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CONTENTS

Chapter 1

SUSTAINABILITY IN ANIMAL NUTRITION: THE STRATEGIC IMPORTANCE OF GRASSLANDS AND PASTURES

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1. Introduction

Sustainability in animal production refers to a holistic approach developed to ensure the conservation of natural resources and the reduction of greenhouse gas emissions from an environmental perspective, to secure profitability and improve resource efficiency from an economic perspective, and to support animal welfare, rural livelihoods, and food security from a social perspective (Darnhofer, 2010; Place, 2019; FAO, 2023). Within this framework, grassland and pasture ecosystems, which form the basis of ruminant husbandry, are of strategic importance due to their provision of low-cost roughage production and their contribution to the conservation of biodiversity (Gökkuş, 2018; Güler & İflazoğlu Mutlu, 2019). Of the total agricultural land worldwide, which amounts to 4,800 million hectares, 3,200 million hectares (66.7%) consist of grassland and pasture areas (FAO, 2025), while in Türkiye, 14.6 million hectares (60.8%) of the total 24 million hectares of agricultural land are composed of grassland and pasture areas (T.C. Tarım ve Orman Bakanlığı Balıkesir İl Tarım ve Orman Müdürlüğü [BİTOM], 2024).

The domestication process of farm animals has shaped not only housing and production systems but also nutritional strategies. Through the controlled use of natural pastures, grazing systems have been developed; however, the seasonal and productive limitations of these areas have led communities transitioning to settled agricultural systems to engage in forage crop cultivation (Gökkuş & Coşkun, 2023). Historically, livestock farming based on grazing, with a background of approximately 10,000 years, has placed grassland and pasture ecosystems at the center of human history; these areas have gained strategic value as they host the genetic resources of both existing cultivated plants and species that may be domesticated in the future (Çaçan & Yüksel, 2016).

Currently, roughage expenses account for 60–70% of total production costs, and 78% of these expenses are met through pastures (Harmanşah, 2018). The fact that approximately 70% of the global feed requirements of ruminants are directly supplied from pastures (Holechek et al., 2011) highlights the critical role of grasslands and pastures in the economic sustainability of livestock production. In Türkiye as well, grasslands and pastures, together with forage crops, constitute the most important sources of high-quality roughage (Özkan & Demirbağ, 2016; Kaya & Ertekin, 2021). However, uncontrolled grazing, improper land use, and agricultural pressures are gradually reducing the productivity of these ecosystems and deepening the roughage deficit (Çaçan & Yüksel, 2016; Gökkuş & Coşkun, 2023).

In Türkiye, there are 18.69 million livestock units (1 LU = 500 kg), and the roughage requirement reaches approximately 85.3 million tons. Of this amount, only 11.7 million tons are supplied from grasslands and pastures, and 17.8 million tons from forage crops; the remaining 55.6 million tons are mostly attempted to be met through low-quality plant residues (Özkan et al., 2025). This clearly underscores the necessity of implementing comprehensive forage crop cultivation and pasture rehabilitation strategies to ensure the long-term sustainability of livestock production systems (Çaçan & Yüksel, 2016).

Globally, increasing population, urbanization, and income levels continuously drive the demand for animal protein. The World Health Organization emphasizes that 10–35% of daily energy requirements should be met from proteins. In Türkiye, this rate is around 10–20% (T.C. Sağlık Bakanlığı Türkiye Halk Sağlığı Kurumu, 2016; Lonnie et al., 2018). As welfare levels rise, the share of animal products in food consumption also increases, and in developing countries like Türkiye, the demand for animal products grows in parallel with population growth (Saygın & Demirbaş, 2018). However, the production of animal products requires significantly more land compared to plant-based products. For instance, while 2.94 m^2 and 3.85 m^2 of land are sufficient to produce 1 kg of corn and wheat, respectively, 326.2 m^2 and 369.8 m^2 are needed for 1 kg of beef and sheep/lamb meat, respectively (Ritchie & Roser, 2020). Therefore, under current conditions where agricultural lands are in competition for both food and feed production, expanding forage crop cultivation areas offers only a limited solution. Instead, more efficient use of existing resources, conservation and improvement of grasslands and pastures emerge as a more sustainable strategy (Yavuz et al., 2020; Kaya & Ertekin, 2021).

As of 2025, Türkiye's population, including undocumented migrants, has reached approximately 91–92 million, and it is projected to rise to 107.7 million by 2069. This demographic trend will increase the demand for food and animal products; however, the current production capacity will be insufficient to meet the demand for high-quality roughage (Gökkuş & Coşkun, 2023; Özkan et al., 2025). Tilman et al. (2011) anticipate an increase of over 100% in the demand for agricultural products by 2050. Accordingly, expanding cultivated areas and/or increasing crop yields are considered primary strategies to boost food production. Although some researchers (Godfray et al., 2010; Foley et al., 2011; Tscharntke et al., 2012) argue that increasing yield is the most sustainable solution, other studies (Grassini et al., 2013; Ray et al., 2013) suggest that yield improvements will become limited as they approach their potential maximum, making it increasingly difficult to meet demand in parallel with population growth. On the other hand, although a 7% expansion in cultivated land is expected by 2030, the creation of new agricultural land is highly constrained due to environmental pressures such as deforestation and the degradation of pastures and grasslands (Smith et al., 2010). This expansion trend leads to the degradation of grasslands and pastures and increases pressure on forage crop production, particularly in countries like Türkiye where livestock production is pasture-based. As a result, serious problems such as insufficient agricultural production, rising food prices, and access issues carry the risk of deepening further in the future (Özkan et al., 2025).

It is stated that Türkiye's current agricultural production capacity, based on a plant-oriented dietary model, can only modestly feed approximately 100 million people (Kışlalıoğlu & Berkes, 1985). To sustain a Western-style balanced and diverse diet, approximately 0.5 hectares of cultivated land per capita are required. Considering Türkiye's total cultivated agricultural land of 23.4 million hectares, it is calculated that only 46.9 million people can be provided with adequate and balanced nutrition. This highlights the urgency of restructuring agricultural production planning on a more efficient and sustainable foundation in response to population growth and evolving dietary patterns (Gökkuş & Coşkun, 2023).

A contraction in food supply will increase dependence on imports, and due to uncertainties in global markets, costs will rise. Therefore, rather than expanding land for feed production, developing strategies aimed at improving the efficiency of existing resources would be a more sustainable approach for both food security and the livestock sector (Gökkuş & Coşkun, 2023). Indeed, research shows that with appropriate management and improvement practices, yields in grassland and pasture areas can be at least doubled. Similarly, in forage crop production, expanding cultivation areas, applying proper agronomic techniques, and incorporating rotational grazing systems can enhance production capacity. Additionally, the inclusion of straw at a rate of 20% in ruminant rations has the potential to significantly reduce the current roughage deficit. Therefore, the conservation of grassland and pasture ecosystems, the development of forage crop production, and the enhancement of resource efficiency should be regarded as strategic imperatives not only for the economic sustainability of livestock production but also for ensuring national food security (Çomaklı & Tufan, 2021).

The aim of this study is to emphasize the strategic importance of pastures in the context of sustainability in animal nutrition and to offer recommendations for the future.

2. Strategic Importance of Grasslands And Pastures

Meadow refers to natural or artificial forage production areas that develop in flat or nearly flat terrains with high groundwater levels, dominated by dense and tall vegetation, and are generally utilized through mowing. Pasture, on the other hand, is found in sloped and rugged terrains with low groundwater levels, characterized by sparse and short vegetation, and is primarily used for grazing purposes. Both types of areas are indispensable natural resources for roughage production, which constitutes a fundamental input in livestock activities, and hold strategic importance in terms of ruminant nutrition (Çaçan & Yüksel, 2016).

Across Türkiye, a total of 1.45 million hectares of grassland and 13.1 million hectares of pastureland are recorded. Various researchers have reported forage yields in grassland and pasture areas ranging from 47 to 375 kg/da since the early 2000s. These variations are attributed to factors such as pasture management, climatic conditions, vegetation cover, and grazing intensity (Çaçan & Yüksel, 2016). As stated by Hatipoğlu et al. (2021), only 1% of pastures are in very good condition, 11.7% are good, 52.56% are moderate, and 34.8% are poor. The majority of Türkiye's pastures offer limited productivity due to low soil quality (Coşkun, 2021) and insufficient precipitation (Figure 1) (MGM, 2025). Recent studies indicate that forage yield in most grassland and pasture areas is significantly below potential, and the feed quality is inadequate to meet the needs of the livestock sector (Sayar et al., 2010; Çaçan & Yüksel, 2016). Regionally, dry matter yield has been reported to range between 60 and 100 kg/da (BÜGEM, 2018). The current state of grasslands and pastures reveals that this potential is not being effectively utilized. Non-agricultural use of farmland, land losses due to industrialization and urbanization, the impacts of climate change, improper grazing practices, and insufficient improvement efforts have led to a significant decline in the productivity and quality of these resources (Koç & Gökkuş, 1994; Çaçan & Yüksel, 2016).

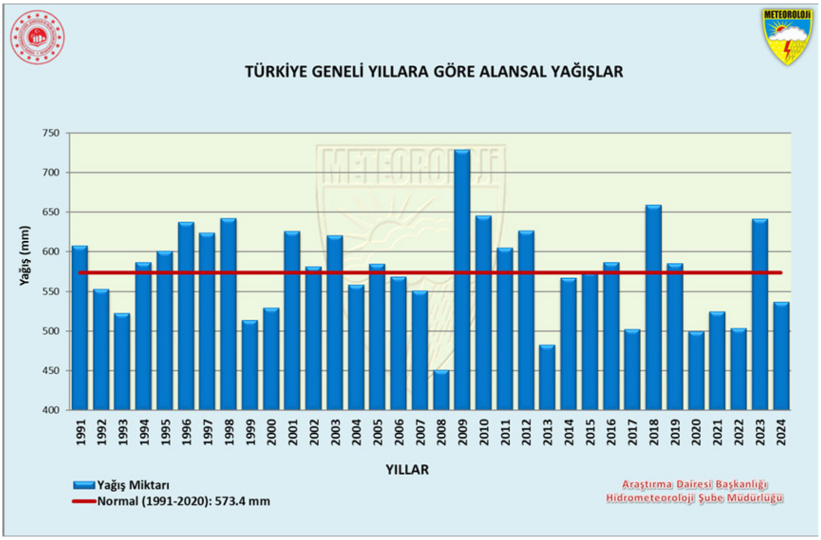

Figure 1. *Annual precipitation distribution across Türkiye by year (MGM, 2025)*

Assuming an average forage yield of 100 kg/da from existing grassland and pasture areas, approximately 14.6 million tons of forage can be produced across Türkiye. However, it is projected that, through rehabilitation of these areas via proper pasture management—particularly by preventing untimely and excessive grazing—the yield potential could be increased up to threefold. This presents a significant opportunity that may contribute to raising rural income levels by reducing the cost of animal production and improving product quality (Çaçan & Yüksel, 2016).

