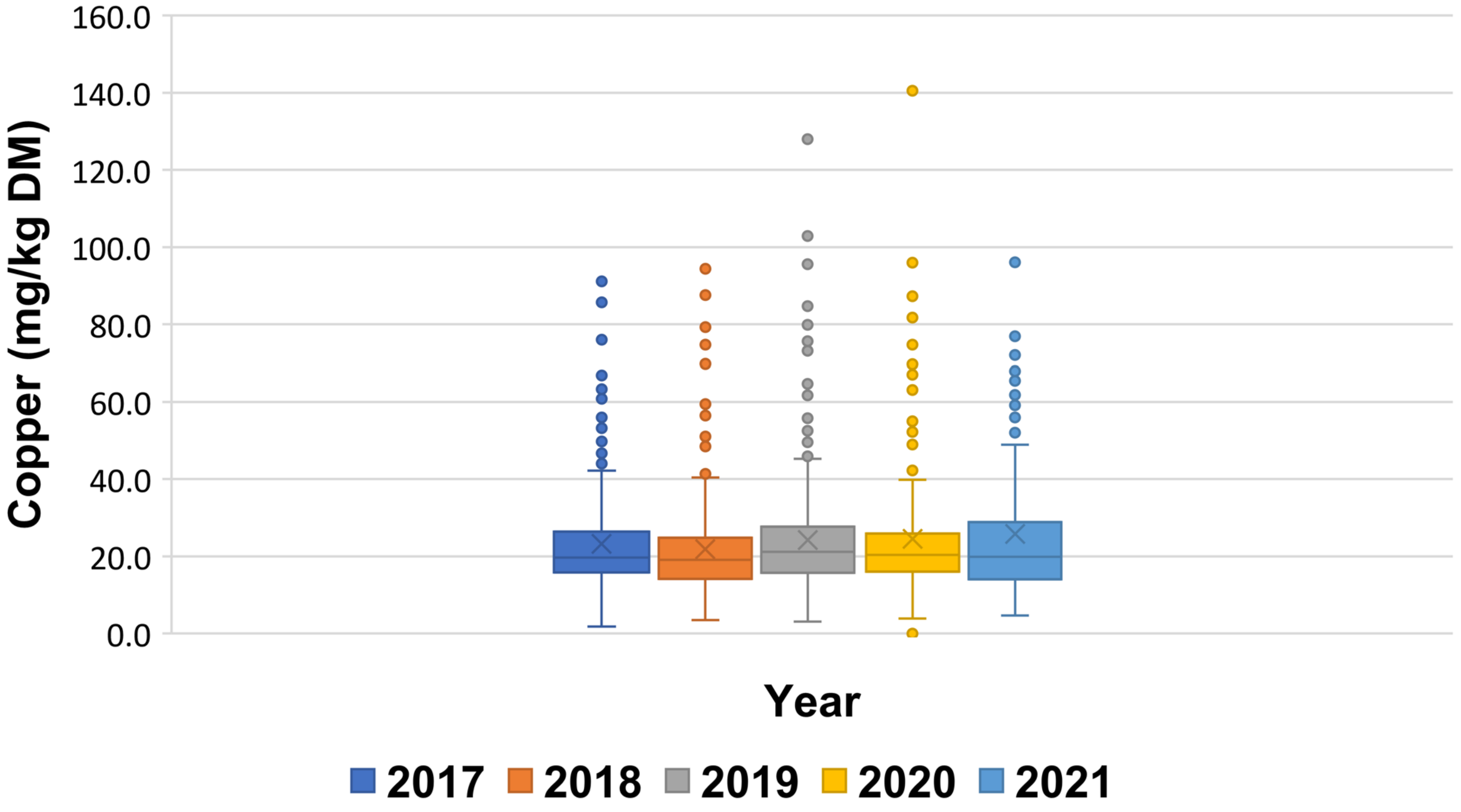
- Assumption was molecular weight of copper is 63.5 – copper gluconate is 453. 14% of molecule
- So food quantity is
  - 0.012% - 17 mg/kg
  - 0.06% - 85 mg/kg
  - 0.24% - 425 mg/kg

- Assume food was 4 kcal/g – beagle (10 kg) eats 200 g food at high RER.
- 10 kg dog would get
  - 3.4 mg = 0.34 mg/kg
  - 17 mg = 1.7 mg/kg
  - 85 mg = 8.5 mg/kg
- SUL proposed at 1.7 mg/kg BW or 85 mg/kg DM diet

Copper in the kidney and liver did increase in all groups as much as we can ascertain from this unpublished study.

FDA - CVM

Figure 2. Assayed Copper Content of Dog Foods 2017-2021 by Year



Here is the problem -Some more math

- Sporting Labrador eating 1700 kcals a day of a food that is 350 kcals per cup = 100 grams per cup – 485 grams
- Shanaman suggesting 30 kg dog at 1.7 mg/kg = 51 mg
- What if dog is eating one of the foods with 100 ppm = 47 mg/kg maybe a lot longer than 1 year
  - What if form of copper is more absorbable than copper gluconate?
  - If we know sufficiency what is the harm of 10x as a limit?
  - Has been proposed – but largely ignored.
  - OF course we are dealing with a susceptible breed!
  - **Why not have a low copper claim so owners can make informed decisions? Will also create industry awareness!**

Are Dogs more sensitive to copper?

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Specialist Subject Editor: G. WEBBE

PHYSIOLOGY AND PHARMACOLOGY OF COPPER

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For dogs, it is known that their sensitivity to copper has been traced to a different binding site for Cu(II) in albumin; there is no histidine residue in the amino terminal amino acid sequence of their albumin (Dixon and Sarkar, 1974) (Fig. 5). This leads to a marked decrease in the binding capacity (*cf.* Dixon and Sarkar, 1972), and as a result, absorbed copper and intravenously injected copper are not properly bound to albumin.

BOVINE:	ASP-THR-HIS-LYS-SER-GLU-ILE-ALA-...
RAT:	GLU-ALA-HIS-LYS-SER-GLU-ILE-ALA-...
HUMAN:	ASP-ALA-HIS-LYS-SER-GLU-VAL-ALA-...
DOG:	GLU-ALA-TYR-LYS-SER-GLU-ILE-ALA-...

Well - Do Low Copper Diets work?

- Examine Labradors with copper hepatopathy
- 11 Labradors followed post tx for progression before any diet treatment initiated – maintenance OTC diet given
  - Increased copper after 8-9 months

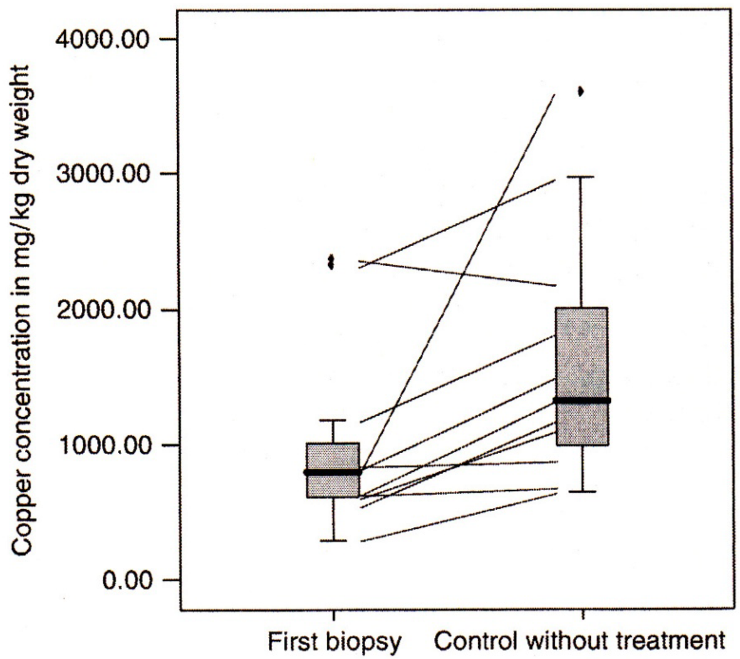


Fig 1. Progression of hepatic copper accumulation without treatment in 11 dogs. Measurement of hepatic copper concentrations was repeated before any treatment was given, and while the dogs were fed their usual maintenance diet. Upper and lower horizontal borders of the boxes describe borders of upper and lower quartile of the data. The distance between these values is H-spread. Values outside 1.5 times H-spread above and below the hinges are outliers. Outliners appear as such in the figure, but these dogs were not excluded from statistical testing. Lines between box 1 and box 2 indicate individual responses of the patients.

Hoffman et al, JVIM, 2009

Low Copper Diets

- 2 dietary strategies (21 dogs)
  - D- Pen treatment 3-6 months
  - Hepatic LS – 4.8 ppm of copper
  - Hepatic LS + Zinc
    - Zinc given at 10 mg/kg
- Biopsies
  - Start
  - Recheck 1 – average 6 m
  - Recheck 2 – average 1 yr

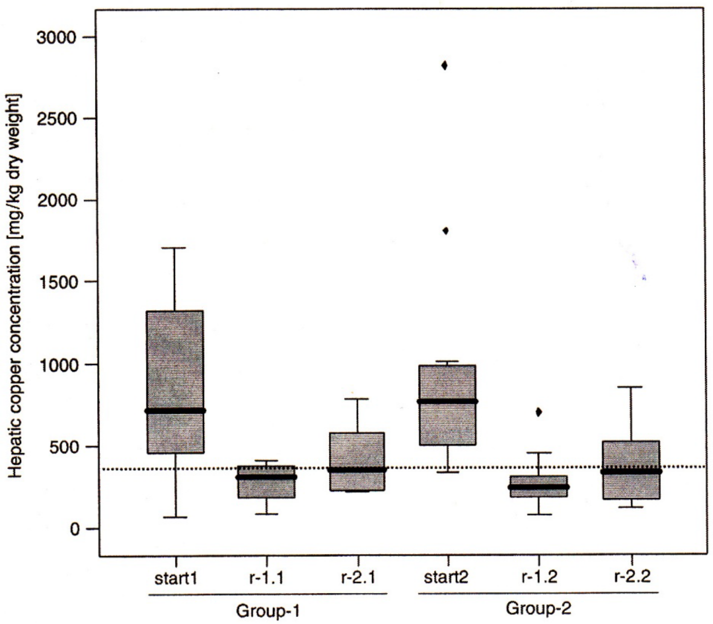


Fig 2. Hepatic copper measurements. Quantitative measurement of hepatic copper improved during treatment in both groups (group-1: diet and zinc; group-2: diet and placebo). Upper and lower horizontal borders of the boxes describe borders of upper and lower quartile of the data. The distance between these values is H-spread. Values outside 1.5 times H-spread above and below the hinges are outliers (diamond). Outliers appear as such in the figure, but these dogs were not excluded from statistical testing. Horizontal bars describe the median of the measured copper concentrations.

