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Influence of Fermented Red Ginseng Extract on Broilers and Laying Hens

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ABSTRACT : The aim of this study was to evaluate the potential of fermented red ginseng extract (FRGE) as feed additive in broilers and laying hens. In broilers, 480 Arbor Acre male broilers were randomly allotted to 4 treatments with 6 replications per treatment and 20 chicks per pen. The experiment lasted 5 weeks and dietary treatments were as follows: i) CON, basal diet; ii) FRGE1, basal diet+1 g/kg fermented red ginseng extract; iii) FRGE2, basal diet+2 g/kg fermented red ginseng extract and iv) FRGE3 basal diet+4 g/kg fermented red ginseng extract. Throughout the experiment, no effects were observed ($p>0.05$) in performance in response to FRGE. At the end of the experiment, FRGE administration improved ($p<0.05$) the lymphocyte level compared with CON. The relative weight of bursa of fabricius and spleen were increased ($p<0.05$) by the inclusion of FRGE3. Besides, redness (a*) value for the breast meat was higher ($p<0.05$) in FRGE1 and FRGE3 treatments than that in CON. In laying hens, 240 ISA brown layers at 35 weeks of age were used in this 8-week trial. Dietary treatments were the same as in the broilers trial with 10 replicates per treatment and 6 layers per replicate. During the entire experiment, there were no significant differences ($p>0.05$) in performance or egg quality among all the treatments. However, the layers fed diets supplemented with FRGE had higher lymphocyte level ($p<0.05$) compared with those fed CON. In conclusion, the dietary supplementation with FRGE did not influence performance but improved the lymphocyte level in both broilers and laying hens. (**Key Words :** Broilers, Fermented Red Ginseng Extract, Laying Hens, Performance)

INTRODUCTION

Panax ginseng, which translated from the Greek word panacea means “cure all”, has been used in oriental cultures as a medicine and aphrodisiac for over 5,000 years. When ginseng is steamed at 98-100°C and dried, it is called a red ginseng, which can extend the preserve period. It is widely used in oriental medicine as a remedy for the treatment of various diseases, including anemia, diabetes mellitus, insomnia, gastritis, abnormalities in blood pressure, dyspepsia, overstrain and fatigue and so on. To date, studies from animal experiments have shown that the ginseng reduced blood pressure (Kang et al., 1995), had a relaxing effect on vascular smooth muscle and anti-inflammatory properties as well as anti-stress effect (Peng et al., 1995) and inhibited calmodulin-dependent phosphodiesterase (Sharma and Kalra, 1993). Several researches have well documented that ginseng contains saponins, antioxidants, peptides, polysaccharides, alkaloids, lignans and polyacetylenes. Among these, saponins (ginsenoside) are considered to be the principal bioactive ingredients (Jo et al., 1995; Sticher, 1998; Palazon et al., 2003) and are believed to exert immune-stimulatory, anti-fatigue and hepato-protective physiological effects (Wu and Zhong, 1999).

Besides, it was reported that the fermentation step, apart from being an easy method to preserve raw materials for a short time prior to further processing, could give several advantages (improved flavor, enrichment with desirable metabolites produced by the microorganisms, and enhanced safety), as has been reported for other vegetable products (Buckenhüskes et al., 1990).

To the best of our knowledge, there are no researches about fermented red ginseng extract (FRGE) in poultry. Considering the above benefits, we hypothesize that FRGE may exert positive effects on poultry. Therefore, the objective of this study was to determine the effects of FRGE on broilers and laying hens.

MATERIALS AND METHODS

All animal-based procedures were in accordance with

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the Guidelines for the Care and Use of Experimental Animals of Dankook University.

