"SHOULD YOU CREATE OR FORMULATE? THE GREAT DEBATE . . . "

WE FORMULATE...SORT OF

INTRO

WHAT IS FORMULATION?

The debate really is not whether to **formulate** versus **not formulate**. With zero formulation, we could just be tipping any old thing into our pets' bowls: chocolate fish, old socks, cardboard. The debate is really about **how *much* we formulate**.

There is a **spectrum** of formulation including but not limited to:

Live prey ⇒ dead prey ⇒ deconstructed approximated prey-based diet: raw meat, bones, organs and tripe (that's us) ⇒ prey model diets ⇒ raw with multivit supplements (+/- AAFCO) ⇒ convenience (AAFCO) raw (eg K9 Natural).

Some level of formulation is absolutely necessary of course (to avoid the inevitable poor outcomes of a sock-based diet). But how much is necessary, how much is useful, and does it really matter?

WHAT DO WE DO?

The aim of a raw diet is to provide palatable, satiating, highly-digestible, nutrient-dense, species-appropriate food that fulfills a dog or cat's nutritional needs. In our practise, this is a diet of raw meat, bones, organs and tripe from a variety of prey sources. Raw Essentials does not formulate from ingredients. Rather, it is just species-appropriate food.

This talk will spend more time exploring how we *don't* formulate than how we *do* formulate. This is because our approach to formulation is very simple, and does not require a great deal of explanation.

HIGHLY FORMULATED DIETS - WHAT WE DON'T DO

1) AAFCO - WE DON'T USE IT

Let's look at diets on the more formulated end of the spectrum: **Raw diets constructed to meet AAFCO requirements.**

There are obvious advantages to these:

- They are **convenient** because they do not require planning - each meal is '**complete and balanced**.'
- Given that **nutritional adequacy** is one of the most common concerns that veterinarians have about raw diets, an AAFCO compliant diet will provide owners and veterinarians with a **level of comfort**.

AAFCO defines pet food ingredients, and specifies the minimum and maximum acceptable levels of a range of nutrients in processed cat and dog food. AAFCO may be the best option we currently have for processed foods.

While some AAFCO compliant raw diets are no doubt really good - is this because of their AAFCO compliance, or because they are species-appropriate diets utilising high quality ingredients?

We do not use AAFCO, because we don't feel that it is the best yardstick by which to measure our diet. Here are our reasons for thinking this way:

a) AAFCO utilises reductionist nutrition

"Nothing in Biology Makes Sense Except in the Light of Evolution."

Gyorgy Scrinis introduced the idea of reductionist nutritionism: over the last hundred years scientists have identified, quantified and qualified individual nutrients; resulting in public health messages about what constitutes 'good' and 'bad' nutrition. Despite this growing body of knowledge, chronic disease is increasingly rapidly in both people and their pets.

Nutrition science is missing the mark. Reductionism fails to understand the true complexity of real food:

> *"attempting to mimic food sources using single constituents such as isolated proteins, vitamins, and minerals is challenging and arguably underestimates the complexity of the food source it is meant to mimic..since foods contain thousands of constituents that can synergistically impact human metabolism, consuming isolated nutrients or fortified foods often do not confer similar benefits when compared to ingesting nutrients as part of their whole-food matrix."*

Raw Essentials emerged from the recognition that, if we leave the narrow confines of reductionism, and widen our perspective so that our viewpoint includes evolutionary biology and nutritional ecology, it becomes apparent that what makes sense is minimally-processed, unadulterated, species-appropriate food - as nature intended it.

Identifying a single nutrient requirement in isolation does *not* tell us how much of that nutrient an animal needs in real life. The nutrient does not exist in a vacuum. Its availability and action will be affected by multiple factors, including:

- **The form of the nutrient**: Is it presented in a whole food form, or as an inorganic supplement?
- **The interaction of the nutrient with other nutrients**: For example, high starch foods such as grains impair the absorption of minerals such as zinc.
- **The condition of the animal**: An animal with chronic health issues, or on medication will absorb and utilise nutrients quite differently to a healthy, unmedicated animal.

Some examples of factors affecting nutrient absorption include:

- Previous iodine intake history affects the response of an individual cat or dog's thyroid gland to future dietary intakes.
- *"Reductions in the secretion of hydrochloric acid, gastric acid, and/or intrinsic factor, together with alterations in the permeability of the intestinal mucosa, are all examples of intestinal factors that can markedly influence the absorption of certain nutrients, but that are often ignored when setting dietary requirements."* Omeprazole is a commonly prescribed drug in dogs which reduces acid secretions.
- "*Folates are produced by bacteria in the gut and are absorbed, but the contribution has not been quantified…the type of diet will affect the amount absorbed…The folic acid needs of dogs given diets based on natural constituents and not containing bacteriostatic agents* [antibiotics, preservatives] *may be partially met by microbial synthesis in the intestine…diets that are inadequate in choline... may increase requirements for folic acid.*"
- "*The quantity of vitamin E required in the diet depends on the rate of production of free radicals, the PUFA composition of membranes (a function of the diet), and other dietary compounds such as selenium*"

b) AAFCO is for processed diets, not raw

AAFCO nutrient recommendations are based on the work of the National Research Council (NRC). The NRC book contains nutrient requirement tables for cats and dogs, and a description of the available nutrition science behind the tables. The scientific papers relied upon in the book almost always examine processed diets, and thus the tables are mostly pertinent to the needs of a dog or cat on a processed diet. There are many ways in which nutrient requirements of cats and dogs on a processed diet differ from those on a whole food diet. The authors of the book point this out multiple times as a caveat.

c) AAFCO requirements are a bit of a guess

Unfortunately, there is not a great deal of good nutrition science for either raw, or processed-fed pets. Most studies are small, and poorly designed. Wading through the NRC book you will find that the authors repeatedly warn us that the established requirements are a best guess based on a paucity of science. All too often people interpret the numbers in the NRC as 'settled science,' without considering the qualitative statements explaining how tenuous the science actually is.

