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Effect of β-Galacto-Oligosaccharides on Growth Performance in Physiologically Stressed Rabbits

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ABSTRACT

Growth performance analysis under this study evaluated the dietary impact of β-galacto-oligosaccharides (β-GOS). Scientists have established that prebiotic β-GOS promotes health in the gut tissue, thus leading to enhanced productivity alongside improved general health during dexamethasone-induced stress conditions. **Objectives:** To investigate whether the addition of β-GOS to rabbit diets would positively affect their physiology-linked weight gain as well as their feed efficiency and developmental metrics. **Methods:** A 12-week experiment with 40 rabbits belonging to 3 ± 0.98 months of age and weighing 1.48 ± 0.41 kg allocated 8 animals to each dietary treatment group. Among all monitored aspects, live body weight and food intake, and feed conversion efficiency (FCR) were ranked as significant items. Rabbits received feed consumption measurements each day and underwent body weight assessment every week. **Results:** Feeding rabbits β-GOS under stress greatly improved their health and growth performance. Compared to Groups A-D, Group E (D-S15 + 0.3% β-GOS) had the greatest FCR and the largest gain in live body weight. The group that consumed the most feed was Group A (Negative Control). Group E. Conclusions showed the most efficient feed conversion. **Conclusions:** It was concluded that supplementing stressed rabbits with β-GOS can successfully increase their growth, feed conversion efficiency, and general health, providing a useful dietary strategy to alleviate growing deficits caused by stress.

INTRODUCTION

Rabbits are regarded as a prime candidate for meat production due to their brief life span, high prolificacy, brief gestational duration and efficient feed conversion capacity on both grain and forage-based diets [1]. These monogastric hindgut fermenters exhibit a distinctive digestive physiology that enables them to acquire proteins and vitamins via caecotrophy. However, the consumption of rabbits has experienced a worldwide decrease due to concerns regarding consumer approval and the extended duration needed for cooking [2]. Prebiotics and probiotics have emerged as promising strategies for mitigating digestive tract diseases in livestock and enhancing the productivity of the animals. These dietary supplements effectively inhibit carcass contamination while augmenting immune responses among animals. Prebiotics, non-digestible dietary components, selectively promote the growth of beneficial microorganisms in the colon. Several functional oligosaccharides, including galacto-oligosaccharide, mannan-oligosaccharide, chito-oligosaccharide, and fructo-oligosaccharide, have been shown to enhance growth performance and improve the well-being of rabbits [3]. β-Galacto-Oligosaccharide is widely acclaimed for its lacto-bifidogenic property, which enhances gastrointestinal health structure & immune function across both humans and animals [4-6]. However, β-GOS failed to improve broilers' performance under

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thermoneutral conditions originating from Bifidobacterium galactosidase, suggesting variable effects between species [7]. Insufficient information exists regarding the effects of β-GOS on rabbit growth performance in instances of heat stress [8].

Although β-galacto-oligosaccharides (β-GOS) have demonstrated beneficial effects on gut health and growth performance in poultry, swine, and aquaculture species, limited information is available regarding their efficacy in rabbits under physiological stress conditions. Most existing studies have focused on normal rearing environments, with insufficient exploration of prebiotic interventions during dexamethasone-induced stress. Furthermore, dose-dependent responses of β-GOS on growth indices and feed conversion efficiency in stressed rabbits remain inadequately documented. Therefore, a systematic evaluation of graded β-GOS supplementation in physiologically stressed rabbits is warranted. This study aims to evaluate the effect of dietary β-galacto-oligosaccharide on the growth performance of rabbits undergoing physiological stress.

