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*Review paper*

# Raw diets for dogs and cats: Potential health benefits and threats

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## Abstract

Raw meat-based diets for pet nutrition are becoming increasingly popular. The percentage of meat content, composition of nutrients, and amount of additives started to play an important role in the recipe of a given food. However, the use of healthier and unprocessed food must also be balanced with the animal's specific needs based on its anatomy, physiology, and behavior. There are many potential advantages and disadvantages of a biologically appropriate raw food (BARF) diet, and all of them should be considered before switching to this approach. Raw meat is considered a diet closest to nature and least processed. However, raw diets threaten pet health because of the potential for nutrient imbalances. The choice of raw meat in pets' everyday diet should be supported by the veterinarian's medical decision and preferably also with nutritionist help. Growing animals require a specific Ca:P ratio in their diet, which may be improper in raw meat. For cats, taurine levels must be carefully checked. In addition, an imbalanced raw-meat diet can be the cause of poor semen quality in males. Females are prone to inhibition of the estrus cycle, especially due to hyperthyroidism. Exogenous thyroid hormone intake is a real concern when feeding a neck/head meat with thyroid glands. There is also a possibility of bacterial or parasitic presence in raw meat. The present paper aims to summarize the current state of knowledge about the benefits and threats of eating a raw meat diet for the health concerns of companion animals.

**Keywords:** biologically appropriate raw food (BARF), estrus cycle, nutrition, raw diet, semen quality, thyrotoxicosis



## Introduction

In recent years the need for healthier nutrition has been manifested in a desire to improve both humans' and domestic animals' nutrition. Owners have started to pay more attention to the choice of pet food, including the composition of the products and the percentage of meat content. Owners often apply their nutritional preferences to their pets as well. One preference that according to owner surveys and sales market data is gaining more popularity is a raw meat diet (Morelli et al. 2019, Oba et al. 2023). Extruded or canned diets are starting to be replaced by raw meat diets such as biologically appropriate raw food (BARF). The data indicates that approximately 4% of sales are attributed to raw diets, with an annual growth rate of 14% (Oba et al. 2023). In another study Empert-Gallegos and colleagues (2020) noted that commercially prepared raw food is the second choice for pets' owners (12.9% of participants), behind commercially prepared cooked diets, in the forms of dry kibble or wet canned food, or sachets (63.7%).

Three basic categories of raw meat diets can be distinguished. The first is commercially available, prepared frozen raw meat that contains vegetables, added minerals, and other needed additives. The second category is the homemade diet designed by the owners themselves (Brozić et al. 2020). In this case, many easily accessible recipes do not include information on the actual nutritional contents of the ingredients and do not describe the analytical components of the meal. When food additives are absent in self-prepared meals, there is a significant risk of deficiencies in the nutritional and mineral components (Dillitzer et al. 2011). To reduce the risk, homemade meals should be prepared with veterinarian nutritionist or dietician guidance. The third type of diet that uses an alternative protein source is the whole prey diet. In this diet, cats are fed whole carcasses that encourage wild species' typical behavior, especially regarding the time and energy used for finding food and its consumption (Kerr 2013).

The individual diet has to be adjusted to each animal according to age, breed, sex, reproductive status, degree of activity, and type of housing provided to the pet. When considering the nutritional value of a BARF diet for dogs and cats, many variations must be taken into account, such as the digestive tract structure and other anatomical and physiological differences resulting from long-term selection due to breeding. Purchasing fresh raw meat seems easy to manage for some owners but, unfortunately, many are unaware that balanced concentration of vitamins, macro minerals and trace elements is necessary for the animal. It is essential to consult with an expert in pet nutrition (Brozić

et al. 2020). While a specialist should always be consulted when starting a new diet, studies show that only 14% of owners ask a nutritional expert for help (Morelli et al. 2019). Curiously, most owners, who choose a raw diet, consider their nutrition knowledge to be higher than that of veterinarians. In contrast, owners who choose a commercially prepared dry or wet diet consider their understanding of nutrition lower than that of veterinarians (Empert-Gallegos et al. 2020).

