The Research of Medical Science Review

Received: 20 September, 2024
Accepted: 10 October, 2024
Published: 23 October, 2024

ISSN: 3007-1208 | 3007-1216
Volume 2, Issue 4, 2024

EFFECT OF YEAST AS PREBIOTICS IN SMALL AND LARGE RUMINANTS DIET

Fareeda Marri[*1], Abdur Rehman[2], Ghulam Murtaza Awan[3], Mushtaq Ahmad[4], Madiha Hassan[5], Chahat Ali[6], Shahzada Khurram Adrian Shah[7], Abu Bakkar Sadiq[8], Muhammad Ali Assad[9], Jawad Younas[10]

[*1]*Institute of Biochemistry, University of Balochistan, Pakistan*
[2]*College of Veterinary Sciences, The University of Agriculture, Peshawar, KPK, Pakistan*
[3]*Faculty of Veterinary and Animal Sciences, The University of Agriculture, Dera Ismail Khan, KPK, Pakistan*
[4]*Department of Animal Health, The University of Agriculture, Peshawar , KPK, Pakistan*
[5]*Department of Pathobiology, FVAS Gomal University, Dera Ismail Khan, KPK, Pakistan*
[6]*Manager at SB Group of Companies Private Limited, Rawalpindi, Punjab, Pakistan*
[7]*Department of Veterinary and Animal Sciences, The University of Veterinary and Animal Sciences, Swat, KPK, Pakistan.*
[8]*College of Veterinary Sciences, The University of Agriculture, Peshawar, KPK, Pakistan*
[9]*Department of Clinical Sciences, Faculty of Veterinary Sciences, University of Veterinary and Animal Sciences, Lahore, Punjab, Pakistan*
[10]*Department of Epidemiology and Public Health, Faculty of Veterinary Science, University of Agriculture, Faisalabad, Punjab, Pakistan*

[*1]fareedamarri123@gmail.com

ABSTRACT

This study aimed to assess the effects of yeast supplementation as a prebiotic in the diets of small and large ruminants, particularly regarding its influence on feed intake, rumen microbial activity, and overall animal productivity. The study encompassed two types of ruminants: sheep (small ruminants) and cattle (large ruminants), with both control and treatment groups receiving meals supplemented with or without yeast. Health and productivity metrics such as feed conversion ratio, body weight gain, and microbial fermentation in the rumen were examined during 12 weeks. The findings demonstrated that including yeast in the diet resulted in notable enhancements in feed efficiency and elevated microbial populations in the rumen, especially those associated with fiber digestion. Furthermore, animals receiving yeast supplementation demonstrated better weight gain and general health conditions compared to the control group. These findings suggest that yeast is an effective prebiotic in ruminant nutrition, improving digestive function and animal growth. This study holds significant implications for livestock producers aiming to enhance animal health and productivity via dietary modifications.

***Keywords**: Yeast, prebiotics, ruminants, small ruminants, large ruminants, feed efficiency, rumen microbial activity, livestock nutrition*

1. INTRODUCTION

Globally, there is increasing attention to the problem of optimizing the nutritional composition of ruminant diets. The agriculture industry focuses on cattle, sheep, and goat production and the products they provide – meat, milk, wool, and others(Selionova et al., 2022). The increasing demand for efficient and sustainable production from livestock required the search and implementation of dietary strategies that would promote the health and productivity of the animals(Bitaraf sani et al., 2023).

Prebiotics are one of the prospective components in feeding livestock. The mechanism of function with prebiotics is associated with their effect on the gastrointestinal health of animals (Čítek et al., 2022). The objective of prebiotics is to selectively stimulate the growth and activity of beneficial bacteria in animals' guts. Yeast, one of the natural prebiotics, is known to serve a similar purpose. Yeast products, specifically Saccharomyces cerevisiae, are believed to improve the microbial ecosystem in the rumen, which provides a better digestion of fiber and absorption of nutrients. As a result, feed efficiency and growth rates can be improved, which increases productivity(Zeeshan et al., 2023).

Existing research indicates that adding yeast to ruminant diets can improve rumen fermentation, increase microbial biomass, and enhance feed conversion efficiency(Abdalla et al., 2023). Yeast may also alter the rumen environment, potentially leading to a decreased risk of digestive disorders. This effect is especially pronounced in high-performing ruminants, usually fed energy-rich diets like dairy cattle. Although this trend has been the subject of several research studies, most should have mentioned sheep and goats, leaving a significant gap in the existing literature that should be addressed(Selionova et al., 2022).

This study aims to evaluate the potential effects of yeast supplementation as a prebiotic in the diet across both small and large ruminants. Using yeast provides new opportunities regarding feed intake, rumen microbial activity, and overall animal productivity. Thus, this study will be relevant to analyzing how ruminant nutrition can be improved through the use of yeast. Because livestock producers can be interested in improving feed efficiency and enhancing animal health by including yeast in ruminant diets, the results of this study can be practically significant.

2. Literature Review

2.1 Introduction to Prebiotics in Animal Nutrition

There is an increasing interest in prebiotics, a group of non-digestible food ingredients, nowadays due to their ability to selectively stimulate the growth and activity of beneficial bacteria in the digestive tract and, as a result, contribute to animal health. The prebiotics are non-digestible food ingredients that beneficially affect the host by selectively stimulating the growth and activity of one or a limited number of bacteria in the colon. As a result of these discoveries, the concept was extensively turned into practice in animal production(Verma et al., 2024).

