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A Review of The Effectiveness of Probiotic Use on The Productivity of Dairy Cows

Tantia Septiani, Sultan Ali Ulfiah, Nafisa Maulidiah, Zhilan Hannina Hidayat, Reni Maida Salma, Iman Aji Wijoyo, Nurdianti
Politeknik Pembangunan Pertanian Malang

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Corresponding Author:
septianitantia@gmail.com

Abstract
Dairy cattle are an important livestock commodity that provide milk as a vital source of protein, fat, vitamins, and minerals for humans. Production in Indonesia still faces major challenges such as low feed efficiency, gastrointestinal disorders, and suboptimal milk quality. A promising strategy to address these issues is the use of probiotics, particularly Lactobacillus rhamnosus, which are live microorganisms that, when administered in adequate amounts, can inhibit pathogenic bacteria, stabilize rumen pH, enhance populations of fiber-degrading microbes, and strengthen immune function. Studies indicate that probiotic supplementation improves crude fiber digestibility, optimizes rumen fermentation, and increases energy availability through volatile fatty acid (VFA) production, leading to higher milk yield, improved protein and fat contents, and enhanced microbiological quality as shown by reduced somatic cell count (SCC). Probiotic effectiveness is not always consistent, as outcomes are influenced by microbial strain, dosage, ration composition, lactation stage, and the physiological status of the animal. Despite these variations, probiotics demonstrate strong potential as a sustainable nutritional approach to improve the productivity, health, and welfare of dairy cattle. This article will review the mechanisms by which probiotics affect rumen fermentation, feed efficiency, and milk quality, as well as the factors influencing variability in probiotic outcomes.

INTRODUCTION

Dairy cattle are a strategic livestock commodity that plays an important role in providing nutritious food for the community. Milk contains high-quality protein, fat, vitamins, and minerals that are essential for human nutrition. In Indonesia, demand for milk continues to increase in line with population growth and nutritional awareness, but domestic production is only able to meet around 20–25% of national demand. This gap has led to a heavy dependence on imported milk powder. Low national productivity is generally caused by poor feed quality, suboptimal management, and tropical climate pressures (Setiadi *et al*., 2020). Therefore, innovative nutritional strategies are needed to improve the efficiency and sustainability of milk production.The main factor determining milk production is rumen fermentation efficiency. The rumen functions as a bioreactor that converts fibrous feed into volatile fatty acids (VFA), microbial protein, and other metabolites that provide the main energy source for cows. Fermentation imbalances, such as a decrease in pH and accumulation of lactic acid, can cause subacute ruminal acidosis (SARA), which impacts feed efficiency and cow health. Tropical conditions with fluctuating forage quality further increase this risk (Plaizier *et al*., 2008). Therefore, maintaining the stability of the rumen microbial ecosystem is an important step in improving dairy cow productivity.

Probiotics have emerged as a promising approach to stabilizing rumen fermentation. Probiotics are defined as live microorganisms that, when administered in adequate amounts, confer a health benefit on the host (Hill *et al*., 2014). In ruminant systems, commonly used probiotics are Lactobacillus, Bifidobacterium, and yeasts such as Saccharomyces cerevisiae. These probiotics work by increasing the activity of cellulolytic bacteria, stabilizing rumen pH, suppressing pathogens, and improving the anaerobic environment so that feed fermentation becomes more efficient (Elghandour *et al*., 2020).

Recent research shows that probiotic supplementation has a positive effect on feed efficiency and milk production. Nalla *et al*. (2022) reported that probiotics can increase feed efficiency by 7–10%, with an increase in milk yield without an increase in feed consumption. Other studies indicate that Saccharomyces cerevisiae can increase VFA production, improve fermentation profiles, and increase milk protein and fat content (Zhang *et al*., 2024). In addition, probiotics have also been shown to reduce somatic cell count (SCC), which is an indicator of udder health and milk quality (Pilarczyk *et al*., 2024).

