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Productive performance and cost effectiveness of broiler using three different probiotics in the diet

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Abstract

The experiment reported here was an attempt to evaluate the effect of feeding three different probiotics to broilers on productive performance, meat yield and profitability of rearing for 42 days in an open sided house, at Bangladesh Agricultural University Poultry Farm. Two hundred fifty-six one-day old Indian River straight run broiler chicks were randomly allotted to four dietary treatments each of four replicates of 16 chicks each providing floor space of 1115 cm^2 per bird. The basal diet was corn-soya and it was supplemented with different probiotics to make test diets. The dietary treatments were: basal diet (T_1); basal diet supplemented with probiotic-1 (PB-1) at 1.0 g/kg feed (T_2); basal diet supplemented with probiotic-2 (PB-2) at 1.0 g/kg feed (T_3); basal diet supplemented with probiotic-3 (PB-3) at 0.5 g/kg feed (T_4). Birds were fed starter diet from 0-21 days of age and grower diet from 22-42 days of age. Records were kept of performance traits and carcass yields by maintaining birds under identical management. Profitability was determined on termination of the trial. Performance and carcass yield data were statistically analyzed employing SAS Computer Package Program (SAS, 2009). Results showed no variation (P>0.05) in growth performance and meat yield characteristics of commercial broilers irrespective of types of probiotic supplementation. However, feed intake increased (P<0.05) due to supplementation of probiotics. Although higher cost (p<0.05) incurred due to addition of probiotics in the diet, such an addition increased profit. Profit over control was BDT 12.20/bird (BDT 5.10/kg) in PB-1, BDT 18.70/bird (BDT 7.40/kg) in PB-2 and BDT 17.10/bird (BDT 6.40/kg) in PB-3 group. The profit was higher in all the treated groups over control indicating that the use of probiotics irrespective of type was profitable and cost effective.

Key words: commercial broiler, probiotics, performance, meat production, profitability

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Introduction

A tendency among the people to get higher gain in body weight from the commercial broilers within the shortest possible time has encouraged the scientists to evolve high yielding broiler strains. Researchers are successful in enhancing body weight gain with lowest feed conversion ratio (FCR). Having such genetically improved stocks, further improvement by dietary intervention has got attention. The use of a number of feed additives and/or growth promoters was in practice for a long time. Several types of antibiotics at sub-therapeutic levels in the diet were the major actors for enhancing growth but their use is being highly criticized due to microbial resistance (Menten, 2001; Sinol *et al.,* 2012). This has led to the use of alternatives to antibiotics in poultry nutrition. Among the alternatives, probiotics are considered worldwide as safe (Roy, 2018; Junaid *et al.,* 2018). Of course, their effects on productive traits differ because of a number of factors. These are the survival and stability of probiotic organisms, the strain, host specifity, manufacturing process, dose frequency, health and nutritional status of birds, the age, physiological stress level and genetics of the host (Chichlowski *et al.,* 2007; Aalaei *et el.,* 2018). Several authors reported beneficial effects of probiotic administration (Corrêa *et al.*, 2003; Vargas *et al.*, 2002), whereas others found no improvement when probiotics were used (Yong *et al*., 2016; Hossain *et al*., 2012). Recently, Al-Khalaifa *et al.* (2019) conducted an experiment and found no effect on productive performance of birds from feeding *Bacillus coagulans* and *Lactobacillus* in the diet. Use of probiotics in the diet obviously increases feed cost, but economic data in the literature are scarce. It is therefore interesting to find out at least a few preparations of probiotics that would increase profit margin in spite of making production costly. The experiment reported here was an attempt to make a comparison of three

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types of probiotics available in Bangladesh to examine their efficacy on performance in one hand and cost effectiveness on the other.

