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ORIGINAL ARTICLE

# Influence of probiotic supplementation on blood parameters and growth performance in broiler chickens

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**Abstract** Effects of commercial probiotic (Bactocell®) on growth performance and blood parameters were evaluated. A total of 800 one day-old Ross broiler chicks were raised over 42 days. Chicks were wing-banded, weighed individually and randomly allocated into four equally major groups each having two replicates. Chicks of group 1 (control group) were fed the starter and finisher diets that did not supplemented with probiotic. The chicks of groups 2, 3, and 4 were fed the control starter and finisher diets supplemented with 1.6 g, 1 g and 0.8 g of probiotic per kg feed, respectively. Weekly body weight, feed consumption and feed conversion were measured. Blood parameters at 1, 4 and 6 weeks of age including packed cell volume (PCV), haemoglobin (Hb), total protein, albumin, total lipid and cholesterol were determined. All birds were kept under similar environmental, managerial and hygienic conditions. The results of the current study revealed that there was no significant change for Hb and PCV concentrations among different groups at all studied times. Also, total protein, lipids and albumin concentrations were not affected by probiotic supplementation. Chicken fed a diet containing various levels of probiotic showed a significant decrease ($p \leqslant 0.05$) in cholesterol concentration compared to control group. Probiotic supplementation significantly increased the body weight and daily weight gain of broiler chicks at late ages (3–6 weeks). Also, the birds fed on probiotic levels 1 and 0.8 g/kg diet exhibited higher body weight among chicken groups at 6 weeks of age. Improved feed conversion was noticed in birds fed a diet supplemented with probiotic. There was no significant difference in mortality rate among groups. We concluded that use of selected commercial probiotic resulted in improved performance parameters and

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reduced serum cholesterol in broiler chickens. Moreover, supplementation of the probiotic to broilers in the levels of 1 and 0.8 g/kg diet was found to be better than control and 1.6 g/kg level indicating that increasing dietary probiotic level does not has the best performance.

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## 1. Introduction

The poultry industry during the past two decades has been one of the most dynamic and ever expanding sectors in the world. It helps to fill the gap between requirement and availability of high quality protein for human consumption. The demand for a higher and safer protein source, free of infectious agents, is getting increased. However, during intensive growth, poultry industry has always been confronted with challenges in the form of various diseases. Among these conditions, the major economic losses are due to infectious diseases which could be caused by viruses, bacteria, fungi, protozoa, and the cost of preventive medication. This led to increased use of antibiotics in the poultry industry for therapeutic, prophylactic and growth promotion purposes. The presence of antibiotic residues in poultry meat and eggs may have deleterious effects on human consumers. The residues of antibiotics can cause resistance of human flora and pathogenic microbes to those groups of antibiotics. Moreover, cross-resistance to antibiotics used in the therapy of humans and other animals could also result (Van den Bogaard and Stobberingh, 2000; Caprioli et al., 2000; Edens, 2003; Pelicano et al., 2004). In the modern intensive poultry production, newly hatched chicks have little chance of contact with their mothers and consequently normal microflora is slow in colonizing the intestine (Fuller, 1989). It is during this early period, when a stable gut microflora has not yet been established, that the chick is most vulnerable to colonization by pathogens. Edens (2003) mentioned that with increasing concerns about antibiotic resistance, and the ban on sub-therapeutic antibiotic usage in Europe and the potential for a ban in the United States, there is increasing interest in finding alternatives to antibiotics for poultry production. The so called probiotics can be listed among these products.

