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Original Research Article

Ginger extract enhances antioxidant ability and immunity of layers

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ABSTRACT

This experiment was to investigate ginger extract on production performance, antioxidant ability and immunity of laying hens. A total of 600 Hy-Line brown laying hens aged at 25 wk old were randomly divided into 2 treatments, 4 replicates per treatment, 75 layers each replicate. The control group hens were fed a basal diet; the experimental group hens were fed basal diets with 0.1% ginger extract. The results were shown as follows: 1) ginger extract significantly enhanced laying rates ($P < 0.05$) and daily egg weight ($P < 0.05$), substantially reduced the ratio of feed to egg ($P < 0.05$) of the hens; 2) ginger extract did not change the activities of glutathione peroxidase (GSH-PX) and total antioxidant capacity (TAOC) but significantly improved plasma superoxide dismutase (SOD) activity ($P < 0.05$), reduced malondialdehyde (MDA) content ($P < 0.05$) of the birds; 3) ginger extract did not affect the contents of serum total protein (TP), albumin (ALB), globulin (GLB), but significantly increased lysozyme (LZM) activity ($P < 0.05$); 4) ginger extract also significantly reduced plasma prostaglandin E_2 (PGE_2) content ($P < 0.05$). This study shows that ginger extract not only can improve the birds' antioxidant capacity, enhance immune function, but also has a potential of reducing inflammatory response.

1. Introduction

Antibiotics are widely restricted or even banned as feed additives in animal production. People are looking for natural alternatives for animal growth promotion. Ginger root has been widely used in China for thousands of years as a spice and herbal medicine mainly in human life for antiemetic and diaphoresis effect (Ma et al., 2013; Hu et al., 2016). Dietary dried fermented ginger can induce broiler growth performance as a result of stimulation of morphological maturation and in consequence intestinal function (Incharoen et al., 2010); Habibi et al. (2014) found that dietary ginger increased serum concentrations of total antioxidant capacity (TAOC) and decreased malondialdehyde (MDA) broilers under heat stress. Zhao et al. (2011a,b) found that dietary supplementation of ginger powder improved laying performance and serum and egg yolk antioxidant status and enhanced dietary oxidation stability in a dose-dependent manner. Akbarian et al. (2011) pointed that the dietary inclusion of ginger root not only significantly decreased the concentration of egg yolk cholesterol, but also has a positive effect on egg production and plasma antioxidant status of laying hens. Incharoen and Yamauchi (2009) also found the beneficial effects of dried fermented ginger on production performance, egg quality and intestinal histology in laying hens. Process method of ginger root may affect antioxidant states and efficacy of birds (Zhang et al., 2009). Ginger extract may be more efficient and convenient because of its small usage in diet compared with ginger root powder. This trial was designed to investigate the effects of ginger extract on production performance, antioxidant capability, immunity and also inflammation of laying hens, trying to find a natural and effective feed additive in poultry production.

2. Materials and methods

2.1. Experiment design

The present study was approved by the Institutional Animal Care and Use Committee of Agricultural University of Hebei and was carried out in accordance with the Guidelines. Six hundred 25-

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wk-old Hy-line brown layers were randomly divided into 2 treatments, 4 replicates per treatment, 75 layers each replicate. The control group hens were fed a basal diet; the experimental group hens were fed the basal diet with 0.1% ginger extract (purchased from Shanxi baiwei biotech Co., Ltd.; standard: 5% gingerols). The basal diet was formulated to meet NRC recommendation (NRC, 1994). The composition and nutrient level of the basal diet are showed in Table 1.

2.2. Raising and management

The experiment started from February 3, 2017. The preliminary trial period was 1 wk, and the formal period was 7 wk. The birds were raised in a caged chicken house. There were 3 layers in one cage. The cage was 45 cm wide, 39 cm deep, and 45 cm high. Feed and water were offered *ad libitum*, and 16 h daily light, manual feeding, natural ventilation were provided.

