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RESEARCH TITLE

Gut Microbiome in Animals: A Review

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Abstract

The gut microbiome is considered a fundamental component of animal biology and plays important roles in nutrition, digestion, metabolism, immunity, intestinal health and productivity. This review aims to collate and critically review the previous studies of gut microbiome in different animal species with special focus on the microbial composition and diversity, factors influencing the microbiome, host-microbe interactions and its relevance to animal health and production. To this end, 20 pre-existing review studies on ruminants, poultry, pigs, companion animals, horses and aquatic animals were reviewed and compared. According to the literature reviewed, there appears to be a great deal of variation in the gut microbial communities of different animal species. Diet, age, genetics, environmental conditions, management practices and health status are major influences on gut microbial communities. Collectively, the evidence suggests that gut microorganisms are involved in nutrient utilization, fermentation, intestinal barrier integrity, immune regulation, resistance to pathogens and efficiency of growth and production. The reviewed studies also highlight the potential of probiotics, prebiotics, dietary manipulation and other microbiome-targeted strategies to improve animal health and productivity. New developments in 16S rRNA sequencing, metagenomics and metabolomics have further increased our knowledge on microbial diversity and host-microbe interactions. To summarize, this review highlights the gut microbiome as an important biological link between nutrition, health, immunity and animal productivity, and calls for more standardized and species-specific research to translate microbiome knowledge into practical and sustainable animal production strategies.

Key Words: Gut microbiome, Gut microbiota, Animals, Animal nutrition, Intestinal health, Immunity, Probiotics, Microbial diversity, Animal productivity, Host–microbe interactions.

عنوان البحث

الميكروبيوم المعوي لدى الحيوانات: دراسة مراجعة

المستخلص

يُعدّ الميكروبيوم المعوي مكوّنًا أساسيًا في بيولوجيا الحيوان، ويؤدي أدوارًا مهمة في التغذية والهضم والتمثيل الغذائي والمناعة وصحة الأمعاء والإنتاجية. تهدف هذه الدراسة إلى جمع الدراسات السابقة المتعلقة بالميكروبيوم المعوي لدى الأنواع الحيوانية المختلفة ومراجعتها نقديًا، مع التركيز بصورة خاصة على تركيب المجتمعات الميكروبية وتنوعها، والعوامل المؤثرة في الميكروبيوم، والتفاعلات بين العائل والميكروبات، ومدى ارتباطها بصحة الحيوان وإنتاجيته. وتحقيقًا لهذه الغاية، جرت مراجعة ومقارنة 20 دراسة مراجعة سابقة تناولت المجترات والدواجن والخنازير والحيوانات الأليفة والخيول والحيوانات المائية. ووفقًا للأدبيات التي تمت مراجعتها، تتباين المجتمعات الميكروبية المعوية بدرجة كبيرة بين الأنواع الحيوانية المختلفة. كما تُعدّ الحمية الغذائية والعمر والعوامل الوراثية والظروف البيئية والممارسات الإدارية والحالة الصحية من أبرز العوامل المؤثرة في هذه المجتمعات. وتشير الأدلة مجتمعةً إلى أن الكائنات الحية الدقيقة في الأمعاء تسهم في الاستفادة من العناصر الغذائية، وعمليات التخمّر، والحفاظ على سلامة الحاجز المعوي، وتنظيم الاستجابة المناعية، ومقاومة مسببات الأمراض، وتحسين كفاءة النمو والإنتاج. وتُبرز الدراسات التي تمت مراجعتها كذلك الإمكانات الواعدة للبروبيوتيك والبريبايوتيك والتعديل الغذائي وغيرها من الاستراتيجيات الموجّهة نحو الميكروبيوم في تحسين صحة الحيوان وإنتاجيته. كما أسهمت التطورات الحديثة في تقنيات تسلسل الحمض النووي الريبوزي الريبوسومي S16، وعلم الميتاجينوميات، وعلم الميتابولوميات، في تعزيز معرفتنا بالتنوع الميكروبي والتفاعلات بين العائل والميكروبات. وخلاصةً، تسلط هذه الدراسة الضوء على الميكروبيوم المعوي بوصفه حلقة وصل بيولوجية مهمة بين التغذية والصحة والمناعة والإنتاجية الحيوانية، وتدعو إلى إجراء مزيد من الدراسات الموحّدة والمراعية لخصوصية كل نوع حيواني؛ من أجل تحويل المعرفة المتعلقة بالميكروبيوم إلى استراتيجيات عملية ومستدامة للإنتاج الحيواني.

