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Influence of Dietary Addition of *Scutellaria baicalensis* Stem-leaf Total Flavonoid on Growth Performance and Immune Functions of Broiler Chickens

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Original Research Article

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Abstract: 500 one-day old Arbor Acres (AA) broiler chickens were randomly allocated into 5 groups, 5 replicates of 20 birds in each. *S*cutellaria Baicalensis Stem-leaf Total Flavonoid (SSTF) was added into the diet (with the purity of 95.27%) of broiler chicken. It was found that SSTF had influence on growth performance and immune organs of broiler chickens. Chicks had SSTF level of 10 mg/kg performed favorably.
Keywords: *S*cutellaria Baicalensis Stem-leaf Total Flavonoid (SSTF); broiler chicken; growth performance; immune function.

INTRODUCTION

Scutellaria baicalensis georgi is a perennial herb which has been used in medicine and diet with a long tradition in China, Russia, Japan, Korea and Mongolia. People pay more attention to the use of natural products like herbs, spices, plant extracts added in human food and animal feed industries [1]. The effective physiological and therapeutic activity is from the existence of almost 70 flavonoids, chalkones, flavanones, flavanonols, flavones, flavonols and anthocyanidines. The total content of flavonoids in the dry roots of *Scutellaria baicalensis* is varying from 15 % to 20 %[1]. Apart from the dry root, the stem-leaf total flavonoids of *Scutellaria baicalensis* (SSDF) is also precious, which is rarely studied.

In recent studies, skullcapflavone is effective in scavenging free radical [2,3] and performing antioxidant activities, treating diabetic [4] and cancer [5], protective function in a cardiomyocyte model [6] preparing protease inhibitors such as ritonavir-induced nausea protease inhibitor [7].

If flavonoids are added into the diet of domestic fowls, the organs of domestic fowls could be protected to a certain degree.

MATERIALS AND METHODS

Experimental materials

Skullcapflavone was extracted from the stem and leaves of *Scutellaria baicalensis* in laboratory. 95.27 % of the dry weight was SSDF which was measured by high performance liquid chromatography (87.63% was baicalin, 2.87% was wogonoside, 3.21% was baicalein, 1.56% was wogonin). Arbor Acres (AA) broiler chickens were selected with similar weight. 1.2 Experimental design and composition of the basal diets.

500 one-day old AA broiler chickens were randomly allocated into 5 groups. Each treatment was replicated 5 times with 20 chickens (10 cocks and 10 hens). Skullcapflavone at 0 (control), 5, 10, 15, 20 mg/kg was added into the basal diet. Preliminary trial period was lasted for 3 days. The experimental trial period lasted for 46 days. The main content of basal diet was bean pulp using NRC (1994) guidelines. The ingredients and chemical compositions were shown in Table 1.

Feeding management

Chicks were scatter-fed in former 3 weeks, and then raised in cage for another 3 weeks. They were fed and drunk freely. The illumination, temperature and humidity were controlled according to immunity procedure. Pens were kept warm in brooding time. Chicks were vaccinated against new-castle and bursa of Fabricius. The cribs and water bowls were sterilized every day. The consumption of basal diet was carefully recorded through all the trial period.

Determining indexes and methods

Growth performance

All chicks in each group were weighed on day 21, day 35 and day 49 with an empty stomach for 12 h. The number of dead chickens and basal diet consumed were carefully counted timely. Take notes of the health condition of chicks and food consumption. Average daily feed consumption (ADFC) and body weight (BW)

were recorded,and then average daily gain (ADG) and feed conversion gain (F/G) were calculated.

Table-1: Ingredients, composition and nutrient levels of the basal diet (air-dry, %)

Items	1~21d	22~49d	Items	1~21d	22~49d
Ingredients			Nutrient levels		
Corn	56.05	65.94	ME(MJ/kg)	12.46	13.32
Soybean meal	36.46	26.04	CP	21.19	20.56
Soybean oil	3.00	3.90	Ca	0.90	0.85
Limestone	2.90	3.00	Total P	0.45	0.41
$CaHPO_4$	0.43	0.30	Lys	1.18	1.02
NaCl	0.30	0.30	Met	0.47	0.45
L-Lys	0.21	0.13			
DL-Met	0.20	0.19			
Vitamin Premix[1)]	0.20	0.05			
Choline chloride	0.15	0.05			
Mineral Premix[2)]	0.10	0.10			
Total	100.00	100.00			

1) Vitamin and mineral premix provided per kilogram of diet: VA 54 000 000IU; VB12 000IU;VD310 800 000IU; VB215 000IU; VE18 000IU; VB67 000IU; VK35 000IU; VB1230mg; D-pantothenic acid 25 000IU; nicotinic acid 35 000IU; folic acid 500mg; biotin 500mg。

2) The mineral premix provides for per kg of diet: Cu 20 mg; Zn 50 mg; Mn 70 mg; I 0.38 g; Se 0.16g.

