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REVIEW ARTICLE

Eubiotics Improve Gut Health and Overall Production in Animals by Reducing Pathogenic Bacteria

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ABSTRACT

Eubiotics, which include prebiotics, probiotics, synbiotics, postbiotics, and organic acids, have been used in poultry and livestock production for a long time. These eubiotics play a pivotal role in sustainable livestock and poultry production by improving gut health, enhancing immune responses, and improving overall animal performance. These eubiotics are effective against a wide range of bacteria, fungi, toxins, and other pathogens. In these eubiotics, there are adequate substitutes for antibiotic-resistant bacteria (AAD), thereby reducing the risk of treatment failure due to the transfer of resistance genes. Among eubiotics, probiotics hold the most tremendous significance. Probiotics encompass non-pathogenic strains of various organisms. The beneficial activities of probiotics include improving gut microbial balance (gut homeostasis), as well as immune-modulatory and anti-inflammatory effects against gut inflammation or chronic low-grade inflammation. Additionally, they resist pathogens in the gut, thereby enhancing animal performance through improved feed conversion ratio (FCR), increased body weight gain, and reduced mortality. Similarly, other eubiotics serve to strengthen gut health and ultimately lead to ornamental animal performance. Thus, objectives of this review are to look into the detailed description of eubiotics, composition, and benefits, which render these a superior alternative to antibiotics in animal feed. Moreover, it is hoped that this article will be of interest to both scientists and field veterinarians as it aims to improve the gut health of animals, thereby enhancing productivity and overall performance.

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INTRODUCTION

Eubiotics, a term derived from the Greek "eubiosis," means "healthy life". Eubiotics are feed additives designed to maintain a healthy balance of gut microbiota, playing a pivotal role in sustaining and improving gut health, as well as enhancing immune responses and overall animal performance, thereby contributing to overall well-being (Stefańska *et al.*, 2022; Ali *et al.*, 2024). The amplified regular use of antibiotics in poultry and livestock production has led to bacterial antibiotic resistance (Mithuna *et al.*, 2024; Absamatovna, 2024; Munir *et al.*, 2025). The spread of AAD from animal products to humans increases the risk of treatment failure due to the transfer of resistance genes (Yaqoob *et al.*, 2022). The development of antibiotic resistance and antibiotic residual effects in poultry products intended for human consumption has led to an increased use of eubiotics as alternatives to antibiotics in livestock and poultry production (Patterson and Burkholder, 2003). Due to ban on AGPs (antibiotic growth promoters) in feed in many countries including European Union (EU) and

OECD (Organisation for Economic Co-operation and Development countries) like Mexico, New Zealand and South Korea (Burel, 2012; Maria Cardinal *et al.*, 2019), eubiotics are more popular in animal feed industries. This review article will focus on a detailed description of eubiotics, examining their diversity, composition, and benefits, which make them a superior alternative to antibiotics in animal feed. This article will be of interest to both scientists and field veterinarians, as it aims to improve the gut health of animals, thereby enhancing productivity and overall performance. In this perspective, important eubiotics, along with their major components and primary effects, are summarized in Table 1.

Eubiotics formation: Eubiotics, comprising essential oils, organic acids, prebiotics, probiotics, and postbiotics, collectively enhance gut health (Wegh *et al.*, 2019; Scott *et al.*, 2022; Anbalagan *et al.*, 2024; Asghar *et al.*, 2024). For example, Prebiotics such as Eubikor have potential effects on the activity of obligatory microflora, reducing the variations among the intestinal microflora and hence reduce the duration of pathogen elimination (Smirnov *et al.*, 2016). Probiotics, including potential species and fermented foods, are not only essential for maintaining gut health through multiple organs but also for alleviating gut diseases (Malaviya *et al.*, 2019; Anbalagan *et al.*, 2024). Postbiotics have immunomodulatory and post-clinical impacts, improving the overall health of animals, and also have the potential to alleviate clinical symptoms in diseases. They are composed of inanimate microorganisms (Wegh *et al.*, 2019; Moradi *et al.*, 2024). Nowak *et al.* (2017) have described that essential oils, exogenous enzymes, herbs, organic acids, prebiotics, and postbiotics are examples of eubiotics.

