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Can probiotics be used to prevent or treat obesity in dogs?

¿Es posible utilizar probióticos para prevenir o tratar la obesidad en perros?

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ABSTRACT

Canine obesity is a complex metabolic disorder that has become increasingly common worldwide, affecting not only animal health but also public health and welfare. Beyond excessive feeding and limited exercise, current research highlights the gut microbiota as a central regulator of metabolic balance. Alterations in its composition (such as an increased Firmicutes/Bacteroidetes ratio, and loss of microbial diversity) disrupt nutrient absorption, lipid metabolism, and immune regulation, creating a pro-inflammatory environment that favors fat accumulation. Probiotics, defined as live microorganisms that promote health when administered in sufficient quantities, have shown potential to restore intestinal balance and improve host metabolism. They act by strengthening the intestinal barrier, modulating immunity, and producing short-chain fatty acids that regulate energy use. However, most commercial probiotics for dogs are adapted from human strains and not specifically developed for metabolic disorders. Emerging evidence suggests that canine-derived strains of *Lactobacillus*, *Bifidobacterium*, and *Enterococcus* may help reduce adiposity and improve metabolic health. Designing next-generation, species-specific probiotics could complement dietary and behavioral interventions, offering a sustainable, microbiota-based strategy to prevent and manage obesity in dogs within the broader “One Health” perspective linking animal and human well-being.

Keywords: obesity, dogs, probiotics.

RESUMEN

La obesidad canina es un trastorno metabólico complejo y multifactorial que ha aumentado de forma alarmante en todo el mundo, lo que afecta tanto la salud animal como la salud pública. Más allá de la sobrealimentación y la falta de ejercicio, las investigaciones actuales destacan a la microbiota intestinal como un regulador clave del equilibrio metabólico. Las alteraciones en su composición (como el incremento en la relación Firmicutes/Bacteroidetes, y la pérdida de diversidad microbiana) perturban la absorción de nutrientes, el metabolismo de lípidos y la regulación inmunológica, esto genera un entorno proinflamatorio

que favorece la acumulación de grasa. Los probióticos, definidos como microorganismos vivos que promueven la salud al administrarse en cantidades adecuadas, muestran potencial para restaurar el equilibrio intestinal y mejorar el metabolismo del hospedero. Su mecanismo de acción implica reforzar la barrera intestinal, modular la respuesta inmunológica y producir ácidos grasos de cadena corta que regulan el uso energético. Sin embargo, la mayoría de los probióticos comerciales para perros derivan de cepas humanas, no diseñadas específicamente para trastornos metabólicos. Evidencias recientes sugieren que cepas de *Lactobacillus*, *Bifidobacterium* y *Enterococcus* de origen canino pueden reducir la adiposidad y mejorar la salud metabólica. El desarrollo de probióticos específicos para perros podría integrarse a estrategias dietéticas y conductuales sostenibles, dentro del marco “Una Salud” que vincula el bienestar animal y humano.
Palabras clave: obesidad, perros, probióticos.

INTRODUCTION

Dogs have become an integral part of modern households, often regarded as family members. However, when exposed to unhealthy lifestyles characterized by physical inactivity and unbalanced diets, they are prone to developing metabolic disorders such as obesity and its associated comorbidities. Obesity, defined as an excessive accumulation of adipose tissue, represents one of the most prevalent nutritional disorders in companion animals (Quesada-López & Villarroya, 2023). The rising incidence of overweight and obesity in dogs poses a significant threat to their health, longevity, and overall welfare.

On the other hand, the gastrointestinal microbiota has gained increasing relevance due to its close association with diet and host health. The composition of this microbial community and the metabolites it produces can be influenced by both intrinsic and extrinsic factors, thereby contributing to the development of obesity (Suarez *et al*., 2022; Sankararaman *et al*., 2023). Several studies have demonstrated a clear relationship between obesity and intestinal microbiota imbalance (Kim *et al*., 2023). Such dysbiosis significantly affects metabolic homeostasis and energy efficiency, as it is associated with enhanced caloric extraction, altered intestinal permeability, and chronic low-grade inflammation (Kim *et al*., 2023; Sankararaman *et al*., 2023). In humans and murine models, obesity has been linked to alterations in the relative abundance of the two dominant bacterial phyla—Firmicutes and Bacteroidetes—characterized by an increase in the former and a decrease in the latter (Abenavoli *et al*., 2019). Similar trends have been reported in dogs (Chun *et al*., 2020; Thomson *et al*., 2022).

