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Research Article

Enhancing Rabbit Growth Performance: The Impact of Genotype and Probiotic Supplementation

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Abstract

This study examines the effects of probiotic supplementation and genotype on the growth performance of post-weaned rabbits. A total of 24 rabbits, equally divided between California White and Soviet Chinchilla breeds, were assigned to three dietary treatments: T1 (control, no probiotics), T2 (1g probiotics/kg feed), and T3 (2g probiotics/kg feed). The experiment lasted 14 weeks, during which body weight, weight gain, feed intake, and feed conversion efficiency were monitored. Results indicated that rabbits in the T3 group achieved the highest body weight gain and feed conversion efficiency compared to T1 and T2. California White rabbits exhibited superior growth performance over Soviet Chinchilla rabbits. Probiotic supplementation enhanced digestion, improved nutrient absorption, and contributed to more efficient feed utilization, leading to better overall growth and health outcomes. The ability of probiotics to support gut integrity and immune function was evident in the improved physiological responses observed in probiotic-supplemented groups. Additionally, no mortality was observed, highlighting the potential of probiotics in reducing disease susceptibility and promoting overall well-being. These findings underscore the potential of probiotics as a natural, cost-effective strategy to improve rabbit growth performance, enhance feed efficiency, and support sustainable rabbit farming. The study also emphasizes the importance of genotype in determining growth outcomes, with California White rabbits demonstrating superior performance. Future research should explore the broader implications of probiotics in livestock, particularly in ruminants like buffaloes, to optimize meat and milk production, reduce antibiotic dependence, and enhance overall farm profitability.

Keywords: California White; Probiotics; Soviet Chinchilla; Feed Supplementation; Growth Performance; Sustainable Farming.

Introduction

The increasing global demand for high-quality protein sources, along with the need for sustainable livestock production, has necessitated alternative approaches to meet these demands. Conventional livestock, such as cattle and poultry, compete with humans for food grains, leading to rising feed costs and resource constraints. Rabbits present a viable alternative due to their efficient feed conversion, rapid growth rate, and ability to digest fibrous feed that is unsuitable for human consumption (Halls, 2008). Additionally, rabbit meat is highly nutritious, rich in high-quality protein, low in fat, and contains minimal cholesterol, making it a suitable dietary option for human consumption (Lebas *et al*., 2017).

Despite these advantages, commercial rabbit farming faces challenges in optimizing growth performance, maintaining feed efficiency, and preventing diseases. The digestive health of rabbits plays a crucial role in achieving optimal growth rates, and poor gut health can lead to nutritional deficiencies and economic losses for farmers. One promising approach to overcoming these challenges is the inclusion of probiotics in rabbit diets. Probiotics are live microorganisms that, when administered in adequate amounts, confer health benefits by enhancing gut microbiota balance, improving nutrient absorption, and boosting immune function (Oso *et al*., 2013).

Recent studies have demonstrated that probiotics contribute to better weight gain, improved feed conversion ratios (FCR), and enhanced resistance to infections in rabbits (Bhatt *et al*., 2017). Moreover, probiotics have been shown to support gut integrity and reduce the risk of digestive disorders such as enteritis, a common issue in rabbit farming (Fathi *et al*., 2017). Given the potential benefits of probiotics, understanding their impact on different rabbit genotypes is essential to optimizing production efficiency.

This study evaluated the effects of genotype and probiotic supplementation on the growth performance of post-weaned rabbits. By examining different probiotic supplementation levels and their impact on body weight gain, feed intake, and feed conversion efficiency, this research aimed to provide insights into enhancing sustainable rabbit farming. Specifically, it sought to analyze the influence of genotype on growth, assess the role of probiotics in improving feed efficiency, and explore their broader applications in livestock production. By integrating probiotics into rabbit diets, farmers can potentially enhance production efficiency while reducing reliance on antibiotics, promoting overall sustainability in animal agriculture.

Materials and Methods

Study Location and Experimental Design

This study was conducted at the Swine and Avian Research Program under the Nepal Agricultural Research Council (NARC), Nepal. The research facility was selected based on its controlled environment and suitability for rabbit farming research. The experiment lasted for 14 weeks, during which all rabbits were housed in well-ventilated cages under uniform environmental conditions. The ambient temperature, humidity, and lighting were regulated to minimize external influences on growth performance.

