

# Grain free diets and DCM

**This article was updated to reflect the most current studies as of January 2019.**

## **Diet-related dilated cardiomyopathy (DCM) in dogs: an update**

Dietary dilated cardiomyopathy (DCM) has been documented in dogs fed “complete and balanced” commercial kibble diets since the early 2000s [1] with a focus on lamb meal and rice kibble [2], high fiber/low protein kibble [3], and recently, legume-heavy grain free kibble [4].

Considering **DCM is presenting in dogs being fed “complete and balanced” diets and is resolved after a diet change**, this indicates that the most likely potential causes may be one or more of the following:

- 1. the bioavailability or digestibility of essential taurine precursors is too low;**
- 2. antinutrient effects, such as blocking absorption or promoting extraordinary loss of involved amino acids or other nutrients; and/or**
- 3. the existence of a genetic predisposition to inhibited taurine synthesis, transport, or metabolism in some dogs.**

## **What’s the big deal?**

DCM is what happens when degeneration of the heart muscle leads to thinner muscular walls of the heart, particularly the left ventricle. When these walls get too thin, the pressure of the blood inside the heart begins to stretch the walls. This results in an enlarged heart characteristic of DCM. The left ventricle is responsible for pumping oxygenated blood out of the heart to tissues all throughout the body. When the walls of the left ventricle get thinner and weaker, the heart’s ability to pump blood out is less efficient, **eventually leading to heart failure.**

**The most sinister part of DCM is the lack of clinical signs.** In many dogs, **this condition can go completely unnoticed until they develop congestive heart failure.** Overall **prognosis for dogs whose DCM has progressed to congestive heart failure is extremely poor** [5]. A seemingly

perfectly healthy dog can succumb to heart failure in a matter of hours, even though there was no indication that the dog had DCM until it was too late.

## **Genetic pathways associated with dietary DCM**

Dietary DCM may involve genetic factors. These would differ from the genetic factors that cause non-dietary DCM in breeds like Dobermans, Great Danes, or Boxers. Genetic factors involved in non-dietary DCM may involve mutations affecting cytoskeletal proteins, resulting in weakened heart muscle or impaired muscle contraction. In contrast, genetic factors involved in dietary DCM may involve mutations affecting proteins or enzymes involved in the metabolic pathways of taurine synthesis or transport, resulting in taurine deficiency. Taurine is involved in the development and structure of cardiac muscle, so taurine deficiency can result in weakened heart muscle or impaired muscle contraction. In this way, **dietary DCM can be reversed by correcting the deficiency, while non-dietary DCM cannot be reversed by a diet change.**

Genetic pathways relating to taurine transportation have been discovered. The knockdown of one of these genes in mice results in taurine deficient cardiomyopathy [6]. Strong evidence exists of a genetic factor in Portuguese Water Dogs associated with abnormal taurine metabolism leading to DCM [7].

**Breed-specific predispositions to dietary DCM have been identified**, involving American Cocker Spaniels [8,9], Golden Retrievers [10,11], Portuguese Water Dogs [12], and Newfoundlands [1], among others.

## **Sulfur amino acid requirements in dogs**

**Taurine is not considered an essential nutrient in dogs** because normal dogs on an adequate diet are able to synthesize taurine from two other amino acids, methionine and cysteine. **Previous studies have hypothesized that taurine deficiency may be caused by low methionine and/or cysteine intake or absorption rather than a direct taurine deficiency** [2]. Studies have also indicated that **some dogs appear to have a higher dietary methionine and/or cysteine requirement** than the typical model breed used to determine nutrient requirements (Beagles) [13].

## Bioavailability & digestibility

Some ingredients might have high concentrations of amino acids, but they are not completely absorbed and metabolized in the body due to low digestibility or bioavailability. This means a diet might be complete and balanced “by formulation”, or laboratory analysis, but in practice the dog isn’t actually able to utilize all of these nutrients, leading to deficiency.

