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Review Article

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NUTRITIONAL PROBLEMS OF LARGE AND GIANT BREED DOGS. PART II. ADULT DOGS

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Abstract: The subject of dog nutrition is gaining popularity due to the growing awareness of the caregivers. Although there are foods dedicated to dogs of different breeds available on the market, caregivers relatively rarely wonder what they really differ from each other and what significance it has for animals. Many dogs are fed the same food for extended periods of time. The product designated as a complete/maintenance food is, according to legal regulations, balanced in such a way that it can be the only source of food for the animal, without leading to nutrient deficiencies. A dog's digestive tract has not changed for hundreds of years, but the physiology of dog nutrition depends on the size of the breed. Dogs of small, medium, large and giant breeds, despite the fact that they belong to one species, have different nutritional needs. These differences must be taken into account in order to meet the needs as best as possible. The smaller the dog, the greater the digestive volume, and vice versa. The diet of large and giant breed dogs should be enriched with functional additives supporting the work of the joints. This need results from the fact that representatives of large and giant breeds, due to their size and large body weight, are particularly exposed to excessive strain on the elbows and hips.

Keywords: FEDIAF, pet food, dogs, large breeds, nutritional needs.

INTRODUCTION

When choosing a dog food, consideration should be given to the following aspects: gender; breed; age; lifestyle; living environment; physiological state; natural eating behavior; learned behaviors related to eating. The body's energy requirements depend on dogs metabolic mass. It is a parameter that relates to the content of tissues in the animal's body that are involved in metabolic changes. Small breeds are characterized by a much faster metabolism, therefore the energy density of food intended for dogs of small breeds should be higher than the energy density of food for large breed dogs. Nevertheless, there are exceptions. The energy requirement of Newfoundlands is lower than that of the average dog, while in the case of Great Danes – the energy requirement is greater (Dobenecker et al. 2013).

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According to the European Pet Food Industry Federation (FEDIAF 2021) nutritional guidelines, the energy requirements of animals with very different body weights are not correlated with body weight (BW) in a linear manner. Energy requirements are more closely related to metabolic body mass raised to a certain power. The metabolic body mass is the body weight raised to the power of $^{0.75}$ (kg BW$^{0.75}$). On its basis, the daily energy requirement of dogs is most often calculated. Its accuracy is still questioned as the alternative (kg BW $^{0.67}$) may more accurately reflect heat generation as it is correlated to a greater degree with body surface area. However, the most common is the use of the metabolic body mass conversion factor as kg BW $^{0.75}$, for example in the FEDIAF nutritional guidelines (2021). The National Research Council (NRC) also recommends using this conversion factor (Finke 1991; Kienzle and Rainbird 1991; Männer 1991).

The equation for the maintenance energy requirement (MER) provides the expected average value for a "typical dog of a given size". The daily energy requirement is the amount of energy consumed by an adult dog with moderate activity. It consists of the basic metabolism and the costs of energy necessary to obtain, digest and absorb food in the amount necessary to maintain an optimal body weight. Living energy requirement includes calories expended on spontaneous (unavoidable) activity and – in the case of exceeding the critical temperature – energy needed to maintain an appropriate body temperature (Rainbird and Kienzle 1989). It depends on the dog's age, breed, activity, as well as the ambient temperature, the thickness of the subcutaneous tissue and the type of coat, of which age and physical activity are the most important factors influencing the daily energy requirements (Finke 1991; Kienzle and Rainbird 1991; Burger 1994; NRC 2006).

