

Evaluation of raw food diets for dogs

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Veterinarians currently must deal with pet owners who, for better or worse, have access to a large body of information on small animal nutrition. There is a growing number of unconventional diets being promoted for dogs and cats, especially on the Internet. It is easy to understand the reasons why nutritional therapy has such a strong appeal. First and foremost, food is something that everyone can relate to, because it is one of the most basic necessities of life. Furthermore, food can have important effects on psychological well-being and is often involved in religious rituals. Diet is something that an owner can control. For these reasons, diet can take on considerable spiritual and psychological importance, particularly in circumstances in which people are dealing with other factors or forces beyond their control such as an incurable illness. Finally, nutritional therapy is viewed as natural (and, therefore, believed to be safe) and holistic; thus, this offers a fundamentally opposite approach to conventional medical practices that involve the use of surgery or administration of manufactured drugs.

A good example of the interest in unconventional diets is raw food diets. Although raw meat has been added to the diets of sled dogs and racing greyhounds for many years, diets that consist entirely of raw meat, bones, and other ingredients are being fed to an increasing number of show animals and pets. Proponents of these diets claim numerous benefits such as improvement in coat and skin; elimination of breath, body, and feces odor; improvement in amount of energy and behavior; improvement in overall health and immune function; and reduction of the incidence of many medical conditions including allergies, arthritis, pancreatitis, and parasitisms. Promotion of these

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diets is a good illustration of the principles that make nutritional therapy appealing to the public.

The rationale for use of a raw food diet is simple. Dogs and cats are carnivores that evolved eating raw foods. In addition, commercial foods are heat processed, which alters or destroys nutrients and essential enzymes. Therefore, commercial foods may not be a natural or nutritionally sound diet for dogs or cats. The arguments are plausible, particularly to lay people, and can be reinforced by specific valid examples (eg, thiamin is extremely heat labile). However, these arguments do not generally fare well under careful scrutiny and are not supported by sound scientific evidence. It is a growing challenge to veterinary practitioners to be sufficiently informed such that they can discuss the benefits and risks of various dietary practices in a nonconfrontational manner with pet owners; at the least, this allows owners the opportunity to make a balanced informed choice for their pet.

Real difficulties face practitioners who use conventional medicine (or who combine conventional medicine with some alternative or complementary modalities) when it comes to making a decision about when and how to incorporate various aspects of nutritional management into their practices. As with every aspect of medicine, practitioners should strive to use an evidence-based approach. However, data are scarce, and well-conducted clinical trials are scarcer. We describe here an outline of some of the more common raw food diets being fed and provide objective information regarding their nutritional and health risks. This should provide veterinary practitioners a context in which to approach this subject with their clients.

Types of Raw Food Diets

All raw food diets are not alike. In fact, there are a number of types of raw food diets currently being fed to dogs and cats. However, there are 3 major categories of raw food diets.

Commercially available complete raw food diets—These diets are intended to be complete and balanced without the need for additional supplements. These diets typically are sold in a frozen form.^{a-c}

Homemade complete raw food diets—Many recipes for homemade raw food diets are available in books and articles as well as on the Internet. The 3 most popular homemade raw food diets are the **bones and raw food (BARF)** diet, the **Ultimate diet**, and the **Volhard diet**.

The BARF diet was popularized by Dr. Ian Billinghurst.¹ The BARF diet advocates a diet “consisting of 60% raw, meaty bones,” with the rest being made up of a “wide variety of foods, based on the type and quantity of foods a wild dog would eat.”¹ Those other foods would include “lots of green vegetables (to mimic stomach contents of prey), some offal (liver, kidneys, etc), meat, eggs, milk, brewer’s yeast, yogurt, and small amounts of grains and legumes.”¹ The diet is expected to be balanced overall, but each meal is not balanced. For instance, Dr. Billinghurst recommends feeding several meals, each of which consists entirely of green leafy vegetables, starchy foods, grains and legumes, meat, milk, offal, or food scraps, during a period of 2 to 3 weeks. A typical schedule could include 10 meals of bones combined with 4 meals of green leafy vegetables, 1 meal of starchy food, 1 meal of grains and legumes, 1 meal of meat alone, 2 meals of milk, and 1 or 2 meals of offal during the period of 2 to 3 weeks.¹