Materials and Methods

Experimental birds, housing and design

A total of 256 Indian River straight run broiler chicks were allocated to four dietary treatments in four replicate pens each of 16 birds in an open sided house. The dietary treatments for comparison were: (1) a corn-soya based basal diet (control); (2) basal diet supplemented with probiotic-1 (PB-1) at 1.0 g/kg feed; (3) basal diet supplemented with probiotic-2 (PB-2) at 1.0 g/kg feed and (4) basal diet supplemented with probiotic-3 (PB-3) at 0.5 g/kg feed. Dietary inclusions were those recommended by manufacturers. The experiment was arranged following the principles of completely randomized design (CRD). Each bird was provided with floor space of 1115 cm^2. The composition of the probiotics are: PB-1; *Lactobacillus* spp.: 3.10^7-10^8 cfu/g**,** *Bacillus* spp.: 3.10^7-10^8 cfu/g and *Saccharomyces*: 10^6-10^7 cells/g; PB-2; *Bacillus subulans* 10^{10} cfu/g, *Bacillus soagulans* 10^{10} cfu/g and PB-3; *Bacillus subtilis*- min. 2×10^9 cfu/g.

Experimental diet

A corn–soya based basal diet was formulated using available feed ingredients. Starter diet was provided from 1-21 days and grower diet from 22-42 days. Both types of diet were supplied in mash form. The nutrient requirements were satisfied close to the requirements of Indian River commercial broilers.

Management practices

The birds were subjected to similar care and management throughout the experimental period. Immediately after arrival of day-old chicks, they were weighed and randomly distributed to each pen. Initially, pieces of newspapers were placed and kept for seven days. The birds were illuminated with incandescent bulb for 23 hours for lighting and one hour of dark period was kept throughout the experimental period. During brooding period 34^0C temperature was maintained initially, thereafter, 2.5^0C was reduced in each week by adjusting heat source. A 100-watt electric bulb for each pen was kept for warming the chicks. Room temperature and humidity were measured four times a day by an automatic digital thermo-hygrometer. Strict biosecurity measures were taken. One round tube feeders and one round drinker with a capacity of eight litters were provided in each pen. Feed and water were provided *ad libitum*. Fresh and clean drinking water were provided and feeders and drinkers were subjected to cleaning when required. Rice husk was used as litter materials at a depth of about 2.5 cm. It was stirred three times daily from the beginning of fourth week until end of the trial to prevent cake formation and minimize dampness.

Table 1: Ingredient and nutrient composition of basal diet

Ingredients (% basis)	**Broiler Starter (0-21 days)**	**Broiler Grower (22–42 days)**
Corn	50.63	54.23
Protein Concentrate	8.50	7.50
Soybean meal	33.30	29.70
Limestone	0.80	0.80
Dicalcium phosphate	1.70	1.70
Soybean oil	4.00	5.00
Vit-mineral premix	0.30	0.30
Lysine	0.20	0.20
Methionine	0.20	0.20
Enzyme	0.05	0.05
Salt	0.30	0.30
Emulsifier	0.020	0.020
Total	100.00	100.00
Nutrient composition		
Energy (ME kcal/kg)	3011	3159
Crude protein, %	24.09	22.25
Calcium, %	1.21	1.15
Total phosphorus, %	0.82	0.79
Av. phosphorus, %	0.51	0.49
Lysine, %	1.42	1.31
Methionine, %	0.61	0.58
Meth+Cyst, %	0.91	0.87
Phenylalanin: Tyr. , %	1.34	1.23

Newcastle disease and Infectious bronchitis disease vaccine (MA5+Clone 30) was given at 5th day of age. It was followed by a booster dose of similar vaccine at 21st days of age. Infectious bursal disease (Gumboro) vaccine (228E) was given on day 10 followed by a booster dose on 17th day.

Performance records

The broiler chicks were weighed group-wise at the beginning of experiment and then every 7 days intervals until the end of experiment at day 42. The weight was taken in the early morning. Average live weight and the live weight gain of the broiler chicks on different dietary treatments were obtained by calculations. The amounts of feed consumed by experimental broilers in different groups were determined by calculations. Feed conversion ratio was calculated as the unit of feed consumed per unit of body weight gain.