2.3. Sample collection and analysis

2.3.1. Production performance of the hens

Eggs number, egg weight and feed intake were recorded every day, other management guideline of the chicken farm was completely abided. At the end of the trial, we calculated hen-housed laying rates, average daily egg mass and the ratio of feed to egg of the hens.

2.3.2. Antioxidant capability of the layers

At 42 d of experiment period, 8 healthy hens (2 hens per replicate) were randomly chosen from each treatment, and 2 blood samples were collected from the wing vein and centrifuged at 3,000 × *g* for 10 min at 4 °C, to make serums and also plasma and then stored at −30 °C until assay.

Plasma was used to measure antioxidant indexes of birds. Plasma MDA content, activities of superoxide dismutase (SOD) and glutathione peroxidase (GSH-Px), and TAOC were detected by biochemical methods following the instructions of reagent kits (Nanjing Jiancheng Bioengineering Institute, Nanjing, China).

2.3.3. Immunity of the layers

The contents of serum total protein (TP), albumin (ALB), globulin (GLB), and lysozyme (LZM) activity were measured according to the guideline of the reagent kits (Nanjing Jiancheng Bioengineering Institute, Nanjing, China).

2.3.4. Prostaglandin E_2 (PGE_2) content

The contents of plasma PGE_2, was detected by using specific radioimmunoassay (RIA) kits (Sino-UK Institute of Biological Technology, Beijing, China) with a γ-911 automatic RIA Counter (Science & Technology Industrial Corporation, University of Science and Technology of China, Hefei, China).

2.4. Statistical analysis

Excel software was used for data recording. *T*-test was performed on all data using compare means procedure of SPSS 20.0. A significance level was set at $P < 0.05$. A very significance level was set at $P < 0.01$.

3. Results

3.1. Effect of ginger extract on production performance of hens

The results are showed in Table 2. Ginger extract significantly enhanced laying rates ($P < 0.05$), daily egg weight ($P < 0.05$) of the hens, and reduced the ratio of feed to egg ($P < 0.05$).

3.2. Effect of ginger extract on antioxidant ability of the hens

As shown in Table 3, ginger extract definitely improved plasma SOD activity ($P < 0.05$), reduced MDA content ($P < 0.05$) of the birds. Furthermore, we also found that plasma enzyme activities of GSH-PX and TAOC of the trial birds were obviously higher than those of the control group, though the difference was not significant.

3.3. Effect of ginger extract on immunity ability of the hens

From Table 4, we can find that ginger extract did not affect the content of serum TP ($P > 0.05$), ALB ($P > 0.05$), GLB ($P > 0.05$) of the birds, but significantly increased LZM activity ($P < 0.05$).

3.4. Effect of ginger extract on plasma PGE_2 of the hens

The result (Table 4) told us ginger extract significantly decreased plasma PGE_2 content ($P < 0.05$).

4. Discussion

4.1. Effect of ginger extract on production performance of hens

The results were not consistent with that of ginger powder on layers (Zhao et al. (2011a,b)). In this study, ginger extract not only enhanced laying rate, but also reduced the ratio of feed to egg. The result indicated that ginger extract maybe more efficient than ginger powder in improving layers performance. The effect of ginger extract on laying performance of hens may be related to the

Table 1
Composition and nutrient levels of the basal diet (%, air-dry basis).

Ingredients	Content	Nutrient levels	Content
Corn	63	CP	15.96
Soybean meal	23	Ca	3.59
Soybean oil	1	TP	0.42
Wheat bran	2	Lys	0.77
Limestone	8	Met + Cys	0.60
Premix[1]	3		
Total	100		

[1] The premix provided the following per kilogram of diet: vitamin A 12,000 IU, vitamin D 2,500 IU, vitamin E 30 IU, vitamin K 2.0 mg, vitamin B_{12} 0.015 mg, vitamin B_1 1.6 mg, vitamin B_6 3.0 mg, vitamin H 0.1 mg, nicotinic acid 20.0 mg, folic acid 0.5 mg, pantothenic acid 10.0 mg, Cu 5.1 mg, I 0.5 mg, Mn 65.0 mg, Fe 23.0 mg, Zn 55.0 mg, Se 0.21 mg, Met 960 mg, NaCl 3.7 g, Ca 3 g, P 0.9 g.

