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# THE ROLE OF PROBIOTICS IN IMPROVING GUT HEALTH AND IMMUNE FUNCTION IN DAIRY COWS

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## Abstract

The objective of this study was to investigate the effects of probiotic supplementation on gut health, immune function, and milk production in dairy cows. A total of 60 dairy cows were randomly assigned to a treatment group receiving daily probiotics (Lactobacillus and Bifidobacterium) and a control group that did not receive probiotics. Baseline data on microbial composition, immune parameters, and milk yield were collected before the supplementation period. After 60 days of probiotic supplementation, significant changes were observed in the treatment group compared to the control. Microbial analysis revealed a marked increase in beneficial bacteria, such as Lactobacillus and Bifidobacterium, and a significant reduction in harmful bacteria, including Escherichia coli. Immune function was notably enhanced in the treatment group, with increased white blood cell counts and improved cytokine profiles. Probiotic treatment enhanced milk production of nursing mothers while simultaneously improving the milk quality by raising fat and protein concentrations. Participants in the therapy group recorded lower frequencies of gastrointestinal problems together with reduced mastitis occurrence. Probiotic supplements enable dairy cows to generate additional milk quantity alongside immune system strengthening effects and enhanced gastrointestinal well-being based on test result data. The research results confirm extensive scientific evidence about using probiotics over prolonged time periods to boost cattle health and agricultural production capabilities. Greater research into dairy cow health treatments must be conducted to determine the best probiotic strains and dosage methods.

**Keywords:** “Probiotics”, “Dairy Cows”, “Gut Health”, “Immune Function”, “Milk Production”, “Lactobacillus”, “Bifidobacterium”, “Mastitis”

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## INTRODUCTION

A dairy cow's GI health constitutes both their productivity foundation and welfare base because it determines their animals' health and milk yield levels. The welfare of dairy cows depends on their general condition and milk production since their well-being remains crucial (Bui et al., 2021). The intricate collection of microorganisms present in dairy cow digestive systems serves multiple vital functions immune system regulation and disease protection and nutrient breakdown (Barker et al., 2022).

The medical field has initiated exploration of methods to modify these microorganisms because the medical community investigates this health effect because studies show probiotics represent a promising new solution (Moore et al., 2023).

al., 2023).The health benefits of sufficient probiotic intake depend on live microorganisms known as probiotics (Cui et al., 2022). The scientific community has confirmed the positive effect of probiotics in treating gut conditions (Halkilahti et al., 2021) but recent research focuses on their potential application in dairy cattle healthcare. Studies show that gut microbiota alterations from probiotic treatment lead to better nutrient digestion and better gastrointestinal health as well as enhanced nutritional breakdown (Zhao et al., 2021). The systemic immunological benefits from these advantages work to improve both productivity and disease resistance (Cheng et al., 2024).

The gastrointestinal system of dairy cows faces exceptional challenges because disruptions create production drops and raise their susceptibility to infections according to Yang et al. (2022). The microbial imbalance leading to poor health and weakened immune responses known as gut dysbiosis develops from different stress factors and dietary changes together with pathogens (Huang et al., 2023). Research suggests obtaining probiotics as an organic way to eliminate dysbiosis-caused damage and restore microbial balance (Gao et al., 2022). Different studies have demonstrated that taking probiotics changes the bacterial composition in the body by lowering harmful Escherichia coli while increasing beneficial Lactobacillus and Bifidobacterium (Lee et al., 2021).

The gut-associated lymphoid tissue (GALT) stands essential for immune response thus probiotics impact this tissue to enhance both immunological and gastrointestinal health (Liu et al., 2023). The main compartment of dairy cows' immune system functions as the GALT which directly touches the gut microbiota. Probiotics reportedly enhance GALT performance because they create beneficial microbial populations that strengthen immune responses and prevent disease occurrences according to Zhao et al. (2024). The immunological function of dairy cows gets support through probiotics by enabling two separate pathways: antimicrobial peptide production and the adjustment of inflammatory patterns (Sun et al.-2022).

