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. Actually looking at the old, unpublished work, "casesum", that includes Little Man, most of the text is still useful today and has been copied and pasted without attribution (since it was a never-published work I authored).
ToDo : Known problems: no refs yet, diettables have unit problems for recent noun additions
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Utility of Copper Supplementation in Dogs

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(Dated: April 20, 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] [3] [18]. 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.

Emerging mechanisms such as extracellular veiscles [8] suggest that uncharacterized mechanisms of metal homeostasis exist.

Combined copper and zinc deficiency was observed to reduce response to covid-19 mRNA vaccines with only minimal copper deficiency [20] The present work considers copper status in light of other nutrients notably amino acids such as Trp and Tyr and with zinc being a possible competitor.

In humans lysyl oxidase is sometimes discussed as a drug target as its quantity seems to increase in pathological situations. This may suggest that additional copper would not likely help.

Regulation at transcriptional and translation and post-translational levels is confusing. For example, it has been described in 1998 as [72],

> While enzyme activity levels were decreased in the skin of weanling rats fed a copper deficient diet, the basal, steady-state levels of LO specific mRNA or immunodetectable LO protein were not significantly reduced (Rucker et al., 1996). These results suggest both that the biosynthesis of the enzyme is not markedly affected by copper deficient diets and that the increasing percentage of copper-deficient, catalytically compromised enzyme molecules presumed to accumulate during this dietary treatment remain relatively stable. Notably, copper-deficient diets significantly reduced cardiac LO activity and induced cardiac pathology in male but not in female rats (Werman et al., 1995).

or more to the point from the same year, [68]

> Although nutritional copper status does not influence the accumulation of lysyl oxidase as protein or lysyl oxidase steady state messenger RNA concentrations, the direct influence of dietary copper on the functional activity of lysyl oxidase is clear. The hypothesis is based on the possibility that copper efflux and lysyl oxidase secretion from cells may share a common pathway. The change in functional activity is most likely the result of posttranslational processing of lysyl oxidase.

It has been observed to upregulate in the injured newborn lung [96] sugesting increased levels may be a response to an insult rather than a cause of damage.

In 2001, it was observed that bovine lyxyl oxidase had enzymatic activity without copper but was less stable [74] although details on reactions catalyzed could not have been fully explored.

However, metallization may not be complete and feedback systems may increase expression to achieve an activity level. Note too that "crosslinking" is a variable modification and physiological as well as pathological crosslinking can occur. While "quantity versus quality" will be the subject of another work, its important to remember that increased expression of lysyl oxidase genes and more patholoical crosslinking could occur in the absence of sufficient copper. Mature functional lysyl oxidase contains an unusual lysine tyrosylquinone (LTQ) which itself is formed in a copper dependent process [84]. Depence on multiple tyrosines or tryptophans can increase the odss of generating dysfunctional enzymes which may be inactive or perform unintended functions when these amino acids are limited. This theme of amino acid starvation also appears in concerns about ceruloplasmin and more generally with aging.

Lysyl oxidase expression has been associated with degenerative mitral valve disease in humans[62].

Over the same time however, concerns about diet linked DCM in dogs have emerged. A genetic link is also being investgated and a recent GWAS pointed to two genes, RNF207 and PRKAA2 as risk factors [53] but did not mention copper. However, RNF207 may mediate degradation of ATP7A [94] while PRKAA2 comes up in cuproptosis [45].

Its possible the two concerns are related in more copper is being absorbed as less is transported to target organs such as the heart. This connection between dysregulated copper metabolism and heart disease has been considered recently in humans [46] in a work that reviews many important aspects of copper metabolism. .

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.

The original motivation for copper was based on notions similar to the table below which reflects current thinking based on results presented here.

Location	site	Effect	time scale
Heart	mitochondria	energy production	maybe days
Heart	mitochondria	remodelling	weeks or months
Heart valves	lysyl oxidase	crosslinking [62]	weeks or months
Trachea	lysyl oxidase	proper crosslinking	months
Macrophage		infection	days
ceruloplasmin		distribution	days
foreign ligand	variable	variable	

TABLE I: Some expected benefits of copper that guided the original interest and observations although sometimes the goals were lost in the details of the diet and outcomes.