A gut microbiota in homeostatic balance—referred to as eubiosis—provides multiple physiological benefits to the host (Park *et al*., 2015). Therefore, restoring microbial equilibrium through the design of a species-specific probiotic formulation for dogs may help prevent or support the treatment of obesity in this species.

In this context, the present mini review aims to synthesize current knowledge on the relationship between the gut microbiota and obesity in dogs, emphasizing the physiological mechanisms through which microbial dysbiosis influences metabolic regulation, lipid accumulation, and inflammation, while also addressing the emerging role

of probiotics as modulators of the canine intestinal microbiome and their potential to restore eubiosis and improve metabolic health. Additionally, this work identifies existing research gaps and highlights the need for probiotic formulations specifically tailored to canine physiology, as dogs differ from humans and rodents in their dietary patterns, digestive physiology, and microbial composition. Understanding these differences is essential to develop effective, evidence-based probiotic interventions capable of mitigating obesity and its associated metabolic complications. Ultimately, this review contributes to a broader understanding of the gut–metabolic axis in dogs and promotes a microbiota-centered approach for the prevention and management of obesity, aligned with the "One Health" framework integrating animal, human, and environmental health.

Obesity in dogs

Obesity is defined as the excessive accumulation of adipose tissue resulting from an imbalance between energy intake and expenditure (Quesada-López & Villarroya, 2023). In dogs, obesity is diagnosed when body weight exceeds the ideal by approximately 15–20% and presents a multifactorial etiology involving nutritional, genetic, endocrine, environmental, and behavioral factors. The most recurrent risk factors include chronic overfeeding and insufficient physical activity; however, the primary determinant of obesity in dogs is often associated with the habits and behaviors of the owner or caretaker (Suarez *et al*., 2022; Radosta, 2024) Although certain genetic predispositions (such as breed susceptibility) and physiological conditions like neutering, which alters hormonal and metabolic profiles, contribute to weight gain, lifestyle factors exert the strongest influence. Feeding frequency, diet composition, the use of treats and table scraps, and even the dog's presence during food preparation or mealtimes have been linked to increased obesity risk. Moreover, several studies report correlations between the owner's characteristics (such as body weight, gender, age, body mass index (BMI), and educational level) and the likelihood of canine overweight and obesity(Suarez *et al*., 2022). Obesity significantly reduces quality of life and increases morbidity and mortality in dogs, predisposing them to metabolic disorders, hypertension, osteoarthritis, urolithiasis, and certain types of cancer.

Current treatments

Therapeutic management of obesity in dogs primarily focuses on lifestyle modifications, particularly dietary restriction and increased physical activity. Complementary strategies such as behavioral interventions, and in specific cases, pharmacological or bariatric therapies, may further support weight reduction. Recent studies in humans, mice, and dogs have established a strong association between obesity and gut microbiota dysbiosis (Abenavoli *et al*., 2019; Chun *et al*., 2020. Modulating the intestinal microbiota through probiotic supplementation has emerged as a promising approach to reshape metabolic

profiles and enhance weight management outcomes when combined with appropriate dietary interventions(Abenavoli *et al*., 2019).

Gut microbiota in dogs

The gastrointestinal microbiota, composed of millions of microorganisms, is a dynamic ecosystem whose composition varies according to genotype, age, diet, and physiological stress of the host. In healthy dogs, the intestinal microbiota is dominated by the phyla Firmicutes, Bacteroidetes, Fusobacteria, Proteobacteria, and Actinobacteria (Chun *et al*., 2020; Thomson *et al*., 2022). Among these, Firmicutes is the most abundant phylum, and together with Bacteroidetes, accounts for approximately 60% of the total bacterial load (Suchodolski *et al*., 2008; Chun *et al*., 2020; Thomson *et al*., 2022). Regarding spatial distribution, members of the order Clostridiales predominate in the duodenum and jejunum, whereas Clostridiales, Fusobacteriales, and Bacteroidales coexist in similar proportions in the ileum and colon (Suchodolski *et al*., 2008; Hand *et al*., 2013).