The degradation of natural vegetation caused by excessive and uncontrolled grazing threatens the biodiversity of pastures, increases erosion, and reduces soil fertility (Çomaklı et al., 2012; Budak & Kılıç, 2022). This situation contributes to the expansion of the roughage deficit and increases dependence on external sources, thereby raising the cost of animal production and weakening the sector's competitiveness. In countries like Türkiye, where feed costs constitute 60–70% of total livestock production expenses, the contribution of pastures to feed production is a key determinant of economic viability and efficiency. The roughage deficit is not only a concern from the perspective of production economics but also represents a critical issue in terms of national food security policies. Inadequate supply of roughage leads to shortages in essential food products such as red meat, milk, and dairy products. Therefore, the widespread implementation of grassland and pasture improvement is imperative to close the feed gap and to establish a sustainable production model in livestock farming (Çaçan & Yüksel, 2016; Tarhan & Çaçan, 2020).

The preservation and enhancement of productivity in grassland and pasture areas are not only essential from economic and food security policy perspectives but also represent a social and environmental necessity. These areas serve as the primary feed source for small-scale producers living in rural regions and directly affect the economic sustainability of families engaged in livestock farming. The degradation of pastures particularly increases the costs for smallholder farms and deepens rural poverty (Zerga, 2015; Çaçan & Yüksel, 2016; Özkan & Demirbağ, 2016).

Roughages are defined as low-energy feedstuffs containing 18% or more crude fiber in their dry matter (Özkan & Demirbağ, 2016). It has been reported that one LU requires 4 kg of dry forage and 10 kg of green forage per day for maintenance, and 2.5% of its live weight (12.5 kg of dry forage) for production purposes (Gökkuş et al., 1995; Alçiçek et al., 2010). Türkiye's roughage requirements are met through forage crop production within field crops, natural and artificial grassland-pasture areas, and residual plant materials such as straw and stubble resulting from crop production. Among these sources, grasslands and pastures hold critical importance (Çaçan & Yüksel, 2016; Tarhan & Çaçan, 2020).

Roughages are a fundamental feed group in ruminant nutrition, essential for maintaining healthy rumen function and formulating balanced and cost-effective rations. Roughages containing adequate cellulose stimulate rumination behavior and saliva secretion, thereby stabilizing rumen pH, supporting microbial fermentation, and regulating the digestive system. Acetic acid, produced through cellulose fermentation, is utilized in milk fat synthesis. Therefore, roughages not only meet maintenance requirements but also enhance feed efficiency and production performance. The inclusion of sufficient roughage in the ration plays a critical role in preventing nutrition-related disorders such as ruminal acidosis and abomasal displacement (Ak, 2021).

Minerals play a vital role in animal health and productivity. In particular, the rations of dairy cows must contain adequate levels of calcium (Ca), phosphorus (P), magnesium (Mg), sodium (Na), chloride (Cl), sulfur (S), and potassium (K). Deficiencies may lead to conditions such as rickets, growth retardation, bone weakness, reduced milk yield, and behavioral disorders—especially in cases of phosphorus deficiency—such as the consumption of soil, wood, or hair (Karan & Başbağ, 2018). Grasslands and pastures, being rich in minerals, offer a cost-effective means of meeting these nutritional requirements. In this context, the use of pastures, which are among the most affordable and high-quality roughage sources, should be considered a strategic priority both for economical feeding strategies and for sustainable livestock production (Gökkuş & Coşkun, 2023).

Pastures are not only a source of feed but also play a significant role in animal welfare. Grazing is a physiological need for ruminants, particularly sheep and goats. Pastures provide environments where animals can exhibit natural behaviors and move freely in fresh air. These conditions help maintain hoof health, reduce respiratory diseases, enhance vitamin D synthesis through sunlight exposure, and support vitamin A intake through the consumption of fresh green forage. Consequently, reproductive performance improves, stress levels decrease, and the immune system is strengthened. Additionally, walking on natural terrain promotes hoof wear, reducing the need for maintenance. Animals grazing on pasture tend to be healthier, which lowers treatment and medication costs and positively reflects on product quality (Ak, 2021; Kaya & Ertekin, 2021; Gökkuş & Coşkun, 2023).

Short shrub-type plants characteristic of the Mediterranean climate and forest pastures can be effectively utilized, particularly by goats, and help reduce fire risk by preventing the accumulation of dry forage (Ak, 2021). However, natural pastures cannot provide continuous forage production throughout the year. Climate changes—such as summer droughts and winter cold—limit the growth of pasture plants, thereby reducing both the quantity and quality of forage (Gökkuş & Hanoğlu Oral, 2022).

In a study conducted in Bandırma (Gökkuş et al., 2017), the crude protein content of pasture forage decreased from 11.86% in May to 5.61% in September, while fiber content increased from 54.60% to 67.53%. During such periods, animals may not find sufficient and high-quality forage on pasture, necessitating supplementary feeding or even a shift to intensive fattening systems (Gökkuş & Hanoğlu Oral, 2022). Most of Türkiye's pastures consist of cool-season plant species, which exhibit active growth primarily in spring and partially in autumn when temperature and humidity conditions are more favorable. The most effective way to address forage shortages during summer and winter months may be the establishment of cereal pastures. These seasonally rotated pastures contribute significantly to livestock systems. Cool-season cereals (such as wheat, barley, rye, oats, and triticale) can be used in late autumn, winter, and spring, while warm-season cereals (such as millet, maize, sorghum, and sudangrass) can be utilized in summer to ensure sustainable forage production. Due to their cold tolerance (cool-season cereals) and drought resistance and regrowth ability (warm-season cereals), these crops can play a vital role in integrated plant-animal production systems that complement natural pastures (Gökkuş & Hanoğlu Oral, 2022).

The widespread use in Türkiye of low-quality roughages such as straw and stubble—materials suitable for limited inclusion in balanced rations when necessary—as primary roughage sources clearly highlights the need for improving the quality of roughage production and enhancing the quality of grasslands and pastures. In this regard, high-quality pastures should be considered a strategic priority for both economic and sustainable livestock production. Accordingly, it is essential to promote pasture improvement, expand forage crop cultivation areas, and integrate alternative roughage sources into production. Furthermore, practical training programs for producers on quality roughage production and feeding techniques are of great importance. In line with these goals, the establishment of artificial grassland and pasture areas should also be encouraged (Ak, 2021).

Following the COVID-19 pandemic, rapidly rising inflation has significantly increased input costs in agriculture. The Agricultural Input Price Index, which was 94.95 in January 2020, reached 619.47 by October 2024—an approximately 6.5-fold increase. During the same period, the Agricultural Products Producer Price Index rose from 91.55 to 692.18, marking an almost 7.5-fold increase. This situation has elevated the cost of roughage production and led farmers to reduce forage crop cultivation areas or compromise on quality. As a result, producers have increasingly turned to pasture-based feeding (Özkan et al., 2025). The rapid shift toward pasture feeding, combined with excessive grazing and insufficient rainfall, has further reduced pasture productivity. Consequently, due to high input costs, some producers have begun to exit the livestock sector. The inability of pastures to regenerate, the inadequacy of forage crops to meet the nutritional needs of the livestock population, and rising production costs are among the primary causes of this issue (Baumgard et al., 2012; Moritz et al., 2025).

In Türkiye, feed costs account for approximately 70% of total production expenses, and in small ruminant production, rations are sometimes composed entirely of roughages. Even in high-yielding animals, more than 50% of total feed intake is supplied through roughages. This situation poses a serious threat to the economic sustainability of livestock production. On the other hand, in meeting the increasing demand for animal products driven by population growth, pastures remain unrivaled feed resources. Even though alternatives such as lab-grown meat and milk may emerge in the future, products derived from animals grazing on natural pastures are unlikely to be replaced (Coşkun, 2021; Gökkuş & Hanoğlu Oral, 2022; Özkan et al., 2025).

3. Significance of Grassland and Pasture Rehabilitation

In the 1950s, Türkiye's grassland and pasture resources covered 46.5 million hectares; today, this figure has declined to 14.6 million hectares

(Çomaklı & Tufan, 2021; BİTOM, 2024). These areas now constitute only 18.6% of the country's surface. Due to improper use, vegetation has deteriorated in approximately 70% of pastures (Çomaklı & Tufan, 2021). Pasture improvement efforts are critically important not only for the sustainability of livestock production but also for the conservation of natural ecosystems and the support of rural development. In addition to providing the most affordable and natural feed source for livestock, pastures contribute to the preservation of soil, water, and biodiversity (Karan & Başbağ, 2018).

Due to long-standing mismanagement in Türkiye—including early and excessive grazing, conversion to cropland, wildfires, urban development pressure, and lack of maintenance—a significant portion of pastures has been severely degraded (Çaçan & Yüksel, 2016). Such degradation has exacerbated the roughage deficit, escalated feed costs, and compromised the overall quality of livestock production. Therefore, the protection, improvement, and productivity enhancement of pastures have become strategic imperatives not only for the livestock sector but also for agricultural production, environmental management, and rural development (Çomaklı et al., 2012; Çaçan & Yüksel, 2016).

Uncontrolled grazing not only damages the vegetation cover but also harms soil structure and disrupts ecosystem balance. The depletion of energy reserves in plants and the weakening of root systems lead to the replacement of desirable species with undesirable ones. In particular, the density of legumes and grasses—species that are highly palatable to livestock—directly influences pasture quality. Excessive and untimely grazing reduces the prevalence of these species, resulting in a decline in pasture quality classification (Karan & Başbağ, 2018).

Due to excessive and untimely grazing, pasture degradation has become a global environmental concern. Such grazing practices lead to a decline in species diversity and population levels within pasture vegetation, negatively affecting biomass production in both arid/semi-arid regions and areas with humid and cool climatic conditions. Overgrazing not only deteriorates plant cover but also disrupts soil structure, causing degradation in physico-chemical properties such as soil porosity, bulk density, water-holding capacity, and organic matter content. These impacts pose a serious threat to the productivity and sustainability of pasture ecosystems (Budak & Kılıç, 2022).

Untimely and irregular grazing practices have caused approximately 85% of Türkiye's pastures to fall outside the "very good" or "good" condition classes (Avağ et al., 2012; Aydoğdu et al., 2020; Gökkuş, 2020). Additionally, the migration of young populations from rural areas limits the effective utilization of grassland and pasture resources. Particularly in the Eastern and Central Anatolia Regions, the primary issue is not excessive grazing pressure, but rather the insufficient conversion of available pasture forage into animal products. This indicates that the potential of pasture resources is not being fully utilized (Gökkuş & Coşkun, 2023).

To prevent more severe challenges in qualified roughage production in the future, grassland and pasture areas must be preserved and effectively managed. In this context, it is essential to prevent changes in land allocation purposes, restrict the conversion of pastures to non-agricultural uses, and control improper practices such as untimely and excessive grazing. Within the framework of rural development policies, the participation of young populations in production should be encouraged, and the integration of grassland and pasture areas into livestock production should be enhanced. These measures will contribute both to closing the roughage deficit and to improving the quality and productivity levels of animal production (Gökkuş & Coşkun, 2023).

