Release Notes xxxx-xx-xx : : Copper was an early part of my interest in optimization of supplements for dogs and humans. Recent literature has expressed concern about copper so I thought I would get out generally supportive results to date although omitting much of my own personal experiences (I'm a human not a dog) that seem similarly beneficial. It seems that often the popular press led by science catches onto incomplete or "close but not quite" ideas and reversals in recommendations are common. Curious to see how attitudes towards copper evolve. It may be worth noting there seems to be a trend to get away from copper plumbing lol.
ToDo : Known problems: no refs yet, diettables have unit problems for recent noun additions
This is a draft and has not been peer reviewed or completely proof read but released in some state where it seems worthwhile given time or other constraints. Typographical errors are quite likely particularly in manually entered numbers. This work may include output from software which has not been fully debugged. For information only, not for use for any particular purpose see fuller disclaimers in the text. Caveat Emptor.
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I am not a veterinarian or a doctor or health care professional and this is not particular advice for any given situation. Read the disclaimers in the appendicies or text, take them seriously and take prudent steps to evaluate this information.
This work addresses a controversial topic and likely advances one or more viewspoints that are not well accepted in an attempt to resolve confusion. The reader is assumed familiar with the related literature and controversial issues and in any case should seek additional input from sources the reader trusts likely with differing opinions. For information and thought only not intended for any particular purpose. Caveat Emptor
The release may use an experimental bibliography code that is not designed to achieve a particular format but to allow multiple links to reference works with modifications to the query string to allow identification of the citing work for tracking purposes. This may be useful for a bill-of-materials and purchases later.

Utility of Copper Supplementation in Dogs

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(Dated: April 15, 2024)

Recent popular news items have suggested a problem with hepatic copper accumulation in dogs thought to relate to increased copper content in some foods. However, that may reflect frustrated attempts to deliver more copper to the heart or other organs as those organs signal to absorb more copper with the intent to deliver it where needed. Consideration of homeostatic mechanisms, feedback loops, is often neglected and that may be the case in the present condundrum. This work describes copper supplementation to a group of dogs over several years with no robust deletious effect eastablished although some suspicious observations are discussed. Some benefits associated with copper supplementation include reduced coughing likely due to infectious respiratory disease, collapsed trachea,, or dilated / hypertrophic heart. Copper in these dogs may be beneficial through accumulation in macrophages and other locations, use by lysyl oxidase to stiffen trachea and other structural organs, and for mitochondrial energy production notably by the heart leading to greater volumetric efficiency. Particular nutrients that may aid transport out of the liver would likely be those which enhance ceruloplasmin quantity or quality or othewise modify copper handling. Tryptophan and tyrosine are two candidates for being copper toxicity limiting and were generally supplemented in this group of dogs. Both amino acids have unique functions and distribution may be modified by many factors including GI health to overall food chemistry and microbial metabolism.

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Contents

1. INTRODUCTION

Copper has become a concern in dog food over the past few years due to the more common observation of "copper associated hepatitis" [2] [9]. Copper homeostasis is a much larger issue including in human health with regard to such unresolved diseases as Alzheimer's where the decades of work on amyloid beta is becoming more clearly futile.

Over the same time however, concerns about diet linked DCM in dogs have emerged.

Its possible the two concerns are related in more copper is being absorbed as less is transported to target organs such as the heart.

To help with this apparent conundrum, this work describes variable copper supplementation to a group of dogs over several years including one pregnant pit bull with uterine fibroids. Generally beneficial results were associated with copper supplementation in the context of broader rationally designed supplements. Apparent benefits to a group of puppies included infection control. Additional respiratory infections were thought to be modulated in older dogs described here as Cookie(AKA Mixie) and Trixie. It may have reduced transmission to the larger group in the latter case. Also an association with likely non-infectious coughing was seen in the case of Happy.

Given the varied canine genetics and known copper related diseases, vigiliance for adverse reactions was maintained but to date only questionable events, such as reduced appetite, remain.

Copper and vitamin K have both seen literature suggesting a role for liver health under some conditions. Vitamin K is note worthy because of many efforts to antagonitze its effects similar to the present concerns with copper.

These cases are described in more detail with the hope of sorting out cause and effect between diet and clinical outcomes as fixation on one nutrient at a time may not be productive.

2. CASES AND OBSERVATIONS

A series of rescue dogs were fed food and vitamin supplements in addition to commercial kibble products. Diet and outcomes were recorded after supplemented meals in MUQED format. Most dogs receieved additional meals of commercial dog food and unfortuntately uncontrolled scraps or treats while others routinely ate toys or yard debris. However, some results appear to relate to the vitamin mix and notably this includes copper.

Dog	Dates	Condition	weight(lbs)	Cu	Outcomes
Cookie	21-09-10 22-01-21	Resp infection/azithromycin	13.5		cleared
Happy	18-09-07 24-04-10	several	13.4 - 17.7		
Happy	18-09-07 19-05-30	heartworm/doxycycline	13.4 - 17.2		cough gone
Happy	24-03-26	coughs	15.2 - 15.5		rare coughing
Brownie	21-01-12 23-02-22	pregnant , fibroids	49 - 64		uneventful
puppies	21-03-23 21-06-09	cough	104		cleared
Trixie	23-12-16 24-04-10	resp infection/Clavamox	37.6 44.6		cleared
Rocky	22-02-05 24-04-10		4.4 8.3		subjective better
Hershey	17-04-22 19-08-27	multiple	8.2 9		heart failure

TABLE I: List of dogs most effected by copper supplementation. The puppies were born on 2021-02-14 but only recorded as weaning began. Puppie weight reflects total as they were placed elsewhere and food shares are unknown

2.1. Cookie or Mixie

Arrived with diagnosed respiratory infection and azirhtromycin. Copper and other nutirents were added and eventually infection resolved well.

2.2. Brownie and puppies

Brownie was determined to be pregnant shortly after arrival and her diet may be notable for includsion of both copper and vitamin K. Other conidtions indluce heartworm positive, treated after weaning with Diroban, and fibroids removed 2021-11-15 well after puppies were gone. She was unevntful until being doganosed with cancer and killed 2023-02-22.

2.3. Happy

Happy arrived heartworm positive coughing to varying degrees. She was treaed with a slow kill approach including ivermectin and doxycycline as previously described. She later was acting sick but appeared to recover well with B vitamin supplements. But her coughing never returned to the very low levels seen after heart worm recovery until copper doses were increased with elimination of any zinc and care with tryptophan.

2.4. Trixie

Trixie began coughing shortly after arrival and was very low energy. Many other dogs began to cough or hack suggesting that she brought a communicable infectious disease. Nutrient mix was modified to add more copper and most dogs coughing returned to normal quanity and qualitiy although her's did not resolve. Copper stopped for a couple day (I was gone) and owner took he to the vet as she began coughing more. Clavamox was prescribed and her coughing stopped within a few days. Her energy level has improved but she still does not run.

2.5. Rocky

Rocky will hopefully be the subject of another work as he responded significantly to iodine and sodium benzoate which was attributed to, but never lab confirmed, low thyroid output. His "plastic" body type changed into a more normal "flexible" type and he began to feel like the other dogs when picked up rather than stiff. The addition of copper may have reduced his morning cough but he continued to have apparent congestion after eating sometimes breathing through his mouth and sneezing. Most recently he had notable muscle tone which had been lacking. His overall activity increased but that may be due to social factors such as feeding ritual.