Contribution to gut health: In terms of gut health, the contributions of eubiotics have been highlighted about gut microbiota, immune system regulation, and the production of metabolites for the well-being of the host (Fathi *et al.*, 2017; Nourizadeh *et al.*, 2022). Probiotics, through both direct and indirect mechanisms, influence colonizing microbes, inhibit the attachment of pathogens, and promote a healthier gut physiology (Sanders, 2011). Postbiotics have been proven to enhance gut health by improving the gut barrier, supporting antimicrobial activity against pathogens, and reducing inflammation (Cortés-Martín *et al.*, 2020; Li HY *et al.*, 2021; Scott *et al.*, 2022; Zhou *et al.*, 2024b).

Table 1: Summary of Eubiotics being used in animal/poultry production

Eubiotics	Definition	Functions/Benefits	Main Ingredients/ bacteria	Common Sources	References
Probiotics	Live microorganisms with health benefits	• Strengthen gut barrier, • Inhibit pathogens • Modulation of the intestinal microbiome, Enhancement of the immune system, and modulation of immunity • Enhance gut health, prevent diseases • Improvement of anti-inflammatory • Anti-cancer properties.	• *Lactobacilli* spp. • *Bifidobacterium* • *Bacilli* spp.	• Yogurt • Soy mil • Fermented tea • Pickles • Olives • Dark chocolates	Ciptaan *et al.* (2024), Harat and Pourjafar (2025)
Prebiotics	Non-digestible food ingredients that stimulate beneficial bacteria	• Improve gut health • Stimulate beneficial bacteria, • Improve bowel function, • Economic advantages	• FOS • Inulin • GOS • Polydextrose • Lactulose • Selectively fermented ingredients	• Breast milk • Soybeans • Raw oats • Plant-derived oligosaccharides	Smirnov *et al.* (2016), Zommiti and Ferchichi (2021) Liu *et al.* (2023), Sankarganesh *et al.*, (2024)
Synbiotics	Combination of probiotics and prebiotics	• Enhance survival • Support beneficial microorganisms	• Prebiotics • Probiotics	• Various dietary supplements	Pattanaik *et al.*, (2022); Li *et al.*, (2023); Anbalagan *et al.*, (2024),
Postbiotics	Non-viable bacterial products or metabolic byproducts with health benefits	• Strengthen gut barrier, • Improve gut health • Reduce inflammation • Modulate the immune system • Remain Stable in various delivery systems • Promote antimicrobial activity • Enhance the survival and activity of beneficial microorganisms	• SCFAs • EPS • Functional proteins • Muropeptides • Metabolites • Teichoic acids	• SCFAs • EPS • Metabolites • Teichoic acids • Various dietary supplements	Wegh *et al.* (2019); Scott *et al.* (2022), Gurunathan *et al.* (2024); Moradi *et al.* (2024)
Organic Acids	Compounds that lower gut pH and inhibit pathogens	• Improve gut health • Enhance nutrient absorption • Inhibit pathogens	Butyrate, propionate, acetate	fruits (like lemons, apples, and grapes), vegetables (like spinach and kale), fermented foods (like yogurt and sauerkraut), and vinegar),	Sharifuzzaman and Austin (2017); Ringø *et al.* (2020); Yaqoob *et al.* (2021); Zommiti and Ferchichi (2021); Zaidi *et al.* (2023); Liu *et al.* (2023); John *et al.* (2024).

Benefits in Animal Nutrition: Eubiotics, used as water and/or feed additives, promote gut health in poultry and animals, and control enteric pathogens, including Clostridium perfringens (John *et al*., 2024) and Salmonella spp. (Neveling *et al*., 2020; Sabry *et al*., 2021; Mehmood *et al*., 2023), *Escherichia coli* (Sabry *et al*., 2021). Widely used in poultry, probiotics regulate pathogenic intestinal microflora, inhibit and treat intestinal disorders, and boost growth by replacing antibiotics. The encapsulation of probiotics has been proven effective in preserving their stability and improving animal intestinal health (Gyawali, 2024).

Role in Reducing Antibiotic Use: Eubiotics, particularly postbiotics, have the potential to reduce antibiotic use by conferring health benefits without requiring living cells to induce health effects (Scott *et al*., 2022; Ahmad *et al*., 2024). In animal production, probiotics serve as alternatives to antibiotics, with the potential to replace antibiotics for controlling pathogens and improving gut health (Rashid *et al*., 2023; Gyawali, 2024). Hence, it is concluded that eubiotics, including per-, pro-, and postbiotics, serve as an alternative to antibiotics, playing a crucial role in maintaining gut health and improving nutritional efficiency. Gut health is improved through the regulation of gut microbiota, strengthening of the intestinal barrier, and overall well-being of the animals, which is an additional potential benefit of eubiotics in replacing antibiotics in animal nutrition.