So in the absence of reliable data from large controlled studies we are left with a combination of supportive data, evolutionary logic (one of the most important questions in science: "*does this make sense?*"), and clinical experience to decide how best to feed our pets. Clinical experience tells us that despite AAFCO compliant diets being the current dominant pet food: obesity, heart disease, skin disorders, diabetes, dental disease, renal disease

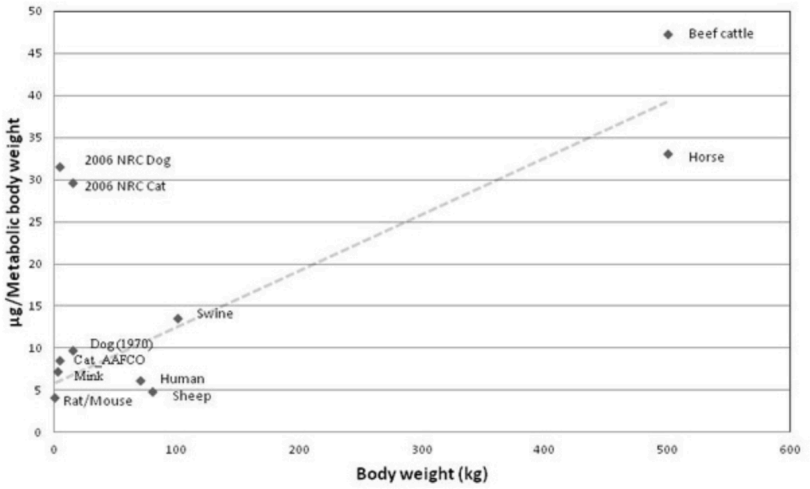
and cancer are common occurrences. If our grasp of nutrition science was really good, vets and GPs would not be nearly so busy.

Take iodine as an example of the uncertainties. Although AAFCO generally follows NRC guidelines, they differ significantly in their iodine recommendations. The NRC states that:

> *"To our knowledge, however, there have been no detailed studies with cats to determine the range of daily iodine intake that is consistent with normal thyroid structure and function, particularly studies of iodine intake conducted over a long period of time…Until more data are accumulated concerning a possible relationship between levels of iodine intake and altered structure or function of the thyroid, it seems reasonable to recommend that pet food manufacturers should adjust the levels of iodine in their products to lie within the broad, albeit at present ill-defined, limits that have been recommended."*

Assessing the requirement for iodine is complicated. The NRC's figures have been called into question:

> *"The recommended iodine intake across species appears to follow metabolic scaling for body weight (FIGURE 2). The recommended daily allowances for dogs and cats suggested by the National Research Council (NRC) in 2006 are in excess of NRC recommendations for other species, current AAFCO recommendations in cats, and earlier recommendations for dogs and cats based on metabolic body weight. The dietary iodine requirement in cats has recently been suggested to be closer to 0.46 ppm than to the 1.3 ppm reported by the NRC."*



In 1970, recommendations fitted a metabolic scaling line along with other species. Today, cats and dogs are outliers.

The studies supporting the NRC iodine requirements had several flaws. Wedekind et al (2010) analysed the three studies and pointed out their weaknesses:

> *"The new NRC I [iodine] recommended allowances for the cat were based on three studies (Scott et al., 1961; Smith, 1996; Ranz et al., 2002) all of which failed to meet key criteria necessary for defining nutrient requirements. The Scott et al. (1961) study was never intended to be used as a requirement study; the diet used was an all meat diet (beef or sheep hearts) deficient in Ca, vitamin A and I and an imbalanced Ca:P ratio."*

d) AAFCO is pretty unreliable in the real world

Consistency is incredibly challenging in the real world - diets which have been formulated to meet AAFCO often fail to actually meet AAFCO,

rendering the formulation pretty redundant. To the best of our knowledge, AAFCO-compliant raw diets have not yet been included in independent studies checking compliance, but non-raw diets have certainly performed poorly.

The Scientific Reports journal (2017) published a paper in which the authors analysed 177 widely available dog and cat foods to see if they complied with FEDIAF (the European version of AAFCO) guidelines for completeness. They discovered that only 8% of wet foods and 39% of dry foods did. Pets were shown to be at risk from copper and selenium toxicity due to the high levels in some foods. The ratio of calcium to phosphorus (vital for proper bone growth) was wildly out in many products. 40% of the foods in the study had excessive ash levels, which is associated with renal disease. The authors suggested a link between the non-compliant foods and disease:

> *"A majority were non-compliant according to current European recommendations (FEDIAF, 2013). Many had either insufficient, excessive or an inappropriate balance of minerals which, if fed exclusively for a long period of time, could underpin a host of clinical diseases in dogs and cats including skeletal, neurological, or dermatological disease. Furthermore, foods with relatively high levels of fish or fish derivatives (i.e. ≥ 14%) also had high levels of undesirable metal elements such as arsenic, which bioaccumulate in internal organs and may contribute toward a plethora of subclinical disease"*

Issues included:

- High **fish** (derivatives, but not oil) content foods had high arsenic and mercury:
    - *"Given that chronic arsenic intake in human epidemiological studies is associated with albuminuria, proteinuria and increased mortality from kidney disease then one must question why a high proportion of these diets are fed to domestic cats, whom are prone to chronic kidney disease."*
- *"40% (71 of 177) of foods analysed in our study had ≥10% **ash** on a dry matter basis, nine with ash ≥14%. Higher ash intake is associated with CKD in cats."*
- **Minerals** were often far too high, or too low
    - **Copper** - some had more than 2x the maximum (impact on zinc and iron), some had less than ½ the minimum
    - High **selenium** in 76% of wet food (7 products had more than 3 times the maximum)
    - **Ca:P** ratio wildly out in many products
    - 32 products had excess **calcium**

In a New Zealand study, Hendricks et al (1997) analysed 29 cat foods (ranging from budget to super premium) to see if their label claims of meeting AAFCO standards were true. 60% of the budget, 18% of the premium, and 43% of super premium cat foods failed to meet their stated AAFCO standards.

> *"The present study provides hitherto unavailable information on the nutrient composition of soft-moist cat foods sold in New Zealand, and indicates that a number of soft-moist cat foods cannot claim to be formulated to meet the nutrient profile of the Association of American Feed Control Officials."*

A study in the Journal of the American Veterinary Association (2014) found that 13.3% of canned cat foods from 45 different brands - all claiming to meet AAFCO standards - were below AAFCO for thiamine (and 15.6% were below NRC for thiamine), which has very serious implications for feline health. Four of these foods were manufactured in New Zealand.

