RESEARCH ARTICLE

DIETARY ADMINISTRATION OF SPIRULINA PLATENSIS AS PROBIOTICS ON GROWTH PERFORMANCE AND HISTOPATHOLOGY IN BROILER CHICKS

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ABSTRACT

A trial was conducted to investigate the effects of dietary supplementations of Spirulina platensis on broiler performance, and Histopathology. Eight hundred day-old Broiler chicks (Ross 308) were randomly assigned to 1 of 4 dietary treatments, consisting of eight replicates of 25 birds each. Commercial mash starter and finisher diets were supplemented with 0%, 0.5%, 1%, and 1.5% of Spirulina platensis. The Body Weight Gain, Feed Conversion Ratio and Villi length, were significantly increased by the dietary inclusion of the 1% of Spirulina platensis as compared to the control fed broilers. In conclusion, 1% of Spirulina platensis supplementation significantly increased Body weight gain, decreased Feed Conversion Ratios and increases the villi height. The Spirulina platensis offers a good natural alternative to improve poultry production.

INTRODUCTION

The intestinal epithelium acts as a natural barrier against pathogenic bacteria and toxic substances that are present in the intestinal lumen. Stressors, pathogens, and chemical substances, among others, cause disturbances in the normal microflora or in the intestinal epithelium that may alter the permeability of this natural barrier, facilitating the invasion of pathogens and prejudicial substances, modifying the metabolism, the ability to digest and absorb nutrients, and leading to chronic inflammatory processes at the intestinal mucosa (Hofstad, 1972; Podolsky, 1993; Oliveira, 1998). Consequently, there is decrease in the villus, increase in the cell turnover and decrease in the digestive and absorptive activities (Visek, 1978).

The action of probiotics can be explained by some mechanisms such as the production of antimicrobial substances and organic acids, protection of the villi and absorptive surfaces against toxins produced by pathogens, as well as the stimulation of the immune system (Dobrogosz et al., 1991; Ewing and Cole, 1994; Walker and Duff, 1998; Pelicano et al., 2002).

Spirulina is the oxygenic photosynthetic bacterium belongs to Cyanobacteria and Prochlorales according to the classification in Bargey’s Manual of Determinative Bacteriology. In this classification, sequence of the Rrna sub-unit 16S is considered. In 1989, these microorganisms were classified into two genera – Spirulina platensis and Spirulina maxima, according to suggestion by Gomont (1892) and Castenholz and Waterbury (1989). This classification is accepted currently. At the present time, there are some discrepancies about classification of Spirulina. Botanists are identifying this microorganism as microalgalae because of their photosynthetic attitude. On the other hand, bacteriologists include this microorganism into bacteria after they determined the main difference as a phospholipidic membrane between prokaryotes and eukaryotes (Tomasselli et al., 1996).

On the other hand, prebiotics effects are based on reduction of the growth of many pathogenic or nonpathogenic intestinal bacteria by means of the pH reduction that results from increased lactic acid levels in the ceca (Choi et al., 1994). Some bacteria may recognize binding sites in such molecules as if they were on the mucosa surface, and the intestinal colonization by pathogenic bacteria is thus reduced. Therefore, there is lower incidence of infectious processes, and the functions of secretion, digestion and absorption of nutrients can be appropriately performed by the mucosa (Iji and Tivey, 1998). The present study evaluated the effects of different levels of Spirulina platensis and their association on the histological of the intestinal mucosa of broilers.

MATERIALS AND METHODS

Eight hundred day-old broiler chicks (Ross 308) were randomly assigned to 1 of 4 dietary treatments, consisting of eight
replicates of 25 birds each. Commercial mash diets were supplemented with 0%, 0.5%, 1%, and 1.5% of *Spirulina platensis*. Chicks fed with four basal diets of Maize-soybean diets during four periods of 0-10 days birds fed with broiler Pre-starter, 11-20 birds fed with broiler Starter I, 21–30 days birds fed with broiler Starter II, 31-36 days birds fed with broiler Finisher. The diets supplemented with amino-acids, minerals, and vitamins to meet all the Ross 308 broiler chicken requirements.

