

Commercial or Raw Food Diet for Dogs: Nutrition and Gut Health

Neive Munrei A Ara-is

20 October 2023

BIOL 405W

Christopher Osgood

Abstract

The rising consciousness of the quality and type of food that humans eat is also paralleled in the realm of dog food. This is in response to the increasing sentiment of domesticated pets being part of the family and should be treated as well as a family member should be. One of the earliest alternative diets to emerge from this sentiment was the raw food diet (RFD) which is often paired with bones and called the Bones and Raw Food diet i.e. the BARF diet. This along with commercial dry dog food, kibble, are being evaluated. The aim of this study is to determine the nutritional value of both kibble and RFD and also to gauge their impacts on the microbiota of the canine gut. This is to gauge their individual merits and determine if either outclasses the other in terms of beneficial aspects to dogs. Nutritional value can be determined through nutritional composition analysis which is done through a large barrage of tests ranging from simple drying techniques to hydrolyzation and liquid-liquid extractions (Tanprasertsuk J. et al, 2021). Gut microbiota could not be tested directly and was done through fecal analysis (Kazimierska et. al, 2021). Fecal analysis was also used to calculate nutritional intake which was then used to calculate the digestibility of the diets (Tanprasertsuk J. et al, 2021).

Introduction

The common diet of domesticated canines has diversified over the years with the introduction of pet meal plans and the expansion of the basic knowledge of animal nutrition made available to the typical dog owner. Many dog owners themselves have moved away from feeding exclusively dried commercial dog food i.e. kibble. My goal is to determine the effects of raw food diets and commercial dog food diets on the gut microbiome of dogs and whether they either are beneficial or detrimental to digestion. Commercial dog food is quite a broad term and can even include alternative diets that are being sold and produced to a specific degree. For the sake of comparison, kibble was chosen as the commercial food to be studied. Kibble is a term used to describe dry pellet dog food that usually is sold commercially in a wide variety of grocery stores. The alternative diet to be studied is the raw food diet or the raw meat diet. Bone and Raw Food diet, or BARF diet, has also been used to refer to this specific diet. The diet consists of animal tissue and offals, bones, and some fruits and vegetables.

Diets

A raw food diet has increased in popularity over the years with many meal plans centering around this concept. This diet consists of raw organ and muscle meat, bones, raw eggs, fruits and vegetables, and dairy products. Benefits that are touted by advocates include shinier coats, healthier skin, improved dental health, increased energy, and smaller stools (Lee, 2009). This diet is not appropriate for all dogs, however, such as those in homes with small children or those with compromised immune systems (Pets O., 2020). This diet also requires a high degree of care in handling, preparing, and sanitizing the food and this diet is more viable for dogs older than a year (Pets O., 2020). There have been cases of salmonella poisoning from RFD as

thermally unprocessed meats, containing pathogenic bacteria that have not been thermally rendered inert, are being fed to domestic pets who are continuously around us.

The raw food diet has long been controversial in its usage by dog owners. The most prevalent reason given for the existence of the raw food diet is the ancestral species that domestic dogs descended from wolves. They argue that dogs should primarily eat raw meat and bones as that is the primary food source of their wolf cousins. This is not necessarily true as fecal analysis has shown large amounts of cholesterol are present which the dog's bodies could not absorb. This logic also discounts the fact that wolves live extremely active lives hunting and traversing large swathes of land, domestic dogs generally do not go through the same rigorous workout that wolves do. RFD also tends to stray towards deficiencies of some essential vitamins, fiber, and an overabundance of protein and fat. This is more often true for dog owners who have learned of the diet through the internet, which is true for a large majority of dog owners who have switched to a raw diet (Morelli, 2019). With such a large majority and only 8% of those people relying on actual veterinarians for diet formulation, there are bound to be errors in nutritional balances with those diets (Morelli, 2019).

The most widespread version of commercial dog food is kibble. Kibble is a dry food pellet composed of proteins, grains, vitamins, minerals, and antioxidants (Pets O., 2020). Most dry kibble contains large amounts of carbohydrates (Pets O., 2020). Kibble contains preservatives to extend its shelf life which makes it easier to store with less risk of spoilage which is cost-effective and it has a reduced risk of bacterial contamination. (Pets O., 2020). It is also believed to reduce dental plaque and help with healthier gums. Some of the risks of kibble have caused some dog owners to switch to other food alternatives.

