ACTA AGRARIA KAPOSVÁRIENSIS *(2020) 24 (2), 75–88; DOI: 10.31914/aak.2433*
Szent István Egyetem Kaposvári Campus, Agrár- és Környezettudományi Kar, Kaposvár
Szent István University Kaposvár Campus, Faculty of Agricultural and Environmental Sciences

One Health approach to companion carnivores with special regard to raw-feeding

Aziz MOUHANNA, Ágnes CSIVINCSIK *

University of Kaposvár, Faculty of Agricultural and Environmental Sciences, Guba Sándor Str. 40., H-7400 Kaposvár, Hungary

ABSTRACT - Keeping and feeding of companion carnivores (dogs and cats) appear to be a simple activity for a shallow observer. By a multidimensional approach, all three domains of health can be analysed in the course of pet-feeding. The interest of animal health requires healthy, nutritious, and non-infectious pet food. At the same time, public health necessitates safety for pet owners and their families. By going much deeper, the environmental impacts of pets and pet foods can be identified. This review gathers the animal and human health and environmental aspects of domestic carnivore feeding. Based on the literature, it can be claimed that for the present, few data are available to determine the right way of feeding to reach the balance between all three domains of health.

Keywords: One Health, domestic carnivores, raw-feeding

INTRODUCTION

Pets are our best companions or even best friends with a deep relationship between the animal and its owner. This human-animal bond can help people get through stressful situations. Companion animals, especially dogs, and cats make the family warmer, provide company for lonely people, support family members after social conflicts, especially children at school (*Martens et al., 2019; Wells, 2009*). We are closely connected to our pets not only through emotions but also through the health. Pet-keepers are responsible for the health and well-being of both their pets and their family members (*Morelli et al., 2019; Morgan et al., 2017*).

Human, animal, and environmental health are closely related. Because many diseases can spread rapidly throughout different ecosystems, it is very important to have sufficient knowledge about the factors that accelerate health risk. The Centers for Disease Control and Prevention (CDC) indicates that 6 out of every ten known infectious diseases in humans are derived from animals. Thousands of cases recorded yearly are attributed to the interactions with animals all around the world. Many people interact with animals daily, whether for production purposes, companions, or wild animals (*CDC, 2019; Belay et al.,*

*CORRESPONDING AUTHOR
Szent István University Kaposvár Campus
✉ *H-7400 Kaposvár, Guba S. str. 40.,* ☎ *+36-82-505-800*
E-mail: csivincsik.agnes@szie.hu

2017). These animals can carry serious microorganisms which can cause severe illnesses, and in some cases, death. This type of harmful microorganisms is labelled as zoonotic diseases. Young children, the elderly, and infants, or others with a weak immune system, can be susceptible to zoonotic diseases (*Morelli et al., 2019*). The dangers of zoonotic diseases need collaborative and multisectoral efforts to encounter. According to the database of the World Health Organization, 7.8 trillion US$ was spent on global health in 2017 (*WHO, 2019*).

While the main requirements imposed on pet foods are to be healthy, nutritious, non-infectious, and environmentally friendly (*Davies et al., 2019; Martens et al., 2019; Schlesinger et al., 2011; Verbrugghe et al., 2019*), it is very difficult to keep the balance between those three domains. Because these pets need high protein and energy content in their diet, which can be provided most appropriately by feeds of animal origin thus consequently increases the carbon dioxide emission, therefore the Ecological Paw Print (EPP) of pet-keeping (*Martens et al., 2019*).

The recognition led to the One Health approach, which is described by the Food and Agriculture Organization of the United Nations as "a holistic vision to address the complex challenges that threaten human and animal health, food security, and the environments where diseases flourish" (*FAO, 2011*). For this reason, a wide range of experts (e.g. public health professionals, veterinarians, plant healthcare professionals, environmental activists) are collaborating interdependently to provide safety and health of humans, animals, and the natural environment. This multidisciplinary approach is especially suitable to analyse the health issues of pet-keeping where the human-animal relation is close, and the disease transmission in both directions is possible.

This multidisciplinary approach is suitable to analyse the interdependence of human and animal health and environmental aspects of pet-keeping. This review attempted to show: a) the responsibility of humans to provide the welfare and health of their pets and; b) how One Health approach can help this effort.

ANIMAL HEALTH AND WELFARE ASPECTS

By feeding domestic carnivores, the aim is to assure fulfilment of the nutritional demands and welfare of the animal. The requirements for certain nutrients are permanently changing by age, species, gender, and physiological status. Studies have been carried to determine the basic requirements for protein, energy, Ca/P ratio, certain vitamins and microelements (*Vester et al., 2010; Beynen, 2015*). Physical activity, pregnancy, lactation and extensive growth also need a sort of quality nutrients (*Beynen, 2015; Morelli et al., 2019*). To meet

all the demands mentioned above, the preparation of an appropriate diet needs specific knowledge. However, in recent days, there has been a popular trend of using Raw Meat Based Diet (RMBD) or in other terms, Biologically Appropriate Raw Food (BARF) in companion animals' feeding. This type of diet is mainly composed of uncooked ingredients derived from animals and can be prepared by the owner or purchased as a frozen meal from commercial suppliers (*Freeman et al., 2013; Fredriksson-Ahomaa et al., 2017*).

