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*Original scientific paper***RAW MEAT-BASED DIET (BARF) IN DOGS AND CATS NUTRITION****Diana BROZIĆ^{1*}, Željko MIKULEC¹, Marko SAMARDŽIJA², Dražen ĐURIČIĆ³, Hrvoje VALPOTIĆ²**¹Department of Nutrition and Dietetics in Animals, Faculty of Veterinary Medicine, Zagreb, Croatia²Clinics of Obstetrics and Reproduction, Faculty of Veterinary Medicine, Zagreb, Croatia³Veterinary Station Đurđevac, Đurđevac, Croatia

*Corresponding author: Diana Brozić, e-mail: diana.brozić@vef.hr

Abstract: Diet based on raw meat or more popularly called BARF (*Biologically Appropriate Raw Food*) is defined as pet food diet that is composed of thermally untreated animal products that are either derived from wild or domestic animals and is used as a pet food diet for pets in households. Raw meat-based diet can be divided into two basic categories: commercially available finished products and diet prepared by pet owner (called *homemade* BARF). Homemade diets are based on recipes that are enabling the owner to self prepare the diet. Nevertheless, the recipes used do not have to be in coordination with official recommendations that could potentially result in the development of pathologies as a result of nutrient imbalances. The lack of good quality studies has resulted in a general discussion on the subject of the potential risks and benefits that arise from this feeding practice. Studies have determined higher digestibility and excellent palatability of BARF diets. Nevertheless, studies that would prove beneficial effects of BARF diet on health or as a diet of choice for certain pathologies are lacking. The proponents of BARF diets base their recommendation on studies conducted on a small sample over a short period of time, or on popular publications that have not undergone peer review. On the other hand, research based on evaluation of infectious disease risks when feeding a BARF diet, is of the better quantity and quality. Namely, microbiological safety of BARF diets is a crucial segment that manufacturers are obligated to control with the additional control of all other production procedures (cold chain in all phases of production and storage) to minimize the contamination with zoonotic pathogens.

Key words: BARF, pets, nutrition, guidelines

INTRODUCTION

In recent years, the trend of feeding dogs and cats with BARF (*Biologically appropriate raw food*) diet has become increasingly popular, besides the usual feeding with extruded or canned diet. It is estimated that the number of pet owners who feed their dogs wholly or partly on raw meat diet in some European countries reaches up to 51 % (Corbee et al., 2013). Products containing animal by-products and not subjected to heat treatment can be divided into three groups: so called chews (porcine ears, veins, tendons), raw meat based homemade diets (so called *homemade* BARF) and commercial BARF preparations that include muscle tissue, internal organs and bones and sometimes unpasteurized dairy products and eggs (Freeman et al., 2013). Additionally, various vitamins and mineral supplements, oil, fruits and vegetables can be included in BARF diet. Pet owners who choose the BARF feeding regimen often do so because they consider it to be a natural product without added preservatives or stabilizers and without added

carbohydrates, which as a result would have positive effects on health and general condition of the pet (Morgan et al., 2017). However, still without scientific evidence, the motivation and choice to feed a BARF diet is often based in the personal experience of the pet owner or manufacturer (Freeman et al., 2013, Morgan et al., 2017). Inconsistency within veterinary profession is the result of the lack of research that would answer the questions related to the level of potential risk or, on the other hand, confirm the positive effects of this feeding form and the indication of its use in diseased animals. Research that indicates on public health risks when feeding pets with a raw diet is more numerous, emphasizing the need for responsible behaviors as a result of using a raw diet in householders. The consequence of the inconsistency in attitudes related to benefits and risks of pet feeding with raw diets is a larger amount of unclear and contradictory information available to pet owners and veterinarians.

FEEDING DOGS AND CATS WITH RAW MEAT-BASED DIETS

The most widespread concept of raw meat-based diet is BARF (Bones and Raw Food) diet concept, whose acronym is now more commonly translated as *Biologically Appropriate Raw Food*. BARF diet for dogs is based on a predator-prey feeding pattern, whereby only non-heat-treated foods that are naturally in the predator i.e. wolf feeding regime are included in the diet (Stahler et al., 2006). The diet is formulated to reflect the composition of the prey caught and is usually composed of muscle, internal organs,

cartilage, bones and a source of fiber in the forms of vegetables or fruits. Usually the ratio of individual components is in approximate proportion of 80% of muscles, 10% bones, 5% liver and 5% other secretory organs. Through the BARF concept of diet, dogs are, like cats, included as obligatory carnivores and, by the proponents of BARF diet, the carbohydrate component in the diet is considered undesirable and harmful (Billinghurst, 2003).