A total of 24 post-weaned rabbits, aged 58 days, were randomly selected for the experiment. The rabbits were equally distributed between two breeds: California White (n=12) and Soviet Chinchilla (n=12). Each breed was further divided into three dietary treatment groups, ensuring an equal distribution of genotype within treatments. The treatment groups were defined as follows:

- **T1 (Control):** Standard basal diet without probiotic supplementation.
- **T2:** Basal diet supplemented with 1g of probiotics per kg of feed.
- **T3:** Basal diet supplemented with 2g of probiotics per kg of feed.

Each treatment group consisted of four rabbits per genotype, following a completely randomized design to eliminate potential biases. The rabbits were provided with feed and water *ad libitum* throughout the experimental period.

Feed Composition and Probiotic Supplementation

The basal diet was formulated to meet the nutritional requirements of growing rabbits, consisting of crude protein (18%), crude fiber (14%), and metabolizable energy (2500 kcal/kg). The diet included durva grass (*Cynodon dactylon*), oat grass (*Avena sativa*), soybean meal, maize, wheat bran, vitamins, and mineral supplements to ensure balanced nutrition.

The probiotic supplement used in this study was purchased from Biovet YC Gold, Vetoquinol India Animal Health Pvt. Ltd., Gurugram, Haryana 122018, India. The supplement was in powdered form and contained a specific blend of probiotic strains along with seaweed powder as a carrier. The exact composition per gram is shown in Table 1.

Table 1. Composition of Probiotics

Ingredients/Probiotic	**Amount (Each gram contains)**
Saccharomyces cerevisiae SC – 47	300 million CFU
Saccharomyces boulardii	50 million CFU
Lactobacillus acidophilus	45 million CFU
Propionibacterium freudenreichii	50 million CFU
Seaweed powder	100 mg

The probiotic supplement was incorporated into the diet at 1g/kg feed (T2) and 2g/kg feed (T3). The formulation was standardized and commercially available, ensuring consistency in bacterial concentration. The probiotic has been reported to enhance gut health, improve nutrient absorption, and support immune function in rabbits (Phuoc and Jamikorn, 2017). The probiotics were mixed thoroughly into the feed before distribution to ensure homogeneity.

Data Collection and Statistical Analysis

Throughout the study, key performance indicators were recorded weekly, including body weight, weight gain, feed intake, and feed conversion ratio (FCR). Feed intake was measured daily by weighing the feed provided and the leftover feed to determine actual consumption.

The collected data were statistically analyzed using R Core Team (2013) and GraphPad Prism (Version 5). A one-way ANOVA was performed to assess significant differences among dietary treatments, while an unpaired t-test was used to compare genotype effects. The standard error of the mean

(SEM) was calculated for all variables. A significance level of P<0.05 was considered statistically meaningful.

By incorporating probiotic supplementation and analyzing its effects on different rabbit genotypes, this study aimed to provide valuable insights into improving rabbit farming efficiency and sustainability.

Results and Discussion

Live Weight

The impact of genotype and probiotic supplementation on live weight is depicted in Figure 1. California White rabbits exhibited a significantly higher live weight than Soviet Chinchilla rabbits from the 11th to 14th weeks (P<0.05).