Organ index and the content of immunoglobulin (lg)

Chicks were tested under germ-free condition. 3 chicks were weighed after slaughtered in each group. The blood serum was saved and kept at -20 ℃. The slaughtered chicks were weighed again after thymus, spleen, fabricius and fat were removed. The lgA, lgG, lgM were determined by immunity transmission turbidity.

Immune organ index (%) =100 × immune organ weight (g)/live weight (g)

All the numerical data was analyzed using SAS 9.0 and DPS v7.05 software. The statistical evaluation of the obtained data with the mean ($\overline{X}$) and standard deviation (SD).

RESULTS AND DISCUSSION

The influence of skullcapflavone on the growth performance of broiler chicks

In recent years, the consumers demands that the production of meat, fruit and vegetables is conducted under environmentally friendly conditions. Of course, the choose of meat, fruit and vegetables has relevance on consumers' acceptance, risk and benefit perception, trust in regulators, knowledge of regulation and their preference for natural products [8]. So a lot of natural materials such as oregano, du-sacch, quiponin, thyme, garlic, anthocyanin, chokeberry [9] were added in the diet of broiler chickens.

As shown in Table 2, the basal diet was supplemented with skullcapflavone at 0 (control), 5, 10, 15, 20 mg/kg diet. Compared with the control diet, values of BW, ADFC, ADG and F/G of each group increased a little. The BW and ADG indexes of the 10 mg/kg supplementation were insignificantly the highest among all groups. The ADFC and F/G index of the 5 mg/kg was significantly the best. The BW index of the 20 mg/kg supplement was the lowest. The ADFC and ADG indexes of the 15 mg/kg supplementation had the lowest values. The F/G index of the 10 mg/kg had the lowest value. In a word, the addition of skullcapflavone didn't affect BW and F/G indexes significantly.

Table-2: Effect of dietary SSTF levels on growth performance of broilers

Items	Age (days)	skullcapflavone levels (mg/kg)				
		0	5	10	15	20
BW/g	21d	499.43±24.18	527.21±14.31	529.28±16.33	526.34±21.37	522.00±19.18
	35d	1358.18±33.69	138869±25.17	1402.56±26.19	1395.73±34.19	137424±26.03
	49d	2008.00±48.70	2067.02±39.05	2138.04±39.15	2089.41±26.55	2041.32±35.13
ADFC/g	1～49d	77.10±1.15[a]	82.53±2.48[b]	76.76±2.14[a]	72.86±3.02[a]	78.86±3.02[a]
ADG/g	1～49d	39.34±1.03[a]	41.02±4.53[b]	41.64±1.68[b]	39.79±2.98[b]	40.01±2.98[b]
F/G	1～49d	1.83±0.06	2.02±0.03	1.84±0.04	1.89±0.03	1.99±0.03

a,b, c… Means in the same row within each classification bearing different letters are significantly ($P \leq 0.05$) different.

The influence of skullcapflavone on the immune organs of broiler chicks

It was testified that some plant extracts could improve the digestibility of the feeds for broilers [10]. Thymus, spleen and bursal of fabricius are important immune organs of poultry. And they are easily hurt by infectious disease, so the indexes of thymus, spleen and bursal of fabricius can reflect the growth of immune organs. Thymus takes part in the function of non-specificity immune which can help the immune of cell and body fluid. Spleen is the biggest peripheral immune organ, and it is the center of creating sensitized lymphocyte. Bursal of fabricius is the special main center organ of poultry. It is the differentiation maturation site of B cell.

As shown in Table 3, the indexes of thymus, spleen and bursal of fabricius had increased a lot compared with those of the control group. The thymus index of 10 mg/kg supplementation had the highest index. On the 21st day of breading, the spleen index of 5 mg/kg was higher than that of 35th day and 49th day ($P \leq 0.05$). As to the bursal of fabricius index, the group of chicks fed 5 mg/kg supplementation was better than that of 35th day and 49th day, while the difference of each supplement group is not significant ($P > 0.05$).