METHODS

Experimental design was used in this study. The rabbits were housed at Animal House, Sindh Agriculture University in Tandojam for a comprehensive study conducted over twelve weeks. A total of forty rabbits, consisting of both male and female individuals aged 3 + 0.98 months old, with an average weight of 1.48 ± 0.41 kg. The rabbits were randomly allocated into five distinct groups, with eight rabbits assigned to each group [9-11]: namely, Group-A=Negative Control (No stress; 0% β-GOS) Group-B=Positive Control-Dexa-stressed 15 mg/kg (D-S 15+0% β-GOS), Group-C (D-S 15+0.1% β-GOS) Group-D (D-S 15+0.2% β-GOS) Group-E (D-S 15 + 0.3% β-GOS). The rabbits were allowed adlib for water via the nipple system. Weekly feed consumption and body weight were recorded, while daily assessments of feed consumption, body weight increase, and feed conversion ratio (FCR) were computed by Abdelatty *et al.,* [12].A basal diet comprising ingredients was administered as control, along with dexamethasone and varying percentages of β-GOS.The feed formula consists of 30% corn, 25% soybean meal, 9% wheat bran, 30% rice husk, 3% fishmeal, 2% di-calcium phosphate, 0.5% salt and 0.45% vitamin-mineral premix per kilogram. Methionine is present at a concentration of .03 % (per kg) while Lysine is present at a concentration of .02 % (per kg). The proximate composition includes metabolizable energy at a rate of 2744 kcal/kg, dry matter 870.47 g/kg and crude protein 180.16 g/kg.Additionally, the feed contains crude fiber (120.64 g/kg), ether extract (110.62 g/kg) and ash (120.05g/kg).Additionally, the antioxidant and carrier limestone $CaCO_3$ [13].All male rabbits (n=8 per treatment) were utilized for the evaluation of growth performance.The weight of the rabbits was documented every week throughout the entirety of the 12-week experiment.The initial weight of each rabbit was recorded upon their arrival, and subsequently measured every week to track their weight gain progress within each group.Fresh food was generously given to the rabbit, and any instances of rejection were noted, measured, and then deducted from the total amount delivered.The final quantity of food consumed was then recorded using the following formula. Motor calculation of feed intake requires subtracting group-level feed denial (g/group/d) from total feed offering (gm).This operation yields the direct product of feed intake (g/b/d).The researchers estimated feed conversion ratio through precise measurements of personal weight growth and eaten feed weight during the 12-week evaluation period using the simple calculation: total consumed feed/total gained weight.The weekly feed intake calculation was performed using this data to compute the FCR ratio through the equation: Feed intake / Body Weight growth. The FCR calculation for each rabbit proceeded through DMI/ADG ratio assessment after researchers measured and recorded beginning and ending body weights and ADG and DMI data. A fully randomized design (CRD) was used to analyze the data collected through the statistical program for social sciences (SPSS version 20.0) by presenting mean ± standard error of the mean (SEM).Tukey's Test evaluated group differences using $p<0.05$ as the significance threshold.

RESULTS

Data indicate that significantly maximum ($p<0.05$) live body weight (2400 ± 61g) was noted in group E (basal diet + D-S 15 + 0.3% β-GOS) as compared to Group-B (Negative control No stress, 0% β-GOS), group C (basal diet + D-S 15 + 0.1% β-GOS) and Group-D (basal diet + D-S 15 + 0.2 β-GOS) with average live body weight (2200 ± 48g, 2300 ± 32g and 2350 ± 40g), respectively. Significantly minimum ($p<0.05$) live body weight (2100 ± 40g) was recorded from group A=Positive Control-Dexa- stressed 15 mg/kg (D-S 15+0% β-GOS). Statistical analysis of the live body weight data between groups revealed essential differences based on the $p<0.05$ criterion. Five separate groups exhibited significant differences from each other according to the Tukey HSD test results. The research findings indicated that β-galacto-oligosaccharides reacted according to the body weight levels of the rabbits. The results regarding β-galacto-oligosaccharides supplement impacts on rabbit live body weight, presented in Figure 1.

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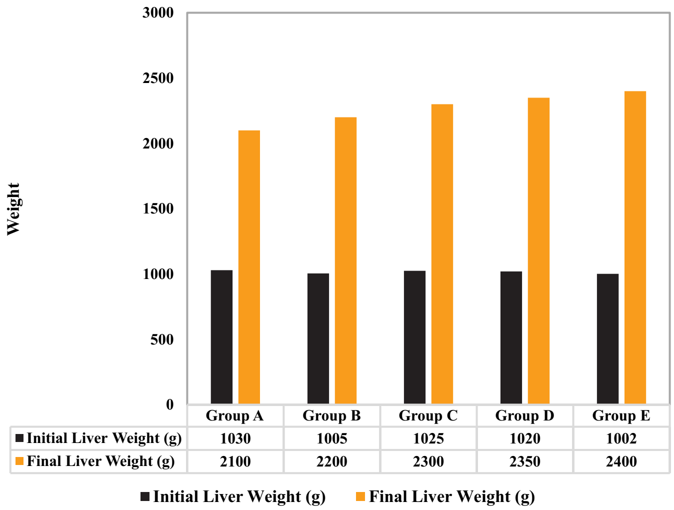