2.6. Miscellaneous Observations

Rocky seemed to do better but was also responding to benzoate and iodine.

In initial attempts to formulate a vitamin mix, copper was added but no zinc. There was some possible feeding hesitance that went away when zinc was added. However a causal link was not established although copper was moderated afterwards. Annie may lose some appetite with excessive copper. However, a causal link was not eastablished.

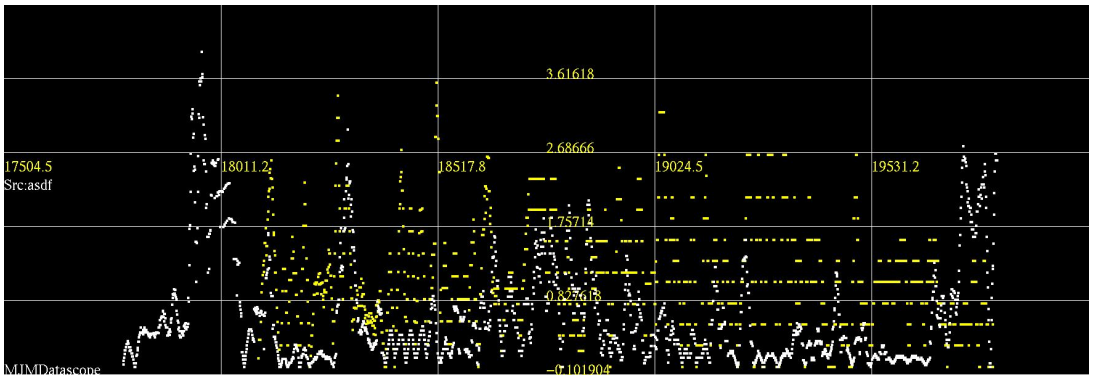

FIG. 1: Copper(white) and Zinc(yellow) dosing per day averaged over prior 10 day period as dosing was highly variable due to rotations of various nutrients. 18046 is 2019-05-30 when the cough was first noted to be gone for a few weeks. 19823 is 2024-04-10 the last date for which data was obtained. The cough stopped prior to the start of the Zinc and gradually increased to a notable background level over most of this interval although notes were incomplete. 19531 2023-06-23 notes the start of Cu depletion and chronic cough was noted by late Fall. During this time Zinc greatly exceeded copper dosing.

3. DISCUSSION

Several likely benefits of copper suypplementation were observed but no clear robust clinical symptoms got worse. This is contrary to some indications from populat concerns about excessive copper in commercial dog foods. Copper

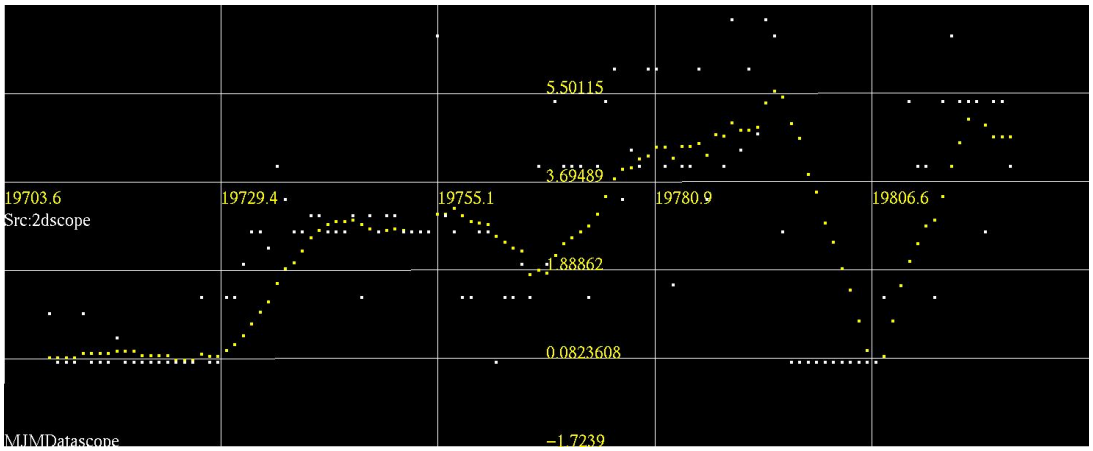

FIG. 2: Trixie copper consumption since arrival. Daily amounts (white)) and trailing 10 day average(yellow). Copper started to be significant around day 19730 in response to coughing. Day 19807 marked the end of the copper fast as well as the end of Clavamox which was prescribed due to worsening when copper stopped days earlier.

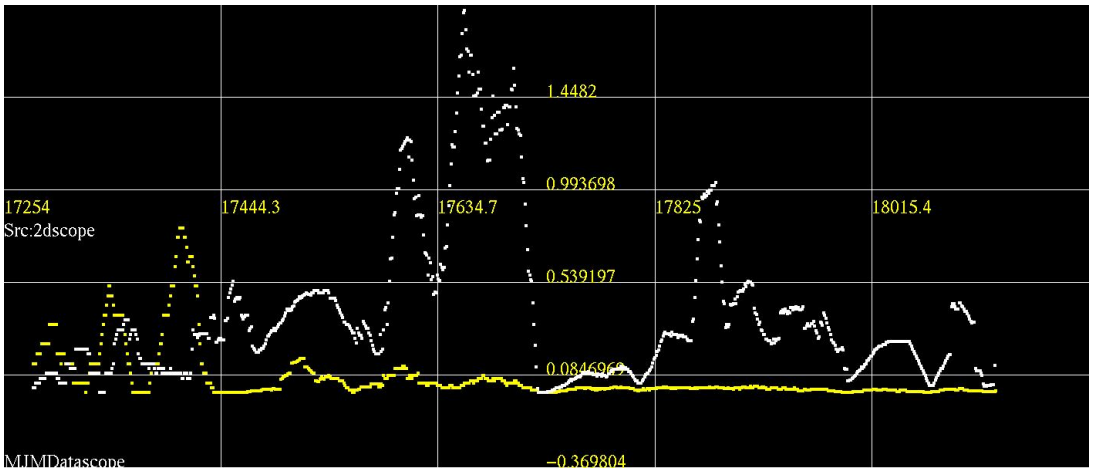

FIG. 3: Herhsey 10 day trailing average copper (white) and iodine (yellow).

use requires uptake and transportation to various targets. Transport out of the liver can be hindered for reasons such as ceruloplasmin defects.

ver a broad range of genetics, its likely that copper intake can be raised as long as other nutirents are also given to handle the copper beneficially. Candidate nutrients include tryrosine and tryptophan.

Copper in these dogs may be beneficial through accumulation in macrophages and other locations, use by lysyl oxidase to stiffen trachea and other structural organs, and for energy production notably by the heart leading to greater volumetric efficiency.

Some precednce for metal modulated toxicity existed back to 1999 when work with cultured neurons showed a dose dependent reduction in abeta toxicity with Zn [16]. By 2005 toxicity of amyloid beta and the metals zinc, iron, and copper was investigated under conditions that created more toxicity with iron and zinc but not copper while amyloid beta reduced metal toxicity in rats [8].