The Ultimate diet program was described by Kymthy Schultze in 1998. In this diet, Schultze recommends a type of food pyramid, with the largest portion of the diet consisting of raw meat (both muscle tissues and organs).² Raw eggs also are included in this category. Raw bones make up the second-largest section of the diet, followed by raw vegetables. An “extras” category is fed in the smallest quantities and is used to “make up for the depletion of our soils that contributes to the lower nutrient content of our foods.”² This category includes kelp and alfalfa, essential fatty acids, and vitamin C.

A raw homemade diet also has been recommended by Wendy Volhard. Cereal is fed in the morning, consisting of grains, molasses, oil, egg, yogurt, and vitamins.³ The evening meal consists of raw beef (muscle tissues and liver), fresh and dry greens and herbs, wheat bran, wheat germ, bone meal, garlic, brewer’s yeast, kelp, apple cider vinegar, cod liver oil, and vitamin C.³ Other foods are recommended on a rotating basis (eg, fruit is given 3 times/wk), and removal of all food is recommended for one half day every week.³

Combination diets—These consist of commercial-ly available grain-and-supplement mixes.⁴ The grain mix is to be fed in combination with raw meat.

Potential Risks

Although there are numerous claims to the health benefits of raw food diets, all are anecdotal. Putting aside the lack of evidence for benefits of these diets, there are a number of important concerns regarding raw food diets. First, there is the nutritional balance of the diets. It can be difficult to formulate a balanced homemade diet in the best of circumstances. Nutritional imbalances in these diets can cause health problems in the animals that eat them, especially young, growing animals. Other potential problems with raw food diets relate to safety. The raw bones included in many of these diets carry risks, and although the actual incidence of complications resulting from ingestion of raw bones is unknown, there are reports of intestinal obstruction, gastrointestinal perforation, gastroenteritis, and fractured teeth in animals

consuming raw bones as a component of raw food diets. Finally, uncooked meat carries the risk of bacterial contamination. Although proponents of the diets argue that dogs are more resistant to bacteria than are people, to our knowledge, this has not been proven to be true. Raw meat diets also can pose a risk to pet owners who formulate and mix the diets, especially people who are young, elderly, or immunocompromised.

Many arguments exist on both sides of the issue, and neither side has provided evidence to prove that their argument is correct. We have concerns regarding nutritional and safety issues of raw food diets but have been hesitant to make recommendations because of a lack of scientific information. Therefore, our goal was to objectively assess whether raw food diets prepared by typical pet owners are nutritionally balanced and safe.

Nutritional Analysis of Raw Food Diets

To perform analyses of homemade diets, we contacted 3 owners who we knew were preparing raw food diets for their dogs. Owners were selected only on the basis of proximity so that we could obtain a sample of the freshly made diets. All 3 owners agreed to participate. Exact recipes of the diets were not provided to us, although all owners used human-quality ingredients. Each owner prepared a serving of the diet that they usually fed to their dog. A chilled sample of the food was brought to our facilities. After arrival at our facilities, samples were handled in an aseptic manner throughout processing. Samples were ground in a sterilized manual meat grinder, because all diets contained entire breasts or legs of chickens. After grinding and complete mixing, an aliquot (100 g) was sealed aseptically in a plastic bag and shipped at 4 C (2 samples) or -20 C (1 sample) to a laboratory⁶ for analysis. All shipments arrived at the laboratory within 18 hours after processing at our facilities.

Two commercial diets were purchased for analysis. Commercial diet 1⁴ was a combination diet in which a grain-and-supplement mix was purchased and mixed with raw meat and water in accordance with the manufacturer’s directions. After mixing, the diet was stored overnight in a refrigerator. The next day, the diet was mixed thoroughly, and an aliquot (100 g) was obtained aseptically and frozen at -20 C. Commercial diet 2^a was a complete food that is sold frozen and is intended to be fed without additional supplements. The frozen diet was ground in a sterilized meat grinder and mixed, and a 100-g aliquot was obtained aseptically and frozen at -20 C. Samples of both commercial diets were shipped at -20 C to a laboratory⁶ for analysis, and all shipments arrived at the laboratory within 18 hours after processing at our facilities.