Most of the pet-owners who provide RMBD have the conviction that raw food is natural and safer than industrial feeds (*Morgan et al., 2017; Morelli et al., 2019*). Popular websites and so-called experts claim that raw-fed dogs are healthier because they eat their ancestors' natural and additive-free food (*Beynen, 2015*). Peer-reviewed studies confirmed some considerable advantages of raw-feeding. By RMBD, a better digestibility can be achieved due to the presence of digestive enzymes, which could be degraded during cooking (*Johnson, 2001; Algya et al., 2018*). Dogs fed RMBD have more diverse and consequently stable and complex enteric microbiota (*Davies et al., 2019; Sandri et al., 2016; Schmidt et al., 2018*). *Kim et al. (2017)* reported a greater faecal bacterial diversity when dogs were fed RMBD compared to conventional diets. *Glasgow et al. (2002)* also reported an improved faecal quality in cats fed RMBD compared to the conventional diet-fed counterpart; however, growth was not improved when RMBD were fed. Better muscle and dental development can be achieved with RMBD (*Stogdale et al., 2003*). If bones are present in RMBD as a calcium source, then chewing will make teeth cleaner, although tooth fracture or other gastroenteric injuries may rarely occur (*Davies et al., 2019; Morelli et al., 2019*). One article pointed out many positive effects for raw feeding such as better hair coat, fewer faeces, less odour, higher activity, better mood, better palatability, satiety improvement, desired weight loss, and desired weight gain (*Hielm-Bjorkman et al., 2019*). However, there were many limitations to this study. These observations were based on the unformal owner feedback where all data are extracted from online submitted reports and not any specialised veterinarian verify the animal's conditions.

On the other hand, many pieces of research have indicated that the disadvantages of this practice far exceed the advantages. The RMBD can harbour harmful bacterial species, such as *Campylobacter* spp., *Salmonella* spp., *staphylococci*, *Clostridium perfringens*, *Brucella suis*, *Listeria monocytogenes, Mycobacterium bovis*, *Sarcocystis spp*., and *Toxoplasma gondii* (*McKenzie et al., 2010; Schlesinger and Joffe, 2011; Freeman et al., 2013; Goh, 2016; Fredriksson-Ahomaa et al., 2017; Davies, 2018; van Bree et al., 2018; Loeb, 2019; Morelli et al., 2019*). Besides, viral species may be present such as the canine H3N8 influenza

(*Gibbs and Anderson, 2010*). These can be harmful to domestic carnivores, especially at young and senior ages, or under stress, like race dogs. (*Morelli et al., 2019; Verbrugghe et al., 2017*). Therefore, it presents a source of infection to the animal due to uncomplete destruction of pathogens during the preparation of the RMBD or contamination during the processing or storage (*Chengappa et al., 1993; Schlesinger et al., 2011; Davies, 2018; van Bree et al., 2018; Clark, 2019; Jones et al., 2019*). Although domestic carnivores have shorter gastrointestinal tracts with very acidic stomach content compared to humans (*Michel and Freeman, 2005*), there is no evidence that these differences can significantly protect those animals from being infected with pathogens (*Dressman, 1986*).

In slaughterhouse offals, some types of parasites, such as tapeworms, protozoans, can be found, which are considered as health risk rather for owners than pets because in many cases like the infection with *Sarcocystis* species, dogs and cats serve as the definitive host for these parasites. However, in some cases like the infection with *S. bovihominis* and *S. suihominis,* humans can serve as the definitive host (*van Bree et al., 2018*).

Using RMBD in companion animals' diets presents a considerable risk for animal health even in the absence of pathogens because some offals can cause nutritional imbalances. Excessive amounts of vitamin A in the body could be toxic and causes hypervitaminosis A. This condition could become acute or chronic and occurs when pork liver is overused in the diet. This problem not an extremely rare health disorder of cats, as they can get used to a certain type of food easily. Fortunately, the animals can recover when the diet is restored to commercially canned food (Polizopoulou et al., 2005). However, recently the regulation (EU) No 2016/429 forbids to give any pork meat to carnivore pets (*More et al., 2017; Lazić et al., 2017*).

Additionally, in certain physiological conditions, the stored body-fat becomes inflamed, which is called pansteatitis. Generally, it emerges as a consequence of imbalanced nutrition with high levels of unsaturated fatty acids and the insufficient intake of vitamin E. It frequently appears as a result of a fish-based diet (*Beynen, 2017*), when the diet is insufficient in calcium, and it contains an excessive amount of dietary phosphorus, nutritional osteodystrophy is observed. This condition results in hyperparathyroidism, reduced kidney ability, and thinning bones. It was recorded when feeding dogs, bones and raw food (*Delay et al., 2002, Schlesinger and Joffe, 2011*). Also, this condition was reported when dogs were fed 80% rice with 20% raw meat (*Kawaguchi et al., 1993*). A very popular raw feed in the USA is calf gullet, which can be contaminated with a considerable amount of thyroid gland tissue. When this type of feed provides animals for a long time, dietary hyperthyroidism with increased

plasma thyroxine concentration can be detected (*Köhler et al., 2012; Schlesinger and Joffe, 2011; Verbrugghe et al., 2017*).