الكلمات المفتاحية: الميكروبيوم المعوي، الميكروبيوتا المعوية، الحيوانات، تغذية الحيوان، صحة الأمعاء، المناعة، البروبيوتيك، التنوع الميكروبي، الإنتاجية الحيوانية، التفاعلات بين العائل والميكروبات.

1: Introduction

The gut microbiome is the collective name for the complex and diverse community of microorganisms that live in the gastrointestinal tract of animals. This community is composed of bacteria, archaea, fungi and viruses which continuously exchange with the host and participate in the digestion, utilization of nutrients, metabolism, regulation of immune system, development of the intestine and protection from pathogens [1]. Accordingly, the gut microbiome is now recognized as a vital functional component of animal physiology and health.The composition and activity of the gut microbiome varies greatly between animal species and is influenced by a range of factors including diet, age, genetics, environmental conditions, management practices and health status. These factors can alter microbial diversity and metabolic activity and subsequently affect animal growth, nutrient utilization and physiological performance. For example, in ruminants, ruminal microorganisms play a key role in the fermentation of complex plant carbohydrates and supply metabolites that make a substantial contribution to the animal's energy supply [2,4].The gut microbiome also plays an important role in maintaining the integrity of the gut and in regulating the immune system. [5].In contrast, dysbiosis or disturbance of the normal microbial balance may compromise intestinal health and increase susceptibility to disease [3,6].Recent developments in molecular biology, 16S rRNA sequencing, metagenomics and other omics technologies have greatly improved our knowledge of animal gut microbiomes. These technologies allow researchers to study microbial composition, functions and host interactions [1]. At the same time, there has been a growing interest in microbiome-based nutritional strategies such as probiotics, prebiotics, dietary manipulation and functional feed additives as potential approaches to improve animal health and production.

2. Previous Review Studies on Gut Microbiome in Animals

The gut microbiome is a complex and dynamic ecology of microorganisms such as bacteria, archaea, fungus, viruses and protozoa dwelling in different regions of the digestive tract. These bacteria strongly affect how the animal host interacts with its diet and environment. These are extremely necessary for digestion, metabolism of nutrients, growth of the intestines, control of the immune system, elimination of infections and maintenance of the body's balance[7]. Recent research has revealed that the gut microbiome is more than a collection of microbes. It is an important part of an animal's body, which can change its metabolism, health, ability to adapt and productivity.The gut microbiome is very different depending on where you are in the digestive tract and the type of animal. Microbial diversity and abundance are greatly affected by factors such as the structure of the digestive tract, diet, age, genetics, environmental conditions, management techniques and the physical state of the person. In ruminants, rumen microorganisms are important in fermenting plant-derived carbohydrates and breaking down intricate feed components to metabolites usable by the host. This microbial fermentation affects the availability of nutrients and feed efficiency. It is also linked to methane production and environmental protection.

[8].