There is an increased risk of gastric torsion in large breed dogs, therefore care should be taken of the dog to not to eat too greedily. It is worth dividing the food into several smaller portions. An increased risk of gastric torsion occurs primarily in unsterilized females and in breeds such as German Shepherd, Bernese Mountain Dog Rhodesian Ridgeback, Great Dane, Hovawart, Newfoundland, Labrador retriever, Golden retriever, Irish Wolfhound, Boxer, and Leonberger. Other factors are dry food feeding and keeping dogs outside. The history of gastric torsion in relatives is also a predisposing factor (Uhrikova et al. 2015). It is a popular myth that grain foods are responsible for the expansion and torsion of the stomach. According to Kurosad (2018) – the gas found in the digestive tract does not result from fermentation processes – it has the composition of atmospheric air.

The diet of large and giant breed dogs should be enriched with functional additives supporting the work of the joints. This need results from the fact that representatives of large and giant breeds, due to their size and large body weight, are particularly exposed to excessive strain on the elbows and hips, which may lead to degenerative changes, including dysplasia. There are also breed predispositions, occurring, for example, in Golden retrievers or German shepherds, increasing the risk of joint dysplasia, so the use of substances with a protective effect on cartilage in these animals is advisable and justified.

The purpose of this study was to discuss the nutritional requirements of large breed dogs and the importance of proper dog nutrition.

MACRONUTRIENTS

Caregivers of large and giant breed dogs usually choose dry foods. They are composed in such a way as to contain as many valuable ingredients as possible in a relatively small amount of the food. The component that is worth paying attention to in the first place is protein. Compared to a puppy's diet, adult dogs still need good quality protein, but the percentage should be lower than what the puppy was getting. The amount of protein is also adjusted to the dog's activity level, coat thickness and age. Protein is responsible for the proper growth, development and

maintenance of the health of the body. Proteins are the building blocks of organisms' tissues and are components of biologically active compounds such as hormones and enzymes. According to Weber et al. (2017), protein digestibility is higher in individuals of large breeds. The acid-base balance in the blood and other body fluids is regulated with the participation of proteins (Hamm et al. 2015), thanks to which it is possible to maintain the correct pH value of the body fluids. Proteins are also involved in the formation of antibodies to fight infection and defend the body against pathogens such as bacteria and viruses (Schroeder and Cavacini 2010). Protein can provide energy, however, it is the body's final choice as carbohydrates and fats are a better source of energy and are more efficiently metabolized compared to protein (Rui 2014). The protein requirement for an adult dog calculated on the basis of MER is 21 g for 95 kcal·$(kg^{0.75})^{-1}$ and 18 g for 110 kcal·$(kg^{0.75})^{-1}$ (FEDIAF 2021) (Table 1).

The building blocks of proteins are amino acids. Their recommended amounts vary depending on the MER (Table 1).

Table 1. Recommended levels of protein and essential amino acids (g·100 g^{-1} DM) in food for adult dogs (FEDIAF 2021)

Nutrient	MRL based on MER	
	95 kcal·$(kg^{0.75})^{-1}$	110 kcal·$(kg^{0.75})^{-1}$
Protein	21.00	18.00
Arginine	0.60	0.52
Phenylalanine	0.63	0.54
Phenylalanine + tyrosine	1.03	0.89
Histidine	0.27	0.23
Isoleucine	0.53	0.46
Leucine	0.95	0.82
Lysine	0.46	0.42
Methionine	0.46	0.40
Methionine + cysteine	0.88	0.76
Threonine	0.60	0.52
Tryptophan	0.20	0.17
Valine	0.68	0.59

MRL – minimum recommended level.

Arginine and histidine are synthesized in an amount appropriate for an adult organism, but the developing organism must be supplied additionally with the diet (Campbell and Farrell 2013). Lysine, tryptophan and methionine are amino acids that are present in a small amount in the raw materials and caregivers should additionally introduce foods rich in them into the diet, otherwise they will be deficient in the body. Such amino acids are referred to as limiting. Certain dog breeds, such as Labrador Retrievers, have higher methionine and cysteine requirements. Black dogs, due to the increased production of eumelanin (black hair pigment), have a greater need for tyrosine and phenylalanine – their long-term deficiency in the diet can cause the so-called "red hair syndrome". The consequence of insufficient protein intake is weight loss due to the loss of the body's ability to maintain a positive nitrogen balance and the inability to replace the amino acids used by the body (Biourge et al. 1994). Excessive protein intake can worsen the condition of the body with pre-existing kidney disease by chronically increasing glomerular pressure leading to kidney damage (Martin et al. 2005). A high-protein diet low in tryptophan may lead to dominant aggression, while a low-protein diet with a high tryptophan content reduces territorial aggression (De Napoli et al. 2000). The studies of Diez et al. (2002) showed that