Animal-based ingredients generally have higher amino acid digestibility than plant-based ingredients, and greater amounts of taurine [14,15], cysteine, and methionine [16]. Novel ingredients like lamb meal, venison meal, and duck meal may have significantly less amino acids and lower digestibility in comparison to more conventional ingredients [17] – however, considering the limited data on these ingredients, it is difficult to make conclusions about their nutritional value, **which poses serious concern especially in regard to limited-ingredient dog foods in which these novel protein meals are the major source of essential amino acids.**

Raw or lightly cooked meat, poultry, and fish have significantly higher amino acid bioavailability and digestibility than rendered ingredients [18,19,20]. The temperature and pressure applied to rendered ingredients during processing has been associated with decreased amino acid bioavailability [19,21]. **Multiple studies have raised the concern that the current methods for measuring bioavailability estimates used by NRC and AAFCO to determine amino acid requirements in dogs may not be sufficient or accurate [22,23].**

“Bioavailability estimates for Lys, Met, and Cys as calculated here require further veracity as the chemical form in which these AA are present in commercial pet foods may significantly reduce their bioavailability.” (Hendriks et al., 2015) [23]

## Vitamins and minerals involved in DCM

While taurine deficient DCM has gotten the most attention as of late, **taurine synthesis relies on the availability of other nutrients.** For example, taurine synthesis cannot occur unless adequate vitamin B6 is present [24]. In addition, **there are nutrients unrelated to taurine that have been associated with dietary cardiomyopathy**, including zinc [25], selenium [26], magnesium [27], calcium [28], vitamin D [29], thiamine [30], and vitamin E [27,31]. Deficiencies of these nutrients may

play a role in causing or exacerbating DCM. Diet type and the extent of processing affects absorption and metabolism of many of these nutrients [32,33].

**A deficiency can also be a consequence of high levels of other nutrients.** For example, beta-alanine, an amino acid, is a competitive inhibitor of taurine, and an excess of beta-alanine can contribute to taurine depletion even in animals whose diets contained adequate taurine [34].

Thus, diets can qualify as complete and balanced according to AAFCO guidelines, yet imbalanced ratios of specific nutrients in the diet can still result in deficiency. **Diets developed by inexperienced individuals without backgrounds in nutritional science are at greater risk of these imbalances.**

Homemade diets have recently increased in popularity, but the vast majority of recipes provided on websites and in books do not meet all minimum requirements for all dogs. Even when given a balanced homemade recipe, owner compliance in following preparation directions can be low [35,36]. The consequences of an unbalanced diet can easily exceed dietary DCM, especially in growing puppies [37,38]. Normal bloodwork results are not an indication that the diet a dog is eating is balanced [39]. It is essential for owners feeding homemade diets (cooked or raw) to make sure the diet they are feeding is adequate and balanced for their dog.

## **Restricted dietary intake**

In a recent study investigating taurine deficient DCM in Golden Retrievers, all but one of the dogs were being fed less than their calculated metabolic energy requirement (MER), which indicates lower daily dietary intake [11].

**One study found that energy restriction resulted in methionine/cysteine, selenium, and choline intake less than the minimum requirement(MR) and tryptophan, magnesium, and potassium less than the recommended allowance (RA), even when consuming a purpose-formulated weight loss diet [40].** Although it was stated that none of the dogs developed taurine deficiency, the methods and data relating to taurine levels were not provided, and it was also noted that the diet contained supplemental taurine. In this study, the mean daily intake was 61kcal/kg<sup>0.75</sup>/day.

**In an analysis of multiple commercially available dog foods fed at less than a dog's MER, it was determined that all diets had multiple nutrients less than RA if they were fed at 70kcal/kg<sup>0.75</sup>/day and at least one essential nutrient less than RA at 79kcal/kg<sup>0.75</sup>/day [41].**

Some breeds, including Golden Retrievers, tend to have lower caloric requirements than other breeds [42,43]. **It has also been suggested that current MER calculations result in daily caloric intakes that are too high for most adult pet dogs** regardless of breed, with new formulas proposed that may be more accurate than the current NRC formula [44].