Figure 1: Effect of β-Galacto-Oligosaccharides Supplementation on Body Weight (G) of Growing Rabbits

Data indicates that significantly maximum ($p<0.05$) feed intake (220 ± 4g) was noted in Group A=Positive Control-Dexa-stressed 15 mg/kg (D-S 15+0% β-GOS), as compared to Group B (Negative control No stress, 0% β-GOS), Group C (basal diet + D-S 15 + 0.1% β-GOS) and Group D (basal diet + D-S 15 + 0.2 β-GOS) with average feed intake (215 ± 6, 210 ± 3g and 200 ± 4g), respectively. Significantly minimum ($p<0.05$) feed intake (190±3g) was recorded from Group E (basal diet + D-S 15 + 0.3% β-GOS). All groups showed distinct ($p<0.05$) differences in their feed consumption based on statistical evaluation of gathered data.The data analysis demonstrated four distinct groups as separated by Tukey's HSD test to each possess a different level of significance when compared to other groups This indicated that the effect of β-galacto-oligosaccharides was dose-dependent on the feed intake of the rabbits. Results on the effects of β-galacto-oligosaccharides supplementation on feed intake of rabbits are presented in Figure 2.

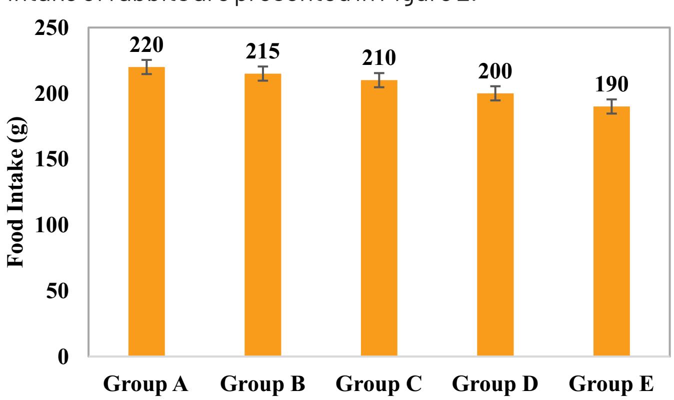

Figure 2: Effect of β-Galacto-Oligosaccharides Supplementation on Feed Intake (G) of Growing Rabbits

Data indicates that significantly maximum ($p<0.05$) body weight gain (80 ± 0.5 g) was noted in Group E (basal diet + D-S 15 + 0.3% β-GOS) as compared to Group B (Negative control No stress, 0% β-GOS), Group C (basal diet + D-S 15 + 0.1% β-GOS) and Group D (basal diet + D-S 15 + 0.2 β-GOS) with average body weight gain (60 + 0.8, 70 + 0.2 and 75 ± 0.5g), respectively. Significantly minimum ($p<0.5$) body weight gain (50 ± 0.4g) was recorded from Group A = Positive Control-Dexa-stressed 15 mg/kg (D-S 15+0% β-GOS). Statistical analysis of data revealed a significant ($p<0.05$) difference in body weight gain among all groups. According to Tukey's HSD test, there were five distinct groups which were significantly different from each other. This indicated that the effect of β-galacto-oligosaccharides was dose-dependent on live body weight gain of the rabbits. Results on the effects of β-galacto-oligosaccharides supplementation on body weight gain of rabbits are mentioned in Figure 3.

