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The role of the intestinal microbiota in the health and disease of dogs and its importance in the agricultural sector

El papel de la Microbiota intestinal en la salud y enfermedad de los perros y su importancia en el sector agropecuario

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Abstract: The intestinal microbiota is fundamental in the proper nutritional, physiological and immunological functions of domestic dogs involved in the agricultural sector in the care of animals and crops. The presence of a microbial ecosystem is essential to maximize animal health and performance. The present study is a systematic review of the role of the intestinal microbiota in the health and disease of dogs and its importance in the agricultural sector. It is aimed at efforts to reduce the use of antibiotics in domestic dogs and production animals. Gut microbiota has the ability to enhance disease resistance in hosts. Developing a diet with cereal grains high in fermentable carbohydrates, probiotics and prebiotics is a sustainable option to increase microbial diversity and beneficial microbes, which help prevent the incidence of diarrhea and decrease the use of subtherapeutic antibiotics. Finally, it is important to mention that the intestinal microbiota provides greater protection to animals against infections.

Keywords: Microbiota, health, domestic dogs and agricultural sector.

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Resumen: La Microbiota intestinal es fundamental en las funciones nutricionales, fisiológicas e inmunológicas adecuadas de los perros domésticos que intervienen en el sector agropecuario en el cuidado de animales y cultivos. La presencia de un ecosistema microbiano es fundamental para maximizar la salud y el rendimiento animal. El presente estudio, es una revisión sistemática sobre el rol que tiene microbiota intestinal en la salud y enfermedad de los perros y su importancia en el sector agropecuario. Y es con el fin de realizar esfuerzos para reducir el uso de antibióticos en los perros domésticos, y en animales de producción. La microbiota intestinal tiene la capacidad de mejorar en los hospedadores la resistencia a las enfermedades. Desarrollar una dieta con granos de cereales con alto contenido de carbohidratos fermentables, probióticos y prebióticos es una opción sostenible para aumentar la diversidad microbiana y los microbios beneficiosos, que ayudan a prevenir la incidencia de diarrea y disminuir el uso de antibióticos subterapéuticos. Finalmente, es importante mencionar que la microbiota intestinal brinda una mayor protección a los animales ante infecciones.

Palabras clave: Microbiota, salud, perros domésticos y sector agropecuario

Introduction

The intestinal microbiota is the set of microorganisms that inhabit the intestine of dogs, forming a complex and diverse community that performs essential functions for the health of animals such as bacteria, although fungi, parasites, and infectious agents such as viruses can also be found. Advances in DNA sequencing techniques have made it possible to study in greater detail the composition and function of the gut microbiota, which has led to a growing interest in the role it plays in the health and disease of dogs that influences the development of the immune system and may be involved in the onset of disease (Garcia-Mazcorro & Suchodolski, 2017).

An important aspect of the gut microbiota is its diversity and balance; a decrease in gut microbiota diversity is known as dysbiosis, and may be associated with intestinal and systemic diseases. In dogs, gut dysbiosis has been linked to diseases such as inflammatory bowel disease, obesity, diabetes and allergy (Garcia & Dowd, 2011).

Knowledge about the intestinal microbiota in dogs is constantly

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evolving, and several factors have been identified that influence its composition and function. These include diet, antibiotic use, stress, age and genetics. Therefore, understanding the role of the gut microbiota in health and disease in dogs is essential for the development of preventive and therapeutic strategies in the future (Garcia-Mazcorro & Suchodolski, 2017).

Among the research conducted on the role of the intestinal microbiota in dogs, it has been found that the use of probiotics and prebiotics can contribute to improve the composition and diversity of the intestinal microbiota, and reduce the risk of intestinal and systemic diseases. On the other hand, it has been shown that the indiscriminate use of antibiotics can alter the composition of the intestinal microbiota in dogs, which can have negative consequences on their health.

It is important to note that the gut microbiota of dogs can be influenced by a variety of factors, such as diet, lifestyle, and the environment in which they are found. Therefore, understanding the role of the microbiota in health and disease in dogs is critical to developing effective preventive and therapeutic strategies (Kogut & Zhang, 2022).

Likewise, the domestic dog plays an important role in the agricultural sector, where it is used in the care of crops, animals, among others. In this context, the objective of this review is to analyze the role of the intestinal microbiota in the health and disease of dogs, describing its composition and functions, as well as the factors that may influence it.

The canine intestinal microbiota is a complex community of microorganisms that plays a fundamental role in the health and disease of dogs. The diversity and balance of this microbiota are essential for the proper functioning of the digestive system, protection against pathogens and modulation of the immune system (Garcia & Dowd, 2011). In farm animals, homeostasis of the neuroendocrine-immune-microbial systems at the level of the intestinal tract is also required to ensure the health, welfare and highest productive benefit of the animals (Kogut & Zhang, 2022). Advances in DNA sequencing techniques have made it possible to study in greater detail the composition and function of the intestinal microbiota, which has led to a growing interest in the role it plays in health and disease in dogs (Garcia & Dowd, 2011). Likewise, knowledge of the different systems mentioned above will allow the identification, planning and implementation of intervention strategies to improve the intestinal health of farm animals with a holistic approach (Kogut & Zhang, 202).