In poultry, eubiotics such as probiotics, prebiotics, and organic acids are utilized to enhance gut health, improve immune response, and increase growth performance (Yaqoob *et al*., 2021; Zaidi *et al*., 2023; Saeed *et al*., 2023; Rashid *et al*., 2024; John *et al*., 2024). In aquaculture, probiotics are used to prevent diseases and improve gut health in fish and shellfish (Sharifuzzaman and Austin, 2017; Ringø *et al*., 2020), while in livestock, probiotics and prebiotics are used to modulate gut microbiota, enhance immune function, and improve overall health and productivity (Zommiti and Ferchichi, 2021; Liu *et al*., 2023; Xue *et al*., 2024; Naqvi *et al*., 2025). Eubiotics encompass a variety of compounds, each with specific properties and benefits. These include probiotics, prebiotics, postbiotics, and organic acids.

Main types of eubiotics

Probiotics: Probiotics are natural growth promoters (Kalia *et al*., 2022). Probiotics, comprising non-pathogenic strains of various organisms (Table 2), are valuable for the host in adjusting the gut microbiota and supporting gut mucosal barrier functions, as well as resisting pathogens in the gut (Szajewska *et al*., 2022). The beneficial activities of probiotics, summarized graphically in Fig. 1, are related to improved gut microbial balance (gut homeostasis), as well as immune-modulatory and anti-inflammatory effects against gut inflammation or chronic low-grade inflammation (Cristofori *et al*., 2021). The use of prebiotics and eubiotics (synbiotics) has yielded a similar range of beneficial effects; however, slight variations in action are sometimes observed, depending on the source of the parent organism and/or the compounds. The primary target of prebiotics and eubiotics (synbiotics) is the optimization of the hindgut microbiota (Fig. 3). For example, when supplemented in the diets of humans and animals, polyphenols, now classified as prebiotics, lead to the production of intermediate metabolites by gut bacteria. Some of these intermediate metabolites may exhibit prebiotic-like effects on the gut microbiota, enhancing the growth of bacteria and promoting the growth of certain probiotic bacteria (Plamada and Vodnar, 2021; Mehmood *et al*., 2023; Chen *et al*., 2024). Unabsorbed phenolics in the diet and their metabolites exhibit bacteriostatic or antimicrobial properties by inhibiting pathogenic bacteria while promoting the growth of beneficial bacteria (Marín *et al*., 2015; Bae *et al*., 2022; Gade and Kumar, 2023).

Table 2: Various agents being used as probiotics and their main effects

Agent used as Probiotics	Properties	References
Lactobacillus acidophilus, L. bulgaricus, L. casei, L. crispatus, L. gasseri, L. paracasei, L. reuteri, L. rhamnosus, L. plantarum	• Antimicrobial • Antiviral, and • Immunomodulatory properties	Jin *et al.* (1998), Huang *et al.* (2004), Salarmoini and Fooladi (2011), Vineetha *et al.* (2017); Kullar *et al.* (2023), Bakhsh *et al.* (2024)
Lactobacillus and *Saccharomyces* Spp.	• Effective against AAD	Kopacz and Phadtare (2022)
Bacillus cereus, B. subtilis, B. coagulans, B. clausii, B. licheniformis, B. pumilus, B. polyfermenticus,	• Antimicrobial, • Anticancer • Antioxidant, • Vitamin Production Properties • Higher body weight gain	Jin *et al.* (1996; 1998), Jahromi *et al.*(2017), Lee *et al.* (2019), Usman *et al.* (2024), Alqahtani *et al.* (2024)
Lactic acid bacteria (LAB)	• Fermented foods - the most common natural source of potentially probiotic strains of LAB. • Significant health Benefits including • Reduced risk of type 2 diabetes and cardiovascular diseases • Beneficial metabolomic profile	Aathouri *et al.* (2001), Marco *et al.* (2017); Ringø *et al.* (2020), Taylor *et al.* (2020) Cunningham *et al.* (2021) Srifani *et al.* (2024), Phupaboon *et al.* (2024)
Lactobacilli and Bifidobacterium	• Anti-atherosclerotic agents • Antidiabetic strains	Costeloe *et al.* (2016), Liu *et al.* (2020), Abdi *et al.* (2022), Lu *et al.* (2024), Cheng *et al.* (2024)
Aspergillus spp.	Effective against pathogenic bacteria	Lee *et al.* (2006)
Aspergillus oryzae	Enhance Performance	Saleh *et al.* (2014)
Aspergillus niger		Zamanizadeh *et al.* (2021)
Aspergillus awamori		Sharma *et al.* (2022)
Lactobacillus sporogenes	Higher body weight gain	Mohan-Kumar and Christopher (1998)
Lactobacillus plantarum,	Good FCR, Body weight gain	Vineetha *et al.* (2017)