**Feeding a commercial diet at less kcal/day than a dog's calculated MER may result in daily intake of some nutrients less than the dog's RA and/or MR, including nutrients essential for taurine synthesis.** This may be a particularly relevant concern for low-energy adult pet dogs and breeds that typically have lower caloric requirements. **Changing low-energy or obese-prone dogs to a weight management diet may decrease the potential of the diet being deficient,** but as mentioned previously [40], it isn't a guarantee.

## **Antinutrients and nutrient interactions**

Antinutrients are compounds in food that decrease the digestibility and bioavailability of particular nutrients by preventing absorption or metabolism.

**High fiber can decrease protein digestion by increasing the excretion of fecal bile acids, decreasing the bioavailability of taurine precursors[3].**

**Many ingredients, particularly legumes, contain numerous antinutrients** including phytates, lectins, saponins, trypsin inhibitors, and protease inhibitors **which can significantly decrease nutrient absorption of minerals and/or amino acids** if not properly processed. While cooking is an effective method of reducing some antinutrients, others are more tolerant of high temperatures and may not be significantly reduced during cooking.

Some antinutrient factors are enhanced by high temperatures, such as protein-polyphenol interactions and maillard reaction products. In addition, **some food processing techniques are associated with changes in the intestinal microbiota, resulting in increased excretion of taurine [45].**

**Maillard reaction products, found in high levels in commercial pet food products [46], can increase microbial degradation and have been associated with significant depletion of plasma and whole blood taurine levels [47].**

Polyphenols are present in many plant-based ingredients and are associated with numerous health benefits owing to their antioxidant activity . In human nutrition, regular consumption of polyphenol-rich foods is strongly associated with reduced risk of cardiovascular disease [48]. However, some polyphenol compounds can bind to proteins, affecting protein digestion and losing their antioxidant activity [49]. These interactions can inhibit or promote protein metabolism depending on the protein involved and the mechanism by which the protein's conformation or function is modified [50]. For example, a digestive enzyme's active site could be blocked, preventing it from assisting in protein digestion, or a protein's shape could be modified in a way that makes it easier for that protein to bind to an enzyme's active site, allowing it to be more easily digested.

**Long story short, interactions between nutrients and other compounds in a food are highly variable and complex, driving home the point that even a seemingly well-formulated balanced diet might have unexpected consequences.**

## **Other factors**

Other factors, like **increased exercise [51], increase the body's demand for taurine. Some health conditions may increase the risk of developing taurine or carnitine deficiency**, including cystinuria [52] and thyroid conditions.

Hyperthyroidism has been identified as a potential cause of DCM in dogs and other species [53]. Hyperthyroidism can be diet-related in dogs that consume excessive amounts of iodine and/or meat products that contain thyroid glands, and DCM in these dogs can be reversed by a corrected diet [54,55,56].

Hypothyroidism has also been associated with cardiomyopathy in dogs and other species [57,58], but it is thought to be relatively uncommon. Researchers have been unable to demonstrate a role of hypothyroidism in the etiology or progression of DCM in Dobermans [59,60], but in Great Danes [61] and Cocker Spaniels [62], DCM has been reversed following thyroid hormone replacement therapy.

In addition, **taurine may be a conditionally essential amino acid required by dogs predisposed to or suffering from heart failure, regardless of whether or not the heart failure is induced by a dietary factor in the first place** [4].

While some of these factors aren't directly legume- or grain free-related, they could be useful to keep in mind when assessing individual cases. **Multiple factors could potentially work together to exacerbate DCM.** Informed owners can make decisions to mitigate risk based on their dog's breed, health status, and lifestyle.

## **The grain free link to DCM**

**One recent study [4] analyzed the echocardiographic results from 48 dogs of various breeds and mixes that had been diagnosed with DCM and had a known diet history.** The 48 dogs consisted of 12 on grain inclusive diets and 36 on grain free diets. Out of the 36 dogs on grain free diets, 14 of them were on one particular grain free diet (identified only as "the most common grain free diet") and the other 22 were on various other grain free diets. In comparison with dogs on grain inclusive diets, **dogs on the most common grain free diet had significantly larger left ventricle diameter associated** with more severe cardiomyopathy. Interestingly, while all of the dogs on grain free diets whose taurine was tested had normal or high taurine levels, two dogs on grain inclusive diets had low taurine levels. One of these dogs, a German Shepherd, died in-hospital. The other, a Bouvier des Flandres, improved with a diet change and taurine supplementation, indicating that this dog's DCM was likely associated with its grain inclusive diet. Unfortunately, this study did not identify the diets in question, so there is no way to know more about the grain inclusive diets these two dogs were on – for example, if they included legumes, were lamb meal based, were rice or rice bran based, were high fiber, and/or were low protein, which would be consistent with prior findings [1,2,3].