An alternative approach to sub-therapeutic antibiotics in livestock is the use of probiotic microorganisms (Patterson and Burkholder, 2003). Many definitions of probiotics have been introduced, starting from Fuller (1989) who defined Probiotics as a live microbial feed supplement which beneficially affects the host by improving its intestinal microbial balance. However, according to the currently adopted definition by Food and Agriculture Organization and World Health Organization (2001), probiotics are: live microorganisms which when administered in adequate amounts confer a health benefit on the host. The most important advantage of a probiotic is that it neither has any residues in animal production nor exerts any antibiotic resistance by consumption. Therefore, a lot of researchers have partially replaced antibiotics with probiotics as therapeutic and growth promoting agents. It was reported that probiotics have a good impact on the poultry performance (Mountzouris et al., 2007; Koenen et al., 2004), improve microbial balance, synthesize vitamins (Fuller, 1989), decrease pH and release bacteriocins (Rolfe, 2000), improve feed consumption in layers and broilers (Nahashon et al., 1994). Most of the previous researches on probiotic utilization in poultry focused on the use of multispecies probiotics and various strains of *Lactobacillus*. The present study was planned to investigate the effects of a monospecies commercial probiotic (Bactocell®) on broiler growth performance and blood parameters.

## 2. Materials and methods

### 2.1. Experimental design and husbandry

A total of 800, one day-old broiler chicks (obtained from Alwadi Company for Poultry), were grown over 42-day period. The chicks were wing-banded, weighed individually and the randomly assigned to four treatment groups following completely randomized design. There were 100 birds per replicate and two replicates per treatment group. The chicks of each replicate were kept in a separate pen measuring 3 m long and 3 m wide at the Agricultural and Veterinary Experiment Station, College of Agriculture and Veterinary Medicine, Qassim University. Feed and water were provided *ad libitum*. Ventilation, air condition and temperature in each room were controlled by a DicamFSC2.2M master unit (Farm Energy and Control Services Ltd. "Farmex", Pinewood, Reading RG 303VR, UK). A probiotic commercially identified as Bactocell® was used as a feed additive in this study. Bactocell was purchased from Lallemand Animal Health Company, France. The bacterial flora in the Bactocell probiotic has mentioned to be *Pediococcus acidilactici* in a concentration of $10^9$ CFU/g. Chicks of group 1 (control group) were fed the starter and finisher diets that did not supplemented with probiotic. The chicks of groups 2, 3, and 4 were fed the control starter and finisher diets plus 1.6 g, 1 g and 0.8 g of a commercial probiotic (Bactocell®) per kg of ration, respectively. Diets were formulated to provide the recommended requirements for broiler (without added antibiotics, or growth promoters). The starter diet was replaced by the finisher diet at 4 weeks.

### 2.2. Haematological and biochemical analyses

Haematological and serum biochemical parameters were examined three times at 7, 28 and 42 days of age. Fresh blood samples were collected from chickens of different groups to measure packed cell volume (PCV) and Haemoglobin (Hb) concentrations. PCV was estimated by the microhaematocrite method using capillary glass tubes. Hb concentration was determined following the cyanhaemoglobin method according to Coles (1986). Total cholesterol content was determined using enzymatic colorimetric method by means of Cholesterol Liquicolor kit (GmbH, Germany). Total protein, albumin, and lipid levels were tested by appropriate commercial diagnostic kits (BioSystems, S.A. Barcelona, Spain) and GmbH, Germany). All parameters were determined in Robert Rielle GmbH Photometer 5010 VST (Germany).

*2.3. Growth performance*

Measurements of broiler performance including body weight, daily weight gain, daily feed consumption and mortality rate were determined. All birds in each group were weighed individually at hatch, 1, 2, 3, 4, 5, and 6 weeks of age. Daily weight gains were then calculated for the periods: hatch-1, 2, 3, 4, 5, and 6 weeks as well as 0–4, 4–6, and 0–6 weeks. Chickens were sexed at 42 days of age. The feed offered to each room was recorded daily with an automatic weighing machine. At the end of each week feed residues were weighed, feed consumption was therefore recorded on a weekly basis and then calculated as feed consumed per day over the periods: hatch-1 week, 2, 3, 4, 5 and 6 week. The feed conversion ratios could then be calculated for the time periods: hatch-1 week, 2, 3, 4, 5 and 6 week expressed as feed conversion ratio: feed consumed/weight gain. Mortality rate was weekly determined as a cumulative percentage, all dead birds were removed daily (morning) and weighed. Their feed consumption was estimated and discounted from the total feed given to the group during that week. Data were subjected to a one-way analysis of variance using GLM procedure (SAS Institute, 1999).