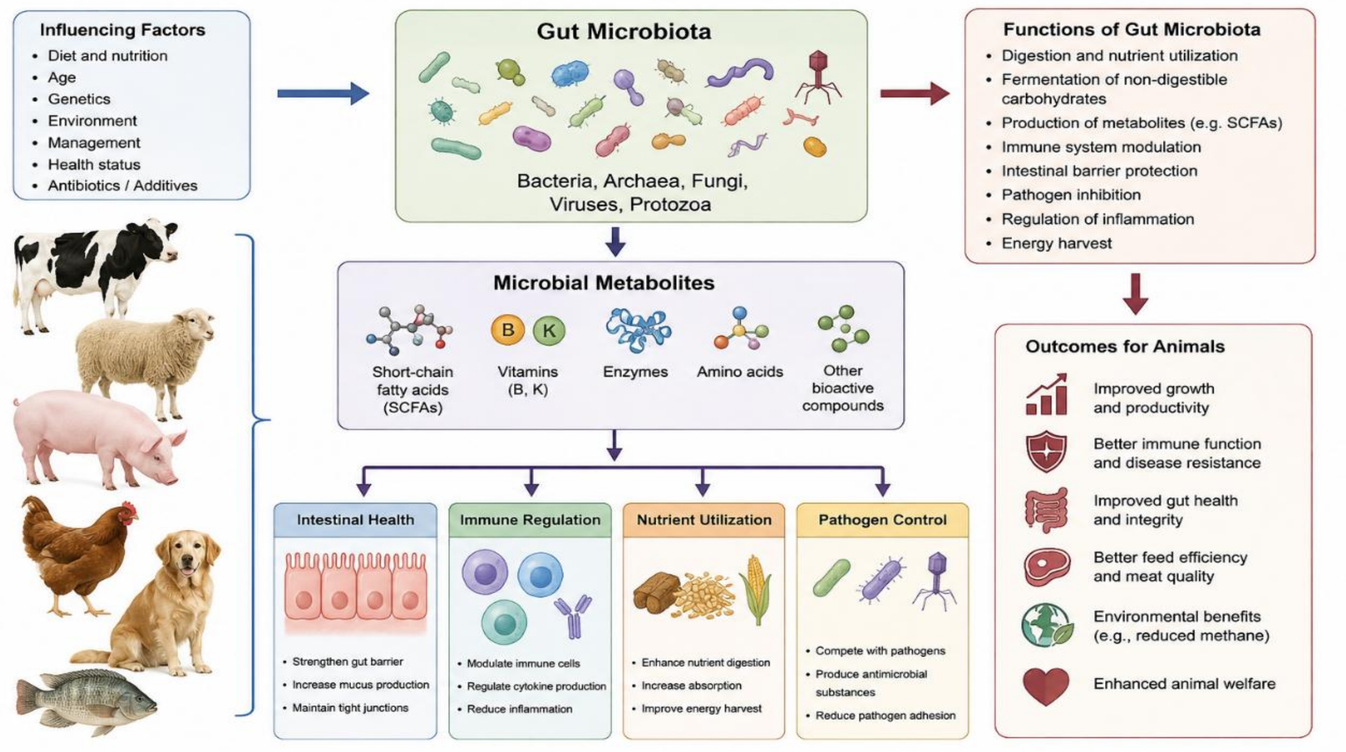

Figure 1. The role of gut microbiota in animal health and productivity.

