Jammu Kashmir J. Agri., 04 (01) 2024. 1-13 DOI: 10.56810/jkjagri.004.01.0120

Faculty of Agriculture, University of Poonch Rawalakot
Jammu Kashmir Journal of Agriculture
ISSN: 2958-3756 (Online), 2958-3748 (Print)
https://jkjagri.com/index.php/journal

EFFECTS OF DIETARY PREBIOTICS, PROBIOTICS AND SYMBIOTICS ON GROWTH PERFORMANCE, CARCASS CHARACTERISTICS, BODY CONDITION SCORE AND NUTRIENTS DIGESTIBILITY OF RABBITS

[a]Samina Memon, [a]Allah Bux Kachiwal, [a]Mool Chand Malhi, [b]Gulfam Ali Mughal

[a]Department of Veterinary Physiology and Biochemistry, Faculty of Animal Husbandry and Veterinary Sciences, Sindh Agriculture University Tandojam, Pakistan.
[b]Department of Animal Nutrition, Faculty of Animal Husbandry and Veterinary Sciences, Sindh Agriculture University Tandojam, Pakistan.

A B S T R A C T

Present study was carried out on thirty-two rabbits that were housed in individual wooden cages during the 12-week experimental period. Results indicates that significantly (P<0.05) maximum live body weight (2484.88±165.5g) was noted in group D as compared to group B (2306.25±241.78g), group C 2249.63±199.79g) and minimum live body weight (2083.88±248.66g) was recorded from group A. Significantly (P<0.05) maximum daily feed intake (97.19±0.65 g) was noted in group D as compared to group B (94.55±0.60g), group C (89.09±0.83g) and minimum daily feed intake (85.79±0.63g) was recorded from group A. Significantly (P<0.05) better FCR (2.75±1.19) was noted in group D as compared to group B (3.13±1.13), and group C (3.60±1.22). Poor FCR (3.87±1.01) was recorded from group A. BCS of group B, C D was recorded as ideal (3±0). BCS was recorded as thin (2±0) in group A. Significantly (P<0.05) maximum carcass weight (1915.68±243.55g) was noted in group D as compared to group B (1604.43±204.67g), group C (1355.28±184.69g) and minimum carcass weight (1000.10±125.34g) was recorded from group A. Significantly (P<0.05) maximum dry matter digestibility (61.50±0.93%) was noted in group D as compared to group B (60.88±1.73%), group C (55.88±1.46%) and minimum dry matter digestibility (54.38±1.69%) was recorded from group A. Maximum crude fiber digestibility (53.50±1.93%) was noted in group A as compared to group C and group B (35.63±2.33% and 28.75±2.60%) and minimum crude fiber digestibility (15.50±1.51%) was recorded from group D. Maximum ash digestibility (50.75±1.49%) was noted in group A as compared to group C and group B (48.50±1.60% and 35.63±1.60%), respectively. Minimum ash digestibility (28.13±1.55%) was recorded from group D. Maximum nitrogen free extract digestibility (73.13±1.89%) was noted in group A as compared to group C and group B (66.75±2.12% and 56.88±1.36%), respectively. Minimum nitrogen free extract digestibility (42.25±2.43%) was recorded from group D. Statistical analysis of data revealed significant (P<0.05) difference in crude fiber, ash and nitrogen free extract digestibility.

Keywords: Probiotics; FCR; BCS; Carcass characteristics; Nutrients digestibility

Corresponding Author: Samina Memon
Email: drsamina80@gmail.com

Article history
Received: January 09th, 2024
Revised: February 13th, 2024
Accepted: February 20th, 2024

INTRODUCTION

Rabbits are an important livestock species worldwide, and their health and growth are essential for the success of rabbit farming. Several factors, including nutrition, genetics, and management, can affect the growth and immune response of rabbits. Prebiotics and probiotics are dietary supplements that have been used in various livestock species, including rabbits, to promote growth and enhance the immune response (Sun et al., 2020). Commercial rabbit production is an important industry for meat, fur, and leather production. Disease has always been a critical issue in animal production, affecting not only animal health and well-being but also the physical and economic condition of the producer. The gut microbiota is a complex ecosystem of microorganisms that inhabit the intestinal tract and perform various essential functions, such as aiding in digestion, nutrient absorption, and immune regulation. The balance and diversity of the gut microbiota are crucial for the health and well-being of the host. Dysbiosis, which refers to an imbalance in the gut microbiota, can lead to various health issues, such as inflammation, metabolic disorders, and infections (Zeng et al., 2021). Probiotics have been introduced as an alternative to antibiotics. Probiotics come under the category of as Generally Recognized as Safe (GRAS) ingredients classified by Food and Drug Administration (FDA) (Bansal et al., 2011). Probiotics are nonpathogenic bacteria that exert a beneficial influence on the health or physiology (or both) of the host, it neither has any residues in animal production nor exerts any antibiotic resistance by consumption (Rajput and Li, 2012).

Dietary supplementation with prebiotics and probiotic increased the body weight, daily weight gain, and feed conversion ratio of rabbits, as well as enhanced their immune response by increasing the serum IgG and IgM levels (Wang et al., 2020). Moreover, probiotic supplementation enhanced the immune response of rabbits by increasing the serum levels of IgG and IgM and the activity of natural killer cells (Yang et al., 2022). Fructooligosaccharides (FOS) supplementation increased the abundance of beneficial bacteria, such as Lactobacillus and Bifidobacterium, and decreased the abundance of harmful bacteria, such as Escherichia coli, in the gut of rabbits. Moreover, FOS supplementation improved the growth performance of rabbits by increasing the average daily gain and feed conversion ratio (Wen et al., 2018).

Prebiotics and probiotics are promising dietary supplements that can improve the growth and immune response of rabbits. These supplements modulate the gut microbiota, which plays a crucial role in the health and well-being of rabbits. Prebiotics mainly include fructooligosaccharides, inulin, and galactooligosaccharides. In contrast, probiotics are live microorganisms that confer health benefits to the host when consumed in adequate amounts (Sun et al., 2020). Various kinds of prebiotics and probiotics, as natural biological response modifiers, have the ability to enhance host defense mechanisms against infections and have been evaluated based on preventive and therapeutic effects on infectious diseases (El-Abasy, 2002).

The use of prebiotics and probiotics in animal feed has gained increasing attention due to their potential benefits, including improving growth performance, feed efficiency, and immune response, as well as reducing the incidence of diseases and antibiotic use. Several studies have investigated the effects of prebiotics and probiotics on the gut microbiota and health of rabbits. However, the optimal dosage, timing, and duration of prebiotic and probiotic supplementation for rabbits are still unclear and require further investigation (Jin et al., 2017). Moreover, the effects of different types and combinations of prebiotics and probiotics on the gut microbiota and health of rabbits need to be explored. Therefore, the purpose of this study is to evaluate the effects of dietary prebiotic, probiotic and symbiotic on growth performance, carcass characteristics and nutrients digestibility in rabbits.