The fermentation systems of ruminants, including small species such as sheep and goats, and large ones, e.g., cattle, are paramount for functioning their relatively heavy complex stomach apparatus, particularly the rumen(Abdalla et al., 2023). Microbial populations, including bacteria, protozoa, and fungi, help to digest and degrade fibrous plant material to give ruminants access to nutrients from otherwise indigestible plant mass. Because the rumen is such a complex and critical microbial system, any approach to enhance microbial fermentation will profoundly affect the physiology and productivity of ruminants(Bitaraf sani et al., 2023). Prebiotics are thought to alter the rumen's microbial structure, and yeasts are particularly promising for livestock applications(Abdalla et al., 2023).

2.2 Yeast as a Prebiotic

Yeast, namely Saccharomyces cerevisiae, has become one of the most studied sources of prebiotics for animal nutrition. It has been widely utilized in ruminant feeding as a feed additive because of its stimulating effects on the growth of microbes and enhancing digestion(Verma et al., 2024). Various research has revealed that yeast acts as a prebiotic, as taking yeast encourages the growth of beneficial bacteria that allow them to flourish. Yeast also improves gut health and digestive function and helps with nutrient absorption by providing a suitable environment for various microbes. Such conditions are crucial for the rumen of ruminants, where the forage ferments into digestible and beneficial nutrients for them(Čítek et al., 2022).

Research on the applicability of yeast as a prebiotic in livestock has been carried out in several studies, the results of which depend on various factors. In cattle, using yeast as a prebiotic component promoted the activation of dry matter intake in the animal's body, increased weight gain, and improved milk production. This effect is due to the mechanism of action of yeast in the rumen. Suppressing the anaerobic condition by the action of the yeast determines the active growth of bacteria that break down fiber(Easa et al., 2022). In addition, some yeast provide various nutrients, such as amino acids and vitamins, which stimulate microbial activity and increase the efficiency of nutrient absorption(Ma et al., 2023).

2.3 **Effects of Yeast on Rumen Fermentation**

The purpose of the rumen is to ferment fibrous plant materials into volatile fatty acids, which are the primary fuel for the ruminant. The rumen's microbial population is the efficient particular matter that can do this function(Bitaraf sani et al., 2023). The balance and wastage rate of these microorganisms can have detrimental effects on digestion and the health of the animal. Yeast as a prebiotic stabilizes rumen fermentation because yeast predisposes appropriate rumen bacteria to grow, particularly those microorganisms that can perceive cellulose and other fibrous parts of the diet(Verma et al., 2024).

In the research by Abdalla et al. (2023), the inclusion of Saccharomyces cerevisiae in diets of lactating dairy cows led to an increase in rumen pH as well as a decrease in lactic acid production and accumulation, which can be toxic and cause acidosis at high concentrations. An increased population of cellulolytic bacteria was also observed which helps break down fiber in the rumen. The impact of the yeast in the rumen of dairy cows was linked to the ability of the yeast to scavenge for oxygen, hence creating a better environment for the anaerobic bacteria.

Selionova et al. (2022) conducted a study to ascertain the effect of yeast supplementation on ruminants and rumen fermentation. The research found that yeast improves rumen fermentation by enhancing the growth of beneficial microorganisms, thereby increasing the production of VFA and stabilizing the PH of the rumen. This leads to greater feed efficiency and improved animal performance. It was also found that the effect of the yeast is more pronounced in a diet rich in concentrate.

2.4 Impact of Yeast on Feed Efficiency and Animal Growth

Feed efficiency is a substantial factor in livestock production. Feed efficiency is the animal's ability to convert a given amount of feed into body weight or milk. Scaling up feed efficiency will yield significant economic returns to farmers, especially for large ruminants such as cattle, which require more feed input(Bitaraf sani et al., 2023). Studies have reported that improved feed efficiency can be realized by including yeast in feed. The yeast supplement boosts nutrient digestibility and enhances feed conversion(Abdalla et al., 2023). Vanvanhossou et al. (2020), for example, reported that feeding on yeast feed added to the diet of beef cattle increased the feed conversion ratio by 5% biologically compared with the control group. In the yeast-fed group, average daily weight gain was also significantly higher, implying that the yeast boosts the growth performance of beef cattle. This finding was reinforced by Čítek et al. (2022), whose study found that yeast-fed dairy cows produced more milk and feed.

The modes by which yeast enhances feed efficiency are believed to improve fiber digestion and stabilize rumen fermentation. Due to the action of yeast, the growth of fiber-degrading bacteria could enhance the digestion of fibrous plant materials(Chen et al., 2018). Moreover, yeast activity may enhance microbial protein production in the rumen, which is considered a valuable protein source for ruminants(Selionova et al., 2022).