In production animals due to the rapid growth of modern genetic lines under stressful conditions and high pathogen pressure present in systems where sanitary conditions vary, the challenge is to ensure adequate nutrient absorption and at the same time avoid dysbiosis (Kogut & Zhang, 2022). The study of the intestinal microbiota in dogs has become a field of research of great interest in recent years, since it has been shown that its imbalance may be related to various diseases. According to studies by Garcia-Mazcorro and Suchodolski (2017), altered gut microbiota in dogs has been linked to gastrointestinal diseases, obesity, diabetes, and autoimmune diseases, among others. Therefore, it is essential to maintain a proper balance in the intestinal microbiota of dogs to preserve their health.

Decreased gut microbiota diversity in dogs, known as dysbiosis, may be associated with intestinal and systemic diseases. Gut dysbiosis can cause a variety of diseases in dogs, including gastrointestinal diseases, allergies, obesity, and autoimmune diseases (Suchodolski, 2016). A state of dysbiosis, which can have negative repercussions on intestinal barrier function, in production animals have been associated with poorly digestible diets (Ducatelle et al., 2018), antibiotic use (Guevarra et al., 2019). An indiscriminate use of antibiotics can alter the composition of the intestinal microbiota in dogs, which can have negative consequences on their health (Koppel et al., 2019). Antibiotics such as tetracycline or streptomycin cause changes in the fecal microbiota of 15- and 46-week-old hens after two days of treatment (Videnska et al. 2013). Dysbiosis can be reversed by using additives such as prebiotics and probiotics individually or together (McFarland 2014; Ducatelle et al. 2015).

Studies by Suchodolski (2011), Handl et al. (2011), Middelbos et al. (2010) and Kin et al. (2017), have shown that the composition of the canine intestinal microbiota is complex and diverse, being mainly composed of bacteria, although fungi, viruses and other microorganisms have also been found in smaller proportions. In cattle, diets have impacts on fungal proliferation with microbial changes in the rumen and methane emission levels Pitta et al. 2014).

In the study by Li et al. (2017), the proportion of protein and carbohydrate in the diet was found to have a significant effect on the diversity and composition of gut microbiota in dogs, and dogs with different body conditions had different gut microbiota. For example,

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butyrate, a result of the fermentation of non-digestible carbohydrates by microbiota (Clostridium), plays an important role in intestinal health by being a source of energy for colonocytes and by anti-inflammatory properties (Sassone-Corsi and Raffatellu 2015).

1. Digestion and absorption of nutrients

Studies by Van den Abbeele et al. (2013) and Zhang, et al. (2028) found that certain butyrate-producing Clostridium species of Clostridium cluster XIVa specifically bind to mucins, glycolyzed proteins that line the gut epithelium and form part of the intestinal barrier. The authors suggest that these findings could have important implications for understanding the role of the gut microbiota in animal health and disease and address the relationship between the gut microbiota and nutrient digestion and absorption in dogs. Clostridium present primarily in the cecum and colon facilitate the degradation of undigested starch and cellulose to obtain energy from food (Stanley et al. 2013).

2. Protection against pathogens

Several studies have reported the diversity and species richness of the gut microbiota in healthy and diarrheic calves (Gomez et al., 2015), in horses (Rodriguez et al., 2018), in piglets (Ross et al. 2015), in dogs and cats (Suchodolski, 2011), many of them agree that a gut dysbiosis is involved in the pathogenesis of intestinal diseases and understanding the microbiota allows the development of preventive and therapeutic strategies.

3. Immune system regulation

Zeng et al. (2017) found that a healthy gut microbiota is related to an adequate immune system response. However, a gut dysbiosis is related to chronic inflammation (Rosii et al., 2014: Zeng et al., 2017) that can be reestablished by addition of beneficial bateria (Schmitz et al., 2015), the same that are related to higher density of goblet cells for increased mucin secretion leading to protective mucus (Broom and Kogut 2018). In addition, it has been shown that dysbiosis can affect the production of short-chain fatty acids (SCFA), which are important for gut health. An imbalance in SCFA production can affect intestinal barrier integrity and immune function (Suchodolski, 2016; Garcia-Mazcorro, and Suchodolski, 2017; Minamoto et al. 2012).

Materials and methods

Among these we have:

Sampling and determination of the intestinal microbiota from fecal samples by stool culture, bacteriological biochemical analysis, API, Vitek and MALDI-TOF (Ritchie et al., 2008).

Handl et al. (2011) used mass sequencing of the 16S rRNA gene to investigate the diversity of fecal bacterial and fungal communities in healthy dogs. The most abundant bacterial genera in dogs were Clostridium, Fusobacterium, Bacteroides and Prevotella.

Molecular Biology techniques such as DNA sequencing, which is a powerful tool for the study of the intestinal microbiota in dogs and can provide detailed information on the diversity and abundance of the bacterial species present. Here are some examples of results obtained by DNA sequencing in studies of gut microbiota in dogs Kim et al. (2017).

