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Effect of dietary supplementation of Lactobacilli and Streptococci cultures on the performance of broiler chickens

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Abstract

An experiment was conducted to study the effect of dietary supplementation of lactic acid cultures (5×10^10 cfu of Streptococcus thermophilus and Lactobacillus bulgaricus per gram) on growth parameters of Lohmann Indian River broiler chicks. Fifty-two unsexed day-old chicks were randomly divided into two groups. Each group was subdivided into two replicates and housed in 108×108 cm pens and reared with a deep litter system. The birds were fed with commercial broiler starter ration for the first 21 days and from 22 to 40 days, they were randomly allocated to one of the two dietary treatments: broiler finisher (control) or broiler finisher supplemented with 1% lactic acid cultures (experimental diet). The study showed that treatment effects on feed intake, live-weight, dressing percentage and weight of the internal organs of broilers were not significant (P>0.05). Total feed intake was 3 786.3 g on control diet and 3 785.3 g on experimental diet. The values for the respective growth parameters on control diet were: live-weight, 2 562.5 g; live-weight gain, 85.1 g/d and relative growth rate, 83.1 g kg^{-1} d^{-1}. The values for the respective growth parameters on experimental diet were: live-weight, 2 371.4 g; live-weight gain, 77.4 g/d and relative growth rate, 82.0 g kg^{-1} d^{-1}. Dressed weight (1 828.6 g) was higher (P<0.05) on control diet. There was no difference in FCR. The findings could be due to combined effects of insufficient bacterial count, and genotype and growth stage of broilers.

Keywords: *Broiler chicken, FCR, Lactic acid culture, Weight gain*

Introduction

Broiler chicken meat is one of the nutritious human food which supplies high-quality protein, vitamins and minerals. Commercial broiler producers continuously increase their production to meet the growing market demand for broiler meat. Successful broiler production highly depends on favourable growth and survival of the birds within a stipulated time period. These factors are mainly influenced by the genotype of the broilers, and the management practices provided *viz.* nutrition and feeding, disease control, litter management, *etc.* Major expenditure encountered in broiler production is feed cost which accounts for more than 70% of the total production cost. Continuous price hike of compounded poultry feed due to increase in the cost of feed ingredients such as fishmeal challenges the profit for broiler producers. In addressing these challenges an extensive attempt has been made by introducing feed supplements and additives such as probiotics (Sultan *et al.*, 2006; Jadhav *et al.*, 2015; Getachew, 2016), antibiotic growth promoters (Dibner and Richards, 2005), *etc* to improve the growth parameters of broilers with minimum cost.

Understandings about the risks of development of resistance to antibiotics and residual effects of antibiotics in broiler meat have alarmed the stakeholders of broiler industries on the health hazards of dietary supplementation of antibiotic growth promoters to the broilers (Otutumi *et al.*, 2012; Jadhav *et al.*, 2015). However, probiotics as an alternative to antibiotic growth promoters are extensively used as feed additives for the broilers. A probiotic is a live microbial feed supplement that beneficially affects the host animal by

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improving its intestinal microbial balance. Antibiotics destroy life but probiotics build up or promote life (Fuller, 1989). The gastrointestinal tract of poultry has *autochthonous* and *allocthonous* microbial populations. *Autochthonous* bacteria colonize in the gut from the environment and *allocthonous* bacteria are introduced through feed or drinking water as direct fed microbial populations or probiotics (Jadhav *et al.*, 2015).

