

When the first of the 5Fs for the welfare of dogs goes wrong. Who is responsible? - a review

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ABSTRACT

The importance of nutrition for the welfare of dogs is highlighted in this review. Malnutrition can be the cause of many health disorders, including behavioural disorders. On the other hand, dietary interventions and modifications, and nutritional enrichment can be used for the treatment of certain health problems and improving welfare in dogs. The paper focuses on data collected from the literature on omissions in the diet of dogs for which owners, food producers, veterinarians and/or animal welfare societies are responsible. Manufacturers are responsible for the composition, quality and safety of commercially available dog food. They are also responsible for the clarity of the feeding guidelines that are provided on the labels. Owners are expected to know what type of food is most suitable for their dogs in terms of any particular allergies or intolerances they may have, as well the quality and quantity of food they should feed their dogs. It is especially important for owners to be aware of the risks of using raw food in dog nutrition. Due to the special social status that dogs have in their owners' families, owners are increasingly interested in the quality and safe nutrition of their companions. This should be a challenge for veterinarians to master the necessary knowledge of pet nutrition, and to develop and provide advice and consulting services in this area within their practice. Owners' interest in good quality and safe dog nutrition should also be a challenge for animal welfare societies to include information on nutrition in general dog ownership education.

Key words: dog; "Five freedoms"; nutrition; welfare

Introduction

Animal welfare is the state of an animal that shows how the animal attempts to cope with its environment (BROOM, 1996). The environment means living conditions designed and managed by the person who cares for the animal. An animal can cope with poor living conditions but cannot adapt to them. Therefore, the results of this coping will be poor welfare, i.e., the poor physical and

mental state of the animal (BROOM, 1996). It is the obligation of humans to provide welfare to the animals they care for. This means to provide them with so called survival-related conditions (MELLOR and BEAUSOLEIL, 2015; WEBSTER, 2016; MELLOR, 2017). In other words, humans are responsible to provide animals with good nutrition, good housing – physical and thermal comfort, good

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physical and mental health, and living conditions for exhibiting normal behaviour, to satisfy their natural needs.

Nutrition is the process of supplying animals with the food they need for their health and welfare (ARAI, 2014). The simplest way to explain and understand how nutrition is important for managing animal welfare is to analyse the meaning and importance of the “Five Freedoms” (“5Fs”) concept, or the “Five Domains” (“5Ds”) model (MELLOR and BEAUSOLEIL, 2015; WEBSTER, 2016; MELLOR, 2017). Both of them consider animal nutrition as one of basic mechanisms for animal welfare management and assessment. The first of the “5Fs” is the freedom from thirst, hunger and malnutrition provided by ready access to a diet that maintains the full health and vigour of the animal (WEBSTER, 2016), and therefore a body condition is the animal-based indicator used for animal welfare assessment. According to the “5Ds” animal welfare may be managed by giving the animal an opportunity to eat enough of a variety of a balanced diet in correct quantities in order to experience the pleasures of different tastes, smells and textures, masticatory pleasures, postprandial satiety and gastrointestinal comfort (MELLOR and BEAUSOLEIL, 2015; MELLOR, 2017). In contrast, the outcome of any restriction in the quality and quantity of food will result in physical and mental hunger, discomfort in the gastrointestinal tract, and even gastrointestinal pain and malnutrition. Taking the “5Ds” into account, the animal-based welfare indicator for nutrition is the positive mental state of the animal. It may be considered that nutrition is an investment in animal welfare. Long-term qualitative and quantitative food restrictions will result in weight loss and diet-associated diseases, and also in severe frustration due to the inability of animals to achieve a sense of satiety. Redirected oral behavioural disorders, which may develop into oral stereotypes, are also possible. Excessive food intake will also result in gastrointestinal discomfort, and the long-term outcome may be overweight or obese animals. A particular problem is the diet of senior and geriatric dogs. Ageing changes in dogs can cause sarcopenia and cachexia (HOLT, 2021). These

conditions increase mortality and morbidity in dogs, and reduce their welfare and quality of life. It is especially important that veterinarians diagnose sarcopenia in a timely manner and give advice to owners on the diet and physical activity of dogs.

