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ORIGINAL ARTICLE

Effect of Dietary Supplementation of Prebiotics, Synbiotics, and Essential Oils on Growth Performance of Broiler Chicken

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Abstract

This study was performed to compare the effect of dietary supplementation of probiotics, prebiotics, essential oils and synbiotics on feed conversion ratio, live body weight and total feed intake of broiler chicken. A total of 800, day-old *Arbor acres* broiler chicks of either sex were randomly assigned into four dietary treatments. Each treatment had four replicates of 50 birds and were reared for over five weeks. Basal diet was supplemented with probiotics (control, T1), essential oils (T2), synbiotics (T3), and prebiotics (T4) as dietary treatments. The birds were provided with *ad libitum* feed and drinking water during the entire experimental period. At the end of 35 days experimental period there was no significant difference in live body weight, total feed intake and feed conversion ratio of broilers fed prebiotic, synbiotic and essential oil groups compared with probiotic supplemented control group. These findings reveal that, there is a potential to use prebiotics, EOs, and synbiotics as non-antibiotic growth promoters to improve broiler chicken's growth performances.

Keywords*: Feed additives, Feed conversion ratio, Live body weight, Total feed intake*

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1. Introduction

The broiler industry has shown a phenomenal growth over the recent past. The broiler industry has reached a step ahead with better performances of the birds (Yadav and Jha 2019). The condition and function of the gastrointestinal tract majorly associate with the health and performance of broiler birds (Clavijo and Flórez 2018). To modulate the intestinal microbiota, broiler feed is usually supplemented with antibiotics. Nevertheless, the emergence of microbial resistance to antibiotics in humans has caused an increased public and governmental concern in eliminating sub-therapeutic usage of antibiotics in livestock and avian production (Landers et al. 2012). The European Union (EU) has banned the sub-therapeutic usage of antibiotics as growth promoters in animal production. This has created an interest in seeking alternatives for antibiotic growth promoters, which can be considered as natural and safe (Casewell et al. 2003).

Prebiotics are non-digestible carbohydrates such as mannan-oligosaccharides & fructo-oligosaccharides, that beneficially effect on the host (Gibson and Roberfroid 1995). Previous studies have found that the dietary supplementation of prebiotics has a positive impact on growth performances in broiler birds (Hooge 2004; Mookiah et al. 2014; Yun et al. 2017). According to Huyghebaert et al. (2011), prebiotics are capable of selectively stimulating the proliferation or metabolic activity of a limited number of beneficial bacteria (e.g. *Bifidobacteria* and *Lactobacillus* species) in the colon.

Probiotics are live microbial feed supplements, which beneficially affect the host animal by improving its intestinal microbial balance (Jin et al. 1997). Based on the recent findings of Yang et al. (2012) and Bai et al. (2013), supplementation of probiotics has a positive impact on immunomodulation, gut health, growth stimulation and feed conversion efficiency of the host. However, those effects mostly relied on the specific strains of bacteria. *Bacillus* species, yeast, and lactic acid bacteria (LAB) are usually used as probiotics in animal nutrition (Fijan 2014). Based on the results of Ahmad (2006), probiotics are capable of maintaining beneficial microflora in the alimentary tract by competitive exclusion and antagonistic activity towards pathogenic bacteria.

Synbiotics include both beneficial micro-organisms (probiotics) and substrates (prebiotics), which may have synergetic effects on the intestine of animals (Markowiak and Ślizewska 2018). Therefore, an appropriate combination of both components in a single product should

ensure a superior effect, compared to the activity of either probiotic or prebiotic individually (Bengmark 2005; De Vrese and Schrezenmeir 2008). The principal aim of this type of combination is the improvement of the survival of probiotics in the intestine of the host by providing a better substrate (Markowiak and Ślizewska 2018).