Preparation of fermented red ginseng

The fermented red ginseng used in this study was provided by SunBio Company (South Korea). Fresh ginseng was steamed at 98-100°C for 4 h and dried for 5 h at 60°C. Then, it was extracted with 60% (v/v) ethanol at 70°C and red ginseng extract was freeze-dried. After that, red ginseng extract was suspended in water, fermented for 5 days by previously cultured *Bifidobacterium* H-1 (10^6 CFU/L) and freeze-dried. Each extract was suspended in water, extracted twice with butanol (1 L) and evaporated to get the fermented red ginseng extract.

Broilers

A total of 480 1-d-old Arbor Acres male broiler chickens with an average initial BW of 43±0.4 g per chick were utilized in this 5-week experiment. The broilers were weighed and randomly placed into 24 floor pens (1 m×1 m) with 20 broilers in each cage, giving 4 treatments with 6 replicate cages per treatment. A 2-phase feeding program was used: a starter diet from day 1 to 21 and a finisher diet from day 22 to 35. All broilers were fed maize-soybean meal-based diets that were formulated to meet or exceed the NRC (1994) nutrient recommendations (Table 1). Treatment additive was included in the diet by replacing the same amount of maize. Dietary treatments included: i) CON, basal diet; ii) FRGE1, basal diet+1 g/kg fermented red ginseng extract; iii) FRGE2, basal diet+2 g/kg fermented red ginseng extract and iv) FRGE3 basal diet+4 g/kg fermented red ginseng extract. Broilers were housed in floor pens covered with clean rice bran or hulls. All cages were in the same room and the temperature was kept at approximately 33°C during the first 3 days and then reduced by 3°C every week until a temperature of 24°C was reached. Artificial light was provided 24 h/d via fluorescent lights. All diets were fed in mash form and feed and water were provided *ad libitum* throughout the experiment.

Sampling and measurements

The broilers were weighed and feed intake (FI) was recorded on day 0, 21 and 35. Body weight gain (BWG), FI and feed conversion ratio (FCR) were then calculated using this information. At the end of the experiment, 30 broilers were randomly obtained from each treatment (5 birds per cage) and 5 ml of blood samples were selected from the wing vein into a sterile syringe and stored at -4°C. Samples for serum analysis were then centrifuged at 3,000×g for 15 minutes and serum was separated. After blood collection, the same broilers were weighed individually and sacrificed by cervical dislocation. The stomach, breast meat, bursa of fabricius, liver, spleen and abdominal fat were removed by trained personnel and weighed. Organ size was expressed as a percentage of BW.

Table 1. Diet composition (as-fed basis) of broiler study

	Starter[1]	Finisher[1]
Ingredients, g/kg		
Maize	556.0	631.1
Soybean meal (CP 48%)	282.5	245.0
Corn gluten meal (CP 60%)	65.0	35.0
Soybean oil	55.0	48.8
Dicalcium phosphate	24.6	22.8
Limestone	8.9	7.5
Salt	2.0	2.0
DL-methionine	1.7	1.7
L-lysine-HCl	2.1	2.1
Vitamin premix[2]	2.0	2.0
Trace mineral premix[3]	2.0	2.0
Analyzed composition		
ME, MJ/kg[4]	13.02	12.82
Crude protein	218.0	189.0
Lysine	11.2	10.4
Met+cys	9.8	9.8
Ca	10.3	9.1
Available P	4.4	3.1

[1] Starter diets, provided during weeks 0-3; finisher diets, provided during weeks 4-5.
[2] Provided per kg of diet: 15,000 IU of vitamin A, 3,750 IU of vitamin D_3, 37.5 mg of vitamin E, 2.55 mg of vitamin K_3, 3 mg of thiamin, 7.5 mg of riboflavin, 4.5 mg of vitamin B_6, 24 μg of vitamin B_{12}, 51 mg of niacin, 1.5 mg of folic acid, 0.2 mg of biotin and 13.5 mg of pantothenic acid.
[3] Provided per kg of diet: 37.5 mg of Zn, 37.5 mg of Mn, 37.5 mg of Fe, 3.75 mg of Cu, 0.83 mg of I, 62.5 mg of S and 0.23 mg of Se.
[4] Calculated value.