Various workshops (Muş Alparslan University Faculty of Applied Sciences, 2021) and research findings (Gökkuş & Coşkun, 2023; Rissman et al., 2023; Özkan et al., 2025) have associated pasture degradation with factors such as overgrazing, untimely grazing, climatic stressors, insufficient farmer education, and deficiencies in practical implementation. These studies have revealed that such issues pose a significant threat to the sustainability of livestock production systems.

In this context, attention has been drawn to pasture-related problems, and concrete solutions have been proposed for rangeland management and improvement. Prominent recommendations include: effective enforcement of the pasture law, prevention of early and excessive grazing, implementation of region-specific pasture rehabilitation projects, balancing livestock population with available feed resources, updating pasture inventories, and developing scientifically grounded pasture management plans. Additionally, emphasis has been placed on educating farmers in pasture management, promoting the cultivation of alternative forage crops, and strengthening collaboration among researchers, government institutions, and farmers.

4. Conclusion

In conclusion, the conservation and rehabilitation of grassland and pasture areas in Türkiye are indispensable for preventing current and potential future shortages of high-quality roughage, ensuring the sustainability of livestock production, and maintaining ecological balance.

Degradation of pasturelands leads not only to feed deficits but also to multifaceted problems such as soil erosion, loss of biodiversity, weakening of rural economies, and increased vulnerability to climate change. To safeguard the nutritional security of future generations—particularly in terms of providing ruminants with high-quality and cost-effective roughage—grassland and pasture areas should be designated as agricultural conservation zones and protected through effective measures. The protection and improvement of these areas must be treated as a national priority, supported by robust collaborations between the government and farmers, and reinforced through scientific research and evidence-based policy interventions. Therefore, immediate and coordinated action is required to protect and rehabilitate these strategic ecosystems.

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Chapter 2

UNDERSTANDING OBESITY IN COMPANION ANIMALS: CAUSES AND CONSEQUENCES

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Introduction

Obesity is a multifactorial metabolic disease characterized by excessive accumulation of adipose tissue due to the interplay of behavioral, endocrine, and metabolic mechanisms in the dogs and cats (Linder & Mueller, 2014). The primary cause of obesity is a chronic energy imbalance, where energy consumption exceeds energy expenditure and leads to storage of excess energy in adipose tissue (Hoenig et al., 2007). This imbalance is exacerbated by overfeeding of high-calorie diets and sedentary lifestyles of the animals (Laflamme, 2012).

Pathophysiologically, obesity is classified into hypertrophic and hyperplastic forms based on adipocyte response. Hypertrophic obesity involves an increase in the size of existing fat cells, typically occurring after puberty when adipocyte proliferation ceases (Sanderson, 2007). In contrast, hyperplastic obesity is defined by an increase both in size and number of adipocyte. Notably, hyperplastic obesity was reported to be greater challenge in clinical management, as the increased number of fat cells complicates weight loss efforts and long-term treatment outcomes (Sakai et al., 2007).

From a nutritional standpoint, high-energy diets coupled with limited physical activity create favorable conditions for excessive fat deposition for developing obesity (Laflamme, 2012). Additionally, free-choice feeding, excessive treats or lack of portion control further exacerbate the risk of obesity by promoting persistent positive energy balance (Courcier et al., 2010).

In both prevention and management of the obesity, nutritional intervention is pivotal. Implementing portion-controlled feeding, formulating calorie-restricted diets, and incorporating functional ingredients such as dietary fibers that enhance satiety can significantly help weight management in the animals (Laflamme, 2012). Moreover, understanding the role of diet composition and feeding behavior is necessary for developing effective prevention strategies and therapeutic interventions aimed at controlling obesity (Mao et al., 2013).

Nutritional Perspective on Identifying Obesity in Cats and Dogs

In humans, obesity assessment predominantly relies on the Body Mass Index (BMI) calculated based on height and weight ratios providing a generalized estimate of body fat (Linder & Mueller, 2014). However, this metric is not applicable to cats and dogs due to species-specific, breed-related, and age-dependent physiological differences altering body composition and fat distribution (German, 2006). Instead, the Body Condition Score (BCS) system is employed, offering a semi-quantitative method combining visual inspection and palpation to evaluate subcutaneous fat deposits and overall body condition (Shearer, 2010). The BCS system focuses on critical anatomical regions, including the rib cage, spine, and abdominal area where fat accumulation is most evident (Shearer, 2010). Nutritional mismanagement, excessive caloric intake, and uncontrolled feeding practices significantly contribute to fat accumulation in those areas (Laflamme, 2012). Obesity was reported to be one of the most prevalent diet-related health problems affecting cats and dogs particularly in Western countries (German, 2006).

Contemporary feeding practices, such as free-choice feeding, the use of energy-dense treats, and high-fat diets, have been directly implicated in the growing rates of obesity among companion animals (Courcier et al., 2010). According to the Association for Pet Obesity Prevention approximately 60% of cats and 56% of dogs in the United States of America were classified as overweight or obese (APOP, 2018).

The BCS methodology typically employs a 1 to 9 scale, with scores of 4 or 5 representing an ideal condition, values below 3 indicating undernutrition, and those above 6 reflecting overweight or obesity (WSAVA, 2020). The evaluation of BCS relies on three primary anatomical landmarks: the ribs, waist, and abdomen. In animals with an ideal body condition ribs are easily palpable beneath a thin layer of fat, but difficulty in feeling the ribs indicates excessive fat accumulation in the animals. A visible waistline when viewed from above further reflects a healthy condition, while its absence suggests overweight or obesity. Additionally, a well-defined abdominal tuck observed from the side is characteristic of optimal weight, whereas a distended or sagging abdomen is a clear sign of obesity. Routine BCS monitoring is vital for mitigating the risks of obesity and maintaining healthy weight through targeted nutritional strategies (Sakai et al., 2007). Obesity predisposes companian animals to several serious health complications, necessitating proactive nutritional management (Salt et al., 2019).

Extreme fat accumulation in adipose tissue may cause metabolic and endocrine disorders such as insulin resistance and dyslipidemia, disrupting metabolic homeostasis and adversely affecting longevity of animals (Hoenig et al., 2007).

Reproductive dysfunctions, such as dystocia and ketosis, are more frequent in obese females (German, 2006). Furthermore, increased adiposity elevates risk of diabetes mellitus (type 2), especially in cats, due to impaired insulin sensitivity (Forcada et al., 2013). Osteoarthritis is also prevalent in obese animals, driven by mechanical overload and chronic joint inflammation (Salt et al., 2019).

Genetic predisposition is an important contributing factor in the development of obesity, although spontaneous mutations like leptin or leptin receptor deficiencies influence only a minority of individuals and do not fully account for the widespread prevalence of obesity (Speakman, 2008). Studies in humans showed that offspring of two obese parents had an 80% likelihood of developing obesity, decreasing to 50% when one parent is obese, and further to 9% if neither parent is affected (Babaoğlu & Hatun, 2002).

The ob gene regulateing leptin synthesis and the db gene which is responsible for leptin receptor function, are pivotal in the controlling appetite and energy balance (Babaoğlu & Hatun, 2002). Additionally, genes such as fat, tub, and agouti was reported to further contribute to obesity susceptibility by modulating metabolic pathways (Speakman, 2008).

In dogs, obesity is largely polygenic, with certain breeds exhibiting higher susceptibility. High-risk breeds include Cairn Terriers, Cavalier King Charles Spaniels, Labrador Retrievers, Scottish Terriers, and Cocker Spaniels, while moderate risk is observed in Boxers, Dachshunds, Poodles, and Spitz breeds. Breeds like Greyhounds show relative resistance (German, 2006). Notably, mutations in the POMC gene in Labrador Retrievers was shown to link increased appetite and fat accumulation (Raffan et al., 2016).

Similarly, feline obesity also shows genetic influence, with domestic short-haired, long-haired, and Manx cats being more prone to excessive body weight gain (Forcada et al., 2013). Polymorphisms in the MC4R gene was reported to be related to obesity and diabetes in fat short-haired cats (Forcada et al., 2013).

In conclusion, while genetic factors substantially contribute to obesity risk, they operate in concert with environmental, nutritional, and behavioral elements. A holistic approach that integrates genetic predisposition with comprehensive lifestyle and dietary management is essential for effective prevention and control of obesity in companion animals (Switonski & Mankowska, 2013).

Age and Obesity in Companion Animals

Previously, obesity prevalence in the companion animals was reported to increase with advancing age, mirroring trends observed in humans and reflecting age-related metabolic and behavioral changes (Robertson, 2003). In dogs, studies showed that obesity rates were relatively low during juvenile stages, particularly in young females where prevalence was around 6%, but the risk increased sharply to approximately 40% in adulthood (Glickman et al., 1995). Similarly, in cats, the likelihood of obesity peaks between five and ten years of age before declining in later years, a pattern attributed to metabolic shifts associated with aging (Oh, 2011).

Research conducted in Korea found that 35% of dogs aged seven to eight years and 27% of cats aged seven to nine years were classified as obese, emphasizing middle age as a critical period for obesity onset (Oh, 2011). Weight gain is commonly observed in dogs during their middle-aged years, while older dogs often experience a decline in body weight due to physiological and metabolic changes (Lund et al., 2006; Usui et al., 2016). Specifically, obesity prevalence peaks at nearly 40% in dogs between five and eight years of age (Lund et al., 2006).

With aging, the body composition of animals undergoes significant changes, notably a decrease in lean muscle mass coupled with increased fat deposition, leading to a reduction in basal metabolic rate and heightened obesity risk (McGreevy et al., 2005). Nonetheless, despite the physiological effects of aging, factors such as nutrition, exercise, and healthcare play more decisive roles in determining an animal's health status and longevity (Bermingham et al., 2024). Remarkable cases such as Bobi, the oldest recorded dog that lived 31 years, and Creme Puff, the oldest cat reaching 38 years, illustrate the potential influence of balanced nutrition, appropriate care, and consistent veterinary oversight on extending lifespan (Bermingham et al., 2024).

Poor management of living conditions, including inadequate nutrition and insufficient physical activity, is strongly correlated with obesity in aging companion animals (Robertson, 2003). Early implementation of preventive strategies such as tailored diets, regular exercise, and health monitoring effectively reduces obesity risk and enhances overall well-being (Lund et al., 2006). Addressing age-related metabolic changes through proactive interventions is vital to maintaining optimal health in aging pets (Usui et al., 2016).

Gender and Obesity in Companion Animals

Gender differences significantly influence obesity prevalence in companion animals, with female dogs generally exhibiting a higher risk compared to males due to hormonal and behavioral factors (Colliard et al., 2006; Holmes et al., 2007). Studies report obesity rates of up to 32% in female dogs versus 23% in males, highlighting the impact of reproductive hormones on metabolism and appetite regulation (Sallander et al., 2010; Usui et al., 2016).

