PEER REVIEWED

Nutritional Benefits of Raw and Lightly Processed Pet Foods

The use of raw and lightly processed foods has seen significant growth in the past several years in North America. Dog food products with raw claims saw a nearly 70% increase in sales during 2017 (Heflin, 2019). And those familiar with North American pet food production realise the considerable growth that lightly processed pet food is experiencing by FreshPet, while other parts of the world recognise the impact that The Real Pet Food Company is having by providing lightly processed and raw pet foods.

Worth the Risk?

As one explores the area of lightly processed and raw food, the primary objection is the risk of pathogen contamination. Increased pathogen contamination has been reported in raw foods (Strohmeyer *et al.*, 2006); whereas Fredricksson-Ahomaa *et al.* (2017) reviewed several studies as well as generating original research indicating sporadic or minor risk of pathogen contamination in raw dog and cat foods. Associated with reduced processing is the need to refrigerate (or freeze) high moisture (>50%) raw or lightly processed foods to reduce the speed at which spoilage organisms take over the product and make it unsuitable for feeding.

Beyond the Risk

While lightly processed and raw foods can present increased risk in decreased shelf-life and/or pathogen contamination, consumers still desire to feed these product forms to their pets and are willing to pay for the convenience that commercially prepared foods offer. Oftentimes consumers have the belief that reduced processing of the food is healthier for the pet. Is that true? Let's look at the evidence.

Modifying the Microbiome

Reduced processing of pet food involves less heating of the food. Reduced heating can allow the addition and survival of certain beneficial organisms (i.e., probiotics). This creates a unique and exciting opportunity to use the food to deliver microorganisms that would otherwise not be available due to heat treatment.

In addition, a growing number of research articles are beginning to evaluate the effect of raw foods compared to traditionally (e.g., extruded, canned) processed foods. Following is a brief summary of research articles identified in this area.

Bermingham *et al.* (2017) observed changes in faecal bacteria populations which are generally consistent with higher meat content, when dogs consumed a raw meat diet compared to a traditional kibbled diet. Consistent with the expected impacts of higher meat content, Algya *et al.* (2018) also found that a raw diet resulted in lower actinobacteria/bifidobacterium and higher fusobacteria and proteobacteria than dogs fed an extruded diet. Surprisingly, Algya *et al.* (2018) found a decrease in Clostridia when the raw diet was consumed compared to the extruded diet. (Clostridia would normally rise in high meat diets.) Because several of the aforementioned bacterial changes and increased dietary levels of protein are expected, differences caused by diet processing methods are less likely.

Sandri *et al.* (2017) observed that the Shannon biodiversity index was increased while decreased numbers of Lactobacilli, Paralactobacillus and Prevotella genera and increased numbers of Clostridium XI and Megamonas genera occurred when dogs consumed the raw meat diet compared to an extruded diet. While Sandri *et al.* (2017) did not observe changes in firmicutes levels between the high protein, low carbohydrate raw meat diet compared to the moderate carbohydrate, moderate protein extruded diet, Schmidt *et al.* (2018) observed decreased firmicutes level when a high protein, low carbohydrate raw meat diet (n=27) was consumed by dogs compared to a control group of dogs fed extruded diets (n=13), canned diets (n=3), or a combination of extruded and canned diets (n=3). Similar to the findings of Sandri *et al.* (2017), Schmidt *et al.* (2018) found increased levels of *Enterobacteriaceae* when the raw meat diet was consumed compared to conventional diets. *Enterobacteriaceae* are generally associated with increased risk of pathogen growth but are also increased when more protein substrate is available in the large intestine. Schmidt *et al.* (2018) also found increased levels of Clostridium perfringens and *E. coli* when dogs consumed the raw meat diet compared to the conventional diet. Increased levels of *C. perfringens* and *E. coli* may pre-dispose the pet to intestinal pathogenesis. With that said, higher amounts of protein are also known to increase these bacterial species. As with previous diet comparisons, the ingredient composition varied between the raw and extruded diets, making it difficult to attribute differences due to ingredients or processing changes.