The most commonly used bacterial species in probiotics for poultry are *Lactobacillus bulgaricus*, *Lactobacillus acidophilus*, *Lactobacillus casei*, *Lactobacillus helveticus*, *Lactobacillus lactis*, *Lactobacillus salivarius*, *Lactobacillus plantarum*, *Streptococcus thermophilus*, *Enterococcus faecium*, *Enterococcus faecalis*, *Bifidobacterium spp*. and *Escherichia coli*. Except *Lactobacillus bulgaricus* and *Streptococcus thermophilus*, all the other remaining species are intestinal strains (Otutumi *et al.*, 2012). Lactic acid, acetic acid and hydrogen peroxide produced by Lactic acid bacteria reduce the pH of the gut content and inhibit some pathogenic bacteria *viz.* coli forms, *Salmonella* and *Clostridia* (Mudalgi *et al.*, 1993; Kumprecht *et al.,* 1994). Lactic acid bacteria are extensively used as probiotics in poultry (Raja *et al.*, 2009; Khan *et al.*, 2011; Mansoub, 2011; Ezema, 2013; Jadhav *et al.*, 2015; Getachew, 2016) as they are considered to be safe for gut health of poultry. Improvements in growth performance, carcass quality, and feed efficiency in broiler chickens have been reported after supplementing yoghurt and lactobacilli probiotics with drinking water (Boostani *et al.*, 2013). However, failure of probiotic cultures to colonize in the gut of the birds will be ineffective of their supplementation to enhance the performance of chicken (Jin *et al.*, 1998; Salarmoini and Fooladi, 2011).

In this context a study was conducted to analyze the effects of yoghurt cultures containing *Lactobacillus bulgaricus* and *Streptococcus thermophilus* fed with the commercial diet on the growth parameters of broiler chickens.

Materials and Methods

Fifty two Lohmann Indian River day-old unsexed broiler chicks were randomly divided into two groups (26 birds per group). Each group was subdivided into two replicates (13 birds per replicate) and housed in identical size pens (108×108 cm) in a deep litter system using paddy husk as litter material. Birds were provided 24 h light, commercial broiler ration at the recommended rate and free access to water.

All the birds were fed with commercial broiler starter ration (Prima) for the first 21 days of growth. Thereafter the birds were fed with broiler finisher ration (Prima) until slaughter at 40th days of growth. Application of dietary treatments such as control diet and experimental diet were started from 22nd days onward with the feeding of finisher ration. The experimental diet contained broiler finisher feed supplemented with 1% of fermented milk (% w/w) which was prepared from Chr Hansen's freeze-dried lactic culture for Direct Vat Set (DVS) (min. 5×10^{10} cfu of *Streptococcus thermophilus* and *Lactobacillus bulgaricus* per gram) and sterile cow milk as prescribed by the manufacturer.

Daily feed intake and body weight gain of all birds were measured from 22 days of growth at 5-days interval. At 40 days of growth, three birds from each pen were randomly selected and their live body weight was measured individually. Then the sampled birds were slaughtered and eviscerated to determine carcass weight as a percentage of live weight (Dressing Percentage). Carcass weight was measured after defeathering and removal of feet, head and viscera. Weight of liver, spleen, gizzard and heart was determined as a percentage of carcass weight. Feed conversion ratio (FCR) was calculated as described by Samarakoon and

Samarasinghe (2012). The data were statistically analyzed using SAS software package (SAS Institute Inc., 1999-2000) with PROC GLM procedure with complete randomized design. Treatment differences were compared using Duncan's multiple range test.

Results and Discussion

Weight gain

Table 1 shows that dietary supplementation of 1% lactic acid cultures (5×10^{10} cfu of *Streptococcus thermophilus* and *Lactobacillus bulgaricus* per gram) did not significantly affect ($P>0.05$) the average live-weight, relative growth rate, live-weight gain and dressing percentage of broilers. However, the dressed weight was 236 g more ($P<0.05$) in control flock than in the experimental flock. It was in agreement with the findings of Watkins and Kratzer (1983) that the broilers fed with dietary supplementation of *Lactobacillus* culture did not perform well as that of grown in control diet. Current findings could be attributed to a combination of effects of insufficient number of living bacteria in the treatment, broiler strains, growth stage of birds and environmental conditions. Lyons (1987) reported that the effectiveness of probiotic supplementation depends on the sufficient number of relevant living bacteria and the absence of stress factors. Salarmoini and Fooladi (2011) stated that the effectiveness of *Lactobacillus* cultures on broilers depends on stress factors, ability of microorganisms to fit into the intestinal wall, antagonistic effects of microorganisms on pathogenic bacteria, and their ability to competitively exclude pathogenic bacteria. Zahid and Hussain (2002) studied the performance of ISA, Ross, Indian River, Arbor Acres, Lohmann and Hubbard broiler strains raised under local environmental conditions. They found that though there were no significant differences in live weight, dressed weight and dressing percentage among the treatments, each strain showed different levels of performance.

