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Effect of Dietary Probiotic, Prebiotic and Synbiotic Supplementations on Growth Performance, Carcass Traits and Serum Lipid Profile in Broiler Chicken

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ABSTRACT

Probiotics, prebiotics, and synbiotics are either microorganisms or substrates that facilitate beneficial microorganisms' growth. These compounds can be supplemented with the diets to modulate the various functions of the body. This study was conducted to evaluate the dietary effect of probiotic, prebiotic and synbiotic supplementation on growth and meat quality parameters of broiler chicken. One-hundred ninety-two, day-old broiler chicks were assigned into four treatments in a completely randomized design with four replicates. Basal feed, basal feed supplement with prebiotic, probiotic and synbiotic were used as treatments. Growth parameters, blood serum parameters, meat quality, abdominal fat deposition and cecum bacterial counts were measured. Data were analyzed using the MixedAnalysis of Variance in SAS. Feed conversion ratio, total feed intake, blood serum and meat quality parameters and bacterial counts in the cecum were not differed significantly ($p>0.05$). The abdominal fat content was significantly lower ($p<0.05$) in the probiotic-fed group. This study revealed that supplementation of probiotic, prebiotic and synbiotic to broiler diet did not cause any significant change in growth performance, meat quality, and blood serum parameters. Feeding probiotics incorporated basal feed is a better solution to reduce fat deposition without interfering with broiler chicken's growth performances at a lower cost.

1. Introduction

The poultry sector is one of the fastest-growing sectors, both in the globe and in Sri Lanka. Broiler production is a popular growing component in the poultry industry. It is an important domestic fowl worldwide, especially for nutritious flesh as a cheap protein source with low cholesterol value. Besides, it contains vitamins and minerals. Therefore, broiler farming is increasing day-by-day all around the world. Moreover, along with population growth, the poultry trade continues to grow to satisfy the world market demand. Over the last three decades, the poultry industry of Sri Lanka has grown from the backyard systeminto a commercial status.The broiler farming sector in Sri Lanka shows a considerable development because of the private sector's participation. The per capita availability of chicken in Sri Lanka was 9.29 kg in 2017. The total broiler meat production in Sri Lanka has increased from 102.50 in 2008 to 200.98 MT in 2017 [1].The production of chicken meat is currently showing an upward trend, while the supply per capita is also rapidly increasing [2].

It has been estimated that 70% of the total production cost in broiler production is spent on feeds [3]. Therefore, the reduction of feed conversion ratio (FCR) is essential to increase the profit margin. Hence, antibiotics have been widely used in broiler production for decades as a prophylactic measurement to serve the above purpose. However, due to the emergence of antibiotic resistance, the use of antibiotics phased out from broiler production and alternatives to antibiotics such as enzymes, inorganic acids, probiotics, prebiotics, etheric oils and immunostimulants were heavily investigated [4]. The probiotics are live microbial feed supplements which beneficially affect the host by improving the intestinal microbial balance. It contains mostly lactic acid-producing bacteria like *Lactobacillus plantarum*, *Lactobacillus acidophilus, Lactobacillus bulgaricus, Bifidobacterium bifidum*, and *Saccharomyces cerevisiae*. These microorganisms reduce the pH in the intestine and thereby decrease the number of harmful bacteria [5]. Prebiotics are

non-digestible substances that provide a beneficial physiological effect on the host by selectively stimulating the favourable growth of a limited number of indigenous bacteria [6] Oligosaccharides such as galactooligosaccharides, fructooligo-saccharides, and mannan oligosaccharides are the most popular types of prebiotics [7]. A combination of probiotic and prebiotic as a single product is called synbiotic [6] and it includes both beneficial microorganisms and substrates, which may have synergistic effects on the intestinal tract of animals.