Intestinal actives (inulin or yeast cell wall extract) were added to diets based on raw chicken or beef to evaluate the ability of these non-meat sources to induce various prebiotic effects (Beloshapka *et al.*, 2013). Inulin increased Megamonas compared to control diets and decreased Escherichia compared to yeast cell wall extract. Inulin increased *Lactobacillus* compared to yeast cell wall extract. The authors explained that the relatively few changes in faecal microbiota, indicating a weak prebiotic effect, was surprising and postulated that the base diet's high protein and fat content simply overwhelmed any other dietary components, such as inulin or yeast cell wall, in altering the intestinal environment.

Nutrient Digestion

In producing dairy cows, milk production declines with the

addition of raw soybeans in the diet (Venturelli *et al.*, 2015), indicating the value of heat processing in decreasing anti-nutritional factors in raw vegetable seeds. In contrast, some researchers have found that raw and lightly processed foods have improved nutrients' digestibility compared to high heat processed (i.e., extruded) foods in dogs. Algya *et al.* (2018) found that a raw diet resulted in increased fat digestibility, whereas lightly processed diets had increased protein digestibility compared to an extruded diet. Bermingham *et al.* (2017) found that the energy, protein and fat digestibility were higher in a raw diet compared to an extruded diet. A caveat to interpreting the results from these studies is that dietary ingredients were not controlled, making it difficult to conclusively state that the processing methods were responsible for diet differences.

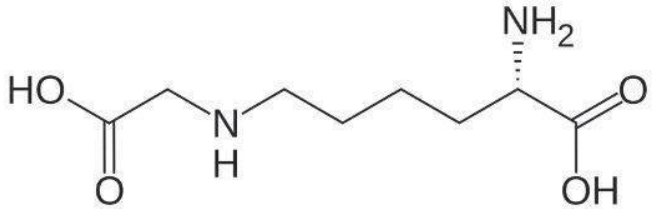
Nutrient digestibility in two raw diets were compared to a standard canned commercial diet when fed to kittens (Hamper *et al.*, 2016). Researchers reported significant increases in several nutrients' digestibility (dry matter, organic matter, crude protein, gross energy) when kittens consumed the raw diets compared to the canned diet. Raw diets resulted in less stool output compared to the canned diet. Researchers pointed out that diets varied in their ingredients and nutrients, thus limiting the extrapolation of their research findings. In the same study, the two raw diets were fed in an approved regulatory (AAFCO) protocol for supporting a claim for all life stages including growth (Hamper *et al.*, 2017). Researchers found that the growth of kittens on both the raw diets, compared to a commercial complete and balanced diet, was similar, indicating that the product was sufficient to meet an AAFCO all life stages (growth) claim.

AGEs

Heat Processing Artefacts

A growing body of evidence in human nutrition research points to the impact of advanced glycation endproducts (AGEs) on human health (Poulsen *et al.*, 2013). The heating of food during the cooking process results in a diverse set of AGEs (Anwar *et al.*, 2018; Guilbaud *et al.*, 2016). Carboxymethylysine is a widely studied AGE that is often measured and used to represent the broader group of AGEs (Guilbaud *et al.*, 2016). These substances are not new to the world of food science as historically many of them are referred to as Maillard Reaction products. An example of Maillard Reaction products being formed is the crust of bread. As the bread is baked, the amino acids and carbohydrates on the surface of the bread react in the presence of oxygen to form a brown crust. AGEs in human nutrition have been reported to be associated with a variety of increased maladies such as certain types of cancer, oxidative stress and inflammation, obesity, diabetes, renal insufficiency, and others (Poulsen *et al.*, 2013; Uribarri *et al.*, 2010; Jiao *et al.*, 2015) Many of these diseases also afflict pets.