MATERIALS AND METHODS

Experimental plan and feeding trial

Thirty-two rabbits (180 days old; mean weight, 1000-1500 g) were procured from the Hyderabad Market and reared at the Department of Veterinary Physiology and Biochemistry, Faculty of Animal Husbandry and Veterinary Sciences, Sindh Agriculture University Tando Jam, Sindh, for the experiment. All the rabbits were housed in individual wooden cages (55 cm x 40 cm x 40 cm) during the 12-week experimental period. The rabbits had access to water and feed ad-libitum twice daily at 08:00 and 16:00. The rabbits were randomly assigned to four dietary treatments in a completely randomized design. Four diets were formulated, including the control (basal diet), diet 2 (prebiotics: Biotronic® at 4 kg/ton), diet 3 (probiotics: Biovet®-YC at 500 g/ton), and diet 4 (symbiotics: the combination of both Biotronic® and Biovet®-YC at the recommended rate above). The prebiotic used was Biotronic®, which contains fructo-oligosaccharides and organic acids. The probiotic used was Biovet®-YC, which contains Lactobacillus acidophilus (45,000 million cfu), Saccharomyces cerevisiae (125,000 million cfu), Saccharomyces boulardii (30,000 million cfu), alpha-amylase, and seaweed powder. The diets were formulated to meet the nutrient requirements of rabbits recommended by the NRC (2000) and contained no antibiotics (Table 1).

The experimental rabbits were randomly selected based on body weight. The initial weight of each experimental rabbit was measured on the 1st day of the experiment, and subsequent body weights were recorded weekly for each group. The final body weight was noted at the end of the experiment. The experimental birds were carefully weighed using an electronic digital balance, and the weight of each rabbit was recorded in grams. Live body weight gain was calculated using the formula: Final weight - initial weight = Live body weight gain. The formulated diets were weighed daily, and any feed refused at the end of the week was also recorded. Feed intake was determined by subtracting the refused diet from the offered diet. Feed intake per rabbit was calculated by dividing the total diet consumed by the number of rabbits in each replicate. The feed conversion ratio was calculated as feed intake per kg divided by body weight gain in kg. The BCS of the animals was assessed using the score proposed by the PFMA (2022). The score ranged from 1 to 5 and it was assigned based on a visual and tactile examination of the rabbits. The scheme scores a rabbit on its body condition, where 1 = very thin, 2 = thin, 3 = ideal, 4 = overweight, and 5 = obese, focusing on assessment of bone prominence, muscle mass, and abdominal waistline. Five rabbits per treatment was selected, fasted overnight, stunned and euthanized at the end of the feeding trial for carcass evaluation.

Table 1. Gross composition (%) of experimental diets for growing rabbits.

Ingredients (%)	1(control)	2(prebiotics*)	3(probiotics**)	4(symbiotics***)
Maize	30	30	30	30
Soybean meal	25	25	25	25
Wheat offal	9	9	9	9
Rice husk	30	30	30	30
Fish meal	3	3	3	3
DCP	2	2	2	2
Salt	2	2	2	2
Premix	0.45	0.45	0.45	0.45
Lysine	0.05	0.05	0.05	0.05
Total	100	100	100	100
Calculated nutrients				
Digestible energy (kcal/kg)	2744	2744	2744	2744
Crude Protein (%)	16.19	16.19	16.19	16.19
Crude fibre (%)	10.18	10.18	10.18	10.18

*Prebiotics (Biotronic®) inclusion rate at 4kg/ton, **Probiotics (Biovet®-YC) inclusion rate at 500g/ton, ***symbiotic: Prebiotics (Biotronic®) + Probiotics (Biovet®-YC) at normal inclusion rate. DCP- Dicalcium phosphate

Each animal was skinned, eviscerated and cut to various body parts or regions (head, neck, chest, loin, arms and legs) and weighed. During the last week of the experiment, fecal droppings from each animal was collected, weighed, mixed and aliquots was taken daily. The daily aliquots and the respective feed samples for each animal was oven-dried in an air circulating oven at 105 ℃ for 24 hours (to determine their dry matter contents) for further analyses. The chemical compositions of the experimental diets (Table 1) and fecal samples collected, which was used to calculate the apparent digestibility of dry matter (DM), crude protein (CP), ether extract (EE), crude fibre (CF), ash and nitrogen-free extract (NFE), was determined by the method of AOAC (2012).

Nutrient digestibility was calculated by using following formula:

$$\text{Nutrient digestibility} = \frac{\text{Total nutrients in feed} - \text{nutrients in feces}}{\text{Total nutrients in feed}} \times 100$$

Statistical Analysis

The data was subjected to statistical analysis using statistics 8.1 computer software (Statistix ver. 8.1). The differences among the treatments were compared by the least significant difference (LSD) test, where necessary.

RESULTS

Body weight (g)

Results on the dietary effects of prebiotic, probiotic and symbiotic supplementation on live body weight of rabbits is mentioned in Figure 1. Data indicates that maximum live body weight (2484.88±165.5g) was noted in group D (basal diet + symbiotic: the combination of both Biotronic® and Biovet®-YC) as compared to group B (basal diet + prebiotic: Biotronic®) and group C (basal diet + probiotic: BioVet®-YC) with average live body weight (2306.25±241.78g and 2249.63±199.79g), respectively. Minimum live body weight (2083.88±248.66g) was recorded from group A (control; basal diet). Statistical analysis of data revealed significant ($P<0.05$) difference in live body weight among all groups. According to Tukey's HSD test there were three distinct group which were significantly different from each other.

Daily feed intake (g)

Results on the effects of dietary prebiotic, probiotic and symbiotic supplementation on daily feed intake of rabbits are mentioned in Figure 2. Data indicates that maximum daily feed intake (97.19±0.65 g) was noted in group D (basal diet + symbiotic: the combination of both Biotronic® and Biovet®-YC) as compared to group B (basal diet + prebiotic: Biotronic®) and group C (basal diet + probiotic: BioVet®-YC) with average daily feed intake (94.55±0.60g and 89.09±0.83g), respectively. Minimum daily feed intake (85.79±0.63g) was recorded from group A (control; basal diet). Statistical analysis of data revealed significant ($P<0.05$) difference in daily feed intake among all groups. According to Tukey's HSD test there were four distinct group which were significantly different from each other.

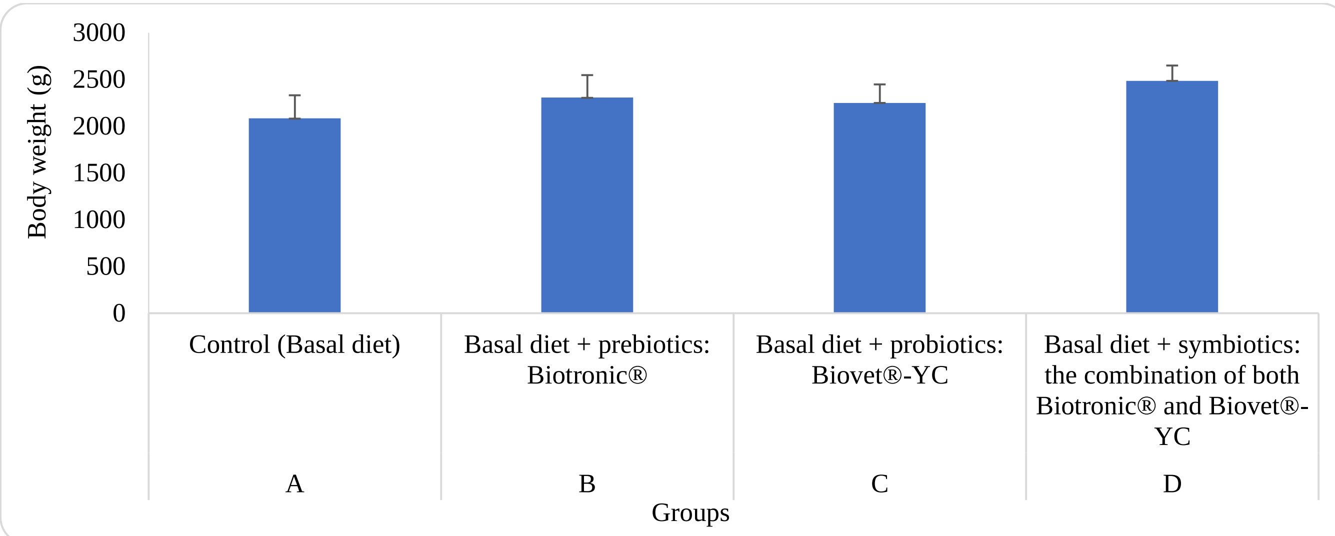

Figure 1. Body weight (g) of rabbits fed dietary prebiotic, probiotic and symbiotic.