The Journal of Animal Physiology and Animal Nutrition (2013) published a paper in which they analysed 12 hypoallergenic diets. These expensive diets are supposed to be free from allergenic proteins in order to relieve itching in pets. 10 of the 12 diets were contaminated with protein allergens not declared on the label. Another paper in the same journal found that all four of the allergy diets they studied were contaminated.

The Australian Veterinary Journal published a paper (2016) which analysed 10 wet and 10 dry 'complete and balanced' commercial cat foods, and compared the results with the labelling on the packages, and with established dietary requirements (AFFCO and NRC) for cats. The nutrient compositions and guaranteed analyses listed on the labels failed to match

the chemical analyses carried out in the study. Deficiencies and excesses of various nutrients were found in nearly all the samples, many of which were identified as potentially harmful to cats ingesting the diets.

> *"The various nutrient deficiencies and excesses observed in a majority of the foods in this study highlight a serious issue in the nutritional composition of commercial cat foods in Australia. Both the nutrient composition and feeding guidelines require extensive review to ensure the adult cat's unique dietary requirements are being met."*

In a 2004 study from the Archives of Veterinary Medicine, 33 brands of dry dog food were analysed to see if they met AAFCO standards. Seven foods had an incorrect calcium:phosphorus ratio. There were inadequacies for potassium (13 foods), zinc (7), iodine (12) and selenium (1). Only 12% of the foods met the minimum requirements for protein, fats and minerals.

2) SYNTHETIC MICRONUTRIENTS & ADDITIVES - WE DON'T ADD THEM

a) Synthetic micronutrients

Synthetic micronutrients do not behave in the same manner as their food-origin counterparts.

Two human nutrition science studies were pivotal in drawing attention to the difference between whole food and synthetic nutrients. Epidemiological (observational) studies identified a link between diets high in carotenoids (lots of fruit and vegetables), and high levels of serum ß-carotene with lower cancer incidence (particularly lung cancer). The correlation was particularly strong in lung cancer patients with a history of smoking. These findings led to the initiation of large controlled supplementation trials. The results were rather shocking:

- The Alpha Tocopherol, Beta-carotene Cancer Prevention Trial (ATBC) revealed an increase in lung cancer risk in the treatment group - smokers who took the ß-carotene supplements.
- The ß-carotene and Retinol Efficiency Trial (CARET) led to an increase in cancer among smokers and asbestos workers.

Both trials were halted before completion due to the increased death rates in the treatment groups.

More recently, evidence in pet nutrition has pointed to similar issues.

Renal (kidney) disease is common in dogs and cats. Survival time in patients with renal disease has been shown to improve when dietary phosphorus is reduced. The implication of this is that too much phosphorus is damaging to the kidneys. This led to the development of prescription renal diets (low in protein and phosphorus).

A recent paper in the British Journal of Nutrition (2019) made an important finding regarding the difference between whole food and supplementary phosphorus. The authors pointed out that *"Phosphorus is present in diets as naturally occurring P from raw materials or added as an inorganic salt"* but that little is known about how these two forms of phosphorus are absorbed in cats after ingestion. Using the data from several studies, the authors concluded that supplementary phosphorus led to an increase of phosphorus levels in the plasma, however phosphorus from whole food did not. So it is possible that the ubiquitous incidence of renal disease in pet cats is, at least in part, due to the presence of supplementary phosphorus which has been added to their processed diets in order to achieve AAFCO requirements.

Another paper in the British Journal of Nutrition (2018) adds weight to this idea. Key points in the paper are as follows:

- *"Renal disease has a high incidence in cats, and some evidence implicates dietary P as well...The bioavailability of dietary P is not only influenced by the P content of the diet, but the ratio of Ca:P and source of P have also been demonstrated to play important roles in absorption."*
- Whole food versus supplementary forms of phosphorus affect plasma and urine levels of phosphorus differently: *"Phosphates are widely used in commercial human and pet food manufacturing, where they serve a number of processing functions and as a source of required dietary P. Such P salts easily disassociate, solubilise and are readily absorbed in the intestinal tract; hence, P absorption can be greatly influenced by the chemical form ingested, with both*

circulating P concentration and urinary P excretion influenced by differences in dietary P availability."

- Supplementary phosphorus is considerably more bioavailable than whole food phosphorus, which suggests there is a greater risk for excessive phosphorus absorption on a processed diet: *"Evidence suggests that over 90% of inorganic P may be bioavailable, compared with between 40 and 60% for naturally occurring sources."*

- Supplementary phosphorus (compared to whole food phosphorus) may actually be harming the kidneys of healthy cats: *"Our findings therefore support other reports indicating that diets including high levels of P from inorganic salts may have adverse effects on renal health in healthy cats."*

Zinc also acts differently depending on the source. Karen et al (1998) found that organic zinc sources were more bioavailable compared to inorganic zinc (such as the zinc oxide form used in Hills products). They explained that:

> *"organic Zn sources resulted in greater Zn retention, higher concentrations of Zn in hair and greater hair growth compared with ZnO."*

No doubt there is still much to learn about the difference between synthetic and whole food nutrients. What little we know so far is not yet accounted for in AAFCO recommendations.

In many (maybe most) cases micronutrients present in whole foods are absorbed and utilised in a way that makes deficiency and excess less likely.

> *"Clinicians should also highlight the many advantages of obtaining vitamins and minerals from food instead of from supplements. Micronutrients in food are typically better absorbed by the body and are associated with fewer potential adverse effects."*

b) Additives

A range of additives can be used to make food safe, stable, palatable, and convenient to handle and store. Long shelf lives are convenient for pet owners. But many of the additives used are controversial in terms of their effects on health. An article in Autoimmunity Reviews (2015) postulated mechanisms by which food additives contribute to the rise in prevalence of autoimmune conditions.

A paper in the Journal of Small Animal Practice (2021) reviewed the most common pet food additives, and found a number of concerning effects, for example: reductions in protein digestibility, potential carcinogenesis, haematological abnormalities, reduction in micronutrient availability, inflammation, and genotoxicity.

Our raw diet contains no additives. It is inherently palatable. Safety and stability is maintained through proper storage and shorter shelf life.