Two Diets - high and low points

- Hill's LD – Dry
- Ingredients- Brewers rice, chicken, chicken fat, egg product, soybean meal, flaxseed, cellulose
  - Kcals ME/kg - 4342
  - Protein – 4.2 g/100 kcal
  - Calcium -220 mg/100 kcal
  - Phos – 159 mg/100 kcal
  - Sodium – 42 mg/100 kcal
  - Copper- 0.1 mg/100 kcal
  - Omega three – 348 mg/100 kcal
  - Mangan. - 0.8 mg/100 kcals
  - Crude F – 700 mg/100 kcals
  - TDF – 1700 mg/100 kcals

- RC Hepatic – Dry
- Ingredients – brewers rice, corn, brown rice, soy isolate chicken fat.
  - Kcals ME/kg - 3761
  - Protein -4.1 g/100 kcals
  - Calcium -190 mg/100 kcals
  - Phos – 130 mg/100 kcals
  - Sodium – 50 mg/100kcals
  - Copper – 0.1 mg/100 kcal
  - EPA/DHA – 50 mg/100 kcals
  - Manganese – 1.8 mg/100 kcals
  - Crude F – 480 mg/100 kcals
  - TDF – 1800 mg/100 kcals

Good for the encephalopathic – not the early chronic cirrhotic where experts suggest the protein should be higher for hepatic regeneration.

Voyager (aka the scoop)?

- Protein about 7 g/100 kcals
- No added copper
- Chicken formula
  - 0.17 mg/100 kcals
- Fish Formula
  - 0.22 mg/100 kcals

- Can we get lower in copper than this
  - Home prepared diet?

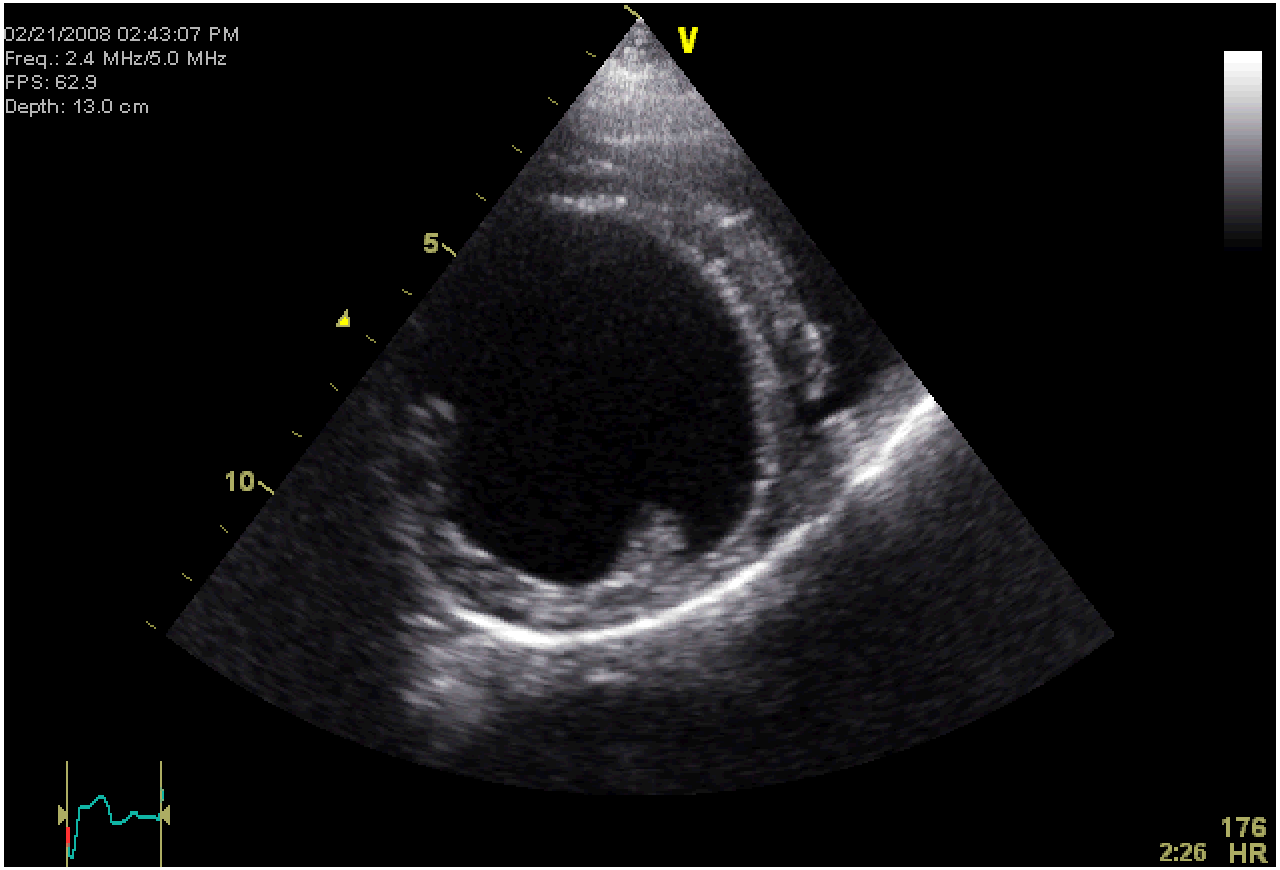
Time for a home-made diet!

- Pick a protein (30% ME)
- Pick a carb (30-40% ME)
- Pick an oil or two (30-40% ME)
- Meet Requirements
  - Stay away from mushrooms
  - Stay away from organ meat
  - Stay away from shellfish
  - Stay away from legumes
  - Use a copper free premix

PRODUCTS PACKAGED IN BOTTLE(S) OR BAG(S)

For those that do not like the powder for some reason: Centrum Silver for women, Morton lite salt, Calcium carbonate, choline supplement

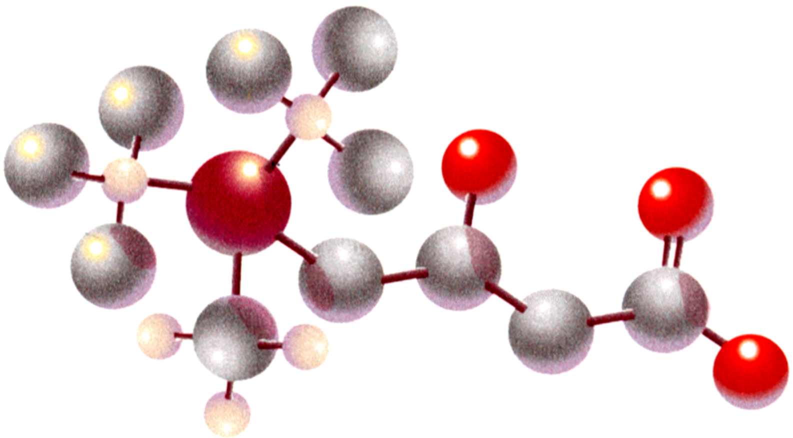
Nutrition and DCM – myth or fact??



Carnitine and Cardiomyopathy

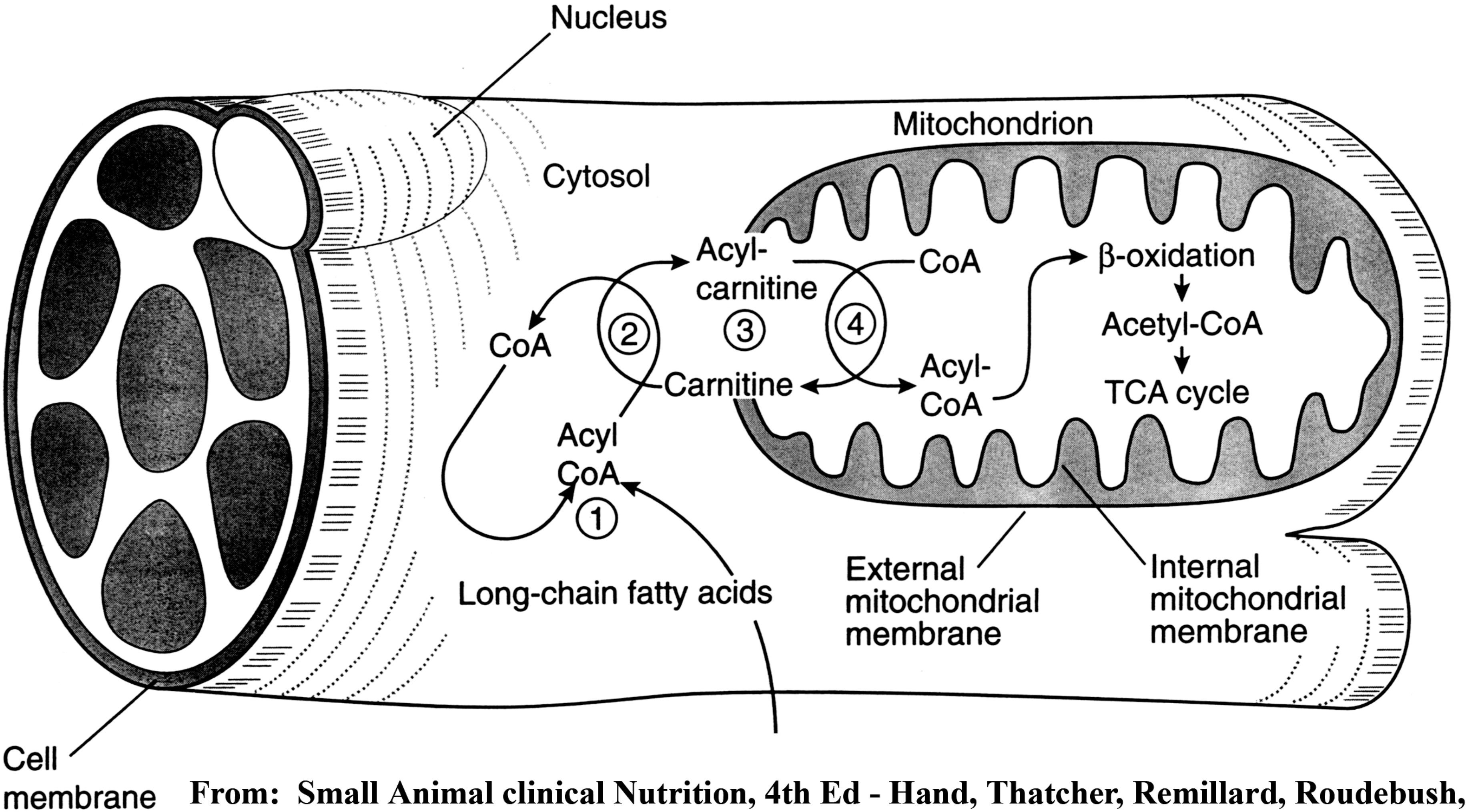
- Breed predilections
  - -Congenital Myocardial deficiency in Boxer dogs

CARNITINE MOLECULE



Discovered in 1905, L-carnitine is synthetized in dogs from lysine and methionine, if vitamin C and pyridoxine (vit B6) are present. It is a quaternary amine that acts as a water soluble vitamin. Carnitine can be synthetized in D or L forms, but L-carnitine is the only one of relevance for dogs with cardiac disease.

