Review Article Compte rendu

Raw food diets in companion animals: A critical review

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Abstract — Feeding of raw meat-based diets to pets has become an increasingly popular trend amongst pet owners. Owners, who desire to provide the best for their pets, seek veterinary opinions about food options. This paper reviews and applies standards of evidence-based medicine to grade the available scientific literature that addresses the nutritional benefits or risks, infectious disease risks, and public health implications of raw, meat-based pet diets. Although there is a lack of large cohort studies to evaluate risk or benefit of raw meat diets fed to pets, there is enough evidence to compel veterinarians to discuss human health implications of these diets with owners.

Résumé — Diètes à base d'aliments crus chez les animaux de compagnie : Un examen critique. Les diètes à base de viande crue pour les animaux de compagnie gagnent de plus en plus en popularité parmi les propriétaires d'animaux de compagnie. Les propriétaires, qui désirent ce qu'il y a de mieux pour leurs animaux de compagnie, cherchent à obtenir des opinions auprès des vétérinaires à propos des choix alimentaires. Le présent article examine les normes de médecine factuelle et les applique afin d'évaluer la documentation scientifique publiée abordant les bienfaits ou les risques nutritionnels, les risques de maladies infectieuses et les répercussions sur la santé publique des diètes à base de viande crue pour les animaux de compagnie. Même s'il y a une absence d'études de grandes cohortes afin d'évaluer les risques ou les bienfaits des diètes de viande crue pour les animaux de compagnie, il existe suffisamment de preuves pour motiver les vétérinaires à discuter des répercussions de ces diètes sur la santé humaine avec les propriétaires.

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Introduction

In recent years, many pet owners have abandoned conventional, veterinary recommended, commercial diets in search of more "natural" and "homemade" choices. This has been partially driven by a movement paralleled in the human food marketplace for natural and organic products. This change was further fueled by the recent Menu Foods melamine contamination. In 2007, an article in the *Wall Street Journal* (1) outlined the dilemma faced by many pet owners. Aside from concerns about commercial foods, there are many additional reasons for this change in feeding practices.

Michel (2) summarized well the reasons people seek unconventional pet foods. Firstly, unlike veterinarians and researchers, most pet owners approach feeding their pets much like they approach feeding their families. While nutrition is important in food choices, there are social and cultural aspects to food selection and feeding practices. Items often included in pet food are by-products of the human food industry. Although generally very nutritional and healthy, pet owners would not choose to eat these foods themselves. Logically, some individuals would then question feeding these items to their pets. Secondly, food has a social significance to humans. As pets become more intimately associated with the family unit, the desire to prepare and vary diet becomes greater. Thirdly, feeding pets is a means by which one can exert some level of control or be empowered in influencing the health and well-being of a loved companion. One increasingly popular trend in unconventional pet food is the feeding of raw, meat-based diets.

The pet owner and the veterinarian are bombarded with a plethora of information and opinions regarding raw foods. So, how is all of this information evaluated? What criteria can be used to make logical, safe decisions?

How to evaluate the evidence

The goal of any therapeutic intervention (recommendation of a specific diet) is to first "do no harm." In addition, the goal is to help the patient live a longer, better life, and ideally, a therapy should be selected based on sound clinical reasoning, scientific evidence, and an understanding of risk management (3). An attempt should be made to grade the type of medical evidence

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available when making these decisions. To grade medical evidence, there must first be an understanding of the different types of studies that are published.

A **case control study** identifies patients that have an outcome of interest (cases) and patients without the same outcome (controls), then looks back to see if these patients had the exposure of interest. A **case series study** is an examination of a series of patients with an outcome of interest. There is no control group. A **cohort study** identifies 2 groups of patients, one that received the exposure of interest and one that did not, and follows these groups forward to the outcome of interest. A **randomized controlled clinical trial** involves participants that are randomly allocated to an experimental group or a control group then, follows both groups over time to assess the outcome of interest. Finally, **a systematic review or meta-analysis** creates a summary of medical literature that uses explicit methods to perform a comprehensive literature search and critical appraisal of individual studies and then uses appropriate statistical techniques to combine these study results (4). Studies are graded as evidence levels 1 to 5 (3,4).

Definitions (3)

Level 1 studies include systematic reviews of multiple studies which have limited variation in their results, randomized controlled clinical trials (multiple), or an individual randomized trial with narrow confidence interval (very little if any overlap between groups). Also included in this group would be an "all or none" study where all patients died before treatment was available, but some now survive or some died before and now all survive with the treatment.

