Effects of Dietary Supplementation of Plant Extract (Impim) on Growth Performance Immune Status, and Nutrient Digestibility of Broiler Chickens

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Abstract The effects of dietary supplementation of plant extract (Impim) on growth performance, immune organ indexes, serum biochemical indicators, and nutrients digestibility of broiler chickens. Nine hundred one-day-old Cobb commercial broilers were randomly allocated into 3 treatments with 3 replicates in each treatment with 100 broilers in each replicate. The 3 dietary treatments were 1) control group (CON), basal diet; 2) CON + 0.02% Impim (Impim group); 3) CON + 0.002% Colistin sulfate premix + 0.004% Aureomycin premix. The trial period were 53 days. The results showed that, compared with antibiotic group, the serum total protein, amylase activity and lipase activity of broilers fed with Impim had been significantly improved by 9.91%, 18.25% and 14.73%, respectively (P < 0.05). In addition, digestibility of Ca, P, CP and ether extraction (EE) were significantly improved by 34.10%, 24.17%, 18.88% and 18.98%, respectively (P < 0.05). Death and culling rate was decreased by 32.09% (P < 0.05), ADG was increased by 2.37% (P < 0.05), feed intake was increased by 0.32% (P < 0.05) respectively, glutamic-pyruvic transaminase (ALT) activity was increased by 2.03% (P < 0.05), and D 42 immune organ indexes was increased (P > 0.05) in broilers of Impim group than antibiotic group. It could be concluded that administration of the Impim to broilers’ diet improved chickens’ growth performance, had a potent immunomodulatory effect (potentiated immune response). Eventually, Impim could be used as a partial replacement to the antibiotics.

Keywords: broilers, growth performance, immune function, plant extract


1. Introduction

The use of antibiotics was considered to be the greatest biotechnology in the 20th century in livestock production. Antibiotics were widely used in the feed industry and the breeding industry, especially played a role in animal disease prevention and growth promotion. The yield of livestock and poultry and the number of livestock products has been greatly improved, and a considerable economic benefit has been obtained [1]. In recent years with the abuse of antibiotics for a long time, residues of antibiotics in meat, eggs, milk and other animal products made a direct threat to human health and lead to antibiotic resistance of pathogenic bacteria, decreasing of growth promotion. In recent years, alternatives to antibiotics are mainly probiotic, oligosaccharide (prebiotic), plant extract, saccharacterpenin, enzyme, acidifier and antibacterial peptide [2]. Advantages of no residue and no drug resistance, plant extracts have been paid more attention in animal husbandry and feed industry [3]. Rich in amino acids, organic acids, vitamins, alkaloids and other nutrients, which plays a role in improving growth performance and immune function of animals [4]. Research has been taken great economic and social benefits in animal husbandry. In this study, Impim which was compared with antibiotics in terms of growth performance, serum biochemical indexes, and small intestine digestive enzymes and feed apparent digestibility in broilers to provide the basic data for the use of Impim. Antibiotics growth promoter have been extensively used in the poultry production to improve growth performance such as improving weight gain and feed utilization efficiency. It was also proved to lessen the number of harmful bacteria and enhance immunity [5].
However, due to its harmful residue effects and speculated risk for generating antibiotic resistance in pathogenic micro biota [6], More and more attention have been paid to ban of use of some specific antibiotics and looking for safe and effective alternatives. A ban had been conducted on most of the antibiotic feed additives within the European Union in 1999 and a complete ban enforced in 2006. Food and Drug Administration (FDA) in America published an announcement that America are planning to completely ban prophylactic administration of antibiotic in livestock’s feed in 3 years beginning from 2014 [7]. A number of feed additives like probiotics, prebiotics, organic acids and plant extracts have been found to have beneficial effects on animal production [8]. Phytogenic feed additives or plant-derived products have recently gained increasing interest. They are proved to have the properties to improve growth performance, digestibility [9,10] and carcass traits [11], antimicrobial [12,13], anti-inflammatory [14], antioxidant [15], immune-stimulant activity.

Poultry industry which is one of the most important food suppliers in the world. Chicken meat represents an important source of animal proteins and fats.