The intestinal microbiome also plays an equally important role in nutrient digestion , intestinal barrier function , immune development and resistance against pathogenic microorganisms in monogastric animals such as pigs and poultry . The microbial community is able to produce bioactive metabolites, particularly short-chain fatty acids (SCFAs), which participate in the maintenance of epithelial integrity and regulation of inflammatory and immune responses. Disturbances in microbial composition, often referred to as dysbiosis, can adversely affect intestinal health and result in reduced growth, impaired nutrient utilization, increased susceptibility to disease and lower production performance [9].Diet is one of the most important determinants of the structure and function of the animal gut microbiome. Dietary fiber, protein, carbohydrates, fats, minerals and various feed additives can cause alterations in microbial populations and their metabolic activities. There is growing evidence that nutritional strategies aimed at modulating the gut microbiome may offer important opportunities to improve animal health and productivity. Thus, probiotics, prebiotics, synbiotics, and postbiotics have attracted significant interest as potential alternatives or adjuncts to conventional antimicrobial strategies. These therapies can trigger beneficial bacteria, enhance the intestinal barrier function, alter immunological responses and promote the consumption of nutrients [10].The link between the gut microbiota and animal health is also very essential from a production perspective. A stable, functionally diversified microbial population can increase feed conversion, growth performance, disease resistance and animal wellbeing. Conversely, environmental stress, rapid dietary changes, viral illnesses, exposure to antimicrobials and poor management may alter microbial homeostasis. Studies on farm animals revealed that diversity of gut microbiota is connected with health, immunity, behavior, stress reactions and welfare, suggesting that characteristics of the microbiome could be used as biological markers of the health condition of animals .Another important advancement in this field is the increasing use of high-throughput sequencing and metagenomic methods. Methods such as 16S rRNA gene sequencing, shotgun metagenomics, metatranscriptomics, metabolomics and other multi-omics methods have expanded our ability to describe microbial communities and study their functional activities. These methodologies are helping scientists to progress from microbial taxonomic identification to microbial roles, host-microbe interaction and metabolic pathways. Recent reviews emphasize that future animal microbiome studies will increasingly depend on multi-omics approaches, standardized databases, and targeted microbiome interventions to improve animal health, production efficiency, and sustainability.Overall, the available literature shows that the gut microbiome is an integral part of animal biology and an important research area linking nutrition, immunity, metabolism, disease resistance, welfare, productivity and environmental sustainability. However, there are large differences between animal species, and the mechanisms by which specific microbial communities influence host physiology are not fully understood. Thus, a comparative analysis of previous studies is useful to identify common patterns, species-specific traits, main research gaps, and promising microbiome-based approaches. The table below summarizes 20 selected review studies that address the gut microbiome of different animal species and highlight their principal research

Table 1. Summary of Previous Review Studies on Gut Microbiome in Animals

o.N	Study focus	Animal	Main findings
1	Gut microbiome overview	Various animals	Microbiota contributes to digestion, immunity, and animal health.
2	Gut microbiota comparison	Ruminants & monogastrics	Microbial composition differs according to digestive physiology.
3	Microbiota and animal welfare	Farm animals	Gut microbiota is associated with health, stress, and welfare.
4	Microbiota and intestinal barrier	Livestock	Microbial metabolites support intestinal barrier integrity.
5	Gut yeasts	Livestock	Yeasts may influence digestion and gastrointestinal health.
6	Microbiome development	Calves	Early diet strongly affects microbial colonization and development.
7	Microbiota and immunity	Young ruminants	Gut microbes interact with intestinal development and immunity.
8	Microbiome sequencing	Ruminants	16S rRNA sequencing improves characterization of gut microorganisms.
9	Microbiota and methane	Ruminants	Dietary manipulation can modify rumen microbes and methane production.
10	Essential oils and microbiota	Ruminants	Essential oils can modify rumen fermentation and microbial activity.
11	Microbiota and meat quality	Livestock	Gut microbes may affect metabolism and meat-quality traits.
12	Microbiota and meat quality	Ruminants	Microbial metabolism is linked to fat deposition and meat characteristics.
13	Poultry gut microbiota	Chickens	Microbiota modulation can improve growth, health, and productivity.
14	Genetic factors	Chickens	Host genetics and environment influence gut microbial composition.
15	Gut microbiota and production	Pigs	Microbes affect nutrient utilization, immunity, and growth performance.
16	Diet and microbiome	Dogs & cats	Dietary composition strongly influences gut microbial communities.
17	Microbiome and health	Dogs & cats	Microbial imbalance is associated with obesity and chronic disorders.
18	Equine microbiome	Horses	Gut microbes participate in fermentation, nutrition, and immune regulation.
19	Fish gut microbiome	Aquaculture fish	Gut microbiota plays an important role in immunity and fish health.
20	Probiotics and gut health	Finfish	Probiotics can improve microbial balance, immunity, and disease resistance.