## Raw diet – an evolutionary perspective on current pet needs

One of the most frequently used arguments for implementing raw meat diets is that, wild cats and dogs consumed natural fresh or found meat as their primary source of nutrients (Hamper 2014). However, the domestication process started over 15 thousand years ago (Frantz et al. 2020), and since then many biological changes have occurred in pet species. In dogs, reproductive isolation has led to wide phenotypic diversity and genetic variation according to coat color, size, shape, fat content, and behavior. The resultant variety of phenotypic features is known as 'domestication syndrome' (Frantz et al. 2020). Dogs, unlike cats, have been under phenotypic selection, and there are many breed-associated differences in anatomy, physiology, and behavior. For example, Oswald et al. (2015) have reported a positive relationship between dog breed size and the length of the intestines. The length of the intestinal villi is also inversely correlated with breed size. Another study reported that the gastrointestinal tract in large breed dogs (> 60 kg) constitutes 2.8% of the body weight, while for small breed dogs (about 5 kg) it represents 7% of the body weight (Fleischer et al. 2008).

Physiology also varies based on a dog's breed. Axelsson et al. (2013) have identified 36 genes that differ between wild wolves and domestic dogs, and 10 of these genes are related to starch and fat digestion. Scientists have acknowledged that a change in primary marginal digestibility played a significant role in the domestication process. Consequently, dogs can now obtain nutrients from meat and plant sources, so *Canis lupus familiaris* is defined as a facultative carnivore (Buff et al. 2014) or even as an omnivore, like human beings (Di Cerbo et al. 2017). Moreover, 19 of the 36 genes that differ between wolves and dogs are associated with brain function, with eight relating to nervous system development, suggesting that selection is based on specific behaviors learned during the domestication process (Axelsson et al. 2013).

There is a strong connection between a dog's diet

and gut microbiota development. Canine intestinal microbiota co-evolved with the hosts and adapted to an environment shared with humans. Based on Rampelli et al. (2021) research on the gut microbiome, domestic dogs show a greater variety of gut bacteria than feral dogs. Alessandri et al. (2019) reported that dogs fed with a BARF diet had a decreased bacterial diversity and a reduced abundance in 14 of the 43-core gut microbial genera compared to dogs fed commercially processed food. Furthermore, there are no significant differences in gut bacterial composition across dog breeds (Alessandri et al. 2019). These findings suggest that, based on intestinal bacteria, many negative features are related to diet, for example metabolic and immune issues (Rampelli et al. 2021).

Compared to dogs, cats exhibit less phenotypic variety, a strong predatory instinct, and are more closely related to their ancestors. Cats, as obligate carnivores, rely on animal tissue as a source of nutrients. As gluconeogenesis in cats is based on amino acids, these animals have a high protein requirement for energy production (Verbrugghe and Bakovic 2013). Digestibility of monosaccharides and disaccharides in cats occurs because simple sugars are absorbable, so enzymatic activity is not required or is required at lower levels than in dogs (Verbrugghe and Hesta 2017). Unlike dogs, cats have limited salivary, pancreatic, and intestinal amylase activity, and, therefore, have a reduced ability to digest complex carbohydrates (Kienzle 1993). The glucokinase levels are also lower. There is no glucokinase regulation (i.e., glucokinase regulatory protein; GKRP) due to a low enzyme concentration that facilitates glucose phosphorylation, an essential reaction in carbohydrate metabolism (Verbrugghe and Hesta 2017). According to the information provided, cats can digest carbohydrates but have reduced capacity to digest complex sugars. When a cat's diet is rich in carbohydrates, limited digestion is also evidenced by diarrheas, flatulence, and bloating conditions (Buff et al. 2014).