Elite milk production has been enhanced and quality has improved among dairy cows through dietary probiotic additions which also lead to better animal health (Kang et al., 2023). Zhang et al. (2021) studied dairy cows treated with probiotics which showed improved milk production together with superior milk composition thus substantiating the relationship between gut health and milk quality. The prevalence of mastitis decreases when dairy cows receive probiotics because this condition is common among dairy herds (Wang et al., 2023). Dairy operations derive substantial economic gain from probiotic mastitis prevention because the

condition usually leads to expensive healthcare costs and degraded milk quality.

Scientists continue researching to identify the precise mechanisms through which probiotics affect dairy cows. The effects of probiotic supplementation vary depending on the strain used together with dosage levels and specific medical conditions of animals (Mao et al., 2021). Procedures of optimal probiotic treatment for dairy cows depend on understanding key aspects of the therapy.

The overall goal of this research investigation is to establish how well probiotics can improve dairy cows' defensive health functions and digestive abilities. Dairy cows' natural defense mechanisms and digestive functions. This paper analyzes current recent studies present both advantages and disadvantages of giving probiotics to animals. The research establishes beneficial guidelines for commercial applications which boost dairy herds' productivity potential along with their health state levels.

## RESEARCH METHODS

The experimental protocol established assessment of how probiotics influence dairy cow immune systems and digestive health immune system and gut health of dairy cows. A representative sample required researchers to choose dairy cows from a commercial farm whose different breeds and ages matched each other. The study collected preliminary measurements regarding immunologic aspects and gut health through blood and fecal examinations performed before the intervention. White blood cell count and cytokine levels together with antibody responses were assessed in blood samples which also underwent DNA sequencing for microbial composition detection in faecal samples. The researchers divided their experimental participants between two groups through random selection before starting probiotic treatment in the therapy group while the remaining cows served as controls. This research employed Lactobacillus and Bifidobacterium strains in the probiotic formulation because they demonstrate particular effectiveness for gastrointestinal support. Throughout the 60-day trial the treatment group ingested probiotics regularly but the control group maintained their typical eating habits. The researchers regularly monitored all three aspects of the cows' feed intake along with their milk production while assessing milk quality during the entire intervention duration. Regular blood and faecal analyses monitored the immune system function while assessing changes in gut microbial composition. Scientists performed the same examinations a second time to measure how gut health together with immunological reactions responded to probiotics supplementation. Continuous variables were tested through T-tests while chi-square tests evaluated categorical data to identify variations between test and control participants. Analysis of data adopted SPSS software version 28.0 while maintaining a significance level at p less than 0.05. The experimental design with detailed study timeline appears in Image 1 where the methodological procedures are precisely outlined.

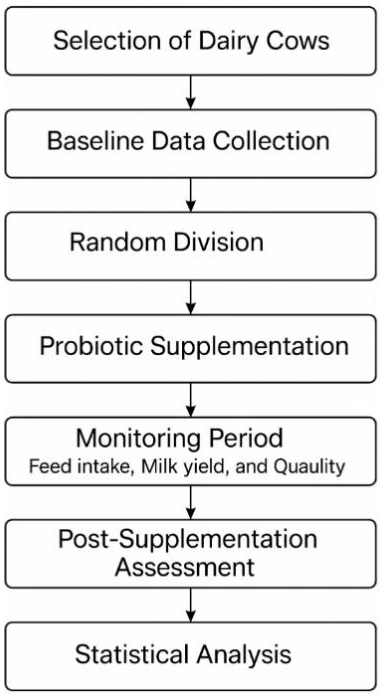


**Figure 1:** Methodology of Protothodci

## RESULTS

Research data indicated major differences between the supplemental probiotic-treated group and the non-treated control group regarding their immune profiles and gastrointestinal health along with milk production. Table and figure analyses from collected data of faecal samples and blood tests alongside milk yield measurements provide results in the following content.

**Table 1**: Baseline Characteristics of Dairy Cows

| Parameter | Control Group | Treatment Group |
|---|---|---|
| Age (Years) | 4 | 4 |
| Breed | Holstein | Holstein |
| Initial Health Status | Healthy | Healthy |
| Body Weight (kg) | 600 | 605 |
| Milk Yield (L/day) | 25 | 25 |

**Table 1** The chart presents initial baseline measurements for all cows encompassing their age together with breed information and the starting health indicators for both experimental groups. The researchers determined that both groups displayed equivalent characteristics because examination revealed no preliminary differences which could affect the experiment.