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.

We tried to set a hard upper limit of 3mg/kg body weight of supplemental copper per day based on some quoted NOAEL's but the original source from 1972 discussed in [22].

Dog	Dates	Condition	weight(lbs)	Cu(mg/day)	Outcomes
Cookie	21-09-10 22-01-21	Resp infection/azithromycin	13.5	2	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	2	cough gone
Happy	24-03-26	coughs	15.2 - 15.5	2	rare coughing
Brownie	21-01-12 23-02-22		49 - 64	1 variable	pts due to cancer
Brownie	21-01-12 21-02-14	pregnant , fibroids		1.5-2.5	uneventful
puppies	21-03-23 21-06-09	cough	104	4.5	cleared
Trixie	23-12-16 24-04-10	resp infection/Clavamox	37.6 - 44.6	5	cleared
Rocky	22-02-05 24-04-10		4.4 - 8.3	1	subjective better
Hershey	17-04-22 19-08-27	multiple	8.2 - 9	.2-.6	heart failure
Hershey	17-04-22 19-08-27	multiple	8.2 - 9	2	some improvements

TABLE II: List of dogs most effected by copper supplementation. Cu amount given is largest thought to be therapeutic and in case of Herhsy amount near death in (). 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.

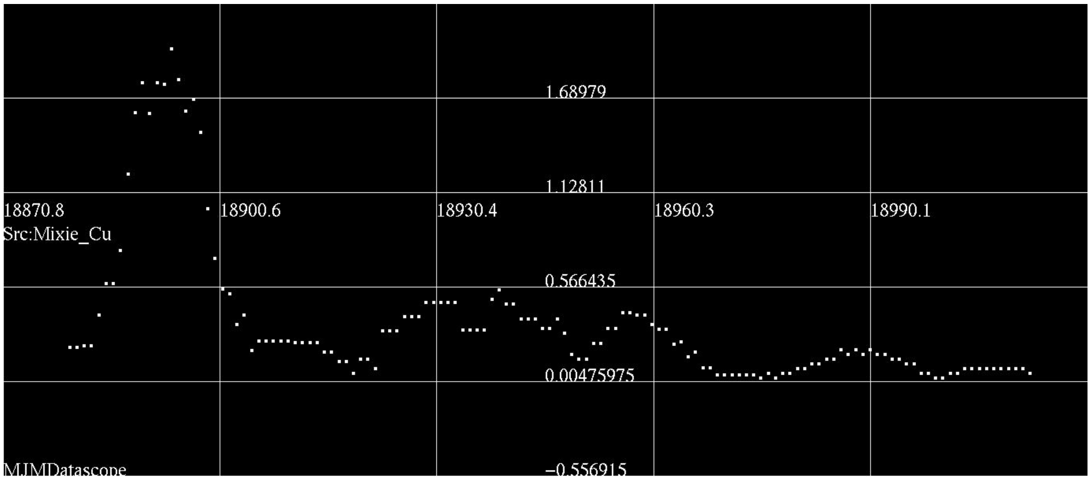

FIG. 1: Mixie 10 day trailing average copper (white) .