Table-3: Effect of dietary SSTF levels on thymus, spleen and bursal of Fabricius indexes of broilers

Items	Age (days)	skullcapflavone levels (mg/kg)				
		0	5	10	15	20
Thymus index	21d	3.67±0.70	4.12±0.32	4.38±0.21	4.01±0.23	3.82±0.23
	35d	4.20±0.28	4.46±0.22	4.57±0.37	4.42±0.20	4.32±0.20
	49d	4.21±0.48^{a}	4.50±0.11^{a}	6.65±0.29^{b}	5.03±0.35^{a}	4.07±0.35^{a}
Spleen index	21d	1.02±0.03^{a}	1.31±0.57^{b}	1.28±0.16^{b}	1.25±0.10^{b}	1.20±0.10^{b}
	35d	1.65±0.26^{a}	1.98±0.43^{b}	2.01±0.13^{b}	1.76±0.27^{a}	1.71±0.37^{a}
	49d	1.74±0.13	1.90±0.37	2.03±0.48	2.01±0.31	1.86±0.31
Bursal of Fabricius index	21d	1.27±0.06^{a}	2.87±0.23^{b}	2.64±0.18^{b}	2.20±0.11^{a}	2.31±0.08^{a}
	35d	2.36±0.25	2.20±0.19	2.35±0.18	2.32±0.10	2.44±0.10
	49d	1.68±0.49	1.83±0.18	1.82±0.11	1.74±0.19	1.61±0.19

a,b, c… Means in the same row within each classification bearing different letters are significantly ($P \leq 0.05$) different.

The influence of skullcapflavone on the immunoglobulin (lg) of broiler chicks

Lg A, lgG and lgM are classified into 2 types, serotype lg and secreting type lg A(SlgA). Serotype lg could devour DDC. SlgA is the main element of the mucosa defense system which can suppress the breed of virus. LgG is the main antibody of organ, the main factor of antibody, and it involves with the immune process of antitumor, anti-parasite, and some allergic reactions. The content of lgM is a little lower than that of lgG, but the molecular weight of the lgM is the biggest. The meditation and disinfection are stronger than those of lgG.

As shown in Table 4, as the level of skullcapflavone increased, the content of lg was increased quickly, then became slowly. The lg content of chicks fed 10 mg/kg supplementation was the highest, while the difference was not significantly ($P > 0.05$). On the 21st day of breading, the difference of lgG in each group is not significantly ($P > 0.05$). On the 35th day and the 49th day of breading, the content of lg of the treated groups was higher than that of the control diet. During all the trial period, the content of lg in all supplemented groups was higher than that of the control diet ($P > 0.05$). As to the content of lgM, it was increased during all the trial period, while the differences among the studied groups were not significant.

Table-4: Effect of dietary SSTF levels on IgA, IgG and IgM in serum of broilers

Items	Days of age/d	Supplemental/(mg/kg)				
		0	5	10	15	20
IgA	21d	1.33±0.15	1.46±0.18	1.50±0.06	1.41±0.10	1.36±0.10
	35d	1.55±0.12	1.65±0.22	1.70±0.06	1.69±0.04	1.60±0.04
	49d	1.59±0.16	1.72±0.10	1.74±0.08	1.65±0.07	1.64±0.07
IgG	21d	1.18±0.12	1.23±0.13	1.32±0.08	1.28±0.06	1.22±0.06
	35d	1.30±0.11^{b}	1.53±0.13^{a}	1.60±0.08^{a}	1.56±0.04^{a}	1.40±0.04^{ab}
	49d	1.52±0.10^{b}	1.97±0.08^{a}	2.07±0.06^{a}	1.86±0.03^{a}	1.87±0.03
IgM	21d	0.81±0.04	0.84±0.07	0.90±0.04	0.87±0.07	0.81±0.07
	35d	1.18±0.12	1.24±0.10	1.30±0.08	1.18±0.06	1.24±0.05
	49d	1.53±0.14	1.56±0.14	1.61±0.10	1.63±0.08	1.54±0.08

a,b, c… Means in the same row within each classification bearing different letters are significantly ($P \leq 0.05$) different.

CONCLUSIONS

In a word, proper amount of skullcapflavone in basal diet could improve the broiler growth performance, the BW and ADG increases, the F/G index decreases. The immune organ growth and functions were enhanced apparently. Also, the digestibility and immunity of broiler chickens could be improved, and the antibiotic and antioxidant activities of SSTF had active influences on growth performance of chickens, The 10 mg/kg supplement was the optimum among the four groups.

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