Samples from the 5 diets (3 homemade diets and 2 commercial diets) were analyzed to determine concentrations of macronutrients (protein, crude fat), macrominerals (calcium, phosphorus, potassium, sodium, and magnesium), trace minerals (iron, manganese, zinc), and vitamins (vitamins A [retinol], D, and E). Results of nutritional analysis were compared with nutrient standards for maintenance or growth and reproduction⁴ that were developed by the Association of American Feed Control Officials (AAFCO). Microbial analysis also was completed at the same lab-

oratory to determine total bacterial count and for identification of *Salmonella* spp and *Escherichia coli* O157:H7.

Comparison of Homemade and Commercial Raw Food Diets with AAFCO Standards

Homemade diets 1 and 2 were being fed to adult large-breed dogs (an Irish Wolfhound and Saint Bernard, respectively), whereas homemade diet 3 was being fed to a 4-month-old Bull Mastiff. The nutritional analyses for homemade diets 1 and 2 and both commercial diets were compared with the AAFCO nutrient standards for maintenance of adult dogs (Table 1). Homemade diet 1 was being fed in accordance with the BARF diet regimen, whereas homemade diet 2 was being fed in accordance with the Ultimate diet regimen. Both of these homemade diets and commercial diet 1 were low in calcium and phosphorus content

and had an unbalanced calcium-to-phosphorus ratio (homemade diet 1 and commercial diet 1 had a low calcium-to-phosphorus ratio, and homemade diet 2 had a high calcium-to-phosphorus ratio). Both commercial diets and homemade diets 1 and 2 were high in vitamin D content. Two of the diets contained less than the AAFCO minimums for concentrations of potassium (homemade diet 1 and commercial diet 1), manganese (homemade diets 1 and 2), and zinc (homemade diets 1 and 2). Other nutritional imbalances included low concentrations of iron (homemade diet 2) and magnesium (homemade diet 1) and high concentrations of magnesium (homemade diet 2), zinc (commercial diet 1), and vitamin E (homemade diet 1).

Nutritional analysis for homemade diet 3 and commercial diets 1 and 2 were compared with the AAFCO nutrient standards for growth (Table 2). The

Table 1—Nutritional analyses for 2 homemade diets and 2 commercial diets, compared with the nutrient standards for adult dogs established by the American Association of Feed Control Officials (AAFCO)

Variable	AAFCO minimum	AAFCO maximum	Homemade diets*		Commercial diets†	
			1	2	1	2
Protein (g/100 kcal)	5.14	—	6.60	5.37	6.77	8.04
Crude fat (g/100 kcal)	1.43	—	8.10	8.17	4.44	9.18
Calcium (g/100 kcal)	0.17	0.71	0.12‡	0.15‡	0.02‡	0.35
Phosphorus (g/100 kcal)	0.14	0.46	0.13‡	0.06‡	0.11‡	0.22
Calcium:phosphorus	1	—	0.92‡	2.50‡	0.15‡	1.61
Potassium (g/100 kcal)	0.17	—	0.12‡	1.15	0.15‡	0.19
Sodium (g/100 kcal)	0.017	—	0.040	0.240	0.030	0.070
Magnesium (g/100 kcal)	0.011	0.086	0.010‡	0.170‡	0.036	0.027
Iron (mg/100 kcal)	2.3	86	3.9	2.0‡	19	29
Manganese (mg/100 kcal)	0.14	—	< 0.10‡	0.09‡	27.2	1.5
Zinc (mg/100 kcal)	3.4	29	0.8‡	0.5‡	43.0‡	11.0
Vitamin A (IU/100 kcal)	143	7,143	5,270	4,145	543	354
Vitamin D (IU/100 kcal)	14	143	2,410‡	1,267‡	247‡	361‡
Vitamin E (IU/100 kcal)	1	29	160‡	5	8	5
Calories (kcal/100 g)	—	—	189	145	102	152

*Homemade diet 1 was being fed to an adult large-breed dog in accordance with the bones and raw food (BARF) diet program, and homemade diet 2 was being fed to an adult large-breed dog in accordance with the Ultimate diet program. †Commercial diet 1 was a combination diet (a grain-supplement mix prepared with raw meat),^d and commercial diet 2 was a complete frozen diet.^e ‡Values are less than the minimum or greater than the maximum amounts established by the AAFCO. — = Not established.