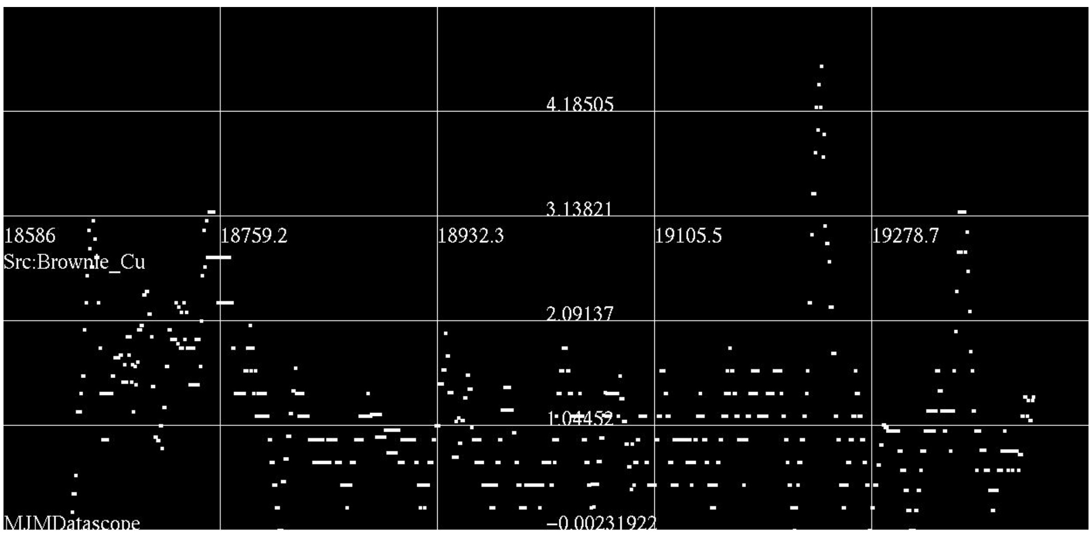

FIG. 2: Brownie 10 day trailing average copper (white) .

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. As copper was increased due to widespread coughing after Trixie's arrival, her cough was noted to decrease.

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.

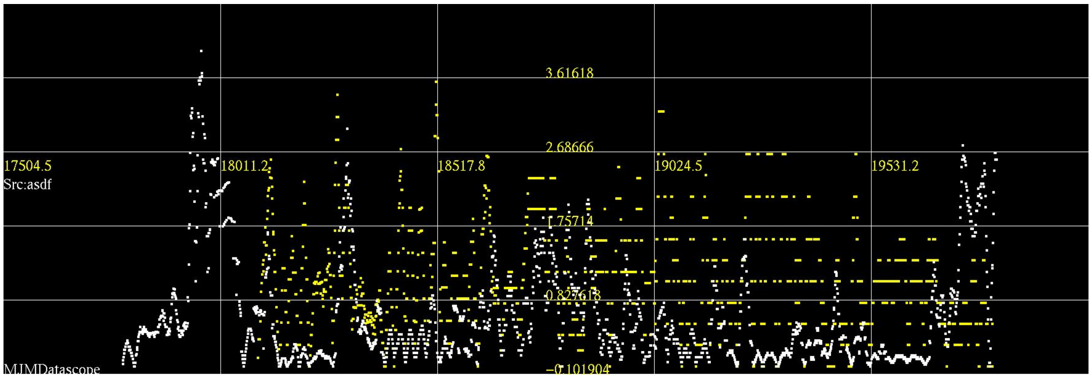

FIG. 3: Copper(white) and Zinc(yellow) dosing per day averaged over prior 10 day period as dosing was highly variable due to rotations of various nutrients. 18046 is 2019-05-30 when the cough was first noted to be gone for a few weeks. 19823 is 2024-04-10 the last date for which data was obtained. The 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.