The antifungal activity of probiotics has been proven in published literature. Recently, Mahjoory *et al*. (2023) reported that probiotics prepared from Limosilactobacillus fermentum strains are more effective against toxigenic, aflatoxin-producing Aspergillus species. Similarly, Prathivadi Bayankaram and Sellamuthu (2016) reported antifungal and anti-aflatoxigenic activity of probiotics against *Aspergillus flavus* and *Aspergillus parasiticus*. Probiotics are also effective against Candida spp. and candidiasis (Ribeiro *et al*., 2020; Andrade *et al*., 2022; Contaldo *et al*., 2023). Similarly, lactic acid bacteria (LAB) are effectiveness against *Penicillium chrysogenum, Aspergillus flavus, A. niger* and *A. parasiticus* (Abbaszadeh *et al*., 2015).

The gut microbiome is an integral part of the living being colonized with commensal bacteria right from birth (Bellais *et al*., 2022; Pattanaik *et al*., 2022; Yun and Hyun, 2023; Hammerhøj *et al*., 2024). The propagation of Élie Metchnikoff's "theory of longevity" in 1907 brought these beneficial microbes to the attention of researchers, thus, led to the establishment of an entirely new area of research involving probiotics, later expanding to include the concepts of prebiotics (Zommiti and Ferchichi, 2021; Liu *et al*., 2023; Sankarganesh *et al*., 2024), synbiotics (Abdel-Fattah and Fararh, 2009; Pattanaik *et al*., 2022; Li *et al*., 2023; Anbalagan *et al*., 2024), and eubiotics (Stefańska *et al*., 2022; Duque *et al*., 2025). Probiotics are comprised of live bacteria, yeast, or fungi that, when fed or offered in sufficient amounts, promote health benefits (Zommiti and Ferchichi, 2021; Zaidi *et al*., 2023; Kalita *et al*., 2023; Susalam *et al*., 2024). These benefits are now well recognized for their advantages towards human and animal health and well-being (Jahromi *et al*., 2017; Pattanaik *et al*., 2022; Bakhsh *et al*., 2024). Probiotic-based dietary prophylactics and therapies are being proposed to prevent and treat a variety of gastrointestinal disorders. Furthermore, these are also considered an inexpensive and environmentally friendly alternative to antibiotics. Probiotics are considered safe and affordable for treating AAD and other gastrointestinal disorders (Kopacz and Phadtare, 2022; Rashid *et al*., 2023).

Due to their associated health benefits, usually, *Lactobacillus* spp. (Reid 1999; Reid, 2006; Abbasi *et al*., 2022; Yao *et al*. 2023; Kullar *et al*., 2023; Bakhsh *et al*. 2024), *Bifidobacterium* spp. (Liu *et al*., 2020; Sharma *et al*., 2021; Cao *et al*., 2023; Lu *et al*., 2024), *Streptococcus thermophilus* (Kapse *et al*., 2024), *Enterococcus* spp. (El-Sawah *et al*., 2020), *Bacillus* spp. (Jin *et al*., 1996; Lee *et al*., 2019; Jahromi *et al*. 2017; Alqahtani *et al*., 2024), and *Saccharomyces* probiotics (Adebiyi *et al*., 2012; Zaidi *et al*., 2023; Magnoli *et al*., 2024) are used. *Saccharomyces cerevisiae,* when used in poultry rations with various doses, leads to increased body weight, enhanced FCR, Improved gut health, gastro-protective effects, limiting pathogenic bacteria in the GI tract, immunomodulation, better growth performance, etc. (Table 3). Probiotics enhance gut health by modulating the gut microbiota (Zaidi *et al*., 2023), improve immune responses and overall health (Zommiti and Ferchichi, 2021), and are used in aquaculture to prevent diseases in fish and shellfish (Sharifuzzaman and Austin, 2017; Ringø *et al*., 2020; Zhou *et al*., 2024a; Sadiq *et al*., 2025; Samia *et al*., 2025).