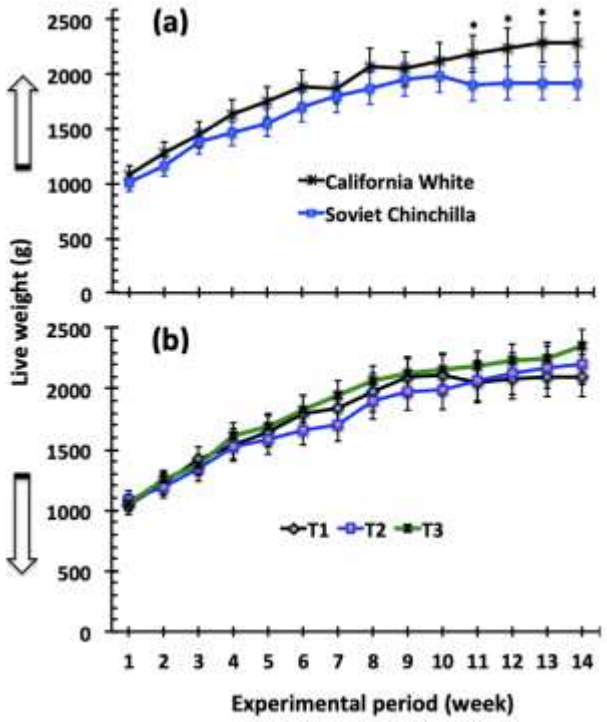

Fig. 1: Effect of (a) genotype and (b) dietary supplementation of probiotics on live weight (g) of post weaned California White rabbits and Soviet Chinchilla rabbits. Each line with error bar represents mean ± SEM value. The same time point indicates significant differences (P<0.05) between the groups of rabbits.

Among the dietary treatments, T3 rabbits demonstrated consistently higher numerical live weights than T1 and T2. This suggests that probiotics contribute positively to growth, possibly due to improved gut health and nutrient absorption. These findings align with Chandra *et al*. (2014) and Fathi *et al*. (2017), who reported improved live weights in rabbits receiving probiotic supplementation. The ability of probiotics to enhance gut microbial diversity and optimize nutrient metabolism has been widely recognized in animal studies (Jha *et al*., 2020).

Live Weight Gain

Live weight gain patterns followed a similar trend, with California White rabbits outperforming Soviet Chinchilla rabbits, particularly in the 3rd-5th and 10th-14th weeks (Fig. 2).

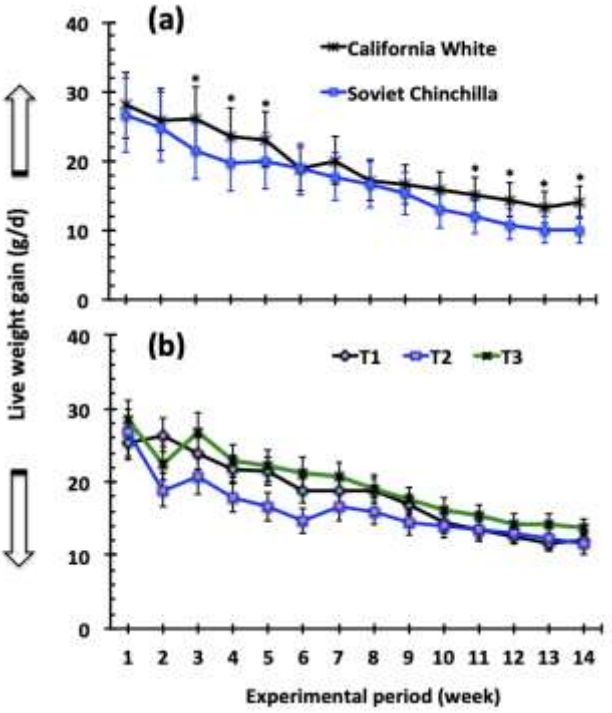

Fig. 2: Effect of (a) genotype and (b) dietary supplementation of probiotics on live weight gain (g/d) of post weaned California White rabbits and Soviet Chinchilla rabbits. Each line with error bar represents mean ± SEM value. The same time point indicates significant differences (P<0.05) between the groups of rabbits.

The probiotic-supplemented groups, particularly T3, exhibited improved weight gain, although not statistically significant. Probiotics are known to enhance nutrient absorption, maintain gut microbiota balance, and reduce intestinal pathogens, which may have contributed to this trend (Bhatt *et al*., 2017; Kritas *et al*., 2008). The observed growth improvements are consistent with previous research suggesting that probiotics optimize digestive processes, leading to enhanced feed efficiency and growth performance. Recent meta-analyses have demonstrated that multi-strain probiotics exert synergistic effects, further improving weight gain and feed efficiency in growing rabbits (Chen *et al*., 2021).

Feed Intake and Feed Efficiency

Probiotic supplementation influenced feed intake, with rabbits in the T3 group showing slightly higher consumption than those in T1 and T2. Improved feed intake in probiotic-supplemented groups is likely due to enhanced gut health, leading to better digestion and nutrient assimilation (Fig. 3).