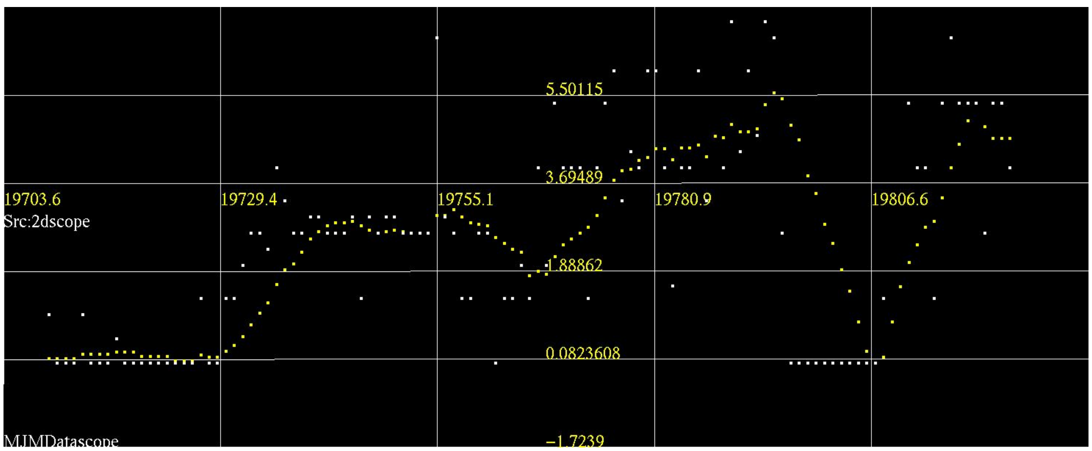

FIG. 4: Trixie copper consumption since arrival. Daily amounts (white)) and trailing 10 day average(yellow). Copper started to be significant around day 19730 in response to coughing. Day 19807 marked the end of the copper fast as well as the end of Clavamox which was prescribed due to worsening when copper stopped days earlier.

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.

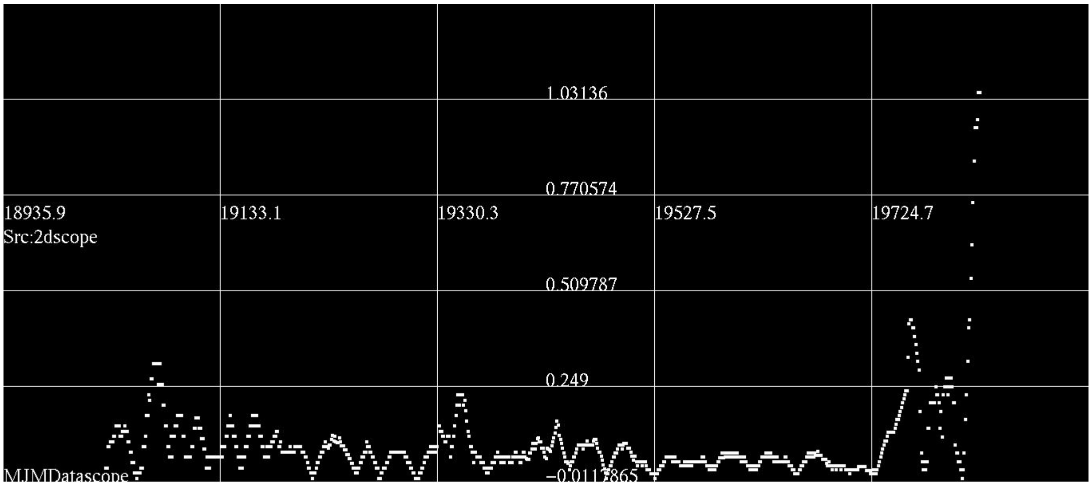

FIG. 5: Rocky 10 day trailing average copper (white) .

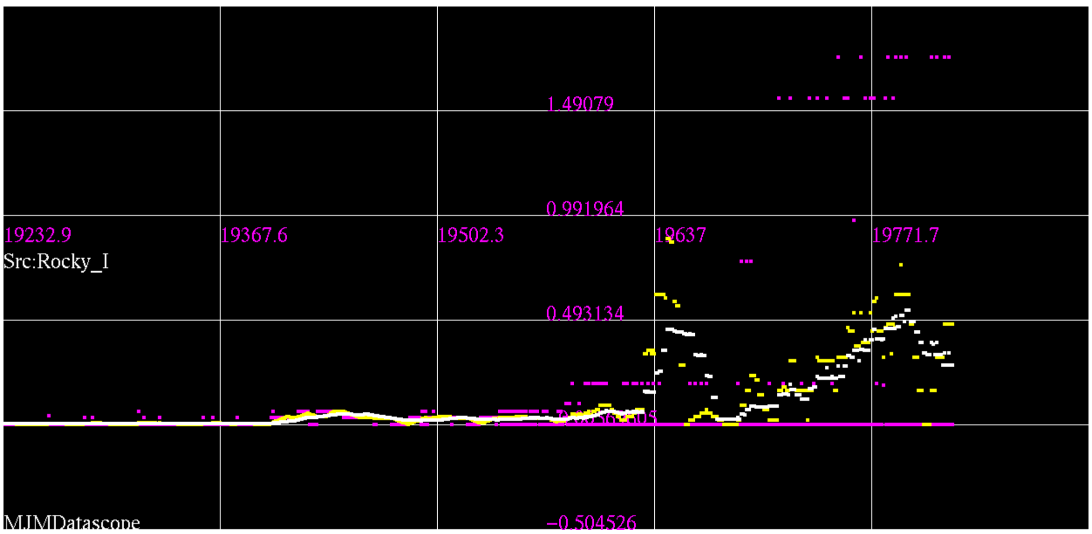

FIG. 6: Rocky iodine intake daily and with 10 and 30 day trailing averages. Patterns are difficult to discern with the pulsed dosing.