3) PREY MODEL

The prey model is about numbers: 80:10:10 (80% meat, 10% bone, 10% organs). These numbers have no scientific basis, because they will vary depending on the prey. Our own dissection studies at Raw Essentials revealed a rabbit (ideal prey for cats and dogs) to be about 25% bone. There will also be variation in what bits of the prey are eaten - a pet may eat whole prey, but more often they will be selective regarding the parts that they favour.

Whilst a quantitative approach can offer us valuable guidance, - it is incredibly difficult to apply in real life. Numbers simply do not behave once they are unleashed in the complex matrix of nutrient, gene, microbiota, environment and lifestyle interactions. Underestimating this can result in a false sense of security. Equally, striving to achieve a rigid adherence to numbers can create a great deal of stress.

We keep things as simple as possible. We aim to cover all the bases by offering a variety of nutrient-dense food. We allow the pet some room to follow their natural instincts. And we constantly ask ourselves: "*Is this*

working? *Are our pets thriving?*" Feedback from the animal is vitally important - energy levels, demeanour, appetite, digestion, coat and body condition, bloodwork - all key indicators of health and vitality. (Afterall, this is what the short AAFCO trials are based on).

4) CARBS & VEGES

a) Carbohydrates

The rise in obesity in pets is concerning, and the role of carbohydrates is increasingly well understood. Fat cells produce inflammatory cytokines and contribute to a range of disease states.

Nutritional ecologist, Professor David Raubenheimer, demonstrated that dogs, cats and humans eat to satisfy their protein requirements. By diluting the protein content of a diet with carbohydrates, the dog, cat or human will be driven to eat their way through the extra carbohydrate in order to get enough protein.

Humans, dogs and cats have no established requirement for carbohydrates. They are expendable - the one macronutrient that we can all survive without. Additionally, the fibre component of carbohydrates reduces the absorption of essential nutrients.

We refer to a raw diet supplemented with carbohydrates as 'mixed feeding.' Mixed feeding may impact gastric acidity, thus impeding protein digestion and raising the risk of food-bourne illness. * * * * *

b) Vegetables

Feeding vegetables to pets is popular. To some degree, dogs will scavenge and eat vegetation in the wild, so it seems likely that many dogs will tolerate some vegetable matter without problems. But figuring out which vegetables are appropriate can be challenging. And we find they can be problematic in general for dogs with weight problems, or digestive issues.

In addition to adding to the carbohydrate load of the diet, some vegetables contain antinutrients:

- **Glucosinolates** * * in cruciferous vegetables can
  - prevent iodine absorption, which may then interfere with thyroid function and cause goiter
  - affect renal/hepatic function

  It is hard to find data specific to cats and dogs, however research shows that ruminants (herbivores) have relatively high tolerance to glucosinolates, while pigs (omnivores) have low tolerance. This may suggest that cats and dogs are likely to have low tolerance.

The EFSA Journal (2008) 590, 1-76

Glucosinolates as undesirable substances in animal feed[1]

Scientific Panel on Contaminants in the Food Chain

(Question N° EFSA-Q-2003-061)

Adopted on 27 November 2007

biological effects of plant glucosinolates in mammalian species are predominantly related to these glucosinolate-derived compounds. They interfere with iodine uptake (thiocyanate ion) and the synthesis of thyroid hormones triiodothyronine (T_3) and plasma thyroxine (T_4) (5-vinyloxazolidine-2 thione), leading eventually to hypothyroidism and enlargement of the thyroid gland (goitre). As a consequence of these changes in thyroid function, clinical signs of toxicity described in farm animals include growth retardation, reduction in performance (milk and egg production), impaired reproductive activity, and impairment of liver and kidney functions, the latter are likely being associated with the formation of nitriles. Data on the toxicity of individual

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Animal Feed Science and Technology
132 (2007) 1–27

ANIMAL FEED SCIENCE AND TECHNOLOGY

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Review

Glucosinolates in animal nutrition: A review

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Received 20 March 2005; received in revised form 2 February 2006; accepted 7 March 2006

Abstract

Glucosinolates (Gls) are secondary plant metabolites that occur in all Brassica-originated feeds and fodders. Content and composition of Gls vary due to plant species, agronomic practices and climatic conditions. The Gls content is generally higher in rapeseed meal (RSM) varieties grown under tropical environment than those occur in temperate regions. The RSM from Indian sub-continent contain primarily 3-butenyl, 2-propenyl and 4-pentenyl glucosinolates. But 2-propenyl glucosinolate accounts more than 0.95 of their total glucosinolates present in RSM of European and other temperate countries, and did not contain 4-pentenyl glucosinolates. Depending on the pH, cofactors and Gls content and composition of RSM, major metabolites of glucosinolates are thiocyanates (SCN), isothiocyanates (ITC), nitriles, 5-vinyl-2-oxazolidinethione (VOT) and 5-vinyl-1,3-oxyzolodine-2-thione (5-VOT). Apart from total glucosinolate (TGls) content SCN, nitriles and VOT estimates are the chief attribute of RSM quality as these are produced upon hydrolysis of Gls following the processing of RSM. Major deleterious effects of glucosinolates ingestion in animals are reduced palatability, decreased growth and production. Progoitrin and epi-progoitrin impair palatability at a level between 2.3 and 4.65 μmol g^{-1} diet, while at higher levels feed intake decreases. Nitriles are known to affect liver and kidney functions. The thiocyanates interfere with iodine availability, whereas VOT is responsible for the morphological and physiological changes of thyroid. Difference in Gls profile among the RSM induces varying levels of glucosinolates metabolites in animal tissues. Rapeseed meal feeding did not impair quality traits of carcass and increased unsaturated fatty acids ($C_{22:2}$ and *trans* $C_{18:1}$) content in carcass and milk fat. Ruminants are less sensitive to dietary glucosinolates. Pigs are more severely affected by dietary glucosinolate compared to rabbit, poultry and fish. The tolerance level

- Lectins in legumes and grains can interfere with the absorption of calcium, iron, phosphorus, and zinc.