RAW MEAT-BASED DIET COMPOSITION

Raw meat-based diets are defined as pet food containing thermally untreated products of either domestic or wild animals' origin (Freeman et al., 2013). Diet based on raw meat can be divided

into two basic categories: commercially prepared and prepared by pet owner (so called *homemade*). Diets made at home are based on recipes and allow the owner to prepare them by

himself. However, used recipes do not have to be in coordinance with official recommendations related to prescribed nutrient intake recommendations (Streiff et al., 2002, Dillitzer et al., 2011). Nutritionally unbalanced diets can lead to the development of numerous path-ological states caused by feeding disturbances (Taylor et al. 2009, Heinze et al., 2012, Larsen et al., 2012, Stockman et al., 2013).

Commercial frozen BARF diets, which are usually *declared* as balanced and complete pet diets, are most commonly chosen by pet owners (NRC, 2006). Balanced formulations that are declared as complete diets for all ages and breeds, must be balanced and in accordance with the nutrient requirements of large and giant dog breeds at an early stage of development (Hazewinkel et

al., 1991, FEDIAF, 2018). This will lead to the addition of calcium and phosphorous, usually included in the form of ground bones in the ratio of 1.1-1.6:1, and the presence of many vitamins, macro-minerals and trace elements at higher concentrations than prescribed for adult dog diets (FEDIAF, 2018). The composition of commercial BARF diet may vary significantly, due to manufacturer's basic recipe, used raw material and production process (Freeman et al., 2013). Commercially prepared BARF diets for dogs are often available in pet shops. On the other hand, formulations of the same concept for cats are rarely available on the market as finished products, so cat owners who want to feed cats with BARF diets usually use available recipes and prepare diets by themselves.

BARF DIET DIGESTIBILITY

Studies have confirmed a better digestibility of crude protein in raw diet compared to heat treated one, thus proving a better digestibility of a BARF diet compared to foods undergoing a heat treatment process (extrusion or canning) (Crissey et al., 1997, Vester et al., 2010, Kerr et al., 2012). Digestibility is influenced by many factors that are present in the pet food production process: composition, processing temperature and processing method: cooking, caning and extrusion. Namely, by thermal treatment, as well as

processes involved in extrusion (moisture and pressure), proteins and amino acids undergo structural changes that affect the digestibility of proteins and the bioavailability of amino acids, or may result in Maillard reaction, which will result in a reaction of free amino groups and the carbonyl compound (Friedman, 1996, Hendriks et al., 1999, Rutherford et al., 2007). Better digestibility of BARF formulations will result in less feces production (Vester et al., 2010).

IMPACT ON ANIMAL'S HEALTH STATUS

Positive effects attributed to the BARF concept of feeding often include: a positive effect on immune response, the coat and skin health, reduction of dental plaque and tartar, better activity and general condition of animal (Morgan et al., 2017). BARF diet feeding has not been monitored through long-term scientific research, so potential positive effect of feeding with raw diet should be considered with caution (*Schlesinger and Joffe*, 2011). However, the extremely high digestibility and simple composition of BARF

diet, often with only one source of protein, as a potential allergen, can result in a good therapeutic response due to the skin or gastrointestinal manifestation of the allergy, provided the animal is not allergic to the protein from the composition (Brozić et al., 2017). The BARF feeding concept is based in the incorporation of raw bones into the diet and these are often added in the form of ground bones to commercial preparations. Feeding dogs and cats with thermally untreated whole bones cannot be considered

completely risk free, since they can be a potentially dangerous due to constipation and perforation within digestive system as well as teeth and the oral cavity injuries (Thompson et al., 2012). When making a BARF diet, it is crucial that no hazardous raw materials, such as thyroid tissue,

are included in the composition, if the manufacturer uses muscle of head and neck. Eating a BARF diet with thyroid tissue can result in the development of food induced hyperthyroidism (Kohler et al., 2012).