Essential Oils (EOs), also known as aromatic oily liquids, are obtained from plant materials. They are complex mixtures of secondary plant metabolites consisting of low-boiling-phenylpropenes and terpenes (Brenes and Roura 2010). Cowan (1992) showed a wide range of antimicrobial properties of EOs. Besides antibacterial properties, EOs or their derivatives have exhibited hypolipidemic, antioxidant, digestive stimulant and immunomodulant properties. Based on the recent studies, dietary supplementation of broilers with EOs has a beneficial impact on the intestinal microflora (Helander et al. 1998) and digestive enzymes (Lee et al. 2003).

Therefore, the aim of the current research was to compare the effects of prebiotics, probiotics, EOs and synbiotics on the growth performance of broiler chicken.

2. Materials and Method

Management and Feeding

This study was carried out at a commercial farm located at Ja-Ela, Sri Lanka (7° 3' 59.84" N and 79° 53' 36.66" E) from 24th of July to 27th of August 2020. A total of 800, day-old *Arbor Acres* broiler chicks of either sex were randomly assigned to four dietary treatments with four replicates of 50 birds in each. The experiment was carried out for five weeks. Paddy husk was spread on the floor as the litter material. Brooding was done up to 10 days of age. During brooding, the heat was provided by using a 250 W incandescent electric bulb to maintain a temperature of 32.5 ^{0}C in each pen for 50 birds. The behaviour of chicks was monitored frequently to ensure the brooding conditions. Up to 14th day papers were laid on the litter to avoid chicks eating paddy husks. Feeders and waterers were changed according to the age and recommendations (Patrick and Ferrise 1962; Reed and Ringrose 1960). Feeders and waterers were cleaned and disinfected regularly. Birds were fed *ad libitum* with the formulated feed and provided fresh water with recommended quality (Mccreery 2015). All the chicks were vaccinated against Gamboro disease at 13th and 19th days of age.

The treatments are presented in Table 1. Basal diet was provided by Chemical Industries Colombo (CIC) Feeds (Pvt) Ltd according to the company's ration.

Broiler chick booster (up to 10 days), broiler starter (11 to 20 days), broiler grower (21 to 28 days) and broiler finisher (29 to 35 days) were provided based on the instructions given by the feed manufacturer, to match the nutritional requirements of the birds.

Table1. Details of the experimental diets

Treatment No.	Treatments
T1	Basal diet + Probiotic (control)
T2	Basal diet + EOs
T3	Basal diet + Synbiotics
T4	Basal diet + Prebiotic

The composition of four different basal diets are given in Table 2. The composition and dosing rates of four different natural growth promoters (probiotics, prebiotics, synbiotics and EOs) are shown in Table 3. The concept of probiotics as a dietary treatment has earned a great attention and support. Significant number of research studies have increasingly demonstrated that probiotics positively affect in promoting the growth of broilers (Park et al. 2016). Accordingly, birds fed probiotic incorporated feed was used as the control.

Body Weight, Feed Intake and Feed Conversion Ratio

Initial body weight of randomly selected 25, day-old chicks in each replicate was measured and average weight of the birds in each replicate was calculated. Thereafter, the body weight of randomly selected 25 birds from each replicate was measured at weekly intervals and average weekly body weight was used for the FCR calculations.

A measured amount of feed was provided for each pen, and then, leftovers of each day were collected separately and measured. Daily feed intake per pen was calculated using above data. Daily mortality was recorded. Feed intake per bird per week was considered for the FCR calculations. Feed Conversion Ratio was calculated in weekly intervals using the following equation.

$$\text{Weekly FCR} = \frac{\text{Weekly Feed Intake (g)}}{\text{Weekly Body Weight Gain (g)}}$$

Data Analysis

The experiment was conducted as a completely randomized design (CRD), and live body weight, feed intake and FCR were analyzed using the one-way ANOVA procedure of the SPSS software programme (Version 16.0). Before submitting data to ANOVA, the conformity of data to the assumptions was tested. Statistical differences were considered significant at $p \leq 0.05$. Data were presented as means ± standard deviation (SD).