From: Encyclopedia of Canine Clinical Nutrition - Pibot, Biourge, and Elliott 2006, Figure 12, Page 337



From: Small Animal clinical Nutrition, 4th Ed - Hand, Thatcher, Remillard, Roudebush, Figure 18-5, Page 540

Carnitine

- Carnitine deficiency diagnosis requires endocardial biopsy – serum or whole blood not indicative (but recent data suggests serum may be OK)
- There have been no canine or feline studies to date showing benefits of carnitine supplementation in CHF.
- In CHF tissue carnitine levels will decrease, but this may be normal in the disease process.
- Supplementation is more expensive than taurine currently recommendations are 50-100 mg/kg q 8 hours.

What about BEG Diets?

Boutique, exotic, grain free

Echocardiographic phenotype of canine dilated cardiomyopathy differs based on diet type

Darcy Adin, DVM*, Teresa C. DeFrancesco, DVM, Bruce Keene, DVM, Sandra Tou, DVM, Kathryn Meurs, DVM, PhD, Clarke Atkins, DVM, Brent Aona, DVM, Kari Kurtz, DVM, Lara Barron, DVM, Korinn Saker, DVM, PhD

https://www.fda.gov/animal-veterinary/animal-health-literacy/questions-answers-fda-center-veterinary-medicines-investigation-possible-connection-between-diet-and

All dogs diagnosed with DCM

Table 1 Median and 95% confidence intervals for weight, age, percentage male, percentage of dogs with congestive heart failure (CHF) at diagnosis, and vertebral heart scale.

	GB (n = 12)	All GF (n = 36)	GF-1 (n = 14)	GF-o (n = 22)	*P* value
Weight (kg)	36.5 (25.3–41.2)	30 (23.3–33.7)	21.0 (13.0–26.5)[a,b]	31.7 (27.1–39.9)	0.01
Age (yrs)	7.5 (4.7–9.7)	5.0 (4.9–6.9)	5.0 (4.6–7.6)	5.0 (4.5–8.1)	0.6
Male (%)	75	56	57	55	0.65
CHF (%)	67	78	93	68	0.32
VHS	11.4 (11.1–12.3)	12.4 (12.0–12.8)	12.5 (12.3–13.5)	11.9 (11.5–12.5)	NS

GB, grain-based diets; All GF, all grain-free diets, GF-1, most common grain-free diet, GF-o, other grain-free diets; VHS, vertebral heart scale.

[a] Significantly different from GB.

[b] significantly different from GF-o. VHS was significantly different between groups ($p=0.04$); however, this significance was lost after multiple comparison testing.

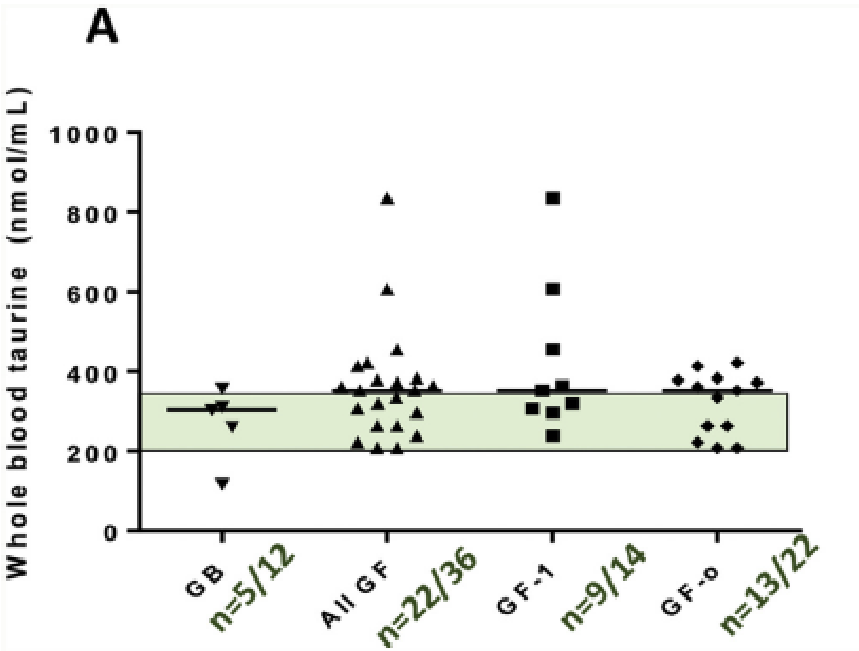
What number of dogs coming into a cardiology service are on a grain free diet?
Is this a disease of the affluent client??
Has DCM incidence risen over the past 10 years??

The clinical and echocardiographic improvement observed in seven dogs that were eating GF diets following a diet change deserves emphasis. The improvement in GF dogs after diet change supports potential causality, and the finding of two affected pairs of unrelated housemates eating GF-1 also causally supports diet as a common environmental factor for the development of DCM in these dogs.

Although most of the group differences in echocardiographic parameters appear attributable to GF-1 diet, one of the dogs that responded to a diet change was eating GF-o, supporting a similar pathophysiologic process and reversibility for GF-o diets.

Only 7 dogs followed up – All dogs had food change and 30 mg/kg taurine BID

More questions than answers?



- Why supplement taurine if adequate?
- Was it food change or taurine supplementation?
- Why not do follow up on all dogs including GB dogs?
- Has taurine supplementation ever been studied in DCM as a treatment regardless of diet?

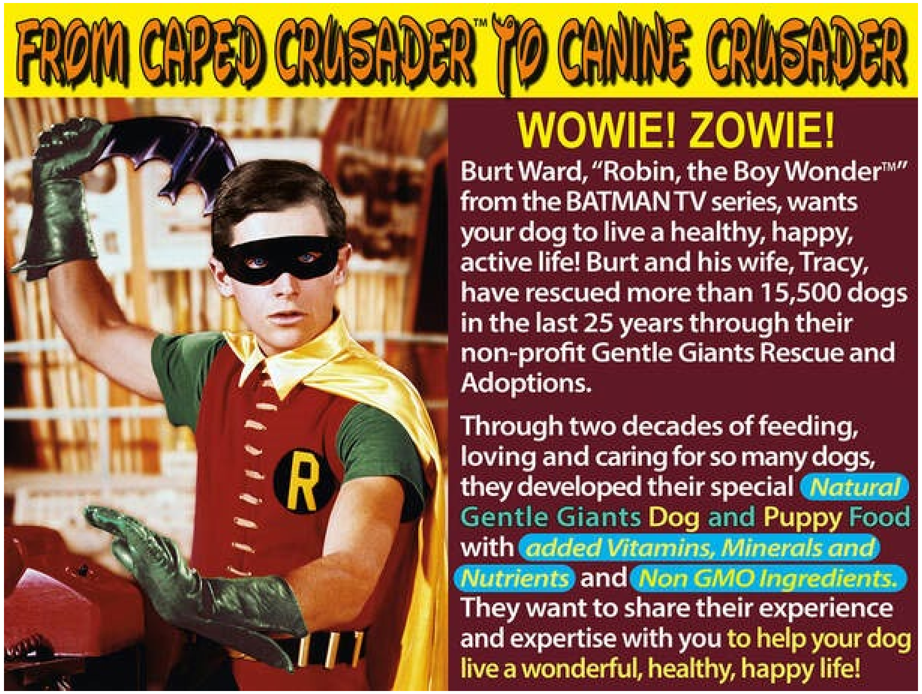
Why did Grain Free take off??

- The bastardization of grains (and soy).
  - Allergy
  - Mycotoxins (recent recall just this year!)
  - Corn somehow considered filler?
  - Soy – estrogen like molecules?
  - Corn prices rose due to ethanol industry.
  - Wolves don't go picking through soy or corn fields
  - (remember your dog and wolves eat their own poop!)

- The reality of Grains
  - Good lower cost energy source
  - Necessary to make stable extruded products
  - Corn and other grains have 14% protein and higher in some cases
  - Provided some fiber
  - Provides certain amino acids in higher proportions
  - Phytonutrients and mineral rich.
  - Really not much different from ancient grains (sorghum, quinoa etc)
  - Actually better glycemic index than tubers (potato, tapioca etc)

The wild west has arrived!

- Everyone and their brother makes a pet food now?
- Do they have qualified individuals formulating?
- My Experiences
  - Third party manufacturers
  - No feeding tests
  - Premix companies



A link between grain free and DCM?