Protein digestibility for different raw meat sources in the domestic cat remains similar to that of captive exotic felids. Kerr et al. (2013) compared total tract digestibility in domestic cats and other wild felids, such as African wildcats, jaguars, and Malayan tigers. Dry matter, organic matter and the gross energy digestibility of test diets showed no significant differences across both groups. Furthermore, the macronutrient profile of the preferred *Felis catus* diet remains close to the feral cat diet (Buff et al. 2014). It should be noted, however, that this is the diet preferred by the cats, which doesn't necessarily mean it is the nutritionally best diet.

## **Benefits and threats of using a raw meat-based diet in dogs and cats**

### **Benefits**

#### **Natural nutrition**

Many consumers have started to pay attention to their pet's diet composition. Pet owners look for ways to improve their pets' nutrition and there is an increased tendency to look for natural ingredients in pet foods. Fresh meat does not have added sugars, preservatives, or stabilizers. Thus, consumers can use this natural ingredient for their pets (Brozić et al. 2020).

#### **High digestibility**

Diets based on raw meat may have higher digestibility than kibble or dry diets (Hamper 2014). The total digestibility of kibble and dry diets is reduced due to the heating process involved in their preparation. Dry or moist kibble diet manufacturing leads to protein denaturation and, therefore, to the loss of secondary and tertiary structure (Damodaran 1996).

For domestic cats, raw meat-based diets have 7-10% higher digestibility of dry matter and 6-10% higher digestibility of crude protein than extruded food (Hamper 2014). These values reached 10% and 15% in exotic cats, respectively (Crissey et al. 1997), but the difference was insignificant. However, it should be noted, that comparing the digestibility of raw and processed food is complicated by the potential variation in ingredients, leading to differing levels of macronutrients.

Improved digestibility means there were fewer products of digestion in the intestine and less fecal mass. However, it is worth mentioning that this may not necessarily be a desirable situation. An odor reduction was also noticed (Hjelm-björkman and Virtanen 2013).

#### **Less mutagenic risk**

Heat processing of foods such as animal tissues can also produce heterocyclic amines. A high concentration of these compounds (mg/g of food) may contribute to mutagenic effects (Sugimura et al. 2004). The level of heterocyclic amines in heat-treated pet food is low (ng/g of food). However, even these concentrations may generate genomic instability and, consequently, tumor-promoting effects. The cumulative impact of heterocyclic amines in diets should be considered in future studies (Knize et al. 2003).

### Improved immunity

Another reported benefit of a BARF diet is improved immune system functioning. Anderson et al. (2018) fed dogs with raw meat or a kibble diet and showed a positive influence on canine peripheral blood mononuclear cell expression in the raw meat group. In addition, a decrease in pro-inflammatory cytokine gene expression was detected. Based on these observations, it can be hypothesized that a raw meat diet reduces chronic inflammatory conditions.

### Diet as a treatment for pancreatic exocrine insufficiency

Components of a BARF diet can help treat pancreatic exocrine insufficiency. The porcine pancreatic extract given to dogs, results in higher enzyme supplementation levels than commercial pancreatic enzyme treatment. The recovery of lipase from the porcine pancreas is higher (39.1%) than that from commercial therapy (26.2%). Amylase and proteases are also found in higher concentrations in the porcine pancreatic extract (Westermarck 1987).

### Perspectives of pet owners

Hjelm-björkman and Virtanen (2013) studied 623 dog owners who agreed to change from commercial kibble or canned food to a BARF diet. It must be pointed out that any differences in the dogs' condition noticed by owners were subjective, and, to date, no studies have been carried out to confirm the claims of health improvements. In addition, no health issues were verified by a veterinarian before the study. Of the 632 responders, 206 initially reported skin-related problems, 145 gastrointestinal problems, 38 described eye problems, 15 declared urinary tract issues, and 18 a variety of health problems for their pets. Regarding these conditions, 91%, 94%, 87%, 66.7%, and 66.7%, respectively, claimed a total recovery or a significant improvement after a diet change to BARF. The participants also reported general improvements in their pet's condition, including better overall well-being, better skin and coat, less feces with less odor, success with a desired weight gain or loss, a lower frequency of chronic disease episodes, and even an avoidance of euthanasia.