3: Composition and Diversity of the Animal Gut Microbiome

The gut microbiome of animals is a highly diverse microbial ecosystem, the composition of which varies according to the species of animal, the region of the gastrointestinal tract, age, diet and environmental conditions . Bacteria are the dominant group of micro-organisms, but other micro-organisms such as archaea, fungi, viruses etc also contribute to the general microbial community. In bacterial groups, Firmicutes, Bacteroidetes, Proteobacteria and Actinobacteria are commonly found in the gastrointestinal tracts of many domestic animals, but their relative abundance differ widely among species [8].Ruminants possess a rumen, which houses a distinctive community of microbes specialized for anaerobic fermentation. Bacteria, archaea, protozoa and fungi together degrade plant structural carbohydrates, and produce volatile fatty acids. The abundance and activity of these microorganisms are strongly affected by diet and feeding conditions, thus the rumen microbiome is especially important for feed digestion and energy metabolism [9].In monogastric animals such as pigs and poultry, most of the microbial populations are present in the distal gastrointestinal tract where undigested components of the diet provide substrates for microbial fermentation. These microorganisms are involved in the metabolism of nutrients, in the production of short-chain fatty acids, in the maintenance of intestinal integrity and in the protection of pathogenic organisms. These communities are subject to considerable change in early life as the gastrointestinal tract develops and is increasingly colonized by microorganisms [10].Microbial diversity is also an important indicator of the stability of gut ecosystems . A diverse microbial community can provide functional redundancy, where different microorganisms can perform similar metabolic functions, and help the ecosystem be stable in the face of diet or environmental changes . However, more diversity does not always translate into better health, as the functional properties and interactions of microbial populations are also important. Thus, recent work has increasingly moved away from measures of diversity [8,11] and toward the composition and function of microbes.The characterization of animal gut microbiomes has been greatly improved by advances in 16S rRNA sequencing, metagenomics, metatranscriptomics, and metabolomics. These approaches enable researchers to characterize microbial taxa and to study their functional genes, metabolic pathways and interactions with the host. This information is crucial to understand how differences in microbiome composition are linked to nutrition, immunity, disease resistance, growth, and productivity of animals [11].

4: Results and Discussion of the Reviewed Literature

Analysis of the 20 studies reviewed shows that the gut microbiome plays a central role in animal digestion, nutrition, immunity, health, growth and productivity. Different animal species were employed, but some recurring themes were discovered in the studies reviewed: the importance of microbial diversity, host-microbe interactions, dietary impacts and microbial metabolites in maintaining intestinal homeostasis [12,13].Another more consistent observation was the considerable effect of nutrition on the composition and activities of the gut microbiota. Dietary substrates may influence the availability of nutrients for microbial growth and fermentation, and hence modify microbial diversity and metabolic pathways. The rumen microbiome is especially important in ruminants since microbes breakdown plant structural carbohydrates and generate metabolites that contribute to host energy metabolism [13,14]. Recent multi-omics investigations have further shown complicated relationships between diet, host and rumen microbes, stressing the significance of microbial activities rather than microbial composition solely [15].The study of literature also identified a significant correlation between gut microbiota and the health and immunity of animals. A healthy microbial community may participate in the integrity of the intestinal barrier, modulation of immune responses and inhibition of dangerous microorganisms. Conversely, a disturbance of microbial balance may increase the vulnerability for intestinal disorders and severely effect the animal health [12,16]. Probiotic supplementation has also been described to alter intestinal microbial communities and immune status in monogastric animals with potential benefits for digestion growth and disease resistance [17].Another important finding is the link between gut microbiota and the growth and productivity of animals. Microbial communities are associated with nutrient transformation and energy metabolism, which could affect feed efficiency and growth. The existence of a core gut microbiota has been linked to animal development and metabolism, indicating that particular microbial communities may be responsible for stable physiological and productive characteristics in individuals [18].The gut microbiome may also affect meat quality in livestock . Microbial activity can influence host metabolism, lipid deposition, oxidative processes and other physiological pathways associated with meat characteristics. Therefore, manipulation of gut microbial communities may be a promising approach to improve not only the animal growth, but also the quality of animal-derived food products [19].The reviewed studies further emphasized the possible role of probiotics and microbial interventions. Probiotic microorganisms may improve the microbial balance thru competitive exclusion of pathogens, alteration of intestinal conditions and stimulation of the host immune response. Probiotic supplementation in ruminants has been associated with improved nutrient digestibility, feed efficiency, growth and production, but the response depends on the microbial strain, dose, diet, animal breed and management conditions [20]. Similar benefits have been reported for multistrain probiotics applied to ruminants, poultry and pigs although not all studies show consistent results [21].Microbial metabolites are another key mechanism linking the microbiome and animal physiology. For example, gut microbiota-derived metabolites are involved in host metabolic and physiological processes in pigs, and probiotics can alter the production of these metabolites [22]. This supports the idea that microbial functional activity and microbial metabolites may be more informative than the mere abundance of single microbial species.Overall the evidence reviewed suggests that the gut microbiome is a major biological link between nutrition, intestinal health, immunity, growth, productivity and food quality. However, there is a large variation between species of animals and experimental conditions. Different diets, ages, breeds, environments, microbial strains, sequencing methods and experimental designs might result in different microbiome responses. Therefore, future investigations should focus on standardized methodologies, functional microbiome analysis, and controlled interventions to determine causal relationships and to develop reliable microbiome-based strategies for animal production