Copper signalling is such that remote signals may exist from the heart to liver and intestines to make more available [20]. In this scenario, local shortage could induce blood stream excess due to added inputs with struggling cardiac specific uptake as has been suggested for other nutrients such as tryptophan and biotin. Note this work also suggests copper deficiency as an issue for cardiac hypertrophy in animals. Copper uptake may depend on anions such as chloride at least in some animals [10] ,suggesting GI chloride per se rather than pH may be an issue. A series of copper deficient liver patients were notable for "steatohepatitis, iron overload, malnutrition, and recurrent infections. " [29] . Its interesting that iron overload occurs along with general malnutrition and sepcific copper deficiency.

Thinking outloud
this may not belong here but relevant to other Cu stuff, A recently published work suggests copper delivery is the important part of a new ALS drug but the work also suggests a "hyperreductive state" around hypoxic mito that promote relase of Cu from the drug complex [12]/ pointing to a possible more general mechnism. The work goes onto suggest possible role in Parkinson's Disease but does not address AD.

In 2021, Ni was found in important amounts in a commercial abeta40 preparation [5] and was found to mediate dityrosine crosslinks [7] similar to the dityrosine crosslinks induced by copper found in 2004 [3].

A 2013 work found in vitro physiological conditions caused copper to prevent fibril formation [17].

Copper is essential for many growth processes and can activate receptor tyrosine kinases without a ligand making it a target for cancer [11].

Rats fed a copper deficient diet shows neurological symptoms by 7 weeks and had reduced tyrosine hydroxylase and SOD activity ZZ [19].

A 2017 study explored the effects of copper and vitamin C as well as other molecules such as clioquninol on abeta and in vitro neurons suggesting abeta could be cleaved by copper in the presence of oxygen as well as an anti-oxidant such as vitamin C although restoration of neuronal functioning was only partial [28]. Interestingly, copper-ascorbate oxidation of tryptophan may be suppressed by Trp chelation of copper at high trp concentrations [18] suggesting reduced amounts may give copper more ability to damage an already low supply. This is interesting in terms of a utrient interaction hypothesis on copper toxicity. And in fact as early as 2012 it was determined that tryptophan intake could reduce copper toxicity at least in carp [13].

Body stores of copper increases with excess tyrisone in the diet of rats [27].

By 2022, work focusing on moving copper into the cell considered many aspects of copper misallocation and devised a copper specific shuttle peptide [21]. Recognition that the cells need copper is important .

A 2016 study in mice suggested adding copper to water was worse than adding it to food and supplementation at 6,15, and 30 ppm with increases in soluble abeta and decreased growth rate and GSH/SOD activity [26]. With a high dose of about 100 micrgograms/day (from CuSO4) and a body weight of about 30grams, the dose was about 3.3mg/kg.

One work in 2022 addressed AD as a consequence of copper deficnecy because [15]

> It is hypothesised that copper deficiency is a plausible cause of Alzheimer's disease(Reference Klevay84). Patients are thinner than normal; weight loss precedes dementia and is associated with greater dementia and neurobehavioural symptoms. Nutritional compromise contributes to morbidity. Cytochrome oxidase depends on copper for activity; at least fourteen publications reveal decreased activity in brain of Alzheimer's patients. Brain copper and caeruloplasmin also are decreased. This hypothesis is the only one that explains why Alzheimer's disease occurs earlier and is more common in Down's syndrome. Superoxide dismutase (SOD1) depends on copper for activity; its gene is on chromosome 21. This enzyme is elevated in Down's syndrome (trisomy 21) and is decreased in people with monosomy. It seems likely that people with Down's syndrome have a higher than average requirement for dietary copper because copper is incorporated into superoxide dismutase and is unavailable for other uses. Thus, Alzheimer's disease fulfills the first two of Golden's criteria (above) for deficiency.

Lysyl oxidase bad for vessels [4] calxification. but may be related to metallization issues [23].

Ceruloplasmin contains a chain of W and Y that are thought important for enzyme preservation [24]. As iron accumulation is related to AD, there is a question about the quality of the circulating ceruloplasmin. If there is high-infidelity translation due to W and Y depletion, there is also the question of how feedback mechanisms control the overall amount. Ceruloplasmin KO mice gained weight and showed increased scatter in weight with lipid dysregulation only partially corrected wth exogenous replacement [22].

Deficiency seems to effect prefernetially proteins involved in neuronal projection and diabetes and iron handling [25].

Copper may antagonize many pathogens including H pylori [6] and clostridum

Combined with vitamin C literature is confusing. It may be bad [14] although alternatives with copper gluconate instead of sulfate

Pulmonary hypertension may be controlled by serotonin [1] and therefore tryptophan intake.

4. LIMITATIONS

While the other components were mentioned as important, it needs to be reiterated that the the other snack components could have effected copper handling significantly and supplementation with another diet lacking these

components may not be beneficiail but copper restriction may not be either. Most food ingredient interact with matals to varying degrees and this notably contained citric acid and spinach along with amino acids.

The residential setting made it difficult to control or monitor all of the factors which could effect health. Besides the main kibble meals not being recorded for some dogs, intake of food and foriegn objects was common and unpredictable. Supplement quantities were often measured by volume using kitchen utensils known to be poorly calibrated. Completely unknown experiences or factors may be involved in their subjective behaviors. Cigarette smoke exposure was common but variable. As is always the case, despite MUQED's ability to keep strcutured outcome notes on things like cough, the resulting outcome data was very sparse and relies on memory in some cases. The lesson remains that notes and data always need to be more complete.

5. CONCLUSIONS

Copper has to be suspected of being important in dogs for functions that likely include strengthening of structural elements such as the trachea, volumetric energy effeiciency of the heart, and infection control. In the GI tract, it may moderate pathogenic phenotypes and change community structure of microbiome. Accumulation in the liver may reflect export problems rather than too much intake as signalling exists to regulate uptake and disposal. Defects may be due to other nutrients and particularly anything that interfers with ceruloplasmin synthesis or quality.

Internal transport and uptake however may both rely on GI defects which limit nutrient avialbility. Low stomach acid may be one common problem.

Zinc excess may also interfer with copper deployment. Dog genetics are varied and specifics likely vary too. Similar considerations may apply to humans.

Liver pathology that includes atypical amounts of copper may not reflect excess dietary intake but some other problem that needs to be fixed.

6. SUPPLEMENTAL INFORMATION

Dog diet data files are available online at https://github.com/mmarchywka/dogdata or other locations as may be required. The author may also be contacted if onlines sources are not avialble. Raw MUQED format as well as parsed text formats are avilable although MUQED software availbility is in the works.