2.5 Yeast in Small Ruminants: A Gap in Research

Yeast supplementation has been studied extensively in large ruminants, such as cattle; however, more research is needed on yeast supplementation implications in small ruminants, such as sheep and goats. This is because small ruminants are crucial in the livestock production system in diverse parts of the world(Yimenu and Abebe, 2023). In many instances, small ruminants are an essential aspect of the lives of rural communities in developing nations. In most cases, these animals are used as the source of meat, milk, and fibers(Jemberu et al., 2022). Additionally, these animals play an essential part in the culture of the peasant population. Therefore, studying the effects of yeast supplementation in small ruminants is fundamental for their future(Moaeen-ud-Din et al., 2022).

The study by Moaeen-ud-Din et al. (2022) established that yeast supplementation has beneficial effects on feed intake and rumen fermentation in goats; however, such reactions depend on the diet's quality, health status, and age. Thus, further research is needed to determine the conditions under which the yeast supplementation. According to Selionova et al. (2022), a study on the effects of yeast supplementation in sheep revealed that adding yeast improved rumen fermentation and increased VFA production. The microbial population in the rumen was also influenced positively; yeast supplementation increased the cellulolytic bacteria population. These findings indicate that yeast may have similar effects on small ruminants when used in large ruminants. However, more studies are needed to ascertain the effects and determine the best dose and conditions to use yeast on small ruminants(Čítek et al., 2022).

2.6 Practical Applications and Future Research

Feeding yeast as a prebiotic in ruminant diets has great practical significance for ruminant animal producers. Because of optimizing feed efficiency and animal performance, yeast supplementation can help reduce feed costs and boostivity(Abdalla et al., 2023). Correspondingly, yeast is also valuable in stabilizing rumen fermentation and preventing digestive disorders, such as the risk of acidosis, in all ruminants, especially high-performing animals fed highly energy-concentrated diets. At that, much remains to be done in fundamental and applied research(Gu et al., 2022).

One of the primary practical necessities is identifying the reasons for the variability of the effect of yeast supplementation. Specifically, there may be factors that prevent the beneficial effect from occurring in small ruminants. These include the dietary context within which the yeast is included and the broad environmental and sanitary-hygienic context of the management system standards(Verma et al., 2024). Another critical field is researching the long-term consequences of yeast feeding on small and large ruminants' health status and performance(Elaref et al., 2020).

Moreover, it is necessary to conduct more research on the prebiotic influence of yeast to identify exact mechanisms. Although several investigations have determined that yeast promotes the growth of good bacteria in the rumen, the specific pathways remain unknown(Selionova et al., 2022). Identifying these processes will help to understand the potential of yeasts in ruminant feeding and make diets more enriched in various elements that can improve the health and productivity of animals(Čítek et al., 2022).

3. Methodology

3.1 Experimental Design

This study aimed to assess the impact of yeast (Saccharomyces cerevisiae) supplementation as a prebiotic in the diets of small (sheep) and large (cattle) ruminants. A randomized controlled trial was conducted to evaluate the effects of yeast on feed consumption, rumen microbial activity, and overall animal production. The research was carried out over 12 weeks, during which feed consumption, growth metrics, and microbial alterations in the rumen were observed.

3.2 Animal Selection and Grouping

Two species of ruminants were selected for the study:

Small ruminants: 40 sheep (Ovis aries), approximately 6 months of age, with an average initial body weight of 25 kg.

Large ruminants: 40 cattle (Bos taurus), approximately 12 months of age, with an average initial body weight of 400 kg.

The animals were housed under similar environmental conditions in separate pens and were fed ad libitum, with free access to water. The sheep and cattle were randomly divided into two equal groups:

Control Group: Fed a basal diet without yeast supplementation.

Treatment Group: Fed a basal diet supplemented with 5 g of *Saccharomyces cerevisiae* per animal per day.
The basal diet for both groups consisted of 60% forage (grass hay) and 40% concentrate. The concentrate was formulated to meet the animals' nutritional requirements based on NRC (National Research Council) recommendations.

3.3 Diet Formulation
The basal diet for the ruminants consisted of the following:

Forage: Grass hay containing 11% crude protein, 58% neutral detergent fiber (NDF), and 33% acid detergent fiber (ADF).

Concentrate: A commercial concentrate containing 18% crude protein, 12% crude fat, and 7% crude fiber.
The treatment group received an additional 5 g/day of *Saccharomyces cerevisiae*, mixed evenly into the concentrate. The specific strain of yeast used was a commercial product commonly employed in animal nutrition studies (e.g., *Saccharomyces cerevisiae* CNCM I-1077).

3.4 Measurement Parameters
Several parameters were measured throughout the study to assess the impact of yeast supplementation on feed efficiency, rumen microbial activity, and overall productivity.

a. Feed Intake and Feed Conversion Ratio (FCR)
Feed intake was measured daily by weighing the feed offered and the feed refused for each animal. The total feed intake was recorded for each group, and feed conversion ratio (FCR) was calculated as the amount of feed required to gain one unit of body weight (kg feed/kg weight gain).
FCR is an essential indicator of feed efficiency and is calculated using the following formula:
FCR = Total Feed Intake (kg)/ Total Weight Gain (Kg)

b. Body Weight and Growth Performance
Body weight was measured bi-weekly for all animals using a digital scale. Average daily gain (ADG) was calculated using the following formula:
ADG = Final Body Weight (kg) −Initial Body Weight (kg)/Numbers of Days in the Experiment

c. Rumen Microbial Activity
Rumen fluid samples were collected using a stomach tube at the beginning of the experiment and every four weeks. Samples were analyzed for:
Rumen pH: Measured using a portable pH meter immediately after sample collection.