Hormonal fluctuations during estrus cycles and the metabolic changes following spaying are known to increase the susceptibility of female dogs to obesity (Diez & Nguyen, 2006). However, some research presents contradictory findings. McGreevy et al. (2005) reported that no significant gender-based differences in obesity prevalence, indicating that gender alone is insufficient to explain the variability in obesity rates. This inconsistency suggests that obesity risk in companion animals is multifactorial, involving complex interactions between genetic predisposition, environmental influences, and lifestyle choices (Holmes et al., 2007). It was reported that regardless of gender, maintaining a balanced diet, ensuring regular physical activity, and applying appropriate weight management protocols remain the most effective strategies to prevent obesity in companion animals (Robertson, 2003). A holistic approach that integrates hormonal influences with environmental and behavioral factors is crucial for promoting optimal health and longevity (Sallander et al., 2010).

Neutering and Obesity

Neutering significantly influences the risk of obesity in the companion animals by inducing physiological and metabolic alterations that predispose pets to excessive weight gain (Diez & Nguyen, 2006). Research consistently showed that neutered animals exhibited higher obesity prevalence compared to intact counterparts, with female dogs particularly affected (Glickman et al., 1995). For instance, ıt was shown that neutered female dogs accounted for approximately 60% of obesity cases, while males represented about 40% (Diez & Nguyen, 2006). In domestic animals, gonadectomy was reported to be associate with reduced energy expenditure and altered appetite regulation (Martin et al., 2006). Neutered female dogs were reported to be twice as likely to become obese compared to intact females (Edney and Smith, 1986). Overall, obesity prevalence reaches 15% in neutered dogs, significantly higher than the 15% observed in intact individuals, regardless of sex (Lund et al., 2006). In felines, neutered males are three to four times more likely to develop obesity, partly due to inherent differences in basal metabolic rates between the sexes (Diez & Nguyen, 2006). Oh (2011) further confirmed the strong association between neutering and increased body weight in both dogs and cats. Importantly, feeding practices and physical activity levels after neutering play a decisive role in moderating obesity risk. For example, pets fed only once daily or frequently given treats demonstrate higher weight gain, while those allowed outdoor activity show reduced obesity prevalence (Bjornvad et al., 2019).

Recent studies also suggest that neutering influences gut microbiota, leading to disrupted lipid metabolism and decreased yield of beneficial short-chain fatty acids, thereby increasing the risk of obesity (Yang et al., 2023). Additionally, neutering was shown to link to a higher prevalence of hypothyroidism, a condition affecting approximately 41% of obese hypothyroid dogs (Panciera, 1994).

The timing of neutering and post-surgical dietary management are critical in mitigating obesity risk. Removal of sex hormones impacts satiety regulation and metabolic control centers in the brain, further contributing to weight gain (McGreevy et al., 2005). Similarly, Robertson (2003) observed that female dogs exhibit higher obesity rates following gonadectomy, with similar but less pronounced trends in males.

In conclusion, while neutering offers vital reproductive and health benefits, its impact on metabolism and energy balance necessitates comprehensive management strategies. Careful dietary planning, regular exercise, and routine veterinary monitoring are essential to prevent the risk of obesity and ensure the long-term health of neutered companian animals.

Dietary Factors and Obesity in Companion Animals

Obesity in companion animals is closely linked to dietary factors and feeding behaviors, reflecting a complex interplay between nutrition, environment, and owner habits (Laflamme, 2012). Studies consistently demonstrate that diet composition, feeding frequency, and the feeding practices of pet owners significantly influence the development of obesity in both cats and dogs (German, 2006).

While calorie restriction is the primary strategy for weight loss in cats, abrupt reductions can lead to undesirable changes in the body content, including muscle mass decline which negatively impacts overall health (Zoran, 2010). In dogs, the role of dietary fiber in promoting satiety during calorie restriction is limited, suggesting that individualized diet plans based on each animal's energy requirements are essential for effective obesity management.

High-carbohydrate diets are a major contributor to excessive energy intake and obesity, especially considering that such diets do not align with the natural dietary needs of cats and dogs (Zoran, 2010). Excess carbohydrates beyond glycogen storage capacity are converted into fat, accelerating weight gain (Laflamme, 2012). Cats, being obligate carnivores, are particularly sensitive to carbohydrate-rich diets, which predispose them to metabolic imbalances (Zoran, 2010). Although dietary fats may enhance satiety, they also was shown to contribute to obesity when combined with sedentary lifestyles (German, 2006).

Feeding frequency impacts weight management as well. Dogs fed once daily have higher obesity rates compared to those fed multiple smaller meals throughout the day, suggesting that dividing meals may help regulate metabolism and control body weight (Diez & Nguyen, 2006). Overfeeding through table scraps and excessive treat provision further exacerbates caloric overload, increasing tha risk of obesity (German, 2006). Economic constraints also influence diet quality; studies showed that dogs consuming cheaper, lower-quality diets had a higher tendency toward obesity, indicating a link between diet affordability and nutritional adequacy (Montoya-Alonso et al., 2017).

Interestingly, behavioral observations in dogs offer insights into obesity mechanisms relevant to humans. Pogány et al. (2018) found that obese dogs exhibited hesitation when confronted with uncertain rewards, a behavioral pattern also seen in obese humans. This similarity underscores the potential of dogs as valuable models for investigating the psychological aspects of obesity.

Ultimately, obesity in companion animals is driven by a combination of dietary composition, excessive energy intake, and feeding behavior (German et al., 2010). Implementing low-carbohydrate, nutritionally balanced diets with proper portion control, modifying feeding routines, and promoting physical activity are crucial strategies to prevent obesity. Through collaborative efforts, pet owners and veterinarians can reduce obesity risk and enhance the health of the animals (Laflamme, 2012).

Behavioral Factors

Behavioral factors was reported to play a significant role in obesity development of companian animals, frequently stemming from owners' misinterpretation of their pets' behaviors (German, 2006). Similar to humans, cats experience psychological states such as anxiety, depression, and impaired satiety regulation, which can lead to overeating and weight gain, especially when structured feeding routines are lacking (Laflamme, 2012). Owners may mistakenly interpret certain feline behaviors as signs of hunger, resulting in unnecessary feeding that perpetuates excessive calorie consumption (Zoran, 2010).

In dogs, social bonding intensifies food-seeking behaviors. Dogs was reported that they often use food as a means of interaction, and owners reinforce this dynamic by overusing treats, leading to weight gain (Montoya-Alonso et al., 2017). The human-animal bond, though emotionally rewarding, inadvertently fosters feeding patterns that promote obesity in both species (Robertson, 2003).

Understanding natural feeding behaviors and educating owners are vital steps in obesity prevention. Recognizing and correcting misinterpretations of hunger cues, along with limiting excessive reward-based feeding, are essential for promoting healthier feeding habits (Laflamme, 2012). Raising owner awareness about the behavioral aspects of obesity is critical for ensuring balanced nutrition and long-term health in companion animals (German, 2006).

Insufficient Exercise

Insufficient exercise is a primary contributor to obesity, particularly in dogs, where reduced physical activity limits energy expenditure and facilitates fat accumulation (Diez & Nguyen, 2006). Studies confirm an inverse relationship between obesity prevalence and weekly exercise duration, underscoring the importance of sustained physical activity for energy balance (McRee, 2009).

Indoor living further compounds the problem, as dogs confined to limited spaces are less active and consequently more sensitive to obesity than those with regular outdoor access (Robertson, 2003). Owner lifestyle also plays a decisive role: A Spanish study reported that overweight or obese owners were more likely to have overweight or obese dogs, reflecting how human behaviors directly affect pet health (Montoya-Alonso et al., 2017).

Addressing these challenges requires integrating regular exercise routines into daily care. Ensuring adequate physical activity and encouraging active lifestyles for both pets and owners are essential for effective obesity prevention and the maintenance of overall health (Diez & Nguyen, 2006).

Pharmacological Management

Pharmacological interventions can either directly or indirectly promote obesity in companion animals, primarily by altering energy balance or stimulating appetite. Medroxyprogesterone acetate, commonly used for contraception in female dogs, was shown to disrupt metabolic regulation, with studies reporting important increase of the weight gain in about 17% of treated animals (Diez & Nguyen, 2006).

Antiepileptic drugs like phenobarbital are known to increase appetite, especially at high serum levels, leading to polyphagia and long-term weight gain (Byers et al., 2011). Similarly, glucocorticoids stimulate gluconeogenesis and fat deposition, particularly in the abdominal region, contributing substantially to obesity risk during prolonged use (Diez & Nguyen, 2006; Byers et al., 2011).

Appetite-modulating drugs such as anabolic steroids, glucocorticoids, megestrol acetate, and benzodiazepines are also used in clinical settings to manage appetite disorders in monogastric animals (German, 2006). However, these medications must be carefully prescribed, considering species-specific metabolic responses, potential side effects, and individual patient needs (Laflamme, 2012).

Veterinary oversight is very crucial when managing pharmacological treatments that influence metabolism, ensuring that therapeutic benefits are balanced against potential risks of obesity and related metabolic diseases such as diabetes (Byers et al., 2011).

Hormonal Factors

Leptin as a Key Regulator of Energy Balance and Obesity

Leptin that is a peptide hormone including of 167 amino acids was first identified by Zhang et al. (1994) as a critical regulator of energy homeostasis. Primarily secreted by adipose tissue, leptin is also produced in the placenta, gastric mucosa, skeletal muscles, pituitary gland, and mammary glands, reflecting its diverse physiological roles (Baile et al., 2000). Its primary function is to signal energy sufficiency to the hypothalamus, thereby modulating appetite, satiety, and energy expenditure to maintain body weight (Frühbeck et al., 1998).

Once leptin secreted into the bloodstream, it circulates in free and protein-bound forms, with the free form being biologically active and predominant in obese individuals (Brabant et al., 2000; Meier & Gressner, 2004). Serum leptin levels were reported to be directly proportional to body fat, with women generally exhibiting higher levels due to greater adiposity (Klein et al., 1996). Leptin was reported to primarily metabolized in the liver and kidneys, possessing a half-life of approximately 25 minutes in humans and 3–10 minutes in rodents (Zeng et al., 1997; Vila et al., 1998).

Leptin crosses the blood-brain barrier to bind its receptors in the hypothalamus, where it inhibits orexigenic neuropeptides while promoting anorexigenic pathways, effectively reducing food intake and stimulating energy expenditure (Baile et al., 2000). In states of energy deficit, leptin levels decrease, triggering hunger and reduced energy utilization, thereby promoting energy restoration (Frühbeck et al., 1998).

Paradoxically, obesity is characterized by leptin resistance rather than leptin deficiency. Despite elevated leptin concentrations, the hormone fails to suppress appetite or enhance energy expenditure effectively (Banks, 2001). Impaired transport of leptin across the blood-brain barrier and hypothalamic dysfunction due to chronic hyperleptinemia are key contributors to this resistance (Klok et al., 2006).