Carcass characteristics

At the end of feeding trial three broilers having body weight near to pen average from each treatment were taken randomly for the quantitative evaluation of meat yield parameters. To facilitate processing of broilers, feed was withdrawn 8 hours before slaughtering but water was supplied in a regular manner. The birds were killed and allowed to bleed for 5 minutes and immersed in hot water (51-55ºC) for 2 minutes for the ease of feather removal. Dressed broilers were cut into different parts and proportion of cut up parts was converted into percentage.

Economics of production

Cost benefit analysis was performed at the end of trial to justify the use of probiotics. In calculating the total cost of production, cost of chicks, feed, vaccine, electricity and casual labor were taken into consideration. In addition, for treated groups, cost of test ingredients was added. The cost benefit was calculated as BDT/bird (basis) and BDT/kg live weight basis.

Results and Discussion

Growth performance

Table 2 shows the comparison of productive performance of commercial broilers receiving different types of probiotics. Initial live weight of the birds in different dietary groups was almost similar and no significant difference was found in the growth performance among the treated groups. Although no significant difference was apparent, birds on treated group showed higher trends in weight gain and lower trends in FCR. None of the parameters except the feed intake differed (P>0.05) between T_3 and T_4 due to supplementation of probiotics in the diet.

No significant improvement in body weight gain was reported by Chen *et al.* (2009) with *Bacillus subtilis* and *Saccharomyces* containing probiotics. No improvement on performance was also reported by Mutus *et al.* (2006) from a feeding trial that lasted for 42 days when they used *Bacillus licheniformis* and *Bacillus subtilis* as dietary probiotic. Karaoglu and Durdag (2005) used *Saccharomyces cerevisiae* as a dietary probiotic to assess growth performance and found no difference in weight gain. In contrast, Awad *et al.* (2013) and Gao *et al.* (2009) reported improved body weight gain upon feeding of *lactobacillus* containing probiotics. Results of feeding *Bacillus subtilis* containing probiotics (Molnar *et al.,* 2012) and Lactobacillus containing probiotics (Gao *et al.,* 2009) showed an increase in feed intake similar to the findings of the current study. Bai *et al.* (2017) conducted an experiment with *Bacillus subtilis* containing probiotics for a period of 42 days and observed increased feed intake.

Table 2: Effect of feeding three different probiotics on production performances of broiler chickens (0-42 days)

Treatment	T_1	T_2	T_3	T_4	P-value
Day-old chick weight (g)	38±0.31	38±0.32	38±0.31	39±0.16	0.5829
Final weight (g)	1846±7.00	1988±28.14	2055±53.98	2057±94.18	0.0848
Weight gain (g)	1808±36.92	1950±28.31	2017±54.14	2018±94.02	0.0852
Feed intake (g)	3350^b±43.91	3423^{ab}±28.66	3475^a±18.00	3534^a±53.57	0.0317
Feed conversion ratio	1.86±0.032	1.75±0.025	1.73±0.052	1.76±0.054	0.2360

*T_1-Control, T_2= PB-1 (*Lactobacillus* spp.: 3.10^7-10^8 cfu/g**,** *Bacillus* spp.: 3.10^7-10^8 cfu/g and *Saccharomyces*: 10^6-10^7 cells/g), T_3=PB-2 (*Bacillus subulans* 10^{10} cfu/g, *Bacillus soagulans* 10^{10} cfu/g), T4=PB-3 (*Bacillus subtilis*- min. 2×10^9 cfu/g), Means with superscripts having no common alphabet in the same row differ significantly at the stated level of probability. Value indicate- mean ± standard error.

However, Patel *et al.* (2015) showed that feed intake was not affected by feeding multi-strain probiotics (*Lactobacillus plantarum, Lactobacillus bulgaricus, Lactobacillus acidophilus, Lactobacillus casei, Streptococcus thermophilus, Streptococcus faecium, Bifidobacterium bifidum, Torulopsis spp. and Aspergillus oryzae*). No effect on feed intake was also in line with the study of Willis and Reid (2008) upon dietary probiotic feeding. No significant variation reported in feed conversion in a trial of Junaid *et al.* (2018) upon feeding *Lactobacillus acidophilus* and *Bifidobacterium bifidi* containing probiotics over a period of 42 days. On the other hand, He *et al.* (2019) expressed improved FCR (P<0.05) by feeding a mixture of *Bacillus subtilis*, *Bacillus licheniformis* and *Saccharomyces cerevisiae* in the diet for a period of 42 days.