MICROBIOLOGICAL SAFETY OF BARF DIET

The research conducted so far has identified a significant risk of microbial malfunction in commercial and home prepared BARF diets (Lejeune and Hancock 2001, Jaffe and Schlesinger, 2002, Weese et al., 2005). However, thermally treated pet food can also be a source of pathogen with zoonotic potential and thus be a risk for human infection (Behravesh et al., 2010, Nemser et al., 2014). Particularly dangerous is the claim, often promoted by BARF diet proponents, that pathogenic in raw meat are not a risk to pets, dogs and cats, since their digestive system is adapted to raw meat feeding. Namely, numerous studies confirming the clinical manifestation of salmonellosis have been reported in dogs that were fed with raw meat (Chengappa et al., 1993, Stiver et al., 2003, Morley et al., 2006, Leonard et al., 2011). As with humans, the transmission and manifestation of the clinical signs will be influenced by many factors including breeding of animals in group, age and immune status of animal (Hellgren et al., 2019). Additionally, the incidence of *Salmonella*

spp. is associated with meat type which is significantly higher in chicken meat than beef and pork meat (Zhao et al., 2002, Bohaychuk et al., 2006, Mollenkopf et al., 2011, Cook et al., 2012). Besides causative agent *Salmonella spp.*, pathogens that are important in controlling the microbiological safety of BARS rations are: *Escherichia coli* O157:H7, *Clostridium spp.*, *Campylobacter jejuni* and *Listeria spp.* (Freeman and Michel, 2001, Weese et al., 2005, Strohmeier et al., 2006, Bohaychuk et al., 2006, Lenz et al., 2009). Parasite contamination in meat and fish can be controlled by the freezing process. The time and temperature at which the procedure can be performed depends on the type of parasite and of the meat used in the formulations (Kotula et al., 1991, Huss et al., 2000). Due to the risk of microbial contamination of animal by-products, producers of BARF diet may use high hydrostatic pressure treatment in the production process, which may reduce, although not completely, the number of pathogens in meat (Aymerich et al., 2008, Baert et al., 2009).

GUIDELINES FOR PETS FEEDING WITH BARF DIET

Public health risk, as a result of a BARF diet use, is present for owners and other household members who are exposed to the contact transmission of raw meat pathogenic microorganisms on daily basis (Lejeune and Hancock, 2001). Environmental contamination is also possible as a result of the excretion of the pathogens from the host organism whereby the pet may be an asymptomatic carriers (Finley et al., 2006). It is

of particular importance for immunocompromised persons, children and the elderly, as well as pregnant women that live surrounded by pets (Finley et al., 2006, Kukanich, 2011). It is therefore of crucial importance to alert owners to the risk related to feeding dogs and cats with BARF diet and to give them guidance on how to use them safely. It is crucial to emphasize the importance of environmental and personal hygiene for household members who are in contact with

BARF diet and pet, the conduct of personal hygiene (hand washing), and the washing and disinfection of water and food bowls as well as household. Particular emphases are on disabling fecal-oral contact, or contact immediately after feeding, when there is the greatest risk of contact transmission of the pathogen. The owner should be warned to regularly control parasitic diseases of the dog and/or cat by a coprological examination. It is important to warn the owner to purchase the BARF diet from a verified and registered manufacturer, whose products comply with the prescribed nutrient content of the pet food (NRC, 2006, FEDIAF, 2018). Furthermore, if pet owner chooses to feed pet according to the recipe (so called *homemade* BARF) with self-prepared diet, it is important to take care that balanced diet based on recipe is made by qualified experts in the field of pet nutrition, in order to avoid mistakes in nutrition such as surplus and/or nutrient deficiency, in particular macrominerals, trace elements and vitamins. It is also important to warn them of the potential health risks of this feeding method and to evaluate which animals are not candidates for BARF for-

mulations: animals with renal and hepatic pathology, history of pancreatitis, giant dog breeds in early stage of growth, patients with impaired immune status, animals with impaired digestive system function caused by addition of ground bones to the formulation (Brozić et al., 2017). During the stay of people with impaired immune status, children, the elderly, pregnant women and women who are breastfeeding in the household, it is necessary to warn them about the high risk of spread and transmission of microorganisms and parasites with zoonotic potential. In addition to that, manufacturers should indicate in the instructions for use of their products the proper procedure for handling and preparing the meal which would include: a defrosting procedure on temperature of 10°C, and a preparation procedure for defrosting a portion of the diet to be used immediately after defrosting. It is important to warn them that once a defrosted package of BARF diet is not frozen again. When feeding, the diet in the feeding bowl should be as short as possible and, if the animal refuses to eat, the diet should be removed (Hellgren et al., 2018).

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