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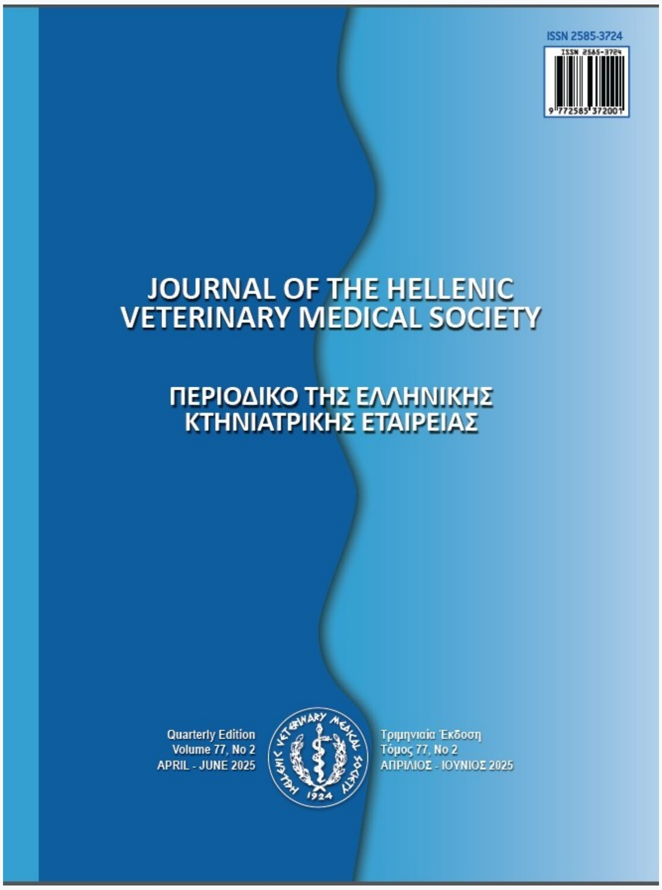

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Effects of panax ginseng root powder supplementations into layer quail diets on egg yield, external and internal quality traits, hatchability and blood parameters

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ABSTRACT: This study uniquely explores the effects of ginseng root powder supplementation in laying quail diets on egg production, egg quality characteristics, hatching performance, and some blood parameters.A total of 144 quails, consisting of 108 females and 36 males, were used. The experiment comprised the control group (YK) and the group with 1% ginseng addition (YG). Each group was divided into threesubgroups, each withsixreplications. At the end of the experiment, it was determined that adding YG did not statistically affect egg production and feed consumption for all weeks and the average of all weeks (P<0.05). The addition of YG was found not to statistically affect the feed conversion ratio except for the seventh week (P<0.05). The effect of adding 1% YG to breeding quail diets on eggshell thickness (mm) did not statistically affect the eggshell thickness for all weeks of the experiment and the average of all weeks (P<0.05). The effect of adding 1% YG to the diets of the experimental groups on shell ratio (%) was found to be statistically insignificant except for the sixth week and the average of all weeks (P<0.05). No differences were detected between the treatment groups regarding hatchability, hatching power, fertility rate, hatching live weight, and first-week live weight in the initial eggs of the quails used in the experiment.Our findings suggest that Panax ginseng root powder added to laying quail diets may improve some performance and egg quality parameters. However, further advanced studies are needed to understand the full potential of ginseng as a feed additive.

Keyword: Quail; Ginseng; Egg; Hatchability; Blood parameters.

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INTRODUCTION

The widespread practice of intensive production in poultry farming encourages the development of related sectors, especially the feed industry. Feed additives are effectively used in the poultry sector to increase animal productivity or improve product quality. The ban on commonly used antibiotics and the restriction of certain synthetic feed additives due to consumer concerns and food safety issues have led to a search for new feed additives, aiming to ensure faster and more economical development while prioritizing animal welfare (Ulger et al., 2017a; Ekizoğlu et al., 2020; Ulger et al., 2020; Ayaşan et al.,2021; Ay et al., 2023; Ulger et al., 2023; Ülger & Mahmood., 2023). These feed additives should be natural, free from harmful compounds that could transfer to products, and should not have toxic effects on animals. They should increase productivity or improve product quality when used in trace amounts, thereby reducing costs and increasing profitability (Ulger et al.,2017b;Ulger, 2019).