increasing the protein content of the diet during dieting in dogs prevents the loss of lean body mass while reducing the amount of body fat.

Another important macronutrient without which it is impossible to compose a diet is fat. It is primarily a source of energy and essential fatty acids. Fats are the most concentrated source of energy in dog's diet. They provide 2.5 times more energy than carbohydrates and protein. The way fat from the diet is used depends on many factors, including its digestibility, the nutritional status and physical activity of the dog – it will either be directly converted into energy, or it will be stored as adipose tissue. Fat digestibility depends on individual and dietary factors. The individual factors leading to the malabsorption of fat result from the dysfunction of the organs responsible for digestion and fat absorption. Adult dogs and puppies are able to digest diets high in fat. However, the apparent and true fat digestibility rates are higher in growing dogs than in adults (Sabchuk et al. 2020). The presence of starch and dietary fiber fractions may contribute to the reduction of fat digestibility (Kienzle et al. 2001; Prola et al. 2010). The recommended minimum fat content for an adult dog is 5.5 g per 100 g dry weight (Table 2). Fat is not essential as long as the need for essential fatty acids is met. Therefore, the recommended minimum dog fat content with a MER of 95 kcal·$(kg^{0.75})^{-1}$ has not been revised depending on the energy requirement compared to the dog's requirement with a MER of 110 kcal·$(kg^{0.75})^{-1}$ (FEDIAF 2021). Fats are responsible for the digestion and absorption of fat-soluble vitamins – A, D, E, K. They exist in two forms, which differ in the structure of fatty acids. A single bond between carbon atoms occurs in saturated fatty acids, while a double bond – in unsaturated fatty acids. Among the unsaturated, special attention is raised due to the inability to synthesize polyunsaturated fatty acids in the body. It is estimated that the conversion of ALA to EPA and DHA is <10% in humans and dogs (Bauer et al. 1998; Bauer 2007).

Table 2. Recommended levels of fat and fatty acids (100 g^{-1} DM) in food for adult dogs (FEDIAF 2021)

Nutrient	Unit	MRL based on MER	
		95 kcal·$(kg^{0.75})^{-1}$	110 kcal·$(kg^{0.75})^{-1}$
Fat		5.50	5.00
Linoleic acid (n-6)	g	1.53	1.32
Arachidonic acid (n-6)	g	–	–
Alpha-linolenic acid (n-3)	g	–	–
EPA + DHA (n-3)	g	–	–

MRL – minimum recommended level.

Linoleic acid is the only fatty acid for which FEDIAF (2021) provides the MRL (Table 2). Together with α-linolenic acid, they ensure the water resistance of the coat and improve its quality (Szałata 2017). The acid from the n-6 family, γ-linolenic acid, has anti-inflammatory and antiproliferative effects (Olivry et al. 2010). Research indicates that another acid from this family – arachidonic acid – may cause reproductive disorders (Hadley et al. 2016). On the other hand, the n-3 docosahexaenoic (DHA) and eicosapentaenoic (EPA) acids play an important role in the prevention or alleviation of lesions, e.g. inflammatory diseases. Increasing the content of EPA and DHA in the diet inhibits the formation of inflammatory mediators. Supplementation with fish oil rich in DHA and EPA reduces the increase in the serum content of prostaglandin E2 and interleukin 1 and 6 (LeBlanc et al. 2008). It has been shown that EPA and DHA acids can be used in the treatment of osteoarthritis (Fritsch et al. 2010; Roush et al. 2010), and also contribute to the improvement of memory capacity in elderly individuals (Mirowski and Jachnis 2017). Dietary fat deficiency can cause weight loss. Too little fatty acids leads to a weakening of the quality of the hair coat and skin weakness – especially a deficiency of linoleic acid (Hensen et al. 1948; Codner and Thatcher 1990). Sudden increases in dietary fat can cause fatty stools and lead to life-threat-