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The Nutrition Source

> The Nutrition Source > Are anti-nutrients harmful? > Lectins

THE NUTRITION SOURCE

Lectins

Animal and cell studies have found that active lectins can interfere with the absorption of minerals, especially calcium, iron, phosphorus, and zinc. Legumes and cereals often contain these minerals, so the concurrent presence of lectins may prevent the absorption and use of these minerals in the body. Lectins can also bind to cells lining the digestive tract. This may disrupt the breakdown and absorption of nutrients, and affect the growth and action of intestinal flora. Because lectin proteins bind to cells for long periods of time, they can potentially cause an autoimmune response and are theorized to play a role in inflammatory conditions like rheumatoid arthritis and type 1 diabetes. [2,3]

There are different types of lectins in different foods, and the reactions people have to them vary widely. It is possible that one who has an underlying digestive sensitivity, such as irritable bowel syndrome, may be more likely to experience negative symptoms from eating lectins and other anti-nutrients. Because the reported symptoms of lectin sensitivity are recognizable with

- **Oxalates** * * in leafy greens may inhibit calcium absorption, contribute to urinary tract stones, and cause gastroenteritis.

Review article — Oorsigartikel

Potential plant poisonings in dogs and cats in southern Africa

C J Botha[a*] and M-L Penrith[b,c]

0038-2809 Jl S.Afr.vet.Ass. (2009) 80(2): 63–74

❖ Soluble oxalate-containing plants

Numerous plants contain soluble oxalates, including common garden plants and vegetables eg. Mesembryanthemaceae (mesems, *vygies*), *Beta vulgaris* (beetroot), *Spinacia oleracea* (spinach), *Oxalis* spp., *Parthenocissus quinquefolia* (Virginia creeper) (Fig. 12), *Rheum* spp. (rhubarb) and *Opuntia* spp. (prickly pear, *turksvy*). Soluble oxalate poisoning has been described in several species of livestock[32] but is relatively rare in dogs and cats[37]. Poisoning occurs when the absorbed oxalates bind serum calcium, resulting in systemic hypocalcaemia. Clinical manifestations include muscle fasciculations, tetany, convulsions, cardiac arrhythmia and nephrosis, which is indicated by polyuria that may progress to anuria. Animals may be weak and lethargic, and show generalised incoordination and signs of abdominal distress[37]. Blood chemistry reveals low calcium and elevated ammonia and BUN. The most prominent histopathological lesions are severe nephrosis with deposition of oxalate crystals in the kidney tubules, dilatation and necrosis of tubules with hyaline and cellular casts, and sometimes tubular regeneration[32].

Food intolerance in dogs and cats

J. M. Craig[1]

Journal of Small Animal Practice (2018)
DOI: 10.1111/jsap.12959

Accepted: 6 October 2018

Plant-derived toxins

Oxalic acid

Oxalic acid and its salts occur as end-products of metabolism in a number of plant tissues, which, if eaten, may have an adverse effect because of the ability of oxalates to bind calcium and other minerals. Although oxalic acid is a normal end-product of mammalian metabolism, the consumption of additional oxalic acid may cause stone formation in the urinary tract. In humans, diets low in calcium and high in oxalates are not recommended (Noonan & Savage 1999).

Lower urinary tract stones are more common in dogs and cats than they are in humans (Syme 2012). The prevalence of calcium oxalate stones, the second most common type (after struvite calculi) found in companion animals, increased in dogs fairly steadily in the three decades leading up to 2012, and in cats quite dramatically between 1981 and 2002. One proposed reason for this is a change in diet. In the 1980s, in an attempt to reduce the prevalence of struvite calculi, most commercial brands of pet food (especially feline diets) were essentially reformulated to be more acidifying and to contain less magnesium. It is possible that there was also a shift in owner-preference to feeding more dry (*i.e.* "kibble") rather than moist (*i.e.* canned or sachet) formulations (Syme 2012).

High levels of oxalates and anthraquinone glycosides in rhubarb, spinach and beetroot can cause gastroenteritis in dogs (Roudebush *et al.* 2000).

- **Phytates** * (in grains, seeds, legumes, and nuts) may inhibit absorption of iron, zinc, magnesium, and calcium. Dietary/organic sourced zinc is less susceptible to phytate-inhibition, so theoretically raw-fed pets should be more resistant to this interaction.

animals

MDPI

Article

Effect of Zinc Source and Exogenous Enzymes Supplementation on Zinc Status in Dogs Fed High Phytate Diets

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Received: 23 January 2020; Accepted: 28 February 2020; Published: 29 February 2020

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Simple Summary: Pet food is a sector in expansion, demanding novel solutions for old issues. The mineral supplementation of animal feed has been a target of research for livestock animals, but less attention has been devoted to companion animals. The present study offers both nutritionists and pet food manufacturers knowledge concerning organic and inorganic sources of zinc for dog food supplementation. Zinc proteinate and zinc sulfate were added to a high phytate dry food for healthy dogs at maintenance. Moreover, the role of exogenous enzymes to overcome the undesirable effects of phytates was also studied, with the inclusion of a solid-state fermentation product from *Aspergillus niger*. Data suggest that organic zinc is promising for dog food supplementation. Yet, the use of exogenous enzymes seems to require refinement to fit the needs and physiological conditions of dogs and thus add value to mineral availability and nutrient digestibility.

Abstract: Zinc is an essential element, a cofactor of many enzymes, and performs catalytic, structural and regulatory functions. Once in the gastrointestinal tract, zinc can interact with food constituents. Phytic acid, the major phosphorus storage in plants, limits zinc availability from animal feeds due to the formation of insoluble complexes with phytates. This study tested the effect of supplemental zinc source (zinc sulfate and a chelate zinc proteinate) and the addition of exogenous enzymes

Even with dietary Zn levels above this recommended minimum, symptoms of Zn deficiency may occur, as the availability of Zn is not merely dependent on its own dietary content [4], but also on its interaction with other elements, especially Cu, Fe, and Ca, and the presence of dietary antagonists.

Phytic acid (PA) is considered the major dietary constituent that limits Zn availability due to the formation of insoluble complexes [5]. Phytic acid is the main form of P storage in plants, and is widely found in cereals, legume seeds, oilseeds, and cereal by-products.