- Remember that the first cases presented were actually taurine deficiency cases.
    - Just like 2003 lamb and rice diets (not very exotic or grain free).
- Golden Retriever problem likely more hereditary and feeding issues.
    - Many not getting energy requirements from food given
    - Taurine levels appear to be lower as a breed thing

Taurine deficiency in dogs with dilated cardiomyopathy: 12 cases (1997–2001)

Andrea J. Fascetti, VMD, PhD, DACVN, DACVIM; John R. Reed, DVM, MS, DACVIM; Quinton R. Rogers, PhD, DACVN; Robert C. Backus, DVM, PhD

PLOS | ONE

RESEARCH ARTICLE

Taurine deficiency and dilated cardiomyopathy in golden retrievers fed commercial diets

Joanna L. Kaplan[1], Joshua A. Stern[1]*, Andrea J. Fascetti[2], Jennifer A. Larsen[2], Hannah Skolnik[1], Gordon D. Peddle[3], Richard D. Kienle[4], Andrew Waxman[5], Michael Cocchiaro[6], Catherine T. Gunther-Harrington[1], Tyler Klose[7], Kendra LaFauci[8], Bonnie Lefbom[9], Maggie Machen Lamy[10], Rebecca Malakoff[11], Satoko Nishimura[1], Maureen Oldach[1], Steven Rosenthal[12], Christopher Stauthammer[13], Lynne O'Sullivan[14], Lance C. Visser[1], Regan William[15], Eric Ontiveros[1]

A couple of reviews for perspective

- High points
  - Ingredients vary and formulation software is only as good as what is entered.
  - DCM has not shown to increase in the past 10 years across the board
  - Incidence is less than 0.002%
  - Is there bias in presentation?

Special topic: The association between pulse ingredients and canine dilated cardiomyopathy: addressing the knowledge gaps before establishing causation[1]

Wilfredo D. Mansilla,[†] Christopher P.F. Marinangeli,[‡] Kari J. Ekenstedt,[||] Jennifer A. Larsen,[$] Greg Aldrich,[¶] Daniel A. Columbus,[††] Lynn Weber,[‡‡] Sarah K. Abood,[||||] and Anna K. Shoveller[†,2]

[†]Department of Animal Biosciences, University of Guelph, Guelph, ON N1G 2W1, Canada; and [‡]Pulse Canada, Winnipeg, Manitoba, Canada, R3C 0A5; [||]Department of Basic Medical Sciences, College of Veterinary Medicine, Purdue University, West Lafayette, IN 47907; [$]Department of Molecular Biosciences, School of Veterinary Medicine, University of California, Davis, CA 95616; [¶]Department of Grain Science and Industry, Kansas State University, Manhattan, KS 66506; [††]Prairie Swine Centre, Saskatoon, SK S7H 5N9, Canada; [‡‡]Department of Veterinary Biomedical Sciences, University of Saskatchewan, 52 Campus Drive, Saskatoon, SK S7N 5B4, Canada; [||||]Department of Clinical Studies, University of Guelph, Guelph, ON N1G 2W1, Canada

BOARD INVITED REVIEW

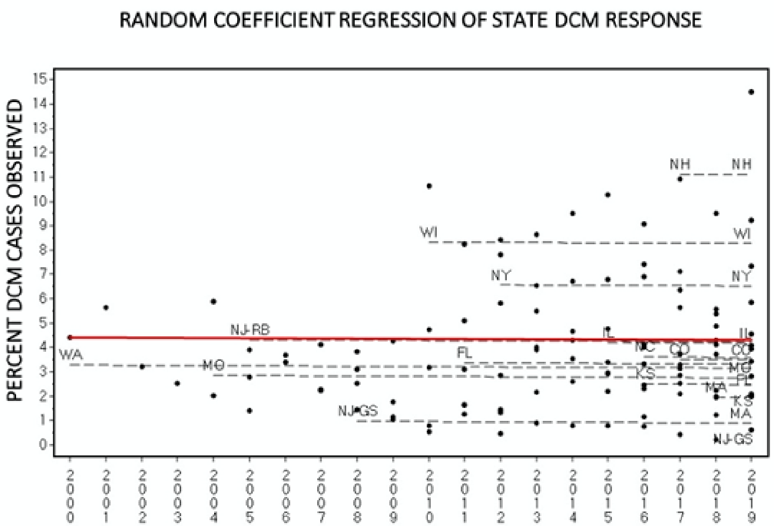
Review of canine dilated cardiomyopathy in the wake of diet-associated concerns

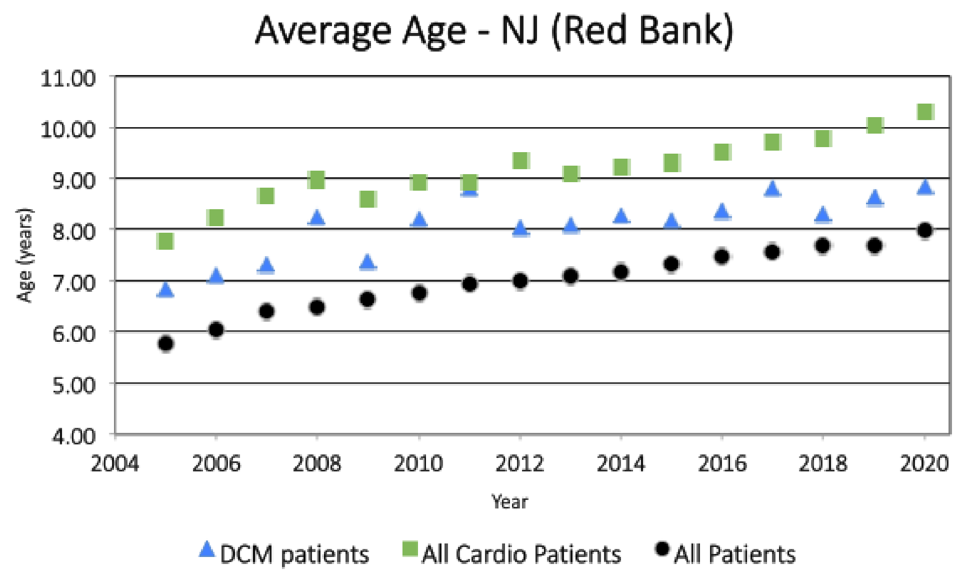
Sydney R. McCauley,[†] Stephanie D. Clark,[†] Bradley W. Quest,[†] Renee M. Streeter,[†,1] and Eva M. Oxford[‡]

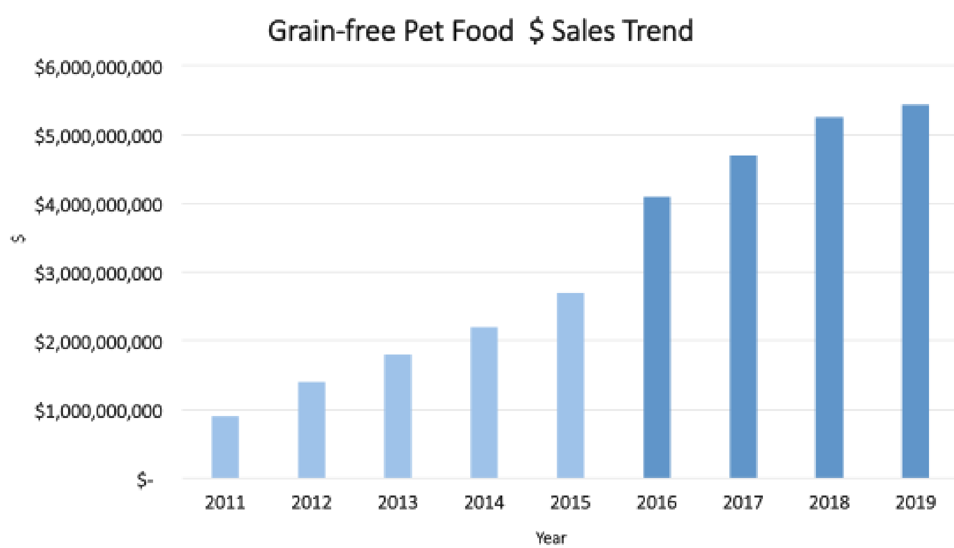
[†]BSM Partners, Bentonville, AR, [‡]The Heart Vet, Ithaca, NY

[1]Corresponding author: drstreeter@bsmpartners.vet

Has DCM increased?

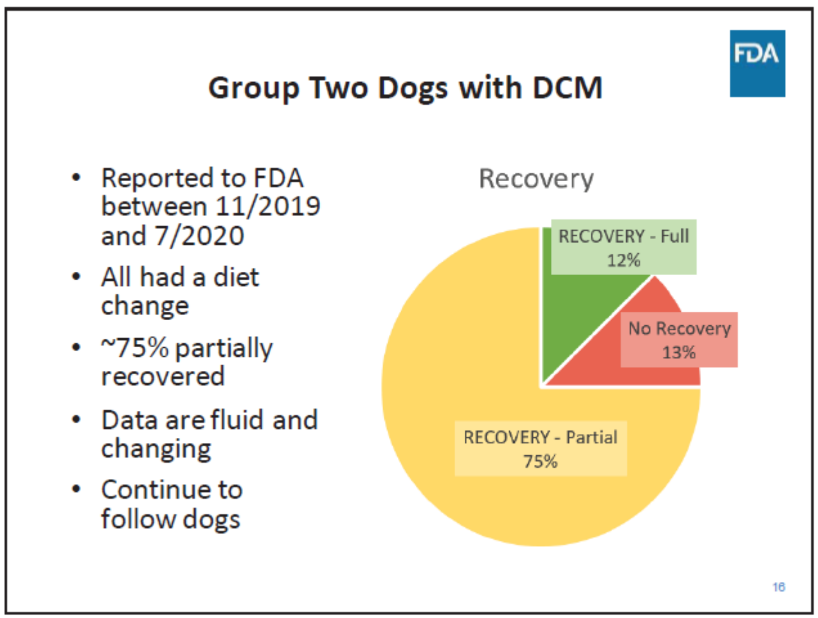


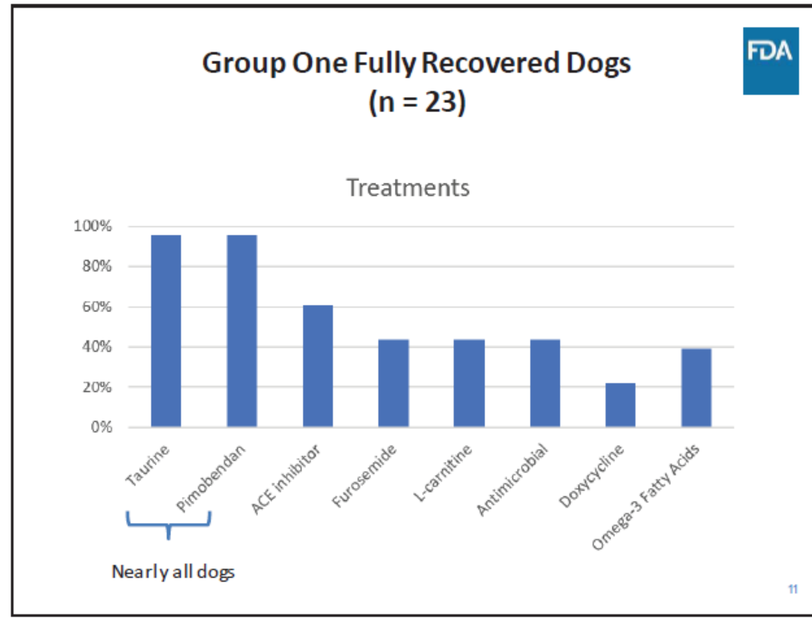




- DATA from BSM partners

What is FDA saying now – well the investigation has ended…





All dogs that fully recovered received a diet change. Nearly all dogs were also treated with taurine and pimobendan. Over half of the dogs also received an ACE inhibitor, whereas additional treatments and supplements varied.