## 3. Results and discussion

With regard to the influence of probiotic on haematological and biochemical parameters investigated in the experimental, no significant changes on haemoglobin and PCV among groups at all times of this trial as illustrated in Table 1. This is in agreement with the study done by Dimcho et al. (2005) who found that the probiotic supplementation did not affect the blood constituents comprising, haemoglobin concentrations. In contrast, the findings disagree with of Cetin et al. (2005) findings, who observed that the probiotic supplementation caused statistically significant increase in the erythrocyte count, haemoglobin concentration and haematocrit values of Turkeys. The differences may be attributed to type and number of species of bacteria present in probiotics.

The serum concentrations of total protein and albumin were not affected by any of the three levels of probiotic supplementation in this study. Similarly, the concentration of total lipids was not affected by the supplementation of probiotic in all treatment groups as presented in Table 4. These findings are in agreement with those of Dimcho et al. (2005) who found that probiotic supplementation did not affect the total proteins concentrations of chickens. Concerning the effect of probiotic supplemented on serum cholesterol, in samples tested illustrated in Table 4 which indicate that the probiotic have cholesterol decreasing effect on broilers. At 28 and 42 days of age, chicken groups fed with various levels of probiotic showed a significant decrease in cholesterol concentrations when compared to the control group. This observation is in agreement with numbers of previous literature. Mohan et al. (1995) reported that probiotic supplementation resulted in lowering of the serum cholesterol level in White Leghorn layers from 176.5 to 114.3 mg/dl serum. Also, Mohan et al. (1996) mentioned that chickens that received 75, 100, and 125 mg probiotic/kg diets had lower serum cholesterol content (93.3 mg/100 ml) compared to the control birds (132.2 mg/100 ml).

Similar results were reported by Arun et al. (2006) who found that serum total cholesterol and triglycerides were reduced significantly by dietary supplementation of probiotic containing *L. sporogene* at 100 mg per kg diet. The significant reduction in serum cholesterol of broiler chickens fed probiotic supplemented diet could be attributed to reduced absorption and/or synthesis of cholesterol in the gastro-intestinal tract by probiotic supplementation (Mohan et al., 1995, 1996). Also, it was speculated that *Lactobacillus acidophillus* reduces the cholesterol in the blood by deconjugating bile salts in the intestine, thereby preventing them from acting as precursors in cholesterol synthesis (Abdulrahim et al., 1996).

*Lactobacillus* has found to have a high bile salt hydrolytic activity, which is responsible for deconjugation of bile salts (Surono, 2003).

Deconjugated bile acids are less soluble at low pH and less absorbed in the intestine and is more likely to excrete in faeces (Klaver and van der Meer, 1993). This could be the case in the present study as the probiotic utilized in the study (*Pediococcus acidilactici*) is acidophilic and it lowers the pH of the environment it occupies. Another explanation of the mechanism by which a probiotic can lower the serum cholesterol has been declared by Fukushima and Nakano (1995). The authors demonstrated that probiotic microorganisms inhibit hydroxy-methyl-glutaryl-coenzyme A; an enzyme involved in the cholesterol synthesis pathway thereby decrease cholesterol synthesis.

**Table 1** Haematological and biochemical parameters in chickens fed on rations containing different concentration of probiotic.