Freedom of provision of quality food in sufficient quantities is a right that should also be exercised by dogs in shelters. Therefore, nutrition is an important factor in the welfare of these dogs, especially if their adoption is planned. Not all dogs caught in public places and confined in shelters are accustomed to kibble food (VUČINIĆ et al., 2011). They need extra time to get used to the new diet. In addition, shelters adopt different age groups of dogs with different health conditions, so some dogs require a special diet adapted to their health. Neophobia should also be considered. Extreme cases of starvation of dogs can be found amongst dog hoarders, involving cannibalism (VUČINIĆ and DIMITRIJEVIĆ, 2007; CALVO et al., 2014).

All of these unpleasant physical and mental conditions are consequences of inappropriate nutrition and impair animal welfare. Therefore, it is easy to understand why the World Small Animal Veterinary Association (WSAVA) included nutritional assessment as the fifth vital sign in performing a clinical evaluation in small animal patients (FREEMAN et al., 2011). The aim of this review is to show how improper diet impacts the welfare of dogs, and to ascertain the responsibility for poor dog welfare due to inadequate nutrition.

Nutrition can compromise or improve a dog's physical health and behaviour. Balanced nutrition is of crucial importance throughout a dog's life. It is of particular importance for young, pregnant and senior/geriatric animals (HEMMINGS, 2016). As BONTEMPO (2005) explained, the primary role of diet is to provide sufficient nutrients to meet metabolic requirements, to promote a state of welfare and better health, and to help to reduce the risk of diseases. Since nowadays dogs as companion animals are best friends, family members, or even a substitute for children, their owners are fully responsible for their longevity, health and welfare. Indeed, dog nutrition and dog food should provide all of this. Food should also provide a sense of physical and mental satiety and satisfaction. This

means that by feeding their dogs, owners need to satisfy the nutritional and behavioural needs of their pets (MANTECA, 2011). Therefore, owners should be well versed in dog nutrition, diet regimes, types of food, energy and nutrient requirements, the physical activity needs of their pets (HILL, 1998; WAKSHLAG and SHMALBERG, 2014), and many other dietary options. In other words, owners need to know how much to feed, how to feed and what to feed their pets (FASCETTI, 2010). They also need to know where to get information about their pets' nutrition and whom to ask for advice or help if something goes wrong with their dog's nutrition. In addition to commercial dry and canned pet food, and homemade foods in the form of cooked or raw food, there are also alternative foods such as commercially available "natural", raw food and vegetarian diets for dogs and many other types. Consumption of alternative dog foods is particularly common in households where the dog is considered as a family member, and the owners need to do their best for the nutrition of their companion animal (MICHEL, 2006). It is crucial to pet welfare for the owners to know that the nutrient and energy requirements of their pets are calculated on an individual basis (FASCETTI, 2010).

Nutrition can affect the welfare of dogs in many ways. Firstly, foods need to be balanced regarding energy and nutrient needs. The diet may deviate from this rule in two directions. It may be excessive in relation to nutrient and energy requirements. Also, nutrition may be balanced with the energy needs of the dogs, but the pets' physical activity may be insufficient. In this case, the consequence is overweight or obesity. Secondly, the nutrient and energy may be insufficient. The outcomes of this type of inadequate nutrition would be serious health disorders, underweight, and a thin body condition in dogs. Also, nutrition can affect the metabolic, endocrine and immunological status of dogs. The simplest explanation was given by ARAI (2014), who claimed that the digestive tract is the most important immune organ, and adipose tissue the largest endocrine organ in an animal's body. Therefore, both obese and emaciated animals are prone to immune and many other health disorders due to inadequate nutrition.

In addition, an incomplete and unbalanced diet can negatively affect the behaviour of dogs. Since behaviour is regulated by hormones and neurotransmitters, changes in the availability of their precursors in the brain can affect dogs' behaviour (BOSCH et al., 2007; VERSTEGEN, 2017). The availability of hormone and neurotransmitter precursors is conditioned by the availability of nutrients and their interaction in the diet. Some behavioural disorders, such as aggressiveness and self-mutilation, and stress resistance may be affected by tryptophan – the precursor of serotonin, or by tyrosine – the precursor of the catecholamines dopamine, noradrenaline and adrenaline (BOSCH et al., 2007; VERSTEGEN, 2017). VERSTEGEN (2017) explained that stress, anxiety and compulsive problems may potentially be linked to the quality of foods. Therefore, special diet regimes can be used to modify and improve the behaviour of dogs with some types of behavioural disorders. It means that by altering the diet, owners are able to regulate the availability of precursors for hormones and neurotransmitters that control the behaviour of their dogs. So, aggressive behaviour in dogs may be decreased by low protein content and by dietary supplementation of tryptophan (DENAPOLI et al., 2000). Tryptophan supplementation may be helpful in reducing dominance and territorial aggression. Some undesirable behaviours are caused by a lack of satiety due to dietary fibres and their fermentability (BOSCH et al., 2007). Further, the activity level of dogs may also be regulated by the fermentability of dietary fibres, energy restriction and, indirectly, by energy surplus. A study conducted by SECHI et al. (2017) confirmed the positive effects of a nutraceutical diet on neuroendocrine parameters associated with stress, anxiety, aggression and numerous behavioural disorders. This, and similar studies are of special importance because they demonstrate that a medication-free approach to the treatment of behavioural disorders in dogs is possible.