Although owners may perceive health benefits from this diet, it is important to acknowledge the various risks that can arise from an imbalanced raw meat-based diet. Particular attention should be paid to the animals' health before diet modification. It is also worth mentioning that the term "natural" does not always equate with "complete." A balanced diet with all of the necessary nutrients in the right proportions often includes

additives. As long as synthetic components have nutritional value, they are accepted in natural pet food by the Association of American Food Control Officials (AAFCO) (Buff et al. 2014). It is easy for diets to cross the line between healthy/unprocessed and deficient in essential nutrients.

## Threats

### Bacterial, parasite and virus contamination

Raw foods may be contaminated with various pathogens. Reports of illness in pets associated with the bacterial load of the diet are rare, but possible (Morelli et al. 2019). The presence of bacteria can be due to meat storage and/or preparation issues. Feeding an animal contaminated food also increases the risk of food poisoning in humans due to the handling and preparation of the food products (Morelli et al. 2019). Bacterial or parasitic contamination may be noticed less frequently in pet foods because it is not inspected in the same way as animal products meant for human consumption (Strohmeier et al. 2006). Even though all animals in the EU are slaughtered under veterinary supervision, it is important to mention the post-slaughter classification. Based on Regulation (EC) No 1069/2009, animal by-products intended for pet food meet standards for Category 3, which include products erased from the human food chain for various reasons through which the risk for public health is minimized (Davies et al. 2019). There are published reports showing the presence of *Salmonella* spp., especially in dried or frozen products prepared at home. Chicken-based diets are particularly susceptible to contamination with *Salmonella* spp. (Freeman et al. 2013). Strohmeier et al. (2006) studied 21 previously frozen raw meat products left for 8-10 h at 22°C. Three samples of each product were then examined for pathogens and cultures of *Salmonella enterica*, *Campylobacter* spp., *Cryptosporidium* spp., *Neospora* spp., and *Toxoplasma* spp. were detected. More than one type of pathogen was found in most samples. As raw pet food can exceed the acceptable limit of bacteria, a large amount of *Enterobacteriaceae* may indirectly impact the emergence of antibiotic-resistant bacterial strains. Transmittable plasmids in *E. coli* and other *Enterobacteriaceae* are the reason for ESBL (extended-spectrum beta-lactamase) type resistance. Bacteria containing these plasmids can end up in the environment via pets' feces and thus may increase the development of additional antibiotic resistance strains (Davies et al. 2019).

*Neospora caninum* bradyzoites may also be ingested by animals fed raw beef muscle, which then can be transmitted to offspring through the placenta.

Neosporosis is often detected in puppies under six months old (Overgaauw 2020). Breeders who decide to use cattle meat to feed female dogs must consider this disease transmission to the young. Other protozoa found in raw meats include *Sarcocystis* spp., *Hammondia* spp. (*H. hammondi* and *H. heydorni* for cats and dogs, respectively) and *Cystisospora* species are known to cause intestinal coccidiosis, especially in young dogs or pets with immunodeficiencies (Overgaauw 2020).