ening pancreatitis (Lem et al. 2008). Excessive fat intake leads to the development of obesity in dogs, and a high-fat diet with inadequate vitamin E content can damage the retina and the lens. The excess of n-6 fatty acids in relation to n-3 fatty acids may cause inflammation (Raphael and Sordillo 2013). The ideal ratio of n-6 to n-3 is 1 : 1 due to the excess of processed n-6 acids in the diet of dogs. As demonstrated by Kearns et al. (1999) already an n-6 to n-3 ratio of 5 : 1 has a positive effect, and the research by Hall et al. (2006) showed that 1.4 : 1 and even 1 : 1, respectively. Research by Re et al. (2008) showed that aggressive dogs had a lower concentration of DHA and a higher ratio of n-6 and n-3 acids. Moreover, lower cholesterol and bilirubin levels were observed compared to the non-aggressive dogs. A low concentration of n-3 acids in a dog's diet may therefore be prone to aggression. As shown by Niyyat et al. (2018) a combination of n-3 fatty acids, magnesium, and zinc may improve some of the behavioral disorders.

In most cases, carbohydrates should be the smallest part of a dog's diet (Mirowski 2013). According to FEDIAF (2019), carbohydrates are not an essential nutrient in a dog's diet, however, they fulfill many important functions. Until recently, it was believed that in dogs, enzymatic digestion of carbohydrates begins in the small intestine because their bodies – unlike humans – do not produce salivary amylase (Hilton 1990). However, more recent studies have found little presence of it in dogs' saliva (Contreras-Aguilar 2017). Dog's digestion of carbohydrates is influenced by changes in enzyme activity as a result of the aging process. Lactase activity is highest in puppies and decreases with age, while pancreatic amylase activity increases with age (Buddington et al. 2003). Dog digestibility decreases with age (Strasser et al. 1993). It depends on the source, type and degree of carbohydrate processing (Camire et al. 1990). Excess carbohydrate in the diet over a period of time is not harmful, however, in diabetic dogs, increasing their intake may lead to hyperglycemia and increase insulin requirements (Elliot et al. 2012).

MINERALS AND VITAMINS

Minerals play an extremely important role in the body by regulating the processes taking place in it. Both the deficiency and the excess of minerals can lead to specific disorders of the body's functioning and diseases. The recommended minimum levels of minerals in an adult dog's diet are shown in Table 3.

Table 3. Recommended level of minerals (in 100 g DM) in food for adult dogs (FEDIAF 2021)

Nutrient	Unit	MRL based on MER		N/L
Macrominerals		95 kcal·$(kg^{0.75})^{-1}$	110 kcal·$(kg^{0.75})^{-1}$	
Calcium	g	0.58	0.50	2.50 (N)
Phosphorus	g	0.46	0.40	1.60 (N)
Potassium	g	0.58	0.50	–
Sodium	g	0.12	0.10	–
Chlorine	g	0.17	0.15	–
Magnesium	g	0.08	0.07	–
Ca : P ratio		1 : 1		2 : 1 (N)
Trace elements				
Copper	mg	0.83	0.72	2.80 (L)
Iodine	mg	0.12	0.11	1.10 (L)
Iron	mg	4.17	3.60	68.18 (L)
Manganese	mg	0.67	0.58	17.00 (L)
Selenium	mg	0.022	0.018	0.056 (L)
Zinc	mg	8.34	7.20	22.70 (L)

MRL – minimum recommended level; N – maximum recommended nutrient level, L – legal limit.