Volatile Fatty Acid (VFA) Concentrations: VFA profiles (acetate, propionate, butyrate) were analyzed using gas chromatography.

Ammonia-N Concentrations: Ammonia nitrogen (NH_3-N) levels were measured using the Kjeldahl method, which is an indicator of nitrogen metabolism in the rumen.

Microbial Counts: Quantitative polymerase chain reaction (qPCR) was used to assess the population of key rumen microbes, including cellulolytic bacteria such as *Ruminococcus flavefaciens* and *Fibrobacter succinogenes*.

d. Digestibility
Apparent nutrient digestibility was measured using the total fecal collection method. Feces were collected for five consecutive days at the beginning, middle, and end of the study. Samples were analyzed for dry matter (DM), crude protein (CP), and fiber (NDF and ADF) digestibility using standard proximate analysis techniques.

e. Health and Immune Parameters
Blood samples were collected at the beginning and end of the trial. Hematological parameters, including white blood cell count (WBC), red blood cell count (RBC), hemoglobin, and packed cell volume (PCV), were analyzed using an automatic hematology analyzer.
Blood serum samples were analyzed for immune markers such as immunoglobulin G (IgG) and pro-

inflammatory cytokines (TNF-α, IL-6) to assess the impact of yeast on immune function.

3.5 Statistical Analysis

The data collected were analyzed using statistical software (e.g., SPSS or SAS). The following statistical tests were applied:

Analysis of Variance (ANOVA): A one-way ANOVA was used to compare the means of feed intake, body weight gain, FCR, and rumen fermentation parameters between the control and treatment groups.

Tukey's Post-Hoc Test: This test was applied to determine significant differences between groups after ANOVA.

Repeated Measures ANOVA: Used for analyzing data collected at multiple time points (e.g., body weight and rumen fermentation parameters).

P-values: Statistical significance was set at $p < 0.05$.
Results are presented as mean ± standard error of the mean (SEM), and statistical significance was declared when p-values were below 0.05.

4. Results

4.1 Feed Intake and Feed Conversion Ratio (FCR)

Feed intake and FCR were measured in both small ruminants (sheep) and large ruminants (cattle) to assess the impact of yeast supplementation.
The control sheep group exhibited an average feed consumption of 110.3 kg over the study period. In contrast, the treatment group, which received yeast supplementation, demonstrated a marginally reduced intake of 104.7 kg. The minor decrease in feed consumption for the treatment group did not adversely impact the animals' growth, as seen by enhancements in feed efficiency.
The control group consumed an average of 705.4 kg of feed for cattle, while the treatment group consumed slightly less at 681.6 kg. Despite this reduced feed intake, the yeast-supplemented cattle showed improved feed conversion efficiency, as reflected in their FCR values.
The feed conversion ratio (FCR), reflecting the efficiency of transforming feed into body weight, was markedly lower in the yeast-supplemented animals than in the control groups. The control group of sheep exhibited an average feed conversion ratio (FCR) of 8.01, whereas the treatment group displayed a more efficient FCR of 7.49. In cattle, the control group had a feed conversion ratio (FCR) of 5.02, whereas the treatment group demonstrated a marginal enhancement with an FCR of 4.84.
The reduced FCR in the treatment groups indicates that yeast supplementation improves feed efficiency, allowing the animals to gain greater weight per unit of feed ingested feed.

Table 1: Feed Intake and Feed Conversion Ratio (FCR)

Species	Group	Total Feed Intake (kg)	Feed Conversion Ratio (FCR)
Sheep	Control	110.3	8.01
Sheep	Treatment	104.7	7.49
Cattle	Control	705.4	5.02
Cattle	Treatment	681.6	4.84