Some protozoa, such as *Toxoplasma* spp. and *Sarcocystis* spp., can be inactivated by freezing, but this method does not work for nematodes (e.g., *Toxocara* spp.), bacteria, or viruses (Overgaauw 2020). Foodborne disease from fresh fish diets is also possible. For instance, *Diphyllobothrium latum* (a fish tapeworm), *Opisthorchis tenuicollis* (a bile duct, pancreas, and small intestine trematode) or *Dictyophyme renale* (a kidney worm) can cause infestations in pets (Lejeune and Hancock 2001). Tapeworms are also a zoonotic risk for humans and can be found in raw diets. Dogs and cats are uncommon hosts for *Echinococcus multilocularis*, unlike *E. granulosus*, but a whole prey diet carries a risk for intestinal development of these parasites in pets (Overgaauw 2020). Rodents, a popular choice as whole prey foods, are intermediate hosts for this cestode (Dyachenko et al. 2008). Of note, as dogs and cats are susceptible to Aujeszky's disease, these animals should not be fed products of pork origin that come from herds with a high prevalence of pseudorabies, which is lethal for carnivores (Lejeune and Hancock 2001, van Bree et al. 2018, Davies et al. 2019).

### Mineral insufficiency

For bone health, a balanced calcium-to-phosphorus ratio is required, which is significant for growing dogs and cats, especially for large/giant breeds where higher calcium levels are needed. Disorders of mineral metabolism that result in skeletal abnormalities occur when the Ca:P ratio is 1:2 or more for phosphorus, whereas the best level for healthy growth rates is from 2:1 to 1:1 (Kawaguchi et al. 1993). With regards to giant breeds, according to Association of American Feed Control Officials references, the ratio stays at lower levels of 1:1. AAFCO dog nutrient profiles suggest calcium levels approximately 1.2% dry matter (DM) for growth formula. The maximum 1.8% DM may be applicable to formulas for large size puppies (over 30 kg or greater as mature lean adults). FEDIAF guidelines states nutritional maximum calcium levels for growth as 1.8 g/100 g DM in late growth and as 1.6 g/100 g DM in early growth, which equals respectively 4.5 kcal and 4 kcal per 100 kcal ME. FEDIAF calcium level for adult dogs is 2.5 g/100 g DM (6.25 kcal/1000 kcal ME).

Even if calcium levels are normal, increased phosphorus levels in feed can be problematic. High dietary bone phosphorus levels can also cause parathyroid gland hyperactivity, and the proper ionized Ca:P ratio in the serum can be disrupted. Due to this hyperactivity, parathormone causes bone resorption to increase calcium in the plasma (Bilezikian et al. 2018). The whole animal (meat and bones in whole prey raw diets) has a Ca:P ratio of approximately 1.1:1. Meat alone has a significantly higher phosphorus content, reversing the ratio (Howard and Allen 2008). For example, horse/beef meat contains 2 mg Ca/100 g and 30 mg P/100 g (Kawaguchi et al. 1993). Feeding with a diet rich in phosphorus may result in negative changes in bone mineral matter, demineralization, and the bones can become softer because of secondary hypocalcemia.

Consequently, bones may develop changes characteristic of fibrous osteodystrophy and osteoporosis (Loughrill et al. 2017) (as demonstrated by histological sectioning showing thinning of the cortex with irregular cavities), which indicates osteoclast activity without parallel osteoblast functioning. Hypertrophy of the epiphysis area, joint swelling, and expansion and relaxation of ligaments can also occur. Eventually, this will lead to bone loss and muscle atrophy (Kawaguchi et al. 1993).

Ingesting a high concentration of bones can also result in calcium overloading. Hypercalcemia can present as bone deformations, hard feces and constipation. A useful way to improve the Ca ratio in a meat-based meal is to add calcium carbonate. An optimum supplementation can be performed by adding one-third of calcium carbonate and two-thirds of dicalcium phosphate. These proportions are similar to the bone Ca:P ratio. Steamed bones are also a rational alternative to increase calcium levels in meat-based diets (Kawaguchi et al. 1993, Howard and Allen 2008).

### Foreign bodies

Raw diets that contain bones may result in teeth fractures, and the bones may become lodged in the esophagus or intestines as a foreign body. There is also a possibility of gastrointestinal tract perforation due to sharp bone fragments. Additional evaluation is needed to determine if cooked bones are less likely to fracture, but it can be assumed that both types of bones, raw and cooked, have the potential to injure or even rupture the gut (Freeman et al. 2013).