Li et al. (2017), analyzed the gut microbiota of dogs with different body conditions (obese and lean) and found that the proportion of Firmicutes and Bacteroidetes in the microbiota of obese dogs was higher than in lean dogs, suggesting a possible link between obesity and gut microbiota composition.

Handl et al. (2011), DNA sequencing was used to analyze microbial diversity in the feces of healthy dogs and cats and found a large variety of bacteria and fungi in both groups, suggesting that the gut microbiota of pets is highly diverse and complex.

The interpretation of the results of DNA sequencing techniques in the study of the gut microbiota of dogs is crucial for understanding the relationship between the microbiota and animal health, and for identifying disease prevention and treatment strategies based on modulation of the microbiota (Suchodolski, 2016; Kin, et al. 2017; Rochus et al. 2018).

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3. Result

Modulation of the intestinal microbiota in dogs

Probiotics and prebiotics

In studies by Hernandez et al. (2017), Grzeskowiak et al. (2015), Rochus et al. (2018) and Gomez et al. (2016) describe that probiotics and prebiotics are immunomodulators of the gut microbiota with beneficial effects on gastrointestinal health in dogs.

2. Antibiotics and their effect on the intestinal microbiota

Grønvold et al. (2020) examined the effect of oral administration of amoxicillin on antimicrobial resistance in the intestinal microbiota of dogs. He determined that exposure to amoxicillin resulted in an increase in the abundance of antibiotic resistance genes in the fecal microbiota of dogs.

Giaretta et al. (2019) examined the effect of oral administration of enrofloxacin on the gut microbiota of dogs with diarrhea. He found that exposure to enrofloxacin resulted in significant changes in the composition of the fecal microbiota of dogs.

3. Diet and its influence on the intestinal microbiota

Diet is one of the major factors influencing the composition and function of the intestinal microbiota in dogs. Recent studies have shown that diet can affect the diversity and abundance of gut bacteria in dogs, and that certain components of the diet can have a significant impact on the health and disease of the animal. It has been shown that the inclusion of dietary fiber in the diet of dogs can improve gut microbiota diversity and promote a healthy gut environment. A study by Li et al. (2017) found that dogs on high-protein, low-fiber diets had lower microbial diversity and a higher abundance of potentially pathogenic bacteria compared to dogs consuming high-fiber diets.

Prebiotics are non-digestible compounds that stimulate the growth and activity of beneficial bacteria in the gut, while probiotics are live microorganisms that confer a health benefit to the host. Rochus et al. (2018) found that supplementation with probiotics and prebiotics in the diet of dogs can improve microbial diversity and promote a healthy gut environment, which could have a beneficial effect on the overall health

of the dog.

However, it is important to keep in mind that not all diets are the same and the impact on gut microbiota can vary depending on the source and amount of nutrients. A study by Vázquez-Baeza et al. (2020) found that the composition of the gut microbiota of dogs can vary significantly depending on the food source, such as meat, fish or plant-based foods.

According to Suchodolski et al. (2012), the intestinal microbiota of dogs is composed of a great diversity of microorganisms that play an important role in maintaining the health of the animal; therefore, an imbalance in the composition of the microbiota, can lead to various diseases in dogs, such as: gastrointestinal diseases, allergies and systemic diseases.

Likewise, Ross et al. (2015) described that probiotic supplementation improves the composition of the intestinal microbiota and thus there is better immune function. These findings suggest that modulation of the gut microbiota may be an effective strategy to prevent or treat disease in dogs.

Diet is a key factor in modulating the gut microbiota of dogs. In a study by Li et al. (2017), they found that the ratio of protein to carbohydrate in the diet had a significant effect on the composition of the gut microbiota in dogs. This study suggests that diet may be an important tool for improving gut microbiota health and preventing disease in dogs. In a study by Handl et al. (2011), dogs and cats were found to have a very high fecal microbial diversity, including a large number of bacteria and fungi. These results suggest that the gut microbiota of dogs and cats is complex and that there is much to be learned about its role in health and disease.

Rochus et al. (2018) concluded that probiotic and prebiotic supplementation can have a beneficial effect on animal health, including improved immune function and reduced intestinal inflammation. However, the authors note that more research is needed to fully understand the effects of these treatments on gut microbiota and health in dogs.

The role of the gut microbiota in health and disease in dogs is a constantly evolving topic, and more research is needed to fully

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understand the complexity of the microbiota and how it can be modulated to improve animal health.

4. Conclusions

The intestinal microbiota of dogs plays an important role in dog health and disease. A dysbiosis or imbalance of the microbiota is linked to gastrointestinal disease, obesity, diabetes and immune-mediated diseases. However, the use of probiotics and prebiotics can help improve gut health and reduce the risk of disease. In addition, diet and other environmental factors have been found to have a significant impact on the composition of the microbiota and, therefore, on the health of dogs and this helps their activity in the agricultural sector. Importantly, antibiotic-induced gut dysbiosis can predispose dogs to a variety of health problems, including secondary infections and inflammatory bowel disease. Therefore, responsible antibiotic use and the need for measures to preserve the health of the gut microbiota during and after antibiotic treatment should be considered.

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