Table 3: *Saccharomyces cerevisiae* (SC) or *Saccharomyces cerevisiae* fermented product (SCFP) being used in poultry production

SC or SCFP	Birds	Dose	Major Effect	References
SC	Broiler Chicks	3g/kg in basal feed	• increased body weight • Enhanced FCR	Zhang *et al.* (2005)
SC	Poultry birds Broiler Chicks	Feed supplementation	• Improved FCR • Weight gain	Mousavi *et al.* (2018), Santin *et al.* (2001), Kumar *et al.* (2019), Zhang *et al.* (2021) Ebeid *et al.* (2021)
SC	Broiler Chicks/ Layer Pullets	0.1%, 0.3%, or 0.5%. 0.25% and 0.50% of Feed	• Significantly better daily weight gain • Improved FCR	Gao *et al.* (2009) Zeinali and Mohammadi (2022). Chaney *et al.* (2023)
SC	Broiler Chicks	Feed supplementation	• Improved gut health • Gastro-protective effects • Immunomodulation • Better Growth performance • Limiting pathogenic bacteria in the GI tract	Onifade *et al.* (1999), Gheisari and Kholeghipour (2006), Saied *et al.* (2011) Takagi (2021), He T, *et al.* (2021), Ramírez-Cota *et al.* (2021); Ansari *et al.* (2023); Soren *et al.* (2023), Zeinali and Mohammadi (2022), Qui (2023), Magnoli *et al.* (2024);
SC	Chickens	Baker's yeast with 1.4% supplementation	• Improves FCR & • Average daily weight gain	Macelline *et al.* (2017)
SC	Chickens	Baker's yeast with 0.4% supplementation	• Increased growth • Improves FCR & • Average daily weight gain	Nabila *et al.* (2017)
SC	Chickens	Baker's yeast with 2.5% supplementation	• Low feed intake • Better FCR	Mulatu *et al.* (2019)
SC	Chickens	Baker's yeast with 1.0% supplementation	• No detrimental effect • Better performance • Better FCR	Ahmad *et al.* (2015) Al-Nasrawi and Al-Kassie (2020)
SC	Turkeys	1, 2, and 3 g/kg Or 0.0625; 0.125 and 0.25%	• No harmful effects on growth performance	Özsoy and Yalçin (2011) Firman *et al.* (2013)
SC	Japanese quails	1 or 2% of feed	• Better performance	Bolacali *et al.* (2017)
SCFP	Broilers	1.25g/kg; 1.5 kg/MT	• Drastically reduced *Salmonella*	Roto *et al.* (2017), Gingerich *et al.* (2021)
SCFP	Broilers	0.625 kg/ton	• Substantially boosted antibody titer in response to NDV vaccines	Cortés-Coronado *et al.* (2017), Hand (2020), Tukaram *et al.* (2022), Abd El-Ghany *et al.* (2022)

Mode of action: The mechanisms of action of probiotics and prebiotics are complex and often strain- and compound-specific (Cunningham *et al*., 2021). Probiotics support intestinal health through various mechanisms (Fig. 1). The beneficial effects of probiotics begin with the secretion of inhibitory compounds, leading to the non-adhesion of the GI tract epithelial layer (Kabir, 2009; Jha *et al*., 2020). Additionally, it generates competition for nutrients between pathogens, thereby decreasing their establishment in the intestinal mucosa. On the other hand, it also helps reduce the toxin bioavailability and modifies the host's immunity (Fig. 2). This intestinal health support starts from increasing gut barrier integrity, followed by boosted immunity, modulating the gut microbiota, increasing water absorption, producing antimicrobial substances, and reducing unscrupulous pathogens in the lumen of the intestine (Fig. 2), thus resulting in enhanced FCR, improved body weight gain, and decreased mortality in broiler birds (Panda *et al*., 2006; El-Sawah *et al*., 2020; Cristofori *et al*., 2021; Sabry *et al*., 2021).