Table 1. Body weight gain and growth performances of Lohmann Indian River broiler chicken after 40 days of growth, fed with broiler finisher ration supplemented with lactic acid cultures

	Treatments	
	Control diet	Experimental diet
Live-weight (g)	2 562.5 ± 194.5^{a}	2 371.4 ± 47.1^{a}
Dressed Weight (g)	1 828.6 ± 77.8^{a}	1 592.9 ± 14.1^{b}
Relative Growth Rate (g kg^{-1} d^{-1})	83.1 ± 9.6^{a}	82.0 ± 4.5^{a}
Live-weight Gain (g/d)	85.1 ± 10.3^{a}	77.4 ± 4.1^{a}
Dressing Percentage (%)	69.5 ± 0.5^{a}	66.8 ± 0.1^{a}

Means±SE with different superscripts within each row are significantly different ($P<0.05$).

Pelicano *et al.* (2005) found that dietary supplementation of 0.1% of probiotics (*Lactobacillus acidophilus, L. casei, Streptococcus lactis, S. faecium, Bifidobacterium bifidum and Aspergillus oryzae*) to the male Cobb broilers did not significantly improve their live weight (2.35 kg on control diet and 2.43 kg on experimental diet) and dressing percentage (74.4 on control diet and 75.0 on experimental diet) after 42 days of growth. Moreover, Salarmoini and Fooladi (2011) found that dietary supplementation of 2% fermented milk that contained 2×10^{8} cfu g^{-1} *Lactobacillus acidophilus* to male Ross broiler chicks raised for 42 days did not show significant increase in daily weight gain (53.4 g/bird/d). However, significant increase has been recorded from day-old to 21 days of growth. Thus dietary supplementation of 2% fermented milk with 2×10^{8} cfu g^{-1} *Lactobacillus acidophilus* could be effective during starter phase of broilers.

In contrast, Mansoub (2011) found that dietary supplementation of 0.5% yoghurt to broiler chicks raised for 42 days improved live weight gain (2184.4 g). Jin *et al.* (1996) reported that dietary supplementation of 0.2% of *Lactobacillus* to male Arbor Acres broiler chicks from 10-day old to 38 days of growth significantly increased weight gain. Hossain *et al.,* (2015) reported that broilers fed with *Bacillus subtilis*, *Clostridium butyricum* and *Lactobacillus acidophilus* (tri-strain probiotics) endospores shown increased body weight gain.

According to past studies and current observation it could be concluded that insignificant treatment effects on broilers growth performances in the current study are due to inability of lactic acid cultures to colonize and effect on the gastrointestinal tract of Lohmann Indian River broiler chickens over the 18 days of growth period with treatment.

Weight of organs

Table 2 shows that there was no significant difference (P>0.05) in mean weight of organs of the broiler chicken reared on control and the experimental diets. The findings agree with Salarmoini and Fooladi (2011) that dietary supplementation of fermented milk with $2×10^8$ cfu g^{-1} *Lactobacillus acidophilus* to male Ross broiler chicks raised for 42 days did not increase (P>0.05) the relative weight of spleen (0.12%), heart (0.55%), liver (1.89%), and gizzard (2.07%). Kalavathy *et al.* (2003) also reported non-significant difference in weight of the organs when *Lactobacillus* fed to broilers. As there was no significant difference in final body weight of the birds, the relative weight of the internal organs also did not differ between treatments. Kokoszyński *et al.* (2017) reported that there is no any significant difference in percentage weight of liver, heart, gizzard and spleen among Ross 308, Hubbard Flex, and Hubbard F15 broiler strains.

In contrast, some investigators reported that there are significant increases in relative weight of internal organs of the broilers when treated with yoghurt (Sultan *et al.*, 2006), dietary *Lactobacillus casei*, *Lactobacillus acidophilus* (Shlej *et al.*, 2015), and *Saccharomyces cerviciae* (Farhoomand and Dadvend, 2007).