| Age in week | Treatment groups | Haemoglobin g/L | PCV % | Total protein g/L | Albumin g/L | Cholesterol mg/dl | Total lipids mg/dl |
|---|---|---|---|---|---|---|---|
| 1 | Control | 89.1 ± 3.97[a] | 25.8 ± 0.38[a] | 28.6 ± 1.87[a] | 15.72 ± 1.22[a] | 151.8 ± 6.58[a] | 824.8 ± 63.8[a] |
| | 1.6 g/kg | 95 ± 3.97[a] | 25.9 ± 0.38[a] | 28.8 ± 1.87[a] | 15.56 ± 1.22[a] | 146.4 ± 6.58[a] | 892.6 ± 63.8[a] |
| | 1 g/kg | 92.4 ± 3.97[a] | 25.7 ± 0.38[a] | 26 ± 1.87[a] | 14.22 ± 1.22[a] | 143.2 ± 6.58[a] | 889.6 ± 63.8[a] |
| | 0.8 g/kg | 89.8 ± 3.97[a] | 25.7 ± 0.38[a] | 29.8 ± 1.87[a] | 15.72 ± 1.22[a] | 154.2 ± 6.58[a] | 811.4 ± 63.8[a] |
| 4 | Control | 102.5 ± 3.02[a] | 29 ± 0.50[a] | 35.4 ± 2.09[a] | 15.54 ± 1.00[a] | 151.8 ± 7.38[a] | 586.1 ± 77.15[a] |
| | 1.6 g/kg | 104.5 ± 3.02[a] | 30.6 ± 0.50[a] | 35.4 ± 2.09[a] | 17.38 ± 1.00[a] | 131.8 ± 7.38[b] | 528.1 ± 77.15[a] |
| | 1 g/kg | 100.1 ± 3.02[a] | 30 ± 0.50[a] | 37.4 ± 2.09[a] | 17.59 ± 1.00[a] | 121.6 ± 7.38[b] | 498 ± 77.15[a] |
| | 0.8 g/kg | 100.3 ± 3.02[a] | 30 ± 0.50[a] | 36.2 ± 2.09[a] | 15.74 ± 1.00[a] | 115.2 ± 7.38[b] | 564.5 ± 77.15[a] |
| 6 | Control | 85 ± 2.24[a] | 28.6 ± 0.38[a] | 41.9 ± 2.43[a] | 17.03 ± 0.74[a] | 128.1 ± 5.33[a] | 793.3 ± 62.10[a] |
| | 1.6 g/kg | 83.9 ± 2.24[a] | 29.6 ± 0.38[a] | 47.6 ± 2.43[a] | 16.61 ± 0.74[a] | 119 ± 5.33[b] | 754.7 ± 62.10[a] |
| | 1 g/kg | 81.4 ± 2.24[a] | 29.4 ± 0.38[a] | 45 ± 2.43[a] | 18.43 ± 0.74[a] | 120.9 ± 5.33[b] | 736.4 ± 62.10[a] |
| | 0.8 g/kg | 83.4 ± 2.24[a] | 29.8 ± 0.38[a] | 46 ± 2.43[a] | 16.75 ± 0.74[a] | 118.8 ± 5.33[b] | 772.6 ± 62.10[a] |

Means within rows with no common letters are significantly different ($P < 0.05$).

**Table 2** Weekly body weight means of chickens fed on rations containing different concentration of probiotic.

| Age in week | Body weight of treatment groups (g) | | | |
|---|---|---|---|---|
| | Probiotic supplementation (g/kg feed) | | | |
| | Control | 1.6 g/kg | 1 g/kg | 0.8 g/kg |
| 1 | 141.18 ± 1.68[a] | 137.92 ± 1.68[a] | 148.75 ± 1.69[a] | 142.62 ± 1.70[a] |
| 2 | 308.70 ± 4.39[b] | 314.16 ± 4.38[b] | 343.77 ± 4.41[a] | 312.04 ± 4.44[b] |
| 3 | 574.74 ± 8.23[c] | 597.75 ± 8.22[b] | 642.45 ± 8.27[a] | 613.93 ± 8.33[b] |
| 4 | 911.15 ± 11.69[c] | 1000.77 ± 11.67[b] | 1060.9 ± 11.74[a] | 995.66 ± 11.82[b] |
| 5 | 1258.71 ± 16.21[b] | 1259.01 ± 16.21[b] | 1376.9 ± 16.28[a] | 1357.06 ± 16.40[a] |
| 6 | 1661.31 ± 26.75[c] | 1776.03 ± 26.71[b] | 1863.6 ± 26.87[a] | 1844.0 ± 27.09[a] |

Means within rows with no common letters are significantly different ($P < 0.05$).