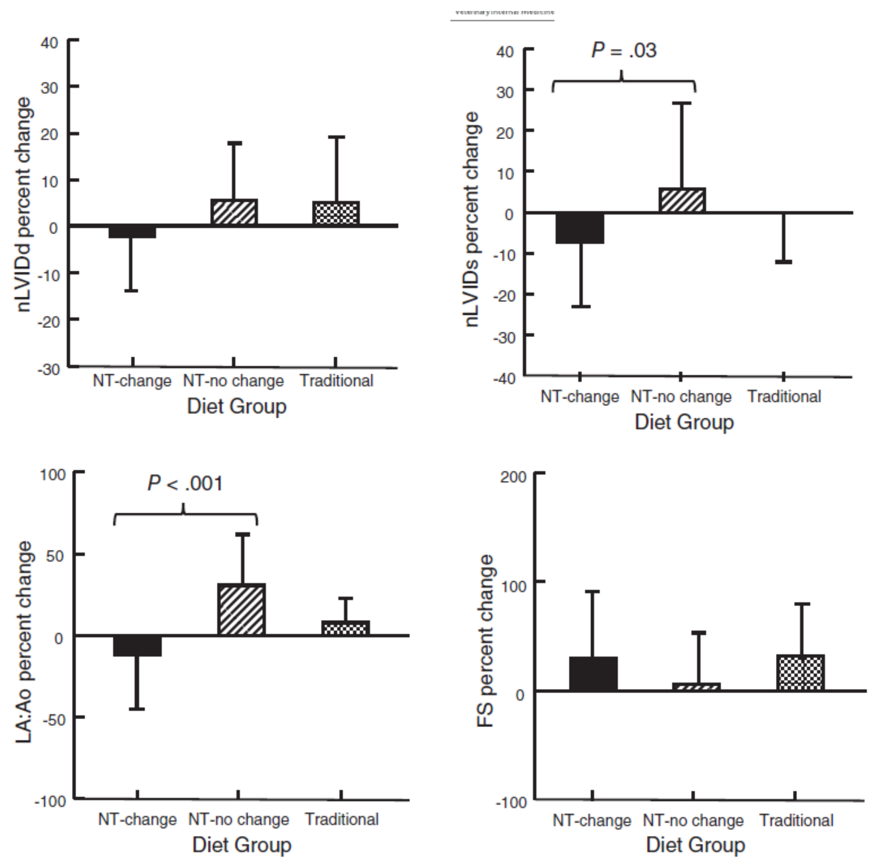
FDA latest……before investigation ended

- 90% of the reported products met our exposure definition for "grain-free" (no corn, wheat, soy, or rice). This is consistent with patterns we've seen when looking at all our DCM cases.
- 94% of reported products contained peas and/or lentils in their top ingredients.
- 91.5% of the products had peas in the top ingredients.
- 87% of the products had whole peas (versus fractions) on their ingredient lists.
- 59% of the products had pea fractions.
- Lentils (45%) and lentil fractions (18%) were less common.
- Sweet potatoes or potatoes were only listed ingredients in 28% of reported products.
- Animal source proteins – No single animal protein type predominated, and this has been consistent over time. Lamb meal is the most common of the animal proteins, but chicken, kangaroo, lamb, and kangaroo meal are also common among reported products. None of the product labels had meat by-products, chicken by-products, or poultry by-products.

Retrospective study of dilated cardiomyopathy in dogs

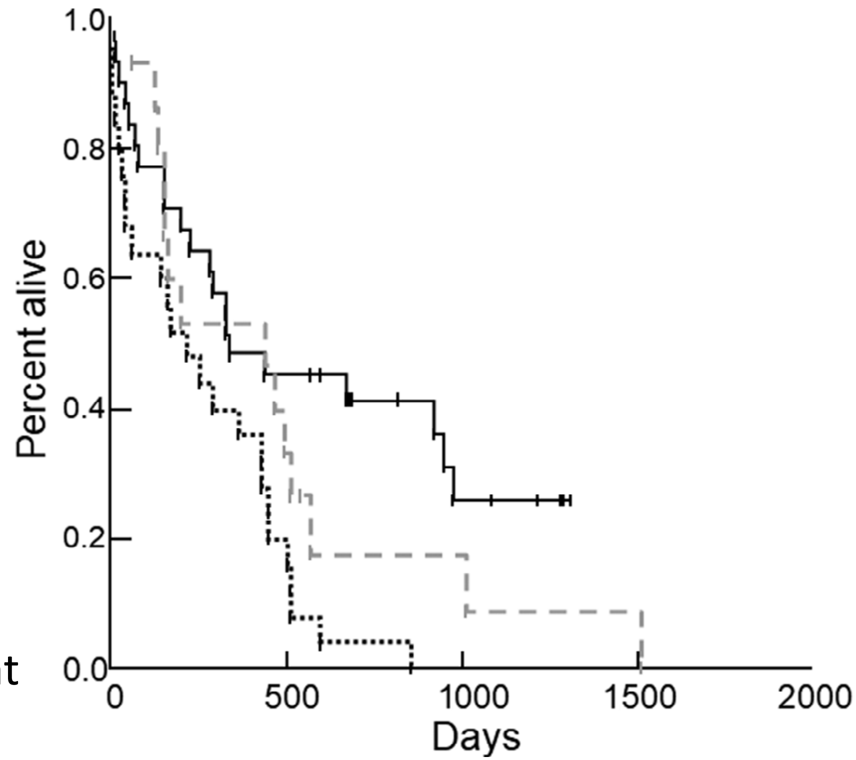
Kimberly J. Freid | Lisa M. Freeman | John E. Rush | Suzanne M. Cunningham | Megan S. Davis | Emily T. Karlin | Vicky K. Yang

- 71 dogs examined retrospectively
  - 15 eating TD
  - 56 eating NTD
- Most dogs not taurine deficient
  - 28 in NTD taurine supplement
  - 2 in TD group
- More dogs with diet change in NTD group tx with taurine.
- 80% on pimo, furosemide and ACE inhibitor
- 60% in each group had diet changes



Take Away

Dogs that received taurine supplementation
during the course of their disease had a
significantly longer
survival time than did dogs not receiving
taurine supplementation
(P = .003), but the presence of low plasma or
whole blood taurine concentration
was not associated with survival (P = .65).

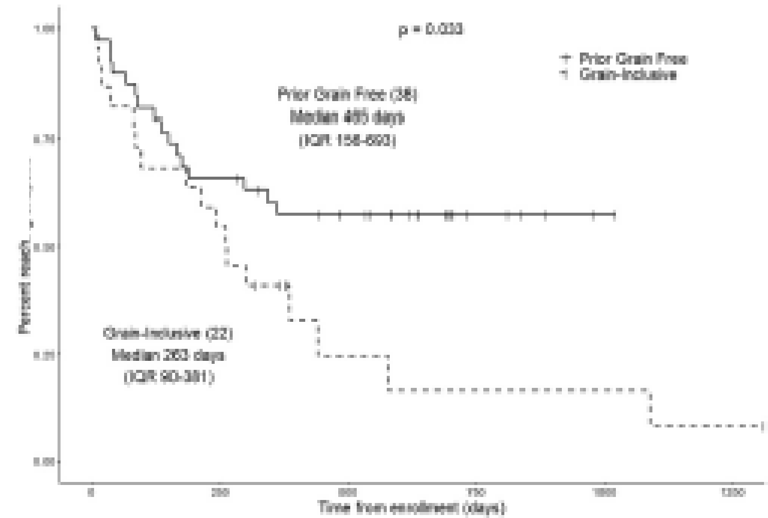


whereas diet group (ie, dogs
that were in the nontraditional diet group that
had their diets changed)
was significantly associated with longer
survival time (P = .001;
Table 3).