Table 1 Effect of growth performance on Broiler Chicks fed with *Spirulina platensis* (g)

<table>
<thead>
<tr>
<th>Days</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
</tr>
</thead>
<tbody>
<tr>
<td>10th</td>
<td>271.44±14.12a</td>
<td>794.7±41.12a</td>
<td>1468.62±75.67b</td>
<td>1847.32±94.94b</td>
</tr>
<tr>
<td>20th</td>
<td>307.04±4.03a</td>
<td>870.5±5.70a</td>
<td>1671.34±3.97a</td>
<td>2065.86±10.16a</td>
</tr>
<tr>
<td>30th</td>
<td>310.06±2.85a</td>
<td>908.92±5.26a</td>
<td>1715.34±7.68a</td>
<td>2162.14±11.27a</td>
</tr>
<tr>
<td>36th</td>
<td>393.70±13.95a</td>
<td>804.5±49.83a</td>
<td>1510.08±91.01b</td>
<td>1921.82±116.16b</td>
</tr>
</tbody>
</table>

(T1-Control,T2-5g/kg of *Spirulina*, T3-1g/kg of *Spirulina*, T2-15g/kg of *Spirulina*  
** and *, Significant at P< 0.01 and not significant respectively. 
Mean in a column followed by a same letter (s) are not significantly (P<0.05) different according to Duncan’s Multiple Range Test. 

Table 2 Effect of Feed Intake on Broiler Chicks fed with *Spirulina platensis* (g)

<table>
<thead>
<tr>
<th>Days</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
</tr>
</thead>
<tbody>
<tr>
<td>10th</td>
<td>319.24±13.14a</td>
<td>1154.60±6.57a</td>
<td>2362.56±12.11b</td>
<td>2497.92±24.05b</td>
</tr>
<tr>
<td>20th</td>
<td>343.0±28.21a</td>
<td>1238.6±6.59a</td>
<td>2682±10.47a</td>
<td>3465±23.75a</td>
</tr>
<tr>
<td>30th</td>
<td>318±3.99a</td>
<td>1144.96±96a</td>
<td>2530±15.9ab</td>
<td>3260.80±96.4ab</td>
</tr>
<tr>
<td>36th</td>
<td>324.28±4.63a</td>
<td>1184.69±17.25a</td>
<td>2595.84±26.01ab</td>
<td>3250.80±96.4ab</td>
</tr>
</tbody>
</table>

(T1-Control,T2-5g/kg of *Spirulina*, T3-1g/kg of *Spirulina*, T2-15g/kg of *Spirulina*  
** and *, Significant at P< 0.01 and not significant respectively. 
Mean in a column followed by a same letter (s) are not significantly (P<0.05) different according to Duncan’s Multiple Range Test. 

Table 3 Effect of Feed Conversion Rate on Broiler Chicks fed with *Spirulina platensis*

<table>
<thead>
<tr>
<th>Days</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
</tr>
</thead>
<tbody>
<tr>
<td>10th</td>
<td>1.157±0.05a</td>
<td>1.420±0.06a</td>
<td>1.582±0.05a</td>
<td>1.864±0.01a</td>
</tr>
<tr>
<td>20th</td>
<td>1.110±0.01a</td>
<td>1.416±0.04a</td>
<td>1.604±0.01a</td>
<td>1.868±0.09a</td>
</tr>
<tr>
<td>30th</td>
<td>1.022±0.01a</td>
<td>1.256±0.96a</td>
<td>1.472±0.09a</td>
<td>1.716±0.09a</td>
</tr>
<tr>
<td>36th</td>
<td>1.085±0.06a</td>
<td>1.455±0.07a</td>
<td>1.575±0.09a</td>
<td>1.897±0.07ab</td>
</tr>
</tbody>
</table>

(T1-Control,T2-5g/kg of *Spirulina*, T3-1g/kg of *Spirulina*, T2-15g/kg of *Spirulina*  
** and *, Significant at P< 0.01 and not significant respectively. 
Mean in a column followed by a same letter (s) are not significantly (P<0.05) different according to Duncan’s Multiple Range Test. 

Table 4 Effect of Spirulina on Histopathology in Broiler at 36th Day

<table>
<thead>
<tr>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 36</td>
<td>270.95±14.36c</td>
<td>331.68±14.78b</td>
<td>362.01±14.53a</td>
</tr>
<tr>
<td>TXD</td>
<td>16.16**</td>
<td>306.27±4.84b</td>
<td></td>
</tr>
</tbody>
</table>

Body weight and Feed Intake Measurement

Birds were group weighed for each replicate at 1, 10, 20, 30 and 36 d of age. Feed intake was monitored replicate wise at 10, 20, 30 and 36 d of age. From the replicate wise Feed intake and bodyweight measurements feed/gain ratios were calculated.