The nutritional requirements of each dog are different and specific to their activity level, health, and their bodies. There is no one-size-fits-all, especially for diets. As an overgeneralization, a 30 lb adult dog who is active requires about 1353 kilocalories which equals 922 calories per day (*A Science-Based Guide for Pet Owners*, n.d.). A steep amount for any organism. It has been found that a dog's diet must contain a minimum of ~5.5% of fat and 10% of protein (*A Science-Based Guide for Pet Owners*, n.d.). A single serving of dog food can contain up to 50% carbohydrates with 2.5%-4.5% being fiber (*A Science-Based Guide for Pet Owners*, n.d.). This does not include the various vitamins and minerals that are required to keep dogs healthy such as Vitamin A which helps in development and growth. A deficiency of it can cause severe weight loss and anorexia, an overdose of it can also cause these symptoms along with dehydration, blood vessel degeneration, and joint pain. Unfortunately, most dog foods do not meet all of the criteria. Most kibble has too many carbohydrates and not enough fiber or vitamins and even raw food diets have to perfectly balance the sheer amount of protein with vegetables and fruits, both diets typically need to be varied and supplements need to be added.

Nutrients found in dog kibble entirely depend on its ingredient list which typically does not go into much detail. When choosing dog kibble, the most prevalent advice given to dog owners is to look at the ingredients list. Generally, ingredients are listed in order of decreasing quantity. If meat or animal products make up the first five ingredients of the kibble, it is generally seen as much healthier than a kibble that has cornmeal or wheat in the first five ingredients (Pets O., 2020). A study determining the different nutrient values and the digestibility of kibble and three types of fresh food was conducted (Tanprasertsuk J. et al, 2021).

Table 1.

Nutrient composition of the study diets

Measure	Kibble-chicken		
	FW	DM	g/Mcal ME ^a
Nutrient (%)			
Moisture	5.40	–	13.78
Protein	35.44	37.46	90.44
Fat	18.25	19.29	46.57
NFE	29.76	31.46	75.94
Total dietary Fiber	12.5	13.2	31.9
Crude fiber	3.3	3.5	8.4
Soluble fiber	9.2	9.7	23.48
Ash	7.85	8.30	20.03
Phosphorus	1.04	1.10	2.65
Calcium	1.37	1.45	3.50
Ca:P ratio	1.32	1.32	–
Calculated ME density (kcal/kg)^b			
Atwater	4,251	4,493	–
Modified Atwater	3,833	4,051	–

FW: fresh weight, DM: dry matter, NFE: nitrogen-free extract, ME: metabolizable energy

^aME calculated based on the measured food and fecal energy content with 10% efficiency^bAtwater and modified Atwater's ME calculation are explained in [Supplemental Table 1](#)

(Tanprasertsuk J, Perry LM, Tate DE, Honaker RW, Shmalberg J. Apparent total tract nutrient digestibility and metabolizable energy estimation in commercial fresh and extruded dry kibble dog foods. Transl Anim Sci. 2021 May 27;5(3):txab071. doi: 10.1093/tas/txab071. PMID: 34278234; PMCID: PMC8279163.)

A nutrient composition analysis of chicken-based kibble, fresh chicken, fresh beef, fresh pork, and fresh turkey, and the projected metabolized energy was also listed for each

one. The fresh weight by percent of the chicken-based kibble was 35.44% protein, 18.25% fat, and 12.5% dietary fiber(both crude and soluble) (Tanprasertsuk J. et al, 2021). The dry matter measurements were also listed and used to calculate the moisture content of the food which was predictable for kibble was relatively low (Tanprasertsuk J. et al, 2021).

Similarly to kibble, RFD's nutrient composition varies in the type of meat and what types of vegetables and fruits are included. Protein and fat are the staples of the dog's meal for RFD and the fat content of the meat should be taken into account as the total percentage of fat should be within the range of 10-20% total fat for the meal (Scott, 2023). This is in addition to the 10-15% of raw bones that are added in for calcium with puppies having the increased 12-15% (Scott, 2023). Organ meat is then added to 10% of the liver, 5% of the heart, and if the dog can tolerate it another 5-10% of other organ meats (Scott, 2023). A further 10% is taken up by fruits and vegetables which benefit the organs and help with inflammation (Scott, 2023).