Table 2—Nutritional analyses for a homemade diet and 2 commercial diets, compared with the nutrient standards for growing dogs established by AAFCO

Variable	AAFCO minimum	AAFCO maximum	Homemade diet 3*	Commercial diets†	
				1	2
Protein (g/100 kcal)	6.29	—	7.13	6.77	8.04
Crude fat (g/100 kcal)	2.29	—	6.29	4.44	9.18
Calcium (g/100 kcal)	0.29	0.71	0.81‡	0.02‡	0.35
Phosphorus (g/100 kcal)	0.23	0.46	0.33	0.11‡	0.22‡
Calcium:phosphorus	1	—	2.5‡	0.15‡	1.61
Potassium (g/100 kcal)	0.17	—	0.22	0.15‡	0.19
Sodium (g/100 kcal)	0.086	—	0.070‡	0.030‡	0.070‡
Magnesium (g/100 kcal)	0.011	0.086	0.042	0.036	0.027
Iron (mg/100 kcal)	2.3	86.0	1.8‡	19.0	29.0
Manganese (mg/100 kcal)	0.14	—	0.41	27.2	1.5
Zinc (mg/100 kcal)	3.4	29.0	1.1‡	43.0‡	11.0
Vitamin A (IU/100 kcal)	143	7,143	1,605	543	354
Vitamin D (IU/100 kcal)	14	143	44	247‡	361‡
Vitamin E (IU/100 kcal)	1	29	62‡	8	5
Calories (kcal/100 g)	—	—	152.0	102.0	152.0

*Homemade diet 3 was being fed to a 4-month-old, large-breed puppy in accordance with the Volhard diet. †Commercial diets 1 and 2 had label claims that they met requirements for growth and reproduction. See Table 1 for remainder of key.

labels on the 2 commercial diets claimed that they met the requirements for growth, reproduction, and maintenance. The puppy (homemade diet 3) was being fed in accordance with the Volhard diet regimen. Homemade diet 3 had low concentrations of sodium, iron, and zinc, high calcium content, and a high calcium-to-phosphorus ratio. Homemade diet 3 was higher in vitamin E than the AAFCO maximum. Although there are purported benefits to providing vitamin E supplements in excess of nutritional requirements, it appears that there is an optimal dose and that higher doses (nearly 900 IU/d in homemade diet 3) may have negative effects on immune function.³ Compared with the AAFCO standards for growth, the 2 commercial diets also had multiple shortcomings. Both commercial diets were low in phosphorus and sodium concentrations and contained concentrations of vitamin D that were higher than maximal recommended amounts. Commercial diet 1 also was severely deficient in calcium content, had a calcium-to-phosphorus ratio of 0.15, was low in potassium content, and had a high concentration of zinc. These imbalances are of special concern in growing puppies.

Microbial analyses were performed on all 5 diets, including a standard plate count for all bacteria and identification of *E coli* O157:H7. In addition, all 3 homemade diets were analyzed for *Salmonella* spp. Homemade diet 1 yielded positive results when tested for *E coli* O157:H7 (Table 3). None of the 3 homemade diets yielded *Salmonella* spp, but total bacterial counts ranged from 45,000 to 760,000 colony-forming units/g. Although it is difficult to interpret the total plate counts in terms of health risks to an animal, the high count of 760,000 colony-forming units/g likely indicates a product of deteriorating quality.