The breast meat Hunter lightness (L*), redness (a*) and yellowness (b*) values were measured using a Minolta CR410 chromameter (Konica Minolta Sensing Inc., Osaka, Japan). Duplicate pH values for each sample were measured using a pH meter (Fisher Scientific, Pittsburgh, PA, USA). The water holding capacity (WHC) was measured in accordance with the methods described by Kauffman et al. (1986). Briefly, a 0.3 g sample was pressed at 3,000 g for 3 minutes on a 125-mm-diameter piece of filter paper. The areas of the pressed sample and the expressed moisture were delineated and then determined using a digitizing area-line sensor (MT-10S; M.T. Precision Co. Ltd., Tokyo, Japan). The ratio of water: meat area was then calculated, giving a measure of WHC (a smaller ratio indicates a higher WHC). The weight of each sample was taken before and after cooking to determine cooking loss, which was defined as the cooked weight divided by uncooked weight multiplied by 100. Drip loss was measured using approximately 2 g of meat sample according to the plastic bag method, which was described by Honikel (1998).

Total cholesterol in the serum was analyzed with an

automatic biochemistry blood analyzer (HITACHI 747, Hitachi, Tokyo, Japan). Red blood cell (RBC), white blood cell (WBC) and lymphocyte counts of the whole blood samples were determined using an automatic blood analyzer (ADVIA 120, Bayer, Tarrytown, NY, USA).

Laying hens

A total of 240 ISA brown laying hens (35 weeks of age) were randomly assigned to the same 4 treatments as broilers trial. The experiment lasted 8 weeks and there were 10 replicates for each treatment with 3 adjacent cages (2 hens/cage, 38 cm×50 cm×40 cm) representing a replication. The laying hens were allowed to adjust to the environment for 4 days prior to the start of the experiment, during which they were fed on a basal (CON) diet (Table 2). The house was provided with programmable lighting and ventilation. All diets used in the current study were formulated to meet or exceed the nutrient recommendations of the NRC (1994). Treatment additive was included in the diet by replacing the same amount of maize. All cages were equipped with nipple drinkers and common trough feeders. Experimental feed and water were provided *ad libitum* throughout the experiment.

Sampling and measurement

Daily records of egg production and weekly records of feed consumption were maintained throughout the experiment. Egg production was expressed as an average hen-day production, which was calculated from the total number of eggs divided by the number of days, and summarized on an average basis. A total of 40 salable eggs (no shell defects, cracks, or double-yolks) were collected randomly from each treatment at 17:00 (4 eggs per replicate) on a weekly basis. Eggshell breaking strength was evaluated using an Egg shell force gauge model II (Robotmation Co., Ltd., Japan). Egg shell thickness was measured on the large end, equatorial region and small end respectively using a dial pipe gauge (Ozaki MFG. Co., Ltd., Japan). Finally, the egg weight, egg yolk color and haugh units were evaluated using an egg multi tester (Touhoku Rhythm Co. Ltd., Japan).

At the beginning of the experiment, two birds per replicate were randomly selected and blood samples were collected from the wing vein into a sterile syringe and stored at -4°C. The same birds were bled again at the end of the experiment. Samples for serum analysis were then centrifuged at 3,000 g for 15 minutes and serum was separated. Total cholesterol in the serum was analyzed with an automatic biochemistry blood analyzer (HITACHI 747, Hitachi, Tokyo, Japan). RBC, WBC and lymphocyte counts of the whole blood samples were determined using an automatic blood analyzer (ADVIA 120, Bayer, Tarrytown, NY, USA).