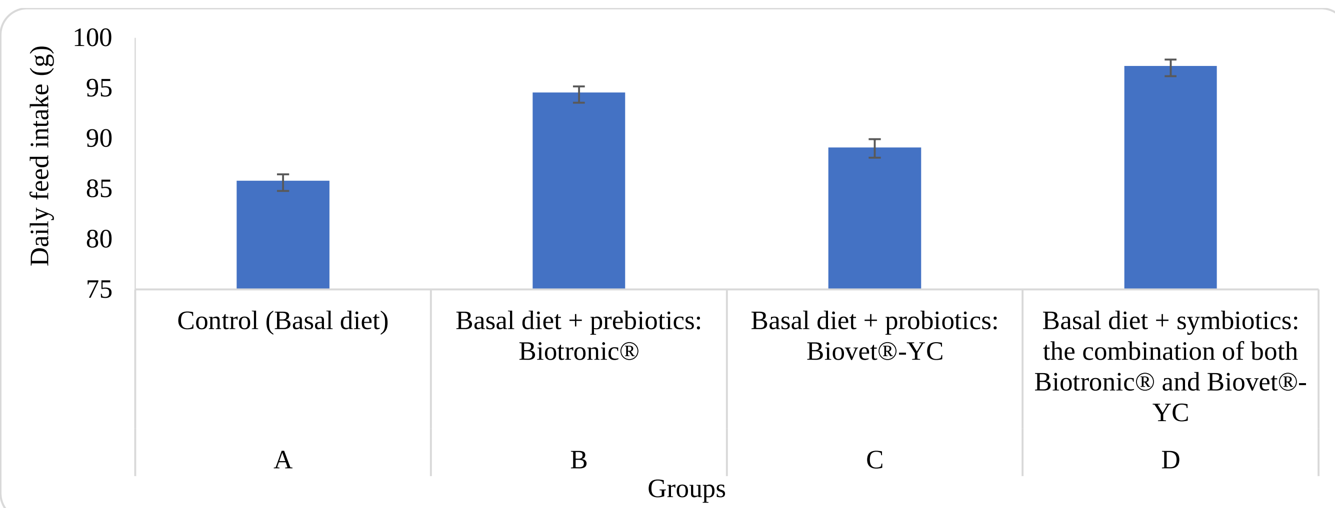

Figure 2. Daily feed intake (g) of rabbits fed dietary prebiotic, probiotic and symbiotic.

Feed conversion ratio (FCR)

Results on the effects of dietary prebiotic, probiotic and symbiotic supplementation on FCR of rabbits are mentioned in Figure 3. Data indicates that better FCR (2.75±1.19) was noted in group D (basal diet + symbiotic: the combination of both Biotronic® and Biovet®-YC) as compared to group B (basal diet + prebiotic: Biotronic®) and group C (basal diet + probiotic: BioVet®-YC) with average FCR (3.13±1.13 and 3.60±1.22), respectively. Poor FCR (3.87±1.01) was recorded from group A (control; basal diet). Statistical

 DOI: 10.56810/jkjagri.004.01.0120

analysis of data revealed significant ($P<0.05$) difference in FCR among all groups. According to Tukey's HSD test there were three distinct group which were significantly different from each other.

Body condition score (BCS)

Results on the effects of dietary prebiotic, probiotic and symbiotic supplementation on body condition score of rabbits are mentioned in Figure 4. The scheme scores a rabbit on its body condition, where 1 = very thin, 2 = thin, 3 = ideal, 4 = overweight, and 5 = obese, focusing on assessment of bone prominence, muscle mass, and abdominal waistline. Data indicates that body condition score of group B (basal diet + prebiotic: Biotronic®), group C (basal diet + probiotic: BioVet®-YC), and group D (basal diet + symbiotic: the combination of both Biotronic® and Biovet®-YC) was recorded as ideal (3±0). Body condition score was recorded as thin (2±0) in group A (control; basal diet).

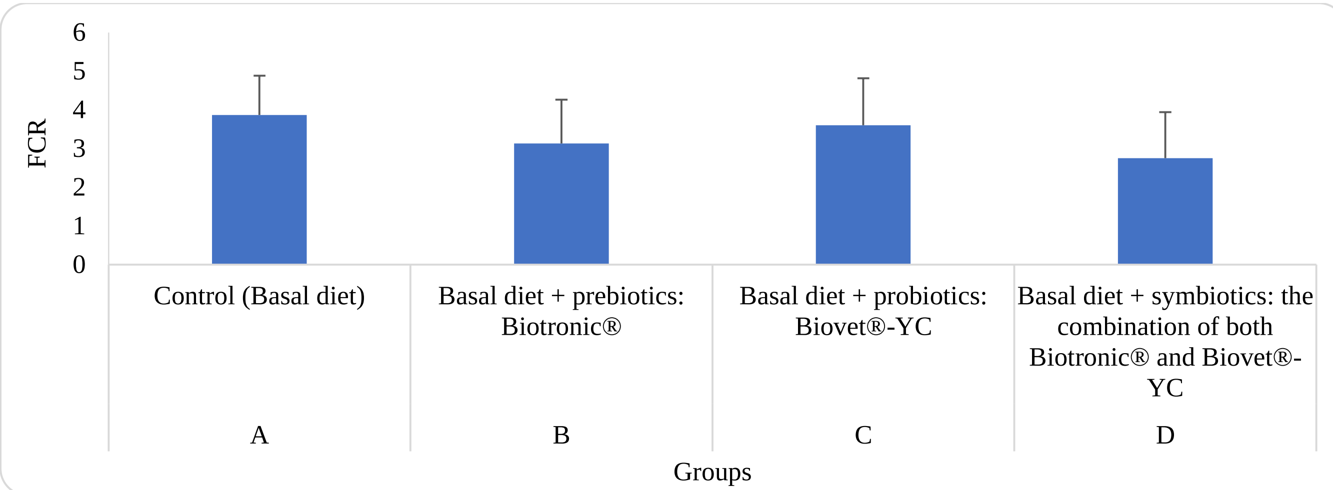

Figure 3. FCR of rabbits fed dietary prebiotic, probiotic and symbiotic.