Additional Considerations

Several difficulties arise when assessing the nutritional adequacy of a diet by using only results of laboratory analysis. First is the obvious question regarding the portion of the nutritional content of a diet detected during analysis that is actually bioavailable to the animal consuming it. The second issue involves the standard used for establishing the nutritional adequacy of a diet. In this case, we chose to use the AAFCO nutrient standards. We selected them because they are the standard that is currently used by the pet food industry. In developing minimum values, AAFCO has tried to consider variation in nutrient availability of ingredients and requirements of the pet population. They also have provided maximum values for nutrients that have the potential to cause adverse effects when consumed in excess. A discussion about the limitations of the use of AAFCO standards or formulation of complete and bal-

anced diets for pets is beyond the scope of this report. Suffice it to say that these standards are not an absolute requirement, and when a diet is made from ingredients that contain a highly bioavailable form of a nutrient, the diet may be adequate despite the fact it contains less of that nutrient than indicated in the AAFCO values. However, even if it was assumed that the nutrients in the diets analyzed had a bioavailability of 100%, in most cases the nutrients that were deficient when compared with AAFCO standards also were deficient when compared with the more stringent guidelines established by the National Research Council.

Recommendations

The owners whose diets were tested for the purposes of this report had the best intentions of feeding their dogs appropriate high-quality diets to enhance their health. It is important to remember that most people feeding raw food diets are educated and research the topic before embarking on this path. Nonetheless, the results of the small number of diets analyzed here indicated that there are clearly nutritional and health risks associated with feeding raw food diets. All the diets tested had nutrient deficiencies or excesses that could cause serious health problems when used in a long-term feeding program. Of equal concern are the health risks associated with bacteria in the raw food diets, especially the homemade diet that yielded *E coli* O157:H7. Although owners feeding raw food diets often claim that dogs are more resistant to pathogenic bacteria, we are not aware of evidence to support that claim. In addition, owners of these pets are at risk of infection as a result of handling the meat or from cross-contamination of common dishes and utensils used to prepare the diets. This can be a problem, especially for households that include young, elderly, or immunocompromised individuals. Although only diets formulated for dogs were tested for this report, cats also are being fed these diets and clearly are exposed to the same potential risks.

For owners who wish to feed homemade diets, we often recommend a compromise: feed a good-quality commercial diet and supplement it with fresh fruits and vegetables. In some situations, homemade diets can be useful (eg, animals with a medical problem that will not eat a commercial therapeutic diet or animals with multiple conditions for which there is not an ideal commercial therapeutic diet). However, we strongly recommend that all homemade diets be cooked and that they be formulated by a credentialed veterinary nutritionist. Qualifications for nutritionists are ill-defined, so it is important to check credentials (for recommendations on nutritionists, contact the American College of Veterinary Nutrition or the American Academy of Veterinary Nutrition). Finally, when own-

Table 3—Results of microbial analysis of 3 homemade and 2 commercial raw food diets

Variable	Homemade diets			Commercial diets	
	1	2	3	1	2
Standard plate count (CFU/g)	45,000	> 250,000	760,000	> 250,000	> 250,000
<i>Salmonella</i> spp	Neg	Neg	Neg	Not tested	Not tested
<i>Escherichia coli</i> O157:H7	Pos	Neg	Neg	Neg	Neg

CFU = Colony-forming units. Pos = Positive result on bacterial culture. Neg = Negative result on bacterial culture.

ers elect to use a nutritionally balanced cooked home-made diet, careful monitoring is necessary, because subclinical deficiencies still can develop when these diets are fed on a long-term basis. Health problems that may result from insufficient nutrient intake include secondary nutritional hyperparathyroidism (calcium), dermatoses (zinc), or anemia (iron). Health problems that may develop from excessive nutrient intake include developmental orthopedic conditions (calcium), hypercalcemia (vitamin D), or interference with bioavailability of other minerals (zinc).

^aSteve's Real Food for Dogs, Steve's Real Food, Eugene, Ore.

^bBil-Jac Fresh Frozen diet, Bil-Jac Foods, Medina, Ohio.

^cMeat Eater Diet for Dogs, Animal Food Services, Iola, Wis.

^dSojourner Farms European-Style Dog Food Mix, Sojourner Farms, Minneapolis, Minn.

^eWoodson-Tenent Laboratories, Memphis, Tenn.

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