Leptin resistance complicates obesity management, as exogenous leptin therapy shows limited efficacy in clinical settings due to this impaired signaling (Kirel et al., 2000). Current research focuses on strategies to enhance leptin sensitivity, including improving leptin transport and combining leptin with sensitizing agents (Frühbeck et al., 1998).

Leptin's role in obesity extends to companion animals. Studies have confirmed elevated serum leptin levels in obese cats and dogs, reinforcing its function in energy regulation. Akgün and Şahinduran (2023) reported significantly higher leptin levels in obese or overweight cats, while Jeusette et al. (2005) demonstrated a decline in the leptin contents following weight loss in dogs.

Beyond appetite regulation, leptin influences multiple physiological systems:

- Metabolism: It regulates glucose and lipid metabolism (Comba, 2014).

- Immune System: It modulates leukocyte production and enhances erythropoiesis (Chelikani et al., 2004).

- Endocrine Function: Leptin impacts reproductive health, thyroid function, and adrenal activity, with deficiencies impairing these systems during malnutrition (Chelikani et al., 2004).

- Thermogenesis and Growth: It contributes to heat production, cardiovascular regulation, and neuroendocrine functions (Thong & Graham, 1999; Dulloo et al., 2002).

Ghrelin as a Central Regulator of Appetite and Metabolism

Ghrelin is often referred to as the "hunger hormone" and has a significant role in the appetite regulation and maintenance of energy homeostasis. It circulates in two main forms: acylated ghrelin, which strongly stimulates appetite, and desacyl ghrelin, which is increasingly recognized for its role in modulating metabolism (Brusach et al., 2023). The orexigenic action of acylated ghrelin promotes food intake and energy storage, while desacyl ghrelin may exert inhibitory effects on metabolic processes (Brusach et al., 2023).

Accumulating scientific evidence has established ghrelin's dynamic role in obesity and weight regulation. For instance, Jeusette et al. (2005) found that obese dogs exhibited lower plasma ghrelin levels compared to lean controls. During weight loss, ghrelin levels increase temporarily, reflecting the body's physiological drive to restore energy reserves. This period was also characterized by decreased leptin and insulin concentrations and elevated glucose levels, underscoring ghrelin's role in energy balance and metabolic adaptation (Jeusette et al., 2005).

In a feline model, Akgün and Şahinduran (2023) reported important differences in the levels of serum ghrelin between obese and non-obese cats, further confirming the hormone's central role in appetite control and energy metabolism in companion animals. Additionally, Makris et al. (2017) identified multiple mechanisms through which ghrelin contributes to obesity. These include excessive ghrelin production, impaired suppression after eating where levels remain elevated, and increased receptor sensitivity that amplifies ghrelin's appetite-stimulating effects. Notably, they observed that bariatric surgery leads to a substantial reduction in ghrelin levels, contributing to long-term weight loss and positioning ghrelin as a promising therapeutic target in obesity management.

Given its multifaceted functions in hunger signaling, metabolic regulation, and adaptive energy responses, ghrelin remains a critical focus in obesity research. Targeted therapeutic interventions aimed at modulating ghrelin signaling hold considerable potential for achieving sustainable weight management in both humans and companion animals.

Adiponectin as a Key Adipokine in Metabolic and Inflammatory Regulation

Adiponectin is an adipokine exclusively synthesized by mature adipocytes and has a significant role in the regulation of energy metabolism, inflammatory responses, and insulin sensitivity (Khoramipour et al., 2021). By enhancing glycolysis and fatty acid oxidation, adiponectin supports glucose homeostasis and lipid metabolism, contributing significantly to metabolic health (Robinson et al., 2011).

Adiponectin levels in the serum were reported to be inversely correlated with fat mass and hepatic lipid accumulation while positively associated with insulin sensitivity, making it a valuable biomarker for metabolic health (Robinson et al., 2011). In obesity, declining adiponectin levels contribute to resistance of insulin and chronic inflammation, exacerbating the risk of metabolic disorders (i.e. diabetes) (Khoramipour et al., 2021).

In companion animals, increased fat mass elevates serum leptin, whereas obesity-related declines in adiponectin impair metabolic and inflammatory balance, underscoring its vital role in homeostasis (Dall'Aglio et al., 2021). A study conducted in obese dogs showed that serum adiponectin levels were inversely correlated with the expression of adiponectin and its receptor ADIPOR2 in skin tissues, suggesting a connection between obesity, adiponectin signaling, and skin health (Dall'Aglio et al., 2021).

Furthermore, Khoramipour et al. (2021) highlighted adiponectin's involvement in energy regulation, immune response modulation, and neuroprotection. Their findings emphasized that healthy dietary practices could elevate adiponectin levels, reinforcing its utility as a biomarker for metabolic and inflammatory status.

Adiponectin also exhibits potent anti-inflammatory and insulin-sensitizing effects, with studies reporting inverse relationships between adiponectin levels and TNF-α and NF-κB (Robinson et al., 2011). Low adiponectin concentrations are frequently observed in critical illnesses, suggesting its broader protective role against metabolic dysfunction and inflammation (Robinson et al., 2011).

Collectively, adiponectin's diverse physiological roles make it a promising target for therapeutic interventions in obesity-related disorders. Encouraging balanced nutrition and regular exercise may help maintain optimal adiponectin levels, enhancing metabolic health and overall well-being in humans and companion animals (Khoramipour et al., 2021).

Obesity and Endocrine Disorders in Dogs

Endocrine disorders (i.e. diabetes mellitus, hypothyroidism, and hyperadrenocorticism) are closely linked to obesity in dogs, contributing to significant metabolic disruptions (Diez & Nguyen, 2006). Studies report that diabetes mellitus affects 9%, hypothyroidism 16%, and hyperadrenocorticism 13% of dogs, with nearly 40% of these cases involving concurrent obesity (Oh, 2011).

The gut-brain axis also plays a crucial role with gastrointestinal hormones like ghrelin, cholecystokinin, and glucagon-like peptide (GLP-1) regulating appetite and satiety (Diez & Nguyen, 2006).

Understanding the interplay between endocrine disorders and obesity is crucial for developing comprehensive treatment strategies. Early diagnosis and targeted interventions, including hormone therapy and lifestyle modifications, are essential for improving the health and longevity of affected dogs.

Diabetes Mellitus

This disarder is a significant metabolic consequence of obesity particularly in the cats and dogs. Obesity predisposes these animals to insulin resistance and impaired glucose metabolism, thereby increasing the risk of developing diabetes mellitus. The reciprocal relationship between insulin resistance and weight gain creates a self-perpetuating cycle that complicates disease management and heightens associated health risks (Oh, 2011).

Insulin resistance, which is the reduced ability of tissues to respond to insulin, is a hallmark of metabolic dysfunction associated with obesity. In cats, this condition frequently progresses to type 2 diabetes mellitus. Chronic obesity elevates insulin demand while concurrently impairing insulin sensitivity, establishing a foundation for metabolic syndrome in pets (Strage et al., 2021; Ramos & Castillo, 2020).

Recent studies suggested that dietary interventions had a critical role in mitigating the resistance of insulin. Ferreira et al. (2022) demonstrated that beta-glucan-enriched diets significantly improved the metabolic and inflammatory profiles of obese dogs over a 90-day period. Ramos and Castillo (2020) also reported that obese dogs exhibited elevated BMI, HOMA-IR values, and increased levels of insulin, glucose, cholesterol, and triacylglycerides, paralleling metabolic syndrome observed in humans.

Verkest et al. (2011) emphasized that hyperleptinemia contributes to insulin resistance in obese dogs, even though beta-cell function remains intact, which may explain the lower incidence of type 2 diabetes in dogs compared to humans. Adiponectin levels were reduced in obese animals but did not show a direct correlation with insulin sensitivity or beta-cell function in their study. These findings were corroborated by Nassar de Marchi et al. (2020), who reported hyperinsulinemia and elevated HOMA-IR in fat dogs, although no important relationship was found between adipokines and metabolic parameters.

While obesity clearly disrupts glucose metabolism, insulin resistance alone is insufficient to induce diabetes. Hoenig (2014) emphasized that beta-cell dysfunction and increased hepatic glucose production are pivotal in the development of hyperglycemia. Clark and Hoenig (2021) found that in obese cats, each additional kilogram of body weight reduced insulin sensitivity by nearly 30%, thereby significantly increasing the risk of diabetes. Their research supported the use of diets including low-carbohydrate, high-protein, along with GLP-1 agonists, as effective adjunct therapies for managing diabetes in obese animals.

Weight loss remains a cornerstone of therapeutic intervention. It was shown that weight reduction in obese dogs led to improvements in insulin levels, lipid profiles, and adiponectin concentrations, reinforcing the metabolic benefits of weight control (Tvarijonaviciute et al., 2012).

Given that obesity is the most common metabolic disease in cats and dogs (German, 2006), preventive strategies focusing on appropriate diet and regular physical activity are essential. Tropf et al. (2017) further associated obesity-induced insulin resistance and dyslipidemia with adverse cardiac changes in dogs, underscoring the systemic impact of metabolic dysfunction.

Hypothyroidism and Obesity

Hypothyroidism is a prevalent endocrine disorder in dogs, primarily marked by a decreased metabolic rate, weight gain, lethargy, and a range of dermatological manifestations (Costa et al., 2016). Although congenital hypothyroidism is rare, it represents a serious condition resulting from primary defects in thyroid hormone synthesis. As described by Bojanic et al. (2011), affected animals may display developmental delays, skeletal deformities, and, in some cases, goiter.

Dermatological symptoms are among the most recognizable signs of hypothyroidism in dogs. These often include bilateral symmetrical alopecia, dry and flaky skin, and impaired epidermal differentiation. Costa et al. (2016) emphasized the importance of a comprehensive diagnostic approach includeing clinical evaluation, laboratory testing, and histopathological analysis to accurately identify skin-related manifestations of hypothyroidism.

In addition to physical symptoms, hypothyroidism can also influence behavior. Atanaskova Petrov (2022) demonstrated that disruptions in neuroendocrine function, particularly involving serotonin and prolactin regulation, may contribute to behavioral changes such as aggression or mood instability.

Hyperadrenocorticism

Hyperadrenocorticism, commonly known as Cushing’s syndrome, is a significant endocrine disorder in dogs characterized by chronic overproduction of cortisol. This excess cortisol, typically resulting from pituitary-dependent hyperadrenocorticism or, less frequently, adrenal tumors, affects a wide range of metabolic processes and accounts for approximately 85% of clinical cases (Lund et al., 2006; Oh, 2011).

Cortisol excess promotes gluconeogenesis, lipogenesis, and preferential fat accumulation in the abdominal region, contributing to notable weight gain and secondary obesity (Diez & Nguyen, 2006). Affected dogs often present with polyphagia, muscle wasting, a pot-bellied appearance, and other signs of metabolic imbalance. These changes are primarily attributed to the catabolic and lipogenic effects of sustained hypercortisolemia.