Modern broiler strains contain 15 to 20% fat, and >85% of this fat is not physiologically required for body function [8]. Further, excessive fat deposition is an unfavourable trait for both producers and consumers because it is considered to be wasted dietary energy and a waste product with low economic value, which also reduces the carcass yield and affects consumer acceptance [9]. Kalavathy et al. [10] showed that probiotics could reduce fat deposition and regulate lipid metabolism. Further, they found that *Lactobacillus* cultures reduced abdominal fat deposition and improve carcass quality. There is great attention in the broiler industry to reduce its fat content due to greater consumer awareness of dietary fat and its adverse effects on human health. Therefore, this study was conducted to evaluate dietary probiotic, prebiotic and synbiotic supplementation on growth performance, carcass traits, serum lipid profile and abdominal fat content in broilers.

2. Material and Methods

2.1 Experiment location

Fieldwork and laboratory analysis were conducted at Livestock Experiment Farm and Animal Science laboratory in the Faculty of Agriculture, Rajarata University of Sri Lanka, Puliyankulama, Anuradhapura, Sri Lanka, respectively from December 2018 to January 2019.

2.2 Birds and experimental design

One hundred ninety-two Cobb500, day-old broiler chicks were purchased from a commercial hatchery and randomly assigned into four treatments designated as T1, T2, T3 and T4 in a Completely Randomized Design (CRD). Each treatment consisted of four replicates, and 12 birds were assigned to each replicate. Treatments were as follows.

T1 - Basal feed (Control)
T2 - Basal feed + Prebiotic (500 g/MT)
T3 - Basal feed + Probiotic (500 g/MT)
T4 - Basal feed + Synbiotic (1000 g/MT)

2.3 Broiler management practices

Poultry house, brooder guards, feeders, and waterers were cleaned and disinfected before the arrival of chicks to the farm. Day-old broiler chicks were weighed and randomly introduced into four brooders. Chicks were kept seven days of the brooding period, and 60 W electric bulbs were used to provide the initial heating and lighting. Dry paddy husk was used as the litter material. All chicks were provided with Vitamin E 1 mL/L (Servite-E) and glucose 25 g/L solution with drinking water to reduce the stress. All birds were vaccinated against infectious bursal disease (IBD) at 7 and 14 days of age.

2.4 Feeding management

Feeds were mixed with prebiotic, probiotic and synbiotic supplements manually and stored in labelled, airtight containers until feeding. During the period of study (0-6 weeks), all the birds were provided with booster diet (with 3000 kcal of metabolizable energy [ME]/kg of ration and 23.5% crude protein [CP]) from 0 to 2 weeks of age, starter diet (with 3100 kcal of ME/kg of ration and 22% CP) from 2 to 3 weeks of age and finisher diet (with 3180 kcal of ME/kg of ration and 19.5% CP) from 4 to 6 weeks of age with *ad libitum*. The composition of prebiotic, probiotic, and symbiotic supplements are presented in Table 1.

Table 1: Composition of prebiotic/ probiotic/ synbiotic used in the diet

Prebiotic	Probiotic	Synbiotic
MOS (Mannan Olygosaccharide)	*Saccharomyces cerevisiae* SC-47 ($3x10^{11}$ CFU),*Saccharomyces boulardii* ($5x10^{10}$CFU), *Lactobacillus acidophilus (*$4.5x10^{10}$CFU),*Propionibacterium freudenreichii* ($5x10^{10}$CFU), Seaweed powder	MOS (naturally derived from extracts of yeast cell walls), *Saccharomyces cerevisiae* SC-47 ($3x10^{11}$CFU), *Saccharomyces boulardii* ($5x10^{10}$CFU), *Lactobacillus acidophilus (*$4.5x10^{10}$ CFU), *Propionibacterium freudenreichii* ($5x10^{10}$CFU), Seaweed powder

2.5 Slaughtering of birds

Three birds were randomly selected and weighed from each replicate at the age of 42 days. The birds were fasted for 12 hours and slaughtered. The major blood vessels (carotid arteries and jugular veins) were severed. They were held in killing cones and kept for bleeding at least for 2 minutes. Slaughtered birds were scaled in hot water (56 ^{0}C) for 2-5 minutes. Feathers were removed by the de-feathering machine and remained feathers were removed manually. Then, a cut was made at the end of the abdomen, the abdominal cavity was opened, and the digestive tract, respiratory tract, heart and liver were removed. Gizzard was cleaned, and the inner layer was removed. Carcasses were portioned, and the weight of breast, thigh, drumsticks, back, wings and neck were recorded. In the end, carcasses were stored at the freezing conditions.