Nutritional diseases in dogs may be caused by nutritional deficiencies, unbalanced meals, or by a particular type of food. Dermatological diseases (WATSON, 1998), orthopaedic diseases (BENNETT, 1976; TAL et al., 2018), nutritional

anaemia (NAIGAMWALLA et al., 2012), neurological disorders (HUTCHINSON et al., 2012), cardiovascular diseases (FREEMAN et al., 2018), metabolic diseases (ARAI, 2014; MONTOYA-ALONSO et al., 2017; SÖDER et al., 2019), immunological disorders (ARAI, 2014) and food allergies (VERLINDEN et al., 2006), food intolerance, (GASCHEN and MERCHANT, 2011), food intoxications due to the pharmacological effect of food components, such as chocolate toxicity in dogs, related to theobromine or toxicity due to vasoactive amines produced by bacteria in spoiled food, dietary indiscretion, food poisoning and food-borne infections are just a short list of the large number of nutrition-related health issues in dogs. Adverse food reactions in dogs also may occur to mites in commercial pet food (OLIVRY and MUELLER, 2019). Human foodstuffs in dog nutrition may also be harmful for pets. Dogs should not be fed chocolate, cocoa-based products, coffee, tea, cola beverages and some other products containing methylxanthines. Dog poisoning with chocolate is most common during celebrations of traditional, religious or national holidays, and house parties. Further, dogs should not be fed hops, grapes, raisins, sultanas and currants, onions, garlic, leek and chives, avocado fruit, pits, leaves and the actual plant, macadamia nuts, walnuts, peanuts, products containing the artificial sweetener xylitol, bread dough, beer and other alcoholic beverages (KOVALKOVIČOVÁ et al., 2009; CORTINOVIS and CALONI, 2016). Also, dogs should not be fed mouldy diets (ERIKSEN et al., 2010).

Obesity of dogs and cats is a growing and serious concern because more than 50% of these pets are overweight or obese (MURPHY, 2016). BLAND et al. (2009) showed that obesity in dogs is affected by the interrelationships between food management, exercise and social factors. These authors found that obese dogs were more often fed their meals in either one or three-plus portions. Also, overweight or obese dogs lived in households with a higher number of people per household than normal weight dogs, and they were not exercised daily. Genetic predisposition and reproductive management also contribute to dog obesity (BLAND et al., 2010). A study conducted

by EASTLAND-JONES et al. (2014) showed that many owners are unaware of obesity in their pet dogs mainly due to their misperception of their dog's body shape. Owners of overweight and obese dogs more commonly misperceive their dog's body condition, both with and without a body condition scoring chart. BLAND et al. (2010) report on the owners of obese dogs trying to reduce the weight of their pets on their own through diet manipulation, and increasing exercise and elimination of treats without prior consultation of veterinarians. This approach to treatment of obesity is not well founded, and it could in turn frustrate the owner as it may not yield the expected results, and further threaten the already undermined welfare of the obese dog. GERSTNER and LIESEGANG (2017) investigated the sources of dog nutrition information available to owners in Switzerland. They noticed that the awareness of the importance of adequate nutrition and activity for pets is rising among pet owners in that country. However, pet owners were overwhelmed by the variety of diets and sources of information available. The consequence of this situation might lead to pet malnutrition. Therefore, there is a clear need for competent specialists in pet nutrition.