If left untreated, hyperadrenocorticism can lead to serious complications, including systemic hypertension, insulin resistance, diabetes mellitus, and recurrent urinary tract infections (Spearman & Little, 1978). The condition's contribution to obesity is particularly concerning, as it amplifies the risk of comorbidities and decreases overall quality of life.

Hormonal Interactions in Weight Control

The regulation of body weight is intricately linked to as ghrelin, cholecystokinin, and glucagon-like peptide-1 (GLP-1), which coordinate appetite control and satiety through interactions with the hypothalamus and brainstem (German, 2006). Dysregulation of these hormones disrupts energy balance, contributing to overeating, weight gain, and obesity (Clark & Hoenig, 2021). Understanding these hormonal pathways provides valuable insights into the complex endocrine contributions to obesity in companion animals.

Consequences of Obesity in Companion Animals

Obesity is an increasingly prevalent health concern in companion animals, significantly contributing to metabolic and systemic diseases. Characterized by excessive fat accumulation, obesity is associated with various health complications, including a reduced lifespan, musculoskeletal disorders, cardiovascular abnormalities, diabetes, dermatological issues, and endocrine imbalances. Understanding these consequences and implementing effective management strategies are essential for enhancing life quality and longevity of pets (German, 2006).

Impact on Lifespan

A strong correlation exists between obesity and reduced lifespan in dogs and cats. Kealy et al. (2002) demonstrated that dogs maintained on a lean diet lived approximately 15% longer (1.8 years) than their overweight counterparts. Energy restriction was reported to prevent chronic diseases, improve metabolic function, and enhance insulin sensitivity, glucose regulation, and lipid metabolism. Similarly, German (2006) reported that dietary control extended the lifespan of dogs by an average of two years, underscoring the long-term benefits of weight management.

Musculoskeletal Disorders

Obesity significantly increases the risk of orthopedic disorders, particularly in dogs. Large breeds are especially vulnerable, as excessive feeding during growth can contribute to irreversible conditions such as hip dysplasia (Marshall et al., 2009). Additionally, orthopedic conditions such as cranial cruciate ligament tears and humeral condylar fractures are more common in obese dogs, leading to decreased mobility and chronic pain (Frye et al., 2016). The additional strain on joints from excess weight exacerbates osteoarthritis, further diminishing mobility and quality of life.

Cardiovascular and Respiratory Effects

Obesity places significant strain on the cardiovascular and respiratory systems, leading to clinical challenges. Obese dogs often exhibit increased heart rate, elevated blood pressure, and greater ventricular volume, predisposing them to cardiac dysfunction and hypertension (German, 2006). Additionally, obesity has been linked to tracheal collapse, particularly in small breeds, where excess fat deposits around the airways increase respiratory resistance and exacerbate breathing difficulties (Tappin, 2016; Zoran, 2010). These findings emphasize the significance of proactive weight management in preventing cardiopulmonary complications.

Metabolic and Endocrine Disorders

Obesity is known as contributing factor to insulin resistance and therefore type 2 diabetes mellitus. Excess adipose tissue promotes pro-inflammatory adipokine production, disrupting glucose metabolism and exacerbating insulin resistance (Gayet et al., 2004). In diabetic dogs, obesity further impairs glucose utilization and increases insulin secretion, complicating disease management (Mattheeuws et al., 1984). The strong link between obesity and metabolic dysfunction highlights the need for preventive measures, including dietary regulation and regular physical activity, to reduce diabetes risk.

Reproductive and Dermatological Health

While the direct effects of obesity on reproductive health are limited, excessive fat deposition around the birth canal can complicate labor, increasing the risk of dystocia in pregnant females. Furthermore, obese cats often experience grooming difficulties due to limited mobility, predisposing them to skin inflammation, infections, and other dermatological issues (Zhang & Silverberg, 2015). These secondary complications highlight the broader systemic impact of obesity beyond metabolic health.

Gastrointestinal and Urinary Health

Obesity is a crucial predisposing factor in the pancreatitis of dogs and cats (Davison, 2015). Additionally, studies have identified a link between obesity and urinary tract diseases, particularly in spayed female dogs, where calcium oxalate stone formation is more prevalent (Lekcharoensuk et al., 2000). Managing obesity through appropriate diet and hydration is essential to reducing these risks and improving overall health outcomes.

Lipid Metabolism and Hyperlipidemia

Disturbances in lipid metabolism are another consequence of obesity, as excessive fat accumulation leads to elevated cholesterol, triglyceride, and phospholipid levels (Bailhache et al., 2003). However, further research is necessary to fully uncderstand the relationship between hyperlipidemia and pancreatitis in obese animals.

Conclusion

Obesity in the companian animals is a prevalent and preventable health issue that significantly reduces life expectancy and quality. It is linked to various metabolic and endocrine disorders, including diabetes mellitus, osteoarthritis, and cardiovascular disease. Effective prevention and treatment require early identification and a multifaceted approach that includes tailored nutrition, regular physical activity, and medical oversight. Nutritional management remains central, supported by owner education to ensure compliance. Hormonal and endocrine influences further complicate the condition, highlighting the need for individualized care. Collaborative efforts between veterinarians and pet owners, guided by current evidence, are essential to improving outcomes and promoting long-term health in companion animals.

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Chapter 3

USE OF PROBIOTICS IN FEEDING CATS AND DOGS

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Introduction

Although the term "probiotic" was first introduced as a feed supplement in 1974, evidence of the use of live microorganisms for fermentation dates back thousands of years, including wall paintings from the Sumerians around 2500 BC (Fuller, 1992). Fermented products have been consumed for nutritional and therapeutic purposes long before probiotics were scientifically recognized (Aykut et al., 2024). In animal nutrition, probiotics are used for various purposes, such as improving growth performance in poultry, enhancing dry matter intake and milk quality in ruminants, and improving water quality in aquaculture (Anee, 2021). With the rising living standards of cats and dogs, there has been an increase in inflammation, digestive, and metabolic disorders. Probiotic use has been found effective in supporting digestive, immune, and oral health, as well as in reducing obesity (Zha et al., 2024). While each animal has its own unique microbiome, mammals generally carry similar bacterial groups; the main differences are at the species and strain level, and hundreds of different bacterial types have been identified in the intestines of cats and dogs. (Batı et al., 2023). A study on probiotic use in dogs reported that administration of Lactobacillus fermentum (AD1) increased serum protein and lipid levels, decreased glucose levels, and raised the number of probiotic bacteria in the feces (Strompfová et al., 2006). Additionally, it has been noted that probiotics shorten the duration of diarrhea and improve stool quality in both cats and dogs (Jugan et al., 2017).

Probiotics

Probiotics are dietary supplements containing live microorganisms that positively influence the health of the host by balancing the intestinal microbiota (Wynn, 2009; Uymaz, 2010). The term "probiotic" was first defined in 1965 by Lilly and Stillwell. Derived from the Latin words “pro” and “bios”, it translates to "for life." In other words, probiotics can be described as beneficial gut microorganisms that support the health of the host (Ceyhan & Alıç, 2012). A joint working group formed by the Food and Agriculture Organization (FAO) of the United Nations and the World Health Organization (WHO) defined probiotics as "live microorganisms which, when administered in adequate amounts, confer a health benefit on the host" (Bajagai et al., 2016). Similarly, a 2013 consensus report by field experts reiterated that probiotics should be defined as "live microorganisms that, when administered in sufficient quantities, provide health benefits to the host" (Gasbarrini et al., 2016). Probiotics exhibit their beneficial effects only when administered at adequate levels (Bajagai et al., 2016). Among the commonly used bacterial strains in probiotic formulations are Lactobacillus, Bifidobacterium, Escherichia, Enterococcus, Bacillus, and Streptococcus (Gupta & Garg, 2009). Due to the sensitivity of probiotic microorganisms to environmental conditions, factors such as storage methods, feed processing techniques, interactions with feed additives, carrier properties, and the pH of the medium must be carefully controlled (Sarıca, 1999).

The History of Probiotic Use

Long before there was any awareness of probiotic microorganisms, fermented products such as beer, bread, wine, kefir, kumis, and cheese were frequently used for both nutritional and therapeutic purposes (Aykut et al., 2024). In 1907, Mechnikov suggested a potential link between lactic acid bacteria and health. Subsequent studies led to the discovery in the 1950s of products that supported Bifidobacteria found in breast milk. In 1953, German scientist Werner Kollath was the first to describe these beneficial products as "active substances necessary for the development of a healthy life" (Gasbarrini et al., 2016). Active scientific research into probiotics began in the 1970s, with early applications involving substances prepared from the intestinal contents of adults carrying Salmonella (Karahan & Çakmakçı, 1996). Although the term "probiotic" was first used in 1974 in the context of feed supplements, the use of live microorganisms dates back thousands of years. There is even evidence from wall paintings of the Sumerians, dating to around 2500 BC, indicating the inoculation of milk for fermentation purposes (Fuller, 1992).

Mechanism of Action of Probiotics

A true probiotic must be safe in terms of its content, should not possess pathogenic or toxic properties, and must be resistant to intestinal conditions. Additionally, it should demonstrate efficacy against pathogens and support the immune system (Diaz et al., 2019). Probiotics exert their effects through several mechanisms, including competition with pathogens for adhesion sites, strengthening of the intestinal mucosal barrier, modulation of the gut immune system, and the production of neurotransmitters (Figure 1) (Yeşilova et al., 2010; Latif et al., 2023; Tankeshwar, 2025). Probiotic bacteria adhere to intestinal epithelial cells and proliferate without being absorbed through the digestive tract. Through this mechanism, they prevent colonization and proliferation of pathogenic bacteria-non-native to the gut that would otherwise adhere to epithelial surfaces (Sarıca, 1999).

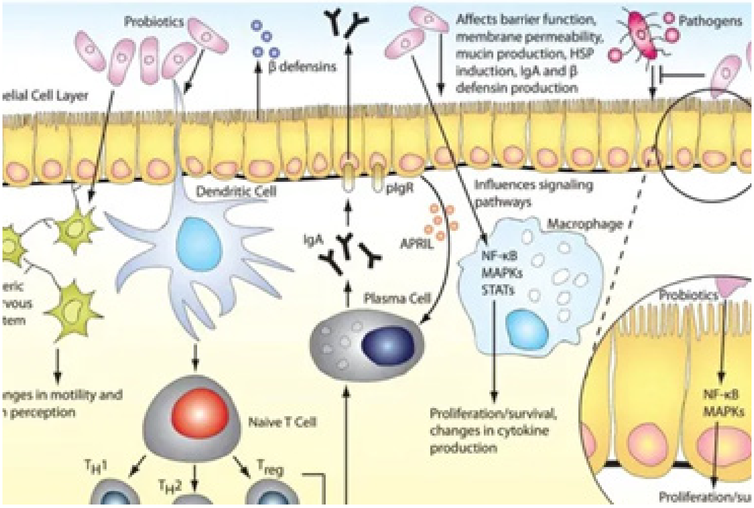

Figure 1. Mechanism of action of probiotics (Tankeshwar, 2025)

When probiotics first reach the intestinal lumen, they interact both physically and chemically with the epithelial cell layer, contributing to the maintenance of the intestinal barrier. Upon binding to epithelial cells, they stimulate the secretion of mucin a hormone responsible for the development of the mucus layer thereby strengthening this protective barrier and establishing the first line of defense against pathogens (Oelschlaeger, 2010). In addition, they enhance the release of immunoglobulin A (IgA) from epithelial cells, further reinforcing the immune barrier. By facilitating more effective antigen recognition by dendritic cells, probiotics help regulate the release of Th1, Th2, and Treg cells, creating a balance that aids in modulating inflammation (Fooks & Gibson, 2002). Probiotics also support the regulation of intracellular signaling pathways and promote a more effective immune response. They are involved in the activation of several key signaling pathways, including nuclear factor kappa-B (NF-κB), signal transducer and activator of transcription (STAT), and mitogen-activated protein kinase (MAPK) pathways (Dong et al., 2002). Furthermore, probiotics play a role in modulating motility and pain perception within the enteric nervous system (Collins et al., 2012).

