Ginger extract enhances antioxidant ability and immunity of layers

Shengying An* , Guanzhong Liu, Xin Guo, Yahui An, Renyu Wang
College of Animal Science and Technology, Hebei Agricultural University, Baoding, 071000, China

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) but significantly improved plasma superoxide dismutase (SOD) activity (P < 0.05), reduced malondialdehyde (MDA) content (P < 0.05) of the hens; 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 E2 (PGE2) 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.

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 birds; 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 E2 (PGE2) 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.
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 serum 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 E2 (PGE2) content

The contents of plasma PGE2 was detected by using specific radioimmunoassay (RIA) kits (Sino-UK Institute of Biological Technology, Beijing, China) with a γ-911 automatic RIA Counter.

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 PGE2 of the hens

The result (Table 4) told us ginger extract significantly decreased plasma PGE2 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    |
| Premix1           | 3       |                 |         |
| Total             | 100     |                 |         |

1 The premix provided the following per kilogram of diet: vitamin A 12,000 IU, vitamin D2,500 IU, vitamin E 30 IU, vitamin K 2.0 mg, vitamin B12 0.015 mg, vitamin B1 1.6 mg, vitamin B2 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, 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.
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 E2 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 PGE2 increases with the progression of human atherosclerosis (Rolland et al., 1984). In the experiment, ginger extract significantly decreased the content of plasma PGE2, 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.

Acknowledgments

This study was financially supported by the Earmarked Fund for Hebei layer/broiler Innovation team of Modern Agro-industry Technology Research System (HBCT2018150205).

References

Akbarian A, Golian A, Ahmadi AS, Moravej H. Effects of ginger root (zingiber-officinalis) on egg yolk cholesterol, antioxidant status and performance of laying hens. J Appl Anim Res 2011;39(1):19–21.

Chen Q, Jiang LL, Xiao YX, Liang JS. Effect of dietary ginger powder on antioxidant performance and serum antibody titer of laying hens. China Poult 2013;13:28–31.

Habibi R, Sadeghi GH, Karimi A. Effect of different concentrations of ginger root powder and its essential oil on growth performance, serum metabolites and antioxidant status in broiler chicks under heat stress. Br Poult Sci 2014;55(2):318–327.

Hu XX, Liu X, Chu Y, Chen WX, Zhang KW, Wu H. Antiemetic activity of effective extract and bioactive compounds in ginger. China J Chin Mater Med 2016;41(5):904–9.

Incharoen T, Yamauchi K. Production performance, egg quality and intestinal histology in laying hens fed dietary dried fermented ginger. Int J Poult Sci 2009;8(11):1078–85.

Incharoen T, Yamauchi K, Thongwittaya N. Intestinal villus histological alterations in broilers fed dietary dried fermented ginger. J Anim Physiol Anim Nutr 2010;94(5):c130–7.

Jiang CH, Gao ZR, Guo LK, Zhang LQ, Fan TR, Wang YD, et al. Research progress of prostaglandin E2 in the development of cancer. Prog Physiol Sci 2018;49(1):53–7.

Kawahara K, Hohjoh H, Inazumi T, Tsuchiya S, Sugimoto Y. Prostaglandin E1-induced inflammation: relevance of prostaglandin E receptors. Biochim Biophys Acta 2015;1844:21.

Ma JJ, Feng SL, Gu XH. Discussion on dia phoresis treatment from interior-exterior of “D aqinglong decotion” in Shanghai Lun. Forum Tradit Chin Med 2011;28(4):7–8.

Rolland PH, Jouve R, Pellegrin E, Mercier C, Serradimigni A. Alteration in prostacyclin and prostaglandin E2 production. correlation with changes in human aortic atherosclerotic disease. Arterioscler Thromb Vasc Biol 1984;4:70–8.

Zhang L, Wei W. The relationship between prostaglandin E2 and tumor necrosis factor-α in rheumatoid arthritis and the regulation of drugs. Chin J Clin Pharmacol Therapeut 2011;16(8):95–955.

Zhang GF, Yang ZB, Wang Y, Yang WR, Jiang SZ, Gai CS. Effects of ginger root (zingiber officinalis) processed to different particle sizes on growth performance, antioxidant status, and serum metabolites of broiler chickens. Poult Sci 2009;88(10):159–66.

Zhao X, Yang ZB, Yang WR, Wang Y, Jiang SZ, Zhang GG. Effects of ginger root (zingiber officinalis) on laying performance and antioxidant status of laying hens and on dietary oxidation stability. Poult Sci 2011a;90(8):1720–7.

Zhao X, Yang ZB, Yang WR, Jiang SZ, Zhang GG, Zuo ZY. Effects of ginger powder supplementation on performance and immune function of laying hens. Chin J Anim Nutr 2011b;3:459–65.

Table 4

| Item      | TP, g/L | ALB, g/L | GLB, g/L | LZM, U/mL | PGE2, 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; PGE2 = prostaglandin E2.