Although some obese dog owners consult veterinarians for the implementation of weight loss programmes in their pets, they are unable to fully implement them and refuse to comply with weight management advice (GERMAN et al., 2015). Two groups of potential risk factors for dog obesity or overweight can be distinguished: animal-related factors, including breed, gender, neuter status and age, and owner-related factors, such as dietary factors, physical activity, attitudes and household characteristics. In a population of French dogs it was found that factors leading to a higher risk of overweight were: being intact females, neutered males, dogs of older age, Golden Retrievers, and the distribution of extra food (COLLIARD et al., 2006). In USA, overweight dogs were older, neutered Cocker Spaniels, Labrador Retrievers, Dalmatians, Dachshunds, Rottweilers, Golden Retrievers, Shetland Sheepdogs and mixed-breeds, with diagnoses of hyperadrenocorticism, ruptured cruciate ligament, hypothyroidism, lower urinary

tract disease, or oral disease (LUND et al., 2006). The risk factors associated with overweight status in a UK population of companion dogs were breed, neutering, middle-age and insurance. The breeds with the highest odds to be overweight were Pugs, Beagles, Golden Retrievers and English Springer Spaniels (PEGRAM et al., 2021).

Risk factors for dog obesity in China were found in young, intact, free physically active, male dogs. Pugs, Cocker Spaniels, Pekingese, Pomeranians and Golden Retrievers were predisposed to obesity (MAO et al., 2013). In a population of Danish companion dogs it was found that the risk of obesity increased in senior bitches and decreased in senior male dogs, while neutering increased the risk of obesity in male dogs but not in bitches (BJØRNVAD et al., 2019). In the USA, obese dogs were more likely to be older Shetland Sheepdogs, Dachshunds and Golden Retrievers, neutered, and were diagnosed with hypothyroidism, *diabetes mellitus*, pancreatitis, ruptured cruciate ligament, or neoplasia (LUND et al., 2006).

The type of food and feeding practices have been proven to be associated with obesity status in dogs. So, commercial dog food (kibble) and leftovers of human meals coincided with overweight or obesity in dogs. The food-related issues, such as stealing food and overeating, and behavioural issues such as excessive barking and overt aggression, also correlated with overweight and obesity in dogs (TORDA et al., 2020). It was confirmed that providing dogs with only one meal per day and treats during relaxation increased body condition score and the risk of being obese. It is an interesting finding that the increased duration of daily walking increased the risk of the dog being obese, but only if the owner was overweight or obese but providing dogs with free running in gardens/properties decreased the risk (BJØRNVAD et al., 2019). There is also an increasing risk of dog obesity and overweight dogs with increasing owner age and lower income households (COURCIER et al., 2010).

A significant number of scientists from 11 European countries investigated dog owner perceptions of obesity and the factors associated with human and canine obesity (MUÑOZ-PRIETO

et al., 2018). This group of European scientists found that common factors associated with obesity in owners and their dogs in 10 European countries (one of the countries was excluded from the study) were age, gender and the owners' attitudes to diet and physical activity. The highest rates of overweight/obese dog owners were found in countries with either low (Croatia, Romania and Serbia) or very high (Denmark and Sweden) gross domestic products (GDP). However, the lowest rates of overweight/obese dogs were found in countries with very high GDP (Denmark and Sweden). The important finding is that those dog owners who did not consider obesity to be a disease were more likely to have obese dogs. BJØRNVAD et al. (2019) and LINDER et al. (2021) confirmed a possible association between overweight/obese status in dogs and their owners. These and similar studies provide considerable evidence of the owner's role in canine obesity. Research conducted in Germany also confirmed that pet obesity is on the rise (BECKER et al., 2012). It is very clear that obesity is a serious health problem, which has a significant negative impact on the welfare of dogs (SANDØE et al., 2014). Obesity-associated diseases include: metabolic abnormalities, endocrinopathies, orthopaedic disorders, cardiorespiratory diseases, disorders of the urogenital system, neoplasia and functional alterations such as joint disorders, dyspnoea, hypertension, dystocia, exercise intolerance, heat intolerance resulting in heat stroke, decreased immune functions, increased anaesthetic risk, decreased lifespan, etc. (GERMAN, 2006).

LARSEN and VILLAVARDE (2016) pointed out that identifying potential risk factors for dog obesity is particularly important for prevention or interventional measures. BLAND et al. (2010) found that veterinarians believed that only 3% of obese cases in dogs were attributed to animal-specific factors, while 97% were caused by human-specific factors.