Ginseng (Panax ginseng), which can be used as a new feed additive, is a plant from the ivy family. Its Latin name, "Panax," is derived from the Greek word "panacea," meaning "complete healing." Ginseng has been used in China, Korea, and Japan for about 2000 years and is considered the most beneficial plant in the Far East due to its positive effects on health. Recently, its use has spread worldwide. Ginseng is a plant species belonging to the Araliaceae family. Panax Ginseng has a different structure from other ginsengs; while other ginsengs contain 8-9 types of ginsenosides, Panax ginseng comprises 22. Panax ginseng has been used in the Far East for many years to increase disease resistance (Helms, 2004; Shin et al., 2006; Shi et al., 2007).

Panax ginseng, native to South Korea, is assumed to be the most effective adaptogen (an agent that increases stress resistance) among all plants. It is reported that ginseng corrects the adverse effects of stress in animals subjected to various forms of stress and regulates blood pressure and blood glucose levels (Kang et al., 2009). It is also argued to be beneficial due to its antioxidant properties, cholesterol-lowering effects, and ability to increase physical activities and body resistance. A Chinese text from the 1st century AD described ginseng as a plant that strengthens the mind and increases wisdom and knowledge.

Research shows that ginseng stimulates protein, nucleic acid, carbohydrate, and fat metabolism, accelerates the burning of toxic substances produced by the body or taken from outside, speeds up their elimination from the body, and thus facilitates the regeneration of liver cells (Song et al., 2004;Kallon & Abdullahi.,2015;Ganguly et al.,2023). Ginseng is a plant known for its effects on the reproductive system and its aphrodisiac properties. It is known to have aphrodisiac effects as it increases reproductive cells and helps develop blood vessels. It is widely used due to its ability to increase the secretion of the male hormone testosterone and its effect on memory centers in women's brains.

This study was conducted to determine the effects of Panax ginseng root powder supplementation on egg production, egg quality characteristics, incubation performance, and some blood parameters in laying quail.

MATERIALS AND METHODS

Animals were handled following the guidelines of the local ethics committee. Ethics committee permission was obtained from the animal experiments ethics committee with the decision numbered 06, 17/064, dated 14.06.2017. The quail (Coturnix Coturnix Japonica) used in the current experiments was obtained from chicks raised in the quail unit of faculty. First, incubation work was done, and the chicks obtained were raised for trials. Afterward, 144 adult quail (108 female and 36 male) were included in the trials. In case of difficulties during the experiment, 14 female and 14 male quail were housed in separate cages as spares.

The chicks used in trials were given chick-rearing feed for the first five weeks and peak laying hen feed after five weeks. Commercial feed mix obtained from a private feed factory operating in the region was used as feed material. Ginseng root powder was supplemented into the diets of treatment groups. Panax ginseng root powder was obtained from a commercial company. Raw nutrient analysis (AOAC, 1990)results of commercial feed mix and ginseng root powder used in present experiments are provided in Table 1.

Experiments were carried out in the Poultry Research and Experimental Unit of the Animal Science Department. Artificial lighting was provided with fluorescent lamps. The experiments provided 16 hours of light and 8 hours of dark periods. They were carried out in five-story layer cages made of hard plasticwith threesections on each story, each

Table 1. Nutrient analysis results of commercial feed mix and ginseng root powder

Composition	Commercial feed mix	Panax ginseng root powder
Dry matter (DM), %	94.50	95
Crude protein, % DM	19.30	0.30
Crude ash, % DM	13.50	0.10
Crude oil, % DM	5.40	0.30

consisting of 30 cm cages and an automatic nipple waterer system. Male animals were housed in five-story stainless steel cages with five compartments on each story, with an individual automatic watering system.

Incubators consisted of two machines: pre-development and hatching. The pre-development machine is used for a 15-day development period at 37.6^{0}C and humidity between 60-70%. Eggs are placed in pans and automatically turn up and down at450 anglesevery two hours. Following the 15-day pre-development period, eggs were checked for fertility under light, and fertile ones were taken into a hatching machine at 36.7 ^{0}C and humidity between 60-70%. Ventilation holes are open to remove gases formed in the machine and to supply oxygen inside. No turning action is required in this section. Temperature and humidity are adjusted automatically in both machines. Temperature and humidity values of the machines were monitored regularly. When the hatchings were completed, unhatched eggs were broken, and the reasons were investigated.

$$\text{Hatchability} = \frac{\text{Number of hatched alive chicks}}{\text{Number of eggs placed for hatching}} * 100$$

$$\text{Hatching power} = \frac{\text{Number of hatched alive chicks}}{\text{Number of fertile eggs placed for hatching}} * 100$$

$$\text{Fertility rate} = \frac{\text{Number of fertile eggs}}{\text{Number of eggs placed for hatching}} * 100$$

The hatching weight of chicks was recorded daily, and they were taken into chick-rearing cages based on treatment groups. Plastic mats were placed inside the cages, and feeders and waterers were also placed. Heaters and lamps were operated and checked regularly. Chicks were housed in this section for two weeks, and weekly live weight gains were calculated.