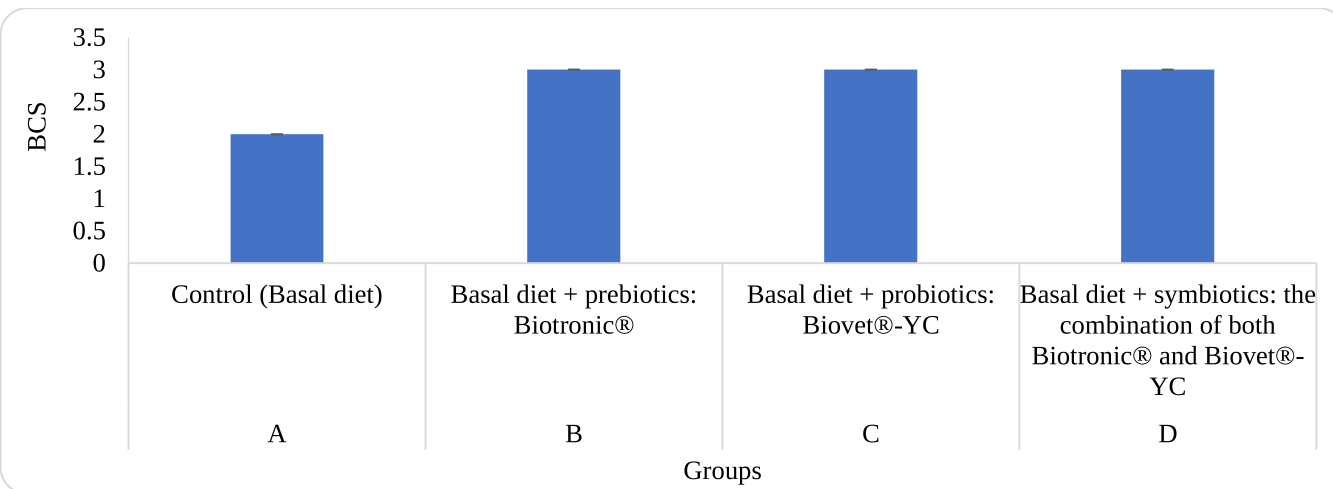

Figure 4. Body condition score of rabbits fed dietary prebiotic, probiotic and symbiotic.

Carcass characteristics of rabbits fed dietary prebiotic, probiotic and symbiotic

Head weight (g)

Results on the effects of dietary prebiotic, probiotic and symbiotic supplementation on head weight of rabbits are mentioned in Table 2. Data indicates that head weight in group A (control; basal diet) was (7.66±0.05 g), group B; (basal diet + prebiotic: Biotronic®) (7.62±0.03 g), group C; (basal diet + probiotic: BioVet®-YC) (7.64±0.04 g) and group D; (basal diet + symbiotic: the combination of both Biotronic® and Biovet®-YC) (7.65±0.06 g), respectively. Statistical analysis of data revealed non-significant ($P>0.05$)

difference in head weight among all groups.

Neck weight (g)

Results on the effects of dietary prebiotic, probiotic and symbiotic supplementation on neck weight of rabbits are mentioned in Table 2. Data indicates that maximum neck weight (1.92±0.06g) was noted in group D (basal diet + symbiotic: the combination of both Biotronic® and Biovet®-YC) as compared to group B (basal diet + prebiotic: Biotronic®) and group C (basal diet + probiotic: BioVet®-YC) with average neck weight (1.83±0.11g and 1.82±0.08g), respectively. Minimum neck weight (1.78±0.15g) was recorded from group A (control; basal diet). Statistical analysis of data revealed significant (P<0.05) difference in neck weight among all groups. According to Tukey's HSD test there were three distinct group which were significantly different from each other.

Rack weight (g)

Results on the effects of dietary prebiotic, probiotic and symbiotic supplementation on rack weight of rabbits is mentioned in Table 2. Data indicates that maximum rack weight (8.48±0.06g) was noted in group D (basal diet + symbiotic: the combination of both Biotronic® and Biovet®-YC) as compared to group B (basal diet + prebiotic: Biotronic®) and group C (basal diet + probiotic: BioVet®-YC) with average rack weight (8.11±0.08g and 8.09±0.04g), respectively. Minimum rack weight (7.87±0.08g) was recorded from group A (control; basal diet). Statistical analysis of data revealed significant (P<0.05) difference in rack weight among all groups. According to Tukey's HSD test there were two distinct group which were significantly different from each other.

Table 2. Carcass characteristics of rabbits fed dietary prebiotic, probiotic and symbiotic.

Parameters	Group A	Group B	Group C	Group D	P-value
	Control (Basal diet)	Basal diet + prebiotics: Biotronic®	Basal diet + probiotics: Biovet®-YC	Basal diet + symbiotics: the combination of both Biotronic® + Biovet®-YC	
Head (g)	7.66±0.05	7.62±0.03	7.64±0.04	7.65±0.06	0.1763
Neck (g)	1.78±0.15b	1.83±0.11ab	1.82±0.08ab	1.92±0.06a	0.0448
Rack (g)	7.87±0.08b	8.11±0.08a	8.09±0.04a	8.48±0.06a	0.0317
Loin (g)	10.85±0.06b	11.37±0.06a	10.91±0.06b	11.80±0.05a	0.0285
Skin (g)	8.46±0.05	8.63±0.03	8.58±0.03	8.64±0.04	0.1347
Left Legs (g)	8.81±0.09b	9.06±0.08a	8.98±0.09b	9.27±0.11a	0.0381
Left Arms (g)	2.84±0.11b	3.47±0.16a	2.91±0.15b	3.75±0.21a	0.0117
Right Legs (g)	8.67±0.05b	9.10±0.05a	9.07±0.25a	9.29±0.07a	0.0281
Right Arms (g)	2.35±0.27b	3.67±0.21a	3.60±0.23a	3.79±0.21a	0.0175

Loin weight (g)

Results on the effects of dietary prebiotic, probiotic and symbiotic supplementation on loin weight of rabbits is mentioned in Table 2. Data indicates that maximum loin weight (11.80±0.05g) was noted in group D (basal diet + symbiotic: the combination of both Biotronic® and Biovet®-YC) as compared to group B (basal diet + prebiotic: Biotronic®) and group C (basal diet + probiotic: BioVet®-YC) with average loin weight (11.37±0.06g and 10.91±0.06g), respectively. Minimum loin weight (10.85±0.06g) was recorded from group A (control; basal diet). Statistical analysis of data revealed significant (P<0.05) difference in loin weight among all groups. According to Tukey's HSD test there were two distinct group which were significantly different from each other.

Skin weight (g)

Results on the effects of dietary prebiotic, probiotic and symbiotic supplementation on skin weight of rabbits is mentioned in Table 2. Data indicates that skin weight in group A (control; basal diet) was (8.46±0.05g), group B; (basal diet + prebiotic: Biotronic®) (8.63±0.03g), group C; (basal diet + probiotic: BioVet®-YC) (8.58±0.03g) and group D; (basal diet + symbiotic: the combination of both Biotronic® and Biovet®-YC) (8.64±0.04g), respectively. Statistical analysis of data revealed non-significant (P>0.05) difference in skin weight among all groups.

Left legs weight (g)

Results on the effects of dietary prebiotic, probiotic and symbiotic supplementation on left legs weight of rabbits is mentioned in Table 2. Data indicates that maximum left legs weight (9.27±0.11g) was noted in group D (basal diet +

symbiotic: the combination of both Biotronic® and Biovet®-YC) as compared to group B (basal diet + prebiotic: Biotronic®) and group C (basal diet + probiotic: BioVet®-YC) with average left legs weight (9.06±0.08g and 8.98±0.09g), respectively. Minimum left legs weight (8.81±0.09g) was recorded from group A (control; basal diet). Statistical analysis of data revealed significant (P<0.05) difference in left legs weight among all groups. According to Tukey's HSD test there were two distinct group which were significantly different from each other.