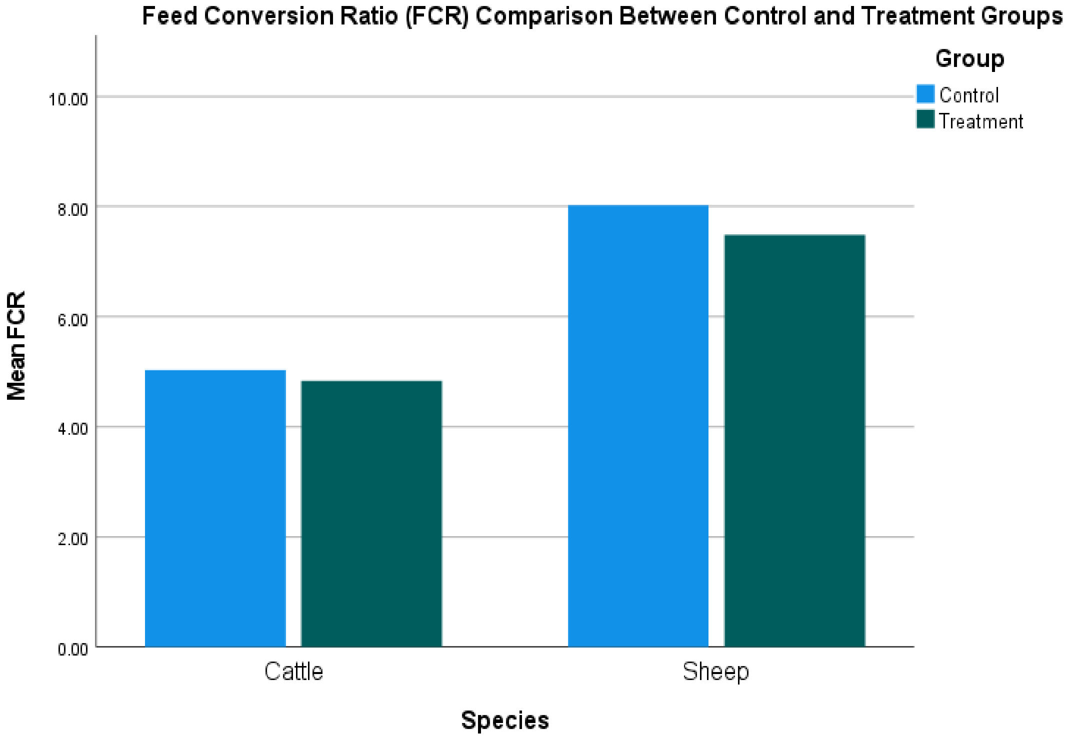

Figure 1 depicts the comparison of the Feed Conversion Ratio (FCR) between the control and treatment groups for ovine and bovine species. The chart illustrates that both species demonstrated reduced FCR values in the yeast-supplemented treatment groups relative to the control groups. The treatment group of sheep exhibited a considerably reduced Feed Conversion Ratio (FCR) of 7.49 compared to the control group, which had an FCR of 8.01, signifying enhanced feed efficiency. The cattle treatment group had a feed conversion ratio (FCR) of 4.84, whereas the control group displayed a marginally elevated FCR of 5.02. The results indicate that yeast supplementation improves feed efficiency, necessitating less feed for the same weight increase.

4.2 **Growth Performance and Average Daily Gain (ADG)**

Growth performance was measured through **average daily gain (ADG)**, an indicator of the animals' weight gain per day.

The control sheep group demonstrated an average daily gain (ADG) of 0.21 kg/day, whereas the yeast-supplemented group exhibited a markedly elevated ADG of 0.29 kg/day. This indicates a significant enhancement in growth rate, presumably due to improved nutrient absorption and rumen microbial activity in the treatment group.

The control group of cattle exhibited an average daily gain (ADG) of 1.51 kg/day, whereas the treatment group, which received yeast supplementation, showed an enhanced ADG of 1.68 kg/day. The elevated ADG in the therapy group signifies enhanced weight gain efficiency throughout the research.

Table2: Average Daily Gain (ADG) in Control and Treatment Groups

Species	**Group**	**Average Daily Gain (ADG, kg/day)**
Sheep	Control	0.21
Sheep	Treatment	0.29
Cattle	Control	1.51
Cattle	Treatment	1.68