Table 2. Proximate composition of basal diets

Basal Diets	Special Broiler chick Booster	Broiler Starter	Broiler grower	Broiler Finisher
Crude Protein % (minimum)	23.0	21.5	21.0	19.5
Crude Fat % (minimum)	4.0	4.0	4.0	4.0
Ash % (maximum)	7.0	7.0	7.5	7.5
Crude Fiber % (maximum)	4.5	4.5	4.5	4.5
Calcium % (minimum)	1.0-1.2	1.0-1.2	1.0-1.2	0.9-1.2
Phosphorous % (minimum)	0.8-1.0	0.7-1.0	0.7-1.0	0.65-1.0
Methionine % (minimum)	0.57	0.55	0.53	0.50
Metabolizable Energy ($kcalkg^{-1}$) (minimum)	3000	3000	3100	3180

(Source: CIC Feeds (Pvt) Ltd)

Table 3. Composition and the dose rates of dietary treatments used in the diet

Dietary treatments	Composition	Amount Incorporated (gt^{-1})
Probiotic	*Bacillus subtilis, Bacillus licheniformis, Bacillus coagulans, Clostridium butyricum* HJCB998	500 gt^{-1} of starter, grower and finisher ration
Essential Oils	*Rosmarinus officinalis* oil (Rosemary oil), *Origanum vulgare* oil (Oregano oil), *Cinnamomum zeylanicum* oil (Cinnamon oil) and *Capsicum annuum* extract (Chili pepper extract)	150 gt^{-1} of starter ration and grower ration.100 gt^{-1} of finisher ration
Prebiotic	Phosphorylated mannan oligosaccharides	800 gt^{-1} of starter ration and grower ration. 500 gt^{-1} of finisher ration
Synbiotics	*Bacillus subtilis* and prebiotic	500 gt^{-1} of starter, grower and finisher ration

3. Results and Discussion

Results of the weekly mean body weight and feed intake are presented in Table 4 and 5, respectively.

Body Weight

The average bodyweight of the day-old chicks was 32 g (Table 4). All the birds were in good health condition during the experimental period of five weeks. The differences observed in body weight among the treatment groups were not significant (p>0.05). In this study, birds were supplemented with a cocktail of probiotics

Table 4. Average body weight (g/ chick/ week), of chicks fed diets supplemented with Probiotics, Essential Oils, Synbiotics, Prebiotics

Dietary Treatment	Day1	Day7	Day14	Day21	Day28	Day35
T1	32.0±0	153.0±5.6	434.7±13.2	889.6±33.5	1497.9±85.2	2003.1±254.1
T2	32.0±0	155.2±4.4	427.2±38.3	913.2±45.9	1487.2±100.2	1953.7±181.9
T3	32.0±0	151.0±4.3	431.8±15.6	908.5±43.0	1457.8±73.1	1926.1±198.3
T4	32.0±0	149.3±6.2	453.8±14.0	891.7±25.3	1435.7±79.3	1958.0±131.6

T1 = Control Group (probiotic), T2 – EOs-treated group, T3 = synbiotic-treated group and T4 = prebiotic-treated group. Values are means ± SD, $\alpha = 0.05$

(*Bacillus subtilis, Bacillus licheniformis, Bacillus coagulans, Clostridium butyricum* HJCB998). Pelicano et al. (2004) reported that the magnitude of the body growth is directly affected by the variations in the strain and dose of the bacterial strain used as the dietary supplement. This could be the cause for the controversial results given by the probiotics as a natural growth promoter in different researches.

Although the differences observed in body weight among the treatments were statistically non-significant, the cumulative body weight of a bird in prebiotic supplemented group was numerically lower than control group. Similary, Sarangi et al. (2016) stated that addition of prebiotics had no significant effect on weight gain of broiler chickens. According to the results of the present study, blend of EOs showed no impact on body weight of the broilers. Those results agree with the findings of Botsoglou et al. (2002), where no significant differences of broiler chicken growth was observed using rosemary and oregano EOs alone or in combination. Moreover, Symeon et al. (2014) found that adding cinnamon oil at the concentrations of 0.5 or 1 $mlkg^{-1}$ to feed did not have the potential to improve broiler growth performance. However, the results of the present study were found contrary to the those of Puvača et al. (2019) who showed that supplementation of the diet with chilli pepper extract exhibits a positive effect on growth performances of the broilers. In contrast, Tiihonen et al. (2010) and Khattak et al. (2014) reported a significant increase in the live body weight of broilers supplemented with a blend of EOs than those fed with individual EOs.The present findings were in agreement with Sarangi et al. (2016) who reported that the dietary inclusion of synbiotics did not show any significant increase in body weight of broiler chickens.

