Efficacy of *Lactobacillus acidophilus* as Probiotic to Improve Broiler Chicks Performance

M. Salarmoini¹*, and M. H. Fooladi¹

ABSTRACT

This experiment was conducted to investigate the effects of *Lactobacillus acidophilus* on performance, carcass characteristics, blood parameters, and intestinal microflora of broiler chicks. The dietary treatments were: basal diet as control 1; basal diet plus 1 g kg⁻¹ of a commercial probiotic Bioplus²; basal diet plus 10 and 20 g kg⁻¹ fermented milk that contained 2×10⁸ cfu g⁻¹ *Lactobacillus acidophilus*. To evaluate the effect of water alone on chick performance, equal volume of water in 20 g fermented milk was added to each kg of the basal diet (control 2). A total of 280 one-day old male broiler chicks were randomly allocated to 5 experimental groups of 4 replicates of 14 chicks each. The chicks were grown to 42 d of age. The result of the experiment indicated that feed intake in chicks fed diet supplemented with commercial probiotic was significantly higher than *L. acidophilus* probiotic. Weight gain for the chicks fed with the diet that contained 20 g kg⁻¹ fermented milk was higher than the control chicks, in the first 3 weeks. There was no significant difference in feed conversion and weight of organs. The number of *Lactobacilli* in ileum and colon were higher in *L. acidophilus* treated birds than the control group and also the number of *Coliforms* was lower, but the effects were not statistically significant. The levels of blood cholesterol, alanine aminotransferase, aspartate aminotrasferase and alkaline phosphatase were the highest in the control group, but the effect was statistically significant only for ALT measured at 21 d of age.

Keywords: Broiler chicken, *Lactobacillus acidophilus*, Probiotic.

INTRODUCTION

A number of health benefits have been claimed for probiotic bacteria such as *Lactobacillus acidophilus*, *Lactobacillus casei* and *Bifidobacterium spp*. It seems that probiotics have beneficial influence on: intestinal microflora balance, especially in young chicks (Nuotio et al., 1992), immune response (Koenen et al., 2004; Perdigon et al., 1995), blood cholesterol concentrations (De Roos and Katan, 2000) and Cancer (Matsuzaki, 1998). Some probiotics have a competitive exclusion effect on specific pathogens (Fedorka-Cray et al., 1999) and help to reduce duration of diarrhea (Marteau et al., 2001).

*Lactobacilli* are normal components of the healthy intestinal microflora. Various effects of lactic acid bacteria as a probiotic have been described in animal and man, which depend on strain, host, dose, timing and viability of the strain (Maassen et al., 2000; Isolauri et al., 2001). It is interesting that some probiotic strains have been selected in rodents or pigs for application in humans. This indicates that it is possible for probiotics to act over several species (Dunne et al., 2001; Kos et al., 2003; Koenen et al., 2004).

To provide health benefits, the suggested concentration for probiotics bacteria is 10⁶ cfu g⁻¹.
cfu g⁻¹ of a product. However, studies have shown low viability of probiotics in market preparations. The need to monitor survival of *L. acidophilus* has often been neglected, with the result that a number of products reach the market containing a few viable bacteria (Shah, 2000).

The present study was conducted to determine the effects of *L. acidophilus* (cultured in milk) on production performance, weight of organs, intestinal microflora and blood parameters in broiler chickens.

**MATERIALS AND METHODS**

**Preparation of *L. acidophilus* culture**

In this experiment, *L. acidophilus* was solely cultured in milk: culture of these bacteria alone in milk is simple and also the bacteria in commercial fermented milk and commercial probiotics may not be alive and/or the number of live bacteria may be lower than the products label (Gilliland, 1981). *L. acidophilus* (KAL Dietary supplements, park city, UT 84060, USA) was cultured in sterile milk. For sterilization, low fat milk was heated to 120°C for 20 minutes, cooled to 37°C and 2 percent of the *L. acidophilus* starter was added and incubated at 37 to 40°C for 18 hours. After incubation, the product was stored at 15°C until use. On the average, the fermented milk contained 2×10⁹ cfu g⁻¹ *L. acidophilus*.