Also, food can aggravate an existing health condition in dogs that suffer from certain diseases. Excellent examples are given by DELANEY (2006). Food rich in internal organ tissue meat can make a hepatoencephalopathic patient's

condition worse. Food with high-protein content can aggravate the condition of uremic dogs. It is not advisable to give high-fat meals to dogs with pancreatitis. Also, treats with high salt content are not indicated in dogs that suffer from pulmonary oedema or ascites due to congestive heart failure.

All this suggests that nutrition can be a key factor of good health and welfare, but also the cause of diseases and impaired welfare. On the other hand, special food products and ingredients, such as nutraceuticals (SECHI et al., 2017; ORLANDO, 2018), dietary supplements, functional food (DI CERBO et al., 2017), therapeutic diet (ORLANDO, 2018) and diet interventions may be used in the management of some medical conditions, behavioural disorders or pathological behaviour of dogs, and may improve dog welfare (KERL and JOHNSON, 2004; BONTEMPO, 2005; FASCETTI, 2010). There is commercially available food adapted to the different life stages of dogs (gestation and lactation, puppies, growing, adult, senior dogs), but also food and fluids adapted for some medical conditions in dogs with anorexia (KERL and JOHNSON, 2004; SECHI et al., 2017; DI CERBO et al., 2017).

Nutrition and nutritional support are important aspects of care for critically ill dogs hospitalized in intensive care units because malnutrition is a common problem for these dogs. Adequate nutrition and nutritional support aim to prevent excessive weight loss and the development of health disorders related to nutritional deficiencies, to facilitate and accelerate wound healing, and the recovery of critically ill dogs, to shorten the duration of hospitalization of dogs, but also to prevent mechanical, infectious and metabolic complications due to enteral or parenteral administration of nutrients (KATHRANI, 2016).

Food can also serve to enrich the life of healthy dogs. Furthermore, dietary interventions and modifications, and nutritional enrichment can be used in the treatment of dogs' appetite disorders, but also in senior and geriatric dogs with neurodegenerative diseases, such as canine cognitive dysfunction syndrome (MANTECA, 2011; LARSEN and FARCAS, 2014; COUPLAND and REYNOLDS, 2018). Nutritional enrichment

can be achieved through the use of food toys and foraging games, and different flavours and textures of food (COUPLAND and REYNOLDS, 2018). Various feeding strategies can be successfully applied in dogs with hyporexia, including nutritional enrichment (DELANEY, 2006).

Nowadays, there is a strong interest in nutrigenomics – the influence of genetic variations on nutrition. ARAI (2014) argued that nutrigenomics can lead to the development of effective foods for many diseases in animals, including obese animals, by development of weight reducing diets.

Owners' feeding and behavioural practices regarding dog nutrition

When discussing how to feed dogs, it is important to consider the types of food and their advantages and disadvantages. Nowadays, a variety of commercial food types are available to pet owners, such as wet or dry, kibble or canned, canned or frozen, fresh or freeze-dried, and breed-specific, age-specific or medical condition-specific options. How the owners will feed their dogs depends on many factors, but first and foremost the attitude of the owners, their knowledge about dog nutrition requirements and information on the types of commercially available food, their lifestyle and eating patterns, and socio-economic status. It was estimated that pet feeding is influenced by beliefs about pet specific needs, pet food and pet health, the owners' perceived control of feeding, and practicality for the pet owner (DOWNES et al., 2017). Although many types of dog food are commercially available, many owners still opt for human table food scraps as their dogs' primary food, homemade food for dogs, or a mixture of commercial food and table scraps or home prepared food for dog nutrition (COLLIARD et al., 2006; LAFLAMME et al., 2008; BECKER et al., 2012; FIELDING and NEWMAN, 2013; THOMPSON et al., 2015). Also, some owners feed their dog vegetarian foods (PARR and REMILLARD, 2014). Dog owners may consult veterinarians about pet care and nutrition. However, many pet owners use the internet and other media as a primary source of information on pet nutrition (LAFLAMME et al., 2008). In addition to the different types of commercially available food, dog owners can buy it in different places, such as pet stores, veterinary