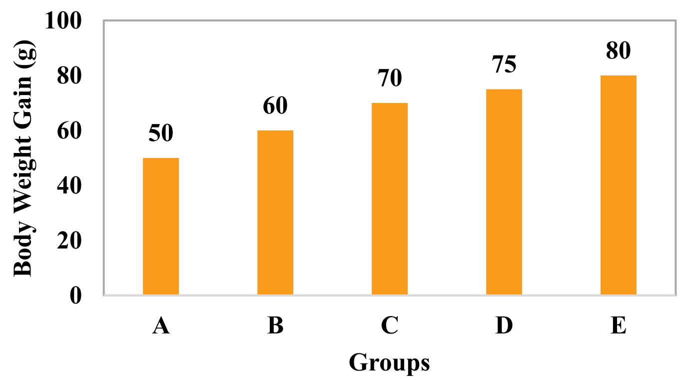

Figure 3: Effect of β-Galacto-Oligosaccharides Supplementation on Body Weight Gain (G) of Growing Rabbits

Data indicates that significantly minimum ($p<0.05$) FCR (2.38 ± 0.2) was noted in group E (basal diet + D-S 15 + 0.3% β-GOS) as compared to Group B (Negative control No stress, 0% β-GOS), Group C (basal diet + D-S 15 + 0.1% β-GOS) and Group D (basal diet + D-S 15 + 0.2 β-GOS) with average live body weight average FCR (3.58 + 0.02, 3.00 ± 0.3 and 2.67 ± 0.2), respectively. Significantly maximum ($p<0.05$) FCR (4.4 ± 0.01) was recorded from Group A=Positive Control-Dexa-stressed 15 mg/kg (D-S 15+0% β-GOS). Statistical analysis of data revealed a significant ($p<0.05$) difference in FCR among all groups. According to Tukey's HSD test, there were five distinct groups which were significantly different from each other. This indicated that the effect of β-galacto-oligosaccharides was dose-dependent on the FCR of the rabbits. Results on the effects of β-galacto-oligosaccharides supplementation on FCR of rabbits are mentioned in Figure 4.

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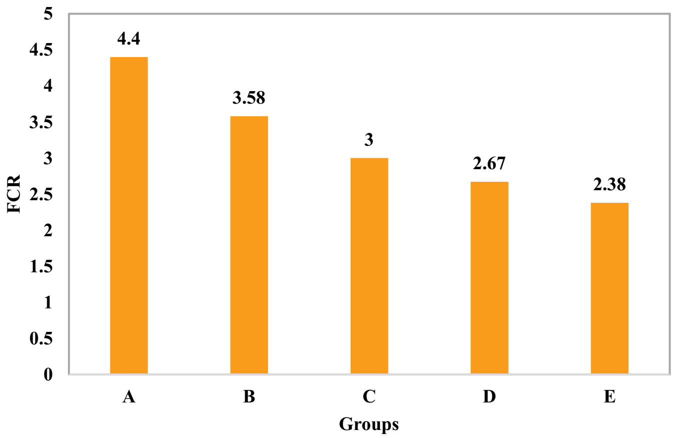

Figure 4: Effect of β-Galacto-Oligosaccharides Supplementation on the Feed Conversion Ratio of Growing Rabbits