Diet plays a major role in shaping the composition of the gut microbiota. Protein-rich diets promote the proliferation of *Clostridium perfringens*, whereas raw food diets (BARF) are associated with an enrichment of *Fusobacterium, Bacteroides*, *C. perfringens*, and Enterobacteriales (Castañeda *et al*., 2023). Conversely, diets high in fermentable carbohydrates increase the abundance of lactic acid bacteria and *Bifidobacterium*, while commercial diets favor the enrichment of *Turicibacter,* Clostridiaceae*,* Ruminococcaceae, Lachnospiraceae*, Faecalibacterium*, and *Peptacetobacter* (Schmidt *et al*., 2018; Castañeda *et al*., 2023).

The canine gut microbiota can also be altered by physiological stress, gastrointestinal diseases, and indiscriminate antibiotic use. Additionally, endocrine disorders that modify cortisol levels may influence behavior and indirectly affect feeding patterns through stress-related conditioning and reinforcement mechanisms (Radosta, 2024).

Gut microbiota in obese dogs

Several studies have investigated the gut microbiota composition of lean and obese dogs, considering variables such as sex, age, breed, and diet. Although the most abundant bacterial phyla are consistently reported; Firmicutes, Bacteroidetes, *Fusobacteria,* Proteobacteria, and Actinobacteria (Forster *et al*., 2018; Chun *et al*., 2020; Thomson *et al*., 2022; Kim *et al*., 2023), no specific microbial signature has yet been identified to distinctly characterize either the lean or obese state in dogs. Bacterial diversity varies across studies (Table. 1); however, an increased Firmicutes/Bacteroidetes ratio, along with higher abundances of Fusobacteria and Proteobacteria, has been consistently associated with obesity (Park *et al*., 2015; Chun *et al*., 2020; Thomson *et al*., 2022). Such compositional shifts are linked to the loss of key species involved in intestinal homeostasis and the overgrowth of potentially toxigenic taxa.

Given the distinct microbial profiles observed between obese and non-obese individuals, it is plausible that modulating gut bacterial diversity could exert beneficial effects on host metabolism and facilitate weight loss as part of obesity management. In this context, probiotic supplementation emerges as a promising strategy with significant potential to restore microbial balance and improve metabolic health.

Table 1. Bacterial diversity in normal-weight and obese dogs

Normal-weight	**Firmicutes**	**Bacteroidetes**	**Fusobacteria**	**Proteobacteria and Actinobacteria**
Relative abundance	~55% [a-d]	~30% [a-d]	~10% [a-d]	~5% [a-d]
	Lactobacillus (61%), *Faecalibacterium* (11%) *Turicibacter* (10%) [e]			
Obesity	**Firmicutes**	**Bacteroidetes**	**Fusobacteria**	**Proteobacteria y Actinobacteria**
Relative abundance	↑ [a, c]	↓ [a, c]	↑ [b, c, e]	↑ [b, c, e, f]
	Eubacterium ↓[a]			*Bifidobacteriaceae* ↑ [a]
	Faecalibacterium ↑ *Megamonas* ↑ [c]			
	Lactobacillus (63%) No clasificados (17%) *Enterococcus* (13%) [e]			
	Blautia (51.2%) *Ruminococcus* (17.6%) *Clostridium* (9.9%) [f]	*Bacteroides* (50.9%) *Prevotella* (49.0%) [f]		
	Roseburia ↑ [f]			

[a] Forster *et al*., 2018; [b] Chun *et al*., 2020;, [c] Thomson *et al*., 2022; [d] Kim *et al*., 2023; [e] Park *et al*., 2015; [f] Handl *et al*., 2011.

Probiotics

Probiotics are defined as live microorganisms that, when administered in adequate amounts, confer health benefits to the host. To be considered probiotic, a bacterial strain must be supported by evidence of efficacy, genomic characterization, and a comprehensive safety assessment (Hill *et al*., 2014).

The effectiveness of probiotics relies on their ability to restore microbial homeostasis in the host (Gómez-Gallego *et al*., 2016). Their mechanisms of action include competitive exclusion of pathogens, production of antimicrobial, anti-inflammatory, and immunomodulatory compounds, modulation of intestinal pH, and regulation of mucus and mucin secretion (Schmitz, 2021). Importantly, the number of viable microorganisms reaching the intestinal tract is critical for clinical efficacy. Studies suggest that a minimum concentration of 10^6 CFU/mL is required in the small intestine and 10^8 CFU/g in the colon to achieve a therapeutic effect. Furthermore, probiotic strains must be species-specific, and their combinations appropriately formulated for canine nutrition, therapy, and health care (Grześkowiak *et al*., 2015).