Level 2 studies are systematic reviews of cohort studies with consistent results or individual cohort studies, including lower quality randomized clinical trials (< 80% follow-up). Level 3 studies include systematic reviews of case control studies with consistent results or individual case-control studies. Level 4 studies are a case series or poor-quality cohort and case-control studies. Level 5 studies include expert opinion without explicit critical appraisal; or the conclusions are based on physiological research or principles.

This paper reviews available scientific literature about possible benefits and risks of feeding raw food to pets. Studies will be classified relative to the level of evidence. Literature was searched using the University of Calgary Library's search engine with key words "raw food diets" and "pets/dogs/cats." This engine searches multiple medical and agricultural databases.

Evidence of nutritional benefit or risk in feeding raw food

There are no published level 1, 2, or 3 studies of nutritional risk or benefit of raw meat feeding to dogs or cats.

Level 4 evidence of nutritional benefit

The only available published information on feeding raw meats to a number of dogs and cats that could be interpreted as remotely positive is a survey study on feeding practices in the United States and Australia (5). Results of the survey indicated that 98.7% of dog owners and 98.5% of cat owners deemed their pet healthy. Of all of those owners, bones or raw food were provided as part of the main meal to 16.2% of dogs and 9.6% of cats. Less than 3% of owners fed exclusively home-prepared diets. The study did not try to correlate the owner's perceptions of health with diet, but the bone and raw food feeders would have been amongst the group that considered their pets to be healthy.

Level 4 evidence of nutritional risk

There are isolated case reports that could be classified as level 4 evidence of risk. Hypervitaminosis A was reported in a cat fed a pork liver-based raw food. The cat returned to normal health when the diet was changed back to a commercial canned food (6). Feline pansteatitis was reported in 10 cats fed a homemade diet of cooked pig brain or raw and cooked oily fish (7). Nutritional osteodystrophy was reported in 2 litters of 6-week-old large breed puppies fed a bones and raw food (BARF) diet from about 3 wk of age (8). Nutritional secondary hyperparathyroidism has also been reported in a litter of German shepherd puppies fed a diet of 80% rice with 20% raw meat. The diet contained excessive amounts of phosphorus (9). Not all puppies fed the diet experienced problems, suggesting individual or genetic susceptibility.

A nutritional analysis of 5 raw food diets (2 commercially produced and 3 home-made) found low calcium and phosphorus in 3 of the 5 diets. Two commercial diets were high in vitamin D. Two of the diets were deficient in potassium, magnesium, and zinc (10).

Supporters of raw food will argue that feeding a variety of foods will lessen the risk of nutritional imbalance (11).

Level 5 evidence of nutritional benefit

In a letter to the editor, proponents of raw food feeding reference a single scientific article supporting their contention that digestive enzymes in fresh food enhance biological availability and that heating depletes these enzymes and therefore the nutritional quality of the ingested food (12). The paper, by Prochaska and Piekutowski (13), is a review of the medical literature supporting their hypothesis that natural enzymes in food act synergistically with those in the human digestive tract to release maximum thermodynamic free energy from food. The report discusses the literature that supports the idea that the enzymes can survive the digestive process in humans and may increase the nutritional value of food. The paper concludes that there is no direct evidence that lack of enzyme synergy leads to any disease processes. Further, the authors state that the role of enzyme synergy has not been studied in sufficient detail to predict its biological significance (13). Another study assessed long-term consumption of raw foods (not meat) in humans to assess the impact on cardiovascular disease (14). Raw fruit and vegetables constituted between 70% to 100% of the diet and it was determined that there was a decreased risk of heart disease based on improvement in LDL cholesterol and triglyceride concentrations, but possibly an increase risk of coronary artery disease because of vitamin B12 deficiency (associated with elevated plasma homocysteine and lower HDL concentrations).

Evidence for infectious disease "risk" to pets or humans sharing the same environment

Level 1 evidence of infectious disease risk-none

Levels 2 and 3 evidence of infectious disease risk

There are several studies that document the presence of infectious agents in raw foods and the potential for contaminating or shedding these agents in the pet's environment. A recent study (15) analyzed 240 samples from 20 commercially prepared raw meat dog diets (beef, lamb, chicken, or turkey), 24 samples from 2 commercial dry dog foods, and 24 samples from 2 commercial canned foods. The commercial foods were collected on 4 different dates, 2 mo apart. Three samples were collected from each product at each sampling point and were evaluated by culture for *Escherichia coli, Salmonella enterica, Campylobacter,* and by polymerase chain reaction (PCR) for *Cryptosporidium, Neospora,* and *Toxoplasma.* The PCR was performed only during the third and final sampling period. Almost 6% of the raw food diets were positive for *Salmonella,* while none of the conventional diets were positive. *Escherichia coli* were isolated from all types of diets. It was found in almost 50% of the raw food diets but in only 8/24 (33%) dry and 2/24 (8%) canned diets. There were no significant association between the type of raw meat and the agents isolated.