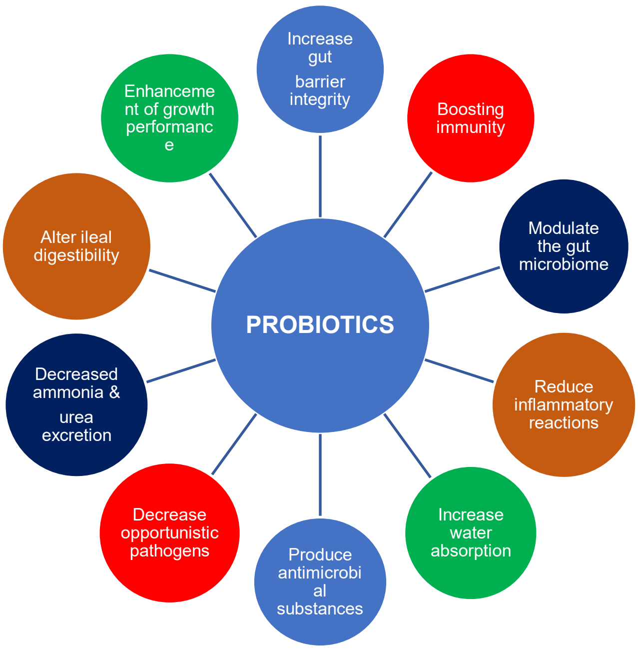

Fig. 1: Probiotics support intestinal health by various means.

There are some drawbacks of probiotics, especially when *Bacillus* spp. are used. Both vegetative form and spores of *Bacillus* spp. have been sourced as probiotics. These are highly stable in the surrounding atmosphere, including conditions such as gastric conditions, moisture, and heat (Lee *et al*., 2019). *Bacillus* probiotic strains have numerous advantages; however, *Bacillus* probiotics can also generate biogenic amines and toxins, and most likely transmit genes of antibiotic resistance; therefore, their safety is a concern (Lee *et al*., 2019; Olmos and Mercado, 2021; Yu *et al*., 2024; Hossain *et al*., 2024).

People have started using fermented foods that are probiotic-rich which have medicinal properties, espacially to prevent AAD, the treatment of irritable bowel disease, vaginitis, *H. pylori* infection, and prevention of necrotizing enterocolitis and allergies (Kopacz and Phadtare, 2022). Probiotics are extensively being used as therapeutic agents in AAD (Kaufman *et al*., 2024). A common side effect of excessive antibiotic use is AAD in nearly 30% of patients. Probiotics use in AAD is based on the hypothesis to regularize unbalanced flora (Kopacz and Phadtare, 2022).

Prebiotics: These are non-digestible food ingredients that positively influence the host by selectively promoting the growth and/or activity of beneficial bacteria in the gut (Patterson and Burkholder, 2003; Abdel-Fattah and Fararh, 2009; Anadón *et al*., 2019; Yaqoob *et al*., 2021; Sankarganesh *et al*., 2024). Prebiotics promote the proliferation of beneficial bacteria, such as *Bifidobacteria* and *Lactobacillus*, while simultaneously suppressing the growth of harmful bacteria (Abdi *et al*., 2022). This can lead to a healthier gut environment, lowering the risk of digestive issues and encouraging overall well-being (Barry *et al*., 2009; Usman *et al*., 2025). Through the action of auxiliary beneficial gut bacteria, prebiotics facilitate the breakdown and utilization of dietary nutrients, leading to enhanced feed efficiency and improved growth rates (Salehimanesh *et al*., 2016; Leone and Ferrante, 2023). Moreover, prebiotics can modulate the immune system, potentially enhancing the production of antibodies and other immune factors, thereby increasing the animals' resistance to infections (Limbu *et al*., 2024; Shehata *et al*., 2024).