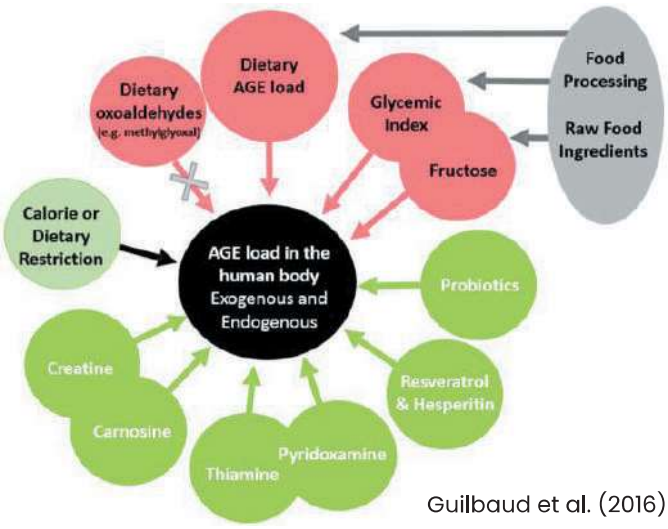
To compound matters, AGEs are produced endogenously (Henning and Glomb, 2016). Researchers discussing human diets have proposed a multifactorial model of mitigating the presence of AGEs in the body including: 1) altered food processing methods that reduce the formation of AGEs, 2) selection of food sources that naturally contain compounds antagonistic to AGE formation in the body, 3) reduction in total caloric intake, and 4) increased intake of raw foods. Such approaches point out the intrinsic value of raw or lightly processed foods to lessen the physiological burden and risk on the body.



Carboxymethyllysine

Interestingly, components of meat (e.g., creatine, carnosine, and thiamine) are antagonistic to the formation of AGEs (Guilbaud *et al.*, 2016). Will AGEs impact pet health similarly to what is purported in humans? Understanding this will shed light on an important putative benefit of raw or lightly processed foods for pets. An initial analysis of extruded, canned, and pelleted forms of pet foods has shown intake of AGEs by pets being 38 (cat foods) to 122 (dog foods) times the level of intake by human (van Rooijen *et al.*, 2014). Based on these findings, there is a need to study AGEs in pet foods and their impacts on pet health since raw or lightly processed foods could significantly decrease the AGE dietary load.

Factors Involved with Creating Advanced Glycation End-Products in the Body



Guilbaud et al. (2016)

Summary

The microbiome holds exciting promise given research findings in pets as well as many other species. The suggestion that lightly processed and raw diets vary from traditionally processed foods in their ability to affect the microbiome indicates the need for further follow-up study given the known profound impact of the microbiome on pet health.

Regarding differences of raw or lightly processed compared to traditionally processed (e.g., extruded, canned) diets on nutrient digestibility, current studies offer promise. Unfortunately, the experimental design of these studies makes it difficult to draw definitive conclusions just yet.

The paucity of AGEs research in dog and cat health points out the need to gain additional insights into these compounds' effects on pet health, especially given the large quantities of AGEs that are consumed by pets in current common product forms (i.e., extruded, canned).

Conclusions

As previously stated, many consumers have an interest in feeding their pets raw or lightly processed foods rather than traditionally processed (i.e., kibbles, canned) foods. Scientists in the field of pet nutrition are just beginning to understand the benefits of feeding raw and lightly processed foods. Studies conducted to date indicate that raw and lightly processed food products can exhibit different effects on the microbiome and superior nutrient digestibility when compared to processed (i.e., kibbled, canned) products. Future studies utilising more rigorous experimental designs can help better understand differences based on processing methodologies. The management of AGEs shows promise given the technical rationale for their health impact. Parallel understandings of AGEs on human health will be insightful to watch as a proxy for AGEs' relevance to pet health.

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Gregory D. Sunvold

With over 25 years of industry experience, Dr. Greg Sunvold currently serves in a scientific role for Cool Springs International based in Franklin, Tennessee, USA, where he assists in maintaining and delivering next-generation nutritional products for international clients. Leveraging his deep technical knowledge of the microbiome, Dr. Sunvold is currently focusing on how to apply innovations arising from this area into the pet food industry.

Email: greg@sunvoldtechnology.com