In addition to their benefits for productivity, probiotics also play an important role in improving livestock health. Lin *et al*. (2021) state that probiotics can stimulate the intestinal mucosal immune system, increase immune cell activity, and help cattle become more resistant to digestive diseases. Thus, probiotics not only improve production performance but also support animal welfare and resistance to environmental stress. the effectiveness of probiotics is not always consistent in all conditions. Variations in response are influenced by differences in strain, dosage, feed composition, lactation stage, and environmental conditions. In Indonesia, the varying quality of feed, heat stress, and inconsistent probiotic product standards cause research results to sometimes differ from one another (Yuniarti *et al*., 2025).

Therefore, contextual trials at the farm level are important so that probiotic application can provide optimal results. In addition to probiotics, recent research also highlights the potential of postbiotics, which are metabolite products or microbial components that are not alive but still provide health benefits. Postbiotics have the advantage of high stability and better storage safety compared to live probiotics. Vicente *et al*. (2024) found that postbiotic supplementation during the transition period was able to increase feed intake, nutrient digestibility, and milk production. Meanwhile, Guo *et al*. (2024) reported that yeast fermentation products (SCFP) can stabilize rumen microbiota in cows experiencing SARA, thereby reducing the negative effects of acid fermentation. The adoption of probiotics and postbiotics also has positive implications for production sustainability. By increasing feed efficiency, production costs can be reduced, considering that feed accounts for 60–70% of total livestock farming costs. Furthermore, several studies have indicated that probiotics can reduce enteric methane emissions, thereby supporting climate change mitigation efforts (Wu *et al*., 2024). Thus, this technology is not only economically beneficial but also contributes to environmental sustainability.

Based on the above description, probiotics and postbiotics can be considered promising nutritional strategies for improving the productivity and quality of dairy cow milk. However, their effectiveness is greatly influenced by biological, nutritional, and environmental factors. Therefore, further contextual research is still needed, especially in tropical systems such as Indonesia. This review article aims to discuss the mechanisms of action of probiotics and postbiotics, their effects on feed efficiency, milk production and quality, as well as the factors influencing response variability, thereby providing evidence-based recommendations for sustainable dairy farming practices in the future (Otto *et al*., 2025).

RESEARCH METHODOLOGY

Materials

The data and information used in this article were obtained from various scientific sources discussing the effects of probiotics in feed on dairy cow productivity. These sources include research journals, experimental reports, and review articles published both nationally and internationally. The literature search was carried out through online media using relevant keywords such as *probiotics in dairy cows*, *rumen fermentation*, *feed efficiency*, and *milk production*.

The references used do not only focus on recent research findings but also include basic theories regarding probiotics, such as their definition, characteristics, and mechanisms of action in the ruminant digestive system. Several articles reviewed provided research results related to the effects of probiotics on rumen pH stability, cellulolytic microbial activity, feed digestibility, milk production, and milk composition (fat, protein, and total solids). In addition, other studies assessed the role of probiotics in maintaining cow health, particularly in balancing gut microflora and enhancing resilience to environmental stress.

Additional information was also collected from studies on the application of probiotics in tropical livestock systems, especially those relevant to dairy farming conditions in Indonesia. This approach was intended to provide a comprehensive overview of the role of probiotics in milk production systems under various environments and management practices. All collected data were analyzed descriptively to synthesize scientific insights regarding the benefits and potential of probiotics as feed additives for improving dairy cow productivity.

Methods

The method applied in preparing this article was a *systematic literature review* by examining scientific research and publications related to probiotic use in dairy cows. The process began with identifying common problems in dairy farming, namely low feed efficiency and rumen fermentation imbalance, which negatively affect production performance. This was followed by a literature search focusing on potential solutions through the application of probiotics as feed additives.