HUMAN HEALTH AND WELL-BEING

Many owners treat their pets as if it is a member of the family, and sometimes the pet's diet is as much as important and sometimes more important than what the owners eat themselves (*Freeman et al., 2013*). Therefore, owners look to provide the best for their pets. The main motivation behind using RMBD is that it is the diet that non-domesticated ancestors of dogs and cats ate before evolving into domesticated animals (*Billinghurst, 1993; Schultze, 1998*). Although the natural diet of cats has remained prey dependent, as they retained the obligate carnivore properties of their ancestors, they can also digest and metabolise a large array of plant-derived nutrients (*De-Oliveira et al., 2008*). Dogs, on the other hand, have gone through immense adaptation and became omnivores; thus, they are very different from their ancestors (*Meyer et al., 1999; Axelsson et al. 2013*).

Planning the diet, collecting its ingredients and the preparation of food; supports the owner to feel caring for the animal, which strengthens the human-animal bond from the viewpoint of the owner (*Wells, 2007*). Because this caring activity of diet preparation is very important to humans and the majority of owners formulate the RMBD by themselves according to other people's suggestions, nutritional websites and books, or without following any guidelines at all; and very few turn to the professional advice; thus, most home-made diets are imbalanced nutritionally due to the lack of knowledge of specific nutritional requirements and the great individual variation (*Larsen et al., 2012; Heinze et al., 2012; Morgan et al., 2017; Morelli et al., 2019*). For this reason, after long-lasting feeding, these arbitrary formulated diets might cause nutritional disorders, especially in young or senior animals (*Larsen et al., 2012; Heinze et al., 2012; Kölle & Schmidt, 2015; Morelli et al., 2019; Verbrugghe et al., 2017*). A study in the USA pointed out that home-made and commercial RMBD was not nutritionally balanced in terms of Ca/P ratio, Vitamins A, E, and D and these imbalances might cause negative consequences on animal health (*Freeman et al., 2001*). Also, a study in Europe revealed that 60% of RMBD samples had excessive or inadequate amounts of nutrients (*Dillitzer et al., 2011*).

For some people, food-processing for the pet is a relaxing, stress-relieving activity completed with a nice feeling of caring. From this side, preparing food for a pet can be an important part of the owners' well-being (*Wells, 2007*). Moreover, being familiar with the nutritional requirements of a pet, and gath-

ering scientific data on health and diets make the owners more health-conscious, and can adapt the knowledge on pet-care to his/her nutritional strategy and lifestyle (*Wells, 2007; 2009*). However, home-made food is time-consuming and speculative; therefore, results in less substantial leisure time being together with the pet.

It's clearly understood that raw food probably contains harmful pathogens for humans and in some cases such as young, senior, and stressed animals; raw food can also be harmful. It is also important to know that even with additional hygiene during raw food preparation, the processing place and feeding containers can serve as a source of infection. A study points out that regular disinfecting methods are barely effective against *Salmonella* (*Weese et al., 2006*). *Salmonella* serovars are pathogenic bacteria that can cause some serious gastrointestinal illnesses in humans. This disease can be transmitted through water, food, animals, the environment, and person-to-person (*Ford et al., 2016*). Therefore, this practice of home-made RMBD might induce a high risk for humans.

RMBD used in companion animals feeding increases the potential of pet associated salmonellosis, especially in young children (*Finley et al., 2006, 2007; Wright et al., 2005*). *Joffe et al. (2002)*, indicates that 30% of stool samples from raw chicken fed pets contained *Salmonella* serovars, contrary to pets on commercial dry food diets. Also, 60% of commercial RMBD samples contained *Escherichia coli*, while it was only present in 8% of the commercial cooked diet (*Strohmeyer et al., 2006; Freeman et al., 2001*). *Weese et al. (2005)* found that 20% of RMBD samples were contaminated with *Clostridium* species. *Lenz et al. (2009)* found that RMBD was contaminated with *Campylobacter jejuni*. Moreover, *Toxoplasma gondii* was also present in RMBD (*Smielewska-Loś et al., 2002; Dubey et al., 2005; Lopes et al., 2008; Taylor et al., 2009*). Consuming RMBD can provide a considerable increase in the incidence of *Toxoplasma gondii* in cats, which can be transmitted to humans (*Opsteegh et al. 2012; Jokelainen et al. 2012*)

A special issue of pet-food safety is the feeding of therapy dogs, which are applied to support the physical or mental recovery of the most susceptible part of the human population. Young children, elderly, chronically diseased persons with an impaired immune system can be the possible patients of therapy animals (*Wells, 2009*). In this case, safe food, which is biologically safe and dedicated not to induce pathogen shedding, should be the primary condition for feeding of therapy animals. Despite this fundamental principle, most organisations of animal therapists do not prescribe special demands on the animals' nutrition or prohibition of raw-feeding for carnivores (*Serpell et al., 2020*).