Tissue Sampling and Measurement of villus height

**Tissue Sampling**

On day 36, six chicks from each treatment were killed by cervical dislocation for measurement of intestinal villus height by method of Sun et al., (2005). Five centimeter a section of jejunum (medial portion anterior to the ileum) was removed, rinsed in Tris-buffered saline, cut into 5 equal pieces, and fixed in 10% neutral buffered formalin. Each intestinal pieces was subsequently cut into 5-mm sections and placed into tissue cassettes.

Cassettes were embedded in paraffin, cut into thicknesses of 5µm, and mounted onto slides. Tissue slides were stained using hematoxylin and eosin Sun et al., (2005)

Measurement of Villus Height

In the jejunum (4 sections for each segment per bird), the villus height was measured from the villus tip to the bottom, not including the intestinal crypt.

The measurement was done with the Scion Image Program (Scion Corporations, Frederick, MD). The mean villus heights from 15 birds were expressed as a mean villus height for 1 treatment group for each as per Zentek et al., (2002)

**Statistical analysis**

All data were analyzed by analysis of variance (ANOVA) procedures (Steel and Torrie, 1980) appropriate for a
completely randomized design by the GLM procedure of SAS (1995). The effect of *Spirulina platensis* on growth performance, feed gain ratio and villus height were the main effect. The level of statistical significance was preset at P > 0.05.

**RESULTS AND DISCUSSION**

**Growth performance**

The present study showed Body Weight Gain (Table 1), Feed Intake (Table 2) and Feed Conversion Ratio (Table 3) of broiler chicks fed different levels of *Spirulina platensis* at 10th, 20th, 30th and 36th days of age. Results showed that chicks fed with 1% of *Spirulina platensis* had the higher body weight gain and improved feed conversion ratio compared with control group or other dietary treatments. The 1% of *Spirulina platensis* (Table 1) supplemented group had a greater Body weight gain (2162.14 ± 11.27a) compared with control birds (1847.32 ± 94.94b), Feed Intake (Table 2) was lower for birds supplemented with 1% *Spirulina platensis* (3207 ±20.6ab) compared with the control (3497.92 ±24.05b). Feed Conversion Ratio (Table 3) was lower for birds supplemented with 1% *Spirulina platensis* (1.716 ±0.09a) than control birds (1.864 ±0.01a). The obtained results confirmed the previous findings of several researchers including Razafindrajaona et al., (2008). Also in agreement with our study, Toyomizu et al., (2001) reported that *Spirulina platensis* confirmed these results when *Spirulina* was introduced at the rates of 40 and 80g/kg in broiler diets. Birds feeding with *Spirulina platensis* shows significant difference (P<0.01). This result was agreed with Hussein and Kaoud (2012), Ross and Dominy (1990), Mariey et al., (2012) and Nikodémusz et al. (2010) also reported that birds fed dietary *Spirulina* had benefit effects on productive performance.

**Histopathology**

Effects of dietary *Spirulina* supplementation on villi height is presented in Table 4. Feeding dietary *Spirulina* had a significant (P<0.01) increase in the height of villi as *Spirulina* levels in diets increased up to 1%. The increased height of villi length may be related to the high protein contents in *Spirulina* (with values ranging from 55-65% and includes all of the essential amino acids).

Intensive livestock production systems may be associated with multiple stressful incidents that negatively impact immune response and animal performance. The high metabolic rate during intensive feeding is accompanied by an increased production of free radicals, and any imbalance between production of these molecules and their safe disposal may culminate in oxidative stress, which can damage cells and tissues (Miller et al., 1993; Lykkesfeldt and Svendsen, 2007). Therefore, under oxidative stress conditions, there is an increased demand for antioxidants to reduce the deleterious effects of free radicals on the immune system (Carroll and Forsberg, 2007).

Interestingly, feeding natural, rather than synthetic, antioxidant could be advantageous to animal welfare and consumer safety (Call et al., 2008; Makkar et al., 2007). The blue-green algae, *Spirulina platensis*, have been considered as a suitable natural antioxidant and immune-stimulant to humans and animals with fewer side effects and more cost effectiveness than synthetic products (Abdel-Daim et al., 2013; Belay, 2002; Khan et al., 2005). Recently, the impact of dietary *Spirulina* supplementation on animal health and productivity has been reported (Holman and Malau-Aduli, 2012).

**CONCLUSION**

The results show that dietary *Spirulina platensis* could improve intestinal villi and epithelial cells, resulting in improved growth performance. The fact that a synergistic effect was observed with regard to growth performance and intestinal histology at 1% level of *Spirulina platensis* suggests a good supplementary partner for probiotics.

**Reference**


Dietary administration of *Spirulina platensis* as probiotics on health and histopathology in broiler chicks

Shanmugapriya. et al