Supplements are typically just added into the RFD when it is being prepared either through a powder, pill, or other additives. RFDs have a tendency to be deficient in Vitamin D and Manganese (Scott, 2023). This can be rectified by adding supplements or adding eggs, fish, mushrooms, or other foods high in both or either of these nutrients (Scott, 2023). Kibble also faces similar issues mostly to do with its fat content, fiber content, and some key nutrients. Most deficiencies could be easily amended by adding salmon oil for fat, a high-fiber vegetable or fruit, and some berries or supplements to boost the deficient nutrients.

The digestibility of a particular food is often the ease with which the food can be broken down by the body into base nutrients and the efficiency with which it is able to be absorbed by the body. When calculating the digestibility of specific foods the food intake and the nutrient

intake would be taken and a fecal analysis should be conducted to determine the number of nutrients actually absorbed into the body (Tanprasertsuk J. et al, 2021).

Table 2.

Daily food and nutrient intakes (mean \pm SD) calculated from d 6 to d 10 of each feeding period.

Measure	Kibble (n = 12)	Fresh C (n = 12)	Fresh B (n = 6)	Fresh P (n = 6)	Fresh T (n = 6)	P value*
Daily food intake						
Daily food intake, in g FW	279 \pm 25 ^a	895 \pm 173 ^b	443 \pm 78 ^c	463 \pm 41 ^c	428 \pm 22 ^c	2.47E-07
Daily food intake, in g DM	264 \pm 23 ^a	243 \pm 47 ^a	126 \pm 22 ^b	122 \pm 11 ^b	124 \pm 6 ^b	5.31E-06
Daily food intake, in kcal	1,388 \pm 123 ^a	1,423 \pm 275 ^a	718 \pm 127 ^b	593 \pm 53 ^b	705 \pm 36 ^b	1.90E-06
Daily nutrient intake, in g						
Protein	98.8 \pm 8.7 ^a	89.0 \pm 17.2 ^a	46.8 \pm 8.3 ^b	48.6 \pm 4.3 ^b	49.4 \pm 2.5 ^b	3.64E-06
Fat	50.9 \pm 4.5 ^a	73.6 \pm 14.2 ^b	32.7 \pm 5.8 ^c	18.3 \pm 1.6 ^d	33.2 \pm 1.7 ^c	3.09E-07
NFE	83.0 \pm 7.3 ^a	59.2 \pm 11.4 ^b	35.1 \pm 6.2 ^{c,d}	42.8 \pm 3.8 ^c	30.5 \pm 1.6 ^d	2.83E-07
Crude Fiber	9.2 \pm 0.8 ^a	4.5 \pm 0.9 ^b	1.3 \pm 0.2 ^c	1.9 \pm 0.2 ^d	1.3 \pm 0.1 ^c	1.22E-07
Soluble Fiber	25.6 \pm 2.3	44.7 \pm 8.6	–	–	–	5.19E-05
Ash	21.9 \pm 1.9 ^a	16.3 \pm 3.1 ^b	9.9 \pm 1.8 ^c	10.6 \pm 0.9 ^c	9.6 \pm 0.5 ^c	5.47E-07

(Tanprasertsuk J, Perry LM, Tate DE, Honaker RW, Shmalberg J. Apparent total tract nutrient digestibility and metabolizable energy estimation in commercial fresh and extruded dry kibble dog foods. Transl Anim Sci. 2021 May 27;5(3):txab071. doi: 10.1093/tas/txab071. PMID: 34278234; PMCID: PMC8279163.)

5 days of feedings were measured with food intake being measured through fresh weight and dry matter weight for kibble, fresh chicken, fresh beef, fresh pork, and fresh turkey (Tanprasertsuk J. et al, 2021). An estimated number of calories was calculated to compare with at a later date. Samples of the food were then studied to determine their nutrient content to which the results of a fecal analysis were compared to determine the amount of each nutrient that the body absorbed (Tanprasertsuk J. et al, 2021).

The mean percentage of nutrient intake which is being used to determine digestibility is significantly lower in kibble than in any of the other fresh foods (Tanprasertsuk J. et al, 2021). This can safely be assumed to be the same for RFD with slight variance due to the content of the food and the easier digestion of the fresh food to it being processed slightly.