ENVIRONMENTAL HEALTH

According to the Europe Pet Food Industry Federation (FEDIAF) and Vetnosis data statistics, 223 million dogs and 220 million cats were registered all over the world in 2014. This number is continuously increasing until this moment because these pets play a significant role in humans' lives. The Ecological Footprint (EF) is a method used to estimate environmental sustainability. Specifically, it means how much can the natural resources support the demands of a certain population (*Wackernagel et al., 2019*). The Ecological Paw Print (EPP) is derived from the EF, and it estimates how much of the productive land is used for the companion animals' food consumption (*Martens et al., 2019*). The diet of these companion carnivores significantly affects the EPP (*Vale et al., 2009; Swanson et al., 2013*). This large impact of EPP is due to the high protein requirements of companion carnivores, which can be provided by feedstuffs of animal origin. Although plant protein-based diets would be more environmental-friendly, it cannot be a sole option for carnivorous animals (*Martens et al., 2019*). In the case of cats, which are as previously mentioned, they retained the obligate carnivore properties of their ancestors. RMBD require more energy and water to produce compared to conventional plant-based diets. The contribution of these animals to the greenhouse gases (GHGs) is obvious (*Pimentel and Pimentel, 2003; Reijnders and Soret, 2003; Wirsenius et al., 2010; Okin, 2017*). A study in Japan (*Su and Martens, 2018*) pointed out that companion animals produce around 2.5 to 10.7 million tons of GHGs per year. *Su et al. (2018b)* mentioned that food consumption by these companion carnivores' results in carbon emissions that is equal to 34-107 million people. Cats and dogs consuming RMBD produce up to 80 million tons of CH_4 and N_2O (*Okin, 2017*).

Knowing that owners consider their pets as a family member or a close friend, the general opinion is that a good owner provides the best for his/her pet. Mostly, it means that these pets are overfed with an excessive amount of nutrients (*Hughes, 1995*). In many cases, the ingredients used in pet feeding are dedicated for human consumption (*Fleeman and Owens, 2007*). Their consumption leads to obesity and an increment in the wastes of these animals. It, therefore, will add to increasing the EPP of these animals and will be a barrier toward achieving environmental sustainability (*Swanson et al., 2013*).

Companion carnivores faeces like dogs and cats contains high amounts of nitrogen and phosphorous and can harbour a large population of bacteria and pathogens, and this causes many environmental problems when used directly as soil fertiliser (*Okoroigwe et al., 2014*). Therefore, it requires processing before it can be used to fertilise the soil. *Martínez-Sabater et al. (2019)*, mentioned the possibility of utilising biological processes such as composting and

anaerobic digestion to add value to these wastes. However, these practices are neglected, especially in urban areas (*Okoroigwe et al., 2014*). On the other hand, companion carnivores can shed dangerous bacteria or parasites without any sign of diseases (*Fredriksson-Ahomaa et al., 2017; van Bree et al., 2018*). These pathogens are originated from pet foods meaning that the food-chain plays a significant role as an indirect source of infection (*Fredriksson-Ahomaa et al., 2017; Strohmeyer et al., 2006*). It means that faeces if not used properly, will raise the amount of municipal waste disposed of in landfills; since contrary to wolves and wild cats, the number of pets is extremely large. Therefore, the sanitation and dilution effect of these carnivores cannot prevail in the urban ecosystem (*Craft et al., 2008; Martens et al., 2019*).

Pathogens accumulation from companion carnivores faeces and urine impacts not only the health of these animals, their owners, and the whole family, but also, the whole ecosystem by increasing the bacterial load in the environment (*Okin, 2017*). A further problem with pathogens from pets, that those are predominantly acquired from the food-chain. Since farm animals which are used to produce the RMBD are very often treated with different types of antimicrobials; therefore, Antimicrobial Resistance (AMR) is not a rare phenomenon in bacteria originated from the food-chain. As cats and dogs get infected with pathogenic bacteria during consuming RMBD, they will harbour resistance genes in their enteric microbiota such as *Salmonella* and Multidrug-resistant (MDR) *Enterobacteriaceae* (*Nüesch-Inderbinen et al., 2019*) and *Escherichia coli* (STEC) O157:H7 (*Pereboom et al., 2018*). These genes then will be shed on the environment with faeces. As a result, resistance plasmids against important antimicrobials (e.g. colistin, methicillin, cephalosporins, fluoroquinolones) can be detected in RMBD of farm animals' origin and in the faeces of carnivores fed these diets (*van Bree et al., 2018; Davies et al., 2019; Nüesch-Inderbinen et al., 2019*).

CONCLUSION

Pet-keeping is a very complex health issue. They have a significant role in our mental health, and we are responsible for their welfare. Notwithstanding, analysing pet-keeping as a whole by a multidimensional approach, we can conclude that it is very hard to keep a carnivore pet while preserving the natural balance throughout the ecosystem.

The two most important health-threatening factors caused by the feeding strategy and especially when RMBD are used, are the spread of pathogens throughout the environment which exposes the humans and the animals to the

risk of infection with antimicrobial-resistant species of bacteria, and the additional accumulation of GHGs which consequently enlarges the Ecological Paw Print (EPP).

It can be claimed that an appropriate diet design should play a central role in risk management. Other words, it is very important to always consider the professional advice from a nutrition specialist or a veterinarian because if the animal is fed close to its specific requirements, its health status will be nearly ideal. It will achieve a balanced immunological state which will enable it to fight against pathogens successfully. Therefore, the risk of pathogen spread will very low or even negligible (*Beynen, 2015; Sandri et al., 2016; Vester et al., 2010*).

Based on the peer-reviewed literature, the raw feeding of companion carnivores needs further research. The obvious advantages, such as better health status, digestibility, behavioural patterns, and balanced microbiota, need further research and cannot exceed the serious risks coming from this practice. Moreover, it is essential to outline the basic rules for safe raw-feeding, because, in the case of therapy animals, it is not recommended until its safety is confirmed without a doubt. For this reason, further investigations on the feeding ecology of wild carnivores are needed to appreciate the natural conditions that we would like to adapt to our pets. Moreover, a complete risk-benefit analysis should claim the right to the existence of raw-feeding.