6.1. Computer Code

note anything using "snacks_Collated.ssv" is obsolete as it messed up adjectives etc. use "linc_graph -dt-mo" NB : the "datealias" entries need to be updated not just datemin and datemax and the latter may not even do anything lol. A note also "reporting units" for many new nouns are not right as tsp has replaced mg etc.

```
2766 ./run_linc_graph -dt-mo txt/happy2cu.txt
 2767 texfrag -include xxxtable
 2768 mv xxxtable /home/documents/latex/proj/copper/keep/monthly.tex
```

7. BIBLIOGRAPHY

[1] Robert J Aiello, Patricia-Ann Bourassa, Qing Zhang, Jeffrey Dubins, Daniel R Goldberg, Stephane De Lombaert, Marc Humbert, Christophe Guignabert, Maria A Cavasin, Timothy A McKinsey, and Vishwas Paralkar. Tryptophan hydroxylase 1 inhibition impacts pulmonary vascular remodeling in two rat models of pulmonary hypertension. *The Journal of pharmacology and experimental therapeutics*, pages 267–279, 12 2016. Available from: https://pubmed.ncbi.nlm.nih.gov/27927914/, doi:10.1124/jpet.116.237933.

[2] LauraA Amundson, BrentN Kirn, ErikJ Swensson, AllisonA Millican, and GeorgeC Fahey. Copper metabolism and its implications for canine nutrition. *Translational Animal Science*, 01 2024. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10787350/, doi:10.1093/tas/txad147.

[3] Craig S. Atwood, George Perry, Hong Zeng, Yoji Kato, Walton D. Jones, Ke-Qing Ling, Xudong Huang, Robert D. Moir, Dandan Wang, Lawrence M. Sayre, Mark A. Smith, Shu G. Chen, and Ashley I. Bush. Copper mediates dityrosine cross-linking of alzheimer's amyloid-upbeta. *Biochemistry*, 43, 01 2004. Available from: http://dx.doi.org/10.1021/bi0358824, doi:10.1021/bi0358824.

[4] Carme Ballester-Servera, Judith Alonso, Manel Tauron, Noemi Rotllan, Cristina Rodriguez, and Jose Martinez-Gonzalez. Lysyl oxidase expression in smooth muscle cells determines the level of intima calcification in hypercholesterolemia-induced atherosclerosis. *Clinica e investigacion en arteriosclerosis : publicacion oficial de la Sociedad Espanola de Arteriosclerosis*, 02 2024. Available from: https://pubmed.ncbi.nlm.nih.gov/38402026/, doi:10.1016/j.arteri.2024.01.003.

[5] Stéphane L. Benoit and Robert J. Maier. The nickel-chelator dimethylglyoxime inhibits human amyloid beta peptide in vitro aggregation. *Scientific Reports*, 11, 03 2021. Available from: https://www.nature.com/articles/s41598-021-86060-1?fromPaywallRec=false, doi:10.1038/s41598-021-86060-1.

[6] Sabine Bernegger, Cyrill Brunner, Matej VizoviUx0161[bad char vv=353]ek, Marko Fonovic, Gaetano Cuciniello, Flavia Giordano, Vesna Stanojlovic, Miroslaw Jarzab, Philip Simister, Stephan M. Feller, Gerhard Obermeyer, Gernot Posselt, Boris Turk, Chiara Cabrele, Gisbert Schneider, and Silja Wessler. A novel fret peptide assay reveals efficient helicobacter pylori htra inhibition through zinc and copper binding. *Scientific Reports*, 10, 06 2020. Available from: https://www.nature.com/articles/s41598-020-67578-2, doi:10.1038/s41598-020-67578-2.

[7] Elina Berntsson, Faraz Vosough, Teodor Svantesson, Jonathan Pansieri, Igor A. Iashchishyn, Lucija OstojiUx0107[bad char vv=263], Xiaolin Dong, Suman Paul, Jüri Jarvet, Per M. Roos, Andreas Barth, Ludmilla A. Morozova-Roche, Astrid Gräslund, and Sebastian S. Wärmländer. Residue-specific binding of ni(ii) ions influences the structure and aggregation of amyloid beta (aupbeta) peptides. *Scientific Reports*, 13, 02 2023. Available from: https://www.nature.com/articles/s41598-023-29901-5?fromPaywallRec=false, doi:10.1038/s41598-023-29901-5.

[8] Glenda M. Bishop and Stephen R. Robinson. The amyloid paradox: Amyloidupbetametal complexes can be neurotoxic and neuroprotective. *Brain Pathology*, 14, 2004. Available from: http://dx.doi.org/10.1111/j.1750-3639.2004.tb00089.x, doi:10.1111/j.1750-3639.2004.tb00089.x.

[9] Sharon A. Center, Keith P. Richter, David C. Twedt, Joseph J. Wakshlag, Penny J. Watson, and Cynthia R. L. Webster. Is it time to reconsider current guidelines for copper content in commercial dog foods? *Journal of the American Veterinary Medical Association*, 258, 02 2021. Available from: http://dx.doi.org/10.2460/javma.258.4.357, doi:10.2460/javma.258.4.357.

[10] R. D. Handy, M. M. Musonda, C. Phillips, and S. J. Falla. Mechanisms of gastrointestinal copper absorption in the african walking catfish: Copper dose-effects and a novel anion-dependent pathway in the intestine. *Journal of Experimental Biology*, 203, 08 2000. Available from: http://dx.doi.org/10.1242/jeb.203.15.2365, doi:10.1242/jeb.203.15.2365.

[11] Fang He, Cong Chang, Bowen Liu, Zhu Li, Hao Li, Na Cai, and Hong-Hui Wang. Copper (ii) ions activate ligand-independent receptor tyrosine kinase (rtk) signaling pathway. *BioMed Research International*, 05 2019. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6537018/, doi:10.1155/2019/4158415.

[12] James W. Hilton, Kai Kysenius, Jeffrey R. Liddell, Stephen W. Mercer, Bence Paul, Joseph S. Beckman, Catriona A. McLean, Anthony R. White, Paul S. Donnelly, Ashley I. Bush, Dominic J. Hare, Blaine R. Roberts, and Peter J. Crouch. Evidence for disrupted copper availability in human spinal cord supports cuii(atsm) as a treatment option for sporadic cases of als. *Scientific Reports*, 14, 03 2024. Available from: https://www.nature.com/articles/s41598-024-55832-w, doi:10.1038/s41598-024-55832-w.

[13] Seyyed Morteza Hoseini, Seyed Abbas Hosseini, and Mohammad Soudagar. Dietary tryptophan changes serum stress markers, enzyme activity, and ions concentration of wild common carp cyprinus carpio exposed to ambient copper. *Fish Physiology and Biochemistry*, 38, 2012. doi:10.1007/s10695-012-9629-x.

[14] Rui Jiang, Yang Sui, Jingru Hong, Manabu Niimi, Qiaojing Yan, Zhuheng Shi, and Jian Yao. The combined administration of vitamin c and copper induces a systemic oxidative stress and kidney injury. *Biomolecules*, 13, 2023. Available from: http://dx.doi.org/10.3390/biom13010143, doi:10.3390/biom13010143.

[15] Leslie M. Klevay. The contemporaneous epidemic of chronic, copper deficiency. *Journal of Nutritional Science*, 11, 2022. Available from: http://dx.doi.org/10.1017/jns.2022.83, doi:10.1017/jns.2022.83.

[16] Mark A. Lovell, Chengsong Xie, and William R. Markesbery. Protection against amyloid beta peptide toxicity by zinc. *Brain Research*, 823, 1999. Available from: http://dx.doi.org/10.1016/s0006-8993(99)01114-2, doi:10.1016/s0006-8993(99)01114-2.