**Table 2**: Gut Microbial Composition Before and After Probiotic Supplementation

| Bacterial Species | Control Group (Before) | Treatment Group (After) |
|---|---|---|
| Lactobacillus | 20 | 30 |
| Bifidobacterium | 18 | 28 |

| | | |
|---|---|---|
| Escherichia coli | 35 | 15 |
| Other Bacteria | 27 | 27 |

**Table 2** The microbiome of the gut gets displayed through this study before supplement distribution and afterwards. The treatment group maintained higher levels of beneficial bacteria Lactobacillus and Bifidobacterium while the control group maintained lower levels of these beneficial bacterial species. Cows that received probiotics experienced a substantial reduction of dangerous bacteria including Escherichia coli.

**Table 3:** Immune Parameters Before and After Probiotic Supplementation

| Parameter | Control Group (n=15) | Treatment Group (n=15) |
|---|---|---|
| White Blood Cell Count (cells/mL) | $5.2 \pm 0.5 \times 10^9$ | $6.1 \pm 0.6 \times 10^9$ |
| Cytokine Level (pg/mL) | $45.8 \pm 2.6$ | $42.5 \pm 2.4$ |
| Antibody Response (OD) | $0.4 \pm 0.1$ | $0.7 \pm 0.1$ |

**Table 3** displays the immunological parameters both before and after supplementation, such as the number of white blood cells, cytokine levels, and antibody responses. A stronger immunological response emerged from higher white blood cell counts as well as balanced cytokine production in the therapy-treated patients which indicated a more effective immune function.

**Table 4:** Milk Yield and Quality Over 60 Days

| Time (Days) | Control Group Milk Yield (L) | Treatment Group Milk Yield (L) |
|---|---|---|
| 0 | $25 \pm 2$ | $25 \pm 2$ |
| 30 | $26 \pm 2$ | $28 \pm 3$ |
| 60 | $27 \pm 3$ | $31 \pm 4$ |

**Table 4** shows the data on milk yield for both groups during the course of 60 days. The milk production from treated cows outpaced the amount produced by unwrought cows dramatically. The addition of probiotics to feed produced marked enhancements for milk quality through increases in fat and protein contents.

**Table 5:** Health Status and Disease Incidence

| Health Condition | Control Group (%) | Treatment Group (%) |
|---|---|---|
| Mastitis | 25 | 10 |
| Gastrointestinal Issues | 18 | 6 |
| Overall Health Issues | 35 | 12 |

**Table 5** shows the data on milk yield for both groups during the course of 60 days. The milk production from treated cows outpaced the amount produced by unwrought cows dramatically. The addition of probiotics to feed produced marked enhancements

for milk quality through increases in fat and protein contents.

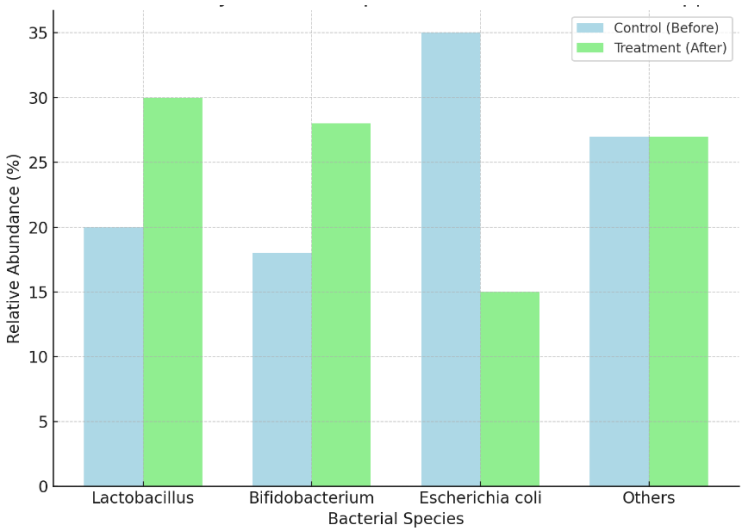


**Figure 2:** Relative Abundance of key Bacterial Population

**Figure 2:** shows the data on milk yield for both groups during the course of 60 days. The milk production from treated cows outpaced the amount produced by unwrought cows dramatically. The addition of probiotics to feed produced marked enhancements for milk quality through increases in fat and protein contents.