DISCUSSION

Studies have shown that incorporating prebiotics in the diet of broiler chickens can enhance growth by using non-antibiotic supplements, leading to improvements in growth parameters without any adverse effects on consumers [14]. Moreover, the discoveries regarding the beneficial impacts of prebiotics on growth performance were observed [15]. Beta-Galacto-oligosaccharide (Beta-GOS) promotes the proliferation of beneficial microorganisms in the gastrointestinal tract, particularly bifidobacteria and lactobacilli, consequently enhancing gut health and immune response [16]. Improved gastrointestinal health can result in enhanced breakdown and absorption of nutrients, thereby leading to increased utilization of feed and, subsequently, enhanced growth performance. Research has indicated that incorporating β-GOS into the diet can enhance intestinal health, boost the immune system, and stimulate growth performance in poultry [17], pigs [18], and fish [19]. The inclusion of dexamethasone in the rabbit's diet led to a reduced amount of weight loss when compared to the control group. Although previous studies have shown comparable effects on body weight in different animal species, our results differed from these findings. These variations may be attributed to individual differences and inconsistencies in the experimental approaches. Numerous variables, such as environment, diet, and heredity, affect the complex system of weight control [20, 21].Our results are in line with other studies that indicate stress has a detrimental effect on rabbits' ability to develop [22, 23]. Compared to the healthy control group, the rabbits in the positive control group gained less weight, fed less effectively, and had a higher feed conversion ratio.The study found that supplementing with β-GOS improved growth performance. When contrasted to the untreated stressed group, our research showed that the rabbits who got β-GOS supplementation had significantly higher body weight growth and greater utilization of feed.A notable improvement in the feed conversion ratio suggests that feed resources are being used more efficiently. As seen by Group B's slower growth rate than all other groups, our study's astounding findings exposed the detrimental impacts of stress on rabbits' development capabilities. This discovery aligns with prior research suggesting that stress can result in diminished weight gain, decreased feed intake, and reduced feed efficiency [22, 23]. Rabbits in Groups C-E with β-GOS had higher body weights than Groups A-B with basal diet or basal diet with dexamethasone.Study findings are consistent with past research, showing prebiotics improve weight gain in animal models [24].Rabbits given Biotronic showed improved growth, consistent with the study [25] on prebiotics and animal growth.Prebiotic supplementation can lead to increased body weight in animals due to various mechanisms. Prebiotics act as substrates for beneficial gut bacteria, promoting their growth and metabolic functions, resulting in increased fermentation and production of short-chain fatty acids. The energy usage efficiency improved due to Biotronic consumption leading to weight gain in rabbits. The use of prebiotics improves nutrient absorption that accelerates both growth and body weight increase. The scientific research on prebiotics reveals that they strengthen animal immunity while improving nutrient uptake in animals and reducing stress effects on growing efficiency. This research shows Biotronic alongside β-galacto-oligosaccharide cause rabbits to gain more weight over 12 weeks. Biotronic acts to enhance immune response alongside energy management and nutritional uptake, thus supporting constant growth [26]. During a 12-week experiment, the rabbits fed with the standard diet (Group A-B) ate greater daily amounts than those consuming Biotronic prebiotic (Group C-E). Animal appetite and feed intake increase when prebiotics, including Biotronic, are added to the diet. The production of short-chain fatty acids increases through prebiotic support of gut bacterial growth. The research on rabbit populations indicates that Biotronic supplementation drives animals to consume more food because of its effects on both appetite and nutritional absorption. The supplements improve consumption by enhancing food taste as well as digestive performance. Professional studies verify that prebiotics enhance food consumption in animals, including pigs, through their effects on intestinal microorganisms and digestive processes. Research studies show that rabbits who receive prebiotic supplements in Biotronic eat more food because of hunger stimulation and better flavor absorption, and nutrient utilization [27]. Rabbits measure feed efficiency through the analysis of feed conversion ratio (FCR). The FCR measurements for Group C-E subjects revealed better numbers than those recorded for Group A-B subjects.The

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feed conversion ratio improves according to these results. Oral consumption of prebiotics helps rabbits absorb their diet better and leads to a reduction in feed conversion ratio. Prebiotic supplements operate as a dual-purpose agent for both immune system enhancement and the treatment of stress-triggered efficiency breakdowns. Research demonstrates that prebiotic consumption leads to better FCR according to [28]. The results of this study established that prebiotic dietary supplements produce favorable impacts on growth indicators. These substances both reduce the feed conversion ratio and enhance overall physical health. The New literature [29] established that prebiotics improve rabbit development as reported by [30]. To fully understand how these supplements affect the immune system and gut flora, further study is needed.

This study is limited by its relatively small sample size and confinement to growth performance parameters without detailed evaluation of gut microbiota composition, immune biomarkers, or intestinal histomorphology. Additionally, the experiment was conducted under controlled conditions, which may limit extrapolation to commercial rabbit production systems. Future research should incorporate molecular and microbiological analyses to elucidate mechanistic pathways, assess long-term health and reproductive outcomes, and evaluate economic feasibility under field conditions to strengthen the practical application of β-GOS supplementation in rabbit production.

CONCLUSION

It was concluded that supplementing stressed rabbits with β-GOS can successfully increase their growth, feed conversion efficiency, and general health, providing a useful dietary strategy to alleviate growing deficits caused by stress.

Authors' Contribution

Conceptualization: JAS
Methodology: JAS, GAM, TJS
Formal analysis: ABK, SAS, GAM
Writing and Drafting: JAS
Review and Editing: JAS, ABK, SAS, GAM, TJS

All authors approved the final manuscript and take responsibility for the integrity of the work.

Conflicts of Interest

All the authors declare no conflict of interest.

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