[17] Matthew Mold, Larissa Ouro-Gnao, Beata M Wieckowski, and Christopher Exley. Copper prevents amyloid-upbeta1-42 from forming amyloid fibrils under near-physiological conditions in vitro. *Scientific Reports*, 3, 02 2013. Available from: https://www.nature.com/articles/srep01256, doi:10.1038/srep01256.

[18] V Moreaux, I Birlouez-Aragon, and C Ducauze. Copper chelation by tryptophan inhibits the copper-ascorbate oxidation of tryptophan. *Redox report : communications in free radical research*, pages 191–7, Jun 1996. Available from: https://pubmed.ncbi.nlm.nih.gov/27406076/, doi:10.1080/13510002.1996.11747048.

[19] R. F. Morgan and B. L. O'Dell. Effect of copper deficiency on the concentrations of catecholamines and related enzyme activities in the rat BRAIN[1]. *Journal of Neurochemistry*, 28, 1977. Available from: http://dx.doi.org/10.1111/j.1471-4159.1977.tb07728.x, doi:10.1111/j.1471-4159.1977.tb07728.x.

[20] Yasuhiro Nose and Dennis J Thiele. Mechanism and regulation of intestinal copper absorption. *Genes & Nutrition*, 5, 2010. Available from: http://dx.doi.org/10.1007/s12263-010-0202-x, doi:10.1007/s12263-010-0202-x.

[21] Michael Okafor, Paulina Gonzalez, Pascale Ronot, Islah El Masoudi, Anne Boos, Stéphane Ory, Sylvette Chasserot-Golaz, Stéphane Gasman, Laurent Raibaut, Christelle Hureau, Nicolas Vitale, and Peter Faller. Development of cu(ii)-specific peptide shuttles capable of preventing cu-amyloid beta toxicity and importing bioavailable cu into cells. *Chem. Sci.*, 13:11829–11840, 2022. Available from: http://dx.doi.org/10.1039/D2SC02593K, doi:10.1039/D2SC02593K.

[22] Sara Raia, Antonio Conti, Alan Zanardi, Barbara Ferrini, Giulia Maria Scotti, Enrica Gilberti, Giuseppe De Palma, Samuel David, and Massimo Alessio. Ceruloplasmin-deficient mice show dysregulation of lipid metabolism in liver and adipose tissue reduced by a protein replacement. *International Journal of Molecular Sciences*, 24, 2023. Available from: http://dx.doi.org/10.3390/ijms24021150, doi:10.3390/ijms24021150.

[23] L I Smith-Mungo and H M Kagan. Lysyl oxidase: properties, regulation and multiple functions in biology. *Matrix biology : journal of the International Society for Matrix Biology*, pages 387–98, Feb 1998. Available from: https://pubmed.ncbi.nlm.nih.gov/9524359/, doi:10.1016/s0945-053x(98)90012-9.

[24] Shiliang Tian, Stephen M. Jones, and Edward I. Solomon. Role of a tyrosine radical in human ceruloplasmin catalysis. *ACS Central Science*, 6, 10 2020. Available from: http://dx.doi.org/10.1021/acscentsci.0c00953, doi:10.1021/acscentsci.0c00953.

[25] Birgitte Villadsen, Camilla Thygesen, Manuela Grebing, Stefan J Kempf, Marie B Sandberg, Pia Jensen, Stefanie H Kolstrup, Helle H Nielsen, Martin R Larsen, and Bente Finsen. Ceruloplasmin-deficient mice show changes in ptm profiles of proteins involved in messenger rna processing and neuronal projections and synaptic processes. *Journal of neurochemistry*, pages 76–94, 01 2023. Available from: https://pubmed.ncbi.nlm.nih.gov/36583241/, doi:10.1111/jnc.15754.

[26] Min Wu, Feifei Han, Weisha Gong, Lifang Feng, and Jianzhong Han. The effect of copper from water and food: changes of serum nonceruloplasmin copper and brain's amyloid-beta in mice. *Food & Function*, 7, 2016. Available from: http://dx.doi.org/10.1039/c6fo00809g, doi:10.1039/c6fo00809g.

[27] Ben-Shan Yang, Hideki Noda, and Norihisa Kato. Elevated intestinal absorption of copper in rats fed on a excessive tyrosine diet. *Bioscience, Biotechnology, and Biochemistry*, 57. Available from: http://dx.doi.org/10.1271/bbb.57.2179, doi:10.1271/bbb.57.2179.

[28] Jing Yang, Xueli Zhang, Yiying Zhu, Emily Lenczowski, Yanli Tian, Jian Yang, Can Zhang, Markus Hardt, Chunhua Qiao, Rudolph E. Tanzi, Anna Moore, Hui Ye, and Chongzhao Ran. The double-edged role of copper in the fate of amyloid beta in the presence of anti-oxidants. *Chem. Sci.*, 8:6155–6164, 2017. Available from: http://dx.doi.org/10.1039/C7SC01787A, doi:10.1039/C7SC01787A.

[29] Lei Yu, Iris W. Liou, Scott W. Biggins, Matthew Yeh, Florencia Jalikis, LingtakNeander Chan, and Jason Burkhead. Copper deficiency in liver diseases: A case series and pathophysiological considerations. *Hepatology Communications*, 3, 2019. Available from: http://dx.doi.org/10.1002/hep4.1393, doi:10.1002/hep4.1393.

Acknowledgments

1. Pubmed eutils facilities and the basic research it provides.

2. Free software including Linux, R, LaTex etc.

3. Thanks everyone who contributed incidental support.

Appendix A: Statement of Conflicts

No specific funding was used in this effort and there are no relationships with others that could create a conflict of interest. I would like to develop these ideas further and have obvious bias towards making them appear successful. Barbara Cade, the dog owner, has worked in the pet food industry but this does not likely create a conflict. We have no interest in the makers of any of the products named in this work.

Appendix B: About the Authors and Facility

This work was performed at a dog rescue run by Barbara Cade and housed in rural Georgia. The author of this report ,Mike Marchywka, has a background in electrical engineering and has done extensive research using free online literature sources. I hope to find additional people interested in critically examining the results and verify that they can be reproduced effectively to treat other dogs.