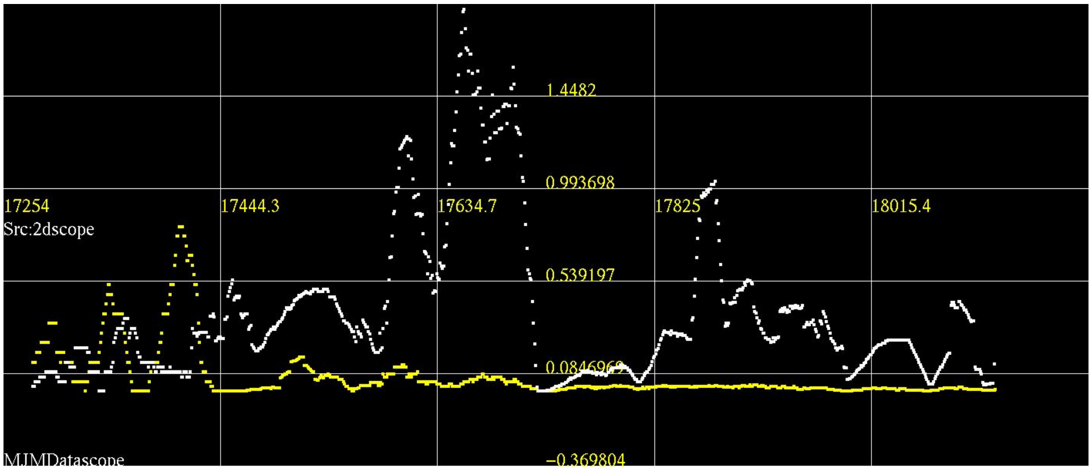

FIG. 7: Herhsey 10 day trailing average copper (white) and iodine (yellow).

2.6. Hershey

Date	Day number	Comment
2017-09-25		developed skin problem, vet prescribed clavamox and miconazole chlorhexidine shampoo Malaseb
2017-10-13		blotches mostly gone yesterday Barb still notes some
2017-11-01		stumbled down steps did not come up until after PMSNACK restart lipoicacid
2017-11-13		struggles up deck steps but finally made it
2017-12-12	17512	seems to be coughing a lot
2018-03-06	17596	seems to cough less, continue copper
2018-04-19	17640	came up steps on own again cadence sounded good
2018-04-20		fur seems thicker except for small area on back behind neck. Still coughing though
2018-04-28	17649	appears alert more flexible and good up steps while still planning although he did stumble the other day
2018-04-29	17650	seems ok on steps, hair filling in.
2018-05-29	17680	not coughing much and energetic but refused to eat and diarrhea. Ate small amount indicated around 830AM. He seems ok at noon not coughing much but subdued.
2018-07-02	17714	lighter and not coughing except when really agitated. Made it up steps good. Could be just weight although not that much lost, something in yard wiped out with spraying, or something like potassium chlorde or the lysine making him worse
2018-07-15	17727	had rear leg problem, Barb gave rimadyl
2018-09-04	17778	seems to be stumbling more on steps last day or 2 but yesterday later came up good with fish at top ...
2018-09-19	17793	left rear leg bad had to help up steps still limping in kitchen 5 mintues of so. Gave some b7ngnnc rested ok. Made it up steps after PMSNACK ok although aborted on attempt but it is 95F out.
2018-10-12	17816	planning and cirling on bottom step then doing good up steps
2018-11-02	17837	walked up first few steps in the rain and then faster up last few no slipping. Rear left leg may be more useful now.
2018-11-26	17861	better again on steps walking up but coughing still
2018-12-04	17869	coughing a lot again try stopping Cu for day or two
2018-12-17	17882	probably made it up steps on own, saw he was gone then heard barking and clumsy step noise. Seems good still coughing on and off, went around shed today.
2018-12-27	17892	coughing less and went out to pee, maybe the extra copper yesterday helped quickly
2019-01-08	17904	seems generally more active maybe coughing less for all the barking with the other 2 BCAA's
2019-03-12	17967	pretty good up steps almost back to recent bests. Coughing like always but darted out the door to deck quite well went around shed etc.
2019-03-14	17969	leapt up some steps then stumbled near top, went around near side of shed ok and wandered yard for a while
2019-04-02	17988	good on steps leaping not slipping
2019-04-26	18012	came up steps without crying on his own.
2019-05-13	18029	Hershey slower than yesterday more normal
2019-06-03	18050	Vet found heart failure on X-ray and bladder stones.