The analysis was carried out by examining studies that describe the mechanisms of probiotics in the rumen, including their role in stabilizing pH, increasing beneficial microbial populations, and optimizing fermentation and nutrient absorption. Furthermore, the review also explored the impact of probiotics on feed efficiency, milk yield, and milk quality, particularly fat, protein, and total solids content. Special attention was also given to their role in digestive health and the immune system, such as suppressing pathogenic microbes and maintaining microbial balance.

The analytical approach used was descriptive, comparing results across studies to identify common patterns and factors influencing variations in responses to probiotics. Variables such as microbial strain type, dosage, administration method, feed type, and cattle physiological conditions were considered as key determinants of probiotic effectiveness. This article also discusses challenges in the practical application of probiotics, including microbial viability during storage and feed mixing, as well as the influence of environmental conditions on probiotic activity.

In addition to reviewing existing research findings, this article evaluates the prospects for future probiotic development, particularly in relation to feed technology innovations such as combining probiotics with prebiotics or other bioactive compounds. Microbial formulation and coating technologies that can protect probiotics from extreme conditions during feed manufacturing are also highlighted. With this approach, the article aims to provide a comprehensive understanding of the role of probiotics in improving the efficiency and sustainability of dairy farming, while serving as a basis for further research and practical applications at the farmer level.

RESULTS AND DISCUSSION

Definition of Probiotics and Gastrointestinal Health in Dairy Casttle

Probiotics play a crucial role in maintaining the balance of gastrointestinal microflora in dairy cattle. Beneficial microbes such as Lactobacillus and Bifidobacterium can dominate the intestinal ecosystem and thereby inhibit the growth of pathogenic bacteria such as *Escherichia coli* and *Clostridium spp.*This mechanism, known as competitive exclusion, occurs when probiotics compete with pathogens for adhesion sites on the intestinal mucosa and for available nutrients. In addition, probiotics produce antimicrobial metabolites such as organic acids, hydrogen peroxide, and bacteriocins that suppress harmful bacteria, maintaining a stable and healthy gut environment (Zeineldin, Aldridge, & Lowe, 2022).

Beyond suppressing pathogens, probiotics have also been shown to improve rumen health by stabilizing pH. Administration of probiotics containing lactate-producing and lactate-utilizing bacteria such as *Lactobacillus acidophilus* and *Propionibacterium freudenreichii* can reduce the risk of ruminal acidosis. *Propionibacterium* converts lactate to propionate, preventing drastic drops in rumen pH when cows are fed high-concentrate diets. Consequently, probiotics help maintain optimal rumen fermentation and prevent metabolic disorders in dairy cattle (Llamas-López, Soberon, & McFadden, 2023).

Probiotic effects on digestion are also reflected in improved nutrient digestibility. Studies indicate that probiotics can enhance digestive enzyme activity and increase populations of cellulolytic bacteria, thereby improving crude fiber digestibility. Another effective probiotic is yeast supplementation such as Saccharomyces cerevisiae can lower oxygen levels in the rumen and supply growth factors (organic acids and B vitamins) that support *cellulolytic bacteria*. This accelerates the degradation of high-fiber feeds, increases the production of volatile fatty acids (VFA), and supports energy availability for the cow (Bach, 2024). Probiotics also influence rumen microbial diversity by promoting beneficial microbial interactions that stabilize fermentation processes. Supplementation with rumen-native microbial inoculants improves total-tract digestibility, nitrogen incorporation into milk, and serum metabolite balance. These improvements reflect better nutrient utilization and reduced rumen metabolic fluctuations. Through these actions, probiotics optimize fermentation, prevent metabolic acidosis, and enhance the efficiency of milk synthesis (Chaiyabutr, Liang, & Wang, 2025).