Appendix C: Background Diet Sumnary

Name	2023-10 Oct	2023-11 Nov	2023-12 Dec	2024-01 Jan	2024-02 Feb
FOOD					
KCl(tsp kcl)	0.045 ;0.031;23/23	0.047 ;0.031;30/30	0.085 ;0.062;24/24	0.094 ;0.062;31/31	0.093 ;0.062;29/29
KibbleAmJrLaPo	0.036 ;0.037;22/23	0.065 ;0.075;30/30	0.07 ;0.075;23/24	0.075 ;0.075;31/31	0.071 ;0.098;29/29
KibbleLogic	0.024 ;0.025;22/23	0.043 ;0.05;30/30	0.047 ;0.05;23/24	0.05 ;0.05;31/31	0.047 ;0.065;29/29
b10ngnc[(c)]	0.019 ;0.25;1/23	0.11 ;0.25;9/30	0.047 ;0.25;3/24	0.11 ;1;7/31	0.067 ;0.25;5/29
b15ngnc[(c)]		0.044 ;0.25;5/30	0.021 ;0.25;1/24	0.06 ;0.25;4/31	
b20ngnc[(c)]	0.18 ;0.25;14/23	0.13 ;0.25;10/30	0.25 ;0.25;14/24	0.14 ;0.25;11/31	0.28 ;0.25;19/29
b25ngnc	0.11 ;0.25;9/23	0.067 ;0.25;6/30	0.026 ;0.25;2/24	0.02 ;0.25;2/31	0.039 ;0.25;4/29
b7ngnc[(c)]	0.1 ;0.25;8/23	0.14 ;0.25;11/30	0.14 ;0.25;9/24	0.2 ;0.25;17/31	0.11 ;0.25;7/29
blackberry		0.058 ;0.25;5/30	0.3 ;0.25;20/24		
blueberry	2.4 ;3.8;23/23	2.4 ;2.2;30/30	1.9 ;2;20/24	0.71 ;1.5;13/31	1.2 ;1.5;29/29
carrot	0.35 ;0.25;23/23	0.36 ;0.25;30/30	0.36 ;0.25;24/24	0.38 ;0.25;31/31	0.38 ;0.25;29/29
cbbrothbs					0.022 ;0.25;3/29
cbbroth	0.16 ;0.25;10/23	0.071 ;0.25;6/30		0.21 ;0.25;15/31	0.25 ;0.25;16/29
citrate(tsp citrate)	0.045 ;0.031;23/23	0.047 ;0.031;30/30	0.048 ;0.062;24/24	0.058 ;0.062;31/31	0.092 ;0.062;29/29
ctbrothbs	0.082 ;0.25;5/23	0.4 ;0.25;25/30	0.48 ;0.25;24/24	0.29 ;0.25;19/31	0.22 ;0.25;14/29
ctbroth	0.17 ;0.25;11/23			0.032 ;1;1/31	
eggo3	0.065 ;0.12;23/23	0.062 ;0.062;30/30	0.055 ;0.12;20/24	0.062 ;0.062;31/31	0.062 ;0.062;29/29
eggo			0.01 ;0.062;4/24		
eggshell	0.13 ;0.25;23/23	0.12 ;0.12;30/30	0.11 ;0.25;21/24		
garlic	0.022 ;0.25;2/23	0.22 ;0.25;26/30	0.083 ;0.25;8/24	1.2 ;1;27/31	0.99 ;1;22/29
marrow	0.19 ;0.25;12/23	0.37 ;0.25;30/30	0.083 ;0.25;6/24		0.078 ;0.25;7/29
oliveoil(tsp)	0.035 ;0.12;8/23	0.014 ;0.12;4/30			0.039 ;0.12;9/29
pepper	0.36 ;0.25;23/23	0.38 ;0.25;30/30	0.35 ;0.25;24/24	0.36 ;0.25;31/31	0.38 ;0.25;29/29
pineapple			0.021 ;0.25;2/24		
raspberry	0.32 ;0.25;23/23	0.28 ;0.25;24/30			
salmon		0.043 ;0.25;8/30		0.025 ;0.25;3/31	
shrimp(grams)		3 ;38;5/30	4.9 ;16;9/24	2.8 ;16;8/31	1.8 ;13;4/29
spinach		0.15 ;0.25;12/30	0.36 ;0.25;24/24	0.38 ;0.25;31/31	0.36 ;0.25;28/29
sunflowerseed	0.23 ;0.25;21/23	0.25 ;0.25;30/30	0.21 ;0.25;20/24		0.034 ;0.25;4/29
tomato	0.36 ;0.25;23/23	0.23 ;0.25;19/30	0.18 ;0.25;12/24	0.17 ;0.25;15/31	0.19 ;0.25;29/29
tuna(oz)					
turkey	0.34 ;0.25;23/23	0.37 ;0.25;30/30	0.35 ;0.25;24/24	0.36 ;0.25;31/31	0.36 ;0.25;29/29
vinegar(tsp)	0.09 ;0.062;23/23	0.094 ;0.062;30/30	0.09 ;0.062;24/24	0.068 ;0.062;24/31	2.16e-03 ;0.062;1/29
VITAMIN					
B-1(mg)	4.09e-03 ;0.012;15/23	5.87e-03 ;0.0059;30/30	6.12e-03 ;0.012;24/24	5.69e-03 ;0.0059;30/31	5.87e-03 ;0.0059;29/29
B-12(mg)	0.033 ;0.25;5/23	0.029 ;0.25;5/30	0.047 ;0.25;6/24	0.024 ;0.25;5/31	0.034 ;0.12;8/29
B-2(mg)	5.7 ;16;15/23	7.9 ;8.1;29/30	8.1 ;16;23/24	21 ;32;30/31	43 ;65;29/29
B-2			1.63e-04 ;0.0039;1/24		
B-3(mg)	8.3 ;24;15/23	12 ;12;30/30	12 ;24;23/24	31 ;48;30/31	60 ;48;29/29
B-6(mg)	6 ;12;11/23	12 ;12;28/30	11 ;12;21/24	8.9 ;12;29/31	5.8 ;12;26/29
B-multi(count)	0.022 ;0.062;8/23			2.02e-03 ;0.062;1/31	
Cu(mg)	0.11 ;0.25;10/23	0.76 ;2;19/30	0.86 ;2;19/24	1.9 ;2;30/31	1.9 ;2;28/29
D-3(iu)	91 ;300;7/23	60 ;300;6/30	62 ;300;5/24	58 ;300;6/31	52 ;300;5/29
Iodine(mg)[(a)]	2.3 ;12;8/23	0.1 ;0.78;4/30	0.065 ;0.78;2/24	0.1 ;0.78;4/31	0.13 ;0.78;5/29
K1(mg)	0.38 ;1.2;7/23	0.92 ;1.2;22/30	1.1 ;1.2;22/24	1.1 ;1.2;27/31	1.2 ;1.2;28/29
K2(mg)	1 ;1.6;15/23	0.3 ;1.9;7/30	0.47 ;3.8;3/24	0.91 ;3.8;8/31	0.81 ;3.8;8/29
K2MK7(mg)	1.63e-03 ;0.025;2/23	5.83e-03 ;0.025;7/30	2.08e-03 ;0.025;2/24		
MgCitrate(mg)	96 ;200;21/23	100 ;100;30/30	92 ;100;22/24	31 ;100;10/31	76 ;100;22/29
Mn(mg)			0.042 ;1;1/24	0.21 ;0.62;12/31	0.12 ;1;6/29

TABLE II: Part 1 of 2. Events Summary for Happy from 2023-10-01 to 2024-04-10A summary of most dietary components and events for selected months between 2023-10-01and 2024-04-10. Format is average daily amount ;maximum; days given/ days in interval . Units are arbitrary except where noted. Any superscripts are defined as follows: **a)** SMVT substrate. Biotin, Pantothenate, Lipoic Acid, and Iodine known to compete..**c)** hamburger with varying fat percentages- 7,10,15,20, etc. ..