TABLE III: An abbreviated set of note on Herhsey. Increased coughing may have occured due to increased excitability and energy prior to heart remodelling and may have been mistaken as a sign of pathology rather than recovery leading to some confusion.

Hershey quickly demonstrated several problems not long after arrival. He had problems with his fur, digestion, and coughing while ultimately being diagnosed with heart failure and bladder stones. During his time here, his diet was varied and he was observed for overall eating and bahvior with specific interest in coughing and ability to make it up a short flight of steps from the backyard to the deck. Again, the notes were not sufficient to fully captures the dynamics of his condition but some representative ones have been edited into the above list. Some correspondence with copper intake is noted. In the last few days of his life, he would pass out and quickly regain consciousness until one day he did not recover presumably due to heart failure. As many features could be rationalized as related to thyroid output, his iodine intake was elevated.

2.7. 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.

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

Coughing and other subjective signs were often used to monitor progress and notes were not always sufficient. Coughing as described before can be produced by many causes. Here, we were concerned mostly with infection, trachea collapse, and heart enlargement. Honking related to trachea collapse may be more common when the dog is excited. In this case, improving "energy" may produce more coughing even though the dog is largely healthier but the heart is still large or trachea still soft. This is further complicated with additions of vitamins that tend to promote alertness as was observed with histidine (indeed there was some concern about aggression when initiating it). This may not have been fully appreciated early on.

While much is not known about cartilage crosslinking, turnover, and remodeling some recent results do point to unexpected beneficial effects of copper mediated cross linking over week time scales [48]. Copper deficiency has been associated with lung development defects in rats [55] and airway and arteriole elastin were at least partially restored after 60 days of additional copper. In poultry, infection is known to cause some tracheal symptoms [91] and relationship to copper status is considered. Copper-garlic may reduce the virulence of some of these for short periods even if not completely able to clear a pathogen[30] and in particular Cu was recently shown to be effective against the toxin of one anaerobe [17] . Collapsed trachea in dogs does not appear to be commonly associated with copper in the literature we found although copper storage disease seems to be an active area of investigation[87] and copper status does come up in other investigations of tracheal damage as highlighted above. It is possible that the original motivation is partially correct and that extra copper combined with garlic did allow for better crosslinking to stiffen tracheal cartilage and prevent dynamic collapse and "honking".

B-6 deficiency has been linked to excess copper excretion [19] possibly making copper a secondary excretion issue rather than a primary absorption problem.

Supplemental copper has been noted to improve symptoms in one case report including symptoms such as hearing loss [38] attributed to defects in cytochrome C oxidase copper loading and restore function in mutant yeast [26] .Cytochrome C oxidase levels in rat hearts were shown to be related to copper deficiency as early as 1998 [66]. It would be interesting to determine if more problems in dogs are related to specific mutations in mitochondrial copper handling. We note again that vitamin K could contribute in similar places and may be synergistic with copper for connective tissue quality as well as in eukaryotic mitochondria [80][93] . Remarkably, copper sulfae was shown to protect against ETC damage by MPP [67] suggesting some activity against toxic insults.

Age related absorption problems in people are known [61] and other apparent deficiencies could be a consequence of insufficient B-6 alone [19][7][27].