**Chickens diets and feeding treatments**

A total of 280 one-day old male Ross chicks were assigned randomly to five treatment groups. The chicks were raised in floor pens with wood shavings litter. Four replicates of 14 chicks were considered for each treatment. The dietary treatments were: basal diet as a control; basal diet plus 1g kg⁻¹ of a commercial probiotic Bioplus2 (Minimum of 1.6×10⁹ cfu/g *Bacillus licheniformis* and *Bacillus subtilis*); basal diet plus 10 and 20 g kg⁻¹ fermented milk, so the number of *L. acidophilus* in these two diets were 2×10⁹ and 4×10⁹ cfu kg⁻¹, respectively. To evaluate the effect of water alone on chick performance, equal volume of water was added to another basal diet and mixed before use (control 2). The composition of the diets is shown in Table 1. The diets were isocaloric and isonitrogenous and formulated to meet the nutrient requirements of the broiler chicks during starter and grower periods according to the National Research Council (NRC, 1994). To avoid mold growth, the fermented milk and water were mixed with the diets daily. No antibiotic and anticoccidials were used in this experiment. Diets were fed *ad libitum* in mash form.

Live body weight and feed consumption were recorded weekly. One chick from each replication was selected randomly and sacrificed at 21 and 42 days of age to determine the populations of *Lactobacilli* and *coliforms* in ileum and at the end of large intestine. Weight of liver, intestines (small intestine, caeca and colon), gizzard, bursa, heart and spleen were also recorded at 21 and 42 days of age. Before weighing the intestine, intestinal digesta were removed by hand. The blood samples were also collected from the wing vein for analyses of total cholesterol, alanine aminotransferase (ALT), aspartate aminotrasferase (AST) and alkaline phosphatase (ALKPH) in serum using Pars-Azmoon kits.

**Isolation and enumeration of intestinal microflora**

The samples from ileum and end of colon were collected at 21 and 42 days of age. The samples were diluted to 10⁻⁶ and then 1 ml from 10⁻⁴ to 10⁻⁶ dilutions were added to MRS plate media for *Lactobacilli* (Oyetao et al., 2003; Tae Ahn et al., 2003; Vinderola et al., 2000) and VRB agar for *coliforms* count. All plates were incubated at 37°C for 3 days (Vindrola et al., 2000).
Table 1. Composition of the experimental diets (g kg⁻¹ as fed).  

<table>
<thead>
<tr>
<th>Feed Ingredients</th>
<th>Starter diets (0-3 weeks) C 10F 20F</th>
<th>Grower diets (3-6 weeks) C 10F 20F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>550 553 556</td>
<td>523 520 515</td>
</tr>
<tr>
<td>Wheat</td>
<td>100 96 92</td>
<td>200 200 200</td>
</tr>
<tr>
<td>Fermented milk (dry matter)</td>
<td>- 1.2 2.4</td>
<td>- 1.2 2.4</td>
</tr>
<tr>
<td>Fish meal</td>
<td>40 40 40</td>
<td>30 30 30</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>279.6 279.4 279.2</td>
<td>220 211 204</td>
</tr>
<tr>
<td>Oyster shell</td>
<td>11 11 11</td>
<td>12 12 12</td>
</tr>
<tr>
<td>Dicalcium phosphate</td>
<td>9.6 9.6 9.6</td>
<td>7 7 7</td>
</tr>
<tr>
<td>Iodonized salt</td>
<td>3.5 3.5 3.5</td>
<td>2.5 2.5 2.5</td>
</tr>
<tr>
<td>DL methionin</td>
<td>1.3 1.3 1.3</td>
<td>0.5 0.5 0.5</td>
</tr>
<tr>
<td>Vitamin-mineral premix</td>
<td>5 5 5</td>
<td>5 5 5</td>
</tr>
</tbody>
</table>

Calculated analysis  
AMEn (kcal/kg) 2890 2950  
Crude protein 208 184  
Lysin 11 9.2  
Methionine 4.8 3.6  
Methionine + cystine 8.1 6.6  
Calcium 9.1 8.3  
Phosphorus 4.1 3.3  
Sodium 1.8 1.4  
Linoleic acid 13 13.6

Statistical analysis  
The data were analyzed as a completely randomized design, using the general linear (GLM) procedure of SAS (1998) and Duncan’s Multiple Range test was used to detect (P<0.05) differences among treatment means.

RESULTS  
Chick growth performance  
Addition of water or probiotics to diet had no significant effect on feed intake during 0-3 week period (Table 2). Birds fed diets contained commercial probiotic from 3-6 week period, had approximately 7 and 8.5 percent higher feed intake than the diets containing 10 or 20 g kg⁻¹ fermented milk, respectively (P<0.05). The same results were shown for 0-6 week period. Birds fed with the diet that contained 20 g kg⁻¹ fermented milk, from 0-3 weeks, had 8 percent higher weight gain than the control (P<0.05). During the 3-6 and 0-6 week periods, birds fed with the diets containing either L. acidophilus or commercial probiotic grew faster than the control, but, the effect was not statistically significant. Feed conversion was improved in birds supplemented with fermented milk, but the differences were not significant. Addition of water to basal diet had no significant effect on growth performance.