Although various fermentable carbohydrates have been shown to have a prebiotic effect, non-digestible oligosaccharides, such as fructans and galactans, are the dietary prebiotics with the most substantial evidence of health benefits in humans and animals (Limbu *et al*., 2024). The definition of prebiotics has been updated to include several other similar compounds (Fig. 3), such as polyphenols and fatty acids (Gibson *et al.*, 2017; Peng *et al*., 2020; Alves-Santos *et al*., 2020; Rodríguez-Daza *et al*., 2021; Tolmacheva *et al*., 2024; Mall *et al*., 2024). Oligosaccharides (OS) are prebiotics, which are non-digestible carbohydrates that serve as food for beneficial bacteria in the gut, promoting their growth and activity (Lee *et al*., 2023). These OS are short chains of sugar molecules (typically 3-10 units) that are resistant to digestion by enzymes. This property is crucial for prebiotic functions, as it allows them to reach the colon where gut bacteria can ferment them (Kumari *et al*., 2024). These oligosaccharides include fructooligosaccharides (FOS), galactooligosaccharides (GOS), Xylo-oligosaccharides (XOS), inulin, polydextrose, and lactulose (Vera *et al*., 2021; Ahmad *et al*., 2023; Kaewarsar *et al*., 2023; Sankarganesh *et al*., 2024). These improve gut health and promote the growth of beneficial bacteria (Shini *et al*., 2021; Shehata *et al*., 2022; Ji *et al*., 2023; Ömer, 2024; Yoo *et al*., 2024; Sankarganesh *et al*., 2024), offer economic advantages by improving feed efficiency, reducing antibiotic use in poultry and reducing mortality rates in poultry (Al-Khalaifah, 2018; Reuben *et al*., 2021; Ricke 2021; Yaqoob *et al*. 2021; Halder *et al*., 2024; Yang *et al*., 2025).

Postbiotics: Though probiotics have numerous functions for the improvement of animal production, in recent years, some concerns have arisen about the feeding of probiotics, especially in defenseless populations. As a result, finding

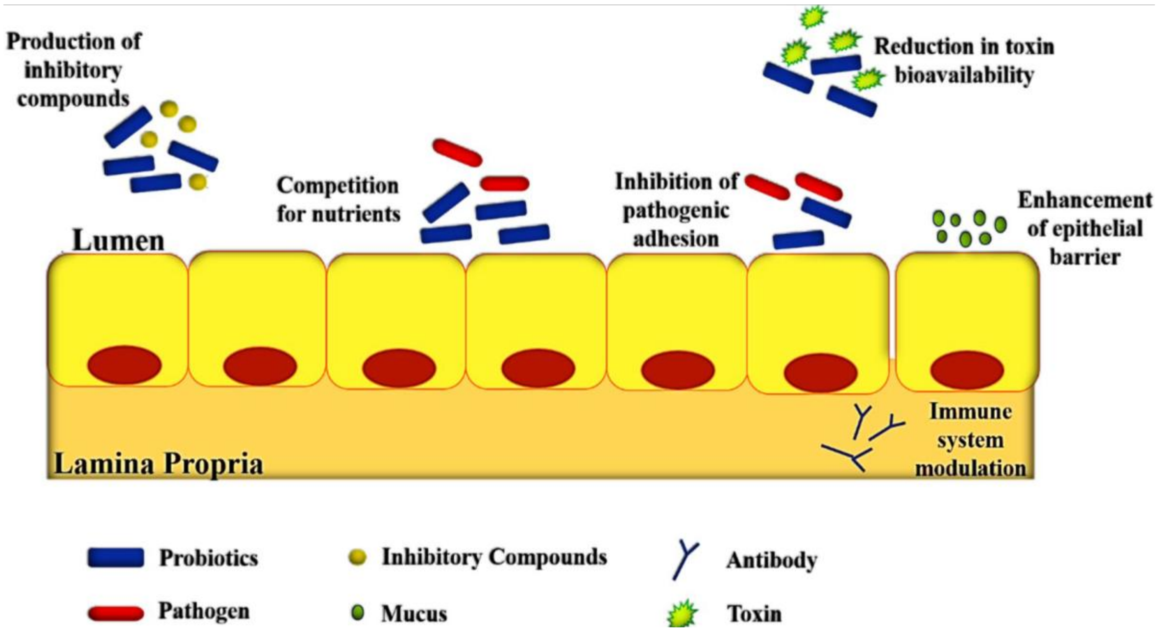

Fig. 2: Mode of action of probiotics. The beneficial effect of probiotics begins with the secretion of inhibitory compounds, which prevent their non-adhesion to the epithelial layer of the GI tract. Additionally, it generates competition for nutrients among pathogens, thereby reducing their ability to colonize. On the other hand, it also helps reduce the toxin bioavailability and modulates the host's immune system (Halder *et al.*, 2024).