Table 2
Effect of ginger extract on production performance of hens.

Item	Laying rate, %	Daily egg weight, g	Feed:Egg
Control	85.25 ± 0.59	49.36 ± 0.45	2.18 ± 0.02
Ginger extract	87.45 ± 0.29	50.87 ± 0.19	2.12 ± 0.01
P-value	0.02	0.04	0.047

Table 3
Effect of ginger extract on antioxidant ability of the hens.

Item	SOD, U/mL	GSH-Px, U/mL	TAOC, U/mL	MDA, nmol/mL
Control	88.37 ± 5.28	917.85 ± 22.00	16.23 ± 1.27	3.89 ± 0.26
Ginger extract	102.97 ± 4.18	980.16 ± 46.48	17.49 ± 0.81	3.10 ± 0.18
P-value	0.048	0.25	0.42	0.03

SOD = superoxide dismutase; GSH-Px = glutathione peroxidase; TAOC = total antioxidant capacity; MDA = malondialdehyde.

Table 4
Effect of ginger extract on immune and anti-inflammation of the hens.

Item	TP, g/L	ALB, g/L	GLB, g/L	LZM, U/mL	PGE_2, pg/mL
Control	52.99 ± 2.65	15.47 ± 0.58	37.52 ± 2.25	89.19 ± 10.39	37.13 ± 1.85
Ginger extract	52.00 ± 2.06	14.59 ± 0.60	37.41 ± 1.62	121.89 ± 10.14	31.56 ± 1.59
P-value	0.77	0.31	0.97	0.04	0.04

TP = total protein; ALB = albumin; GLB = globulin; LZM = lysozyme; PGE_2 = prostaglandin E_2.

stimulation of morphological maturation and in consequence intestinal function (Incharoen et al., 2010; Incharoen and Yamauchi, 2009), then promoting the digestion and absorption of nutrients in the small intestine.

4.2. Effect of ginger extract on antioxidant ability of the hens

Antioxidant function is an important index to measure the body's health, and MDA, SOD, GSH-PX, and TAOC are most widely used as the indicators of the body's antioxidant capability. The results of the study on antioxidant capacity of ginger extract are consistent with the previous literature of ginger powder (Zhao et al. (2011a,b); Abdollah et al., 2011; Chen et al., 2013), so we can draw a conclusion that either ginger root powder or ginger extract can enhance the antioxidant ability of the birds, which is very beneficial to animals' health and production performance.

4.3. Effect of ginger extract on immunity of the hens

In this study, the contents of serum TP, ALB and GLB were not affected by ginger extract, whereas serum LZM activity was significantly improved. Lysozyme is secreted by macrophages, reflecting the cellular immunity and the anti-infection ability of the body. The enhancement of LZM activity indicated that ginger extract significantly increased the non-specific immune function of the body.

4.4. Effect of ginger extract on inflammation of the hens

Prostaglandin E_2 is a proinflammatory eicosanoid, closely related to a variety of inflammation (Rolland et al., 1984; Zhang and Wei, 2011; Kawahara et al., 2015) and also cancer (Jiang et al., 2018). The production of PGE_2 increases with the progression of human atherosclerosis (Rolland et al., 1984). In the experiment, ginger extract significantly decreased the content of plasma PGE_2, indicating that ginger extract has a potential effect of improving anti-inflammatory capacity of the body.

5. Conclusion

This study shows that ginger extract not only can improve the birds' antioxidant capacity, enhance immune function, but also has a potential of reducing inflammatory response. These beneficial effects of ginger extract may induce a better production performance of the layers.

Conflicts of interest

We declare that we have no financial and personal relationships with other people or organizations that can inappropriately influence our work, there is no professional or other personal interest of any nature or kind in any product, service and/or company that could be construed as influencing the content of this paper.

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