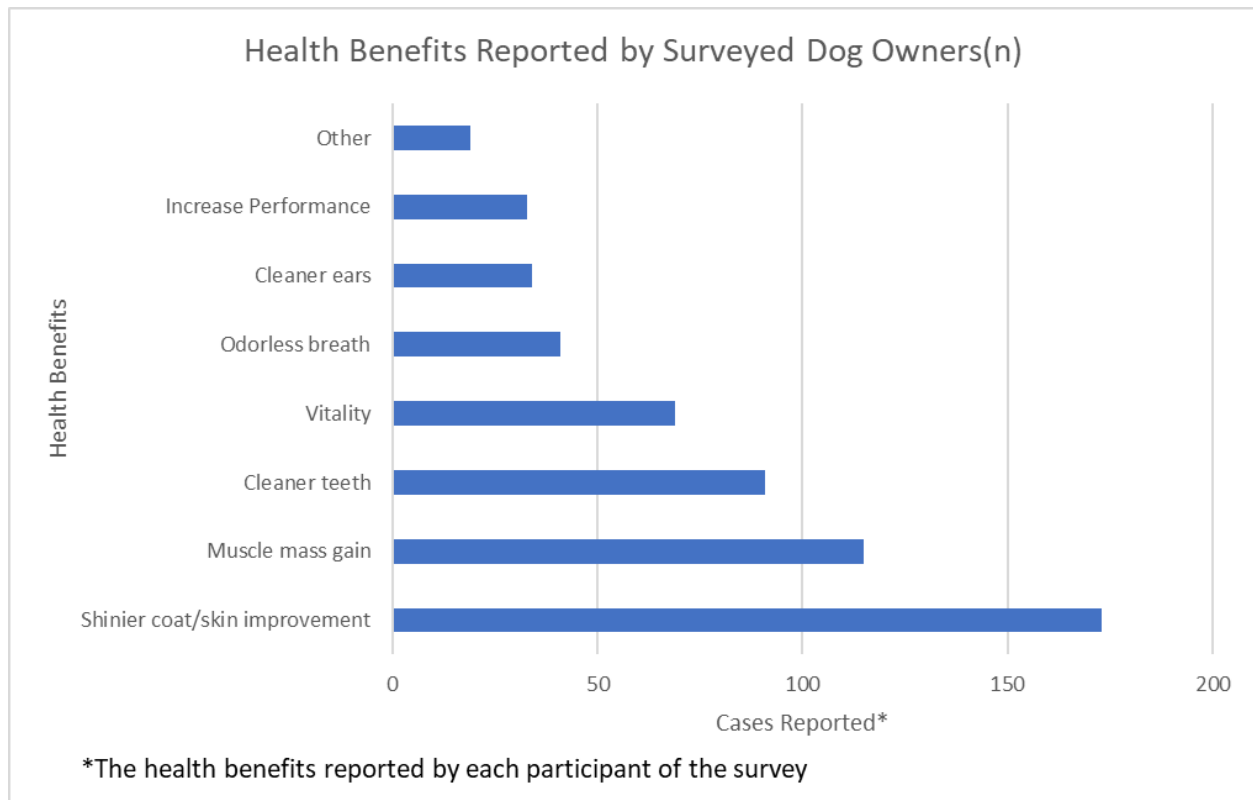
The Gut

The gut microbiome of any animal has a major impact on its health and overall well-being. This microbiome is usually made up of bacteria, archaea, viruses, and other eukaryotic organisms which all live and function within the gastrointestinal tract (Pilla, 2020). Many of them contribute greatly to the metabolic functions of their host body and defend the body against ingested pathogens while also priming the immune system, and many other physiological functions (Pilla, 2020).

Several things can disrupt the microflora of the digestive tract; your diet and the introduction of another bacteria or pathogen. Commercial foods are often processed at high temperatures, around 80-160 C, at high pressure in an effort to reduce waste and reduce pathogenic bacteria (Kazimierska et al, 2021). This effort for sterilization and heat treating the food is not at all effective, however, in preventing it from becoming infected later down the line of production. The most common pathogenic contamination found in dry dog food has been: *Salmonella*, *Listeria*, *Escherichia*, and a few others (Kazimierska et al, 2021 & Morgan et al, 2022). This is not only isolated in commercial dry dog food as it is also seen in RFD-fed dogs with higher chances of infection should there be cross-contamination (Lee, 2022).

A qualitative study was conducted in 2019 to better understand the motivation and habits of owners feeding their dogs RFD (Morelli, 2019). 218 dog owners, of whom 62 were living with an immunocompromised person, completed the questionnaire (Morelli, 2019).