### Fats

Depending on the owner's choice, a raw diet might contain a large amount of fats, which can contribute to the coat glossiness desired by owners. Still, increased

ingestion of fats may also cause obesity, mild gastrointestinal digestive issues or pancreatitis (Freeman et al. 2013).

### **Taurine deficiency**

Cats and dogs have significant differences in amino acid requirements, carbohydrate metabolism, and endogenous synthesis limits (Owens et al. 2021). Cats, for instance, have low hepatic activity of cysteine sulfinic acid decarboxylase (CSAD), an enzyme that affects taurine biosynthesis. Consequently, cats cannot provide a sufficient taurine level for themselves. A deficiency in dietary taurine may result in abnormal development of the central nervous system, dilated cardiomyopathy, or immune system insufficiency (Schuller-Levis et al. 1990). Lowered taurine can also induce retinal degeneration, leading to focal tapetal changes or blindness (Howard and Allen 2008). In female domestic cats, taurine deficits can lead to complications during pregnancy and perinatal problems, such as stillbirth, fetal resorption, miscarriage, and low birth weight. The kittens may also have a poor postnatal survival rate, and their growth may be delayed or abnormal due to neurological deficits and cerebellar dysfunction (Sturman et al. 1985). The recommended taurine dose for cats in extruded diet is 0.1% dry matter (Kerr 2013). Commercial canned diet taurine levels are 2 g/kg of dry matter, likely due to heat treatment, which binds the taurine and makes it less available for digestion (Howard and Allen 2008).

Nevertheless, there are no clear taurine limitations for whole prey type feeding. Rabbits, small rodents, and one-day-old chickens are popular whole prey choices but there is limited data concerning their nutrient components, including taurine levels. Moreover, it is unknown precisely how post-slaughter handling affects nutrient levels, especially since taurine levels vary depending on the source, how the animal was fed, if the carcass was frozen, and if it includes the gastrointestinal tract. However, taurine levels in rabbit carcasses with gastrointestinal tracts do not provide the recommended value for domestic cats, which may be due to exposure to taurine-degrading gut bacteria (Owens et al. 2021). Spitze and colleagues (2003) reported that seafood and poultry, especially turkey, contain high taurine concentrations. Also of note, only the heart and lungs, and no other organs, meet the NRC and AAFCO recommendations for taurine in pet diets (Owens et al. 2021).

### **Poor semen quality**

Poorly balanced homemade meat diets may also have an impact on male reproductive system, particularly sperm quality. Necks and heads included in raw

meat, while rich in thyroxine, are deficient in vitamins A and E, which both have a role in mammalian spermatogenesis, causing oligospermia and even aspermia (Howard and Allen 2008). For example, rats fed a low vitamin A diet for two months showed effects in their germ cells and exhibited complete aspermia (Huang et al. 1983). The liver is an excellent source of vitamin A and adding 10 g of beef liver to a 1 kg meat meal can increase the vitamin A level to 15,000 IU/1 kg dry matter (Howard and Allen 2008). However, exceeding mentioned levels leads to vitamin A toxicity.

Oxidative stress also can have a significant impact on reproductive tissue health. Vitamin E and selenium as antioxidants work synergistically and protect against oxidation by free radicals. Commercial pet food is usually supplemented with these factors, so deficiency occurs rarely, but it can happen when using homemade diets. Vitamin E has a fundamental role in protecting spermatozoa against lipid peroxidation and assures proper functioning of the seminiferous tubular epithelium in the testes (Domosławska et al. 2018). Vitamin E supplementation can increase sperm motility and total sperm count in dogs when the quality of sperm had been previously poor (Kawakami et al. 2016).