Table 2. Diet composition (as-fed basis) of layer study

Ingredients (g/kg)	
Maize	210.0
Soybean meal (CP 46%)	210.0
Wheat	321.0
Grass meal	20.0
Rapeseed cake	40.0
Cornstarch	60.0
Rapeseed oil	25.0
Limestone	88.0
Tricalcium phosphate (P 18%)	17.0
Salt	3.0
DL-methionine (50%)	1.0
Vitamin-mineral premix[1]	5.0
Analyzed composition	
ME (kcal/kg)[2]	11.45
Crude protein	170.0
Lysine	8.1
Met+cys	6.7
Ca	37.0
Available P	3.7

[1] The premix provided per 1 kg of diet: vitamin A, 10,000 IU; vitamin D_3, 3,000 IU; vitamin E, 50 IU; vitamin K_3, 2 mg; vitamin B_1, 1 mg; vitamin B_2, 4 mg; vitamin B_6, 1.5 mg; vitamin B_{12}, 0.01 mg; Ca pantothenate, 8 mg; niacin, 25 mg; folic acid, 0.5 mg; choline chloride, 250 mg; manganese, 100 mg; zinc, 50 mg; iron, 50 mg; copper, 8 mg; iodine, 0.8 mg; selenium, 0.2 mg; cobalt, 0.2 mg.
[2] Calculated value.

Statistical analysis

Data were statistically analyzed by ANOVA using GLM procedure SAS (1996) for a randomized complete block design in both experiments. Differences among all treatments were separated by Duncan's multiple range tests. The linear and quadratic effects of FRGE among treatments were analyzed using a contrast statement. Mean values and standard error (SE) were reported. Probability values less than 0.05 were considered as significant.

RESULTS

Broilers

Throughout the experiment, there were no differences ($p>0.05$) in BWG, FI or FCR among all the treatments (Table 3). The lymphocyte level in FRGE treatments was improved ($p<0.05$) compared with CON treatment (Table 4). No effects were observed ($p>0.05$) in WBC, RBC or total cholesterol in response to FRGE administration. The relative weight of bursa of fabricius and spleen was increased ($p< 0.05$) by the FRGE3 treatment compared with CON (Table 5). Additionally, no differences in the relative weight of

Table 3. Effect of fermented red ginseng extract supplementation on growth performance in broilers[1]

	CON	FRGE1	FRGE2	FRGE3	SE[2]	p-value[3]	
						Linear	Quadratic
Day 0-21							
BWG (g)	685	684	678	674	15	0.17	0.43
FI (g)	1,011	997	986	973	26	0.26	0.53
FCR	1.48	1.46	1.45	1.44	0.02	0.25	0.62
Day 22-35							
BWG (g)	821	812	811	810	24	0.23	0.51
FI (g)	1,596	1,613	1,622	1,589	31	0.66	0.25
FCR	1.94	1.99	2.00	1.96	0.03	0.67	0.22
Day 0-35							
BWG (g)	1,506	1,496	1,489	1,484	27	0.39	0.48
FI (g)	2,607	2,610	2,608	2,562	37	0.19	0.54
FCR	1.73	1.74	1.75	1.73	0.02	0.73	0.26

[1] CON = Basal diet; FRGE1 = Basal diet+1 g/kg fermented red ginseng extract.
FRGE2 = Basal diet+2 g/kg fermented red ginseng extract and FRGE3 basal diet+4 g/kg fermented red ginseng extract.
[2] Pooled standard error. [3] Linear and quadratic effect of fermented red ginseng.

Table 4. Effect of fermented red ginseng extract supplementation on blood profiles in broilers[1]

	CON	FRGE1	FRGE2	FRGE3	SE[2]	p-value[3]	
						Linear	Quadratic
Total cholesterol (mg/dl)	137	135	132	129	7.51	0.25	0.63
RBC (10^6/dl)	2.07	2.28	2.56	2.68	0.12	0.26	0.49
WBC (10^3/dl)	314	313	318	311	22.21	0.31	0.45
Lymphocyte (%)	71[b]	80[a]	86[a]	88[a]	2.44	0.03	0.15

[1] CON = Basal diet; FRGE1 = Basal diet+1 g/kg fermented red ginseng extract;
FRGE2 = Basal diet+2 g/kg fermented red ginseng extract and FRGE3 basal diet+4 g/kg fermented red ginseng extract.
[2] Pooled standard error. [3] Linear and quadratic effect of fermented red ginseng.
[a, b] Means in the same row with different superscripts differ ($p<0.05$).