Finally, the human health hazards, nutritional risks in animals, and the tremendous environmental impacts require caution when adapting any new feeding strategy without a solid foundation and scientific background. Because many infectious diseases can be opportunistic, and the novel emerging Covid-19 is supposed to be a wakeup call for the close connection between humans, animals, and the environment. Therefore, One Health meetings and conferences could provide solutions and awareness since it is aimed toward establishing a better understanding of these connections, and developing better criteria to encounter the damaging effects of diseases. The outcome will improve the allocation of resources for disease management.

ABBREVIATIONS:

Raw Meat Based Diet (RMBD), Biologically Appropriate Raw Food, Ecological Paw Print (EPP), The Ecological Footprint (EF), Antimicrobial Resistance (AMR), Multidrug-resistant (MDR), Food and Agriculture Organization (FAO), Centers for Disease Control and Prevention (CDC), World Health Organization (WHO), Dogs and Cats (Companion Carnivores), European Union (EU), European Pet Food Industry Federation (FEDIAF), Greenhouse Gases (GHG)

REFERENCES

Algya, K. M., Cross, T. W. L., Leuck, K. N., Kastner, M. E., Baba, T., Lye, L., ... & Swanson, K. S. (2018). Apparent total-tract macronutrient digestibility, serum chemistry, urinalysis, and fecal characteristics, metabolites and microbiota of adult dogs fed extruded, mildly cooked, and raw diets. Journal of Animal Science, 96(9), 3670-3683. DOI: *10.1093/jas/sky235*

Axelsson, E., Ratnakumar, A., Arendt, M. L., Maqbool, K., Webster, M. T., Perloski, M., ... & Lindblad-Toh, K. (2013). The genomic signature of dog domestication reveals adaptation to a starch-rich diet. Nature, 495(7441), 360-364. DOI: *10.1038/nature11837*

Beynen, A. C. (2015). Raw pet foods make raw claims. All About Feed, 23(5), 22.

Beynen, A. C. (2017). Fish for cats. Creature Companion, 32-33. DOI: *10.22233/20412495.0817.32*

Billinghurst, I. (1993). Give your dog a bone: the practical common sense way to feed dogs for a long healthy life.

Chengappa, M. M., Staats, J., Oberst, R. D., Gabbert, N. H., & McVey, S. (1993). Prevalence of Salmonella in raw meat used in diets of racing greyhounds. J. Vet. Diagn. Invest., 5(3), 372-377. DOI: *10.1177/104063879300500312*

Clark, K. (2019). Feline TB cases linked to raw pet food. Vet. Rec., 184(20), 605. DOI: *10.1136/vr.l3072*

Craft, M. E., Hawthorne, P. L., Packer, C., & Dobson, A. P. (2008). Dynamics of a multihost pathogen in a carnivore community. J. Anim. Ecol., 77(6), 1257-1264. DOI: *10.1111/j.1365-2656.2008.01410.x*

Davies, M. (2018). Health hazards associated with feeding raw foods. Vet. Rec., 182(4), 114. DOI: *10.1136/vr.k358*

Davies, R. H., Lawes, J. R., & Wales, A. D. (2019). Raw diets for dogs and cats: a review, with particular reference to microbiological hazards. J. Small Anim. Pract., 60(6), 329-339. DOI: *10.1111/jsap.13000*

Delay, J., & Laing, J. (2002). Nutritional osteodystrophy in puppies fed a BARF diet. AHL Newslet-ter, 6(2), 23.

De-Oliveira, L. D., Carciofi, A. C., Oliveira, M. C. C., Vasconcellos, R. S., Bazolli, R. S., Pereira, G. T., & Prada, F. (2008). Effects of six carbohydrate sources on diet digestibility and postprandial glucose and insulin responses in cats. Journal of Animal Science, 86(9), 2237-2246. DOI: *10.2527/jas.2007-0354*

Dillitzer, N., Becker, N., & Kienzle, E. (2011). Intake of minerals, trace elements and vitamins in bone and raw food rations in adult dogs. Br. J. Nutr., 106(S1), S53-S56. DOI: *10.1017/S0007114511002765*

Dressman, J. B. (1986). Comparison of canine and human gastrointestinal physiology. Pharm. Res., 3(3), 123-131. DOI: *10.1023/A:1016353705970*

Dubey, J. P., Hill, D. E., Jones, J. L., Hightower, A. W., Kirkland, E., Roberts, J. M., ... & Sreekumar, C. (2005). Prevalence of viable Toxoplasma gondii in beef, chicken, and pork from retail meat stores in the United States: risk assessment to consumers. J. Parasitol., 91(5), 1082-1093. DOI: *10.1645/GE-683.1*

Finley, R., Reid-Smith, R., Weese, J. S., & Angulo, F. J. (2006). Human health implications of Salmonella-contaminated natural pet treats and raw pet food. Clin. Infect. Dis., 42(5), 686-691. DOI: *10.1086/500211*

Finley, R., Ribble, C., Aramini, J., Vandermeer, M., Popa, M., Litman, M., & Reid-Smith, R. (2007). The risk of salmonellae shedding by dogs fed Salmonella-contaminated commercial raw food di-ets. The Canadian Veterinary Journal, 48(1), 69.