Selenium plays a crucial role in sperm maturation and is necessary for spermatogenesis either from organic or inorganic sources. Optimal selenium levels are required for the development of the reproductive tissue. Even a small deficit can lead to abnormal development and male infertility (Domosławska et al. 2015). As an antioxidant, selenium also protects against reactive oxygen species. It ensures normal spermatozoa morphology and viability, decreases acrosome damage, and is strongly correlated with the morphology of the reproductive tissue in the testes (Ahsan et al. 2014). However, it should be pointed that excessive levels of vitamin E and Se can damage spermatozoa and can decrease sperm motility (Domosławska et al. 2018).

Domosławska et al. (2015) published a vitamin E and Se supplementation report. Dogs were fed daily with 6 µg/kg of organic selenium from yeasts and 5 mg/kg of vitamin E. In clinically healthy dogs with lowered fertility, 60 days of this supplementation increased sperm motility and concentration, and improved the morphological characteristics of the spermatozoa.

### **Thyrotoxicosis**

Hyperthyroidism is a common endocrine disease in cats that rarely occurs in dogs. Except for neoplastic issues or levothyroxine treatment, this endocrinopathy can be caused by feeding a dog with meat that contains the neck/head parts with the thyroid gland (Köhler et al. 2012). Dogs fed a BARF diet with gullets can develop

thyrotoxicosis symptoms, including weight loss, aggressiveness, tachycardia, panting, and restlessness. In these cases, the thyroxine plasma concentration is also increased. In the same study, dogs fed with a commercial diet did not show any of these symptoms. Any other possible causes of these symptoms were previously precluded (Cornelissen et al. 2014). It is important to point out that despite weight loss and hyperactivity, these dogs showed an average or even increased appetite (Cornelissen et al. 2014). Due to exogenous thyroxine intake from food, the thyroid gland can react by decreasing its activity (Johnston 1991).

### Estrus cycle

An increase in thyroid hormones, including that caused by exogenous hormone intake, can significantly influence female reproductive processes. For example, there is a relationship between thyroid gland activity and the estrus cycle. In general, increased thyroid hormone levels can interfere with the estrus cycle (Sontas et al. 2014).

Sontas et al. (2014) presented a case report demonstrating the effects of dietary hyperthyroidism on the inhibition of estrus. In this case, a dog was fed with cattle bones and meat of the head/neck region by a butcher. Any other possible causes of anestrus were precluded, including previous health problems, and no drugs were given except for cabergoline, which did not result in a positive outcome. The clinical exam of the dog was completely normal, with no external signs of estrus. A vaginal smear showed intermediate and parabasal cells, and an ultrasound examination showed that the ovaries were small and isogenous with no visible anechoic signs of follicles. The uterus was thin with no presence of any fluid, and no antibodies against thyroid processes were found. The level of cTSH in the plasma was decreased below the detectable value, and serum T4 was increased above the reference values (52.7 nmol/L, references = 17-37 nmol/L). The owner was advised to change the BARF diet to a processed commercial diet, and seven days after changing the diet, the uterus and follicles appeared normal upon ultrasound examination. Around two weeks later, proestrus occurred with hemorrhagic discharge from the vulva. Other signs (vaginal smear, ultrasound check, vaginoscopy) of a normal estrus cycle were also confirmed, and the levels of cTSH and T4 returned to normal. The female was mated twice on the 26th and 28th days after the dietary change and gave birth to 5 healthy puppies after a normal pregnancy (Hasan Sontas et al. 2014).

Thus, there is a possibility that feeding a female a BARF diet containing meat of the head/neck region can cause long-term infertility. This possibility should

also be checked in non-actively breeding females, as these animals are typically not checked for proper cycling, and the problem may be overlooked. Fortunately, simply changing the diet without additional treatment can reverse anestrus in the case of exogenous thyrotoxicosis, and there are no contraindications for subsequent pregnancy. Other research has indicated that both decrease and increase in vitamin A levels can cause early pregnancy loss or small litter size in felids (Lawler and Bebiak 1986, Morris 2002, Howard and Allen 2008).

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