Probiotics also support the immune function of the gastrointestinal tract. They can stimulate immune cells such as macrophages and lymphocytes in the gut to produce cytokines that strengthen the immune response against pathogens. With this stimulation, cattle become more resistant to digestive diseases such as diarrhea or enteritis. Enhanced immune status also helps cows better cope with dietary stress, environmental fluctuations, and early lactation periods, which are characterized by reduced immunity (Lin, Xie, Sun, Liu, & Zhao, 2021). Overall, probiotics help maintain digestive health in dairy cattle by stabilizing intestinal microbial populations, improving nutrient digestibility, reducing the risk of ruminal metabolic disorders, and strengthening the immune system. Through these mechanisms, probiotics not only improve animal health but also support productivity in terms of both growth and milk production (Carvalho *et al*., 2025).

Mechanisms of Action of Probiotics

Probiotics work to improve the digestive health of dairy cows by stimulating and balancing the microflora in the digestive tract, especially in the rumen and intestines. Probiotic microorganisms such as *Lactobacillus* and *Bifidobacterium* help create a microbiome environment conducive to feed fermentation, thereby improving nutrient digestion efficiency. With a good balance of microflora, the growth of pathogenic bacteria can be suppressed, reducing the risk of digestive infections and health disorders that often occur in dairy cows (Astuti *et al*., 2022).

In addition probiotics play a role in enhancing the function of the local immune system in the digestive tract. Probiotic bacteria stimulate the production of antimicrobial compounds and strengthen the mucosal immune response, thereby protecting the intestinal wall from pathogen invasion. This helps reduce the incidence of diarrhea and intestinal inflammation, which often interfere with the productivity and health of dairy cows (Yuniarti *et al*., 2025a).

Probiotics also improve intestinal epithelial integrity by repairing microvilli structure and reducing excessive intestinal permeability. This maintains the intestinal barrier function so that digested nutrients can be optimally absorbed and toxins from pathogenic bacteria do not enter the bloodstream. Additionally, probiotics aid in the production of volatile fatty acids (VFA) and ammonia (NH3) from fermentation, which are important for microbial protein synthesis. This increase in nutrient availability is crucial for supporting high-quality milk production in dairy cows (Prihartini *et al*.,n.d.).

Research conducted from 2022 to 2024 shows the significant effect of probiotics on increasing milk production and the health of dairy cows. Probiotic supplements not only improve milk quality with better protein and fat content, but also reduce the incidence of diseases such as mastitis by enhancing the systemic immune response. However, the effectiveness of probiotics is influenced by the type of microorganism, dosage, and physiological condition of dairy cows, so the selection of the right probiotic is crucial for optimal results in modern dairy farming practices (Campbell *et al*., 2024).

Effects of Probiotics on Milk Production and Quality in Dairy Cattle

The use of probiotics in dairy cows has grown rapidly in line with the restriction of antibiotic growth promoters, as this approach aims to improve production efficiency through manipulation of the gastrointestinal microbial community. Optimizing the microbial ecosystem is associated with a better energy status, thereby supporting production and efficiency at the farm level. At the same time, microbial intervention positively affects animal health and milk safety. Strategically, probiotics are positioned as a key element in enhancing milk production and quality in modern dairy systems (Llamas-López, Soberon, & McFadden, 2023).

Mechanistically, probiotics, particularly live yeast Saccharomyces cerevisiae balance the rumen microbiota, stabilize pH, and improve fiber and starch fermentation, resulting in increased digestibility. These changes lead to greater effective dry matter intake and improved energy availability for milk synthesis. In addition, modulation of antioxidant activity and immune function helps maintain production performance throughout lactation. The combined implications of these effects contribute to enhanced milk yield and compositional quality under practical production conditions (Zhang *et al*., 2024).

Under nutritionally challenging conditions, such as feed restriction, supplementation with S. cerevisiae fermentation products (SCFP) has been shown to maintain energy-corrected milk production. This positive effect is linked to more controlled metabolic and inflammatory responses during periods of nutritional stress, including improved handling of negative energy balance and a tempered acute-phase response. Thus, probiotics not only enhance production under normal conditions but also sustain output when feed resources are limited. This resilience is vital for maintaining both milk quantity and day-to-day quality stability at the herd level (Dias *et al*., 2022).