4. Conclusion

This review highlights the gut microbiota as an important feature of animal health and productivity. Its composition and activity are greatly modified by diet, age, genetics, environment and management, its key roles are digestion, nutrient metabolism, immunological modulation and disease defense. Microbiome-targeted techniques such as probiotics, prebiotics and nutritional manipulation offer potential opportunities to improve animal performance and support sustainable production. Future work should focus on identifying functional microbial communities and creating accurate and species specific strategies for microbiome management.

5: References

[1] O'Hara, E., Neves, A. L. A., Song, Y., & Guan, L. L. (2020). The role of the gut microbiome in cattle production and health: Driver or passenger? *Annual Review of Animal Biosciences, 8*, 199–220. https://doi.org/10.1146/annurev-animal-021419-083952.

[2] Cholewińska, P., Czyż, K., Nowakowski, P., & Wyrostek, A. (2020). The microbiome of the digestive system of ruminants—A review. *Animal Health Research Reviews, 21*(1), 3–14. https://doi.org/10.1017/S1466252319000069.

[3] Chen, S., Luo, S., & Yan, C. (2022). Gut microbiota implications for health and welfare in farm animals: A review. *Animals, 12*(1), 93. https://doi.org/10.3390/ani12010093.

[4] Ma, J., Piao, X., Mahfuz, S., Long, S., & Wang, J. (2022). The interaction among gut microbes, the intestinal barrier and short chain fatty acids. *Animal Nutrition, 9*, 159–174. https://doi.org/10.1016/j.aninu.2021.09.012.

[5] Fiebiger, U., Bereswill, S., & Heimesaat, M. M. (2016). Dissecting the interplay between intestinal microbiota and host immunity in health and disease: Lessons learned from germfree and gnotobiotic animal models. *European Journal of Microbiology and Immunology, 6*(4), 253–271. https://doi.org/10.1556/1886.2016.00036.

[6] Perlman, D., Martínez-Álvaro, M., Moraïs, S., Altshuler, I., Hagen, L. H., Jami, E., Roehe, R., Pope, P. B., & Mizrahi, I. (2022). Concepts and consequences of a core gut microbiota for animal growth and development. *Annual Review of Animal Biosciences, 10*, 177–201. https://doi.org/10.1146/annurev-animal-013020-020412.

[7] Pilla, R., & Suchodolski, J. S. (2021). The gut microbiome of dogs and cats, and the influence of diet. *Veterinary Clinics of North America: Small Animal Practice, 51*(3), 605–621. https://doi.org/10.1016/j.cvsm.2021.01.002.