Table 5. Effect of fermented red ginseng extract supplementation on relative organ weight in broilers[1]

	CON	FRGE1	FRGE2	FRGE3	SE[2]	p-value[3]	
						Linear	Quadratic
Liver	3.08	3.00	2.91	2.85	0.09	0.21	0.64
Bursa of fabricius	0.12[b]	0.14[ab]	0.15[ab]	0.18[a]	0.01	0.03	0.25
Spleen	0.18[b]	0.20[ab]	0.22[ab]	0.25[a]	0.01	0.02	0.16
Gizzard	1.49	1.48	1.50	1.52	0.32	0.55	0.23
Breast	7.77	7.51	7.80	7.76	0.42	0.46	0.19
Abdominal fat	1.35	1.34	1.32	1.33	0.07	0.37	0.68
Liver	3.08	3.00	2.91	3.04	0.09	0.33	0.25

[1] CON = Basal diet; FRGE1 = Basal diet+1 g/kg fermented red ginseng extract;
FRGE2 = Basal diet+2 g/kg fermented red ginseng extract and FRGE3 basal diet+4 g/kg fermented red ginseng extract.
[2] Pooled standard error. [3] Linear and quadratic effect of fermented red ginseng.
[a, b] Means in the same row with different superscripts differ ($p<0.05$).

Table 6. Effect of fermented red ginseng extract supplementation on meat quality in broilers[1]

	CON	FRGE1	FRGE2	FRGE3	SE[2]	p-value[3]	
						Linear	Quadratic
Meat color							
Lightness (L*)	52.35	51.9	53.12	52.92	1.64	0.67	0.24
Redness (a*)	13.91[b]	14.82[a]	14.29[ab]	14.87[a]	0.19	0.04	0.15
Yellowness (b*)	9.14	9.16	9.15	9.17	0.22	0.54	0.36
Cook loss (%)	20.89	21.02	20.65	21.26	0.21	0.75	0.33
Drip loss (%)	1.23	1.15	1.02	1.18	0.12	0.26	0.41
WHC (%)	65.15	64.25	66.23	65.25	3.65	0.30	0.49
pH	5.95	5.94	5.86	5.89	0.21	0.64	0.35

[1] CON = Basal diet; FRGE1 = Basal diet+1 g/kg fermented red ginseng extract;
FRGE2 = Basal diet+2 g/kg fermented red ginseng extract and FRGE3 basal diet+4 g/kg fermented red ginseng extract.
[2] Pooled standard error. [3] Linear and quadratic effect of fermented red ginseng.
[a, b] Means in the same row with different superscripts differ ($p<0.05$).

liver, gizzard, breast or abdominal fat were observed ($p>0.05$) among treatments. The redness (a*) value for broilers fed FRGE1 and FRGE3 diets was higher ($p<0.05$) than that for broilers fed CON (Table 6). However, no other significant differences were observed among treatments when the other meat quality criteria investigated in the current experiment were evaluated.

Laying hens

No significant effects were observed ($p>0.05$) in egg production, feed intake, egg weight, yolk height, yolk color, haugh unit, egg thickness or egg strength (Tables 7 and 8). FRGE administration improved the lymphocyte level ($p<0.05$) while it had no influence on RBC, WBC or total cholesterol in laying hens (Table 9).