Association of diet with clinical outcomes in dogs with dilated cardiomyopathy and congestive heart failure☆

A.L. Walker, DVM[a], T.C. DeFrancesco, DVM[b,*], J.D. Bonagura, DVM[b], B.W. Keene, DVM[b], K.M. Meurs, DVM[b], S.P. Tou, DVM[b], K. Kurtz, DVM[c], B. Aona, DVM[d], L. Barron, DVM[e], A. McManamey, DVM[b], J. Robertson, MS[b], D.B. Adin, DVM[f]

- Retrospective study to examine survival of dogs that were eating GI or GF diets before presentation for DCM.
- 67 dogs 47 GF and 20 GI diets at least 6 month prior to presentation.
- All dog pimobendan and loop diuretic – most ACE inhibitor.
- Grain inclusive diet not described – lower in sodium?
- Followed mortality and drug changes as primary outcome



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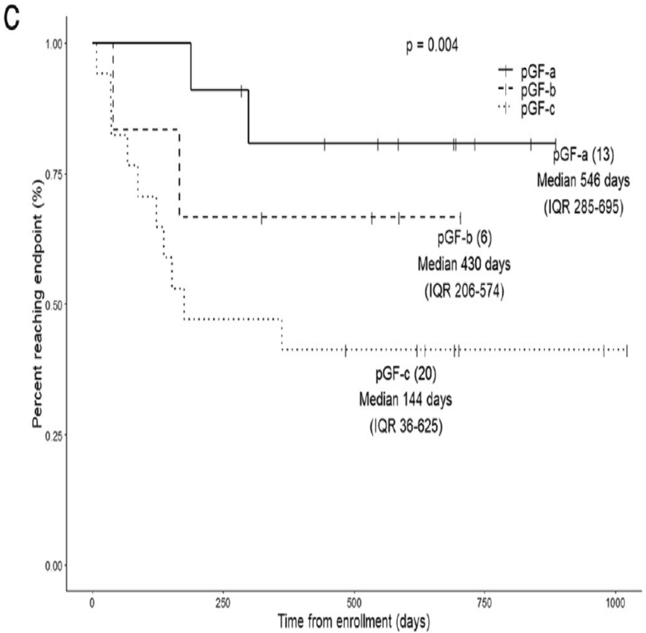


Take Away

Table 2 Echocardiographic measurements and vertebral heart scale measurements for the two study groups at initial and final evaluations are shown as median ± SD for normally distributed data and median (IQR) for non-normally distributed data. The difference in the mean or median change between the two groups from the initial measurement to the last follow-up was calculated only considering dogs with both an initial and a follow-up measurement. Comparisons were conducted via a t-test or Wilcoxon rank sum test and P-values are displayed.

	GI Initial	pGF Initial	GI Final	pGF Final	Difference between the groups	P-value
LVIDdN	2.11 ± 0.29	2.27 ± 0.36	1.95 ± 0.38	1.88 ± 0.41	0.277	0.0378*
LVIDsN	1.26 ± 0.22	1.36 ± 0.28	1.11 ± 0.30	1.07 ± 0.35	0.154	0.112
LV fractional shortening (%)	13.0 (9.65–16.23)	14.0 (11.35–18.55)	14.0 (12.05–20.20)	20.7 (14.47–26.0)	1.300	0.9828
Mitral EPSS (cm)	1.72 ± 0.79	1.68 ± 0.70	1.12 ± 0.78	0.92 ± 0.56	0.325	0.0306*
Ratio of left atrial to aortic size	1.94 (1.14–2.81)	2.09 (1.38–3.23)	1.63 (1.23–2.26)	1.52 (1.22–3.16)	0.410	0.134
Vertebral heart scale	11.85 ± 0.73	12.32 ± 0.97	11.63 ± 0.89	11.65 ± 1.01	0.538	0.151

EPSS: E-point septal separation of the mitral valve; GF: grain-free; LVIDdN: normalized left ventricular internal diastolic diameter; LVIDsN: normalized left ventricular internal systolic diameter; pGI: prior grain-inclusive.
*The asterisk define statistical significance.

One dog in the GI group and 30 dogs in the pGF received taurine supplementation.

Additionally, a considerable number of dogs (23%) within the pGF group were able to have their diuretic medication discontinued and a smaller number of pGF dogs were also able to have their pimobendan discontinued (9%).

- More dogs on GF once changed could have lower doses of furosemide, and ACE inhibitor
- Diet change helped however what is it?
- Protein changes, electrolyte status- sodium, enhanced damage to myocardium that is reversible??

Prospective study of dilated cardiomyopathy in dogs eating nontraditional or traditional diets and in dogs with subclinical cardiac abnormalities

Lisa Freeman[1] | John Rush[1] | Darcy Adin[2] | Kelsey Weeks[1] | Kristen Antoon[1] | Sara Brethel[2] | Suzanne Cunningham[1] | Luis Dos Santos[1] | Renee Girens[2] | Robert Goldberg[3] | Emily Karlin[1] | Darleen Lessard[3] | Katherine Lopez[1] | Camden Rouben[2] | Michelle Vereb[2] | Vicky Yang[1]

- 60 dogs on NTD vs TD with DCM (51 in NTD and 9 TD group!)
- 16 dogs with Subclinical Abnormalities
  - All dogs on NTD for 6 months prior to enrollment
  - 3,6,9 month re-evaluations
  - Nearly all dogs on some form of antihypertension meds.

instructed to change to 1 of 6 commercial
extruded diets that were lower in sodium,
grain-inclusive, did not
contain pulses or potatoes/sweet potatoes in
the top 10 ingredients

TABLE 1 (Continued)

Variable	Nontraditional diet (n = 51)	Traditional diet (n = 9)	*P* value
Echocardiography			
M-mode			
Fractional shortening (%)	14.12 ± 5.22	17.85 ± 6.82	.06
LVIDdN	2.25 ± 0.39	2.05 ± 0.19	.03
LVIDsN	1.80 ± 0.34	1.56 ± 0.21	.04
2D			
Left atrium : aorta	2.17 ± 0.57	2.21 ± 0.58	.83
Sphericity index	1.34 ± 0.21	1.30 ± 0.16	.56

- Study was controlled for taurine and only supplemented in dogs with low taurine status.
- No differences in arrhythmia status in this study
- No vitamin or mineral status was different between groups

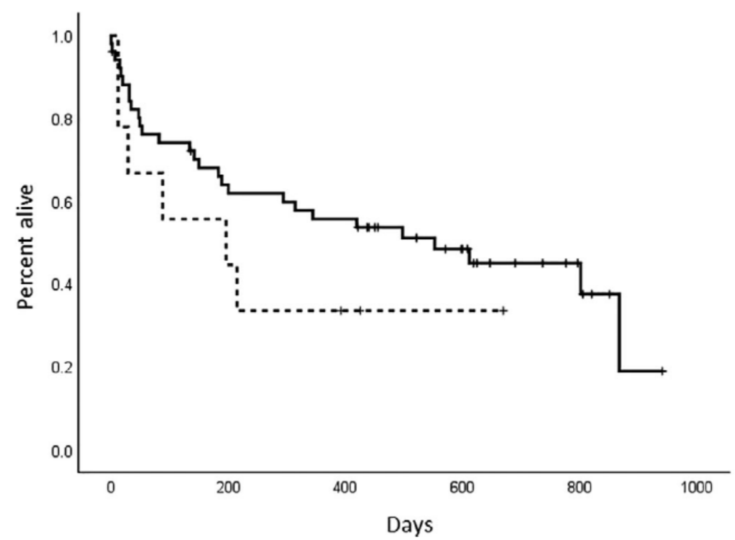


FIGURE 2 Kaplan-Meier survival curves comparing survival time in 60 dogs with dilated cardiomyopathy (DCM) after diet change. Median survival time of the 51 dogs originally eating a nontraditional diet (611 days, range, 2-940 days; solid line) was not significantly longer than that of the 9 dogs originally eating a traditional diet (161 days, range, 12-669 days; dashed line; $P = .21$)

In our study, LVIDdN, LVIDsN, and LA : Ao all
showed significant within-group improvements in the NTD group, but
the mixed models diet group time interaction for these echocardiographic
variables was not significant

What about the SCA dogs?

TABLE 4 Changes in cardiac biomarkers and key echocardiographic variables after diet change in dogs with subclinical cardiac abnormalities that had been eating nontraditional diets. Values [presented as mean ± SD or median (range)] are for 15 of 16 dogs at baseline (0 months) and 9 months. One dog died suddenly 95 days after starting the study and is not included in the analysis. *P*-values are for comparison of variables from 0 to 9 months, with significant *P* values in bold

Variable	0 months	9 months	*P* value
Biomarkers			
hs-cTnI (ng/mL)	0.126 (0.017-0.504)	0.121 (0.024-0.363)	.49
NT-proBNP (pmol/L)	1346 (302-3706)	1275 (250-5533)	.87
Echocardiographic variables			
Fractional shortening (%)	24.06 ± 4.65	30.11 ± 5.81	**.005**
LVIDdN	1.59 ± 0.13	1.51 ± 0.19	**.02**
LVIDsN	1.11 ± 0.12	0.99 ± 0.18	**.005**
LA : Ao	1.70 ± 0.34	1.55 ± 0.18	**.04**

Abbreviations: hs-cTnI, high-sensitivity cardiac troponin I; LA : Ao, ratio of the left atrial to aortic diameters (2-dimensional); LVIDdN, normalized left ventricular internal diameter in diastole; LVIDsN, normalized left ventricular internal diameter in systole; NT-proBNP, N-terminal pro-B-type natriuretic peptide.

Nutrition and Disease

The Pulse of It: Dietary Inclusion of Up to 45% Whole Pulse Ingredients with Chicken Meal and Pea Starch in a Complete and Balanced Diet Does Not Affect Cardiac Function, Fasted Sulfur Amino Acid Status, or Other Gross Measures of Health in Adult Dogs

Pawanpreet Singh [1], Sydney Banton [1], Shari Raheb [2], James R. Templeman [1], Jennifer Saunders-Blades [3], Darcia Kostiuk [3], Janelle Kelly [3], Christopher PF. Marinangeli [4], Adronie Verbrugghe [2], Shoshana Verton-Shaw [2], Anna K. Shoveller [1,*]

- 7 dogs in each group fed diets for 5 months

TABLE 1

The ingredient list for dietary treatments with increasing concentrations of whole pulse ingredient inclusion [Ctl (0% inclusion), Pulse15 (15% inclusion), Pulse30 (30% inclusion), Pulse45 (45% inclusion)] on an as-fed basis

Ingredient	Ctl	Pulse15	Pulse30	Pulse45
Whole grain corn	33	-	-	-
Corn gluten meal	12	-	-	-
Chicken meal	25	33	27.25	25
Pea starch	2.20	24.20	14.94	2.20
Whole green and yellow peas flour	-	5	10	15
Whole pinto beans flour	-	5	10	15
Whole chickpeas and lentils (50:50) flour	-	5	10	15
Fresh chicken	10	10	10	10
Chicken fat	7.5	7.5	7.5	7.5
Ground miscanthus grass	2.00	2.00	2.00	2.00
Natural chicken flavor (dry)	1.50	1.50	1.50	1.50
Natural chicken flavor (liquid)	2.5	2.5	2.5	2.5
Salt	2.5	2.5	2.5	2.5
Potassium chloride	0.75	0.75	0.75	0.75
Kelp	0.25	0.25	0.25	0.25
Potassium, (%)	0.75	1.08	1.18	1.23

Results

- No differences in any cardiac function parameters
- No differences in amino acid and taurine profiles
- No differences in cardiac markers (ProBNP) monthly measures
- No differences in whole body lean mass (DEXA)
- No differences in hematology (CBC; Chemistry),monthly measures
- Legumes – do not cause DCM then why do they do poorer when on these diets?