clinics, supermarket chains, corner stores, animal welfare groups or *via* the internet. There are different reasons and motives why people become vegetarians or vegans. Among them are those related to concern about their own health, the environment, and animal protection and welfare. In addition, according to NEZLEK and FORESTELL (2020), food choices can be a way for people to express their ideals and identities. In households with dogs where the owners are vegetarians or vegans, there may be nutritional inadequacies and health problems in dogs if the owners desire to make their pets' diet vegan or vegetarian as well. Scientists agree that a dog's diet can be based on plant foods. If the owners decide to feed their dogs with vegetarian or vegan diets then those diets must be nutritionally complete and balanced. Also, the palatability and digestibility of plant-based diets are key considerations (BROWN, 2009). In addition, the owners are obliged to monitor urinary acidity in their dogs regularly. Urinary alkalisation should be corrected through appropriate dietary additives (KNIGHT and LEITSBERGER, 2016). It was also confirmed that nutritionally complete and balanced vegan pet food is at least as palatable to companion animals as conventional meat or raw meat diets, and does not compromise their welfare (KNIGHT and SATCHELL, 2021). However, one should still be careful with a vegan diet in dogs. Owners must be extremely skilled in preparing vegan meals for dogs, and seek the advice of veterinary experts because legal, ethical and welfare implications of this feeding practice exist (BENNET, 2021). With vegetarian and vegan food, the physical and physiological satiety of dogs may be achieved, but there may be no emotional satiety, i.e., no feeling of satisfaction. This is why this type of food should be very delicious. Recently, ZAFALON et al. (2020) evaluated the macronutrient composition, fatty acid and amino acid profiles, and essential mineral content of three vegan foods for dogs on the Brazilian market. They found that all the foods analysed had one or more nutrients below the recommended levels, and some presented zinc and copper excess. They concluded that these foods should not be recommended for dogs, because the dietary deficiencies found may lead to health risks for dogs.

Nutrients and energy from food are involved in maintaining the structure and function of cells, tissues, organs and the whole organism. Like all other animals, dogs also require energy and nutrients in the form of proteins, carbohydrates, lipids, macrominerals, vitamins and trace elements supplied in their diet, that should be palatable, digestible and free from chemical and biological contamination (RITSKES-HOITINGA and STRUBBE, 2007). However, chemical analysis of commercial dog diets disclosed that the diets differed in digestibility (DAUMAS et al., 2014); their content and chemical composition did not comply with generally accepted standards; the recommendations and guidelines regarding dog nutrient requirements usually contained nutrient quantities just above the minimum requirements (ALVARADO et al., 2008; DAVIES et al., 2017; BRUNETTO et al., 2019); they often contained ingredients not listed in the label/declaration, including those arising from animals (FOSSATI et al., 2019), or they contained various harmful and toxic ingredients such as additives, preservatives, and other contaminants (DOBSON et al., 2008; REMILLARD, 2008). Therefore, it is clear that eating food of this quality can cause nutritional deficiencies, toxicoses, or food allergies and intolerance in dogs (HARVEY, 1993; CRAIG, 2019).

Dissatisfied with the quality of commercial food, many owners decide to feed their dogs homemade cooked or raw food, although this is not the only reason. Their inability to understand food label ingredients, dissatisfaction with practitioners who only recommend one or two major commercial brands without considering other diet alternatives for pets (REMILLARD, 2008), and a loss of confidence in veterinarians due to their lack of knowledge and experience in pet nutrition (MORGAN et al., 2017; MORELLI et al., 2019; EVASON et al., 2020), are some of the key reasons why many dog owners opt for alternative types of diet for their pets, such as homemade foods, either cooked or raw. Another reason is the lack of a suitable commercial product for a particular set of medical conditions in dogs (REMILLARD, 2008). In addition, the poor digestibility of commercial

food is still one of the objections of pet owners. It is well known that low digestibility levels may increase fermentation by colonic bacteria and consequently lead to excessive production of gas (flatulence) and stools, and contribute to poor stool consistency in dogs (DAUMAS et al., 2014).

However, it has recently been confirmed that the situation is similar with homemade food for dogs (PEDRINELLI et al., 2019). Even when owners prepare food for their pets, it may be improperly formulated, incomplete and unbalanced, with nutrients below the recommendations and real requirements for dogs, and may contain harmful substances above the maximum tolerable levels (STOCKMAN et al., 2013; PEDRINELLI et al., 2017; 2019). The recipes with instructions for preparation of homemade diets had no precise determination of the ingredients or their quantities (PEDRINELLI et al. 2017). That is why both commercial and homemade foods pose a risk to dog health if they are not properly formulated or contain harmful ingredients.