Left arms weight (g)

Results on the effects of dietary prebiotic, probiotic and symbiotic supplementation on left arms weight of rabbits is mentioned in Table 2. Data indicates that maximum left arms weight (3.75±0.21g) was noted in group D (basal diet + symbiotic: the combination of both Biotronic® and Biovet®-YC) as compared to group B (basal diet + prebiotic: Biotronic®) and group C (basal diet + probiotic: BioVet®-YC) with average left arms weight (3.47±0.16g and 2.91±0.15g), respectively. Minimum left arms weight (2.84±0.11g) was recorded from group A (control; basal diet). Statistical analysis of data revealed significant (P<0.05) difference in left arms weight among all groups. According to Tukey's HSD test there were two distinct group which were significantly different from each other.

Right legs weight (g)

Results on the effects of dietary prebiotic, probiotic and symbiotic supplementation on right legs weight of rabbits is mentioned in Table 2. Data indicates that maximum right legs weight (9.29±0.07g) was noted in group D (basal diet + symbiotic: the combination of both Biotronic® and Biovet®-YC) as compared to group B (basal diet + prebiotic: Biotronic®) and group C (basal diet + probiotic: BioVet®-YC) with average right legs weight (9.10±0.05g and 9.07±0.25g), respectively. Minimum right legs weight (8.67±0.05g) was recorded from group A (control; basal diet). Statistical analysis of data revealed significant (P<0.05) difference in right legs weight among all groups. According to Tukey's HSD test there were two distinct group which were significantly different from each other.

Right arms weight (g)

Results on the effects of dietary prebiotic, probiotic and symbiotic supplementation on right arms weight of rabbits is mentioned in Table 2. Data indicates that maximum right arms weight (3.79±0.21g) was noted in group D (basal diet + symbiotic: the combination of both Biotronic® and Biovet®-YC) as compared to group B (basal diet + prebiotic: Biotronic®) and group C (basal diet + probiotic: BioVet®-YC) with average right arms weight (3.67±0.21g and 3.60±0.23g), respectively. Minimum right arms weight (2.35±0.27g) was recorded from group A (control; basal diet). Statistical analysis of data revealed significant (P<0.05) difference in right arms weight among all groups. According to Tukey's HSD test there were two distinct group which were significantly different from each other.

Carcass weight (g)

Results on the effects of dietary prebiotic, probiotic and symbiotic supplementation on carcass weight of rabbits is mentioned in Figure 5. Data indicates that maximum carcass weight (1915.68±243.55g) was noted in group D (basal diet + symbiotic: the combination of both Biotronic® and Biovet®-YC) as compared to group B (basal diet + prebiotic: Biotronic®) and group C (basal diet + probiotic: BioVet®-YC) with average carcass weight (1604.43±204.67g and 1355.28±184.69g), respectively. Minimum carcass weight (1000.10±125.34g) was recorded from group A (control; basal diet). Statistical analysis of data revealed significant (P<0.05) difference in carcass weight among all groups. According to Tukey's HSD test there were four distinct group which were significantly different from each other.

Nutrients digestibility of rabbits fed dietary prebiotic, probiotic and symbiotic

Dry matter digestibility (%)

Results on the effects of dietary prebiotic, probiotic and symbiotic supplementation on dry matter digestibility of rabbits is mentioned in Table 3. Data indicates that maximum dry matter digestibility (61.50±0.93%) was noted in group D (basal diet + symbiotic: the combination of both Biotronic® and Biovet®-YC) as compared to group B (basal diet + prebiotic: Biotronic®) and group C (basal diet + probiotic: BioVet®-YC) with average dry matter digestibility (60.88±1.73% and 55.88±1.46%), respectively. Minimum dry matter digestibility (54.38±1.69%) was recorded from group A (control; basal diet). Statistical analysis of data revealed significant (P<0.05) difference in dry matter digestibility among all groups. According to Tukey's HSD test there were four distinct group which were significantly different from each other.

Crude protein digestibility (%)

Results on the effects of dietary prebiotic, probiotic and symbiotic supplementation on crude protein digestibility of rabbits is mentioned in Table 3. Data indicates that maximum crude protein digestibility (76.50±2.20%) was noted in group D (basal diet + symbiotic: the combination of both Biotronic® and Biovet®-YC) as compared to group B (basal diet + prebiotic: Biotronic®) and group C (basal diet + probiotic: BioVet®-YC) with

 DOI: 10.56810/jkjagri.004.01.0120

average crude protein digestibility (75.38±2.20% and 72.63±2.00%), respectively. Minimum crude protein digestibility (70.63±2.26%) was recorded from group A (control; basal diet). Statistical analysis of data revealed significant (P<0.05) difference in crude protein digestibility among all groups. According to Tukey's HSD test there were three distinct group which were significantly different from each other.

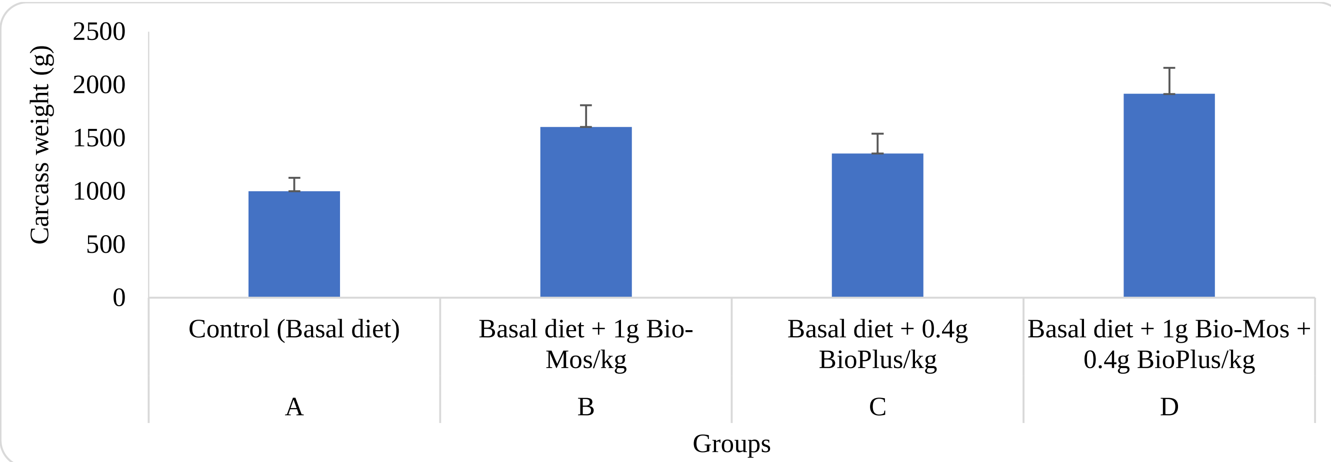

Figure 5. Carcass weight (g) of rabbits fed dietary prebiotic, probiotic and symbiotic.

Table 3. Nutrients digestibility of rabbits fed dietary prebiotic, probiotic and symbiotic.