DISCUSSION

It was suggested that ginseng may improve psychological function and immunity and exerts various pharmacological effects (Kiefer and Pantuso, 2003). Therefore, it was expected that beneficial influence was observed in performance. But from the results of this study, no positive effects on performance were observed in broilers or laying hens. However, Jang et al. (2007) reported that fermented wild ginseng culture by-product could increase the egg production which may be attributed to the improvement in healthy status of birds fed diets supplemented with ginseng. This inconsistency may be due to the use of different ginseng sources, methods of preparation of ginseng products and strains used in the experiment. In addition, the supplementation level may be not enough to cause the improvement in performance because positive effects were observed with the addition of at least 10 g/kg wild ginseng adventitious root meal in their study. To the best of our knowledge, there are no other studies about ginseng in livestock and therefore no comparisons could be made here. Nonetheless, there were

Table 7. Effect of fermented red ginseng extract supplementation on egg production in laying hens[1]

	CON	FRGE1	FRGE2	FRGE3	SE[2]	p-value[3]	
						Linear	Quadratic
Egg production (%)							
1 week	88.09	88.16	87.76	88.38	3.02	0.20	0.31
4 week	93.33	94.76	93.29	93.76	3.31	0.36	0.61
8 week	93.38	94.14	95.77	94.81	2.09	0.25	0.13
Feed intake (g/d)							
1 week	119.4	118.2	119.0	120.4	2.01	0.43	0.29
4 week	120.4	119.5	119.1	121.6	2.56	0.54	0.35
8 week	121.3	120.6	119.8	120.9	2.51	0.48	0.32
Egg weight (g)							
1 week	57.77	57.85	58.71	58.42	3.16	0.49	0.21
4 week	57.03	58.33	59.49	58.08	4.99	0.16	0.13
8 week	60.35	61.62	62.34	60.61	3.01	0.23	0.31

[1] CON = Basal diet; FRGE1 = Basal diet+1 g/kg fermented red ginseng extract;
FRGE2, basal diet+2 g/kg fermented red ginseng extract and FRGE3 basal diet+4 g/kg fermented red ginseng extract.
[2] Pooled standard error. [3] Linear and quadratic effect of fermented red ginseng.

Table 8. Effect of fermented red ginseng extract supplementation on egg quality in laying hens[1]

	CON	FRGE1	FRGE2	FRGE3	SE[2]	p-value[3]	
						Linear	Quadratic
Yolk height (mm)							
1 week	8.09	8.09	8.05	8.07	1.40	0.45	0.64
4 week	8.41	8.36	8.45	8.10	1.21	0.10	0.16
8 week	8.43	8.62	8.75	8.49	1.03	0.11	0.29
Yolk color							
1 week	8.17	8.33	8.57	8.87	2.65	0.31	0.43
4 week	8.20	8.67	8.60	8.53	2.04	0.43	0.39
8 week	8.77	9.88	10.00	9.91	1.69	0.23	0.65
Haugh unit							
1 week	91.06	91.08	90.21	91.09	0.95	0.31	0.61
4 week	92.56	90.65	91.81	92.39	1.21	0.43	0.64
8 week	93.28	94.11	93.86	92.36	0.73	0.19	0.73
Egg thickness (10^{-2} mm)							
1 week	38.42	37.13	38.80	39.65	1.09	0.42	0.103
4 week	39.28	37.77	38.73	37.24	1.06	0.60	0.13
8 week	40.91	38.92	40.71	39.19	1.01	0.23	0.16
Egg strength (kg/cm^2)							
1 week	4.97	5.03	5.02	4.96	1.03	0.12	0.64
4 week	4.89	5.01	4.96	5.01	1.06	0.32	0.34
8 week	5.05	5.08	4.99	5.16	1.03	0.26	0.32

[1] CON = Basal diet; FRGE1 = Basal diet+1 g/kg fermented red ginseng extract;
FRGE2 = Basal diet+2 g/kg fermented red ginseng extract and FRGE3 basal diet+4 g/kg fermented red ginseng extract.
[2] Pooled standard error. [3] Linear and quadratic effect of fermented red ginseng.

some researches on saponins (main bioactive compounds in ginseng) in chicks. Jenkins and Atwal (1994) suggested that dietary saponins (3 g/kg) had adverse effects on growth rate and feed intake of chicks due to their bitter taste (Milgate and Roberts, 1995). In contrast, the reduction in feed intake was not observed in the current study. This may be due to the fermentation process and the low supplementation level. Owing to the limited studies on ginseng in livestock, further researches are needed to determine its effects on livestock.