Due to their suspicion of industrially produced pet food or perceived health benefits to pets, some owners feed their dogs with raw food, using either home recipes or commercial preparations (DAVIES et al., 2019). However, there are several types of risks from using raw food in dog nutrition. The first type of risk relates to malnutrition in dogs. The second relates to infections affecting pets and other animals. This concern relates to microbiological or parasitological contamination of the products (meat, eggs, fish) used for dog food preparation, and infection of dogs with bacteria, viruses or parasites, and parasite developmental forms (LEJEUNE and HANCOCK, 2001; REMILLARD, 2008; PARR and REMILLARD, 2014; VAN BREE et al., 2018; DAVIES et al., 2019). The third risk embraces infections affecting household members and public health concern. Recently, the zoonotic livestock pathogen *Brucella suis* was identified in the European Union and the United Kingdom in raw pet meat imported from Argentina (DAVIES et al., 2019). Also, there is a risk of introducing antimicrobial-resistant bacteria to a household (DAVIES et al., 2019; NÜESCH-INDERBINEN et al., 2019). Therefore, it is very important that

veterinarians recognize these risks and inform their clients and the public about them. The results of the study conducted and published recently by ANTURANIEMI et al. (2019) confirmed the risk of transmission of a pathogen from raw pet food to a human family member. The study disclosed that the owners prepared the raw food for their pets in the same place and using the same utensils as the family's food. At the same time, the study conducted by MORELLI et al. (2019) disclosed that the majority of owners saw improvements in their dogs fed raw meat-base diets, considering them absolutely safe for dogs, and their dogs had shinier coats, muscle mass gain, and cleaner teeth. However, most owners were unaware of the risks posed by feeding raw meat-based diets to both animal and human health.

There are other areas of concern regarding homemade and raw diets: the appropriate profile of nutrients, preparation of homemade foods according to instructions, deviation from the original recipe, and the safety concern related to the use of bones in dog nutrition (PARR and REMILLARD, 2014). Bones in dog nutrition may cause injuries of the mouth or jaw, including fracture of teeth, obstructions of the digestive tract pathways associated with complications such as sepsis or peritonitis, and constipation or obstruction of respiratory pathways. Consequences of inadequate diet with incomplete and unbalanced foods made at home may be unexplained weight loss or gain, accompanied with a thin, overweight or obese body condition, poor skin and hair quality, dental abnormalities and diseases, ocular changes, such as nyctalopia (night blindness) and xerophthalmia (severe conjunctival dryness) due to vitamin A deficiency, decreased bone mineral density, accompanied with microfractures or complete fractures of bones and bone pain, iron-deficiency anaemia or macrocytic anaemia, hypoalbuminaemia, abnormal gastrointestinal function, and many others. Therefore, PEDRINELLI et al. (2017) warned and emphasized the need to remind owners of the risk of homemade foods that may potentially expose pets to nutritional deficiencies. Such deficiencies clearly indicate the need for better training of professionals who

provide advice on pet nutrition, and who prepare recipes for homemade pet foods (STOCKMAN et al., 2013; PEDRINELLI et al., 2017).

In the study conducted by MORGAN et al. (2017) the main reason why owners fed their pets raw animal products was a lower level of trust in veterinary advice both 'in general' and 'with respect to nutrition'.

Food can be a reward for a dog's obedience. In training, food functions as a reinforcer if trained dogs increase or maintain the frequency of behaviour that they follow. Some dogs show a preference for varied food rewards, some for a constant food reward, while other dogs exhibit no significant preference for either option (BREMHORST et al., 2018).

Did veterinarians and animal welfare advocates forget something? From the text above, many deficiencies in the diet of dogs can be clearly observed. The market is full of different kinds of dog foods that can be of questionable quality. On some food packages, the declarations do not contain all the ingredients used. Some feeding guidelines written on food packages are not clear enough for owners to understand. Owners tend to modify the feeding routine and the composition of the dog meals. They are also inclined to consult non-professional sources to obtain information on dog nutrition. Lastly, many dog owners consider that veterinarians are not sufficiently trained to offer dog nutrition advice. It is true that many veterinary practices do not have pet feeding experts, or they do not provide consultancy and advisory services on pet nutrition. In addition to their numerous daily professional responsibilities and obligations, veterinarians do not have enough time to advise owners, and information or advice on pet nutrition given to owners is often insufficient, as highlighted by PARR and REMILLARD (2014). These authors advised veterinarians to meet the growing client demand for dietary information specific to their pets. Veterinarians can do this by raising their level of nutritional competency, or incorporating nutritionists' advice, by bringing nutritionist consultants into their practices. The important question is how to best inform and educate owners about pet nutrition. Certain information can also be