Dietary fibers might also decrease Zn bioavailability due to the formation of insoluble chelates [6]. Dietary fiber is traditionally used in dog foods to promote stool quality and is comprised of the plant components of the diet that are not digested by endogenous enzymes but are fermented in the large intestine with the production of gases and volatile fatty acids. Non-starch polysaccharides (NSP) are a component of dietary fiber and comprise soluble and insoluble fractions. Soluble NSP become viscous in solution, inhibiting endogenous enzymes to interact with nutrients, compromising nutrient digestibility [6]. Despite being important for bacterial biomass, an excessive fermentation of soluble NSP in the large intestine induces poor fecal quality [7]. Insoluble NSP are important to bulk feces, but can also reduce nutrient and mineral digestibility by setting nutrients apart from endogenous enzymes and by binding minerals within polysaccharide and phytate molecules [6]. The addition of exogenous enzymes has been used as a strategy to reduce the undesired effects of fiber and phytate and thus improve feed efficiency in fish and broillers [8,9].

The magnitude of the effect of dietary antagonists and interaction with other elements on Zn bioavailability may be influenced by the source of supplemental Zn. It is well known that inorganic sources of Zn, such as Zn oxide or Zn sulfate, commonly used in dog food supplementation, are more susceptible to interaction with other dietary constituents when compared to organic forms of Zn [10], whose bioavailability may depend on the nature of the organic form [11]. The greater absorption of organic Zn sources as Zn amino-acid chelate [12] and Zn propionate [4], reported in dogs, is more likely

Phytic acid

Phytic acid is the major storage form of phosphorus in cereals, legumes, oil seeds and nuts (Gupta *et al.* 2015). Beneficial activities include effects on calcification and kidney stone formation, and lowering of blood glucose and lipids. However, it chelates micronutrients reducing bioavailability in monogastric animals such as humans, dogs and cats, which lack the enzyme phytase in their digestive tract (Schlemmer *et al.* 2009).

High levels of dietary phytate may hinder intestinal zinc absorption in dogs. Historically, most cases of zinc-responsive dermatosis in dogs were associated with feeding poor quality, cereal- or soy-based dry foods, the effects of which may have been exacerbated in some animals by a simultaneous inherent defect of zinc absorption (Watson 1998).

- Thiamine deficiency can be fatal. Fruits and vegetables such as blueberries and red cabbage destroy thiamine. The impact has not been studied in dogs and cats, however it is a theoretical risk.

veterinary sciences

MDPI

Review

The Role of Thiamine and Effects of Deficiency in Dogs and Cats

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Received: 31 July 2017; Accepted: 17 November 2017; Published: 24 November 2017

Abstract: Recent pet food recalls for insufficient dietary thiamine have highlighted the importance of adequate thiamine intake in dogs and cats, as thiamine is an essential dietary nutrient with a critical role in energy metabolism. Prolonged thiamine deficiency leads to clinical signs that can span several organ systems, and deficiency can be fatal if not reversed. In this review, the current knowledge of thiamine metabolism will be summarized. Dietary recommendations for dogs and cats will be discussed, and the risk factors and clinical signs associated with thiamine deficiency will be examined.

Keywords: vitamin B_1; water-soluble vitamins; dog food; cat food; nutrient imbalance

and destroy thiamine by an oxidative process that transforms it to non-absorbable thiamine disulfide [17,63,66,87–90]. Plants containing polyhydroxyphenols include coffee, tea, and some fruits and vegetables, such as blueberries and red cabbage [17]. While research in dogs and cats has not been conducted to determine the effect of plant-derived anti-thiamine factors on blood nutrient concentrations, the presence of anti-thiamine factors in plant matter may be of importance for dogs and cats being fed homemade diets or large portions of table scraps containing ingredients with these compounds.

- **Canine Dilated Cardiomyopathy** - we still have a lot to learn on this issue, but it seems to be pretty well accepted that it is related to the vegetable content of grain-free diets.
- **Gluten/Oats/Fibre** - a study in the 'Journal of the American Medical Association - Paediatrics' showed that high childhood intakes of these correlate with the development of autoimmune disease. There are so many other studies about the negative impacts of gluten and grains that we recommend absolutely avoiding them.
- **Fibre** is believed to be beneficial in humans largely because it undergoes anaerobic bacterial fermentation in the large bowel, giving rise to short chain fatty acids (which promote and maintain a healthy gut wall, and control inflammation). Humans, dogs and cats have no requirement for carbohydrates, and therefore fibre, as an essential nutrient. It has been demonstrated in cheetahs that connective tissue and other nondigestible animal matter (bones, tendons, cartilage, hair, feathers) act as substrates for large bowel microbes, giving rise to plentiful SCFAs and other beneficial compounds. Unfortunately, the value of plant fibre has been overemphasised in humans, and anthropomorphised to pets. Despite a widespread campaign to the contrary, there are numerous studies showing a detrimental effect of fibre on human health. *

Published in final edited form as:
Gastroenterology. 2012 February ; 142(2): 266–72.e1. doi:10.1053/j.gastro.2011.10.035.

A High-Fiber Diet Does Not Protect Against Asymptomatic Diverticulosis

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Abstract

BACKGROUND & AIMS—The complications of diverticulosis cause considerable morbidity in the United States; health care expenditures for this disorder are estimated to be $2.5 billion per year. Many physicians and patients believe that a high-fiber diet and frequent bowel movements prevent the development of diverticulosis. Evidence for these associations is poor. We sought to determine whether low-fiber or high-fat diets, diets that include large quantities of red meat, constipation, or physical inactivity increase risk for asymptomatic diverticulosis.

METHODS—We performed a crosssectional study of 2104 participants, 30–80 years old, who underwent outpatient colonoscopy from 1998 to 2010. Diet and physical activity were assessed in interviews using validated instruments.

RESULTS—The prevalence of diverticulosis increased with age, as expected. High intake of fiber did not reduce the prevalence of diverticulosis. Instead, the quartile with the highest fiber intake had a greater prevalence of diverticulosis than the lowest (prevalence ratio = 1.30; 95% confidence interval, 1.13–1.50). Risk increased when calculated based on intake of total fiber, fiber from grains, soluble fiber, and insoluble fiber. Constipation was not a risk factor. Compared to individuals with <7 bowel movements per week, individuals with > 15 bower movements per week had a 70% greater risk for diverticulosis (prevalence ratio = 1.70; 95% confidence interval, 1.24–2.34). Neither physical inactivity nor intake of fat or red meat was associated with diverticulosis.

CONCLUSIONS—A high-fiber diet and increased frequency of bowel movements are associated with greater, rather than lower, prevalence of diverticulosis. Hypotheses regarding risk factors for asymptomatic diverticulosis should be reconsidered.