[8] Kauter, A., Epping, L., Semmler, T., Antão, E.-M., Kannapin, D., Stoeckle, S. D., Gehlen, H., Lübke-Becker, A., Günther, S., Wieler, L. H., & Walther, B. (2019). The gut microbiome of horses: Current research on equine enteral microbiota and future perspectives. *Animal Microbiome, 1*, 14. https://doi.org/10.1186/s42523-019-0013-3.

[9] Ding, S., Yan, W., Ma, Y., & Fang, J. (2021). The impact of probiotics on gut health via alternation of immune status of monogastric animals. *Animal Nutrition, 7*(1), 24–30. https://doi.org/10.1016/j.aninu.2020.11.004.

[10] Lambo, M. T., Chang, X., & Liu, D. (2021). The recent trend in the use of multistrain probiotics in livestock production: An overview. *Animals, 11*(10), 2805. https://doi.org/10.3390/ani11102805.

[11] Reuben, R. C., Elghandour, M. M. M. Y., Alqaisi, O., Cone, J. W., Márquez, O., & Salem, A. Z. M. (2022). Influence of microbial probiotics on ruminant health and nutrition: Sources, mode of action and implications. *Journal of the Science of Food and Agriculture, 102*(4), 1319–1340. https://doi.org/10.1002/jsfa.11643.

[12] Vasquez, R., Oh, J. K., Song, J. H., & Kang, D.-K. (2022). Gut microbiome-produced metabolites in pigs: A review on their biological functions and the influence of probiotics. *Journal of Animal Science and Technology, 64*(4), 671–695. https://doi.org/10.5187/jast.2022.e58.

[13] Chen, B., Li, D., Leng, D., Kui, H., Bai, X., & Wang, T. (2022). Gut microbiota and meat quality. *Frontiers in Microbiology, 13*, 951726. https://doi.org/10.3389/fmicb.2022.951726.

[14] Du, Y., Gao, Y., Hu, M., Hou, J., Yang, L., Wang, X., Du, W., Liu, J., & Xu, Q. (2023). Colonization and development of the gut microbiome in calves. *Journal of Animal Science and Biotechnology, 14*, 46. https://doi.org/10.1186/s40104-023-00856-x.

[15] Amin, N., & Seifert, J. (2021). Dynamic progression of the calf's microbiome and its influence on host health. *Computational and Structural Biotechnology Journal, 19*, 989–1001. https://doi.org/10.1016/j.csbj.2021.01.035.

[16] Tardiolo, G., La Fauci, D., Riggio, V., Daghio, M., Di Salvo, E., Zumbo, A., & Sutera, A. M. (2025). Gut microbiota of ruminants and monogastric livestock: An overview. *Animals, 15*(5), 758. https://doi.org/10.3390/ani15050758.

[17] Malmuthuge, N., & Guan, L. L. (2017). Understanding the gut microbiome of dairy calves: Opportunities to improve early-life gut health. *Journal of Dairy Science, 100*(7), 5996–6005. https://doi.org/10.3168/jds.2016-12239.

[18] Cammack, K. M., Austin, K. J., Lamberson, W. R., Conant, G. C., & Cunningham, H. C. (2018). Tiny but mighty: The role of the rumen microbes in livestock production. *Journal of Animal Science, 96*(2), 752–770.

[19] Weimer, P. J. (2015). Redundancy, resilience, and host specificity of the ruminal microbiota: Implications for engineering improved ruminal fermentations. *Frontiers in Microbiology, 6*, 296.

[20] Moraïs, S., & Mizrahi, I. (2019). The road not taken: The rumen microbiome, functional groups, and community states. *Trends in Microbiology, 27*(6), 538–549.

[21] Liu, L., Wu, P., Guo, A., Yang, Y., Chen, F., & Zhang, Q. (2023). Research progress on the regulation of production traits by gastrointestinal microbiota in dairy cows. Frontiers in Veterinary Science, 10, 1206346. https://doi.org/10.3389/fvets.2023.1206346.

[22] Liu, Y., et al. (2023). Recent advances in the use of bacterial probiotics in animal production. Animal Health Research Reviews, 24(2), 41–53. https://doi.org/10.1017/S1466252323000063.