The objective of this study was to evaluate effects of blends of dandelion fluid extract and glycyrrhizin fluid extract on broilers production Figure 1. The hypothesis is that it can promote development of immune organs, promote gut health and improve livers’ function.

Figure 1. Feed additive of plant extract (Impim), collection, feeding on broiler production
2. Materials and Methods

2.1. Description of Experimental Site

This experimental protocol was involved in the present study and it was approved by the Animal Care and Use Committee of China Agricultural University (Beijing, China). Impim which were provided by a commercial company (Beijing Keepyoung Technology Co., Ltd., Beijing China) and the main composition was dandelion fluid extract, glycyrrhiza fluid extract and so on. The contents of total flavonoids and glycyrrhizin are no less than 2.0% and 0.1%, respectively.

2.1.1. Experimental Design and Field Management

Nine hundred one-day-old Cobb commercial broilers were randomly allotted into 3 treatments with 3 replicates in each treatment, with 100 broilers in each replicate, with male and female half in half. The 3 dietary treatments were 1) control group (CON), basal diet; 2) CON + 0.02% Impim (Impim group); 3) CON + 0.002% Colistin sulfate premix + 0.004% Aureomycin premix. The trial period was 53 d.

Colistin sulfate premix and Aureomycin premix were purchased from Ningxia Duo Wei Tai Rui Co. Ltd. The feed and water were available ad libitum. The basal diet were mainly consisted of corn and soybean meal. The compositions and nutrients content of basal diet are presented in Table 1.

<table>
<thead>
<tr>
<th>Group</th>
<th>Treatments</th>
<th>Trial period, d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group</td>
<td>Basal diet</td>
<td>53</td>
</tr>
<tr>
<td>Antibiotic group</td>
<td>Basal diet + Antibiotic (200 g/t)</td>
<td>53</td>
</tr>
<tr>
<td>Impim group</td>
<td>Basal diet + Impim (200 g/t)</td>
<td>53</td>
</tr>
</tbody>
</table>

\(^1\text{Impim} \text{ was provided by Beijing Keepyoung Technology Co. Ltd.}\)

2.1.2. Growth performance

Health and growth situation of birds as well as dead birds were recorded during the whole trial. BW of all birds and feed weighed and recorded on Day 1 and D 53. Feed intake, ADG, ADFI, feed conversion ratio (FCR) and death and culling rate were calculated as whole period.

2.1.3. Immune Organ Indexes

On the 21 and 42 day of age, 6 birds were randomly selected from each treatment group and killed by suffocating with carbon dioxide. The spleen, thymus and bursa of fabricius of killed chicken were collected and weighed individually after blood and water on those organs’ surface were absorbed by filter paper. The organ indexes were calculated as following formulas:

- Spleen index = weight of spleen (g) / BW (kg)
- Thymus index = weight of thymus (g) / BW (kg)
- Bursa of fabricius index = weight of bursa of fabricius (g) / BW (kg).

2.1.4. Serum Biochemical Parameters

On the 42 day of age, 10 birds were randomly selected from each replicate. Blood samples were collected into glass tubes without anticoagulant from vein of left wing. 2 mL of blood samples were centrifuged (3, 000 × g) for 15 min at 4°C. The serum samples were collected and stored at -20°C for determination of activity of AST, glutamic-pyruvic transaminase (ALT) and the content of total protein and albumin. The kits for testing AST, ALT, total protein and albumin were purchased from Nanjing Jiancheng Bioengineering Institute, Nanjing, China.

2.1.5. Activity of Small Intestine Digestive Enzymes

On the 42 day of age, 10 birds with similar weight were selected form each replicate. The selected birds were fasted for 12 hours, but with free access to water. The birds were then killed by suffocating with carbon dioxide and opened. The contents from duodenum were collected. The activity of amylase and lipase was determined.

2.1.6. Nutrients Digestibility

On the 42 day of age, 30 birds form each group were randomly selected and housed in individual cages. Thirty broilers in each group on the 42 day of age were selected and individually housed in cages. The 0.5 % Cr2O3 was used in the digestion trial as the exogenous indicator. The experimental period lasted 7 d with 3-d adaptation and 4-d collection of the feces. Feces were collected (three times a day, each time about 100 g) into a sealed bag and stored at -20°C. The feed and fecal samples were used to test the nutrition ingredients and to calculate the nutrition digestibility as the method of Experimental course of animal nutrition (Yuan, 2006).