Fleeman, L. M., & Owens, E. (2007). Applied animal nutrition. Animal Physiotherapy: Assessment, Treatment and Rehabilitation of Animals, 14-31. DOI: *10.1002/9780470751183.ch3*

Ford, L., Glass, K., Veitch, M., Wardell, R., Polkinghorne, B., Dobbins, T., ... & Kirk, M. D. (2016). Increasing incidence of Salmonella in Australia, 2000-2013. PLoS One, 11(10), e0163989. DOI: *10.1371/journal.pone.0163989*

Fredriksson-Ahomaa, M., Heikkilä, T., Pernu, N., Kovanen, S., Hielm-Björkman, A., & Kivistö, R. (2017). Raw meat-based diets in dogs and cats. Veterinary Sciences, 4(3), 33. DOI: *10.3390/vetsci4030033*

Freeman, L. M., & Michel, K. E. (2001). Evaluation of raw food diets for dogs. J. Am. Vet. Med. Assoc., 218(5), 705. DOI: *10.2460/javma.2001.218.705*

Freeman, L. M., Chandler, M. L., Hamper, B. A., & Weeth, L. P. (2013). Current knowledge about the risks and benefits of raw meat-based diets for dogs and cats. J. Am. Vet. Med. Assoc., 243(11), 1549-1558. DOI: *10.2460/javma.243.11.1549*

Gibbs, E. P. J., & Anderson, T. C. (2010). Equine and canine influenza: a review of current events. Anim. Health Res. Rev., 11(1), 43. DOI: *10.1017/S1466252310000046*

Goh, L. M. (2016). BSAVA Congress 2016-Raw food diets for dogs and cats: do we know enough?. Vet. Rec., 549-550. DOI: *10.1136/vr.i2949*

Heinze, C. R., Gomez, F. C., & Freeman, L. M. (2012). Assessment of commercial diets and recipes for home-prepared diets recommended for dogs with cancer. J. Am. Vet. Med. Assoc., 241(11), 1453-1460. DOI: *10.2460/javma.241.11.1453*

Hielm-Bjorkman, A., & Virtanen, J. (2019). Exploratory study: 632 shared experiences from dog owners changing their dogs'food to a raw food (BARF) diet. Link

Hughes, D. (1995). Animal welfare: the consumer and the food industry. Br. Food. J., DOI: *10.1108/00070709510104529*

Joffe, D. J., & Schlesinger, D. P. (2002). Preliminary assessment of the risk of Salmonella infection in dogs fed raw chicken diets. The Canadian Veterinary Journal, 43(6), 441.

Johnson, W. (2001). Mr. Johnson and Dr. Sinning respond: Letter to the editor. J. Am. Vet. Med. Assoc., 218(10), 1553-4. DOI: *10.1097/00061198-200108000-00022*

Jokelainen, P., Simola, O., Rantanen, E., Näreaho, A., Lohi, H., & Sukura, A. (2012). Feline toxoplasmosis in Finland: cross-sectional epidemiological study and case series study. J. Vet. Diagn. Invest., 24(6), 1115-1124. DOI: *10.1177/1040638712461787*

Jones, J. L., Wang, L., Ceric, O., Nemser, S. M., Rotstein, D. S., Jurkovic, D. A., ... & Brown, C. A. (2019). Whole genome sequencing confirms source of pathogens associated with bacterial foodborne illness in pets fed raw pet food. J. Vet. Diagn. Invest., 31(2), 235-240. DOI: *10.1177/1040638718823046*

Kim, J., An, J. U., Kim, W., Lee, S., & Cho, S. (2017). Differences in the gut microbiota of dogs (Canis lupus familiaris) fed a natural diet or a commercial feed revealed by the Illumina MiSeq platform. Gut Pathog., 9(1), 68. DOI: *10.1186/s13099-017-0218-5*

Köhler, B., Stengel, C., & Neiger, R. (2012). Dietary hyperthyroidism in dogs. J. Small Anim. Pract., 53(3), 182-184. DOI: *10.1111/j.1748-5827.2011.01189.x*

Kölle, P., & Schmidt, M. (2015). Raw-meat-based diets (RMBD) as a feeding principle for dogs. Tierarztliche Praxis. Ausgabe K, Kleintiere/Heimtiere, 43(6), 409-19. DOI: *10.15654/TPK-150782*

Larsen, J. A., Parks, E. M., Heinze, C. R., & Fascetti, A. J. (2012). Evaluation of recipes for home-prepared diets for dogs and cats with chronic kidney disease. J. Am. Vet. Med. Assoc., 240(5), 532-538. DOI: *10.2460/javma.240.5.532*

Lazić, G., Petrović, T., Lupulović, D., Topalski, B., Božić, B., & Lazić, S. (2017). Aujeszky's disease in a dog-case report. Arhiv Veterinarske Medicine, 10(1), 61-69. DOI: *10.46784/e-avm.v11i1.82*

Lenz, J., Joffe, D., Kauffman, M., Zhang, Y., & LeJeune, J. (2009). Perceptions, practices, and consequences associated with foodborne pathogens and the feeding of raw meat to dogs. The Canadian Veterinary Journal, 50(6), 637.