Parameters	Group A	Group B	Group C	Group D	P-value
	Control (Basal diet)	Basal diet + prebiotics: Biotronic®	Basal diet + probiotics: Biovet®-YC	Basal diet + symbiotics: the combination of both Biotronic® + Biovet®-YC	
Dry Matter (%)	54.38±1.69[b]	55.88±1.46[b]	60.88±1.73[ab]	61.50±0.93[a]	0.0014
Crude Protein (%)	70.63±2.26[bc]	75.38±2.20[a]	72.63±2.00[b]	76.50±2.20[a]	0.0035
Ether Extract (%)	64.00±1.51[cd]	70.88±1.81[b]	66.50±2.20[c]	75.38±2.39[a]	0.0017
Crude Fibre (%)	53.50±1.93[a]	28.75±2.60[c]	35.63±2.33[b]	15.50±1.51[d]	0.0028
Ash (%)	50.75±1.49[a]	35.63±1.60[c]	48.50±1.60[b]	28.13±1.55[d]	0.0014
Nitrogen Free Extract (%)	73.13±1.89[a]	56.88±1.36[c]	66.75±2.12[b]	42.25±2.43[d]	0.0011

Ether extract digestibility (%)

Results on the effects of dietary prebiotic, probiotic, and symbiotic supplementation on ether extract digestibility of rabbits is mentioned in Table 3. The data indicate that the maximum ether extract digestibility (75.38±2.39%) was noted in group D (basal diet + symbiotic: the combination of both Biotronic® and Biovet®-YC) compared to group B (basal diet + prebiotic: Biotronic®) and group C (basal diet + probiotic: BioVet®-YC) with average ether extract digestibility (70.88±1.81% and 66.50±2.20%), respectively. The minimum ether extract digestibility (64.00±1.51%) was recorded in group A (control; basal diet). Statistical analysis of the data revealed a significant (P<0.05) difference in ether extract digestibility among all groups. According to Tukey's HSD test, there were four distinct groups that were significantly different from each other.

Crude fiber digestibility (%)

Results on the effects of dietary prebiotic, probiotic, and symbiotic supplementation on crude fiber digestibility of rabbits is mentioned in Table 3. The data indicate that the maximum crude fiber digestibility (53.50±1.93%) was noted in group A (control; basal diet) compared to group C (basal diet + probiotic: BioVet®-YC) and group B (basal diet + prebiotic: Biotronic®) with average crude fiber digestibility of 35.63±2.33% and 28.75±2.60%, respectively. The minimum crude fiber digestibility (15.50±1.51%) was recorded in group D (basal diet + symbiotic: the combination of both Biotronic® and Biovet®-YC). Statistical analysis of the data revealed a significant (P<0.05) difference in crude fiber digestibility among all groups. According to Tukey's HSD test, there were four distinct groups that were significantly different from each other.

Ash digestibility (%)

Results on the effects of dietary prebiotic, probiotic, and symbiotic supplementation on ash digestibility of rabbits are mentioned in Table 3. The data indicates that the maximum ash digestibility (50.75±1.49%) was noted in group A (control; basal diet) compared to group C (basal diet + probiotic: BioVet®-YC) and group B (basal diet + prebiotic: Biotronic®) with average ash digestibility of 48.50±1.60% and 35.63±1.60%, respectively. The minimum ash digestibility (28.13±1.55%) was recorded in group D (basal diet + symbiotic: the combination of both Biotronic® and Biovet®-YC). Statistical analysis of the data revealed a significant ($P<0.05$) difference in ash digestibility among all groups. According to Tukey's HSD test, there were four distinct groups that were significantly different from each other.

Nitrogen free extract digestibility (%)

Results on the effects of dietary prebiotic, probiotic, and symbiotic supplementation on nitrogen-free extract digestibility of rabbits is mentioned in Table 3. The data indicate that the maximum nitrogen-free extract digestibility (73.13±1.89%) was noted in group A (control; basal diet) compared to group C (basal diet + probiotic: BioVet®-YC) and group B (basal diet + prebiotic: Biotronic®) with average nitrogen-free extract digestibility (66.75±2.12% and 56.88±1.36%), respectively. The minimum nitrogen-free extract digestibility (42.25±2.43%) was recorded in group D (basal diet + symbiotic: the combination of both Biotronic® and Biovet®-YC). Statistical analysis of the data revealed a significant ($P<0.05$) difference in nitrogen-free extract digestibility among all groups. According to Tukey's HSD test, there were four distinct groups that were significantly different from each other.

DISCUSSIONS

In this study the growth performance of rabbits was significantly improved by the dietary prebiotic, probiotic and symbiotic. Maximum weight gain, feed intake, better FCR, carcass weight was recorded in group fed on dietary symbiotic compared to prebiotic and probiotic feeding. The observed increase in live body weight in the symbiotic group could be attributed to the combined effects of prebiotics and probiotics. Prebiotics promote the growth and activity of beneficial bacteria in the gut, while probiotics introduce live microorganisms that contribute to a healthy gut microbiota. The symbiotic combination may have led to a more balanced and beneficial gut environment, positively influencing nutrient absorption and utilization, thereby enhancing the overall growth of the rabbits. Similarly results were obtained by Kritas and Morrison (2005), Tellez et al. (2006), Mountzouris et al. (2010) and Bansal et al. (2011) as they reported beneficial effect of probiotic supplementation to broiler diet in terms of increased body weight and feed conversion through a natural physiological way and improving digestion by balancing the resident gut microflora as they can improve the integrity of the intestinal mucosal barrier, digestive and immune functions of intestine. Improvement in digestion and absorption of intestine of nutrient transportation systems leads to immune resistance and productivity. Similarly, Amat et al. (1996) and Shirani et al. (2019) reported that prebiotics and probiotics are growth promoters that can be used as alternative non antibiotic feed additives because they improve growth indices of broiler chickens without side effects on the consumers. Similar findings on the positive effect of probiotics on growth performances have been well documented by Sieo et al. (2005), Apata (2008) and Yu et al. (2008). The significant increase in the final live weight and daily weight gain of rabbits fed prebiotic and symbiotic diets was in agreement with the findings of Piray et al. (2007) who reported significant increase in body weight gain in broilers receiving diets supplemented with prebiotics. At variance to this result was the finding of Peeters et al. (1992) who observed that gluco-oligosaccharides did not affect any significant differences in treated rabbits compared to the control. Lebas (1996) and Mourão et al. (2004) The significant increase in the final live weight and daily weight gain of rabbits fed prebiotic and symbiotic diets was in agreement with the findings of Piray et al. (2007) who reported significant increase in body weight gain in broilers receiving diets supplemented with prebiotics. At variance to this result was the finding of Peeters et al. (1992) who observed that gluco-oligosaccharides did not affect any significant differences in treated rabbits compared to the control. Lebas (1996) and Mourão et al. (2004) reported that under commercial condition, the combination of prebiotics and probiotics in broiler diet have been shown to increase daily weight gain and feed efficiency than feeding only prebiotic or probiotic which corroborates the result with symbiotic diet observed in this study. Probiotics, containing lactic acid bacteria lowers the intestinal pH due to production of lactic acid and organic acid while cells adhere to intestinal cell wall and prevent colonization by pathogens. Probiotic microbes stall competition for nutrient with pathogenic bacteria. Probiotics

 DOI: 10.56810/jkjagri.004.01.0120

and prebiotics suppress the growth of pathogenic microorganisms in the intestine and increases the growth rate and feed conversion efficiency. The inclusion of *L. sporogenes* at 100mg/kg in commercial broiler feed has been reported to increase body weight gain and improved feed conversion ratio in broiler chicks during 0–6 weeks of age (Panda et al., 1995). The addition of probiotic at 50g/100kg feed in broiler mash significantly increase growth performance (Gohain and Sapcota, 1998). Live yeast culture (*S. cerevisiae*) plus lactic acid producing bacteria (*L. acidofillus* and *S. faecium*) was supplemented in broilers (1kg/tonne) and results showed improved weight gain and feed conversion. With laying hens, lactobacilli resulted in an improved egg production and feed efficiency (Mohan et al., 1996) contrary to the observation with probiotics in this study probably because of the strains, composition and dosage of the Biovet® -YC used as probiotics. Similar results in line with the finding in this study for probiotics were reported by Gohain and Sapcota (1998) and for prebiotics by Sims and Sefton (1999). In contrary to non-significant differences in feed intake among the dietary treatments, dietary probiotics and prebiotics (Sanchez and Ayaya, 1998) have been shown to increase feed intake. We hypothesized that dietary supplementation of lactobacillus-based probiotics would help the beneficial microflora by stimulating the good microflora or by adding beneficial microbes in the gut. This might improve gut health and, in that aspect, indirectly cause an increase feed intake.