Journal of Animal Physiology and Animal Nutrition

DOI: 10.1111/j.1439-0396.2011.01252.x

ORIGINAL ARTICLE

Animal fibre: The forgotten nutrient in strict carnivores? First insights in the cheetah

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Keywords
Acinonyx jubatus, fermentation, whole prey, intestinal health

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Summary

As wild felids are obligate carnivores, it is likely that poorly enzymatically digestible animal tissues determine hindgut fermentation, instead of plant fibre. Therefore, faecal concentrations of short-chain fatty acids (SCFA, including branched-chain fatty acids, BCFA), indole and phenol were evaluated in 14 captive cheetahs, fed two different diets differing in proportion of poorly enzymatically digestible animal tissue. Using a

5) FREEZE DRYING - WE DO IT A BIT

Freeze-drying is a really useful option for raw feeders, and it can reduce microbial loads.

We do freeze-dry some of our products to use in addition to a frozen raw diet. It is handy for pet owners going away on holiday, or for when someone is pet-sitting. We don't recommend feeding freeze-dried as the main diet, however, because it may result in suboptimal gastric acidity.

Lichtenberger (1982) described the effect of freeze-drying on gastric acidity:

> *"lyophilization (freeze-drying) resulted in a significant 50% reduction on the diet's ability to stimulate [gastrin] release."*

Those with impaired gastric acidity are at greater risk of food-bourne illness. * * A healthy carnivore is generally well equipped with gastric secretions and microbes which allows them to safely digest high bacterial loads.

MINIMALLY FORMULATED DIETS - WHAT WE DO

1) FORMULATE USING NUTRITIONAL ECOLOGY

It is clear, from both an evolutionary perspective and from nutritional analysis of prey species, that a well planned raw diet provides an appropriate range and balance of micronutrients from which the individual pet can absorb and utilise nutrients to meet their needs. Evolution has provided us with most of what we need to know for this. The fact that dogs have survived well over 100,000 years on a predominantly prey-based diet speaks volumes for the suitability of a prey-based diet.

We 'loosely' formulate, based on nutritional ecology and evolutionary science. We know that wild dogs and cats consume wild prey. They usually consume more than one species, and they eat a variable ratio of meat, bone, organs and tripe. It is somewhat easier to balance a diet for carnivores, relative to other classifications, given that:

> "*prey are less variable in nutrient composition than the foods of herbivores and omnivores*"

Wild canids may, to a varying degree, eat some plant matter too. This plant matter is not the same as the fruit and vegetables available in your local supermarket, and we have discussed potential issues with the types of plant matter that people might feed their pets. We keep it simple by feeding a small amount of plant matter in the form of stomach contents (green tripe).

Macronutrient studies have shown us that protein and fat are the most important macronutrients, and that protein levels are the key to balancing intake. Raubenheimer et al have established macronutrient preferences for dogs (30%protein:63%fat:7%carb) and cats (52% protein:36% fat:12%carb).

Bear in mind that - although dogs, cats, and even humans have no established requirement for carbohydrates - these studies included various levels of carbohydrate in order to factor in the reality that most modern petfoods will contain carbohydrates.

> *"For most carnivores, the relevant macronutrient space is two-dimensional: protein and fat are the most important macronutrients, whereas carbohydrate is rare in natural foods and plays a lesser role in nutritional regulation."*

Cats and dogs (and humans, as it turns out) eat to satisfy their protein requirements. If more of their diet consists of carbohydrates, they will try and eat their way through the excess carbs in order to reach their inherent protein goals. This happens with fat, but to a much lesser extent.

> *"when confined to diets that prevented them from achieving the target intake, the cats showed a complex pattern of compromises. On low-protein diets they overate both fat and carbohydrate to approach their target protein intake, but carbohydrate represented more of an impediment to protein gain than did fat."*

> *"When unsuccessful* [at reaching optimal protein intake]*, cats fed commercial foods will be held in a chronic state of nutritional imbalance. This raises welfare concerns, and will also in the long term likely affect cat metabolism and health."*

Cats and dogs have both been shown to balance their own diets when offered a range of foods. On a varied raw diet, we have some room to move with our fat and protein levels.

> *"cats are better adapted to deal with variation in the protein to fat balance of their diet than the protein to carbohydrate balance, which probably reflects the low levels of carbohydrate in their pre-domesticated ancestral diets"*

This may explain to some extent what we regularly see in practise: our dog and cat owners tell us that their pets will often change their product preferences over time - one week, their pet may prefer rabbit legs; the next they may opt for wallaby mince. Our clients become very intune with the dietary choices of their pets.

> *"If given the opportunity, cats are capable of composing the preferred diet by mixing their intake from nutritionally complementary foods, but in reality they are seldom provided by their owners the luxury of several complementary foods."*

It is a uniquely satisfying aspect of our diet of mixed, raw prey that we are able to give some credence to the innate abilities of our domestic carnivores to participate in managing their own food selection.

So we advise our clients thus: feed a mix of raw meat, bones, organs and tripe from a range of prey species. Feed an amount that maintains your pet at an ideal weight. While some clients find the lack of prescriptiveness initially unnerving (it's funny how simplicity can be scary when we are used to being told that nutrition is such a complex beast), this soon changes to a feeling of empowerment when clients realise that they are well-educated raw feeders who know exactly how to feed their pet. In fact, clients often tell us that they have re-learned their own relationship with food after experiencing the joys of real-feeding their pets.

2) TESTING

Whilst we are focused on a whole food approach, we understand that vets with conventional nutrition training will often question the nutritional completeness of our diets. Nothing unnerves the reductionist nutritionist quite so much as the absence of a nutritional panel.

Each pet that we feed is a little different. The diet will be tailored to them, and will change over time, and with seasons. This renders accurate 'complete and balanced' testing impossible.

We do some testing to help reassure vets of the suitability of our diet for domestic carnivores. Our testing is targeted on common areas of concern. We generally test a sample 'average' diet that has been minced together, as well as a selection of individual products. In addition to general macro and micronutrient panels, some of the things we have specifically tested for include:

- Calcium:Phosphorus ratios (for growing dogs)
- Fat content (for pancreatitis diets)
- Taurine and thiamine (particularly for cats)

3) NUTRITIONAL AIDS

The majority of our clients do very well on their diets of meat, bones, organs and tripe. We may use nutritional aids in our protocols for those with clinical conditions.