At the end of the fourth week, the quail were separated into male and female. Distinctive features of males and females become evident after the second and third weeks. Males have brown-red feathers, while females have gray feathers with black spots. Animals were weighed and taken into cages to have equal weights. Individual mating was applied in the experiment. In the individual mating method, one male is mated with a certain number of females kept in groups. Quails with individual mating were grouped based on three male/female ratios: 1/2, 1/3, and 1/4. The number of animals in each group was determined.

Experiment 1 comprises the Control Group (C) and the 1% Ginseng Added Group (G). Each group was planned to have three sub-groups and six repetitions for each sub-group. Eggs were collected during the first three weeks of the experiment and analyzed for egg quality traits. In the four thweek, collected eggs were placed into the incubator for hatching performance. In total, six egg analyses and three incubation experiments were carried out. The entire trial lasted nine weeks.

Feeds remaining on sub-group feeders were removed weekly. The average feed consumption was determined as the difference between the amount of feed given and the amount of feed remaining on feeders. Daily average feed consumption per animal was obtained by dividing weekly feed consumption by the number of days and then the number of animals in that group. Feeders were refilled with specified feed quantities.

$$\text{Feed Consumption}\left(\frac{g}{day}\right) = \frac{\text{Weekly Feed Consumption (g)}}{\text{Number of Days} * \text{Number of Animals}}$$

The feed conversion ratio was calculated with the use of the following equation:

$$\text{Feed Conversion Ratio} = \frac{\text{Feed Consumption (g)}}{\text{Egg Weight (g)}}$$

Eggs were collected at the same time daily, and the number of eggs was recorded. Egg yield was determined as a percentage by dividing the number of eggs collected weekly for each group by the total number of quail.

$$\text{Egg Yield (\%)} = \frac{\text{Total Number of Eggs}}{\text{Total Number of Quail}} * 100$$

Egg weight, shell weight, shell thickness, shell ratio, yolk ratio, and albumen ratio of the eggs collected were determined at the Animal Nutrition Laboratory of Erciyes University Agricultural Faculty. Using resultant data, shape index, shell surface area, shell weight per unit surface area, and egg density were calculated. Eggs collected from each group were weighed separately. Eggs were broken and kept at room temperature for a day. Dried eggshells were weighed using a precise scale (±0.01 g).Eggs were broken, dried, and weighed. Then, the eggshell thickness was measured from blunt, mid, and pointed sections of the egg, and an average of three measurements were taken. The eggs were broken, and yolk and shell weights were determined. Then, resultant values were subtracted from egg weight to get albumen weight. The albumen ratio was calculated using the following equation:

$$\text{Albumen Ratio (\%)} = \frac{\text{Albumen Weight (g)}}{\text{Egg Weight (g)}} * 100$$

The yolks were separated into a plate and weighed using a precise scale. The yolk ratio was calculated with the use of the following equation:

$$\text{Yolk Ratio (\%)} = \frac{\text{Yolk Weight (g)}}{\text{Egg Weight (g)}} * 100$$

The following equations were calculated using data from egg quality traits, shape index, shell surface area, shell weight per unit surface area (SWPUSA), and egg density:

$$\text{Spahe Index (\%)} = \frac{\text{Egg Width}}{\text{Egg Length}} * 100$$

$$Shell\ Surface\ Area\ (cm2) = 3{,}9782 * (Egg\ Weight)\ \hat{}\ 0{,}7056$$

$$\text{SWPUSA} \left(\frac{\text{mg}}{\text{cm2}}\right) = \frac{\text{Shell Weight} * 1000}{\text{Shell Surface Area}}$$

$$Egg\ Density \left(\frac{g}{cm3}\right) = \frac{\text{Shell Weight}}{\text{Shell Thickness} * \text{Shell Surface Area}}$$

At the end of the experiment, six animals were randomly selected from each subgroup, and blood samples were taken into sample tubes. Tubes were centrifuged at 3000 rpm for 10 minutes, and serum collected in the upper part was transferred into 2 ml Eppendorf tubes. Blood serums were stored in a deep freezer at -80°C until the time of analysis. With the use of commercial kits, blood serums were analyzed for Triglyceride (TG, mg/dl), Glucose (mg/dl), Total Cholesterol (mg/dl), HDL-Cholesterol (HDL-C, mg/dl), and LDL-Cholesterol (HDL-C).