Table 2. Weight of the internal organs of Lohmann Indian River broiler chicken after 40 days of growth, fed with broiler finisher ration supplemented with lactic acid cultures

	Treatments	
	Control diet	Experimental diet
Spleen Weight (% body weight)	0.12 ± 0.04	0.15 ± 0.07
Heart Weight (% body weight)	0.60 ± 0.09	0.62 ± 0.08
Liver Weight (% body weight)	2.91 ± 0.35	2.43 ± 0.44
Gizzard Weight (% body weight)	3.17 ± 0.42	3.72 ± 0.95

Feed intake

There was no significant difference in feed intake by the birds. Total feed intake of broilers raised on control and experimental diets were 3 786.3 g and 3 785.3 g respectively. Non-significant effects in feed intake have previously been reported when broiler were given yoghurt (Sultan *et al.*, 2006; Khan *et al.*, 2011), *Lactobacillus* *acidophilus* (Salarmoini and Fooladi, 2011) and *Lactobacillus johnsonii* (Olnood *et al.*, 2015). This result could be attributed to the inability of supplemented microorganisms to effect on the gut of the birds (Jin *et al.*, 1998).

Feed conversion ratio

There was no difference (P>0.05) in feed conversion ratio from 22 to 40 days of growth of broilers reared under control diet (1.85) and that of under the experimental diet (2.05). It was in agreement with the findings of Sarangi *et al.* (2016). In another study, Salarmoini and Fooladi (2011) found that dietary supplementation of 2% fermented milk that contained 2×10^{8} cfu g^{-1} *Lactobacillus acidophilus* to male Ross broiler chicks raised for 42 days did not show significant increase in feed conversion ratio (1.74). Otutumi *et al.* (2012) suggested that the age of the birds which receive the probiotic treatment influences their feed efficiency. Poultry fed with probiotics have shown improved feed conversion ratio up to 21 days of age. However, there were no significant differences for the total period of 42 days.

Table 3 shows that there was a linear increase in FCR of birds until five weeks. Improvement in FCR was observed from fifth week onward for both control and experimental diets. This may be attributed to less handling stress of birds within last three days and pre-slaughter feed withdrawal allowed the birds to utilize nutrients efficiently. Mehmood *et al.* (2013) found that one hour feeding and three hours off improves FCR in broilers. However, excessive duration of feed withdrawal will increase FCR due to body weight loss (Hamidu *et al.*, 2015).

In contrast, some other investigators showed that the FCR was significantly reduced when the broiler chicks were fed with 0.5% yoghurt for 42 days (Mansoub, 2011), 0.2% of *Lactobacillus* from day 10 to 38 days (Jin *et al.*, 1996), and *Bacillus subtilis*, *Clostridium butyricum* and *Lactobacillus acidophilus* (Hossain *et al.*, 2015). However, Samarakoon and Samarasinghe (2012) reported that there is a linear increase in FCR of broiler chicken with their age.

Table 3. FCR of Lohman Indian River broiler chicken fed with broiler finisher ration supplemented with lactic acid cultures

Age (days)	FCR	
	Control Diet	Experimental Diet
22	1.11 ± 0.14	1.15 ± 0.12
27	1.37 ± 0.15	1.37 ± 0.11
32	1.40 ± 0.15	1.48 ± 0.13
37	1.71 ± 0.16	1.72 ± 1.16
40	1.50 ± 0.19	1.60 ± 0.13

Conclusion

Dietary supplementation of 1% lactic acid cultures (5×10^{10} cfu of *Streptococcus thermophilus* and *Lactobacillus bulgaricus* per gram) to unsexed Lohmann Indian River broiler chicks from 22 to 40 days of growth has not shown significant effects on their body weight gain, weight of internal organs, feed intake and feed conversion ratio. These findings are in consistent with past studies and could be attributed to combined effects of insufficient bacterial count, genotype of broilers, and duration of experimental period.

Thus, the experiment could be repeated with different treatment levels in order to find out the effective dose of microbial cultures to supplement with the feed.

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