The present feeding trial has provided evidence that the dietary inclusion of Biotronic® Prebiotics and its combination with Biovet®-YC Probiotics (symbiotics) in rabbit diets made the animal to utilized the diet better as they used lesser quantity of feed to gain unit weight compared to other treatments. Similar observation on the beneficial effects of these feed additives on weight gain and feed conversion ratio were reported by some researchers in farm animals like poultry and pigs (Abdel-Hamid and El-Tarabany, 2019; Dela Cruz et al., 2019). A significant positive effect on body weight and feed conversion ratio of broiler chickens was observed when given a prebiotic (*Mannan oligosaccharide*) plus an antibiotic growth promoter (copper sulfate) (Çınar et al., 2009). Research investigations have shown that dietary supplements (probiotic, prebiotic, organic acids, and their various combinations) improved body weight compared with the control to a similar extent other animal species which is in agreement with the results obtained in this research study (Bozkurt et al., 2009). Reports have showed that diets containing prebiotics achieved improved performance in poultry like other performance enhance feed additives, and that prebiotics and symbiotics were superior to probiotics in improving broiler chickens' performance (Celi et al., 2019; Shirani et al., 2019). Findings from this study were at variance with the report that diets supplemented with probiotics, Phyto biotics and symbiotics had no effect ($P > 0.05$) on body weight, weight gain, feed intake and feed conversion efficiency of broiler chickens (Erdoğan et al., 2010; Jung et al., 2008).

The significant difference in organ weights obtained in this study does not corroborates the earlier findings who reported that prebiotics and probiotics have no significant effect on carcass and organ characteristics of rabbits (Ayyat et al., 2018; Bhatt et al., 2017). However, Mohan et al. (1996) reported that prebiotic and probiotic supplementation to diets caused a significant decrease on the liver weight of male broiler chickens when compared to the control treatment. There are a lot of discrepancy in the results of some pre-and pro-biotic studies that might be related to the dosage administration of probiotics and prebiotic inclusion, animal species, and study population (e.g. in age, gender, weight, or breed), strains of microorganism used and composition of diets (Cakır et al., 2008).

Caraccas characteristics were improved by dietary prebiotic, probiotic and symbiotic feeding. Similar effect of probiotic and prebiotic on carcass characteristics was reported by Khan et al. (1992) and Öztürk and Yıldırım (2005) respectively. A possible explanation for the differences between findings of different researchers may be related to the doses of probiotics and prebiotics applied, animal species and study population (e.g. in age, weight or breed), strains of microorganism used and composition of diets.

Nutrients digestibility was improved by dietary prebiotic, probiotic and symbiotic feeding. The nutrient digestibility of the rabbits was significantly ($P<0.05$) influenced by the dietary treatments. There were significance ($P<0.05$) differences in the dry matter, crude protein, crude fibre, ash and ether extract among the dietary treatments. The effect of prebiotics and probiotics on digestibility has not been seriously addressed by researchers. In the trial of El-Gaafary et al. (1992), lacto-sacc (a complex product containing micro-organisms percentage Lactobacillus acidophilus, Streptococcus faecium and yeasts percentage but also enzyme activities percentage protease, cellulases, amylase) improved crude fibre digestibility at 8 and 12 weeks. Amber et al. (2005) worked with Lact-A-Bac (*Lactobacillus acidophilus*) and reported improvement in the digestibility of energy and of most analytical fractions (dry matter, crude protein, ether extract) including crude fibre which corroborates the results obtained in this study. However, Gippert et al. (1992) found no effect of these growth promoters on nutrient digestibility in rabbits.

CONFLICT OF INTEREST

The authors declare that there is no conflict in the publication of this article.

AUTHOR'S CONTRIBUTION

Missing

REFERENCES

Abdel-Hamid, T.M., El-Tarabany, M.S., 2019. Effect of bee pollen on growth performance, carcass traits, blood parameters, and the levels of metabolic hormones in New Zealand White and Rex rabbits. Tropical Animal Health and Production 51, 2421-2429.

Amat, C., Planas, J., Moreto, M., 1996. Kinetics of hexose uptake by the small and large intestine of the chicken. American Journal of Physiology-Regulatory, Integrative and Comparative Physiology 271, 1085-1089.

Amber, K., Yakout, H., Rawya, S.H., 2005. Effect of feeding diets containing yucca extract or probiotic on growth, digestibility, nitrogen balance and caecal microbial activity of growing New Zealand white rabbits, Proceedings of the 8th World Rabbit Congress, Pueblo, Mexico, pp. 737-741.

AOAC, 2012. Official Method of Analysis. Association of Official and Analytical Chemists, Washington, D.C, USA.

Apata, D., 2008. Growth performance, nutrient digestibility and immune response of broiler chicks fed diets supplemented with a culture of *Lactobacillus bulgaricus*. Journal of the Science of Food and Agriculture 88, 1253-1258.

Ayyat, M.S., Al-Sagheer, A.A., Abd El-Latif, K.M., Khalil, B.A., 2018. Organic selenium, probiotics, and prebiotics effects on growth, blood biochemistry, and carcass traits of growing rabbits during summer and winter seasons. Biological Trace Element Research 186, 162-173.

Bansal, G., Singh, V., Sachan, N., 2011. Effect of probiotic supplementation on the performance of broilers. Asian Journal Animal Science 5, 277-284.

Bhatt, R., Agrawal, A., Sahoo, A., 2017. Effect of probiotic supplementation on growth performance, nutrient utilization and carcass characteristics of growing Chinchilla rabbits. Journal of Applied Animal Research 45, 304-309.

Bozkurt, M., Küçükyılmaz, K., Çatlı, A., Çınar, M., 2009. Effect of dietary mannan oligosaccharide with or without oregano essential oil and hop extract supplementation on the performance and slaughter characteristics of male broilers. South African Journal of Animal Science 39, 223-232.

Cakır, S., Midilli, M., Alp, M., Ylımaz, H., Muglal, O., Turan, N., Kocabaglı, N., 2008. Effects of dietary probiotic and prebiotic supplementation on growth performance and serum IgG concentration of broilers. South African Journal of Animal Science 38, 21-27.

Celi, P., Verlhac, V., Calvo, E.P., Schmeisser, J., Kluenter, A.-M., 2019. Biomarkers of gastrointestinal functionality in animal nutrition and health. Animal Feed Science and Technology 250, 9-31.