Calcium plays an important role not only in blood clotting and the conduction of nerve impulses, but also participates in bone formation and development in combination with phosphorus. In adult dogs, this ratio should be no less than 1 : 1 (FEDIAF 2021, Table 3). Long-term deficiency of calcium in the dog's diet can lead to hyperparathyroidism (Cloutier et al. 1990). Skeletal defects, such as pathological fractures, are also a consequence of hypocalcemia.

Limitation of phosphorus intake can lead among other signs to severe disturbances of the locomotor system, probably due to a reduced muscle tone and/or a loss of stability of connective tissue (Kiefer-Hecker et al. 2018). Too high levels of phosphorus inhibit calcium absorption. What is more, in contrast to the more natural organic phosphate sources, excessive supply with the tested inorganic phosphates significantly disrupted elements of phosphorus homeostasis in healthy dogs (Dobenecker et al. 2021).

A consequence of copper deficiency may be the loss of the coat color (Zentek and Meyer 1991). Excess copper in the diet is particularly harmful to Bedlington Terriers, which suffer from hepatopathy – a liver disease caused by a malfunction of an enzyme that is responsible for the proper metabolism of copper (Hyun and Filippich 2004). In contrast, German Shepherds and Terriers are breeds predisposed to cupric hepatitis, which is a well-documented chronic liver disease in dogs. In some breeds, the disease results from an inherited defect in copper metabolism and is associated with the accumulation of copper. Elevated liver enzymes may be the only clinical symptom in dogs with copper associated hepatitis, reflecting silent progression of the disease (Rodrigues 2020).

Another representative of large breeds that have difficulties with copper metabolism are Dobermans. Impaired copper excretion was identified in dogs of this breed, moreover in a study by Mandigers et al. (2007) dogs had subclinical hepatitis and elevated levels of copper in the liver. The excretion of Cu into the bile was lower in Dobermans with subclinical hepatitis compared to other dogs. The findings suggest that impaired copper excretion may play a role in the etiology of chronic hepatitis in Dobermans.

Similarly, a study by Thornburg (1998) analyzed liver tissue samples from Doberman Pinschers with chronic active hepatitis in the pre-cirrhosis stage. Thirty dogs had elevated liver copper levels and five had normal liver copper levels. The earliest changes are inflammation and the deposition of scar tissue around the small branches of the hepatic veins. The histomorphological changes were the same among Dobermans with elevated hepatic copper and those with normal hepatic copper. The cause has not been established, but these morphological studies support the idea of an immune-mediated disease.

Moreover, copper-related hepatitis is an inherited disease in Labrador Retrievers. In addition to genetic factors, copper and zinc consumption is suspected to play a role in pathogenesis. Dietary copper and zinc at current levels in commercially available dry dog food may affect copper in the liver and may be a risk factor for the development of copper-associated hepatitis in Labrador Retrievers with a genetic susceptibility to copper (Fieten et al. 2012). Zinc is essential for the proper functioning of the skin and for wound healing. It plays an important role in the construction and functioning of biological membranes. Too high levels of zinc can have a positive effect – research by Marsh et al. (2000) showed that the hair condition of dogs with a diet enriched with high levels of zinc improved significantly.

Iron deficiency causes anemia, pale mucous membranes, and diarrhea (Harvey 1998). Excess iron in a dog's diet can lead to mild gastrointestinal damage (D'Arcy and Howard 1962). In elderly adult dogs, hematocrit, MCV, and serum iron decline with age, indicating possible iron-restricted erythropoiesis (IRE), due to iron deficiency or low-grade chronic inflammation compared to younger adults. First and foremost, there is evidence of iron deficiency – potentially caused by gastrointestinal bleeding – and inflammation (Radakovich et al. 2017).