Despite their benefits, probiotics are sensitive to various physiological factors such as gastric and pancreatic fluids, bile, pH, and the intestinal mucosa. Inadequate conditions may reduce their activity (Ersoy et al., 2018; Kerry et al., 2018). Enzymes like cellulase, xylanase, lipase, protease, β-glucanase, and amylase interacting symbiotically with the animal's digestive cells assist in nutrient digestion, especially in young animals with underdeveloped digestive systems (Vanbelle et al., 1990). Probiotics exhibit antimicrobial activity by producing substances such as short-chain fatty acids, organic acids, hydrogen peroxide, and bacteriocins, which reduce the number of pathogenic bacteria in the gut (Tejero-Sariñena et al., 2013; Kareem et al., 2014). Additionally, certain probiotic strains may influence mood, behavior, gut motility, and stress-related mechanisms by regulating levels of neurotransmitters like serotonin, gamma-aminobutyric acid (GABA), and dopamine (Latif et al., 2023).

The mechanisms through which probiotics exert their effects can be summarized as follows (Figure 2) (Anee, 2021):

a) Inhibition of Pathogen Adhesion: Suppresses the growth of pathogenic organisms in the gastrointestinal tract and reduces their ability to adhere to intestinal surfaces.

b) Secretion of Defensins and Bacteriocins: Enhances the secretion of antimicrobial proteins, which help eliminate pathogens.

c) Competitive Exclusion: Binds tightly to intestinal receptors, outcompeting harmful microorganisms and preventing their colonization.

d) Enhancement of Barrier Function: Increases mucus production, creating a dense protective layer and reducing intestinal permeability to pathogens.

e) Reduction of Luminal pH: Stimulates acetic acid production, lowering the pH in the intestinal lumen and creating an unfavorable environment for pathogens.

f) Modulation of the Immune System: Supports the secretion of immune defense cells, contributing to immune regulation.

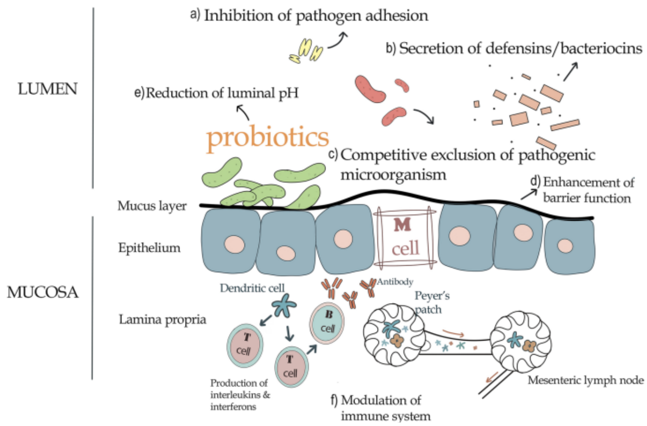

Figure 2. Mechanisms of action of probiotics (Anee, 2021)

Characteristics of Probiotics

To exert their intended effects, probiotics must possess certain essential characteristics. These include:

- Being present in sufficient quantities in the intestinal lumen,
- Not having pathogenic or toxic properties,
- Resistance to low gastric pH, bile salts, and lysosomal enzymes in the intestines,
- Stability during feed production and storage processes,
- High stability in the presence of nutrients and feed additives,
- Preferably administered during early life stages,
- Ease of production in both in vivo and in vitro conditions (Yalçın et al., 1996).

Moreover, the conditions under which probiotics are used are equally important, and appropriate parameters must be ensured. Due to the sensitivity of probiotic microorganisms to environmental factors, attention must be paid to storage conditions, feed processing methods, interactions with feed additives, carrier properties, and the pH of the medium. Commercial probiotic preparations are produced in various forms. When stored in cool and dry environments with low moisture content, they can maintain their viability for longer periods (Sarıca, 1999). Ensuring proper usage conditions such as appropriate duration, temperature, and pH is crucial for their effectiveness (Figure 3).

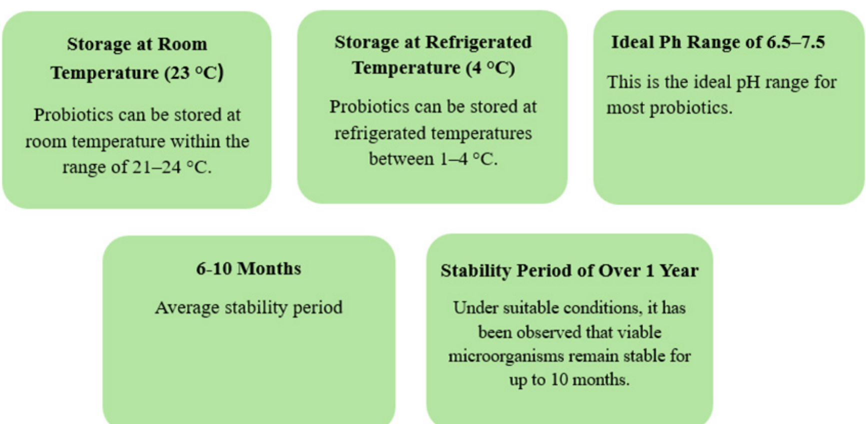

Figure 3. Storage conditions of probiotics (Ledoux, 2017)

Probiotic preparations are available in various forms such as powders, granules, pellets, liquid suspensions, and capsules, and can be administered by mixing them into drinking water or feed. For probiotics to exert their beneficial effects, the live bacteria, fungi, and yeasts used must survive storage, the application process, and the conditions within the intestinal environment. Thanks to recent advancements in microencapsulation technology, bacterial probiotics can now withstand pelleting temperatures of 90–95°C (Güçlü & Kara, 2009).

Use of Probiotics in Animal Nutrition

The digestive systems of companion animals host complex microbial communities composed of bacteria, protozoa, fungi, archaea, and viruses. These communities play critical roles in animal health and nutrition, including the digestion and fermentation of plant polymers. The gut microbiota is responsible for functions such as vitamin synthesis, detoxification of harmful compounds, stimulation of the immune system, regulation of intestinal motility, maintenance of mucosal integrity, and serving as a barrier against pathogens (Chaucheyras-Durand & Durand, 2009). Probiotic bacteria can enhance nutrient utilization and support animal immunity through the production or activation of enzymes. They lower the environmental pH by producing substances such as lactic acid, acetic acid, and hydrogen peroxide, thereby inhibiting pathogens like Salmonella typhimurium and Clostridium difficile (Tejero-Sariñena et al., 2013; Kerry et al., 2018). Naturally occurring probiotic bacteria in the digestive systems of humans and animals are also found in environmental sources such as grains, by-products, silages, plants, water, and soil (Güçlü & Kara, 2009).

According to the European Parliament and Council Regulation No. 1831/2003 (EC) dated 22/9/2003 on feed additives used in animal nutrition, microorganisms are classified as "zootechnical additives" and included among substances that stabilize the gut flora (Anadón, 2006). Probiotics are particularly effective in restoring microbial balance in young animals and under stressful conditions such as extreme temperatures, poor hygiene, weaning, transportation stress, and post-antibiotic treatment (Kerry et al., 2018). The efficacy of probiotics depends on the microorganism species, the mode of administration, and the health status of the animal (Boaventura et al., 2012).

Today, producers use probiotic feed supplements for poultry, ruminants, and fish. Although probiotics are primarily composed of gram-positive bacteria, gram-negative bacteria, yeasts, and fungi are also included in this group (Anee, 2021). Over the years, probiotics have been used for various purposes in livestock. Notably, in the 1960s, positive effects on growth performance were observed in pigs following studies with Lactobacillus strains (Ahasan et al., 2015). For monogastric animals, yeasts such as Saccharomyces boulardii and Saccharomyces cerevisiae, alongside bacterial probiotics, are commonly preferred and specifically targeted to affect the cecum and colon (Batı et al., 2023). The effects of probiotic applications in animals are illustrated in Figure 4.

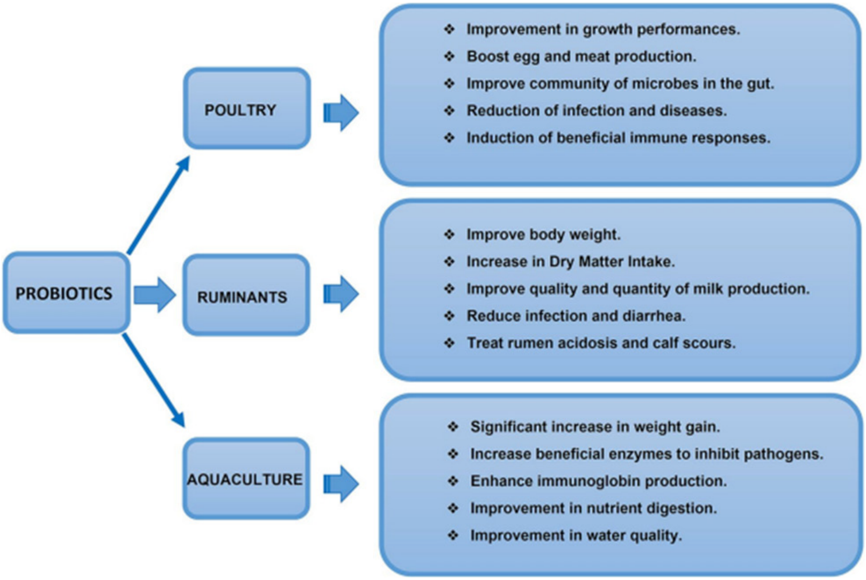

Figure 4. Use and effects of probiotics in animals (Anee, 2021)

The main benefits of using probiotics in animal nutrition can be summarized as follows (Musa et al., 2009):

- Growth Support: Optimizes digestion, enabling farm animals to maximize nutrient utilization.
- Gut Health: Regulates the intestinal flora, preventing infections and supporting immunity.
- Lactose Intolerance: Breaks down lactose, facilitating digestion and alleviating symptoms of lactose intolerance.
- Relief from Constipation: Regulates bowel movements, preventing constipation and side effects such as antibiotic-associated diarrhea.
- Cancer Prevention Potential: Inactivates carcinogenic enzymes, potentially reducing the risk of colon cancer.
- Cholesterol Reduction: Lowers cholesterol and lipid levels,

improving cardiovascular health.