In high producing cows, live yeast improves digestibility, milk yield, and feed efficiency without compromising health or reproductive indicators, and without increasing methane emissions. In practical terms, this means that productivity gains do not come at the expense of animal welfare or environmental sustainability. These findings demonstrate that probiotic strategies can align with modern goals for efficiency and responsibility, helping producers achieve simultaneous increases in milk volume and component yields while meeting environmental expectations (Toral *et al*., 2024).

The quality dimension of milk encompasses oxidative stability, hygienic status, and macronutrient composition. Combinations of probiotics or yeast with selected minerals have been reported to enhance these quality traits while lowering somatic cell counts (SCC). Because SCC is a sentinel of udder health, its reduction signals better intramammary status and, by extension, higher-value milk with improved safety for processing and consumption. Consequently, probiotic intervention exerts a dual impact on yield and on quality positioning probiotics as an actionable lever for on-farm milk quality management programs (Pilarczyk *et al*., 2024).

Nevertheless, responses to probiotic supplementation are context-dependent. Outcomes vary with product form (live versus autolyzed yeast), viability at feeding, dosage, delivery method, ration composition (particularly the forage-to-concentrate ratio and effective fiber), stage of lactation, and thermal or humidity load. Two controlled experiments highlighted distinct differences in rumen fermentation end-products and animal performance between live yeast and autolyzed yeast, indicating that metabolic activity at the site of action matters. These observations underscore the importance of product choice that is fit-for-purpose, matching strain characteristics and dose to explicit farm objectives such as stabilizing early-lactation intake, supporting mid-lactation persistency, or mitigating heat stress (Paula *et al*., 2024).

Recent randomized trials have further evaluated SCFP for its effects on milk yield and responses to intramammary challenges, providing direct evidence for the link between probiotic supplementation, udder health, and final product quality. By focusing on both clinical outcomes and compositional parameters, these studies clarify pathways by which probiotics can reduce quality losses while maintaining throughput, thereby broadening the scientific foundation for incorporating probiotics into integrated milk quality management systems (Carvalho *et a*l., 2025).

Quantitatively, a multilevel meta-analysis of dozens of trials has shown a positive association between yeast-based probiotic supplementation and milk production in lactating cows, although effect sizes vary across studies. Such heterogeneity does not negate the benefits;

rather, it highlights the need for defined minimum effective doses, careful strain selection, and robust feeding management, including attention to particle size, bunk management, and buffer use. With well-designed protocols, productivity gains can be achieved while maintaining milk component integrity and digestive health (Wu, Liang, Zhu, & Wang, 2022).

Translating this evidence base into practice benefits from a structured pathway (Llamas-López, Soberon, & McFadden, 2023). First, define explicit goals elevating peak milk, lowering bulk tank SCC, stabilizing intake and energy balance during the transition period, or buffering seasonal heat stress and choose products with peer-reviewed support for those endpoints (Pilarczyk *et al*., 2024; Toral *et al*., 2024; Benedetti *et al*., 2024). Second, establish a herd baseline for dry matter intake, milk yield, component percentages, and SCC (Wu, Liang, Zhu, & Wang, 2022). Third, introduce the probiotic gradually over 7–14 days to minimize ration sorting and transient digestive upsets, and monitor responses over at least 6–8 weeks to capture adaptation dynamics steps that align with evidence on product form, dosage, and context-dependent responses (Paula *et al*., 2024; Dias *et al*., 2022). Attention to storage (temperature, moisture, and shelf life) to preserve viability, accurate mixing to ensure dose consistency, and collaboration with the nutritionist to harmonize buffers and effective fiber will further increase the probability of success, consistent with the broader probiotic implementation principles highlighted in recent reviews (Llamas-López *et al.*, 2023; Zhang *et al*., 2024).