2.6 Data collection and calculations

Feed and remaining feed per pen were measured, and feed intake was calculated daily throughout the research period. Bodyweight was measured weekly, and weight gain and feed conversion ratio (FCR) were calculated. Live and carcass weights were recorded, and the dressing percentage was calculated. The weights of internal organs (liver, gizzard, and heart), abdominal fat and carcass parts (breast, thigh, drumstick, back, wings and neck) were measured using an electrical balance as expressed as a percentage of carcass weight.

2.7 Blood sample analysis

Blood serum parameters were measured for birds slaughtered at 42 days. Blood samples were properly collected to sterilize tubes (without anticoagulant) at slaughtering from three randomly selected birds representing each replicate. Serum was immediately separated by centrifugation at 1500 rpm for 20 min (Labnet Int-C406490, USA). Then, samples were stored in -20^{0}C until further analysis. Serum samples were tested for total cholesterol, high-density lipoproteins (HDL), triglycerides (TAG), very low-density lipoproteins (VLDL) and low-density lipoproteins (LDL) using a commercial kit (BIOLABO, France) as per the manufacturer's guidelines using a spectro-photometer (LABOMED, USA).

2.8 Meat quality analysis

Skinless meat samples were taken from the broiler breast muscle (*Pectoralis major*) using sterilized polythene bags and stored at -18ºC for further analysis. Dry matter, crude fat, crude protein, crude ash, and moisture contents in meat were analyzed according to the Association of Official Analytical Chemist methods [11]. Meat colour, pH, and water holding capacity (WHC) measured [12]. Briefly, for colour measurements, three skinless breast samples for each replicate were used and thawed 1 hr before the measurement. The values of lightness (L*), redness (a*), and yellowness (b*) were obtained at three sites on the same breast muscle using Colourimeter (Konica Minolta, CR 10, Japan). pH was measured using the filtrate method, and for that, 1 g of meat from each sample was homogenized with 9 mLof distilled water at 1,130 × g for 30 sec [12]. The supernatant was filtered (No. 4; Whatman International Ltd.) and the pH of the filtrate was determined using a pH meter (E-08328 ALELLA, Barcelona). Samples were cut into cubes of 2.0 ± 0.10 g. They were then carefully placed between 2 pieces of filter papers (No. 4; Whatman International Ltd.) and left under a 10 kg weight for 5 min, separately. After recording the final weight of each sample, WHC was calculated using the following equation

$$WHC\ (\%) = 100 - \left[\frac{(Wi - Wf) \times 100}{Wi}\right]$$

W_i = Initial weights of the sample
W_f = Final weights of the sample

2.9 Bacteriological analysis

The bacteriological analysis was done according to the method described by Jin et al. [13]. Briefly, 1 g of the ceca content was mixed with 9 mL of sterile distilled water and homogenized for 3 min. From the initial 10^{-1} dilution, 10-fold serial dilutions were subsequently made in sterile pre-reduced dilution blank solution in 0.1% peptone for aerobic bacteria. Samples from cecum were diluted up to 10^{-7}. From each dilution, 0.1 mL was inoculated in agar plates. The plate media used were MRS agar (CM0361, England) for *Lactobacilli* and MacConkay agar3 (DM141D, UK) for *Coliforms*. All the inoculated plates were incubated at 39 ^{0}C, and the MRS and McConkey agar plates were incubated for 48 and 24 hrs, respectively. Total numbers of bacterial colonies were counted by using the colony counter (Galaxy 330, Taiwan).