Edible meat yield characteristics

Application of dietary probiotics did not cause any significant changes in meat yield characteristics of chicken (Table 3). This was an indication that inclusion of dietary probiotics did not alter meat yield characteristics.

A study was conducted to evaluate the potential of *Bacillus subtilis* based probiotic and no significant improvement was noticed in carcass characteristics (Mahmoud *et al.,* 2017). Patel *et al.* (2015) reported no changes in edible organ weights fed probiotics containing diet. In agreement with our results, Anjum *et al.* (2005) found no significant improvement in dressing percentage of broiler chickens because of dietary probiotic supplementation. In addition, Racevičiūtė-Stupelienė *et al.* (2007) found similar carcass and breast meat yield in birds fed diet with or without probiotic based on *Saccharomyces cervisiae*. However, other research findings (Kabir *et al.,* 2004; Farhoomand and Dadvend, 2007) showed that probiotic inclusion to broiler diets increased dressing percentage. No significant change in abdominal fat was found in this study. This was in agreement with the earlier findings (Aksu *et al.,* 2005; Karaoglu and Durdag, 2005; Farhoomand and Dadvend, 2007 and Racevičiūtė-Stupelienė *et al.,* 2007).

Table 3: Effect of feeding three different probiotics on meat yield of broiler chickens (0-42 days)

Parameters (%)	T_1	T_2	T_3	T_4	P-value
Dressed weight	70.74±0.557	71.56±1.164	71.34±0.505	68.93±0.971	0.1951
Breast	22.79±0.569	23.64±1.233	21.89±1.032	22.03±1.172	0.6292
Thigh	13.06±0.908	13.72±0.216	12.95±1.279	12.55±0.233	0.7793
Drumstick	9.51±0.163	9.83±0.666	10.83±0.169	9.9±0.176	0.1400
Heart	0.55±0.026	0.53±0.008	0.55±0.028	0.50±0.057	0.7232
Liver	2.27±0.250	2.50±0.046	2.52±0.157	2.28±0.053	0.5107
Gizzard	1.910±0.082	1.66±0.041	1.87±0.147	1.88±0.107	0.3432
Giblet	4.74±0.262	4.69±0.093	4.95±0.278	4.67±0.173	0.7766
Head	1.25±0.073	1.23±0.026	1.21±0.051	1.17±0.029	0.7055
Wing	8.47±0.149	8.04±0.303	7.98±0.073	7.69±0.337	0.2359
Neck	4.34±0.349	4.90±0.282	5.32±0.174	4.73±0.299	0.1871
Fat	1.01±0.430	0.80±0.232	0.92±0.217	0.43±0.087	0.4965

*T_1-Control, T_2= PB-1 (*Lactobacillus* spp.: 3.10^7-10^8 cfu/g**,** *Bacillus* spp.: 3.10^7-10^8 cfu/g and *Saccharomyces*: 10^6-10^7 cells/g), T_3=PB-2 (*Bacillus subulans* 10^{10} cfu/g, *Bacillus soagulans* 10^{10} cfu/g), T_4=PB-3 (*Bacillus subtilis*- min. 2×10^9 cfu/g), none of the variables showed significant difference (P>0.05), Value indicate- mean ± standard error.