Loeb, J. (2019). Why don't we feed cats raw mice? Vet. Record, 386. DOI: *10.1136/vr.l5837*

Lopes, A. P., Cardoso, L., & Rodrigues, M. (2008). Serological survey of Toxoplasma gondii infection in domestic cats from northeastern Portugal. Vet. Parasitol., 155(3-4), 184-189. DOI: 10.1016/j.vetpar.2008.05.007

Marks, B., ACVN, D., & Niels, C. Role of Diet in the Health of the Feline Intestinal Tract and in Inflammatory Bowel Disease.

Martens, P., Su, B., & Deblomme, S. (2019). The ecological paw print of companion dogs and cats. BioScience, 69(6), 467-474. DOI: 10.1093/biosci/biz044

Martínez-Sabater, E., García-Muñoz, M., Bonete, P., Rodriguez, M., Sánchez-García, F. B., Pérez-Murcia, M. D., ... & Moral, R. (2019). Comprehensive management of dog faeces: Composting versus an-aerobic digestion. J. Environ. Manage., 250, 109437. DOI: 10.1016/j.jenvman.2019.109437

McKenzie, E., Riehl, J., Banse, H., Kass, P. H., Nelson, Jr, S., & Marks, S. L. (2010). Prevalence of diarrhea and enteropathogens in racing sled dogs. J. Vet. Intern. Med., 24(1), 97-103. DOI: 10.1111/j.1939-1676.2009.0418.x

Meyer, H., Zentek, J., Habernoll, H., & Maskell, I. (1999). Digestibility and compatibility of mixed diets and faecal consistency in different breeds of dog. Journal of Veterinary Medicine Series A, 46(3), 155-166. DOI: 10.1046/j.1439-0442.1999.00201.x

Michel, K. E., & Freeman, L. (2005). Nutritional Requirements Across Animal Species. In Clinical Nutrition (pp. 43-54). WB Saunders. DOI: 10.1016/B978-0-7216-0379-7.50009-7

More, S., Bøtner, A., Butterworth, A., Calistri, P., Depner, K., Edwards, S., ... & Miranda, M. A. (2017). Assessment of listing and categorisation of animal diseases within the framework of the Animal Health Law (Regulation (EU) No 2016/429): paratuberculosis. EFSA Journal, 15(7).

Morelli, G., Bastianello, S., Catellani, P., & Ricci, R. (2019). Raw meat-based diets for dogs: survey of owners' motivations, attitudes and practices. BMC Vet. Res., 15(1), 74. DOI: 10.1186/s12917-019-1824-x

Morgan, S. K., Willis, S., & Shepherd, M. L. (2017). Survey of owner motivations and veterinary input of owners feeding diets containing raw animal products. Peer. J., 5, e3031. DOI: 10.7717/peerj.3031

Nüesch-Inderbinen, M., Treier, A., Zurfluh, K., & Stephan, R. (2019). Raw meat-based diets for com-panion animals: a potential source of transmission of pathogenic and antimicrobial-resistant Enterobacteriaceae. Royal Soc. Open Sci., 6(10), 191170. DOI: 10.1098/rsos.191170

Okin, G. S. (2017). Environmental impacts of food consumption by dogs and cats. PLoS One, 12(8), e0181301. DOI: 10.1371/journal.pone.0181301

Okoroigwe, E. C., Ibeto, C. N., & Ezema, C. G. (2014). Experimental study of anaerobic digestion of dog waste. Scientific Research and Essays, 9(6), 121-127. DOI: 10.5897/SRE2013.5705

Opsteegh, M., Haveman, R., Swart, A. N., Mensink-Beerepoot, M. E., Hofhuis, A., Langelaar, M. F. M., & Van der Giessen, J. W. B. (2012). Seroprevalence and risk factors for Toxoplasma gondii infection in domestic cats in The Netherlands. Prev. Vet. Med., 104(3-4), 317-326. DOI: 10.1016/j.prevetmed.2012.01.003

Pereboom, M. T. R., Todkill, D., Knapper, E., Jenkins, C., Hawker, J., & Coetzee, N. (2018). Shiga toxin-producing Escherichia coli (STEC) O157 outbreak associated with likely transmission in an in-flatable home paddling pool in England, June 2017. Perspect. Public Health, 138(5), 279-281. DOI: 10.1177/1757913918774072

Pimentel, D., & Pimentel, M. (2003). Sustainability of meat-based and plant-based diets and the environment. Am. J. Clin. Nutr., 78(3), 660S-663S. DOI: 10.1093/ajcn/78.3.660S

Polizopoulou, Z. S., Kazakos, G., Patsikas, M. N., & Roubies, N. (2005). Hypervitaminosis A in the cat: a case report and review of the literature. J. Feline Med. Surg., 7(6), 363-368. DOI: 10.1016/j.jfms.2005.05.004

Reijnders, L., & Soret, S. (2003). Quantification of the environmental impact of different dietary protein choices. Am. J. Clin. Nutr., 78(3), 664S-668S. DOI: 10.1093/ajcn/78.3.664S

Sandri, M., Dal Monego, S., Conte, G., Sgorlon, S., & Stefanon, B. (2016). Raw meat based diet influences faecal microbiome and end products of fermentation in healthy dogs. BMC Vet. Res., 13(1), 65. DOI: 10.1186/s12917-017-0981-z

Schlesinger, D. P., & Joffe, D. J. (2011). Raw food diets in companion animals: a critical review. The Canadian Veterinary Journal, 52(1), 50.