**Another recent study [11] investigated taurine deficiency and DCM in Golden Retrievers in an effort to identify why this breed is over-represented in cases of taurine deficient DCM.** This is the same study that found almost all of the affected dogs were consuming less than their calculated MER, discussed earlier in this article. In this study, the diets these dogs were on at the time of their diagnosis were identified. Of the 24 dogs diagnosed with taurine deficient DCM, 15 (62.5%) were fed Acana, 2 (8.3%) were fed 4health, 2 were fed Fromm, and 1 dog was fed each of the following brands: Taste of the Wild, Zignature, Instinct, NutriSource, Kirkland Nature's Domain, and Orijen. 9 (37.5%) of these dogs were on a kibble that included lamb and/or lamb meal. All but 1 (95.8%) of

these diets were grain free (the only grain-inclusive food was Fromm Salmon a la Veg), and all but 1 of these diets included legumes (the only one that didn't was Fromm Salmon a la Veg, which included the following carbohydrate sources: brown rice, sweet potato, barley, potato, oatmeal, white rice, and millet). 4 (16.7%) of these dogs were on a diet that included potatoes.

## **Risk vs benefit: is feeding a kibble with legumes worth it?**

**It is highly unlikely that all grain free kibble diets carry a risk of dietary DCM and there is no evidence at this time of any characteristics specific to grains themselves that would prevent DCM.**

Additionally, dietary DCM isn't exclusive to grain free kibble – as mentioned previously, DCM has been associated with grain-inclusive foods too [2,63]. In one study, rice was associated with significantly lower taurine levels [63] in comparison to corn or barley, however this study didn't seem to involve any legume or potato ingredients for comparison.

Rather than the blame being placed 100% on grain free diets in general, it seems more likely based on current literature that this issue is multi-faceted; we may be witnessing the consequences of a “perfect storm” of factors, so to speak. But **while it is important to remember that correlation is not causation, the correlation between legume-heavy grain free kibble and dietary DCM is compelling and should not be ignored.**

In my opinion, **the potential risks outweigh the benefits of feeding legume-heavy grain free kibble** – particularly those identified as common denominators in recent dietary DCM cases (like Acana, Zignature, Fromm, 4health, and Taste of the Wild), and with breeds that tend to be susceptible to DCM (dietary or non-dietary) – **until the exact cause(s) can be identified and addressed.**

Although many owners may be resistant to a diet change away from grain free kibble, many of the reasons why owners want to feed grain free diets are based on myths and misunderstandings. **There is no evidence that grain free is more beneficial than grain inclusive kibbles** or that using grains as a source of carbohydrates is any more harmful than using alternative carbohydrate sources. Grain free diets are not inherently lower in carbohydrates than grain inclusive diets. Grain

allergies are significantly less common in dogs than chicken or beef allergies [64]. Despite the pervasive myth that grains are not digestible in dogs, grains like rice, corn, and sorghum are in fact *more* digestible than legumes like peas and lentils [65].

**A diet change may be especially important in breeds that have been overrepresented in cases of dietary DCM, like Golden Retrievers, and dogs that are known to have a non-dietary genetic predisposition to DCM, like Dobermans.**

There have been reports of reversible DCM occurring in breeds that are genetically susceptible to non-dietary DCM, like Dobermans, Great Danes, and Boxers. To clarify, usually DCM in these breeds is not related to diet and therefore not reversible, yet some dogs of these breeds diagnosed with DCM have actually improved after a diet change, indicating that their condition *was* diet-related. As mentioned previously, taurine may be a conditionally essential amino acid required by dogs predisposed to or suffering from heart failure, regardless of whether or not the heart failure is induced by a dietary factor in the first place [4].