From an economic perspective, adoption should be framed as a managed on-farm experiment, leveraging designs that generate decision-grade evidence for the specific herd (Nalla et al., 2022; Wu, Liang, Zhu, & Wang, 2022). Split-herd or crossover designs reduce confounding and create farm-specific estimates of effect, while partial budgeting that explicitly accounts for milk premiums, feed savings, veterinary events, and culling risk yields realistic payback estimates aligned with demonstrated improvements in feed efficiency and milk output (Terré *et al*., 2024; Nalla *et al*., 2022). Documenting product specifications strain identity, guaranteed CFU at feeding, carrier, and recommended dose together with key farm conditions improves reproducibility and supports scale-up decisions, in line with consensus guidance on probiotic identification, evidence standards, and minimum viable dose labeling (Hill *et al*., 2014; Gibson *et al.,* 2017). Moreover, addressing practical adoption barriers through transparent labeling and ROI communication is consistent with field surveys emphasizing farmer trust and product quality consistency (Vial *et al.,* n.d.).

Taken together, contemporary literature indicates that probiotics are neither a universal remedy nor a marginal add-on. They are targeted tools that unlock measurable gains when matched to the right animals, diets, and environments, and when supported by sound management. Integrated with balanced rations, cow comfort, heat abatement, and hygienic milking routines, probiotic supplementation can help modern dairy systems reach higher tiers of performance, quality, and sustainability while safeguarding animal well-being and consumer trust (Llamas-López, Soberon, & McFadden, 2023; Zhang *et al*., 2024; Dias *et al*., 2022; Toral *et al*., 2024; Pilarczyk *et al*., 2024; Paula *et al.*, 2024; Carvalho *et al.,* 2025; Wu, Liang, Zhu, & Wang, 2022).

Feed Efficiency and Nutrient Digestibility

Feed efficiency is a key indicator in dairy farming because feed costs can account for 60-70% of total production expenses. The higher the feed efficiency, the more nutrients are utilized for milk production rather than lost as feces or gas (Nalla *et al*., 2022) One approach to improving efficiency is the use of probiotics, whether as live bacteria, yeasts, or postbiotics.

International studies show fairly consistent results. (Terré *et al*., 2024) reported that supplementing early-lactation cows with a Bacillus-based direct-fed microbial (DFM) increased feed efficiency by about 7.5% compared with controls, even though dry matter intake (DMI) did not differ significantly. In other words, cows receiving probiotics produced the same amount of milk from less feed, indicating a more optimal feed conversion.

Supporting evidence was also provided (Cappellozza *et al*., 2023) through in vitro and ex vivo tests. A combination of Bacillus subtilis with fibrolytic enzymes increased neutral detergent fiber (NDF) digestibility by 8-8.5% in total mixed ration (TMR) diets. This improvement is meaningful because NDF is the fiber fraction that is typically difficult to digest, so probiotics help enhance energy availability from fiber.

Yeast fermentation products have likewise proven effective. (Zhang *et al*., 2024) found that supplementing Saccharomyces cerevisiae at 20 g/head/day in mid-lactation dairy cows increased DMI ($P = 0.016$), improved rumen fermentation profiles (higher propionate and total VFA), and led to *gaetins* in milk yield and quality. Another study by Kumprechtová *et al*. (2024) showed a dose response effect: higher doses of S. cerevisiae produced more consistent increases in energy-corrected milk (ECM) than lower doses, especially in early-lactation cows.

Beyond live probiotics, (Vicente *et al*., 2024a) reported that postbiotic supplementation in Friesian cows during the transition period (30 days prepartum to 60 days postpartum) increased DMI, improved apparent total-tract digestibility of DM, OM, and NDF, and raised milk yield with higher fat and protein contents compared with controls. This indicates that both probiotics and postbiotics play important roles during physiologically critical phases in dairy cattle.