Deficiencies are not always correctable by simply eating more of something- for example, calcium intake alone may not fix osteoporosis. Distribution may be a concern as it is possible to have both too much and too little in differing locations due to defects not with absorption but rather handling proteins that would transport or chaperone copper compounds. The combination of the garlic and copper, while sounding like a medieval concoction, has been described as synergistic against fungus [56] and seems plausible for generating perhaps more volatile and diffusable copper that could find otherwise inaccessible lysyl oxidase and other targets. Folklore regarding copper persists and yet clinical trials for Cu in arthritis continue to show lack of any benefit [65] even as other controlled tests show some effects of Cu on processes related to collagen properties [29] Copper dosing with dogs of unknown background may raise some very real cause for concern and deficiency has not been considered a problem [76] although suspected years earlier in commercial foods [78] and low copper is associated with liver problems related to high fructose(including increased heaptic iron) [83] and fat diets in other species [33] . Copper storage diseases and in essence "overdose" are well known

[25] and a role in cancer is suspected [13] . However, see the comments below about complexed copper actually being an active compound similar to other drugs, perhaps Pt based for example, which may kill cancer. Copper toxicity has been noted to differ between host cell types and may be reducible, at least in Long Evans Cinnamon rats, with thiamine or lipoic acid [69]. Lysyl oxidase activation, the goal of this therapy, is also associated with cancer spread [75][63][82] . Although it is likely to remodel possible tumor locations, its role in growth or metastases in a clinically relevant situation is currently unresolved (see for example [5] or [95] and the survival curve in figure 1). Incidence of liver cancer in Wilson's Disease patients is remarkably low [52] and a discussion of possible treatment effects [81] points out that the copper per se rather than removal is likely to help while also mentioning differences with iron overload. Indeed, extra copper that prevents iron overload may be therapeutic as originally intended.

Two types of excess have been identified as potentially important to pathogenesis- mineral and antioxidant. Iron overload copper deficiency was identified early on as a concern with animals getting high iron diets and generally free of parasites in stark contrast to the likely situation over evolutionary time scales. A second type emerged on consideration of the copper response and cytochrome C oxidase copper loading - that of antioxidant overload. ROS have generally gained more acceptance as having physiological roles at low concentrations rather than simply being a source of damage. Literature related to these experiments suggests a very specific role in mitochondrial function. The original concern about antioxidant overload was mostly confined to vitamin E-K antagonism and it is not clear how or if these concerns relate. Coupled with empirical deleterious effects of some antioxidant combinations in clinical trials (one high profile example [58]) , it is clear that antioxidant excess should be considered as a problem with some diets. The antioxidant paradox now seems to be gaining acceptance , for example see [15] and [34] . Copper loading of cytochrome C oxidase relies on an oxidized Cox11 to interact with Cox19 [14] and this may be inhibited by GSH but is enhanced by GSSG. Redox regulation in the IMS seems to be integral to proper copper disposition [31] and indeed mitochondrial related signaling [70] . The latter reference also points to tissue specific mitochondrial isoform expression suggesting that maybe some related diseases are states rather than traits and hence correctable with signaling. Certainly excess antioxidants would be suspicious (for example reference 24 [16] in [70]) . However, the enhancement by GSSG suggests that the presence of oxidized antioxidants may be beneficial but not in their reduced state. We should note that complexed copper is not equivalent to copper deficiency as the complex may not be inert. However, when an ROS generating complex has been observed it effects were diminished by antioxidants [24]. This also suggests that copper depletion per se may not kill cancer cells as much as copper complexes and that concerns about copper supplements and cancer may not be significant.

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. As with most other sites, copper in macrophages can be considered pathological and attempts may be made to limit rather than enhance it. For example, targeting mitochondrial copper with "rationally" designed metformin dimers [73] even as the other correlates sound pathological and its likely the inflammation being reduced would be beneficial if some other problem was corrected.

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 [47]. 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 [12].

Copper signalling is such that remote signals may exist from the heart to liver and intestines to make more available [54]. 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 [28] ,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. " [92] . 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 [36]/ 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 [9] and was found to mediate dityrosine crosslinks [11] similar to the dityrosine crosslinks induced by copper found in 2004 [4].

A 2013 work found in vitro physiological conditions caused copper to prevent fibril formation [49].