**Table 3** Daily weight gain of chickens fed on rations containing different concentration of probiotic.

| Age in week | Daily weight gain of treatment groups (g) | | | |
|---|---|---|---|---|
| | Probiotic supplementation (g/kg feed) | | | |
| | Control | 1.6 g/kg | 1 g/kg | 0.8 g/kg |
| 0–1 | 14.03 ± 0.240[a] | 13.54 ± 0.240[a] | 14.51 ± 0.241[a] | 14.24 ± 0.243[a] |
| 1–2 | 23.93 ± 0.495[b] | 25.16 ± 0.495[b] | 27.86 ± 0.497[a] | 24.20 ± 0.502[b] |
| 2–3 | 38.01 ± 0.757[c] | 40.56 ± 0.757[b] | 43.11 ± 0.767[a] | 42.67 ± 0.760[a] |
| 3–4 | 48.06 ± 0.916[c] | 57.60 ± 0.916[a] | 59.79 ± 0.920[a] | 54.58 ± 0.928[b] |
| 4–5 | 46.84 ± 1.378[b] | 45. 14 ± 1.371[b] | 51.69 ± 1.389[a] | 49.65 ± 1.372[a] |
| 5–6 | 57.51 ± 2.726[b] | 70.96 ± 2.725[a] | 69.53 ± 2.738[a] | 69.45 ± 2.761[a] |
| 0–4 | 31.00 ± 0.417[c] | 34.28 ± 0.417[b] | 36.36 ± 0.419[a] | 34.04 ± 0.423[b] |
| 4–6 | 53.58 ± 1.646[b] | 55.40 ± 1.645[ba] | 60.57 ± 1.667[a] | 57.33 ± 1.653[a] |
| 0–6 | 38.53 ± 0.637[c] | 41.29 ± 0.637[b] | 43.35 ± 0.640[a] | 42.88 ± 0.645[ba] |

Means within rows with no common letters are significantly different ($P < 0.05$).

Table 2 clearly demonstrated that the probiotic tested in the study significantly improved the body weight of the broilers. The effect of probiotic started at two weeks of age. At 3 weeks of age, the probiotic supplementation showed significant increase in the body weight compared with the control group, at the same age, there were significant differences among the three probiotic treatment groups, with group of level 1 g/kg having the significantly higher body weights than the other levels of treatment as well as control group. This positive effect of probiotic on body weight persisted until 6 weeks of age. The differences in the body weight became greater towards the end of the trial period. On 6 weeks, the two levels (1 g and 0.8 g/kg ration) of probiotic groups showed significant increase in the body weight compared with the third treatment group (1.6 g/kg) as well as the control group. The birds fed on probiotic level 1 g/kg exhibited higher body weights among groups at all times of this trial. Daily weight gain was also significantly influenced by supplemented probiotic. The average daily weight gain of the broiler groups for weeks 1, 2, 3, 4, 5, 6, 0–4, 4–6 and 0–6 are summarized in Table 3. The effect of probiotic on the broiler daily weight gain is consistent with its effect on body weight in this study. The probiotic treatment groups showed a significant increase in the daily weight gain at 3, 4, 5, 6, weeks of age. In addition, the average daily weight gain over weeks 0–4 and 0–6, the birds fed on the probiotic showed higher daily weight gains than the control group. Moreover, the birds fed on probiotic levels 1 g and 0.8 g/kg ration showed best daily weight gain than the other level of probiotic as well as control group. This finding is in agreement with several reports demonstrating that probiotic supplemented to the birds improve the body weight and daily weight gain (Khaksefidi and Ghoorchi, 2006; Liu et al., 2007; Mountzouris et al., 2007; Timmerman et al., 2006; Torres-Rodriguez et al., 2007). However, the results obtained in this study concerning body weight and daily weight gain are contrary to the findings of other studies. Mohan et al. (1996) reported that the beneficial effect of probiotic on chicken occurred only after the 4th week of growth.

Yeo and Kim (1997) found that average daily weight gain of chickens fed probiotics was significantly increased during the first 3 weeks but not during the 4–6th weeks of growth.