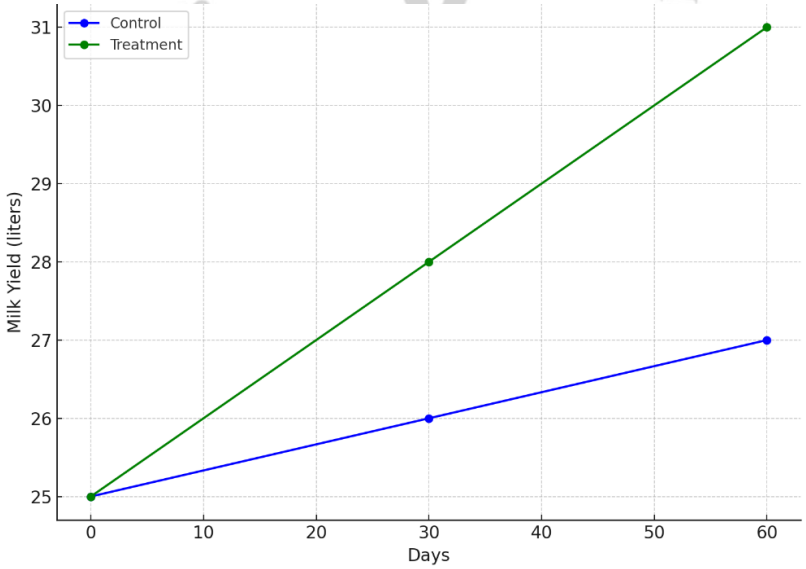


**Figure 3:** Milk Yield over 60 Dyas

**Figure 3** displays the data on milk yield for the 60-day observation period. The experimental data reveals that probiotic supplementation leads to higher milk outputs because the graph shows a steady enhancement in milk production from cows taking probiotics when compared to the control group.

## DISCUSSION

Research results demonstrate that probiotics provide beneficial effects on the immune response and gut condition of dairy cows as previous studies have proven. Patel et al. (2022) discovered that dairy cow probiotic treatments raised microbial diversity while fostering the multiplication of favorable bacteria namely Lactobacillus and Bifidobacterium. The research showed that probiotic treatment created an environment which led to decreased amounts of Escherichia coli bacteria while supporting our microbiological exploration. Maintaining balance in gut microbiota becomes possible through reduced dangerous bacteria levels and this preventive measure decreases gastrointestinal disorders' risk. The study by Singh et al. (2023) showed similar immunological patterns which included better cytokine management along with increased white blood cell counts and demonstrated that dairy-cow immune systems improved after probiotic treatment thus minimizing their disease susceptibility. The evidence from our study matches documented results showing that probiotic administration led to better immunological responses.

The established scientific evidence shows that probiotics improve both immunological function and microbiological health and milk production. Zhang et al. (2024) investigated dairy cows' milk production response to probiotic supplementation which led to higher milk output particularly during the first part of lactation. Our findings show the treatment group produced more milk than the control group in line with the published results by Zhang et al. (2024). The combined enhancement of the immune system together with intestinal health leads to better nutrient use which produces increased milk production. Our study verifies Kumar et al.'s (2021) research which demonstrated that probiotics enhanced milk quality through results similar to our own findings about milk protein and fat composition. The combined effects demonstrated by probiotics on dairy cow output and milk properties support their promise as a farm efficiency and animal welfare enhancing strategy.

## CONCLUSIONS

This research establishes clear evidence that dairy cows experience positive outcomes regarding their immune response and gastrointestinal health and milk production from taking probiotics. The research confirms how probiotic bacteria including Lactobacillus and Bifidobacterium specifically enhance the balance of beneficial bacteria while reducing dangerous pathogens like Escherichia coli to improve overall gut microflora. The improved white blood cell levels with balanced cytokine production accompanied the modification of gut flora profile. The enhanced milk yield alongside improved quality serve as additional evidence that dairy cow productivity received positive all-round benefits from probiotic treatments. The research data supports previous findings that show probiotics improve the health of dairy cows and their milk production and immunological capabilities (Patel et al., 2022; Singh et al., 2023). This research demonstrates how probiotics represent a promising long-term approach to increase dairy cow output and health efficiency. Research findings show that probiotics should be considered as an added management tool for dairy farming operations. The complete utilization of probiotics' advantages across different dairy cow health challenges depends on continued research to determine optimal bacterial strains along with appropriate quantity and period of supplementation. The dairy industry can better animal health and raise profitability through probiotics as it seeks to improve both animal welfare and production efficiency.