Where does this leave us?

Printe

SUMMARY OF INGREDIENTS & AMOUNTS COMPARED TO SELECTED REQUIREMENT

Pet: Class DCM, 5 yr, canine, Neutered, weighing 60 lb

[n16070] Lentils, mature seeds, cooked, boiled, without salt	396.000 g.	2 cup	460.98 kcal
estimated yield from 134.2 g (approx. 3/4 cup) of raw/unprepared/dry Lentils...			
[n11305] Peas, green, cooked, boiled, drained, without salt	320.000 g.	2 cup	268.98 kcal
[n5120] Chicken, roasting, dark meat, meat only, cooked, roasted	170.100 g.	6 oz	303.12 kcal
[n4542] Fat, chicken	12.800 g.	1 tbsp	115.23 kcal
[m96175] meat enhance	6.000 g.	6 gram	0.00 kcal
[n4582] Oil, canola	4.500 g.	1 tsp	39.78 kcal
[n20020] Cornmeal, whole-grain, yellow	0.000 g.	0 cup	0.00 kcal
[m14] Rice, white, long-grain, regular, cooked (BalanceIT.com)	0.000 g.	0 cup	0.00 kcal
Totals:	**909.400 g.**		**1188.08 kcal**

1.306 kcal/gram w/o added water; 70.27 % moisture w/o added water; 4394.38 kcal/kg DM; 85.02 LA+AA:EPA+DHA rati

Total calories fed: 1188.1 kcal/day OR 89% of the calculated requirement

Protein calories: 29.7% (1% – 20% – 30% – 100%)

Fat calories: 25.9% (1% – 20% – 30% – 100%)

Carbohydrate calories: 44.4% (1% – 40% – 60% – 100%)

29.7% ME Protein 25.9% ME Fat 44.4% ME Carbohydrate

Calculated Energy Requirement Range 39% 1188.083 kcal — Min kcal/day (50% MER):6 Max kcal/day (150% MER):

Nutrients	% of Requirement	Amount (per Mcal)	Requirement Range
[203] Protein	311.2%	77.789 g	(25 to *no max* g)
[511] Arginine	621.6%	5.470 g	(0.88 to *no max* g)
[512] Histidine	450.6%	2.163 g	(0.48 to *no max* g)
[503] Isoleucine	376.6%	3.578 g	(0.95 to *no max* g)
[504] Leucine	325.9%	5.540 g	(1.7 to *no max* g)
[505] Lysine	656.0%	5.773 g	(0.88 to *no max* g)
[506] Methionine	168.3%	1.397 g	(0.83 to *no max* g)
[1001013] Methionine-cystine	141.3%	2.303 g	(1.63 to *no max* g)
[508] Phenylalanine	295.4%	3.338 g	(1.13 to *no max* g)
[1001017] Phenylalanine-tyrosine	300.9%	5.567 g	(1.85 to *no max* g)
[502] Threonine	280.0%	3.024 g	(1.08 to *no max* g)
[501] Tryptophan	216.9%	0.759 g	(0.35 to *no max* g)
[510] Valine	306.4%	3.769 g	(1.23 to *no max* g)
[204] Total lipid (fat)	209.6%	28.926 g	(13.8 to 77.5 g)
[618] 18:2 undifferentiated	211.4%	5.918 g	(2.8 to 16.3 g)
[205] Carbohydrate, by difference	100.0%	109.193 g	(0 to *no max* g)
[421] Choline, total	110.9%	468.830 mg	(422.874 to *no max* mg)
[435] Folate, DFE	1357.5%	916.323 mcg_DFE	(67.5 to *no max* mcg_DFE
[406] Niacin	404.4%	17.189 mg	(4.25 to *no max* mg)
[410] Pantothenic acid	160.2%	6.007 mg	(3.75 to 5000 mg)
[405] Riboflavin	173.3%	2.253 mg	(1.3 to 375 mg)
[404] Thiamin	1431.7%	8.017 mg	(0.56 to 450 mg)
[320] Vitamin A, RAE	125.1%	474.055 mcg_RAE	(379 to 16000 mcg_RAE)
[418] Vitamin B-12	385.3%	33.718 mcg	(8.75 to *no max* mcg)
[415] Vitamin B-6	431.7%	1.619 mg	(0.375 to 125 mg)
[323] Vitamin E (alpha-tocopherol)	911.4%	68.358 IU, Vit E	(7.5 to 250 IU, Vit E)
[430] Vitamin K (phylloquinone)	19.0%	0.078 mg	(0.41 to *no max* mg)
[301] Calcium, Ca	98.5%	0.985 g	(1 to *no max* g)
[1000000] Chloride	138.0%	0.414 g	(0.3 to 5.875 g)
[312] Copper, Cu	160.2%	2.403 mg	(1.5 to *no max* mg)
[1000001] Iodine	75.8%	0.167 mg	(0.22 to 1 mg)
[303] Iron, Fe	406.5%	30.484 mg	(7.5 to *no max* mg)
[304] Magnesium, Mg	213.5%	0.320 g	(0.15 to *no max* g)
[315] Manganese, Mn	368.4%	4.421 mg	(1.2 to *no max* mg)
[305] Phosphorus, P	154.7%	1.160 g	(0.75 to *no max* g)
[306] Potassium, K	228.1%	2.281 g	(1 to *no max* g)
[317] Selenium, Se	121.3%	0.109 mg	(0.09 to *no max* mg)
[307] Sodium, Na	136.0%	0.272 g	(0.2 to 3.75 g)
[309] Zinc, Zn	203.2%	30.486 mg	(15 to *no max* mg)

SUMMARY OF INGREDIENTS & AMOUNTS COMPARED TO SELECTED REQUIREMENT

Pet: Class DCM, 5 yr, canine, Neutered, weighing 60 lb

[n5120] Chicken, roasting, dark meat, meat only, cooked, roasted	283.500 g.	10 oz	505.20 kcal
[m14] Rice, white, long-grain, regular, cooked (BalanceIT.com)	237.000 g.	1 1/2 cup	307.64 kcal
estimated yield from 84.0 g (approx. 5/8 cup) of raw/unprepared/dry Rice...			
[n20020] Cornmeal, whole-grain, yellow	122.000 g.	1 cup	441.74 kcal
[n4542] Fat, chicken	12.800 g.	1 tbsp	115.23 kcal
[m96175] meat enhance	6.000 g.	6 gram	0.00 kcal
[n4582] Oil, canola	4.500 g.	1 tsp	39.78 kcal
[n11305] Peas, green, cooked, boiled, drained, without salt	0.000 g.	0 cup	0.00 kcal
[n16070] Lentils, mature seeds, cooked, boiled, without salt	0.000 g.	0 tbsp	0.00 kcal
Totals:	**665.800 g.**		**1409.59 kcal**

2.117 kcal/gram w/o added water; 54.80 % moisture w/o added water; 4683.53 kcal/kg DM; 74.44 LA+AA:EPA+DHA ratio

Total calories fed: 1409.6 kcal/day OR 106% of the calculated requirement

Protein calories: 23.6% (1% – 20% – 30% – 100%)

Fat calories: 29.9% (1% – 20% – 30% – 100%)

Carbohydrate calories: 46.5% (1% – 40% – 60% – 100%)

23.6% ME Protein 29.9% ME Fat 46.5% ME Carbohydrate

Calculated Energy Requirement Range 56% 1409.592 kcal — Min kcal/day (50% MER):667 Max kcal/day (150% MER):2002