2.10 Data analysis

Weight gain, feed intake, FCR, dressing percentage of birds, serum lipid profile and proximate composition, quality parameters of the meat samples and cecum microbial content were analyzed using the Analysis of Variance (ANOVA) procedure in Statistical Software for Data Analysis (SAS), Ver 9.0 [14]. Mean separation was done by Turkey's Standardized Range Test (TSRT). Statistical significance was declared at $p< 0.05$.

3. Results and Discussion

3.1 Evaluation of growth performances

Effect of treatments on feed intake, weight gain and feed conversion ratio (FCR) during the study period are presented in Table 2. During the second week, feed intake of birds fed with synbiotic diet was significantly different ($p<0.05$) compared to the other treatments. However, the total feed intake did not differ significantly ($p>0.05$) among treatments. Others have also reported that neither prebiotic, probiotic and synbiotic diet supplementation [15, 16]. nor growth stimulants [7, 17] affect cumulative feed consumption of broilers. However, Salianeh et al. [18] reported that prebiotic dietary inclusion significantly improved the bodyweight and FCR with lower feed intake in broiler chickens compared to the control group. The researchers speculated that the presence of MOS in the yeast cell wall reduces the colonization of enteropathogenic bacteria [18]. It has been also found that MOS blocks the binding sites of bacterial fimbrial lectins to gut intestinal receptors containing D-mannose, inhibiting the connection of bacteria receptors with the intestine mucosa by agglutination [18]. In contrast, Abdel-Raheem et al. [19] found that feed intake significantly differed in birds fed with prebiotic, probiotic and synbiotic supplements and significantly higher average feed intake in birds fed with prebiotic supplements and the least feed intake resulted in birds fed with basal feed.

The average bodyweight gain showed a significantly higher value ($p<0.05$) in the synbiotic group compared to others in the second and third weeks of the age (Table 2). Further, at the end of the research period, there was a significant difference ($p<0.05$) in the bodyweight gain among treatments and similar values were reported in the birds fed with probiotic (612.08 ± 29.93 g) and synbiotic (540.51 ± 29.93 g) supplements. Similarly research showing significant differences in weight gain of birds fed with prebiotic, probiotic and synbiotic supplements are also available [16, 19]. Contrasting these results, Ashayerizadeh et al. [17] found that, when the prebiotic, probiotic, and mixture were used, the bodyweight gains did not differ significantly among treatments.

Table 2: The effect of dietary probiotic, prebiotic and synbiotic supplementation on growth parameters of broilers

Age (wks)	Treatments*				*P*-value	SE
	T1	T2	T3	T4		
			Feed intake (g/bird)			
2	329.19^{b}	322.44^{b}	324.65^{b}	341.08^{a}	0.00	5.75
3	608.89	603.71	606.46	611.00	0.87	33.66
4	884.08	886.75	885.75	888.10	0.84	10.99
5	955.83	951.33	954.17	958.41	0.89	6.66
6	895.92	895.16	895.83	894.58	0.38	6.89
Total	3673.91	3659.39	3666.86	3693.17	0.15	28.56
			Average body weight gain (g/bird) per week			
2	229.21^{b}	240.52^{b}	221.25^{b}	270.10^{a}	0.00	7.77
3	457.83^{b}	464.71^{b}	473.21^{b}	498.75^{a}	0.02	8.15
4	552.00	549.46	530.48	536.61	0.12	6.54
5	577.65	584.27	563.29	563.23	0.44	10.71
6	463.23^{bc}	427.62^{c}	612.08^{a}	540.51^{ab}	0.00	29.93
			FCR (Cumulative)			
2	1.44	1.34	1.47	1.37	0.07	0.03
3	1.38	1.31	1.34	1.33	0.30	0.02
4	1.51	1.44	1.48	1.49	0.45	0.02
5	1.57	1.50	1.55	1.56	0.25	0.02
6	1.61	1.59	1.54	1.58	0.20	0.02