Table 4: Economic analysis and cost-effectiveness of feeding probiotics

Parameters	T_1	T_2	T_3	T_4	P-value
(a) Feed cost (BDT/bird)	129.00^{b}±1.69	131.90^{ab}±1.11	133.90^{a}±0.69	136.20^{a}±2.07	0.0318
(b) Probiotic cost (BDT/bird)	0.00^{d}±0.00	2.00^{a}±0.02	1.57^{b}±0.01	1.13^{c}±0.0158	<0.0001
(c) Chick cost (BDT/bird)	40.00	40.00	40.00	40.00	-
(d) Other cost (BDT/bird)	25.00	25.00	25.00	25.00	-
(e) Total cost (BDT/bird) (a+b+c+d)	194.10^{b}±1.69	199.00^{a}±1.12	200.50^{a}±0.70	202.30^{a}±2.08	0.0125
(f) Total cost (BDT/kg body weight)	105.20±1.86	100.10±1.35	97.80±2.79	98.80±3.46	0.2119
(g) Sale price (BDT/bird @120/kg live wt.)	221.50±4.44	238.60±3.38	246.60±6.48	246.80±11.30	0.0849
(h) Profit (BDT/bird) (g-e)	27.40±3.94	39.60±3.20	46.10±6.74	44.50±9.53	0.2083
(i) Profit (BDT/kg) (h/live weight of bird)	14.80±1.86	19.90±1.35	22.20±2.79	21.20±3.46	0.2119
(j) Profit over control (BDT/bird)	-	12.20	18.70	17.10	-
(k) Profit over control (BDT/kg)	-	5.10	7.40	6.40	-

* T_1-Control, T_2= PB-1 (*Lactobacillus* spp.: 3.10^{7}-10^{8} cfu/g**,** *Bacillus* spp.: 3.10^{7}-10^{8} cfu/g and *Saccharomyces*: 10^{6}-10^{7} cells/g), T_3=PB-2 (*Bacillus subulans* 10^{10} cfu/g, *Bacillus soagulans* 10^{10} cfu/g), T_4=PB-3 (*Bacillus subtilis*- min. 2×10^{9} cfu/g), Body weight of T_1=1846g, T_2, 1988g, T_3=2055g, T_4=2057g, BDT=Bangladeshi Taka, Means with superscripts having no common alphabet in the same row differ significantly at the stated level of probability. Value indicate- mean ± standard error.

Economics of feeding probiotics

The cost of production per live broiler was observed higher ($P<0.05$) in the treated groups, as would be expected. Although higher cost incurred in probiotics fed groups, it was minimized due to the increased sale price of the birds. The additional cost incurred for probiotic feeding over control was BDT 2.00/bird in PB-1, BDT 1.57/bird in PB-2 and BDT 1.13/bird in PB-3 treated group. It appears from Table 4 that the profit per bird over control was BDT 12.20/bird in PB-1, BDT 18.70/bird in PB-2 and 17.10/bird in PB-3 group. Despite the highest cost, the income generated from the broilers that consumed probiotics was numerically higher but was not statistically significant. Net profit over control was higher in all the probiotic treated groups. Patel *et al.* (2015) found higher profit over control upon multi-strain probiotic feeding; BDT 1.63 with a dose rate of 50 g/ton feed and BDT 5.40 with a dose rate of 100g/ton feed. Roy (2018) conducted a series of experiments using probiotics and showed better profit in probiotics treated groups over control in all trials. Multiple trials showed that, profit in *Bacillus subtilis* DSM 17299 (1.6×10^{9} cfu/g) over control was BDT 13.00/kg live weight. In another trial, he showed that profit over control in *Bacillus subtilis* DSM 17299 (1.6×10^{9} cfu/g) was BDT 12.15/kg and *Bacillus subtilis* PB6 @ 1×10^{9} cfu/g was BDT 12.31/kg. He also concluded both *Bacillus subtilis*

@ 4×10^{10} and *Bacillus licheneformes* @4×10^{10}) contained diet showed BDT 9.31/kg profit over control and *Saccharomyces cerevisiae* probiotic fed birds reflected a profit of BDT 6.80/kg body weight over control.

Conclusion

Feeding probiotics at three preparations increased feed intake of broilers without altering other growth parameters and meat yield characteristics. An increasing trend in body weight and decreasing trend in FCR contributed to the profit in probiotic treated broilers. Dietary inclusion of three different probiotics as considered in the study increased profit over control and probiotic containing *Bacillus subulans* and *Bacillus soagulans* (PB-2) was found to be most cost effective.

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Conflict of interest

The authors have no conflict of interest to declare.

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