Bacterial count  
Addition of fermented milk containing L. acidophilus to the diets increased the
Table 2. Production parameters for broiler chickens fed diets with or without probiotics at different ages.

<table>
<thead>
<tr>
<th>Dietary Treatments</th>
<th>Feed intake (g/bird/d)</th>
<th>Weight gain (g/bird/d)</th>
<th>Feed conversion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0-21</td>
<td>21-42</td>
<td>0-42</td>
</tr>
<tr>
<td>C 1</td>
<td>46.6 b</td>
<td>143.3 ab</td>
<td>94.8 a</td>
</tr>
<tr>
<td>C 2</td>
<td>46.9 bc</td>
<td>140.3 bc</td>
<td>93.6 ab</td>
</tr>
<tr>
<td>B</td>
<td>46.1 abc</td>
<td>148.5 abc</td>
<td>97.3 bc</td>
</tr>
<tr>
<td>10F</td>
<td>48.1 abc bc</td>
<td>135.8 cbc</td>
<td>91.9 bc</td>
</tr>
<tr>
<td>20F</td>
<td>47.7 ab c</td>
<td>138.1 abc</td>
<td>92.9 b</td>
</tr>
<tr>
<td>SE</td>
<td>0.31</td>
<td>1.26</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Note: a-d Values within a column with no common superscript differ significantly (P<0.05).

* C1=Control 1; C2= Control 2= control 1 plus water ; B= Diet contained Bioplus2; 10F= Diet contained 10g kg⁻¹ fermented milk; 20F= Diet contained 20g kg⁻¹ fermented milk.

无力的菌群数量在十二指肠和肠道（表3）以及在饲料中添加乳酸菌或商业化益生菌时，（表4）的益生菌显著降低，但效果未达到统计学意义。

体重

表器官的重量在肉鸡中测量为身体重量的百分比，并在表5中显示。没有显著差异的体重在表器官中，（除处女器官外）使用的饮食组被控制的，低于3周和6周的年龄，但，效果未达到统计学意义。ALT活动和胆固醇的水平在20 g kg⁻¹乳酸菌显著低于用0或20 g kg⁻¹乳酸菌或商业化益生菌的饲料的肉鸡（P<0.05）。

**DISCUSSION**

在这项实验中，益生菌在血液分析中表现出血清总胆固醇，AST，ALT和ALKPH在第3和6周的年龄中是显示在表6。ALKPH活动和胆固醇的水平在20 g kg⁻¹乳酸菌显著低于用0或20 g kg⁻¹乳酸菌或商业化益生菌的饲料的肉鸡（P<0.05）。
positive effect on growth performance, but the effect was not significant. Many investigators have studied the effects of *Lactobacillus* cultures on the performance of chickens. Some results indicate that *Lactobacillus* sp. are capable of improving broilers' performance (Jin *et al*., 1996a; Nahashon *et al*., 1994, 1996), while other works show that *Lactobacillus* sp. do not have any positive effect on broilers' performance (Buenrostro and Kratzer, 1983; Maiolino *et al*., 1992; Watkins and Kratzer, 1984). Factors affecting effectiveness of probiotics depend on stress condition of broilers (Jin *et al*., 1998; Lyons, 1987), capability of microorganisms to attach to the intestinal wall, their antagonism towards pathogenic bacteria, and their ability to competitively exclude some pathogenic bacteria (Jin *et al*., 1996b,c).

The result of the bacterial analysis showed improvement in intestinal microflora balance. The result on *coli*form count in the intestinal contents showed that the addition of fermented milk or the commercial probiotic depressed the *coli*form population in the ileum and colon, although the effect was not statistically significant. Jin *et al*., (1996a) and Francis *et al*., (1978) reported that chickens fed with a diet supplemented with a *Lactobacilli* culture had lower *coli*form numbers in the intestine, while, according to Jin *et al*., (1998), addition of a single strain of *L. acidophilus* or a mixture of *Lactobacillus* did not increase significantly *Lactobacilli* numbers in the ileum and cecum, except at 30 days after feeding. Also, these results agree with Watkins and Kratzer (1983, 1984) who found that chicks dosed with host specific *Lactobacillus* strains had only slightly higher numbers of *Lactobacilli* in their intestine. Supplemeting probiotics to the diets of broilers did not affect the weights of different organs. These findings are in agreement with the results of the present study.