$^{a, b, c,}$ means within the same row with different superscripts are significantly different *($p<0.05$).*

* T1= Basal feed (Control), T2= Basal feed + Prebiotic (500 g/MT), T3= Basal feed + Probiotic (500 g/MT), T4= Basal feed + Synbiotic (1000 g/MT)

The FCR of birds fed in different dietary supplements were not significantly different (p>0.05) (Table 2). Similarly, Denli et al. [20] and Sarangi et al. [15] found no significant difference in FCR among basal feed, prebiotic, probiotic, and synbiotic treatments. However, Abdel-Raheem et al. [19] recorded that the birds fed with synbiotic supplements had least FCR, and the prebiotic group had highest FCR in their experiment. The recorded FCR values were 2.09, 1.92, and 1.88 for control, prebiotic, probiotic, and synbiotic, respectively.

Though the feed intake and FCR were similar between probiotic and synbiotic fed birds, they had significantly higher weight gain at the 6th week of age than the others (Table 2). It is speculated that the high growth performances and the feed efficiency with the probiotic and synbiotic supplemented diets are due to having a beneficial microbial population [21], improving feed intake and digestion [22], and altering bacterial metabolism [11, 23]. Further, Awad et al. [24] found that the dietary supplementations by probiotic and symbiotic caused an increase in the villus height and crypt depth of intestinal mucosa of broilers. Moreover, it is suggested that higher villus height improves nutrient absorption by having a higher surface area [24]. The researchers stated that the increase in the villus height and villus height:crypt depth ratio affects the broilers' growth performance.

3.2 Carcass characteristics of broilers

The live weight, carcass weight, dressing percentage, weight of carcass parts and internal organs of birds fed with different treatments are presented in Table 3. There were no significant differences (p>0.05) in live weight and dressing percentages among the treatments. Sarangi et al. [15] found no significant differences in live weight and the dressing percentages in broilers fed with basal feed, probiotic, prebiotic and synbiotic. However, this study's results did not agree with Ashayerizadeh et al. [7] and Abdel-Raheem et al. [19] who found that the synbiotic and probiotic fed group had the highest significant live weight compared to control treatment. These results may be due to the differences in the flock size, mortality, age, and floor construction since better utilization of available facilities could affect the broilers' performance. Similarly, Midilli et al. [17] also found no significant differences in the dressing percentages among treatment groups fed with prebiotic, probiotic and synbiotic supplementation.

Table 3: Live and carcass weight, dressing percentage, weights of carcass parts and internal organs and abdominal fat of broilers fed with prebiotic, probiotic and synbiotic supplements

Parameter	Treatments*				*P*-value	SE
	T1	T2	T3	T4		
Live wt (g)	2422.33	2434.08	2518.33	2584.58	0.10	47.23
Carcass wt (g)	1878.08^{b}	1879.92^{b}	1983.42^{a}	2008.67^{a}	0.01	29.36
Dressing %	77.54	77.34	78.76	77.73	0.67	0.86
Weight of carcass parts (% carcass wt)						
Breast	36.26	35.81	34.48	35.57	0.36	0.70
Thigh	13.88	12.40	10.10	12.33	0.15	1.07
Back	21.11	21.39	22.23	20.65	0.20	0.49
Drumstick	15.30	14.93	16.68	15.24	0.22	0.60
Neck	4.85	4.70	4.22	4.57	0.57	0.32
Wings	9.84	10.39	9.85	10.10	0.79	0.44
Weight of internal organs and abdominal fat (% carcass wt)						
Liver	2.07	2.00	1.99	1.90	0.52	0.08
Heart	0.006	0.005	0.005	0.005	0.15	0.00
Gizzard	1.63	1.43	1.53	1.41	0.27	0.08
Abdominal fat	1.65^{a}	1.52^{a}	1.19^{b}	1.46^{a}	0.00	0.66

$^{a, b, c,}$ means within the same row with different superscripts are significantly different *(p<0.05).*