Concerning the average feed consumption rate over 0–4 and 0–6 weeks, the birds at the level (1 g probiotic/kg ration) consumed significantly more feed than control group as well as the other birds receiving either of the other two levels of probiotic. Whereas, the birds fed probiotic level (1.6 g/kg ration) consumed significantly less feed than the other probiotic treatment groups and the control group. At 3, 4, 5 and 6 weeks of age there were a significant differences in the daily feed consumption among the probiotic treatment groups and also between the probiotic groups and the control group. These findings are in agreement with those of Willis et al. (2007) who observed significant differences in feed consumption and efficiency of broiler chickens receiving the probiotic. The means of feed conversion ratio over 0–4 and 0–6 weeks

**Table 4** Daily feed consumption of chickens fed on ration containing different concentration of probiotic.

| Age in week | Daily feed consumption of treatment groups (g) | | | |
|---|---|---|---|---|
| | Probiotic supplementation (g/kg feed) | | | |
| | Control | 1.6 g/kg | 1 g/kg | 0.8 g/kg |
| 0–1 | 25.78 ± 0.77[a] | 23.61 ± 0.77[a] | 23.90 ± 0.77[a] | 25.64 ± 0.77[a] |
| 1–2 | 43.17 ± 1.11[a] | 44.61 ± 1.11[a] | 45.41 ± 1.11[a] | 41.19 ± 1.11[a] |
| 2–3 | 71.60 ± 1.53[a] | 59.80 ± 1.53[b] | 77.59 ± 1.53[a] | 73.38 ± 1.53[a] |
| 3–4 | 83.56 ± 0.54[c] | 85.98 ± 0.54[b] | 96.22 ± 0.54[a] | 87.55 ± 0.54[b] |
| 4–5 | 103.36 ± 2.17[a] | 95.36 ± 2.17[b] | 109.50 ± 2.17[a] | 107.67 ± 2.17[a] |
| 5–6 | 117.79 ± 1.55[b] | 114.72 ± 1.55[b] | 129.85 ± 1.55[a] | 125.43 ± 1.55[a] |
| 0–4 | 56.03 ± 0.76[b] | 53.50 ± 0.76[c] | 60.78 ± 0.76[a] | 56.94 ± 0.76[b] |
| 4–6 | 110.57 ± 1.47[b] | 105.04 ± 1.47[b] | 119.68 ± 1.47[a] | 116.55 ± 1.47[a] |
| 0–6 | 74.21 ± 0.85[b] | 70.68 ± 0.85[c] | 80.41 ± 0.85[a] | 76.81 ± 0.85[b] |

Means within rows with no common letters are significantly different ($P < 0.05$).

**Table 5** Feed conversion ratio of chickens fed on rations containing different concentration of probiotic.

| Age in week | Feed conversion ratio of treatment groups | | | |
|---|---|---|---|---|
| | Probiotic supplementation (g/kg feed) | | | |
| | Control | 1.6 g/kg | 1 g/kg | 0.8 g/kg |
| 0–1 | 1.84 ± 0.055[a] | 1.74 ± 0.055[a] | 1.65 ± 0.055[a] | 1.80 ± 0.055[a] |
| 1–2 | 1.80 ± 0.045[a] | 1.77 ± 0.045[a] | 1.63 ± 0.045[a] | 1.70 ± 0.045[a] |
| 2–3 | 1.88 ± 0.040[a] | 1.47 ± 0.040[c] | 1.80 ± 0.040[b] | 1.72 ± 0.040[b] |
| 3–4 | 1.74 ± 0.010[a] | 1.49 ± 0.010[c] | 1.61 ± 0.010[b] | 1.60 ± 0.010[b] |
| 4–5 | 2.21 ± 0.043[a] | 2.11 ± 0.043[b] | 2.12 ± 0.043[b] | 2.19 ± 0.043[b] |
| 5–6 | 2.1 ± 0.026[a] | 1.55 ± 0.026[c] | 1.87 ± 0.026[b] | 1.81 ± 0.026[b] |
| 0–4 | 1.81 ± 0.024[a] | 1.56 ± 0.024[c] | 1.67 ± 0.024[b] | 1.67 ± 0.024[b] |
| 4–6 | 2.06 ± 0.025[a] | 1.9 ± 0.025[b] | 1.98 ± 0.025[ba] | 2.0 ± 0.025[a] |
| 0–6 | 1.93 ± 0.021[a] | 1.71 ± 0.021[c] | 1.85 ± 0.021[b] | 1.79 ± 0.021[cb] |

