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 cm² 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 (T1); basal diet supplemented with probiotic-1 (PB-1) at 1.0 g/kg feed (T2); basal diet supplemented with probiotic-2 (PB-2) at 1.0 g/kg feed (T3); basal diet supplemented with probiotic-3 (PB-3) at 0.5 g/kg feed (T4). 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

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 specificity, 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 al., 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-Khalifa 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 cm². The composition of the probiotics are: PB-1: Lactobacillus spp.: 3.10⁷-10⁸ cfu/g, Bacillus spp.: 3.10⁷-10⁸ cfu/g and Saccharomycyes: 10⁹-10⁷ cells/g; PB-2: Bacillus subulans 10¹⁵ cfu/g, Bacillus soagulans 10¹⁰ cfu/g and PB-3: Bacillus subtilis min. 2×10⁹ 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°C temperature was maintained initially, thereafter, 2.5°C 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

|                      | 100.00  | 100.00  |
|----------------------|---------|---------|
| 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    |
| Phenylalanine: Tyr., %| 1.34    | 1.23    |

Newcastle disease and Infectious bronchitis disease vaccine (MAS+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 (51-55°C) 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 T3 and T4 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          | T1       | T2       | T3       | T4       | 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±43.91| 3423±28.66| 3475±18.00| 3534±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  |

*T1=Control, T2= PB-1 (Lactobacillus spp.: 3.10^7-10^8 cfu/g, Bacillus spp.: 3.10^7-10^9 cfu/g and Saccharomyces: 10^4-10^7 cells/g), T3=PB-2 (Bacillus subulans 10^9 cfu/g, Bacillus soagulans 10^10 cfu/g), T4=PB-3 (Bacillus subtilis- min. 2×10^7 cfu/g), Means with superscripts having no common alphabet in the same row differ significantly at the stated level of probability. Value indicate ± 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 bifidum 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.

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

| Parameters (%) | T₁ | T₂ | T₃ | T₄ | 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 | 1.660±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 |

*T₁=Control, T₂= PB-1 (Lactobacillus spp.: 3.10⁷-10⁸ cfu/g, Bacillus spp.: 3.10⁷-10⁸ cfu/g and Saccharomyces: 10⁸-10⁹ cells/g), T₃=PB-2 (Bacillus subulans 10⁸ cfu/g, Bacillus soagulans 10⁸ cfu/g), T₄=PB-3 (Bacillus subtilis min. 2×10⁸ cfu/g), none of the variables showed significant difference (P>0.05), Value indicate- mean ± standard error.

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 Dadwend, 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 Dadwend, 2007 and Racevičiūtė-Stupelienė et al., 2007).
Table 4: Economic analysis and cost-effectiveness of feeding probiotics

| Parameters                        | T₁           | T₂           | T₃           | T₄           | P-value  |
|-----------------------------------|--------------|--------------|--------------|--------------|----------|
| (a) Feed cost (BDT/bird)          | 129.00±1.69  | 131.90±1.11  | 133.90±0.69  | 136.20±2.07  | 0.0318   |
| (b) Probiotic cost (BDT/bird)     | 0.00±0.00    | 2.00±0.02    | 1.57±0.01    | 1.13±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)         | 194.10±1.69  | 199.00±1.12  | 200.50±0.70  | 202.30±2.08  | 0.0125   |
| (a+b+c+d)                         |              |              |              |              |          |
| (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)               | 14.80±1.86   | 19.90±1.35   | 22.20±2.79   | 21.20±3.46   | 0.2119   |
| (h/live weight of bird)           |              |              |              |              |          |
| (j) Profit over control (BDT/bird)| -            | 12.20        | 18.70        | 17.10        | -        |
| (k) Profit over control (BDT/kg)  | -            | 5.10         | 7.40         | 6.40         | -        |

* T₁:Control, T₂= PB-1 (Lactobacillus spp.: 3.10⁷-10⁸ cfu/g, Bacillus spp.: 3.10⁷-10⁶ cfu/g and Saccharomyces: 10⁶-10⁷ cells/g), T₃=PB-2 (Bacillus subulans 10⁸ cfu/g, Bacillus soagulans 10⁵ cfu/g), T₄=PB-3 (Bacillus subtilis- min. 2x10⁹ cfu/g), Body weight of T₁=1846g, T₂, 1988g, T₃=2055g, T₄=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 (1.6x10⁹ 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 (1.6x10⁹ cfu/g) was BDT 12.15/kg and Bacillus subtilis PB6 @ 1x10⁹ cfu/g was BDT 12.31/kg. He also concluded both Bacillus subtilis
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 over control and probiotic containing diet showed BDT 9.31/kg profit over control and probiotic containing Bacillus subtilis and Bacillus soaugulans (PB-2) was found to be most cost effective.

**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 subtilus and Bacillus soaugulans (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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**Probiotics in broiler diet**

@ $4 \times 10^{10}$ and *Bacillus licheniformes* @ $4 \times 10^{10}$ 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.
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