In 1 small study of client-owned dogs, 80% of raw chicken diets were culture positive for *Salmonella* serovars, while none of the commercial dry foods were positive. Thirty percent of the stool samples of the raw chicken eaters were also positive; the commercial diet consumers' stools were negative (16). Another study looked at research dogs fed a frozen commercial raw food (17). The diet was tested for *Salmonella* prior to feeding and divided into contaminated and non-contaminated. The contaminated diet was fed to 16 dogs and the same non-contaminated diet was fed to 12 dogs. There were no clinical signs of disease in any of the dogs, but 7 of the dogs fed the contaminated diet shed *Salmonella* serovars in their stool for 1 to 7 d after consumption. Five of the 7 shed the same serovar that was recovered from the food sample. All dogs had tested negative prior to starting the trial. In a cohort study examining shedding of *Salmonella* and other pathogens in a group of healthy pet therapy dogs (n = 200), there was 0.61 case/dog year of *Salmonella* shedding in dogs consuming raw food versus 0.08 case/dog year in non raw food consumers. There was also an increased risk of shedding extended spectrum cephalosporinase producing *E. coli* (18).

Raw diet feeding is especially prevalent in greyhound facilities. One study evaluated the *Salmonella* serovars isolated from feces obtained from greyhounds with gastroenteritis against those isolated from the diet fed prior to the onset of diarrhea (19). Out of 41 fecal samples assessed, 31 were positive for *Salmonella* and 16 were the same serovar as found in the diet. For control, 35 "normal" fecal samples were cultured. Four "normal" samples were positive for *Salmonella.*

Another documented risk is the occurrence of antimicrobial resistance in many of the isolates. A study analyzing 166 commercially available raw food samples, purchased randomly from local pet stores in 3 Canadian cities found a prevalence of 21% for *Salmonella,* with chicken being an ingredient in 67% of the positive diets. Eighteen serovars were observed with resistance present to 12/16 antibiotics tested (20).

Few studies document that *Salmonella* shedding by dogs or cats can result in illness in humans. An outbreak of disease due to multi-drug resistant *Salmonella* Typhimurium in 4 animal facilities has been reported (21,22). Illness occurred in employees, clients, and animals that were present in 3 different companion animal facilities and 1 animal shelter (21,22). Eighteen humans and 36 animals were fecal culture positive for *Salmonella.* Some of the animals died. Equally disturbing was that some animals in the facilities and in clients'/employees' homes cultured positive but were asymptomatic. Those affected clinically included veterinary staff, pet owners, children, and other pets. Although the diet fed to the pets was not discussed, the study demonstrated that *Salmonella* can cause disease in pets and that humans in contact are at risk.

Other examples of this risk are reports of *Salmonella* infections in humans linked to pig ear treats (23–26). A recent survey reports a multistate outbreak of human salmonellosis linked to contaminated commercial dry dog food (27). This case illustrates that *Salmonella* present in a pet's food can affect humans in the household, with young children being at the greatest risk for exposure.

Level 4 evidence of infectious disease risk

One study evaluated 25 commercial raw food diets for dogs and cats (28). Coliforms were found in all diets and *Salmonella* in 20%. Another study looked at the association between feeding raw meat and *Salmonella enterica* infections in a greyhound breeding facility (29). The bacteria were isolated from 93% of fecal samples and 66% of all samples (environment, feces, food). The investigation was prompted by an outbreak of illness in the dogs linked to the feeding of raw meat that was classified as unfit for human consumption. In the 10 mo prior to the investigation, 27 puppies from 8 litters had been affected, with 37% mortality.

An earlier study (30) cultured 112 samples of commercial raw meat used in greyhound diets. Almost 45% of samples were positive for *Salmonella* serovars and there was widespread antimicrobial resistance. The findings, however, are not restricted to meat fed to greyhounds. *Salmonella* serovars were isolated from 3.5% of fresh ground beef samples collected from retail stores in the United States (31). *Salmonella* serovars were isolated from 20% of broilers, 8.7% of market hogs, 7.5% of ground beef, 44.6% of ground chicken, and 49.9% of ground turkey (32) samples from federally inspected facilities in the United States. In a group of racing sled dogs, where diarrhea is relatively common during racing and raw meat feeding is prevalent, *Salmonella* was isolated from approximately 63% of fecal samples (33). There was no significant difference between dogs with diarrhea and with normal stool. Another study of pet dogs consuming mostly commercial foods found an isolation rate of about 1% (34).