Experimental data were subjected to a One-Way Analysis of Variance using SPSS (2007) software. Significant differences in treatment means were compared using Duncan's Multiple Comparison Test at a significance level of 5%.

RESULTS

In this study, effects of 1% Panax Ginseng (G) supplementation into quail diets on performance parameters (egg yield (the number of eggs and %, egg weight, daily feed consumption, and feed conversion ratio), egg external quality traits (egg shape index, egg surface area, surface area per unit area, shell weight, shell thickness, shell ratio, egg width and egg length), egg internal quality traits (albumen ratio, yolk ratio), blood serum parameters (cholesterol, glucose, total protein, triglyceride) and hatchability characteristics (fertile egg ratio, hatchability, embryo mortality rate, hatching weight and first-week live weight) were determined. Effects of ginseng supplementations in quail diets on performance parameters (egg yield, egg weight, daily feed consumption, and feed conversion ratio) are provided in Table 2.

Panax ginseng supplementations into quail diets did not significantly affect egg yields of the weeks and egg yields in general (p >0,05). The highest egg yield was seen in the third week of ginseng treatments (6,57 eggs and 93,86%) and the lowest in the second week (5,92 eggs and 84,52%). Ginseng supplementations also did not significantly affect-weight (p >0,05). The most significant egg weight was observed in the firs tweek of control treatments (12,85 g) and the lowest in the seventh week (11,90 g). Ginseng supplementations did not affect feed consumption significantly (p>0,05). The highest feed consumption was seen in the second week of control treatments (38,99 g) and the lowest in the sixth week

Table 2. Effects of ginseng supplementations on performance parameters

	2nd week	3rd week	4th week	6th week	7th week	8th week	General
				Egg Yield (eggs)			
G	5.92	6.57	6.09	6.02	6.29	6.28	6.16
C	6.20	6.55	6.20	6.32	6.17	6.31	6.26
SEM	0.134	0.088	0.178	0.150	0.134	0.137	0.070
P	0.139	0.864	0.678	0.160	0.543	0.903	0.280
				Egg Yield (%)			
G	84.52	93.86	87.06	85.99	89.68	89.76	87.94
C	88.53	93.57	88.49	90.32	88.10	90.12	89.46
SEM	1.920	1.255	2.537	2.139	1.921	1.955	1.001
P	0.138	0.866	0.681	0.161	0.544	0.901	0.278
				Egg Weight (g)			
G	12.70	12.76	12.56	12.57	12.50	12.66	12.67
C	12.85	12.69	12.63	12.69	11.90	12.72	12.57
SEM	0.186	0.172	0.186	0.191	0.265	0.226	0.138
P	0.558	0.773	0.778	0.648	0.105	0.868	0.567
				Daily Feed Consumption (g/day)			
G	38.76	38.10	37.13	32.21	35.92	36.36	36.44
C	38.99	37.33	37.04	32.31	38.69	36.11	36.70
SEM	0.851	1.061	1.126	1.466	1.003	0.627	0.500
P	0.845	0.599	0.952	0.959	0.056	0.785	0.708
				Feed Conversion Ratio			
G	3.06	2.99	2.97	2.58	2.90	2.89	2.89
C	3.04	2.95	2.94	2.56	3.22	2.85	2.92
SEM	0.062	0.075	0.098	0.136	0.110	0.078	0.049
P	0.775	0.702	0.828	0.886	0.042	0.738	0.579

G: Ginseng, C: Control group, SEM: Standard Error of Mean, P: Probability

of ginseng treatments. Besides the seventh week of the experiments, ginseng supplementations did not significantly affect feed conversion ratios and feed conversion ratios of the weeks (p>0,05). The lowest feed conversion ratio was seen in the seventh week of ginseng treatments (2,90 g).Effects of Panax ginseng supplementations into quail diets on egg external quality traits (shape index, surface area, shell weight per unit area, shell thickness, shell ratio, egg width, and egg length) are given in Table 3.