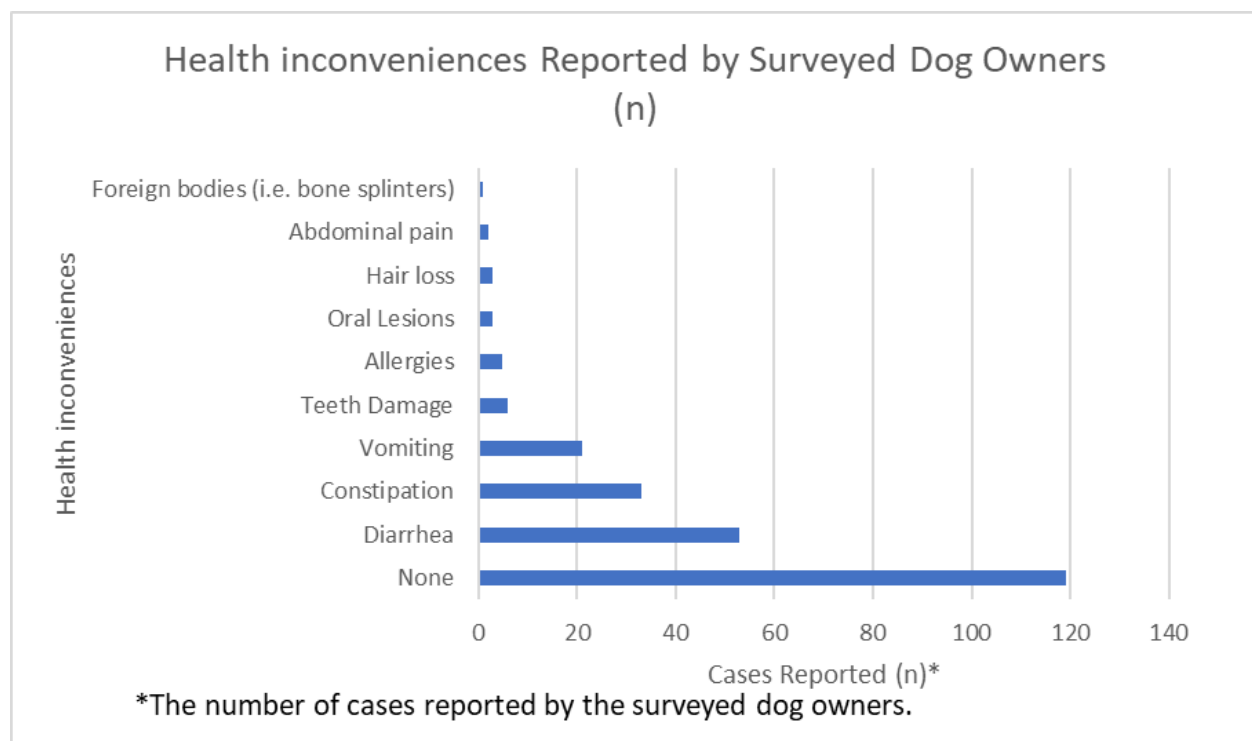
Immunocompromised people were tagged due to a concern about RFD's viability and safety in use in a household with immunocompromised individuals. Bacteria present in meats used for RFD cannot be degraded with heat so it is still present and very much viable. This bacteria can cause any number of foodborne diseases like E. coli and so would pose a threat to those who have issues with their health and those with not fully developed immune responses like children. Vulnerable people in contact with the dog food or those who come into contact with the dog's saliva or feces run the risk of contracting these food-borne illnesses and so it would play a role in their choice of dog food. A vast majority of the participants showed a marked distrust of commercial pet food due to its lack of clarity and have completely abandoned it and about 94% completely are convinced of RMBDs' (or RFDs, as I've been referring to them) safety (Morelli, 2019).



(Morelli, G., Bastianello, S., Catellani, P., & Ricci, R. (2019). Raw meat-based diets for dogs: survey of owners' motivations, attitudes and practices. BMC veterinary research, 15(1), 74.

<https://doi.org/10.1186/s12917-019-1824-x>

Of the people questioned, 94% attributed their dog's shinier coats, muscle mass gain, and cleaner teeth to RFD (Morelli, 2019). 141 owners, around 65% of them, were completely convinced that dogs could not become ill from the diet with 17% acknowledging it but discounting it as not a pressing issue (Morelli, 2019).