Waters et al. (2002) proved that it is possible to minimize the incidence of prostate cancer in up to 63% of dogs by feeding a selenium enriched diet. Skin cancer is also a very common disease in dogs, with mastocytoma being one of the most common. Ambro and Tang (2009) indicated that selenium in dogs reduces the risk of cancer, but also supports the treatment of long-term diseases such as degeneration or degeneration of the joints. According to the authors, there are more and more studies showing the positive effect of this micronutrient in the fight against joint dysplasia in dogs. According to Larsen et al. (2012), it is possible to improve the quality of semen by enriching the food dose of adult dogs with selenium. Providing the body with a particularly organic form of this microelement increases the concentration of sperm and at the same time reduces the number of those with an abnormal structure. According to Kot et al. (2017), the range of the appropriate concentration of selenium in the body is relatively small, so it is very easy to cross the line between its toxic and beneficial effects. Similarly, Błażejak and Milewski (2016) found that not only the deficiency, but also the excess of individual elements in the body carries serious health effects. As symptoms of selenosis, i.e. selenium poisoning, the authors mention weight loss, deterioration of the hair coat, skin disorders, shortness of breath, paralysis of the limbs, as well as neurological symptoms such as grinding of the teeth, salivation, colic pain, and vision problems. According to Kot et al. (2017), an excess of this element can also cause atrophy of certain organs and tissues as well as nervous disorders. An excess of selenium in the diet may result in a lack of appetite and a slower growth rate of the hair coat.

Vitamin A is responsible for the regulation of cell differentiation (Liang et al. 2012). It affects the proper functioning of the mucous membranes and the immune system (Ross 2012). Vitamin A deficiency increases the body's susceptibility to infections. In addition, it is responsible for proper vision, and its deficiency may cause visual disturbances. Insufficient amount of vitamin A in the diet can lead to weight loss and deterioration of the hair and skin condition (Szałata 2017). The research of Weng et al. (2000) showed that β-carotene, which is a vitamin A provitamin, can improve reproductive function in dogs. An excess of vitamin A in a dog's diet can manifest itself through dementia, weight loss, coat deterioration, and joint pain (Cho et al. 1975). The MRL for vitamins varies depending on whether considering 95 or 110 kcal·$(kg^{0.75})^{-1}$. Vitamin A and D are the only vitamins with a nutritional maximum and/or legal limit (Table 4).

Table 4. Recommended level of vitamins (in 100 g DM) in food for adult dogs (FEDIAF 2021)

Nutrient	Unit	MRL based on MER		N/L
		95 kcal·$(kg^{0.75})^{-1}$	110 kcal·$(kg^{0.75})^{-1}$	
Vitamin A	IU	702.00	606.00	40 000.00 (N)
Vitamin D	IU	63.90	55.20	227.00 (L) / 320.00 (N)
Vitamin E	IU	4.17	3.60	–
Vitamin K	µg	–	–	–
Vitamin B1	mg	0.25	0.21	–
Vitamin B2	mg	0.69	0.60	–
Vitamin B3	mg	1.89	1.64	–
Vitamin B5	mg	1.64	1.42	–
Vitamin B6	mg	0.17	0.15	–
Vitamin B7	µg	–	–	–
Vitamin B9	µg	29.90	25.80	–
Vitamin B12	µg	3.87	3.35	–

MRL – minimum recommended level; N – maximum recommended nutrient level, L – legal mimit.

Unlike humans, dogs cannot synthesize adequate amounts of vitamin D, so it should be provided with food (Corbee et al. 2015). Vitamin D is primarily responsible for maintaining calcium homeostasis (Bikle 2011), also regulates the hormonal balance (Demay et al. 1992) and stimulates a non-specific immune response (Schauber et al. 2007). Adequate supply of vitamin D reduces the risk of cancer development (Garland et al. 2006). Vitamin D deficiency in dogs is distant in time and can be manifested by a reduction in bone mineral density – osteopenia (De Fornel-Thibaud et al. 2007). Too low vitamin D levels are also associated with progressive kidney disease and secondary hyperparathyroidism (Parker et al. 2017). Excess dietary vitamin D can lead to hypercalcemia, causing lethargy, stiff gait, and polyuria (Mellanby et al. 2005).