Means within rows with no common letters are significantly different ($P < 0.05$).

are summarized in Table 5. It can be noticed that the probiotic treatment groups showed less feed conversion ratio than control group. These results showed that there were no significant differences in the means of feed conversion ratio between probiotic groups and control group at 1 and 2 weeks of age. However, there were significant differences between probiotic groups and control group at 3, 4, 5 and 6 weeks of age. The probiotic group level 1.6 g/kg ration showed less feed conversion ratio than the other levels of probiotic groups as well as control group Whereas, the control group showed higher feed conversion ratio than probiotic treatment groups at all times. These findings are in agreement with the findings of Maiorka et al. (2001) who found that the use of a synbiotic composed of *Saccharomyces cerevisiae* and *Bacillus subtilis* improved feed conversion compared with antibiotic and control treatments at 45 days of age. Also, Khaksefidi and Ghoorchi (2006) concluded that feed conversion of birds fed diet supplemented with 50 mg/kg of probiotic were significantly better from 22 to 42 days than birds fed the control diets (see Table 5).

The improvement in the body weight, daily weight gain, feed consumption and feed conversion ratio in this study may be due to the increased efficiency of digestion and nutrient absorption processes due to presence of the probiotic bacteria. Edens (2003) reported that the inclusion of desirable microorganisms (probiotics) in the diet allows the rapid development of beneficial bacteria in the digestive tract of the host, improving its performance. As a consequence, there is an improvement in the intestinal environment, increasing the efficiency of digestion and nutrient absorption processes. Edens et al. (1997) showed that *in vivo* and *ex vivo* administration of *Lactobacillus reuteri* resulted in an increased villus height, indicating that probiotics are potentially able to enhance nutrient absorption and thereby improve growth performance and feed efficiency. Concerning mortalities, cumulative mortality rates

**Table 6** Mortality percentage of chickens fed on different rations containing probiotic.

| Age in week | Mortality percentage of treatment groups (%) | | | |
|---|---|---|---|---|
| | Probiotic supplementation (g/kg feed) | | | |
| | Control | 1.6 g/kg | 1 g/kg | 0.8 g/kg |
| 1 | 1.5 | 0 | 1.5 | 1.5 |
| 2 | 0 | 0 | 0.51 | 0 |
| 3 | 0.51 | 1 | 1.02 | 0.51 |
| 4 | 1.02 | 0 | 0 | 1.02 |
| 5 | 0.51 | 0.50 | 0.51 | 0.51 |
| 6 | 2.59 | 3.50 | 2.07 | 2.59 |
| 0–6 | 6 | 4.50 | 5.5 | 6 |

Means within rows with no common letters are significantly different ($P < 0.05$).

were lower in the birds fed the probiotic level 1.6 g/kg than the other groups over the period 0–6 weeks of age (Table 6). With similar trials with broilers given *Lactobacillus* preparations, the effects on mortality were inconsistent (Jin et al., 1998a,b; Zulkifli et al., 2000). Yörük et al. (2004) found that Supplementation of probiotic (containing *Lactobacillus*, *Bifidobacterium*, *Streptococcus*, and *Enterococcus* species) during the late laying period in layer hens reduced mortality. O'Dea et al. (2006) reported that there were no significant differences in broiler mortality between the probiotic treatments and the control group in any of the trials.

Conclusively, supplementation of the probiotic (*Pediococcus acidilactici*) to broilers improves performance and reduces serum cholesterol in broiler chickens. The probiotic levels of 1 and 0.8 g/kg ration were found better than control and 1.6 g/kg ration levels. This indicates that increasing the probiotic level in the ration does not ensure the best performance. It is worth to mention that no any antibiotic was supplemented to or injected in the broilers from the first day until the end of the experiment.

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