**The association with grain free kibble and DCM seems to be particularly strong in some breeds, but it also is not limited to these breeds [4], and other breeds may have similar predispositions to dietary DCM that have yet to be identified. For this reason, **even if your dog is not a breed that has been identified as at risk of DCM, feeding a grain inclusive kibble or a balanced homemade diet still may be the safer bet.****

If your dog legitimately has a condition that requires a grain-free diet and you cannot feed a balanced homemade diet, it would be best to avoid legume-heavy kibbles if possible. While potatoes have been identified as a potentially risky ingredient in the recent FDA warning about grain free diets and DCM, the correlation between legumes and dietary DCM seems to be much stronger at this time. So if you must feed grain free kibble, I would still recommend avoiding legumes, and I would supplement the diet with taurine-rich fresh foods if possible.

## **Taurine tests and supplementation**

Even if your dog has been taurine tested and came back with high taurine results on a grain free diet, I would still personally recommend a diet change away from legume-heavy kibble. In fact, **very high taurine levels in dogs that aren't given supplemental taurine may be particularly**

**concerning because this may indicate myocardial injury [66].** In addition, taurine deficiency isn't the only potential dietary cause of DCM, and **there have been dogs diagnosed with DCM that had normal or high taurine levels [4].** For these reasons, **I would not recommend relying on taurine test results as an indication that the diet you feed is safe and/or your dog is not at risk of dietary DCM** – taurine test results are only one piece of the puzzle, not a definitive diagnosis one way or the other.

As more kibble manufacturers begin to add supplemental taurine to their formulas in light of recent studies and public outcry, taurine test results may be artificially higher and provide a false sense of security. **The addition of taurine to certain formulas may not be enough to overcome taurine deficiency,** as demonstrated by one study that found dogs on lamb and rice formulas had the lowest taurine levels, *including 2 dogs on lamb and rice formulas that had been supplemented with taurine [63].*

Whether or not taurine supplementation in dogs that have not been diagnosed with DCM is beneficial remains uncertain at this time. The optimal dosage of taurine for dogs is also not fully understood. However, according to Freeman et al. (2018):

“...taurine supplementation may still have some benefits owing to other effects of taurine (eg, antioxidant and positive inotropic effects).” [67]

Taurine supplementation is generally safe since excess taurine can be excreted in urine, but it is still important to avoid overdosing – too much of a good thing can easily backfire. Some commercial dog foods already contain added taurine. I would recommend talking with your vet to determine if adding a taurine supplement is right for your dog. Some owners with DCM diagnosed dogs have posted the amount of taurine their cardiologist prescribed to their dog online – **DO NOT** give your dog that much taurine unless you have been personally instructed to do so by your dog's veterinary cardiologist.

I believe **adding taurine-rich fresh foods would be the safest and most beneficial method of introducing more taurine to your dog's diet.** Decreasing the risk of dietary DCM will be one of many benefits of introducing more fresh foods to your dog's diet! The following table contains a list of food items and their taurine content [15,68]. Seafoods, dark meats, and organ meats generally contain the most taurine. Each food item in this table is raw unless otherwise noted.

Taurine (mg/100g)

Tuna (albacore)	176-200
Tuna (canned)	42
Tuna (whole)	284
Salmon	60-130
Mackerel	78
Mackerel (whole)	207
Cod	31
Whiting	40
Haddock	28
Whitefish	114-151
Clam (fresh)	520
Clam (canned)	152
Shrimp	155-390

Scallops	827
Octopus	388
Mussels	655
Oysters	396-698
Herring (whole)	154
Capelin (whole)	144
Smelt (whole)	69
Chicken (light meat)	18
Chicken (dark meat)	83-170
Chicken breast	16
Chicken leg	34
Chicken liver	110
Chicken hearts & livers	118
Chicken necks & backs	58