(Morelli, G., Bastianello, S., Catellani, P., & Ricci, R. (2019). Raw meat-based diets for dogs: survey of owners' motivations, attitudes and practices. BMC veterinary research, 15(1), 74.

<https://doi.org/10.1186/s12917-019-1824-x>

45% of the owners reported diarrhea, constipation, and vomiting when asked about some detrimental side effects they have noticed (Morelli, 2019). This study was primarily done through questionnaires and through self-reporting from willing participants so all answers should

be taken with a hint of alacrity. Most health benefits touted by the participants could be attributed to other aspects of the diet and not the actual diet itself. The shinier coat and skin would also be present in high-fat diets and can be achieved without a raw food diet (Lee, 2022). The same could be said for cleaner teeth as the mere addition of bones to chew on allows the dog to self-clean their teeth as just the act of chewing helps with reducing tartar (Pietraniec, 2017).

Conclusion

Nutritionally, the raw food diet generally is much more nutritionally valuable, especially with the basic composition of the raw food diet. Kibble has much too large a range to be generally better than raw food, but some of the best and most nutritionally beneficial kibble could outclass raw food per serving. Digestability in particular is where kibble was slightly detrimental to dogs as the nutrient intake for kibble was significantly lower than any of the other fresh options. The gut microbiota is where some of the kibble and raw food's mutual deficiencies take front and center, although raw food would receive more criticism. Both kibble and raw food are susceptible to cross-contamination and the introduction of pathogenic bacteria into the digestive system. Kibble's issues with cross contamination take place after the manufacturing process and there are more steps taken to remove the risk of contamination through heat treating and pressurization. Raw dog food has always had to prioritize sanitation as unless the dog food is stored and fed to the dog through a sterile field, there is a chance of contaminating the meat which has not had the advantage of heat treatment. This does not even account for the origins of the meat and vegetables and how the food is prepared, stored, and served. Every step of feeding raw food needs to be handled with care and precision. And, despite all the steps taken to keep the food from becoming cross-contaminated, bacterial diseases could still pass on to the owners which did not affect the dogs.

Neither diet was perfect or almost perfect. Supplements and additives were needed to maintain the dogs' health as most of the diets were not enough by themselves to provide all the nutrients needed. Kibble requires additions for fat, moisture, and specific vitamins like D. This does not discount the fact that most kibble does have the advantage of less preparation and easier storage. Raw dog food also has issues with nutrients and would require supplements, particularly with vitamin D and manganese which could be solved with just the addition of specific foods. Raw food requires time to prepare and generally requires dog owners to meal-prepare in advance. This brings up the issue of storage and with upwards of 7 meals being stored in the freezer for at most a month, preprepared meals for raw dog food will take up a significant amount of space.

Bibliography:

A Science-Based Guide For Pet Owners. (n.d.).

https://nap.nationalacademies.org/resource/10668/dog_nutrition_final_fix.pdf

Castañeda, S., Ariza, G., Rincón-Riveros, A., Muñoz, M., & Ramírez, J. D. (2023). Diet-induced changes in fecal microbiota composition and diversity in dogs (*canis lupus familiaris*): A comparative study of barf-type and commercial diets. *Comparative Immunology, Microbiology and Infectious Diseases*, 98, 102007.

<https://doi.org/10.1016/j.cimid.2023.102007>

Davies, R., Lawes, J. R., & Wales, A. (2019). Raw diets for dogs and cats: a review, with particular reference to microbiological hazards. *Journal of Small Animal Practice*, 60(6), 329–339. <https://doi.org/10.1111/jsap.13000>

Hiney, K., Sypniewski, L., Rudra, P., Pezeshki, A., & McFarlane, D. (2021). Clinical health markers in dogs fed raw meat-based or commercial extruded kibble diets. *Journal of Animal Science*, 99(6). <https://doi.org/10.1093/jas/skab133> van Zelst M, Hesta M, Gray K, Beech K, Cools A, Alexander LG, Du Laing G, Janssens GP. Selenium Digestibility and Bioactivity in Dogs: What the Can Can, the Kibble Can't. *PLoS One*. 2016 Apr 4;11(4):e0152709. doi: 10.1371/journal.pone.0152709. PMID: 27043433; PMCID: PMC4820116.