* T1= Basal feed (Control), T2= Basal feed + Prebiotic (500 g/MT), T3= Basal feed + Probiotic (500 g/MT), T4= Basal feed + Synbiotic (1000 g/MT)

According to the present study, carcass weight differed significantly (p<0.05) among treatments. Birds fed with synbiotic and probiotic supplements showed significantly higher carcass weight while broilers fed with the prebiotic had a significantly lower carcass weight. However, the present study results did not agree with Sarangi et al. [15] who recorded that there were no significant differences in carcass weight among birds fed with the probiotic, prebiotic and synbiotic supplements. Strains of the bird, bodyweight, nutrition, sex, age, and environmental conditions could influence the yield of broiler parts, carcass composition and carcass weight.

The percent weight of the breast, thigh, back, drumstick, neck, and wings did not show any significant difference (p>0.05) among treatments. Further, the percent weight of the heart, liver, and gizzard did not show any significant difference in broilers. The present findings were in agreement with the reported values of Sarangi et al. [15] and Ghareeb et al. [25] who reported that the prebiotic, probiotic, and synbiotic supplementation had no significant positive effect on internal organs of broilers.

The percent abdominal fat content in birds fed with probiotics was significantly different (p< 0.05) among the treatment. A significantly higher abdominal fat content was observed in birds fed with basal feed (control), prebiotic and synbiotic. The lowest abdominal fat content was reported in birds fed with probiotics. Probiotics were added broiler diets to reduce body fat deposition and carcass cholesterol, suggesting that probiotics beneficially regulate lipid metabolism [26]. Kalavathy et al. [10] investigated the effects of *Lactobacillus* cultures on the abdominal fat traits and lipid profiles of broiler chickens and found that feeding chickens aged from 14 to 42 days on diets supplemented with a mixture of 12 *Lactobacillus* strains at 0.1% significantly reduced the serum triglyceride concentration, with a concomitant decrease in abdominal fat.

This study's results were not per the results of Ashayerizadeh et al. [7]. They reported that prebiotic had the least abdominal fat content and the highest abdominal fat content reported in the control group. Kalavathy et al. [10] found that probiotics can reduce fat deposition and regulate lipid metabolism. *Lactobacillus* cultures helped to reduce abdominal fat. It also improved carcass quality [10]. Further, Mookiah et al. [16] reported that reducing the energy level from 3,200 to 3,000 kcal/kg in broiler chickens from 21 to 42 days of age can significantly reduce the abdominal fat percentage and total body fat deposition without any negative effects on the average daily gain, feed intake, or dressing percentage.

3.3 Blood serum parameters

The total cholesterol content of different treatments is presented in table 4. The total cholesterol did not show any significant difference (p>0.05) in birds fed with basal feed, prebiotic, probiotic and synbiotic. These results did not agree with Ashayerizadeh et al. [7] who reviewed, that plasma cholesterol concentrations were significantly different when feeding prebiotic, probiotic and symbiotic supplements.

The total triglyceride levels in blood serum were not significantly different (p>0.05) in birds fed with different supplementations (Table 4). However, Kalavathy et al. [10] reported that supplementation of *Lactobacilli* culture significantly reduced triglycerides in blood serum. The present study's findings were higher than their reported values [10] who reported the serum triglycerides in birds fed basal feed as 77.19 ± 2.52 mg/dL and probiotic supplement as 58.03 ± 2.52 mg/dL.

The HDL and LDL levels in blood serum were not significantly different (p>0.05) in birds fed with different supplementations (Table 4). These results agreed with Ashayerizadeh et al. [7] and Lakshani et al. [28] who concluded that there was no significant difference in serum HDL and LDL among birds fed prebiotic, probiotic and synbiotic supplementations.