Copper is essential for many growth processes and can activate receptor tyrosine kinases without a ligand making it a target for cancer [32].

Rats fed a copper deficient diet shows neurological symptoms by 7 weeks and had reduced tyrosine hydroxylase and SOD activity ZZ [51].

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 [89]. Interestingly, copper-ascorbate oxidation of tryptophan may be suppressed by Trp chelation of copper at high trp concentrations [50] 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 [39].

Body stores of copper increases with excess tyrisone in the diet of rats [88].

By 2022, work focusing on moving copper into the cell considered many aspects of copper misallocation and devised a copper specific shuttle peptide [57]. 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 [85]. 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 [42]

> 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 [6] calxification. but may be related to metallization issues [71].

Ceruloplasmin contains a chain of W and Y that are thought important for enzyme preservation [77]. 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 [64].

Deficiency seems to effect prefernetially proteins involved in neuronal projection and diabetes and iron handling [79].

Copper may antagonize many pathogens including H pylori [10] and clostridum

Combined with vitamin C literature is confusing. It may be bad [41] although alternatives with copper gluconate instead of sulfate

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

Copper solubility is pH dependent [23]

Content in drinking water is variable and may be perceived by humans depending on factors like pH [37] sugesting it may be perceived by dogs too. Interaction with food components such as polyphenols is significant and pH dependent [60] motivating a larger interest in food interactions and in particular rings such as in tyorinse. Speciation gradients may be large in the range of possible stomach acid levels. A 2021 study did in fact explore copper speciation in simulated gastic juices with food components such as tyrosine and citric acid among others [86].

Zinc absorption has been shown to depend on salt type and gastric pH [35].

Impact of GI pH on broiler chicks has been studied due to impact on nutrition and micrbial populations and Cu-Zn antagonism in the digestive system was also observed [59]. Iron intake in ruminant feed has also been observed to decrease copper uptake [21]. In humans, PPI usage has become common. Empirically thate may be a tumor protective effect and there is a suggestion that pH 6 encourages cancer progression versus pH 8 [44] yet alkaline stomach pH is observed is commonly observed in gastric carcinoma [90]. Probably the dominant effect on tumors is unrelated to ambient pH although increased pH may reduce nutrient accumulation by many cells. An absolute apoptosis rate at near neutral pH is probably not indicative of the overall fitness in the stomach.

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.

```
diet tables,

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

datascope output,

./run_linc_graph -2dscope Iodine "Happy" "filter=lag20"
```

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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;24/24	21 ;32;30/31	43 ;65;29/29
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
Se(mcg)		0.42 ;12;1/30			0.43 ;12;1/29

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	2023-10 Oct	2023-11 Nov	2023-12 Dec	2024-01 Jan	2024-02 Feb
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	0.018 ;0.016;25/31	0.018 ;0.016;24/29
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

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. ..

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-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	
Se(mcg)		

TABLE VI: 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
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)	0.016 ;0.016;14/20	7.81e-04 ;0.0078;1/10
wormer	0.075 ;1.5;1/20	
RESULT		
weight(lbs)		
sorbitol(tsp)	0.044 ;0.031;20/20	0.041 ;0.031;10/10

TABLE VII: 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: Notable Food Components with Copper Interactions

Title		
Cu		
Zn		
Fe		
Mo		
H/ OH		
S and amino acids		reduce toxicity [40]
PO4		
Fructose		
Tyr		
Trp		
Pi-complex		
Fenton		
Ammonia, Amides, N		
Citrate		
Ascorbate		
garlic		enhancing bioavailability Cu etc [43]
Microbial products		
phytate		

TABLE VIII: Some entities that may interact with copper

Appendix E: Symbols, Abbreviations and Colloquialisms

TERM	definition and meaning

Appendix F: 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 G: 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 20, 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

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filename ={copper} ,
run-date ={April 20, 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 20, 2024} ,
startdate ={2024-04-12} ,
day ={20} ,
month ={4} ,
year ={2024} ,
author1email ={marchywka@hotmail.com} ,
contact ={marchywka@hotmail.com} ,
author1id ={orcid.org/0000-0001-9237-455X} ,
pages ={ 27}
}

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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