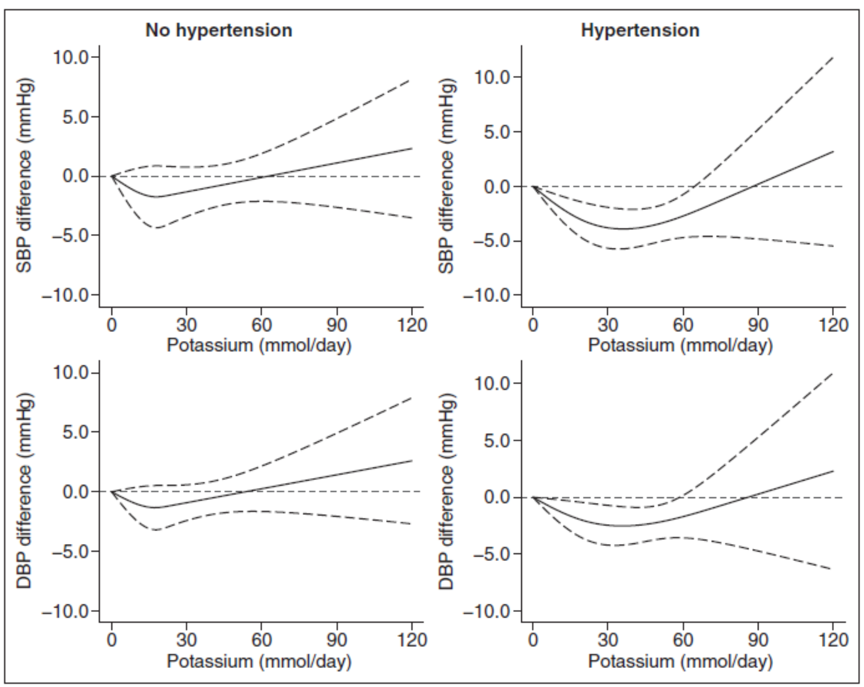
Nutrients	% of Requirement	Amount (per Mcal)	Requirement Range
[203] Protein	233.2%	58.312 g	(25 to *no max* g)
[511] Arginine	403.1%	3.547 g	(0.88 to *no max* g)
[512] Histidine	369.3%	1.773 g	(0.48 to *no max* g)
[503] Isoleucine	307.0%	2.917 g	(0.95 to *no max* g)
[504] Leucine	279.1%	4.745 g	(1.7 to *no max* g)
[505] Lysine	492.3%	4.333 g	(0.88 to *no max* g)
[506] Methionine	186.5%	1.548 g	(0.83 to *no max* g)
[1001013] Methionine-cystine	145.2%	2.366 g	(1.63 to *no max* g)
[508] Phenylalanine	216.3%	2.444 g	(1.13 to *no max* g)
[1001017] Phenylalanine-tyrosine	241.1%	4.460 g	(1.85 to *no max* g)
[502] Threonine	222.3%	2.400 g	(1.08 to *no max* g)
[501] Tryptophan	185.3%	0.648 g	(0.35 to *no max* g)
[510] Valine	239.9%	2.950 g	(1.23 to *no max* g)
[204] Total lipid (fat)	242.3%	33.431 g	(13.8 to 77.5 g)
[618] 18:2 undifferentiated	259.1%	7.256 g	(2.8 to 16.3 g)
[205] Carbohydrate, by difference	100.0%	113.912 g	(0 to *no max* g)
[421] Choline, total	61.1%	257.924 mg	(422.306 to *no max* mg)
[435] Folate, DFE	461.0%	311.179 mcg_DFE	(67.5 to *no max* mcg_DFE)
[406] Niacin	403.8%	17.162 mg	(4.25 to *no max* mg)
[410] Pantothenic acid	127.3%	4.773 mg	(3.75 to 5000 mg)
[405] Riboflavin	131.2%	1.706 mg	(1.3 to 375 mg)
[404] Thiamin	1134.4%	6.353 mg	(0.56 to 450 mg)
[320] Vitamin A, RAE	87.4%	331.146 mcg_RAE	(379 to 16000 mcg_RAE)
[418] Vitamin B-12	327.3%	28.636 mcg	(8.75 to *no max* mcg)
[415] Vitamin B-6	278.1%	1.043 mg	(0.375 to 125 mg)
[323] Vitamin E (alpha-tocopherol)	765.6%	57.420 IU, Vit E	(7.5 to 250 IU, Vit E)
[430] Vitamin K (phylloquinone)	0.6%	0.003 mg	(0.41 to *no max* mg)
[301] Calcium, Ca	74.6%	0.746 g	(1 to *no max* g)
[1000000] Chloride	167.0%	0.501 g	(0.3 to 5.875 g)
[312] Copper, Cu	84.5%	1.267 mg	(1.5 to *no max* mg)
[1000001] Iodine	67.7%	0.149 mg	(0.22 to 1 mg)
[303] Iron, Fe	252.2%	18.916 mg	(7.5 to *no max* mg)
[304] Magnesium, Mg	151.0%	0.227 g	(0.15 to *no max* g)
[315] Manganese, Mn	198.9%	2.387 mg	(1.2 to *no max* mg)
[305] Phosphorus, P	83.3%	0.625 g	(0.75 to *no max* g)
[306] Potassium, K	75.8%	0.758 g	(1 to *no max* g)
[317] Selenium, Se	135.1%	0.122 mg	(0.09 to *no max* mg)
[307] Sodium, Na	162.5%	0.325 g	(0.2 to 3.75 g)
[309] Zinc, Zn	156.9%	23.539 mg	(15 to *no max* mg)

Can potassium influence heart disease??

SYSTEMATIC REVIEW AND META-ANALYSIS

Potassium Intake and Blood Pressure: A Dose-Response Meta-Analysis of Randomized Controlled Trials

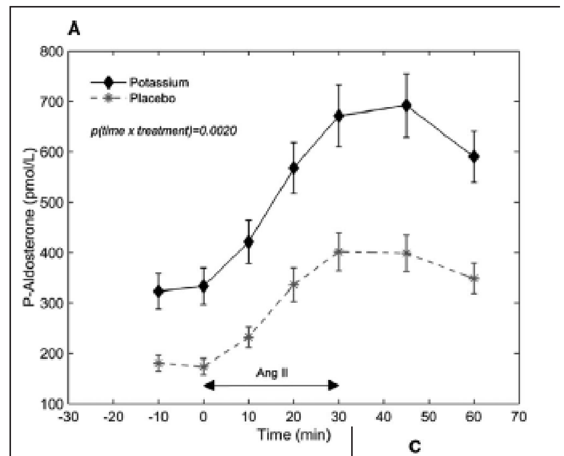
Tommaso Filippini, MD; Androniki Naska, PhD; Maria-Iosifina Kasdagli, MSc; Duarte Torres, PhD; Carla Lopes, PhD; Catarina Carvalho, MSc; Pedro Moreira, PhD; Marcella Malavolti, BSc, PhD; Nicola Orsini, PhD; Paul K. Whelton, MB, MD, MSc; Marco Vinceti, MD, PhD

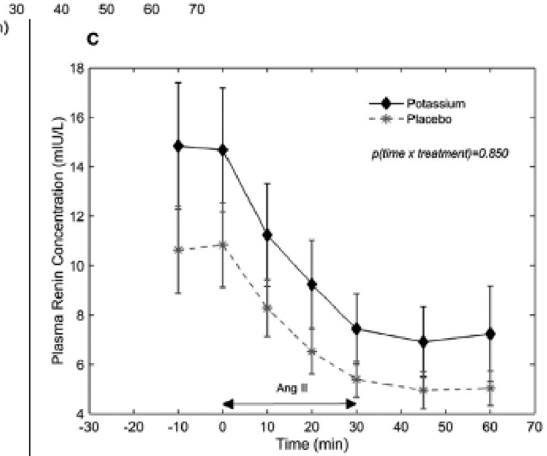


ORIGINAL RESEARCH

Effect of Increased Potassium Intake on Adrenal Cortical and Cardiovascular Responses to Angiotensin II: A Randomized Crossover Study

Rasmus Dreier, MD, PhD; Ulrik B. Andersen, MD; Julie L. Forman, MSc, PhD; Majid Sheykhzade, MSc, PhD; Martin Egfjord, MD, DMSci; Jørgen L. Jeppesen, MD, DMSci





Human vs Labrador

- Average person consumption of kcals 2200 per day
- Recommended potassium 2.5 g/day
- 1.15 g/1000 kcals
- Humans usually deficient provided 3.5 g per day so in study
- 4-5.5 grams per day
  - Equals around 1.8-2.2 g/1000 kcals

- Average Lab consumption of 1200 kcals
- Recommended intake min 1.5 g/1000 kcals by AAFCO and 1g/1000 kcals NRC
- Grain free Diet upwards of 2 g/1000 kcals
  - What if company adds potassium to premix and its used in grainful and grainfree formulas?
  - Can commonly exceed 3 g/1000 kcals
- Maybe diets should be below 2 g/1000 kcals?

WSAVA

WSAVA
Global Nutrition
Committee

Updated on 10 March 2021

WSAVA Global Nutrition Committee: Guidelines on Selecting Pet Foods

Pet food labels include a lot of required and useful information for veterinary teams and pet owners. They may also include marketing images and phrases that are designed to promote product sales rather than relay nutritional information. This means that some of the information, including unregulated terms such as 'holistic' or 'premium', is of little practical value for nutritional assessment. The veterinary team has a vital role in helping pet owners make informed decisions on the optimal diet for their dog or cat.

What to look for in a brand

1. Do they employ a Nutritionist?

- Appropriate qualifications are either a PhD in Animal Nutrition or Board Certification by the American College of Veterinary Nutrition (ACVN) or the European College of Veterinary Comparative Nutrition (ECVCN).
- What are the Nutritionist's name, qualifications and employment status? Consultants may have limited influence compared to a staff Nutritionist.

2. Who formulates the diet?

- Is the recipe developed by an experienced pet food formulator (MS or PhD in Animal Nutrition), a veterinarian, or a pet owner/breeder/trainer?
- Recipe development is a complex process requiring knowledge of nutrition, raw materials, and processing not taught in veterinary school programs.
- Trained and experienced formulators may have a degree (MS/PhD) in food science and technology to help guide ingredient selection and nutrient levels for health or disease management.
- An individual with Board Certification by ACVN or ECVCN may also be cross-trained in pet food formulation or work in collaboration with experienced pet food formulators to help guide ingredient selection and nutrient levels.

3. What is the quality control process for ingredients and finished products?

- Diets formulated to meet Association of American Feed Control Officials (AAFCO) or European Pet Food Industry Federation (FEDIAF) guidelines should meet their nutrient profiles. Does the diet meet the profile based on analysis using a nutrient database or on chemical analysis of the finished product?
- Manufacturers and pet food providers should have adequate quality control to ensure companion animal and owner safety. This should include ingredient (food and supplement) validation, final diet nutrient analysis, toxicology, bacteriology, and packaging/shelf-life screenings prior to, during, and after manufacturing.

4. What kind of product research or nutrition studies have been conducted? Is it published in peer-reviewed journals?

- Pet food companies are not required to conduct or sponsor nutritional research in order to produce and sell a food, but when they do, it indicates a commitment to animal health and wellness.

What to look for on a label

1. Nutrition Adequacy Statement?

- Is it a complete diet? Foods should be labeled to indicate if they provide a "complete" diet with all required nutrients. The label might also specify if this was determined via life stage feeding trials vs formulation to meet requirements. Those labeled as intended for "short-term", "intermittent", or "complementary" feeding should only be fed as a small portion of the diet (10% or less), or under veterinarian supervision if feeding a therapeutic diet.
- Does the food match the nutritional needs of the individual dog or cat? AAFCO and FEDIAF provide pet food manufacturers with recommended nutrient levels for different life-stages (reproduction, growth, and adult) for healthy dogs or cats. Diets labeled "for all life-stages" are formulated for reproduction and growth.

2. How many calories per gram or serving of food?

- Obesity prevalence is increasing in pets in many areas of the world. Having access to accurate pet food caloric content can help prevent unintended overfeeding. Calorie information is only required on pet food labels in the US. Where it is not provided on the label it should be available by contacting the manufacturer or calculating from label nutrient analysis.

3. Does the company provide immediate contact information such as a phone number or email address?

- Company representatives should be easily accessible for additional questions, such as the level of specific nutrients not on the label. Pet food companies should be able to provide an "average" or "typical" analysis for all essential nutrients in their food.

4. Who makes the food?

- Companies may make their own food (i.e.,"Made by") or use a third- party manufacturer (i.e.,"Made for" or "Distributed by").

If the manufacturer cannot or will not provide any of this information, veterinarians and owners should be cautious about feeding that brand.

wsava.org

Questions??