James. (2022, January 23). The Complete History of Commercial Dog Food. *Pet Food Reviewer*. <https://petfoodreviewer.com/history-of-dog-food/>

Kazimierska, K., Biel, W., Witkowicz, R., Karakulska, J., & Stachurska, X. (2021). Evaluation of nutritional value and microbiological safety in commercial dog food. *Veterinary Research Communications*, 45(2–3), 111–128. <https://doi.org/10.1007/s11259-021-09791-6>

Lee, E. (2009, June 28). Raw dog food: dietary concerns, benefits, and risks. WebMD.

<https://www.webmd.com/pets/dogs/features/raw-dog-food-dietary-concerns-benefits-and-risks>

Morgan G, Williams N, Schmidt V, Cookson D, Symington C, Pinchbeck G. A Dog's Dinner: Factors affecting food choice and feeding practices for UK dog owners feeding raw meat-based or conventional cooked diets. *Prev Vet Med.* 2022 Nov;208:105741. doi: 10.1016/j.prevetmed.2022.105741. Epub 2022 Aug 9. PMID: 35994979.

Morelli, G., Bastianello, S., Catellani, P., & Ricci, R. (2019). Raw meat-based diets for dogs: survey of owners' motivations, attitudes and practices. *BMC veterinary research*, 15(1), 74. <https://doi.org/10.1186/s12917-019-1824-x>

Pets, O. (2020, November 24). *Fresh vs Raw Dog Food vs Kibble: Which Diet Is Best For Your Dog?* American Kennel Club.

<https://www.akc.org/expert-advice/nutrition/feed-my-dog-fresh-raw-food-or-dog-kibble/>

Pietraniec, A., Bauer, A., Stella, J., & Croney, C. (2017). Preventing Periodontal Disease in Dogs VA-20-W. <https://www.extension.purdue.edu/extmedia/VA/VA-20-W.pdf>

Pilla, R., & Suchodolski, J. S. (2020). The role of the canine gut microbiome and metabolome in health and gastrointestinal disease. *Frontiers in Veterinary Science*, 6.

<https://doi.org/10.3389/fvets.2019.00498>

Schaffer, M. 2009. *One nation under dog*. Macmillan, New York, NY.

Schmidt, M., Unterer, S., Suchodolski, J. S., Honneffer, J. B., Guard, B. C., Lidbury, J. A., Steiner, J. M., Fritz, J., & Kölle, P. (2018). The fecal microbiome and metabolome differs between dogs fed Bones and Raw Food (BARF) diets and dogs fed commercial diets. *PLOS ONE*, 13(8), e0201279. <https://doi.org/10.1371/journal.pone.0201279>

Scott, D. (2023, May 4). Raw dog food: 6 Simple Rules to get Started - Dogs naturally. Dogs Naturally. <https://www.dogsnaturallymagazine.com/raw-feeding-primer/>

Son, K. (2022, July 27). Kibbles 'n Bits Dog Food Reviewed: Pros, Cons, and Ingredient Analysis. Veterinarians.org. <https://www.veterinarians.org/kibbles-n-bits-dog-food/#:~:text=Great%20Ingredients%3A%20Beef%20%26%20bone%20meal%2C%20wheat%20middlings%2C>

Tanprasertsuk J, Perry LM, Tate DE, Honaker RW, Shmalberg J. Apparent total tract nutrient digestibility and metabolizable energy estimation in commercial fresh and extruded dry kibble dog foods. Transl Anim Sci. 2021 May 27;5(3):txab071. doi: 10.1093/tas/txab071. PMID: 34278234; PMCID: PMC8279163.

van Zelst M, Hesta M, Gray K, Beech K, Cools A, Alexander LG, Du Laing G, Janssens GP. Selenium Digestibility and Bioactivity in Dogs: What the Can Can, the Kibble Can't. PLoS One. 2016 Apr 4;11(4):e0152709. doi: 10.1371/journal.pone.0152709. PMID: 27043433; PMCID: PMC4820116.

Vecchiato, C. G., Schwaiger, K., Biagi, G., & Dobenecker, B. (2022). From Nutritional adequacy to hygiene quality: A detailed assessment of commercial raw Pet-Food for dogs and cats. Animals, 12(18), 2395. <https://doi.org/10.3390/ani12182395>

Wikipedia Contributors. (2019, September 3). Dog food. Wikipedia; Wikimedia Foundation. https://en.wikipedia.org/wiki/Dog_food