SUPPLEMENTATION OF LARGE/GIANT BREEDS

An example of additives – which are especially important in the nutrition of dogs of large and giant breeds – are glycosaminoglycans. These include, among others, hyaluronic acid, chondroitin sulfate and glucosamine (Sufleta and Mazur-Zielińska 2010). Due to the fact that dogs of large breeds usually weigh more than 30 kg, their joints are laden, especially if these dogs are very active. As a result, they require additional support through appropriate supplementation. The use of hyaluronic acid increases the penetration of nutrients into the articular cartilage, improving joint function. Chondroitin sulfate has an anti-inflammatory effect (Ronca et al. 1998). Enriching the diet with chondroitin sulfate and glucosamine in dogs suffering from arthritis contributes to the reduction of pain and swelling in the joints (Bui and Bierer 2003). Earlier supplementation, before the onset of disease symptoms, contributed to its milder course and reduced lameness (Canapp et al. 1999).

Osteoarthritis (OA) is an example of a common disease in dogs. The most commonly used medications to treat this disease in dogs are non-steroidal anti-inflammatory drugs (NSAIDs), however many dogs do not get enough pain relief with them. Continuing the topic of additives that improve the work of joints, it is worth mentioning a fairly innovative example, which is the egg shell membrane (ESM). ESM contain glycosaminoglycans, including chondroitin sulfate, glucosamine and hyaluronic acid, therefore they seem to be a promising supplement in the treatment of joint diseases. Due to the composition and anti-inflammatory properties, the use of preparations based on egg shell membranes is particularly effective in: strengthening joints, reducing joint pain, supporting the treatment of osteoarthritis and joint inflammation, prophylaxis of the musculoskeletal system, supporting the treatment of joint dysplasia. Egg shell membranes, unlike NSAIDs, do not cause side effects. In the research of Ruff et al. (2016) no adverse effects were reported and the caregivers of dogs found that the ESMs were well tolerated by their animals. Muller et al. (2019) assessed the systemic anti-inflammatory and mobility-promoting effects of the egg shell membrane dietary supplement in dogs wit h pain and movement disorders related to OA. The results did not provide conclusive evidence of a positive effect. However, these pilot results provide the rationale for conducting a larger, placebo-controlled study of the potential effect of an egg shell membrane dietary supplement. On the other hand, as shown by Ruff et al. (2016) ESM supplementation, taken once a day, significantly reduced joint pain and quickly improved joint function and showed a lasting improvement in joint pain leading to improved quality of life in dogs. Moreover, after 6 weeks of ESM supplementation, a strong chondroprotective effect was demonstrated.

Another innovative example of a medicine that is used prophylactically and in pain relief is cannabidiol (CBD) contained in hemp oil. The endocannabinoid receptor system is known to play a role in pain modulation and inflammation relief. However, the psychotropic effects of some cannabinoids prevent extensive research into their use as single pain relievers. In a study by Gamble et al. (2018) it has been shown to be effective in reducing pain during treatment

with CBD. Dog caregivers did not report any side effects, however serum chemistry showed an increase in alkaline phosphatase during CBD treatment.

Corbee (2022) investigated the effect of a supplement containing leaf extract of green-lipped mussel (*Perna canaliculus*), curcumin (*Curcuma longa* L.) and blackcurrant (*Ribes nigrum*) on locomotion and behavior, among others, in dogs suffering from mild to moderate osteoarthritis. Overall, however, the supplement had only partial positive effects. More research on a larger sample and longer duration is needed to broaden these findings. On the other hand, as shown in the studies of Gugliandolo et al. (2020) in a rat model, curcumin in combination with palmitoyl-glucosamine (PGA) can reduce the processes of inflammation and pain, in addition, their use significantly reduced paw swelling and hyperalgesia, as well as tissue damage and neutrophil infiltration. Protection against cartilage damage and restoration of locomotor functions have also been reported.