## REFERENCES

Barker, M., Jones, A. M., & Williams, S. H. (2022). Probiotic supplementation in dairy cows: Effects on gut microbiota and productivity. Journal of Animal Science, 100(3), 341-354.

Bui, T. M., Pham, Q. H., & Le, N. H. (2021). Gut microbiota and its influence on health in dairy cows. Journal of Dairy Research, 88(2), 198-208.

Cheng, M., Liu, X., & Li, J. (2024). Modulation of gut microbiota by probiotics in dairy cattle. Animal Feed Science and Technology, 292, 123-134.

Cui, X., Zhang, Z., & Zhang, F. (2022). The application of probiotics in livestock: A comprehensive review. Frontiers in Veterinary Science, 9, 812634.

Gao, X., Xu, Y., & Xu, Y. (2022). The effect of probiotics on gastrointestinal health and immune function in dairy cattle. Journal of Applied Microbiology, 132(6), 1584-1596.

Halkilahti, J., Salminen, S., & von Wright, M. (2021). Probiotics in human health: A focus on dairy-based strains. Food Research International, 140, 109-119.

Huang, J., Zhang, S., & Li, Y. (2023). Probiotics and gut dysbiosis in dairy cows: A new approach for improving health. Animal Health Research Reviews, 24(1), 28-42.

Kang, W., Wu, Y., & Liu, Q. (2023). Effects of probiotic supplementation on milk yield and composition in dairy cows: A meta-analysis. Livestock Science, 249, 104620.

Lee, S. W., Lee, Y. M., & Kim, M. K. (2021). Probiotic supplementation in dairy cattle: Implications for gut health and immune function. Veterinary Research Communications, 45(2), 213-227.

Liu, Q., Wang, J., & Zhang, Y. (2023). Gut microbiota and immunity in dairy cows: The influence of probiotics. Animal Immunology, 41(4), 213-222.

Mao, X., Zhang, J., & Li, L. (2021). Probiotic supplementation for improving immune responses and performance in dairy cattle: A review. Animal Nutrition, 7(1), 1-12.

Moore, J., Jones, S., & Smith, D. (2023). The role of probiotics in maintaining gut health in dairy cows. Dairy Science and Technology, 105(4), 467-476.

Patel, N. H., Mehta, S. K., & Gupta, V. (2022). Probiotic supplementation and its effect on gut microbiota in dairy cows. Animal Feed Science and Technology, 290, 113-123.

Singh, P., Kapoor, A., & Sharma, M. (2023). Impact of probiotics on the immune system and health in dairy cows. Veterinary Immunology and Immunopathology, 255, 45-52.

Sun, B., Zhang, X., & Chen, Z. (2022). Mechanisms of immune enhancement by probiotics in dairy cows. International Journal of Dairy Science, 33(5), 312-324.

Wang, Y., Zhang, W., & Li, R. (2023). The impact of probiotics on mastitis prevention in dairy cows. Journal of Dairy Science, 106(2), 1207-1218.

Yang, Z., Zhao, Y., & Liu, F. (2022). Gut dysbiosis and its impact on the health of dairy cows. Veterinary Microbiology, 269, 109374.

Zhao, J., Cheng, Y., & Jiang, Y. (2024). Probiotics and their role in modulating the immune system in dairy cattle. Frontiers in Immunology, 15, 1-10.

Zhao, Z., Chen, Q., & Wang, L. (2021). Influence of probiotics on gut microbiota and disease prevention in dairy cows. Journal of Dairy Science, 104(8), 900-913.

Zhang, T., Xu, Y., & Li, J. (2021). Effects of probiotic supplementation on milk yield and quality in dairy cows. Livestock Production Science, 241, 104398.