Çınar, M., Çatlı, A., Küçükyılmaz, K., Bozkurt, M., 2009. The effect of single or combined dietary supplementation of prebiotics, organic acid and probiotics on performance and slaughter characteristics of broilers. South African Journal of Animal Science 39.

Dela Cruz, P.J.D., Dagaas, C.T., Mangubat, K.M.M., Angeles, A.A., Abanto, O.D., 2019. Dietary effects of commercial probiotics on growth performance, digestibility, and intestinal morphometry of broiler chickens. Tropical Animal Health and Production 51, 1105-1115.

El-Abasy, M.A.M., 2002. Studies on sugar cane extracts for the control of chicken diseases. Tokyo University, Tokyo, Japan.

El-Gaafary, M., Rashwan, A., El-Kerdawy, D., Yamani, K., 1992. Effects of feeding pelleted diet supplemented with probiotic (Lacto-Sacc) on digestibility, growth performance, blood constituents, semen characteristics and reproductive traits of rabbits. Egyptian Journal of Rabbits Science 2, 95-105.

Erdoğan, Z., Erdoğan, S., Aslantaş, Ö., Çelik, S., 2010. Effects of dietary supplementation of synbiotics and phytobiotics on performance, caecal coliform population and some oxidant/antioxidant parameters of broilers. Journal of Animal Physiology and Animal Nutrition 94, 40-48.

Gippert, T., Virag, G., Nagy, I., 1992. Lacto-Sacc in rabbit nutrition. Journal of Applied Rabbit Research 15, 1101-1101.

Gohain, A., Sapcota, D., 1998. Effect of probiotic feeding on the performance of broilers. Indian Journal of Poultry Science 33, 101-105.

Jin, Y., Wu, S., Zeng, X., Lin, X., Li, W., Li, F., Wang, X., 2017. Effects of dietary supplementation of *Bacillus subtilis* B10 on growth performance, cecal microbiota, small intestinal morphology, and immune response of Rex Rabbits. Probiotics and Antimicrobial Proteins 9, 445-454.

Jung, S., Houde, R., Baurhoo, B., Zhao, X., Lee, B., 2008. Effects of galacto-oligosaccharides and a Bifidobacteria lactis-based probiotic strain on the growth performance and fecal microflora of broiler chickens. Poultry Science 87, 1694-1699.

Khan, M., Ullah, I., Javed, M., 1992. Comparative study of probiotics, TM 50 Biovin-40 and Albac on the performance of broiler chicks. Pakistan Veterinary Journal 12, 45-47.

Kritas, S., Morrison, R., 2005. Evaluation of probiotics as a substitute for antibiotics in a large pig nursery. Veterinary Record-English Edition 156, 447-447.

Lebas, F., 1996. Effects of fruct-oligo-saccharides origin on rabbit's growth performance in 2 seasons, 6th World Rabbit Congress, Toulouse, France, pp. 211-215.

Mohan, B., Kadirvel, R., Natarajan, A., Bhaskaran, M., 1996. Effect of probiotic supplementation on growth, nitrogen utilisation and serum cholesterol in broilers. British Poultry Science 37, 395-401.

Mountzouris, K., Tsitrsikos, P., Palamidi, I., Arvaniti, A., Mohnl, M., Schatzmayr, G., Fegeros, K., 2010. Effects of probiotic inclusion levels in broiler nutrition on growth performance, nutrient digestibility, plasma immunoglobulins, and cecal microflora composition. Poultry Science 89, 58-67.

Mourão, J., Alves, A., Pinheiro, V., 2004. Effects of fructo-oligosaccharides on performances of growing rabbits, 8th World Rabbit Congress, Puebla, México, pp. 915 - 921.

Öztürk, E., Yıldırım, A., 2005. Prebiotics supplementation to the diets broiler on performance and intestinal microbiological characteristics. III, National Animal Nutrition Congress, pp. 69-75.

Panda, A., Singh, R., Pathak, N., 1995. Effect of dietary inclusion of *Saccharomyces cerevisiae* on growth performance of crossbred calves. Journal of Applied Animal Research 7, 195-200.

Peeters, J., Maertens, L., Geeroms, R., 1992. Influence of galacto-oligosaccharides on zootecnical performance, cecal biochemistry and experimental colibacillosis O103/8+ in weanling rabbits. Journal of Applied Rabbit Research 15, 1129-1129.

PFMA, 2022. Rabbit size-o-meter. Pet Food Manufacturers Association, London, UK.

Piray, A., Kermanshahi, H., Tahmasbi, A., Bahrampour, J., 2007. Effects of cecal cultures and aspergillus meal prebiotic (Fermacto) on growth performance and organ weights of broiler chickens. International Journal of Poultry Science 6, 340-344.

Rajput, I.R., Li, W.F., 2012. Potential role of probiotics in mechanism of intestinal immunity. Pakistan Veterinary Journal 32, 303-308.

Sanchez, R., Ayaya, J., 1998. Effect of Mos on broiler performance under field conditions, Alltech's Inc.

Shirani, V., Jazi, V., Toghyani, M., Ashayerizadeh, A., Sharifi, F., Barekatain, R., 2019. Pulicaria gnaphalodes powder in broiler diets: Consequences for performance, gut health, antioxidant enzyme activity, and fatty acid profile. Poultry Science 98, 2577-2587.

Sieo, C., Abdullah, N., Tan, W., Ho, Y., 2005. Influence of β-glucanase-producing *Lactobacillus* strains on intestinal characteristics and feed passage rate of broiler chickens. Poultry Science 84, 734-741.

Sims, M., Sefton, A., 1999. Comparative effects of a mannan oligosaccharide and an antibiotic growth promoter on performance of commercial turkeys, Proceedings of Western Poultry Disease Conference.

Sun, Y., Zhang, Y., Wang, X., Li, H., 2020. Effects of dietary supplementation with probiotics on growth performance, blood parameters, and immune function of Rex rabbits. Journal of Applied Animal Research 48, 246-251.

Tellez, G., Higgins, S., Donoghue, A., Hargis, B., 2006. Digestive physiology and the role of microorganisms. Journal of Applied Poultry Research 15, 136-144.

Wang, Y., Wang, J., Li, Y., Song, X., Zhang, Y., Zhu, L., 2020. Effects of dietary *Lactobacillus plantarum* on growth performance, immune function, and antioxidant capacity in weaned rabbits. Animals 10, 332.

Wen, C., Wu, M., Qin, C., Liu, X., He, B., 2018. Effect of fructooligosaccharides (FOS) on growth performance, gut microbiota, and parameters of immune function in rabbits. Journal of Animal Science and Biotechnology 9, 68.

Yang, K., Song, Z., Jia, D., Ma, J., Huo, Y., Zhao, Y., Zhang, W., Ding, W., Wu, Z., Yang, S., 2022. Comparisons between needle puncture and chondroitinase ABC to induce intervertebral disc degeneration in rabbits. European Spine Journal 31, 2788-2800.

Yu, B., Liu, J., Hsiao, F., Chiou, P., 2008. Evaluation of Lactobacillus reuteri Pg4 strain expressing heterologous β-glucanase as a probiotic in poultry diets based on barley. Animal Feed Science and Technology 141, 82-91.

Zeng, B., Dong, Y., Liu, H., Zeng, Q., Wang, X., 2021. Effects of dietary supplementation with inulin on growth performance, cecal microbiota, and immune function in Rex rabbits. BMC Veterinary Research 17, 44.