**Table 5.** Percentage by weight of organs from broilers fed diets with or without probiotics at 21 and 42 days of age.

<table>
<thead>
<tr>
<th>Dietary Treatments</th>
<th>Liver</th>
<th>Spleen</th>
<th>Intestines</th>
<th>Gizzard</th>
<th>Heart</th>
<th>Bursa</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>2.8</td>
<td>2.04</td>
<td>0.13</td>
<td>0.12</td>
<td>4.9</td>
<td>3.94</td>
</tr>
<tr>
<td>B</td>
<td>2.7</td>
<td>2.11</td>
<td>0.08</td>
<td>0.13</td>
<td>6.1</td>
<td>4.17</td>
</tr>
<tr>
<td>10F</td>
<td>3.2</td>
<td>1.91</td>
<td>0.14</td>
<td>5.93</td>
<td>2.8</td>
<td>2.41</td>
</tr>
<tr>
<td>20F</td>
<td>3.1</td>
<td>1.89</td>
<td>0.10</td>
<td>5.34</td>
<td>2.9</td>
<td>2.07</td>
</tr>
<tr>
<td>SE</td>
<td>0.09</td>
<td>0.07</td>
<td>0.006</td>
<td>0.14</td>
<td>0.13</td>
<td>0.06</td>
</tr>
</tbody>
</table>

\[a\] C1=Control 1; B= Diet contained Bioplus2; 10F= Diet contained 10g kg\(^{-1}\) fermented milk; 20F= Diet contained 20g kg\(^{-1}\) fermented milk.

\[a,b\] Values within a column with no common superscript differ significantly (P<0.05).

**Table 6.** Serum biochemical markers in chicks at 21 and 42 days of age.

<table>
<thead>
<tr>
<th>Dietary Treatments</th>
<th>AST (IU/l)</th>
<th>ALT (IU/l)</th>
<th>ALKPH (IU/l)</th>
<th>Cholesterol (mg/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>188</td>
<td>229</td>
<td>10.5(^a)</td>
<td>14.7</td>
</tr>
<tr>
<td>B</td>
<td>176</td>
<td>185</td>
<td>10.6(^a)</td>
<td>12.7</td>
</tr>
<tr>
<td>10F</td>
<td>180</td>
<td>195</td>
<td>8.6(^b)</td>
<td>15.7</td>
</tr>
<tr>
<td>20F</td>
<td>168</td>
<td>234</td>
<td>11.0(^a)</td>
<td>20.3</td>
</tr>
<tr>
<td>SE</td>
<td>5.5</td>
<td>22.3</td>
<td>0.38</td>
<td>1.5</td>
</tr>
</tbody>
</table>

\[a\] C1=Control 1; B= Diet contained Bioplus2; 10F= Diet contained 10g kg\(^{-1}\) fermented milk; 20F= Diet contained 20g kg\(^{-1}\) fermented milk.

\[a,b\] Values within a column with no common superscript differ significantly (P<0.05).
agreement with the results of Fethiere and Miles (1987) and Watkins and Kratzer (1984). Similarly, Perdigon et al. (1988) found that feeding cultured milk containing L. acidophilus or L. casei or both had no effect on the weight of the spleen or liver of mice. Pulusani and Rao (1983) also reported that liver weights were not different between the rats feeding on diets with or without skim milk fermented by L. acidophilus, L. bulgaricus or L. thermophilus. In one study, an implantation of L. acidophilus in broilers caused a reduction in the weight of the ceca (Tortuero, 1973).

AST, ALT and ALKPH activities of the serum may indicate the liver function and health. Cellular injury in liver may increase the level of these enzymes in serum. ALT is principally found in the liver and is regarded as being more specific than AST for detecting liver cell damage. According to Table 6, the probiotics showed lower level of these enzymes. There is no available report in this regard in chicks, but Oyetao et al. (2003) showed that adding L. acidophilus to the diets decreased ALT level in rats.

Only a slight anticholesterolemic effect was also observed in chicks treated with probiotics. Oyetao et al. (2003) also showed similar results in rat and Lactobacilli had been found to have direct effect on cholesterol levels by assimilation and removal from the growth media. According to De Smet et al. (1994) and Ahn et al. (2000 and 2003), bile salt hydrolase activity of Lactobacilli might have some role in the reduction of serum cholesterol level.

Overall, the results indicated that addition of acidophilus yoghurt to broilers diet had some positive effects on growth performance, intestinal microbial balance, and liver health.

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REFERENCES


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