Local evidence supports these findings. (Cahyono *et al*., 2015) examined a PUFA-containing concentrate with Curmiyeast in Fries Holland cows and observed an increase in dry matter digestibility from 65.47% to 74.31% and organic matter digestibility from 57.20% to 72.32%. Crude protein and fat digestibility also rose significantly ($P < 0.01$) relative to controls. This demonstrates that probiotic supplementation strategies are not only effective internationally but also relevant for implementation in Indonesian dairy systems.

Although the data show positive trends, probiotic outcomes are not always consistent. Variability is influenced by strain type, dosage, ration composition (forage vs. concentrate), lactation stage, and the quality of the probiotic product itself. Therefore, on-farm implementation should begin with pilot trials accompanied by systematic measurements such as DMI, digestibility (via fecal collection or markers), rumen VFA profiles, and routine monitoring of milk production and quality.

Challenges and Considerations in The Use of Probiotics in Dairy Cattle

Probiotics in dairy cows, particularly live yeast (*Saccharomyces cerevisiae*) and *Lactobacillus*-based DFM, have been shown to modulate the rumen and gastrointestinal microbiota, thereby affecting milk performance and quality. However, consistency of results remains an issue, as the effects are highly dependent on factors such as lactation stage, feed composition, and temperature and humidity (THI). Thus, the successful use of probiotics requires standardization of dosage, strain, and administration method (Feng et al., 2025).

During the transition period, probiotics have enormous potential in maintaining metabolic stability while improving digestive tract health in dairy cows. However, this period is marked by complex and dynamic physiological changes, so that the benefits of probiotic supplementation are often not immediately apparent or may even be reduced by fluctuating body conditions. Therefore, the effectiveness of probiotics is highly dependent on several key factors, such as the timing of administration prior to calving, the selection of strains that are truly suited to the physiological needs of the cows, and consistent monitoring of gastrointestinal biomarkers, including rumen pH and short-chain fatty acid (SCFA) levels. On the other hand, postbiotics which refer to fermented probiotic metabolites without live microorganisms are gaining attention as an innovative alternative. Their main advantage is higher stability and greater safety, particularly in long-term storage and distribution. However, their use still faces a number of limitations, mainly due to inconsistent definitions, variability in composition, and a lack of in-depth understanding of how they work in the digestive tract. Therefore, product standardization, composition transparency, and broader, more systematic mechanistic research are needed for postbiotics to be widely adopted in modern livestock farming practices. (Benedetti *et al*., 2024, Vicente *et al*., 2024b).

Additionally, long-term studies confirm that rumen microbiota dynamics are temporal and highly influenced by seasonality and changes in feed management. This means that short-term evaluations often do not reflect actual results in the field. Thus, research based on longitudinal designs and multi-omics approaches is crucial to directly link changes in microbial communities to digestive tract function (Campbell et al., 2024).

From a practical adoption perspective, common barriers include cost, uncertainty about benefits, and variations in product quality between manufacturers. Surveys at the farmer level show that the adoption of probiotics is greatly influenced by trust in scientific evidence and ROI (return on investment). Therefore, selecting products based on peer-reviewed research and clear strain/CFU labeling is an important consideration before widespread implementation (Vial et al., n.d.).

The local context in Indonesia shows that liquid probiotics based on agricultural waste and herbal medicine-probiotic combinations have not shown significant results on milk quality. This highlights the importance of raw material standardization, quality control, and rigorous research design so that the benefits of probiotics are truly manifested in gut health and milk production (Yuniarti et al., 2025b).

CONCLUSIONS AND SUGGESTION

Conclusions

Probiotics play an important role in maintaining the health of dairy cows' digestive tracts by suppressing pathogenic microbes, increasing the population of fiber-degrading bacteria, stabilizing rumen pH, and strengthening the immune system. This mechanism improves nutrient utilization efficiency, energy availability, and milk quality, although its effectiveness is influenced by strain type, dosage, stage of lactation, and feed management.

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