Schmidt, M., Unterer, S., Suchodolski, J. S., Honneffer, J. B., Guard, B. C., Lidbury, J. A., ... & 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. DOI: 10.1371/journal.pone.0201279

Schultze, K. R. (1998). The Ultimate Diet: Natural Nutrition for Dogs and Cats. Affenbar Ink.

Serpell, J. A., Kruger, K. A., Freeman, L. M., Griffin, J. A., & Ng, Z. Y. (2020). Current Standards and Practices Within the Therapy Dog Industry: Results of a Representative Survey of United States Therapy Dog Organizations. Front. Vet. Sci., 7, 35. DOI: 10.3389/fvets.2020.00035

Smielewska-Loś, E., Rypuła, K., & Pacoń, J. (2002). The influence of feeding and maintenance system on occurrence of Toxoplasma gondii infections in dogs. Polish Journal of Veterinary Scienc-es, 5(4), 231-235.

Stogdale, L., & Diehl, G. (2003). In support of bones and raw food diets. The Canadian Veterinary Journal, 44(10), 783.

Strohmeyer, R. A., Morley, P. S., Hyatt, D. R., Dargatz, D. A., Scorza, A. V., & Lappin, M. R. (2006). Evaluation of bacterial and protozoal contamination of commercially available raw meat diets for dogs. J. Am. Vet. Med. Assoc., 228(4), 537-542. DOI: 10.2460/javma.228.4.537

Su, B., & Martens, P. (2018). Environmental impacts of food consumption by companion dogs and cats in Japan. Ecol. Indic., 93, 1043-1049. DOI: 10.1016/j.ecolind.2018.06.015

Su, B., Martens, P., & Enders-Slegers, M. J. (2018). A neglected predictor of environmental damage: The ecological paw print and carbon emissions of food consumption by companion dogs and cats in China. J. Clean. Prod., 194, 1-11. DOI: 10.1016/j.jclepro.2018.05.113

Swanson, K. S., Carter, R. A., Yount, T. P., Aretz, J., & Buff, P. R. (2013). Nutritional sustainability of pet foods. Adv. Nutr., 4(2), 141-150. DOI: 10.3945/an.112.003335

Taylor, M. B., Geiger, D. A., Saker, K. E., & Larson, M. M. (2009). Diffuse osteopenia and myelopathy in a puppy fed a diet composed of an organic premix and raw ground beef. J. Am. Vet. Med. Assoc., 234(8), 1041-1048. DOI: 10.2460/javma.234.8.1041

Vale, B., & Vale, R. J. D. (2009). Time to eat the dog?: the real guide to sustainable living. Thames & Hudson.

van Bree, F. P., Bokken, G. C., Mineur, R., Franssen, F., Opsteegh, M., van der Giessen, J. W., ... & Overgaauw, P. A. (2018). Zoonotic bacteria and parasites found in raw meat-based diets for cats and dogs. Vet. Rec., 182(2), 50-50. DOI: 10.1136/vr.104535

Verbrugghe, A., & Hesta, M. (2017). Cats and carbohydrates: the carnivore fantasy?. Veterinary sciences, 4(4), 55. DOI: 10.3390/vetsci4040055

Vester, B. M., Burke, S. L., Liu, K. J., Dikeman, C. L., Simmons, L. G., & Swanson, K. S. (2010). Influence of feeding raw or extruded feline diets on nutrient digestibility and nitrogen metabolism of African wildcats (Felis lybica). Zoo Biol., 29(6), 676-686. DOI: 10.1002/zoo.20305

Wackernagel, M., Lin, D., Evans, M., Hanscom, L., & Raven, P. (2019). Defying the Footprint Oracle: implications of country resource trends. Sustainability, 11(7), 2164. DOI: 10.3390/su11072164

Weese, J. S., & Rousseau, J. (2006). Survival of Salmonella Copenhagen in food bowls following contamination with experimentally inoculated raw meat: Effects of time, cleaning, and disinfection. The Canadian Veterinary Journal, 47(9), 887.

Weese, J. S., Rousseau, J., & Arroyo, L. (2005). Bacteriological evaluation of commercial canine and feline raw diets. The Canadian Veterinary Journal, 46(6), 513.

Wells, D. L. (2007). Domestic dogs and human health: An overview. Br. .J Health. Psychol., 12(1), 145-156. DOI: *10.1348/135910706X103284*

Wells, D. L. (2009). The effects of animals on human health and well-being. Journal of social issues, 65(3), 523-543.DOI: *10.1111/j.1540-4560.2009.01612.x*

Wirsenius, S., Azar, C., & Berndes, G. (2010). How much land is needed for global food production under scenarios of dietary changes and livestock productivity increases in 2030?. Agric. Syst., 103(9), 621-638. DOI: *10.1016/j.agsy.2010.07.005*

Wright, J. G., Tengelsen, L. A., Smith, K. E., Bender, J. B., Frank, R. K., Grendon, J. H., ... & Barrett, T. J. (2005). Multidrug-resistant Salmonella Typhimurium in four animal facilities. Emerging Infect. Dis., 11(8), 1235. DOI: *10.3201/eid1108.050111*