In dogs, probiotics are most commonly used for the management of gastrointestinal disorders. However, most commercial probiotic strains are of non-canine origin and are primarily designed to support treatment of infectious or antibiotic-associated diarrhea rather than metabolic conditions such as overweight and obesity.

Functional composition of the gut microbiota and its association with obesity in dogs

In the intestinal microbiota of humans and mice, the dominant bacterial phyla are Firmicutes, Bacteroidetes, Actinobacteria, and Proteobacteria, whereas in dogs, Fusobacteria is also a major component (Forster *et al*., 2018; Chun *et al*., 2020; Thomson *et al*., 2022; Kim *et al*., 2023; Maciel-Fiuza *et al*., 2023). In humans, Firmicutes are associated with butyrate production and the reduction of proinflammatory cytokines, Bacteroidetes with epithelial cell maturation, maintenance, and nutrient absorption, Proteobacteria with protection against pathogen colonization through the production of antibacterial compounds such as bacteriocins, and Actinobacteria with enhancement of the intestinal barrier and inhibition of inflammation (Maciel-Fiuza *et al*., 2023). In dogs, the abundance of the phylum Fusobacteria (which has been linked to colorectal cancer in humans) is noteworthy. However, its functional role in the canine gut remains unclear, although it appears to be positively correlated with overweight and obesity (Chun *et al*., 2020).

When the gastrointestinal microbiota remains diverse and balanced, it provides multiple benefits to the host. Conversely, dysbiosis can trigger infectious, inflammatory, autoimmune, or metabolic disorders such as obesity. The increase in Firmicutes observed in obese dogs may be associated with enhanced energy extraction, whereas the decrease in Bacteroidetes could compromise intestinal epithelial integrity, promoting chronic low-grade inflammation (Park *et al*., 2015; Schmidt *et al*., 2018; Chun *et al*., 2020; Thomson *et al*., 2022; Maciel-Fiuza *et al*., 2023).

The intestinal microbiota is a dynamic ecosystem that responds to environmental and physiological factors. This adaptability can be harnessed in the treatment of obesity-associated dysbiosis by employing probiotics containing bacterial strains enriched in

healthy dogs, aiming to reestablish microbial proportions compatible with intestinal homeostasis. Studies using *Lactobacillus* and *Bifidobacterium* strains have demonstrated improvements in gut microbiota composition, enhanced antibacterial activity, accelerated resolution of acute idiopathic diarrhea, reduced pharmacological dependence, and alleviation of gastrointestinal discomfort (Grześkowiak *et al*., 2015; Gómez-Gallego *et al*., 2016). Currently, most commercial canine probiotics are formulated for gastrointestinal disorders rather than metabolic regulation. Therefore, the development of species-specific probiotic formulations for the prevention and management of overweight and obesity in dogs is essential.

CONCLUSIONS

Probiotics represent a promising and practical strategy for the management of dysbiosis-related conditions, including obesity. Studies employing probiotic strains of both canine and non-canine origin have demonstrated measurable improvements in canine health. An effective probiotic formulation aimed at preventing or treating obesity in dogs should be composed primarily of the dominant bacterial phyla found in healthy individuals, but selectively enriched with beneficial taxa. For instance, a higher relative abundance of *Firmicutes* (particularly genera such as *Eubacterium*) and a reduced proportion of *Clostridiales, Roseburia*, and *Megamonas* may be desirable, along with a balanced representation of *Bacteroidetes* genera such as *Bacteroides* and *Prevotella*. Lower abundances of *Actinobacteria*, *Fusobacteria*, and *Proteobacteria* may also contribute to a healthier microbial profile.

It is equally important to emphasize that dietary modification is indispensable for the success of probiotic therapy. Without concurrent adjustments in feeding practices, the therapeutic response may be diminished, delayed, or absent, thereby preventing full resolution of dysbiosis. Finally, it is essential to raise awareness among pet owners and animal health professionals that obesity in companion animals constitutes a significant medical concern, requiring multidisciplinary strategies that integrate nutrition, behavior, and microbiota-based interventions.

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