Table 5. Feed intake (g/ chick/ week), of chicks fed diets supplemented with Probiotics, Essential Oils, Synbiotics, Prebiotics

Dietary Treatment	Day7	Day14	Day21	Day28	Day35
T1	196±14	552±7	1090±40	1974±46	2888±113
T2	193±5	543±13	1140±20	2060±80	3034±156
T3	203±20	548±8	1120±0	1990±30	2853±47
T4	218±218	563±7	1120±0	1975±25	2950±10

Means within a column with different superscripts were significantly different ($p > 0.05$). T1 = Control Group (probiotic), T2 – EOs-treated group, T3 = synbiotic-treated group and T4 = prebiotic-treated group. Values are means ± SD $\alpha = 0.05$.

Feed Intake

The cumulative feed intake per chick was same for every group (Table 5). Similarly, Brenes and Roura (2010) and Bozkurt et al. (2014) had reported that the feed intake in broilers was unchanged or slightly reduced by supplementation of EOs. Halle et al. (2004) and Amad et al. (2011) reported that the feed intake of broilers was decreased by increasing the dietary level of a blend of thyme, and Origanum leaves, and it's associated with EOs compared with control. Accordingly, there can be an effect of composition and quantity of the EOs on the feed intake. In the present study, the impact of dietary supplementation of prebiotic, probiotic, essential oil and synbiotic on cumulative feed intake during the entire period of the experiment, was found to be non-significant (p>0.05).

Several other studies also showed that the supplementation of probiotics or prebiotics alone or in combinations as synbiotics had no significant effect on the feed intake of broilers (Mookiah et al. 2014; Sarangi et al. 2016; Jung et al. 2008; Olnood et al. 2015).

Feed Conversion Ratio

The FCR of the birds assigned to different treatments was ranged from 1.22 ± 0.04 to 1.55 ± 0.05 (Fig. 1). Over the first 21 days of treatment, there was a decreasing trend in the FCR values irrespectively of the treatment. However, after 21 days of treatment, there was a marked increase in the FCR values in all treatments up to the 35th day. At the 28th day, the FCR of the control group was lower than that of the EOs, synbiotic and prebiotic treated groups. The FCR values after the end of the experiment did not differ significantly between prebiotic, EOs and synbiotic group compared to control (p> 0.05). The present findings were in agreement with several studies that reported no significant difference in FCR values between probiotics, prebiotics, and synbiotics (Mokhtari and Yazadani 2010; Sarangi et al. 2016).