Chicken (whole)	100
Turkey (dark meat)	306
Turkey (light meat)	30
Turkey (ground, 7% fat)	210
Duck leg (meat)	178
Duck leg (skin)	62
Rabbit (whole, ground)	37
Beef (ground, 15% fat)	40
Beef (ground, 25% fat)	28
Beef heart	65
Beef kidney	69
Beef spleen	87
Beef lung	96
Beef tongue	175

Beef gullet	80
Pork loin	50-61
Pork lung	78
Pork gullet	65
Pork liver	86
Pork kidney	77
Lamb leg	47
Lamb kidney	24
Venison	60
Veal	40
Horse	31

## **What should I do if my dog may be at risk?**

If you are worried that your dog may be at risk, here are some steps you can take:

- **Avoid legumes and lamb based kibbles, even if it has added taurine.**
- If you feed a homemade diet (raw or cooked), make sure it is balanced. If you feed kibble, add taurine-rich fresh foods to your dog's diet.

- Get bloodwork done at your vet, including proBNP,— you may need to ask your vet about this, as it isn't always included in full panel bloodwork.
- Taurine testing can help determine if your dog is at risk of taurine deficiency, but keep in mind that high taurine doesn't rule out DCM.
- If necessary, get a referral to a veterinary cardiologist for an echo.
- If you own a breed like a Doberman, ideally you should do annual 24-hour holter tests regardless of diet, but especially if they have been on a legume heavy or lamb meal based diet.

## A call to action

If I may take a moment to rant...

This situation highlights the importance of pet food manufacturers' participation in digestibility studies and feeding trials. While concerns have been raised regarding the validity of AAFCO feeding trials due to their less-than-ideal requirements, it could also be argued that something is better than nothing, and if the feeding trials are so easy to pass, then why do so few pet food companies do them? Or, even better, why don't they go above and beyond? There is nothing that prevents pet food companies from exceeding current AAFCO feeding trial requirements and carrying out a feeding trial that involves more dogs and more tests over a longer period of time. ([Look to Just Food For Dogs as an example!](#))

In any case, pet food manufacturers should be encouraged to prove the adequacy of their diets in some capacity beyond laboratory analysis as more and more evidence emerges that laboratory analysis isn't a guarantee of adequacy. While funding more research like this may be expensive, pet food companies have a responsibility to thoroughly demonstrate the products they are selling are adequate, and I find it very disappointing that so few have taken the initiative to do so.

Any owner that feeds a commercial diet to their dog should be outraged at the lack of research from the vast majority of pet food manufacturers. But nothing will change if pet food companies aren't motivated to do so. I encourage everyone to let these companies know that they need to do more to validate the adequacy of their diets. **When dogs are eating the same exact thing, every single day, for every single meal, it is critical that this food is up to the task of keeping them healthy.**

**When pet food companies claim that their products are safe, healthy, and nutritious, then they should be expected to have proof of those claims, and they shouldn't be charging premium prices to essentially use their customer's dogs as guinea pigs.** Pet food manufacturers need to ask themselves: "do I want to be part of the problem or part of the solution?"

## **Conclusion**

While it may be some time before researchers and veterinary cardiologists are able to get to the bottom of what exactly is causing this issue, there are some things we do know for sure as of right now:

1. **There is a significant correlation linking legume-heavy grain free diets with reversible diet-associated DCM, but the exact cause has yet to be identified**
2. In previous cases of diet-associated DCM, bioavailability/digestibility of taurine and/or taurine precursors and genetic predispositions to inhibited taurine synthesis/metabolism were identified as the most likely causes
3. Current cases of diet-associated DCM may have similar and/or additional factors, including antinutrients, deficiencies of other nutrients, underlying health issues, unbalanced diets, or restricted dietary intake
4. DCM has been diagnosed in breeds that have previously not been considered at risk of DCM
5. Some dogs with high taurine levels have been diagnosed with DCM
6. Look out for these red flags: **legumes** (peas, lentils, beans, etc), **novel protein sources** (lamb, venison, kangaroo, duck, etc), and **ingredient splitting** (i.e. "chicken meal, whole green peas, whole yellow peas, pea protein, pea fiber" – this food probably has more peas than chicken by weight)

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