- Nutrient Production and Absorption: Produces B vitamins and amino acids, supporting energy metabolism.

- Protein Sparing: Prevents pathogens from consuming proteins, ensuring efficient protein utilization in the body.

- Immune Enhancement: Strengthens the immune system, providing protection against infections.

Use of Probiotics in Cats and Dogs

Pets are increasingly regarded as family members, and their numbers grow every year, driving rapid expansion in the pet industry. Alongside rising living standards, health issues such as inflammatory bowel disease, allergies, diarrhea, constipation, periodontal disease, obesity, and diabetes have become more prevalent in cats. Research indicates that probiotics support digestive and immune health in cats, help maintain oral hygiene, and reduce obesity (Zha et al., 2024).

The use of probiotics in feeding cats and dogs has significantly increased in recent years due to their positive effects on physiological and immune functions. The beneficial impacts of probiotics on both digestive health and overall well-being are supported by scientific studies as well as clinical applications (Strompfová et al., 2006; Torres-Henderson, 2017). Probiotics suppress the proliferation of pathogenic microorganisms in the gastrointestinal tract, maintaining microbial balance and strengthening the intestinal mucosa. These effects are especially pronounced in young, elderly, or stressed animals (Boaventura et al., 2012).

In cats, the probiotic digestive process begins with nutrient intake, forming the initial link in the digestive chain. In the first stage, macronutrients such as carbohydrates, proteins, and lipids are prepared for digestion (Wernimont et al., 2020). This initial phase involves digestion by the host, where these macronutrients are broken down into monosaccharides, disaccharides, amino acids, and fatty acids through saccharolytic digestion, proteolysis, and lipolysis mechanisms. These digested products become usable by the body. The nutrient building blocks are absorbed through the intestinal epithelium and utilized by the host in absorption and energy metabolism (Wernimont et al., 2020). The undigested portion remains in the intestine, at which point the gut microbiota becomes involved. Microbial fermentation begins during this phase. Probiotic bacteria in the intestine ferment indigestible carbohydrates, converting them into beneficial metabolites such as energy and short-chain fatty acids (Wernimont et al., 2020). During this process, probiotics produce postbiotics that are beneficial to the host. Postbiotics are biological products containing metabolites released through the metabolic activities of probiotic microorganisms or through the breakdown of these microorganisms, as well as components of microbial cell walls, which can exert beneficial effects on the host (Wernimont et al., 2020; Aydın, 2023). The use of probiotics in cats impacts multiple systems, as illustrated in Figure 5.

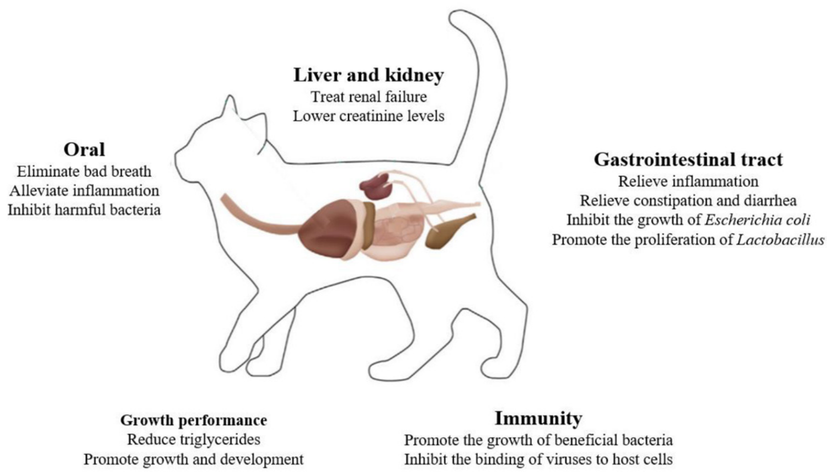

Figure 5. Systems affected by probiotics in cats (Zha et al., 2024).

Anatomical and physiological differences result in each section of the intestine harboring a unique microbial ecosystem. Microorganisms utilize host nutrients to produce metabolites and perform specialized functions. While each animal possesses a distinct microbial profile, mammals generally share similar groups of bacteria; the primary differences are observed at the species and strain levels. Recent studies have identified hundreds of different bacterial phylotypes in the intestinal systems of cats and dogs (Batı et al., 2023). Dominant bacterial groups found in the colon and feces of cats and dogs include Firmicutes, Bacteroidetes, Proteobacteria, and Fusobacteria. Additionally, Eubacterium species play a significant role in cats. Furthermore, certain Lactobacillus species are commonly present in the intestines of both cats and dogs. The most prevalent species for dogs is Lactobacillus acidophilus, whereas for cats, examples include L. acidophilus, L. salivarius, and L. johnsonii (Grześkowiak et al., 2015). The density levels of bacterial phylotypes found in cats and dogs are illustrated in Figure 6.

	Stomach	Small Intestine	Colon	Feces	
The number of total bacteria	10^4 -10^5 CFU/g (cats and dogs)	10^5- 10^9 CFU/g (cats and dogs)	10^9 – 10^{11} CFU/g (cats and dogs)	10^8 – 10^{11} CFU/g (cats and dogs)	(Lee et al., 2022)
	Helicobacter and *Lactobacillus* (cats and dogs)				(Grześkowiak et al., 2015) (Lee et al., 2022)
Dominant bacteria		Firmicutes Proteobacteria Bacteroidetes Fusobacteria Actinobacteria (cats and dogs)			(Grześkowiak et al., 2015) (Schmitz & Suchodolski, 2016) (Ziese et al., 2021) (Lee et al., 2022)
				Firmicutes, Proteobacteria Bacteroidetes, Fusobacteria, Actinobacteria (cats and dogs), a core microbiata composed of Firmicutes, Bacteroides, and Fusobacteria (dogs), Prevotella 9 and Bacteroides (cats and dogs)	(Alessandri et al., 2020) (Pilla et al., 2021) (Lee et al., 2022)

Figure 6. Bacterial density in cats and dogs (Yang and Wu, 2023)

In a study conducted on fifteen healthy adult dogs, dogs were given either a probiotic-containing (Lactobacillus acidophilus DSM13241) or standard diet, with probiotics sprayed onto the food to maintain stability. At the end of the study, the presence of live bacteria in the food was confirmed (Baillon et al., 2004). In another study (Strompfová et al., 2006), administration of the Lactobacillus fermentum (AD1) strain isolated from dogs resulted in a significant increase in serum protein and lipid levels, while blood glucose levels decreased. No changes were observed in serum cholesterol, alanine aminotransferase, and urea levels, but a marked increase in the number of probiotic bacteria in feces was recorded (Strompfová et al., 2006). In sled dogs, where diarrhea usually occurs due to exercise, the addition of a probiotic composed of Enterococcus faecium F68, Bacillus coagulans, Lactobacillus acidophilus, and other agents reduced diarrhea recovery time and improved fecal scores (Jugan et al., 2017). Positive effects of probiotics have been observed in cats and dogs with intestinal disorders. Oral administration of products fermented with Bacillus licheniformis alleviated symptoms in chronic diarrhea cases and reduced Clostridium perfringens levels in feces (Yang and Wu, 2023). Additionally, inclusion of the Enterococcus faecium SF68 strain in the diet improved fecal quality in cats receiving amoxicillin-clavulanate treatment (Torres-Henderson et al., 2017).

In a study investigating the viability and effects of the Enterococcus faecium EE3 canine strain on microbiological and biochemical parameters in healthy dogs (Marciňáková et al., 2006), the strain was individually administered orally at a dose of 109 CFU/mL (ranging between 2 and 3 mL) for one week to 11 dogs and was found to persist in feces for 3 months after cessation of administration. Seven days post-administration, a significant decrease in staphylococci and Pseudomonas-like bacteria was observed. Meanwhile, the concentration of lactic acid bacteria increased, but E. coli growth was unaffected (Marciňáková et al., 2006). Blood samples from dogs taken 0-1 days before administration and one week after showed that total lipids decreased in 8 dogs, total protein also decreased, and cholesterol levels normalized—meaning cholesterol levels rose to physiological levels in samples with low cholesterol and decreased in those with high cholesterol, while cholesterol levels in 3 dogs remained unchanged (Marciňáková et al., 2006). Similarly, daily administration of another potential probiotic canine strain, Lactobacillus fermentum AD1 (109 CFU/mL), for one week to 15 healthy dogs increased total protein and total lipid levels in their serum and decreased glucose (Strompfová et al., 2006). In a laboratory study on domestic cats, Enterococcus faecium SF68 or placebo was administered for 14 days, with amoxicillin-clavulanate given for 7 days. Vomiting, diarrhea, and changes in the gastrointestinal microbiome were monitored before and after antibiotic treatment. Of the 13 cats fed SF68, 9 (69.2%) had fecal scores greater than 5 on a 7-point scale, while in the placebo group of 14 cats, 12 (85.7%) exhibited this (Torres-Henderson, 2017). Scores of 7 were only detected in the placebo group, and when comparing total diarrhea scores between days 1-11, cats fed SF68 had statistically lower scores (Torres-Henderson, 2017).

However, the efficacy of probiotics varies depending on many factors such as the strain type, dosage, duration of administration, and the animal's health status (Latif et al., 2023). Appropriate storage, formulation, and administration conditions are also crucial for probiotics to be effective (Sarıca, 1999). Especially with new methods like microencapsulation technology, the resistance of probiotics to stomach acid and bile salts is increased, allowing live probiotics to reach the target site (Güçlü and Kara, 2009).

Conclusion

In the past, antibiotics were widely used to support animal growth and health. Later, scientific studies revealed the harmful effects of antibiotics on animal health, leading to a ban on their use. Supported by the World Health Organization, this decision led to natural feed additives replacing antibiotics. Among these, probiotics stand out with their benefits such as disease recovery and supporting healthy immunity. Probiotics benefit by supporting the immune system and protecting the host from pathogens. They adhere to intestinal epithelial cells without being absorbed in the digestive tract and multiply there. This feature prevents pathogenic bacteria that want to colonize the intestine from attaching and multiplying. For probiotics to exhibit these effects, proper storage conditions and usage requirements must be followed. With the increase in the number of pets, probiotic use in cats and dogs has also risen. In cats, health problems such as inflammatory bowel disease (IBD), allergies, diarrhea, and obesity have gained more attention, and studies show that probiotics support digestive and immune systems. In developed countries, probiotic products have become a preferred choice for cat and dog health issues and are also used as supportive treatments. It is recommended that future studies explore the use of probiotics in animal health to accelerate and support disease recovery.

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