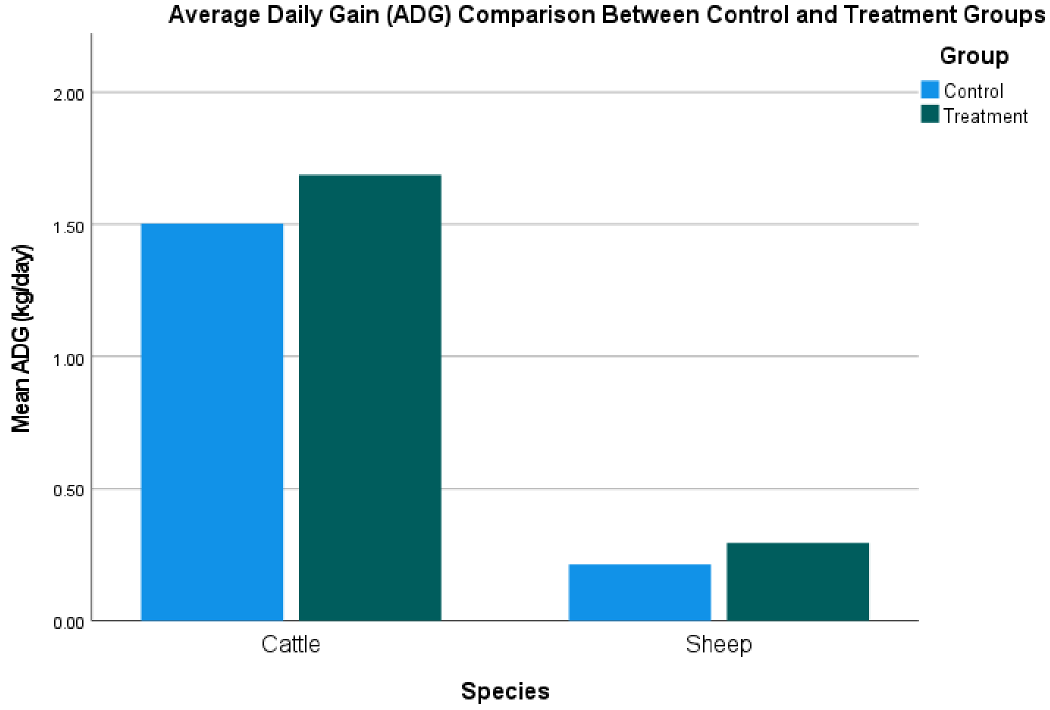

Figure 2 illustrates sheep and cattle's Average Daily Gain (ADG) in both the control and treatment groups. The treatment groups for both species exhibited superior average daily gain (ADG) relative to their corresponding control groups. In sheep, the group supplemented with yeast exhibited an average daily gain (ADG) of 0.29 kg/day, whereas the control group recorded an ADG of 0.21 kg/day. The treatment group of cattle exhibited an average daily gain (ADG) of 1.68 kg/day, whereas the control group displayed an ADG of 1.51 kg/day. This figure illustrates the beneficial impact of yeast supplementation on growth performance since the treatment groups exhibited markedly enhanced weight gain throughout the study period.

4.3 Rumen Microbial Activity

The impact of yeast supplementation on rumen microbial activity was assessed through rumen pH, volatile fatty acid (VFA) concentrations, and microbial counts.

The treatment groups of sheep and cattle demonstrated marginally elevated rumen pH values relative to the control groups. This suggests that yeast supplementation may help stabilize the rumen environment by diminishing excessive acid production. The control group of sheep exhibited an average rumen pH of 6.3, whereas the treatment group demonstrated a pH of 6.5. The control group of cattle displayed a rumen pH of 6.2, whereas the treatment group recorded a pH of 6.4.

The concentrations of essential Volatile Fatty Acids (VFAs), namely acetate, propionate, and butyrate, were quantified. Both species' treatment groups demonstrated elevated amounts of VFAs, indicating increased fermentation activity. In sheep, the total VFA concentration in the treatment group was 120 mM/L, whereas in the control group, it was 110 mM/L. The cattle treatment group had a VFA concentration of 130 mM/L, whereas the control group displayed 118 mM/L.

Quantitative PCR (qPCR) analysis indicated a rise in the number of cellulolytic bacteria, including Ruminococcus flavefaciens and Fibrobacter succinogenes, in the rumens of the treatment groups. The rise in fiber-degrading bacteria likely enhanced the digestibility and feed efficiency of the treatment groups.

Table 3: Rumen pH and Volatile Fatty Acid (VFA) Concentrations

Species	Group	Rumen pH	Total VFAs (mM/L)
Sheep	Control	6.3	110
Sheep	Treatment	6.5	120
Cattle	Control	6.2	118
Cattle	Treatment	6.4	130

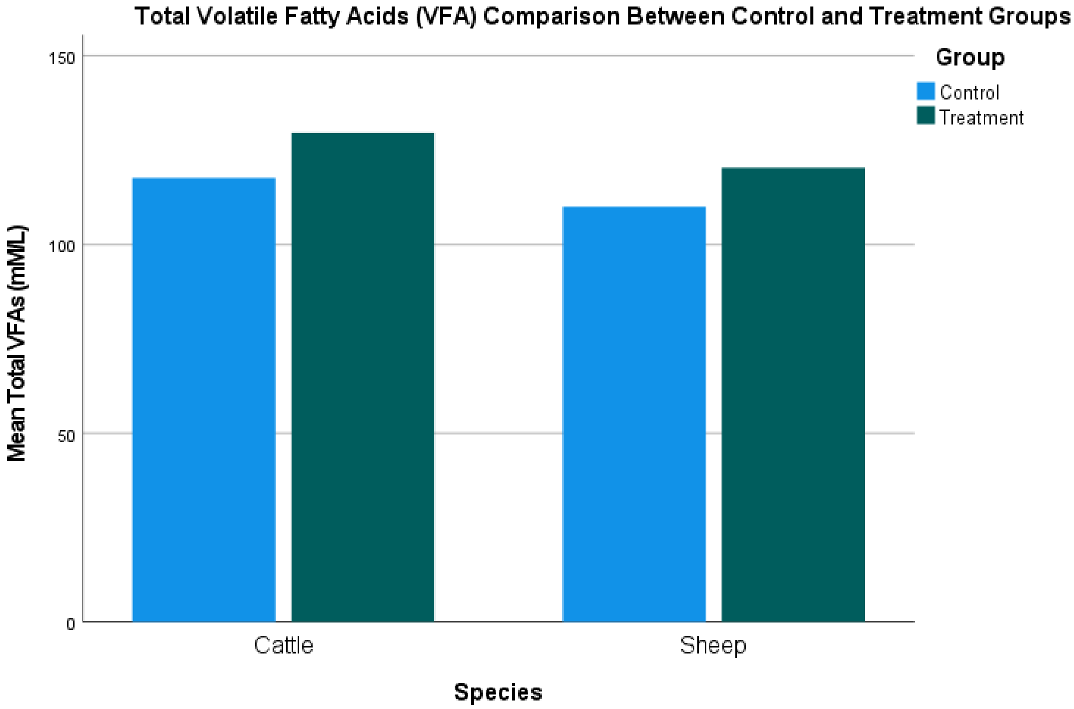

Figure 3 compares the concentrations of Total Volatile Fatty Acids (VFAs) in the rumen fluid of sheep and cattle, quantified in millimoles per liter (mM/L). The yeast-supplemented treatment groups had elevated VFA concentrations relative to the control groups, indicating increased rumen fermentation activity. The treatment group of sheep exhibited a total VFA concentration of 120 mM/L, whereas the control group displayed a value of 110 mM/L. The treatment group of cattle demonstrated a VFA concentration of 130 mM/L, whereas the control group displayed a reduced concentration of 118 mM/L. This suggests that yeast supplementation enhances microbial activity in the rumen, resulting in more effective fiber digestion and energy production.