2.1.7. Statistical Analysis

The data were shown as mean ± SD. One-way analysis of variance and independent-samples T test were used in significance testing with the software of SPSS17.0. Mean values were assessed with significance set at P < 0.05.

3. Results

3.1. Effects of Impim on Growth Performance of Broilers

The effect of Impim on the growth performance of broilers (0 ~ 53d) is shown in Table 3. Comparing with control group and antibiotic groups, the death and culling rate of Impim groups significantly decreased 51.57% (P < 0.05) and 32.09% (P < 0.05), respectively. Comparing with antibiotic groups, ADG and FI of Impim group was increased, while FCR was decreased (P > 0.05), respectively.

3.2. Effects of Impim on Immune Organ Indexes of Broilers

The effects of Impim on immune organ indexes of broilers is shown in Table 4. In the 21 day, the thymus index was the highest in Impim group, the spleen index and bursa of fabricius index were the highest in antibiotic
groups ($P > 0.05$). There were no any significant difference founded in all indexes of 42-days-old broilers ($P > 0.05$). The thymus index, spleen index and bursa of fabricius index in Impim group were higher than that compared to other groups ($P > 0.05$).

3.3. Effects of Impim on Serum Biochemical Indicators of Broilers
The serum biochemical indicators of 42-days-old broilers is shown in Table 5. Comparing with control and antibiotic groups, the total protein of Impim group was increased significantly by 8.89% and 9.91% ($P < 0.05$), respectively. There was no significant difference founded in albumin among the three groups ($P > 0.05$). ALT of antibiotic group was reached up to 72.19 u/port, which was significantly higher than that in control and Impim group ($P < 0.05$). Glutamic-oxalacetic transaminase (AST) of antibiotic and Impim group were significantly lower than that in control group ($P < 0.05$), respectively.

3.4. Effects of Impim on Small Intestine Digestive Enzymes of Broilers
Compared to control, and antibiotic groups, the amylase activity of Impim group was significantly increased by 15.71% and 18.25% ($P < 0.05$) respectively, and it’s also shown in Table 6. The lipase activity of antibiotic group was 238.54 u/mgport of antibiotics group ($P < 0.05$) and 215.41 u/mgport of control group ($P < 0.05$), respectively.

<table>
<thead>
<tr>
<th>Item</th>
<th>Control group</th>
<th>Antibiotic group</th>
<th>Impim group¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days 21</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thymus index</td>
<td>5.51 ± 0.44</td>
<td>4.88 ± 0.54</td>
<td>5.60 ± 0.61</td>
</tr>
<tr>
<td>Spleen index</td>
<td>0.89 ± 0.08</td>
<td>0.94 ± 0.06</td>
<td>0.84 ± 0.07</td>
</tr>
<tr>
<td>Bursa of fabricius index</td>
<td>1.96 ± 0.18</td>
<td>2.07 ± 0.24</td>
<td>1.89 ± 0.22</td>
</tr>
<tr>
<td>Days 42</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thymus index</td>
<td>2.93 ± 0.62</td>
<td>2.00 ± 0.50</td>
<td>2.95 ± 0.32</td>
</tr>
<tr>
<td>Spleen index</td>
<td>1.22 ± 0.12</td>
<td>1.25 ± 0.17</td>
<td>1.38 ± 0.20</td>
</tr>
<tr>
<td>Bursa of fabricius index</td>
<td>0.62 ± 0.10</td>
<td>0.78 ± 0.15</td>
<td>0.85 ± 0.15</td>
</tr>
</tbody>
</table>

¹Impim was provided by Beijing Keepyoung Technology Co. Ltd.
Table 5. Serum biochemical indicators of 42-day-old broilers