The feed conversion ratio (FCR) was most efficient in T3 (3.08), compared to T2 (3.53) and T1 (3.35). This supports the hypothesis that probiotic inclusion in diets enhances feed utilization efficiency. Studies by El-Katcha *et al*. (2011) and Oso *et al*. (2013) similarly observed that probiotics improve FCR in rabbits, possibly due to their role in enhancing gut microbial balance and enzymatic activity.

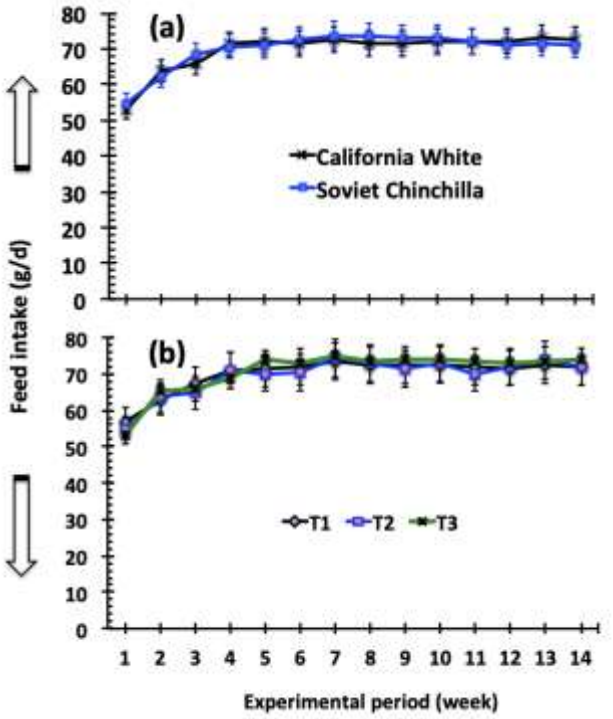

Fig. 3: Effect of (a) genotype and (b) dietary supplementation of probiotics on feed intake (g/d) of post weaned California White rabbits and Soviet Chinchilla rabbits. Each line with error bar represents mean ± SEM value. The same time point indicates significant differences (P<0.05) between the groups of rabbits.

Moreover, the beneficial effects of probiotics on FCR could be attributed to their role in reducing gut inflammation and increasing the bioavailability of nutrients. Probiotic supplementation has been reported to enhance enzyme activity in the digestive tract, leading to improved breakdown and absorption of dietary components (Phuoc and Jamikorn, 2017). These findings suggest that dietary probiotics not only improve growth performance but also optimize nutrient utilization, making rabbit farming more cost-effective.

Health status and mortality

No mortality was recorded in any of the treatment groups throughout the experiment. This indicates that probiotic supplementation may contribute to improved gut health and immune response, reducing the likelihood of disease-related mortality. Previous research has demonstrated that probiotics play a crucial role in enhancing immune function by increasing lymphocyte proliferation and modulating gut microbiota (Aattouri *et al*., 2002; Khaksefidi and Ghoorchi, 2006).