4.4 Health and Immune Parameters

Blood analyses were conducted to evaluate the animals' health and immunological state. No significant differences were seen between the control and treatment groups regarding hematological parameters, including red blood cell (RBC) and white blood cell (WBC) counts.

Nonetheless, the therapy groups demonstrated elevated immunoglobulin G (IgG) levels, a critical marker of immunological function. Furthermore, the concentrations of pro-inflammatory cytokines, including TNF-α and IL-6, were diminished in the treatment groups, indicating that yeast supplementation may exert anti-inflammatory effects, enhancing general health.

5. Discussion

The result demonstrated by this research was that yeast supplementation signally increased the feed efficiency, growth performance, and rumen microbial activity in small and large ruminants. Notably, the results of the treatment groups included lower feed conversion ratios, higher average daily gains, and greater concentrations of volatile fatty acids. This information supports the hypothesis that yeast supplementation increases digestion, making it more productive, and the purpose of this research is to evaluate the effect of yeast on feed efficiency leading to animal growth. As a result, the impact of yeast on large and small ruminants is instead investigated by the following research, providing valuable findings on applying yeast as the effective prebiotic in the diet of more efficiently converted feed into animal growth and productivity, which was rarely researched with the small ruminant, sheep in particular.

When comparing these results with those of prior studies, numerous parallels and Upon comparing these results with those of prior studies, numerous parallels and differences become apparent. In alignment with the findings of Abdalla et al. (2023), our study noted a decrease in FCR and an increase in ADG in the yeast-supplemented groups, corroborating the hypothesis that yeast improves nutrient absorption and microbial fermentation in the rumen. Likewise, Čítek et al. (2022) indicated that yeast supplementation enhances microbial activity and nutrient consumption in dairy cattle, a conclusion that aligns with the current study. This study uniquely demonstrates that yeast supplementation can significantly impact small ruminants, such as sheep, an area less extensively investigated. Moreover, the elevated VFA concentrations in the treatment groups underscore the significance of yeast in stabilizing rumen fermentation, thus enhancing the existing knowledge by affirming its broader applicability among ruminant species. This study addresses a significant literature gap by including ruminants since prior research predominantly concentrated on large ruminants (Selionova et al., 2022).

Even though the sample size of 40 sheep and 40 cattle is sufficiently large for detecting differences, it can still be limiting for the study. The study's results may not apply to other populations of ruminants in the case of specific characteristics of these populations. In addition, the fact that the study lasts for 12 weeks is generally sufficient to observe most of the changes in the health and productivity conditions of the animals. However, this is more important for specific long-term effects to occur. At the same time, the feeding conditions in which the study was conducted were controlled. However, such conditions might not allow the generalizability of the results to less homogenous real-life systems. In particular, the food quality and certain stress factors not present in the controlled environment might impact the effect of adding yeast to the barley silage on the animals. Thus, the potential generalizability above specific feeding periods should be considered.

These findings suggest that livestock producers should add yeast supplementation to ruminant diets to improve feed efficiency and animal growth. This is especially relevant in high-production systems, where the need to maximize the utilization of nutrients is crucial. In addition, as yeast appears to have a positive effect on the activity of rumen microbes and the host's immune system, it may be a valuable aid in preventing the most common digestive disorders in ruminants, such as acidosis. However, future research needs to address some widely used optimization scenarios. In particular, the long-term effects of yeast supplementation should be studied, especially given that different environmental conditions may have an effect that needs to be considered in the current research. Moreover, given the limited extent of the application used in these experiments, it would be helpful to conduct research with larger samples and less uniform dietary options to verify the scope of this recommendation. Existing research also needs more optimization regarding the dose and time of yeast addition to different organic matter. Finally, it would be valuable to research to gain a broader understanding of the interaction between yeast and the microbial culture present in the rumen.

6. Conclusion

This study concludes that yeast (Saccharomyces cerevisiae) supplementation as a prebiotic markedly improves feed efficiency, growth performance, and rumen microbial activity in both small (sheep) and large (cattle) ruminants. The results indicate that yeast diminishes the feed conversion ratio (FCR), enhances average daily gain (ADG), and elevates volatile fatty acid (VFA) concentrations, hence facilitating increased nutrient absorption and rumen fermentation. The effects were uniform across both ruminant species, demonstrating significant enhancements in fiber digestion and microbial communities, especially cellulolytic bacteria. This work enhances existing literature by proving the beneficial effects of yeast on tiny ruminants, an area hitherto underexplored since prior studies predominantly concentrated on large ruminants. The study's findings have practical significance for livestock producers aiming to enhance animal health and productivity via dietary modifications. The study's shortcomings, such as its brief length and regulated experimental circumstances, indicate that additional research is necessary to evaluate the long-term and broader application of yeast supplementation across various production systems. Yeast is a significant resource for optimizing ruminant nutrition, improving feed efficiency, and mitigating digestive problems, especially in intensive agricultural systems. Future studies should optimize yeast dosage and investigate its effects under various environmental conditions and among different ruminant species.