<table>
<thead>
<tr>
<th>Item</th>
<th>Total protein g/L</th>
<th>Albumin g/L</th>
<th>ALT u/port</th>
<th>AST u/port</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group</td>
<td>50.53 ± 2.03 a</td>
<td>18.81 ± 0.91</td>
<td>4.57 ± 0.66b</td>
<td>65.16 ± 2.37b</td>
</tr>
<tr>
<td>Antibiotic group</td>
<td>50.06 ± 1.89 a</td>
<td>19.95 ± 0.88</td>
<td>2.95 ± 0.22a</td>
<td>72.19 ± 1.53b</td>
</tr>
<tr>
<td>Impim group</td>
<td>55.02 ± 3.28 b</td>
<td>19.45 ± 0.84</td>
<td>3.01 ± 0.21a</td>
<td>62.77 ± 2.21</td>
</tr>
</tbody>
</table>

**Means in the same row with different superscript differ significantly (P < 0.05).
1 ALT = Glutamic-pyruvic transaminase.
2 AST = Glutamic-oxalacetic transaminase.

Table 6. Activity of amylase and lipase in duodenum of 42-day-old broilers

<table>
<thead>
<tr>
<th>Item</th>
<th>Amylase, u/mgport</th>
<th>Lipase, u/mgport</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group</td>
<td>2.80 ± 0.09 a</td>
<td>215.41 ± 32.01a</td>
</tr>
<tr>
<td>Antibiotic group</td>
<td>2.74 ± 0.10 a</td>
<td>238.54 ± 30.38 b</td>
</tr>
<tr>
<td>Impim group</td>
<td>3.24 ± 0.16 b</td>
<td>279.74 ± 34.09 c</td>
</tr>
</tbody>
</table>

**Means in the same row with different superscript differ significantly (P < 0.05).

Table 7. Analysis of apparent digestibility in 42-day-old broilers

<table>
<thead>
<tr>
<th>Item</th>
<th>CP, %</th>
<th>Ca, %</th>
<th>P, %</th>
<th>EE1, %</th>
<th>Organic matter, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group</td>
<td>27.10 ± 1.10 a</td>
<td>23.22 ± 1.05 b</td>
<td>18.28 ± 0.36 a</td>
<td>44.31 ± 1.27 a</td>
<td>64.00 ± 2.59</td>
</tr>
<tr>
<td>Antibiotic group</td>
<td>33.36 ± 1.31 b</td>
<td>21.23 ± 0.90 a</td>
<td>21.14 ± 0.20 a</td>
<td>52.70 ± 1.70 b</td>
<td>68.79 ± 2.06</td>
</tr>
<tr>
<td>Impim group</td>
<td>39.64 ± 0.79 c</td>
<td>28.47 ± 0.86 c</td>
<td>26.25 ± 0.36 c</td>
<td>62.70 ± 1.46 c</td>
<td>68.44 ± 2.07</td>
</tr>
</tbody>
</table>

A-C, Means in the same row with different superscript differ significantly (P < 0.05).
1 EE = Ether extraction.

3.5. Effects of Impim on Apparent Digestibility of Feed

The apparent digestibility of 42-days-old broilers is shown in Table 7. Comparing with the antibiotic groups and control group, the CP digestibility of Impim group was significantly increased by 18.82% and 46.27% (P < 0.05), respectively. Ca and P absorption rate of Impim group were significantly higher than that in antibiotic groups and control group (P < 0.05), respectively. Comparing with control group and antibiotic groups, the ether extraction (EE) digestibility of Impim group was significantly increased by 18.98% and 41.50% (P < 0.05), respectively. The organic matter digestibility of Impim and antibiotic groups were higher than that in control group (P > 0.05), respectively.

4. Discussion

4.1. Effects of Impim on Growth Performance of Broilers

Dandelion which has strong bactericidal action on staphylococcus aureus, hemolytic streptococcus, diplococcus pneumoniae, meningococcus, corynebacterium diphtheriae, pseudomonas aeruginosa, proteusbacillus vulgaris, shigella dysenteriae, typhoid bacillus and catarrhal catarrh coccus [16]. Adding dried tangerine peel, rhizoma atractylodis, glauber's salt and other components of Chinese herbal additives with the levels of 1.75%, 2.25% and 2.75% to the standard ration of Radix Aconiti broilers [17]. The results were showed that in comparison with chicken in control group, the survival rate of chicken in treated groups has been improved by 5.1%~10.3%. The Impim is rich in flavonoid and has the effects of microorganism's resistance, liver and gallbladder protection. As a result, the death and culling rate of broilers fed with Impim was significantly reduced.