Table 4: The effect of dietary probiotic, prebiotic and synbiotic supplementation on blood serum parameters of broilers

Parameter (mg/dL)	Treatments*				*P*-value	SE
	T1	T2	T3	T4		
Cholesterol	152.10	143.78	140.89	146.14	0.77	7.78
Triglyceride	78.88	58.51	61.75	68.21	0.62	11.43
HDL	76.17	71.82	72.35	67.37	0.82	6.53
LDL	60.16	60.25	56.19	65.13	0.89	8.12
VLDL	15.78	11.70	12.35	13.64	0.62	2.28

* T1= Basal feed (Control), T2= Basal feed + Prebiotic (500 g/MT), T3= Basal feed + Probiotic (500 g/MT), T4= Basal feed + Synbiotic (1000 g/MT)

The very low-density lipoprotein levels in blood serum were not significantly different (p>0.05) in birds fed with different supplementations (Table 4). These results were not agreed with the findings of Lakshani et al. [28], who concluded that there was a significant difference among treatments. According to their results, the significantly highest VLDL values were observed in birds fed with basal feed (0.44 mmol/L) and the significantly lowest VLDL values were observed in birds fed with probiotics (0.28 mmol/L). Ashayerizadeh et al. [7] also found that significantly higher VLDL in birds fed with basal feed and the significantly lower VLDL was observed in birds fed with probiotics. According to Lakshani et al. [28], triglyceride levels in blood serum were significantly different; therefore, it affects the VLDL values.

3.4 Meat quality parameters

The pH, colour(L* value) and WHC of breast muscle are shown in table 5, and it is reported that meat quality parameters were not significant (p>0.05) among the treatments.

Table 5: Effect of dietary probiotic, prebiotic and synbiotic supplementation on meat quality

Parameter	Treatments*				P-value	SE
	T1	T2	T3	T4		
pH	6.19	5.92	5.95	6.04	0.05	0.06
Colour (L* value)	54.82	54.54	52.91	54.77	0.23	0.70
WHC (%)	63.79	63.01	66.27	64.99	0.62	1.82

* T1= Basal feed (Control), T2= Basal feed + Prebiotic (500 g/MT), T3= Basal feed + Probiotic (500 g/MT), T4= Basal feed + Synbiotic (1000 g/MT)

Karunanayaka et al. [12] reported that broiler meat's normal pH value is 5.9 and pale, soft, and exudative (PSE) pH value is 5.83. However, [28] reported that in normal breast muscle pH value is 6.45. The values reported in the present study are following the above two studies. Pre-slaughter stress and muscle glycogen content were affected by the pH because ultimate pH is considered the main factor affecting all quality attributes like tenderness, WHC, colour, juiciness shelf life and cooking loss [28]. Because of the minimum pre-slaughter stress and normal meat colour, the pH ranges in normal value. Besides, the high pH results in dark meat while low pH results in light meat.

According to the present study, the birds fed with basal feed reported higher L* value in breast meat while lower L* value was observed in birds fed with the probiotic supplements (Table 5). Karunanayaka et al. [12] and Lakshani et al. [28] reported that broiler meat's normal L* value is 56.82 and 58.57, respectively. According to the present study results, though the values were little less than Karunanayaka et al. [12] and Lakshani et al. [28], it ranged the normal L* value of broiler meat.Colour is an important factor that influences consumer preference for meat and various factors, like pigments, genetics, and feeding can affect the colour of meat [28]. However, dietary supplementation of prebiotic, probiotic and synbiotic did not change the colour in the present study.

The WHC measured in the breast meat was not significantly different (p>0.05) among the treatments (Table 5). Lakshani et al. [28] and Karunanayaka et al. [12] reported that WHC in broiler meat is 77.32% and 77.95%, respectively. These values are a bit higher than the reported values in the present study. It is believed that post-mortem activities, pH, proteolysis and protein oxidation might have affected the WHC [28].