Name	2023-10 Oct	2023-11 Nov	2023-12 Dec	2024-01 Jan	2024-02 Feb
Se(mcg)		0.42 ;12;1/30			0.43 ;12;1/29
Zn(mg zn)	1.3 ;5.9;9/23	1.1 ;5.9;10/30	0.73 ;2.9;6/24	0.47 ;2.9;5/31	0.61 ;5.9;5/29
arginine(mg)	68 ;175;9/23	82 ;350;10/30	51 ;175;7/24	79 ;350;12/31	275 ;350;15/29
biotin(mg)[a]	2.4 ;5;11/23	4.3 ;5;26/30	4 ;5;19/24	3.5 ;5;22/31	3.6 ;5;21/29
folate(mg)	0.022 ;0.12;5/23	0.019 ;0.12;6/30	0.018 ;0.12;4/24	0.016 ;0.12;5/31	0.011 ;0.12;3/29
histidine(tsp)					2.42e-03 ;0.016;7/29
histidinehcl(mg)	3.7 ;85;1/23	1.4 ;42;1/30	1.6 ;38;1/24		
iron(mg)		1 ;4;8/30	1.8 ;4;11/24	1.3 ;4;10/31	2.2 ;4;18/29
isoleucine(mg)	30 ;200;5/23	47 ;200;8/30	17 ;200;2/24	48 ;200;9/31	45 ;200;8/29
lecithin(mg)	215 ;225;22/23	225 ;225;30/30	281 ;225;22/24	330 ;225;31/31	338 ;225;29/29
lecithin(tsp)	0.046 ;0.062;22/23	0.036 ;0.042;30/30	0.012 ;0.062;8/24		
leucine(mg)	74 ;162;20/23	76 ;81;28/30	85 ;162;24/24	66 ;81;25/31	67 ;81;24/29
leucine					
lipoicacid(mg)[a]	3.1 ;25;5/23	7.6 ;25;16/30	24 ;25;21/24	18 ;25;22/31	31 ;25;28/29
lysinehcl(mg)	170 ;162;23/23	203 ;162;30/30	186 ;162;24/24	218 ;325;30/31	235 ;325;14/29
methionine(mg)	57 ;62;21/23	46 ;62;22/30	38 ;125;20/24	4 ;62;3/31	9.7 ;62;7/29
pantothenate(mg)[a]	22 ;78;12/23	20 ;39;15/30	21 ;39;13/24	32 ;39;25/31	30 ;39;22/29
phenylalanine(mg)	38 ;125;7/23	23 ;125;6/30	18 ;125;4/24	8.1 ;125;2/31	15 ;125;4/29
proline(mg)	143 ;100;23/23	35 ;100;7/30			
taurine(mg)	323 ;225;23/23	338 ;225;30/30	323 ;225;24/24	345 ;225;31/31	338 ;225;29/29
threonine(mg)	95 ;162;23/23	374 ;325;30/30	467 ;325;24/24	488 ;325;31/31	487 ;325;29/29
tryptophan(mg)	52 ;150;14/23	40 ;150;14/30	25 ;150;6/24	17 ;150;6/31	24 ;75;10/29
tyrosine(mg)	17 ;100;4/23	6.7 ;100;2/30	12 ;100;3/24	19 ;100;6/31	19 ;100;6/29
valine(mg)	165 ;200;19/23	160 ;200;24/30	133 ;200;16/24	135 ;200;21/31	159 ;200;23/29
vitamina(iu)	489 ;2250;5/23	600 ;2250;8/30	656 ;4500;6/24	435 ;2250;6/31	466 ;2250;6/29
vitaminc(tsp)	3.23e-03 ;0.0078;11/23	3.39e-03 ;0.0078;13/30	8.14e-04 ;0.0039;5/24	5.04e-04 ;0.0039;4/31	5.39e-04 ;0.0078;2/29
vitamine(iu)	8.2 ;38;5/23	8.8 ;38;7/30	9.4 ;38;6/24	7.3 ;38;6/31	6.5 ;38;5/29
MEDICINE					
SnAg				1.1 ;1;13/31	0.66 ;1;12/29
sodiumbenzoate(tsp)	0.011 ;0.016;12/23	8.85e-03 ;0.016;12/30	0.012 ;0.031;15/24	0.017 ;0.016;25/31	0.018 ;0.016;24/29
sodiumbenzoate				5.04e-04 ;0.016;1/31	
wormer					
RESULT					
weight(lbs)			0.63 ;15;1/24		1.1 ;16;2/29
sorbitol(tsp)	0.045 ;0.031;23/23	0.047 ;0.031;30/30	0.045 ;0.031;24/24	0.046 ;0.062;31/31	0.047 ;0.031;29/29
sorbitol					

TABLE III: Part 2 of 2. Events Summary for Happy from 2023-10-01 to 2024-04-10A summary of most dietary components and events for selected months between 2023-10-01and 2024-04-10. Format is average daily amount ;maximum; days given/ days in interval . Units are arbitrary except where noted. Any superscripts are defined as follows: **a)** SMVT substrate. Biotin, Pantothenate, Lipoic Acid, and Iodine known to compete..**c)** hamburger with varying fat percentages- 7,10,15,20, etc. ..

Name	2024-03 Mar	2024-04 Apr
FOOD		
KCl(tsp kcl)	0.084 ;0.062;20/20	0.087 ;0.062;10/10
KibbleAmJrLaPo	0.034 ;0.037;18/20	0.034 ;0.037;9/10
KibbleLogic	0.023 ;0.025;18/20	0.022 ;0.025;9/10
b10ngnc[(c)]	0.069 ;0.25;4/20	0.056 ;0.25;2/10
b15ngnc[(c)]	0.022 ;0.25;2/20	
b20ngnc[(c)]	0.33 ;0.25;17/20	0.19 ;0.25;6/10
b25ngnc		
b7ngnc[(c)]		0.16 ;0.25;4/10
blackberry		
blueberry	0.75 ;0.75;20/20	0.9 ;1;10/10
carrot	0.35 ;0.25;20/20	0.35 ;0.25;10/10
cbbrothbs		
cbbroth	0.1 ;0.25;5/20	
citrate(tsp citrate)	0.081 ;0.062;20/20	0.086 ;0.062;10/10
ctbrothbs	0.33 ;0.25;17/20	0.41 ;0.25;10/10
ctbroth		
eggo3	0.025 ;0.062;8/20	0.062 ;0.062;10/10
eggo	0.037 ;0.062;12/20	
eggshell		
garlic	1.4 ;1;18/20	1.1 ;1;10/10
marrow		
oliveoil(tsp)	0.042 ;0.12;6/20	
pepper	0.36 ;0.25;20/20	0.35 ;0.25;10/10
pineapple		
raspberry		
salmon		
shrimp(grams)		
spinach	0.35 ;0.25;20/20	0.35 ;0.25;10/10
sunflowerseed	0.037 ;0.25;3/20	0.2 ;0.25;8/10
tomato	0.12 ;0.12;20/20	0.12 ;0.12;10/10
tuna(oz)	0.062 ;0.25;5/20	0.075 ;0.25;3/10
turkey	0.33 ;0.25;20/20	0.35 ;0.25;10/10
vinegar(tsp)	6.25e-03 ;0.062;3/20	3.13e-03 ;0.031;1/10
VITAMIN		
B-1(mg)	5.58e-03 ;0.012;18/20	5.87e-03 ;0.0059;10/10
B-12(mg)	0.05 ;0.25;6/20	0.025 ;0.12;2/10
B-2(mg)	47 ;16;20/20	37 ;16;10/10
B-2		
B-3(mg)	69 ;24;20/20	55 ;24;10/10
B-6(mg)	4.7 ;6.2;15/20	3.8 ;6.2;6/10
B-multi(count)	3.13e-03 ;0.062;1/20	
Cu(mg)	2.2 ;2;20/20	2.6 ;2;10/10
D-3(iu)	62 ;350;4/20	60 ;300;2/10
Iodine(mg)[(a)]	0.19 ;0.78;5/20	0.16 ;0.78;2/10
K1(mg)	1.1 ;1.2;17/20	1.2 ;1.2;10/10
K2(mg)	0.75 ;3.1;6/20	
K2MK7(mg)		
MgCitrate(mg)	88 ;100;18/20	90 ;100;9/10
Mn(mg)	0.14 ;1.2;3/20	