The polysaccharides and saponin (bioactive constituent

Table 9. Effect of fermented red ginseng extract supplementation on blood profiles in laying hens[1]

	CON	FRGE1	FRGE2	FRGE3	SE[2]	p-value[3]	
						Linear	Quadratic
Total cholesterol (mg/dl)							
Initial	181	178	184	179	9.31	0.44	0.31
Final	176	185	179	182	10.10	0.36	0.14
RBC ($\times 10^6$/dl)							
Initial	2.10	1.94	1.88	2.21	0.11	0.78	0.65
Final	2.23	2.07	2.30	2.16	0.14	0.67	0.39
WBC ($\times 10^3$/dl)							
Initial	3.53	3.34	3.41	3.62	0.22	0.21	0.37
Final	3.44	3.68	3.36	3.73	0.31	0.29	0.24
Lymphocyte (%)							
Initial	70.21	71.32	70.81	72.30	3.01	0.36	0.27
Final	71.32^b	79.56^a	78.27^a	82.19^a	3.11	0.03	0.19

[1] CON = Basal diet; FRGE1 = Basal diet+1 g/kg fermented red ginseng extract;
FRGE2 = basal diet+2 g/kg fermented red ginseng extract and FRGE3 basal diet+4 g/kg fermented red ginseng extract.
[2] Pooled standard error. [3] Linear and quadratic effect of fermented red ginseng.
[a, b] Means in the same row with different superscripts differ ($p<0.05$).

of red ginseng) were found to have a positive effect on the immune function, which has great potential for the use of immune modulators (Ilsley et al., 2005). Controlled experiments in farm animals indicated that ginseng had adjuvant effects in stimulating antibody responses to immunization against various pathogens in cattle and pigs (Hu et al., 2003; Rivera et al., 2003). In the herein research, FRGE administration increased the lymphocyte level in both broilers and laying hens which may identify its immune function *in vivo*. Measurement of immune organ weights is a common method for evaluation of immune status in chickens (Heckert et al., 2002). The bursa of fabricius has been suggested to be the primary site of immunoglobulin synthesis (Glick, 1977). The spleen is also considered an essential lymphoid organ that plays an important role in cell-mediated immunity, e.g., its function in the development of suppressor T cells (Welles and Battisto, 1978). In this study, the relative weight of the bursa of farbicius and spleen of broilers in FRGE3 treatment were higher than those in CON, which is in agreement with Dong et al. (2007) who suggested polysavone (main saponin and polysaccharides) supplementation increased the relative spleen weight and bursa weight. Therefore, the improvement of the relative spleen weight and bursa weight could mirror the increase in the lymphocyte level. Several studies observed that dietary ginseng addition decreased the level of blood lipids (Muwalla and Abuirmeileh, 1990; Yokozawa et al., 2004). It was well documented that some saponins form insoluble complexes with cholesterol in the digesta and inhibit the intestinal absorption of endogenous and exogenous cholesterol (Rao and Gurfinkel, 2000). Jang et al. (2007) demonstrated that the total cholesterol was decreased by fermented ginseng culture in laying hens. However, this effect was not confirmed in the study which may be caused by the low supplementation dosage or different saponins sources.

The FRGE supplementation had little effect on breast meat quality in this experiment. Meat color is important because it affects the first impressions of the meat by consumers. Data from the present study indicated that redness (a*) values were increased when chickens were fed diets with FRGE1 and FRGE3.

Considering the data obtained herein, it can be included that the addition of FRGE had no beneficial effects on performance but improved lymphocyte level in broilers and laying hens.

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