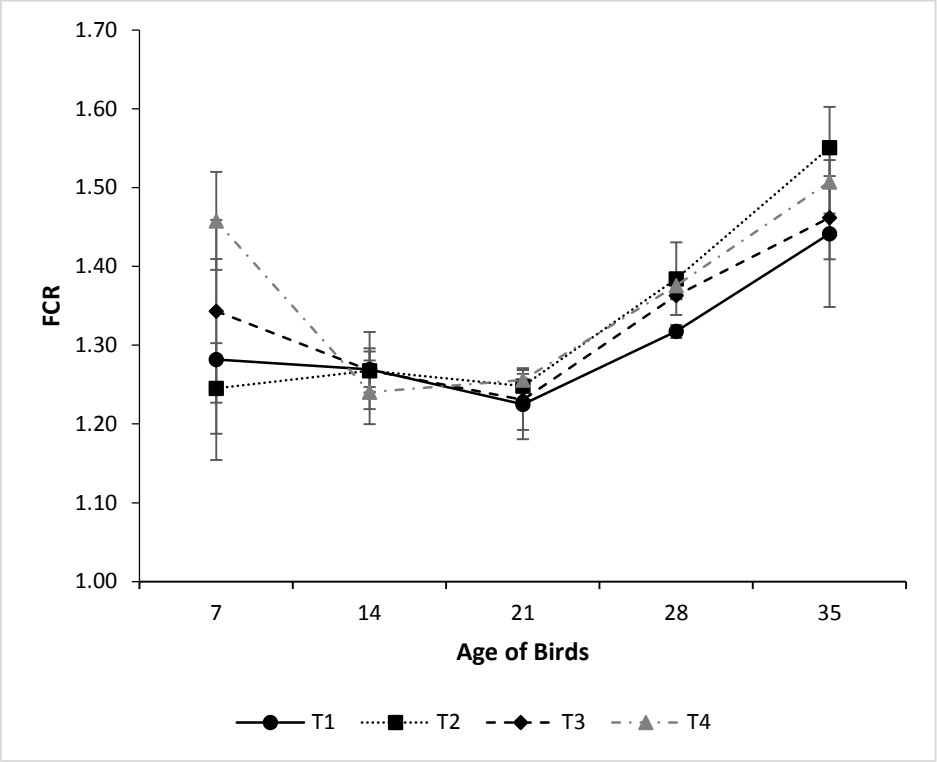

Figure 1. Changes in FCR of broilers fed diets supplemented with different dietary treatments over the experimental period. T1 = Control Group (probiotic), T2 – EOs-treated group, T3 = synbiotic-treated group and T4 = prebiotic-treated group. Values are means ± SD, α = 0.05

The results of the present study showed that there was no difference in inclusion of probiotics, essential oils, prebiotics or synbiotics on FCR. In contrast, Talebi et al. (2008), Wang and Gu (2010) and Harrington et al. (2015) observed that the inclusion of probiotic to broiler diets has decreased FCR significantly. Hassanpour et al. (2013) stated that synbiotics promote the growth of the probiotic by providing a specific substrate to the probiotic for its fermentation. The FCR of prebiotic-supplemented group (1.50 ± 0.04) was numerically higher than the FCR of the control group. Further, present findings were in agreement with Hernández et al. (2004) who found that the addition of EOs did not have any significant effect on the FCR of broiler chickens. However, the present observation was found not in concurrence with Hong et al. (2012) who reported that EOs feed supplementation significantly improved the FCR. Similarly, studies done by Guler et al. (2005) and Gao et al. (2010) also reported that dietary supplementation of EOs has a significant improvement of FCR in broilers when compared to the control group.

There are evidences that the EOs have a positive effect on the production performance of broiler chickens. Two well-accepted mechanisms of EOs are the stimulation of digestive enzyme secretion and the stabilization of ecosystem of gut microflora, leading to ameliorated feed utilization and less exposure to growth-depressing disorders related with digestion and metabolism (Bento and Ouwehand 2013; Brenes and Roura 2010; Zhai et al. 2018). The major cause for the contradictory results of the EOs treated group in the present study could be due to the variation in the efficacy of EOs. Growth performance and feed intake could be associated with the composition of the EOs mixture and inclusion level of the EOs (Yitbarek 2015). There are various types of herbs and spices used as phytogenic feed additives in poultry production. The impact of harvesting time, state of maturity of plants, extraction methods of plants, method and duration of conservation and storing, possible synergistic or antagonistic effect of the bioactive compounds may also affect to the results (Brenes and Roura 2010; Krishan and Narang 2014).

4. Conclusions

The present study did not show any significant effect on the body weight and FCR of the broilers by the dietary inclusion of prebiotics, blend of EOs, and synbiotics compared with probiotics supplemented control at the end of 35 days experimental period. Further studies should be conducted to confirm the present findings and evaluate the suitability of these natural growth promoters as promising alternatives for antibiotic growth promoters in broiler industry.

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