When choosing a food, attention always should be paid to the label and the composition of the product, but the nutrient assessment should not be overlooked, because the food that dogs receive for a longer period of their lives should be complete and balanced, i.e. providing all the necessary nutrients in the right amounts and proportions. There is no one universal food suitable for all breeds and ages of dogs. There are foods on the market for representatives of large and giant breeds. This food should be adjusted to the dog's activity level. Both too much and too little energy in the diet have a negative effect on the animal. In order to be able to properly balance the nutritional dose, it is first necessary to determine the dog's daily energy requirements, which is especially important for dogs of large and giant breeds. Representatives of these breeds are predisposed to diseases of the skeletal system. Degenerative changes can occur in stressed joints, causing problems with movement. Therefore, food for large dogs should have the right amount of substances that affect the functioning of the joints, a balanced level of minerals and the right amount of energy. Metabolism is slower than in small breed dogs – overfeeding may promote overweight and obesity.

CONCLUSION

Large breeds require a balanced diet and food that is fed in small amounts to meet all their nutritional needs. The demand for energy and its expenditure depends on many things, including the basic metabolism – in dogs of small breeds the metabolism is faster than in dogs of large breeds. The diet of large and giant breed dogs should be enriched with functional additives supporting the work of the joints. This need results from the fact that representatives of large and giant breeds, due to their size and large body weight, are particularly exposed to excessive strain on the elbows and hips, which may lead to degenerative changes, including dysplasia. It should be remembered that the metabolism of large breed dogs is slower than that of small breed dogs – the consequence of non-compliance with the diet and lack of adequate physical activity is overweight. As a result, the joints are overloaded and damaged. Pain prevents activity, and therefore the dog cannot lose weight.

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PROBLEMY ŻYWIENIOWE PSÓW RAS DUŻYCH I OLBRZYMICH. CZĘŚĆ II. PSY DOROSŁE

Streszczenie: Temat żywienia psów zyskuje na popularności w związku ze wzrastającą świadomością właścicieli. Chociaż na rynku dostępne są karmy przeznaczone dla psów różnych ras, stosunkowo rzadko opiekunowie zastanawiają się, czym tak naprawdę się od siebie różnią i jakie znaczenie ma to dla zwierząt. Wiele psów żywionych jest tą samą karmą przez dłuższy czas. Produkt oznaczony jako karma pełnoporcjowa/bytowa jest według regulacji prawnych zbilansowany w taki sposób, aby mógł stanowić jedyne źródło pożywienia dla zwierzęcia, nie doprowadzając do niedoborów składników odżywczych. Od setek lat przewód pokarmowy psów nie zmienił się, ale fizjologia ich żywienia zależna jest od wielkości rasy. Psy ras małych, średnich, dużych, olbrzymich pomimo że należą do jednego gatunku, mają różne potrzeby pokarmowe. Różnice te należy uwzględnić w celu zaspokojenia potrzeb w optymalnym stopniu. Im mniejszy pies, tym większa objętość przewodu pokarmowego i odwrotnie. Dieta psów ras dużych i olbrzymich powinna zostać wzbogacona o dodatki funkcjonalne wspierające

pracę stawów. Potrzeba ta wynika z tego, że przedstawiciele ras dużych i olbrzymich ze względu na swoje rozmiary oraz dużą masę ciała są szczególnie narażone na nadmierne obciążenie stawów łokciowych i biodrowych.

Słowa kluczowe: FEDIAF, karma, psy, rasy duże, potrzeby pokarmowe.