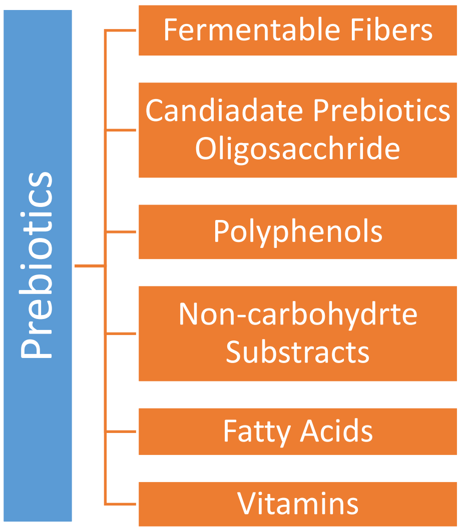

Fig. 3: Major components of prebiotics.

a new complement to probiotics that has the same function but is reliable and safe has been advised. Postbiotics by performance and functions over probiotics could be selected (Harat and Pourjafar, 2025).

Postbiotics are non-viable bacterial products or metabolic byproducts from probiotic microorganisms that confer health benefits to the host (Moradi *et al*., 2024; Wegh *et al*., 2019; Gurunathan *et al*., 2024). Postbiotics are composed of functional proteins, microbial cell fractions, extracellular polysaccharides (EPS), short-chain fatty acids (SCFAs), and peptidoglycan-derived muropeptides (Moradi *et al*., 2024; Gurunathan *et al*., 2024). These have numerous benefits, not limited to (i) modulating the immune system and improving gut health (Wegh et al., 2019; Moradi et al., 2024), and (ii) being suitable for various delivery systems due to their stability (Scott *et al*., 2022). Postbiotics formed by *Saccharomyces cerevisiae* contain several antimicrobial components, including proteins, peptides, short-chain fatty acids, and organic acids, which reduce the pH of the gut to prevent the growth of pathogenic bacteria and foster positive poultry health. These postbiotics inhibit the growth of gut pathogens such as *Salmonella typhimurium, E. coli,* and *Vancomycin-resistant Enterococcus*, and are also considered an alternative to antibiotics (Aguilar-Toalá *et al.,* 2018; Soren *et al*., 2023; Tabassum *et al*., 2024).

Published scientific literature proves that postbiotics, due to their antiviral, antimicrobial, and immunomodulatory properties, can be considered a novel biotherapeutic approach (Nataraj *et al*., 2020; Abbasi *et al*., 2022; Hijová, 2024; Mojgani *et al*., 2025).

Organic Acids: This class of Eubiotics comprises Butyrate, propionate, and acetate (John *et al*., 2024). Their numerous benefits have been reported. Some of these improve gut health by lowering pH and inhibiting pathogenic bacteria (Denli *et al*., 2023) and enhance nutrient absorption and overall animal performance (John *et al*., 2024; Oleinikova *et al*., 2024).

Conclusions: Eubiotics play a pivotal role in sustaining and improving gut health, as well as enhancing immune responses and improving overall animal performance, thereby contributing to overall well-being. Important eubiotics used in animal and poultry production include prebiotics, probiotics, synbiotics, postbiotics, and organic acids. New probiotics and prebiotics are emerging to meet the economic and environmental needs of targeting a growing range of compositional and functional niches within the microbiome. These eubiotics are effective against a wide range of bacteria, fungi, toxins, and other pathogens. There are adequate substitutes for AAD, thereby protecting humans from the risk of treatment failure due to the transfer of resistance genes. In the future, it can be seen that this substance will likely remain at the heart of these therapies. Clinical applications will continue to expand not only in humans but also in veterinary medicine to the oral cavity, immune system, nervous system, cardiometabolic system, respiratory system, urogenital tract, and skin.

Abbreviations used

AGPs	Antibiotic growth promoters
EPS	Extracellular polysaccharides
EU	The European Union
FOS	Fructooligosaccharides
GOS	Galactooligosaccharides
OECD	Organisation for Economic Co-operation and Development
SCFAs	Short-chain fatty acids
OS	Oligosaccharides
FOS	Fructooligosaccharides
GOS	Galactooligosaccharides
XOS	Xylo-oligosaccharides
AAD	Antibiotic-associated diarrhea
FCR	Feed conversion ratio

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