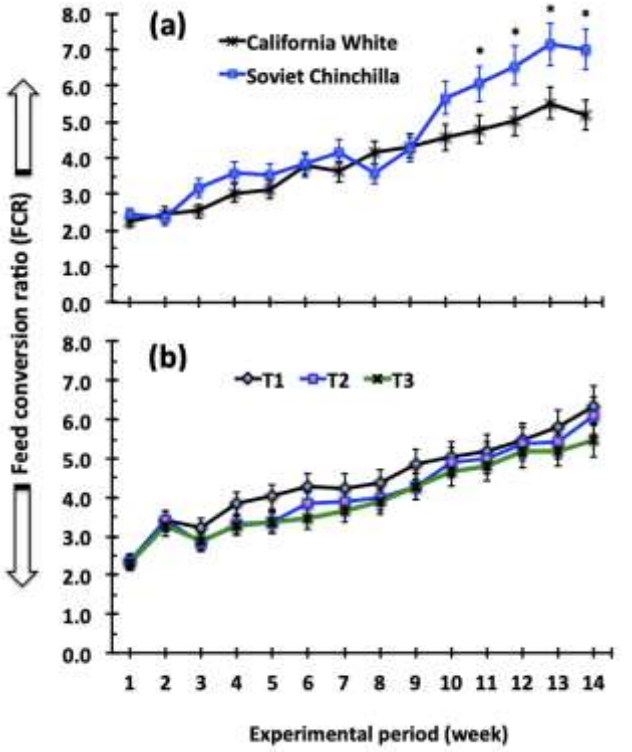

Fig. 4: Effect of (a) genotype and (b) dietary supplementation of probiotics on feed efficiency (shown as feed conversion ratio) of post weaned California White rabbits and Soviet Chinchilla rabbits. Each line with error bar represents mean ± SEM value. The same time point indicates significant differences (P<0.05) between the groups of rabbits.

Additionally, probiotics have been reported to mitigate enteric diseases and improve gut integrity, which may explain the zero-mortality rate in the present study. This aligns with the findings of Ewuola *et al*. (2011), who observed that probiotic supplementation reduced disease susceptibility in rabbits, likely due to improved gut microbial stability. The ability of probiotics to suppress pathogenic bacteria such as *Escherichia coli* and *Clostridium spp.* has been well-documented, further supporting their role in maintaining overall rabbit health (Fathi *et al*., 2017).

Comparative analysis with other livestock

Probiotics have shown promising results in various livestock species beyond rabbits. Studies on poultry and ruminants have indicated similar benefits, including enhanced growth rates, better nutrient digestibility, and improved immune responses (Mookiah *et al*., 2014; Patel *et al*., 2015). In broilers, probiotic supplementation has been linked to higher carcass yields and lower feed costs, emphasizing its potential for cost-effective meat production

(Zhou *et al*., 2020). Given the positive outcomes observed in rabbits, future research should explore the long-term benefits of probiotics in larger-scale livestock production, particularly in buffaloes and cattle, to enhance both meat and milk yields.

Additionally, research on probiotic formulations tailored for specific livestock species could further optimize their efficacy. The use of next-generation probiotics and postbiotics in ruminants has demonstrated promising results in improving fiber digestion, enhancing milk composition, and promoting overall gut health (Yang *et al*., 2022).

Future research and recommendations

While this study provides valuable insights into the effects of probiotics on rabbit growth performance, further investigations are necessary to explore their long-term impact on reproductive efficiency, carcass quality, and gut microbiota composition. Advanced molecular techniques such as metagenomics and next-generation sequencing could offer deeper insights into the specific microbial shifts induced by probiotics. Moreover, economic evaluations should be conducted to determine the cost-benefit ratio of probiotic supplementation in commercial rabbit farming.

Overall, the findings of this study suggest that probiotic supplementation, particularly at 2g/kg feed, enhances growth performance, feed efficiency, and overall health in rabbits. Probiotic use represents a sustainable and effective approach to optimizing livestock productivity while reducing reliance on antibiotics. Future research should focus on multi-strain probiotic formulations and their synergistic effects on different rabbit breeds and other livestock species. Additionally, longitudinal studies evaluating the impact of probiotics on gut microbiota stability, immune responses, and stress resilience in commercial farming conditions would be beneficial in validating their widespread adoption.

Conclusion and Recommendations

This study demonstrates that probiotic supplementation positively affects the growth performance of post-weaned rabbits. California White rabbits showed better growth rates and feed efficiency than Soviet Chinchilla rabbits. Probiotic supplementation at 2g/kg feed (T3) exhibited the highest growth performance, suggesting its potential in commercial rabbit production. Further research is recommended to explore probiotics' role in ruminant livestock, including buffaloes, for meat and milk production.

Authors' Contribution

All of the authors conceptualized and designed the research plan. The experimental works were carried out, performed the data analysis, and the manuscript was drafted collaboratively by Komal Laxmi Osti, Netra Prasad Osti and Manoj Kumar Shah. Abdul Gaffar Miah and Ummay Salma contributed in drafting, critical revision and finalization of the manuscript. All authors approved the final version of the manuscript.

Conflict of Interest

The authors declare that they have no conflict of interest regarding the publication of this paper.

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