Bone broth: As discussed earlier, this is the basis of our gut healing protocols. We make our own bone broth and supply it in frozen sachets. Alternatively, we teach clients how to use our meaty bones to make their own if they choose.

Probiotics: Whilst we aim to influence the microbiome through appropriate food, beneficial microbe supplementation may help influence the environment in the gut. We use a range of probiotics including spore based products.

Digestive enzymes/aids: These are particularly for dogs with challenged gastric acidity due to aging, medications, disease, dietary carbohydrates and anxiety.

Herbal: We use this for gastric acidity support, liver tonic, microbiome influence

Diatomaceous earth: For parasite burdens and microbiome biofilms.

Glandulars: Whilst we have as much organ variety as possible within our frozen product range, we also use freeze dried organ products to provide nutrient boosts and support the corresponding organs.

Blended food supplement 'Superfood Crunch': Our freeze dried blend of bones, tendons, cartilage and organs is a useful nutrient boost to use in our short term protocols, and to provide additional substrates for large bowel microbes.

4) CLINICAL EXPERIENCE

We moved a little more toward the formulated end of the spectrum for our 'prescription' diets - designed for pets with clinical conditions.

Our clinical cases are closely monitored by our veterinary support team and in-store case managers. Most of these protocols begin with novel meats poached in bone broth. This easily digestible phase gives the gut a chance to rest, and inflammation a chance to settle.

Bone broth contains an array of amino acids known to be immunomodulatory. Mouse studies have shown that they can significantly reduce gut inflammation. Bone broth is similar in composition to EEN (exclusive enteral nutrition) drinks that are given to hospitalised sufferers of severe gut inflammation, to heal their mucosal lining. Studies * * have shown these drinks to be more effective than steroid treatment for inducing remission in Crohn's disease patients.

Once we are satisfied that the digestive tract is settled, we proceed gradually towards a maintenance raw diet by introducing the various components in a stepwise fashion: raw meat, minced bone, tripe, organs, and whole bones from a variety of sources. We tailor this to each individual pet, using our clinical experience and extensive product range.

We consider each clinical case, in its entirety, as to whether we can accommodate them with our food, within our recommendations. Very occasionally we may advise a client and their veterinarian that a switch to a raw diet would not be advisable.

Sometimes we face a challenging situation in which we feel that a change to raw *is* appropriate, the primary veterinarian disagrees, but the client wishes to proceed with the change against their vet's advice. In most cases, we are able to resolve the conflict with some sensitive diplomacy.

It's interesting to look at processed prescription diets, and their main variations from regular commercial pet foods. Many actually seem to be taking steps towards a raw diet by:

- improving omega ratios
- boosting vitamin B content
- lowering carbohydrate
- glucosamine/chondroitin supplementation
- improving protein sources, adding amino acids (taurine, L-carnitine) etc
- avoiding excess copper
- adding antioxidants

I can't help asking the question - *why wouldn't they want these enhancements in every commercial diet*?

Let's touch on a couple of the more challenging disease states we deal with -

Hyperlipidaemia

Primary veterinarians may ask us to formulate low-fat diets for their hyperlipidaemia patients. It is a complex disease, especially where genetics are a factor (ie in schnauzers). We do not yet have canine hyperlipidaemia studies examining a range of fat and carbohydrate contents within the context of a raw diet. There is growing evidence in the human realm to suggest it's more of a carbohydrate issue than a fat issue:

> *"This meta-analysis suggests that low-carbohydrate diets are effective at improving weight loss, HDL and TG lipid profiles."*
>
> *"The consumption of diets rich in carbohydrates have been shown to promote elevations in circulating lipids. In particular, the consumption of monosaccharides, such as glucose and fructose, have been shown to induce increases in intestinal de novo lipogenesis, as well as be used as a substrate for the synthesis of triglycerides and lipoprotein export in the form of chylomicrons."*

So currently we use the product testing that we have done to identify our lower fat products. Our diet is already essentially carbohydrate-free.

Cystine uroliths

Research suggests there are many more Type 3's (androgen dependent mutation) than once thought, which is consistent with what I have observed in my recent cases which have responded well to neutering.

Ammonium urate uroliths

A low purine diet can be successful. This involves avoiding the particularly nutritious organs, seafood and wild prey, however it is still a more appealing option for many than long term u/d.

Renal disease

It is commonly believed that reducing protein, and more especially phosphorus intake is the cornerstone of treating renal disease. A deeper look into the science raises some questions around this approach.

Finco et al found that dog survival was significantly enhanced by 0.4% (vs 1.4%) P diets, however the amount of dietary protein was not a significant factor. Urine protein excretion was not affected by the amount of protein or P in the diet. They also found that protein restriction was not helpful for cats:

> *"Diets replete in protein were not associated with increased severity of glomerular or nonglomerular renal lesions, increased proteinuria, or decreased GFR... Results raise questions about the practice of restricting quantity of protein in the diet of cats with chronic renal failure, with the intention of ameliorating development of further renal damage."*

It is important to maintain adequate protein levels to avoid wasting. This is easily done on a raw diet.

The amount of phosphorus in the diet may be less important than the type of phosphorus. As discussed earlier, phosphorus from a natural source is absorbed and utilised in a different manner compared to the synthetic sources in processed food. While we can alter our diets to reduce phosphorus somewhat, and will do this when a primary veterinarian requests it, experience has shown us that normal calcium:phosphorus ratios in a well-planned raw diet can support renal pets.

Proteinuria

Whilst the IRIS consensus for proteinuric pets recommends reduced dietary protein, there is actually very little research to support this. It is a very complex disease state requiring more research. I have a few cases which have needed to continue with raw food for various reasons which hasn't been detrimental to their health.

Feed the individual: Our close relationship with clients allows us to adjust protocols for the individual - prescription-type diets.

CONCLUSION

> *"Look deep into nature, and then you will understand everything better."* (Albert Einstein)

First and foremost, we believe that the very best diets consist of species-appropriate, real food. This concept is one-size-fits-all.

The details within this concept may differ along various lines, formulation being one of them. We acknowledge that high quality raw diets can fit within a range of formulation types.

We sit comfortably and confidently on the minimal formulation end of the spectrum - as close to nature as we can be, within the confines of modern life.

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