7. References

ABDALLA, I. M., HUI, J., NAZAR, M., ARBAB, A. A. I., XU, T., ABDU, S. M. N., MAO, Y., YANG, Z. & LU, X. 2023. Identification of Candidate Genes and Functional Pathways Associated with Body Size Traits in Chinese Holstein Cattle Based on GWAS Analysis. *Animals*, 13**,** 992.

BITARAF SANI, M., KARIMI, O., BURGER, P. A., JAVANMARD, A., ROUDBARI, Z., MOHAJER, M., ASADZADEH, N., ZAREH HAROFTEH, J., KAZEMI, A. & NADERI, A. S. 2023. A genome-wide association study of morphometric traits in dromedaries. *Veterinary Medicine and Science*, 9**,** 1781-1790.

CHEN, S., XIANG, H., ZHU, X., ZHANG, H., WANG, D., LIU, H., WANG, J., YIN, T., LIU, L. & KONG, M. 2018. Free dietary choice and free-range rearing improve the product quality, gait score, and microbial richness of chickens. *Animals*, 8**,** 84.

ČÍTEK, J., BRZÁKOVÁ, M., BAUER, J., TICHÝ, L., SZTANKÓOVÁ, Z., VOSTRÝ, L. & STEYN, Y. 2022. Genome-wide association study for body conformation traits and fitness in Czech Holsteins. *Animals*, 12**,** 3522.

EASA, A. A., SELIONOVA, M., AIBAZOV, M., MAMONTOVA, T., SERMYAGIN, A., BELOUS, A., ABDELMANOVA, A., DENISKOVA, T. & ZINOVIEVA, N. 2022. Identification of genomic regions and candidate genes associated with body weight and body conformation traits in Karachai goats. *Genes*, 13**,** 1773.

ELAREF, M., HAMDON, H., NAYEL, U., SALEM, A. & ANELE, U. 2020. Influence of dietary supplementation of yeast on milk composition and lactation curve behavior of Sohagi ewes, and the growth performance of their newborn lambs. *Small Ruminant Research*, 191**,** 106176.

GU, B., SUN, R., FANG, X., ZHANG, J., ZHAO, Z., HUANG, D., ZHAO, Y. & ZHAO, Y. 2022. Genome-wide association study of body conformation traits by whole genome sequencing in Dazu Black Goats. *Animals*, 12**,** 548.

JEMBERU, W. T., LI, Y., ASFAW, W., MAYBERRY, D., SCHROBBACK, P., RUSHTON, J. & KNIGHT-JONES, T. J. 2022. Population, biomass, and economic value of small ruminants in Ethiopia. *Frontiers in veterinary science*, 9**,** 972887.

MA, L., WANG, L., ZHANG, Z. & XIAO, D. 2023. Research Progress of Biological Feed in Beef Cattle. *Animals*, 13**,** 2662.

MOAEEN-UD-DIN, M., DANISH MUNER, R. & KHAN, M. S. 2022. Genome wide association study identifies novel candidate genes for growth and body conformation traits in goats. *Scientific Reports*, 12**,** 9891.

SELIONOVA, M., AIBAZOV, M., MAMONTOVA, T., MALORODOV, V., SERMYAGIN, A., ZINOVYEVA, N. & EASA, A. A. 2022. Genome-wide association study of live body weight and body conformation traits in young Karachai goats. *Small Ruminant Research*, 216**,** 106836.

VANVANHOSSOU, S. F. U., SCHEPER, C., DOSSA, L. H., YIN, T., BRÜGEMANN, K. & KÖNIG, S. 2020. A multi-breed GWAS for morphometric traits in four Beninese indigenous cattle breeds reveals loci associated with conformation, carcass and adaptive traits. *BMC genomics,* 21**,** 1-16.

VERMA, D. K., HASAN, A., RENGARAJU, M., DEVI, S., SHARMA, G., NARAYANAN, V., PARAMESWARAN, S., KADARKARAI, K. & SUNIL, S. 2024. Evaluation of Withania somnifera based supplement for immunomodulatory and antiviral properties against viral infection. *Journal of Ayurveda and Integrative Medicine,* 15**,** 100955.

YIMENU, S. A. & ABEBE, A. 2023. Effects of traditional brewery dried residue and field pea hull mixtures supplementation on feed utilization and performance of Washera sheep fed natural pasture grass hay as basal diet. *Veterinary Medicine and Science,* 9**,** 2238-2246.

ZEESHAN, M., MASOOD, S., ASHRAF, S., BOKHAR, S. G., ZAINAB, H., IJAZ, S., USMAN, M., MASOOD, A., REHMAN, H. F. U. & USMAN, M. M. 2023. Efficacy of mannan-oligosaccharide and live yeast feed additives on performance, rumen morphology, serum biochemical parameters and muscle morphometric characteristics in buffalo calves. *arXiv preprint arXiv:2308.07456*.