TABLE IV: Part 1 of 2. Events Summary for Happy from 2023-10-01 to 2024-04-10A summary of most dietary components and events for selected months between 2023-10-01and 2024-04-10. Format is average daily amount ;maximum; days given/ days in interval . Units are arbitrary except where noted. Any superscripts are defined as follows: **a)** SMVT substrate. Biotin, Pantothenate, Lipoic Acid, and Iodine known to compete..**c)** hamburger with varying fat percentages- 7,10,15,20, etc. ..

Name	2024-03 Mar	2024-04 Apr
Se(mcg)		
Zn(mg zn)	0.73 ;5.9;3/20	0.59 ;5.9;1/10
arginine(mg)	245 ;350;10/20	228 ;350;5/10
biotin(mg)[a]	3.4 ;5;14/20	3.5 ;5;7/10
folate(mg)	0.013 ;0.12;3/20	
histidine(tsp)	0.021 ;0.016;19/20	0.02 ;0.031;8/10
histidinehcl(mg)		
iron(mg)	2.4 ;5.3;17/20	5.3 ;5.3;8/10
isoleucine(mg)	25 ;200;3/20	20 ;200;1/10
lecithin(mg)	315 ;225;20/20	315 ;225;10/10
lecithin(tsp)		
leucine(mg)	73 ;81;18/20	81 ;81;10/10
leucine		
lipoicacid(mg)[a]	16 ;25;12/20	20 ;25;8/10
lysinehcl(mg)	228 ;325;10/20	244 ;325;5/10
methionine(mg)	12 ;62;8/20	25 ;62;4/10
pantothenate(mg)[a]	33 ;39;17/20	35 ;39;9/10
phenylalanine(mg)	28 ;125;5/20	12 ;125;1/10
proline(mg)		
taurine(mg)	315 ;225;20/20	315 ;225;10/10
threonine(mg)	455 ;325;20/20	422 ;325;10/10
tryptophan(mg)	26 ;75;7/20	22 ;75;4/10
tyrosine(mg)	22 ;100;6/20	30 ;100;3/10
valine(mg)	160 ;200;16/20	160 ;200;8/10
vitamina(iu)	506 ;2250;5/20	675 ;2250;3/10
vitaminc(tsp)	8.79e-04 ;0.0039;5/20	1.95e-03 ;0.0039;5/10
vitamine(iu)	7.5 ;38;4/20	7.5 ;38;2/10
MEDICINE		
SnAg		
sodiumbenzoate(tsp)	0.015 ;0.016;14/20	7.81e-04 ;0.0078;1/10
sodiumbenzoate	7.81e-04 ;0.016;1/20	
wormer	0.075 ;1.5;1/20	
RESULT		
weight(lbs)		
sorbitol(tsp)	0.043 ;0.031;20/20	0.039 ;0.031;9/10
sorbitol	7.81e-04 ;0.016;1/20	1.56e-03 ;0.016;1/10

TABLE V: Part 2 of 2. Events Summary for Happy from 2023-10-01 to 2024-04-10A summary of most dietary components and events for selected months between 2023-10-01and 2024-04-10. Format is average daily amount ;maximum; days given/ days in interval . Units are arbitrary except where noted. Any superscripts are defined as follows: **a)** SMVT substrate. Biotin, Pantothenate, Lipoic Acid, and Iodine known to compete..**c)** hamburger with varying fat percentages- 7,10,15,20, etc. ..

Appendix D: Symbols, Abbreviations and Colloquialisms

TERM definition and meaning

Appendix E: General caveats and disclaimer

This document was created in the hope it will be interesting to someone including me by providing information about some topic that may include personal experience or a literature review or description of a speculative theory or idea. There is no assurance that the content of this work will be useful for any paricular purpose.

All statements in this document were true to the best of my knowledge at the time they were made and every attempt is made to assure they are not misleading or confusing. However, information provided by others and observations that can be manipulated by unknown causes ("gaslighting") may be misleading. Any use of this information should

be preceded by validation including replication where feasible. Errors may enter into the final work at every step from conception and research to final editing.

Documents labelled "NOTES" or "not public" contain substantial informal or speculative content that may be terse and poorly edited or even sarcastic or profane. Documents labelled as "public" have generally been edited to be more coherent but probably have not been reviewed or proof read.

Generally non-public documents are labelled as such to avoid confusion and embarassment and should be read with that understanding.

Appendix F: Citing this as a tech report or white paper

Note: This is mostly manually entered and not assured to be error free.
This is tech report MJM-2024-010.

Version	Date	Comments
0.01	2024-04-12	Create from empty.tex template
-	April 15, 2024	version 0.00 MJM-2024-010
1.0	20xx-xx-xx	First revision for distribution

Released versions,
build script needs to include empty releases.tex

Version	Date	URL

@techreport{marchywka-MJM-2024-010,
filename ={copper} ,
run-date ={April 15, 2024} ,
title ={Utility of Copper Supplementation in Dogs} ,
author ={Mike J Marchywka } ,
type ={techreport} ,
name ={marchywka-MJM-2024-010} ,
number ={MJM-2024-010} ,
version ={0.00} ,
institution ={not institutionalized, independent } ,
address ={ 44 Crosscreek Trail Jasper GA 30143 USA} ,
date ={April 15, 2024} ,
startdate ={2024-04-12} ,
day ={15} ,
month ={4} ,
year ={2024} ,
author1email ={marchywka@hotmail.com} ,
contact ={marchywka@hotmail.com} ,
author1id ={orcid.org/0000-0001-9237-455X} ,
pages ={ 16}
}

Supporting files. Note that some dates,sizes, and md5's will change as this is rebuilt.

This really needs to include the data analysis code but right now it is auto generated picking up things from prior build in many cases

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11754 Apr 15 18:07 copper.aux ec324c3b20d6f0a36185fed942fdc5c4
14718 Apr 15 18:07 copper.bbl 8531c1dc19450e5041a90762c10c7f91
287940 Apr 15 18:07 copper.bib f94b341a1cd165ccdd04363bcdd76bf1
1431 Apr 15 18:07 copper.blg 669f017766ba8a5607f40fd9f2f997db
0 Apr 15 18:08 copper.bundle_checksums d41d8cd98f00b204e9800998ecf8427e
31841 Apr 15 18:07 copper.fls acc8b0b56cc4b3f3f66af6e13b18ea2e
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