provided at pet food stores or pet shops. It is also important that non-governmental organisations become involved in educating owners about the importance of nutrition for pet welfare. One very useful observation was made by FIELDING and NEWMAN (2013). These scientists observed that, while many animal welfare groups provide educational programmes, not all of these provide recommendations on feeding pets. Finally, these authors concluded that by missing the opportunity to provide information and education about pet nutrition, animal welfare groups fail to provide information on a very important aspect of animal welfare. That is why training animal welfare advocates in the area of pet nutrition is very important.

Conclusions

Proper nutrition of dogs is a key factor in their welfare, including physical health and behaviour. Improper diet may be the cause of many physical health and behavioural disorders. On the other hand, food and nutrition can be used in the treatment of many dog health disorders, including behavioural disorders. Food can be presented to dogs in a different way than using a bowl, enriching their living conditions, and making eating more fun, while improving their cognitive functions. The risks of health disorders in dogs caused by food are numerous and may come from the animals themselves, the food itself and feeding management, and environmental factors including the practice, attitudes, knowledge and skills of the owners in relation to their pets' nutrition. Food can be a reward for obedience in dog training. In the hands of inexperienced owners and irresponsible producers, food becomes a cause of harm to the welfare of dogs. Veterinarians should be more interested in dog nutrition and include an assessment of the nutritional status of dogs in their clinical examinations. Animal welfare activists should include proper nutrition education in their dog owner education programmes.

When a dog's long-term diet is incomplete or irregular, and results in behavioural and health disorders with various unpleasant physical and mental experiences, then everyone, from the

manufacturers, veterinarians, animal welfare activists to the owners may be responsible. Therefore, the science on animal welfare has to pay more attention to the first of the “Five freedoms”.

Conflicts of Interest

The authors declare no conflict of interest.

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VUČINIĆ M. M., A. A. HAMMOND-SEAMAN, K. NENADOVIĆ: Kad se naruši prvo načelo od pet sloboda u pasa. Tko je odgovoran? - pregledni rad. *Vet. arhiv* 93, 191-204, 2023.

SAŽETAK

U ovom preglednom članku govori se o važnosti prehrane za dobrobit pasa. Pothranjenost može uzrokovati mnoge zdravstvene poremećaje, uključujući i poremećaje u ponašanju. S druge pak strane, promjena i prilagodba prehrane te njezino obogaćivanje mogu koristiti u liječenju određenih zdravstvenih problema i poboljšati dobrobit pasa. U ovom su radu prikupljeni podaci iz literature o pogreškama u prehrani pasa za koje su odgovorni vlasnici, proizvođači hrane, veterinar i/ili udruge za zaštitu životinja. Proizvođači su odgovorni za sastav, kvalitetu i sigurnost komercijalno dostupne hrane. Također su odgovorni za jasne upute o hranjenju koje se nalaze na deklaracijama. Od vlasnika se očekuje da znaju koja je vrsta hrane najprikladnija za njihove pse s obzirom na moguće alergije ili intoleranciju, a trebali bi poznavati i kvalitetu i količinu hrane koju njihov pas treba. Posebno je važno da budu svjesni rizika pri davanju sirove hrane psima. Zbog posebnog statusa koji psi imaju u obiteljima raste zanimanje vlasnika za kvalitetu i sigurnost prehrane tih kućnih ljubimaca. Veterinarima bi pak mogao biti izazov svladavanje nužnih znanja o prehrani kućnih ljubimaca te razvijanje i pružanje usluga savjetovanja o prehrani životinja. Zanimanje vlasnika za kvalitetnu i sigurnu prehranu pasa izazov bi mogao biti i udrugama za zaštitu životinja s obzirom na to da bi spoznaje o prehrani pasa trebale biti dio općeg obrazovanja za sve vlasnike životinja.

Ključne riječi: pas; pet sloboda; prehrana; dobrobit