3.5 Meat composition

Table 6: Effect of dietary probiotic, prebiotic and synbiotic supplementation on meat composition

Parameter (%)	Treatments*				P-value	SE
	T1	T2	T3	T4		
Dry matter	27.01	27.63	28.35	27.97	0.28	0.47
Ash	2.08	1.98	1.82	1.86	0.97	0.41
Crude Protein	14.70	14.67	14.95	14.91	0.88	0.30
Crude Fat	4.37	1.17	3.85	4.49	0.28	0.43
Moisture	72.99	72.36	71.65	72.03	0.28	0.47

* T1= Basal feed (Control), T2= Basal feed + Prebiotic (500 g/MT), T3= Basal feed + Probiotic (500 g/MT), T4= Basal feed + Synbiotic (1000 g/MT)

There was no significant difference (p>0.05) in the dry matter and ash contents of meat samples taken from breast muscle (Table 6). The highest total ash content was reported in birds fed with basal feed and the lowest in the probiotic group.

However, Lakshani et al. [28] reported that broiler chicken's total ash content was 0.83 ± 0.06%. The present study's findings were higher than the reported values of Lakshani et al. [28]. The moisture content in meat of the breast did not show any significant difference (p> 0.05) among treatments (Table 6). However, many variables, such as breed, feed, age, sex, and production method, can affect meat's nutritional composition [29].

3.6 Microbiological analysis

The results of the cecum microbial population are presented in Table 7. No significant difference was observed in *Lactobacilli* and *Coliform* populations in the cecum of broilers fed with dietary supplementation of prebiotic, probiotic and synbioticat the end of the experimental period. However, the number of *Lactobacilli* has increased numerically in the ceca of broilers fed diets containing probiotic compared to the birds fed with basal feed. [19] recorded that *Lactobacilli* population of birds fed control, prebiotic, probiotic and symbiotic diets were 8.9, 10.22, 9.58 and 9.23 (log cfu/mL), respectively. However, the number of *Coliform* was reduced numerically in the ceca of broilers fed diets containing synbiotic compared to the birds fed with basal feed.

Table 7: The effect of dietary probiotic, prebiotic and synbiotic supplementation on *Lactobacilli* and *coliform* population in ceca of broilers

Population (log cfu / ml)	Treatments*				*P*-value	SE
	T1	T2	T3	T4		
Lactobacilli	9.8	9.8	10.0	10.0	0.31	0.09
Coliform	8.6	4.1	4.1	4.0	0.76	3.55

* T1= Basal feed (Control), T2= Basal feed + Prebiotic (500 g/MT), T3= Basal feed + Probiotic (500 g/MT), T4= Basal feed + Synbiotic (1000 g/MT)

3.7 Feed cost analysis

As per the table 8, the feed cost analysis showed no significant difference (p>0.05) among the treatments on the cost spent for feeds to produce 1 kg of live weight. However, feeds' cost to produce 1 kg of carcass weight in birds fed with probiotics was significantly lower (p<0.05) compared to control and prebiotic supplementation.

Table 8: Feed cost analysis based on live and carcass weight of broilers fed the probiotic, prebiotic and synbiotic supplemented diet

Treatments/parameters	Cost (LKR)	
	Feed cost/ kg of live weight	Feed cost/ kg of carcass
T1	151.98	196.10[a]
T2	151.35	195.69[a]
T3	146.13	185.56[b]
T4	146.61	188.62[ab]
P value	0.26	0.04
SE	2.38	2.76

[a, b, c,] means within the same column with different superscripts are significantly different *(p<0.05)*.
* T1= Basal feed (Control), T2= Basal feed + Prebiotic (500 g/MT), T3= Basal feed + Probiotic (500 g/MT), T4= Basal feed + Synbiotic (1000 g/MT)

4. Conclusion

Supplementation of probiotic, prebiotic and synbiotic to broiler diet does not cause any significant change broiler performance, meat quality, meat composition and blood serum parameters in broiler chicken. However, birds fed with the probiotic-supplementation show the lowest abdominal fat content in carcass without reducing the carcass's quality. Therefore, feeding probiotic incorporated basal feed is a better solution to reduce the fat deposition without interfering with broiler chicken's growth performances at a lower cost.

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