4.2. Effects of Impim on Immune Organ Indexes of Broilers

The immune function of organism can be evaluated by observing the immune organ indexes. Poultry immune organ weight (Bursa of fabricius, Spleen and Thymus) is an important index in measuring the effect of nutrients on poultry immunity. Immune organ is the organizational structure which executes the immune function. The thymus which can produce thymosin is the central organ of poultry cellular immunity. It is also the main place for the differentiation and development of T cells. The bursa of fabricius is the specific humoral immune system of birds. It can induce lymphoid stem cell from bone marrow into mature B cells. The spleen is the largest peripheral immune organ of poultry. The volume of poultry spleen is relatively smaller than that in other animals. The spleen executes the function of filtering blood and immune response to the blood-borne antigens substances. Both cell growth and proliferation in a healthy environment can alter the weight of immune organs, which can be used as an important organism immune function indicator. Therefore, the immune function of organism is closely related to the development of immune organs. Increasing of the immune indexes indicated the rapid maturity of the organ and the additives plays an important role in it. The study showed that in comparison with chicken in control group, the thymus index, spleen index and bursa of fabricius index of chicken both in Impim and antibiotic groups were improved, even without significant differences (P > 0.05). In addition, the immune organ indexes of chicken in Impim group were relatively higher than those in antibiotic group. The results indicated that Impim can improve immunity and enhance the body's resistance to disease.
4.3. Effects of Impim on Serum Biochemical Indicators of Broilers

AST and ALT are important transferases in amino acid metabolism. In normal, the activity of AST and ALT in serum were very low, while the AST levels in serum increased sharply with necrosis of liver cells [18]. The AST levels of chicken in antibiotic group increased significantly, which indicated that antibiotics may cause liver damage. The AST levels of chicken in Impim group was the lowest, which indicated that Impim could effectively protect the liver of broilers.

The serum total protein was synthesized in liver. The level was a directly reflection to the condition of feeds and growth of the animal. In a certain range, the increasing of serum total protein content means that the liver synthesis ability was strengthened [19]. In this study, the serum total protein of chicken in Impim group was significantly higher than that in antibiotic and control group, which indicated that the ability of protein synthesis in liver was stronger, with the decreasing of catabolism and accelerating of protein deposition and growth.

4.4. Effects of Impim on Small Intestine Digestive Enzymes of Broilers

The study showed that in comparison with chicken in control and antibiotic groups, the activity of amylase and lipase of chicken in Impim group was significantly improved (P < 0.05). The prebiotics such as oligosaccharide in Impim can improve proliferation of Bifidobacterium, Lactobacillus and other beneficial bacteria, which is beneficial for secretion of animal digestive enzymes, intestinal peristalsis, inhibiting the growth of harmful bacteria, maintaining intestinal microecological balance and improving the small intestine digestive enzyme activity [20].

This study showed that the digestibility of EE of chicken in Impim group was significantly higher than those in other two groups, which was consistent with the results that Impim could significantly improve the activity of lipase. The addition of 1.5 g fructo-oligosaccharide in diets of weaning piglets in each day and each pig, the CP and P was improved [22]. This is consistent with our study. Impim contains a large quantity of oligosaccharides which are conducive to the propagation of intestinal probiotics and inhibition of harmful bacteria. Probiotics can produce short chain fatty acids (SCFA) and lactic acid, which help to reduce intestine pH, promote minerals solubility and absorption. At the same time, probiotics can accelerate the secretion of digestive enzymes (such as amylase, protease and so on), improve the digestion and absorption of effective components in feeds.

5. Conclusions

Plant extract compound Impim has antimicrobial activity to maintain animal intestinal micro ecological balance. It also can improve the activity of digestive enzyme and absorption of the effective components in feeds, therefore enhance growth performance of broilers. In addition, Impim could increase the immune organ indexes and protect the liver of broilers. Eventually, the Impim can be used as a replacement of antibiotics additives in daily diets of poultry.

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References

transcription factors NR-1B and Nrf2 in the duodenal mucosa of pigs". Acta Vet. Scand., 55, 18, 2013.


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