As there appears to be strong evidence that raw food can contain *Salmonella,* it is vitally important, if feeding a raw meat diet to a pet, that hygiene of the food preparation area and the feeding bowls be diligently maintained. This may, however, be

difficult to achieve. A recent study found that standard methods of cleaning and disinfecting food bowls were minimally effective at eliminating *Salmonella* (35). This included soaking with bleach and cleaning in a dishwasher.

Level 5 evidence of infectious disease risk

Feeding raw meet to pets has been cited as a human risk factor in several review articles related to public health (36–38). However, there have been no studies conclusively documenting the risk to either pets or owners. *Salmonella* infections have been reported in cats (39–40). In one of the reports, the infection was associated with raw diet and the infection was fatal (39). There are also isolated case reports of illness in humans associated with *Salmonella* in household pets, although raw food was not identified in these cases (41,42).

Clearly, there is some compelling evidence suggesting that raw food diets may be a theoretical risk nutritionally. In addition, raw food poses a substantial risk of infectious disease to the pet, the pet's environment, and the humans in the household. What is lacking, however, is level 1 evidence from randomized controlled trials or strong level 2 evidence from large cohort studies to evaluate risks or benefits of raw meat diets in pets. There is, though, sufficient evidence available that veterinarians should feel obligated to discuss the human health implications of a client's decision to use a raw meat-based food for their pet.

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Answers to Quiz Corner
Les réponses du test éclair

1. **a)** Cats show "pinking up" (hyperemia) of the nipples at 2 to 3 weeks of gestation.
a) Les chattes présentent de la «rougeur» (hyperhémie) des tétines lorsqu'elles atteignent 2 à 3 semaines de gestation.

2. **b)** Stay sutures allow relatively atraumatic manipulation of tissue.
b) Les sutures de «support» permettent une manipulation atraumatique relative des tissus.

3. **e)** Intestinal lymphangiectasia is a significant cause of protein-losing enteropathy but is not associated with tenesmus or dyschezia.
e) La lymphangiectasie intestinale est une cause importante d'entéropathie avec perte de protéines, mais n'est pas associée au ténesme ou à la dyschésie.

4. **d)** Xerostomia by definition means dry mouth. It would not be associated with excessive salivation (ptyalism).
d) Par définition, la xérostomie signifie bouche sèche. Elle n'est donc pas associée à une salivation excessive (ptyalisme).

5. **b)** Colic may accompany these diseases in cattle.
b) Les coliques peuvent accompagner ces problèmes chez les bovins.

6. **d)** The cornea/limbus is affected in 60% of patients, the lower eyelid in 27%, the upper eyelid in 10%, and the nictitans in 7%. Orbital involvement is due to local extension from one of the primary sites.
d) La cornée/limbe est affectée chez 60 % des patients, la paupière inférieure chez 27 %, la paupière supérieure chez 10 % et la membrane nictitante chez 7 %. L'orbite est touchée en raison d'une extension locale à partir d'un des sites primaires.

7. **c)** Although they are the classic lesions of campylobacterosis, these lesions are only observed in 10% to 30% of lambs aborted from this disease.
c) Bien que ce soit les lésions classiques de la campylobactériose, ces lésions sont observées chez seulement 10 % à 30 % des agneaux qui avortent à cause de cette maladie.

8. **c)** In neonatal isoerythrolysis the dam makes antibodies against the foal's red blood cells, and these antibodies are concentrated in the colostrum.
c) Dans l'isoérythrolyse néonatale, la mère fabrique des anticorps contre les globules rouges du poulain et ces anticorps sont concentrés dans le colostrum.

9. **c)** Milk spots (lesions of ascarid infection) are large and fibrotic, not necrotic. Fluke infection and contagious hepatitis do not occur in pigs. Selenium deficiency is associated with liver hemorrhage.
c) Les taches de lait (lésion d'une infection par les ascarides) sont grosses et fibreuses, non nécrotiques. L'infection par les douves et l'hépatite contagieuse n'affectent pas les porcs. La carence en sélénium est associée à l'hémorragie hépatique.

10. **e)** Cats with hepatic lipidosis are notorious for their refusal to eat.
e) Les chats qui souffrent de lipidose hépatique sont remarquables dans leur refus de manger.