Besides the sixth week, ginseng supplementations significantly affected the shape index in general and the shape index of the weeks (p<0,05). The most significant shape index was seen in the seventh week of ginseng treatments (80.66%) and the lowest in the eighth week of control treatments (78.88%). Except for the sixt hand seventh weeks and general means, ginseng treatments did not have significant effects on egg surface area (p >0.05). The greatest egg surface area was seen in the eighth week of control treatments (24.07 cm^2) and the lowest in the seventh week of ginseng treatments (22.60 cm^2). Except for the sixth week, ginseng treatments did not have any significant effects on shell weight per unit area (p>0.05). The most significant shell weight per unit area was seen in the sixth week of control treatments (0.0468 mg/cm^2) and the lowest in the sixth week of ginseng treatments (0.0453 mg/cm^2).

Effects of Panax ginseng supplementations into quail diets on shell thickness were not found to be significant (p>0.05). The greatest shell thickness values were seen in the third week of ginseng and control treatments, and the lowest was measured in the sixth week of control treatments (0.200 mm). Ex-

Table 3. Effects of ginseng supplementations on egg external quality traits

	2nd week	3rd week	4th week	6th week	7th week	8th week	General
				Shape Index			
G	79.53	80.14	80.00	79.79	80.66	79.70	79.94
C	79.17	79.52	79.23	79.51	78.92	78.88	79.17
SEM	0.235	0.243	0.228	0.243	0.306	0.249	0.137
P	*0.025*	0.017	0.003	0.189	0.000	0.005	0.000
				Surface Area			
G	24.01	24.02	23.62	23.51	22.60	23.77	23.63
C	23.91	23.82	23.80	23.09	23.97	24.07	23.83
SEM	0.126	0.131	0.130	0.141	0.176	0.145	0.078
P	0.851	0.276	0.101	*0.032*	*0.000*	0.133	*0.027*
				Shell Weight per Unit Area			
G	0.0465	0.0456	0.0461	0.0453	0.0459	0.0456	0.0392
C	0.0467	0.0462	0.0464	0.0468	0.0461	0.0465	0.0409
SEM	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P	0.370	0.076	0.496	*0.010*	0.254	0.070	*0.000*
				Shell Thickness			
G	0.219	0.223	0.204	0.196	0.221	0.204	0.211
C	0.220	0.223	0.208	0.200	0.218	0.206	0.213
SEM	0.002	0.002	0.001	0.002	0.002	0.002	0.001
P	0.320	0.867	0.047	0.384	0.453	0.485	0.087
				Shell Ratio			
G	8.73	8.57	8.75	8.61	8.81	8.60	8.65
C	8.87	8.70	8.76	8.94	8.68	8.74	8.77
SEM	0.065	0.064	0.065	0.070	0.084	0.062	0.037
P	0.092	0.064	0.942	0.002	0.740	0.155	0.005
				Egg Width			
G	26.40	26.42	26.15	26.16	25.69	26.40	26.24
C	26.30	26.31	26.22	25.91	26.40	26.32	26.25
SEM	0.064	0.068	0.068	0.070	0.134	0.090	0.040
P	0.393	0.135	0.285	*0.006*	*0.000*	0.595	0.938
				Egg Length (mm)			
G	33.23	33.00	32.72	32.82	31.89	32.93	32.86
C	33.27	33.06	33.13	32.63	33.40	33.57	33.21
SEM	0.119	0.133	0.125	0.136	0.180	0.206	0.077
P	0.211	0.559	*0.003*	0.427	*0.000*	0.015	*0.000*

G: Ginseng, C: Control group, SEM: Standard Error of Mean, p: Probability

cept for the sixth week and general means, ginseng treatments did not have significant effects on shell ratios (p>0.05). The greatest shell ratio was seen in the sixth week of control treatments (8.94%) and the lowest in the third week of ginseng treatments (8.57%). For the sixth and seventh weeks, ginseng treatments had no significant effects on egg widths (p>0.05). The highest egg width was observed in the third week of ginseng treatments (26.42 mm) and the lowest in the seventh week (25.69 mm).

Except for the second, third,and sixth weeks of the experiments, ginseng treatments did not have any significant effects on egg lengths (p>0.05). The highest egg length was observed in the eighth week of control treatments (33.57 mm) and the lowest in the seventh week of ginseng treatments (31.89 mm).

The effects of Panax ginseng supplementations inquail diets on egg internal quality traits (albumen ratio and yolk ratio) are provided in Table 4.

Besides the seventh week and general means, ginseng supplementations into quail diets did not significantly affect egg albumen ratios (p>0.05). The greatest albumen ratio was seen in the third week of ginseng treatments (61.27%) and the lowest in the eighth week of control treatments (58.96%). Again, except for the seventh week of the experiments, ginseng treatments did not significantly affect egg yolk ratios (p>0.05). The greatest yolk ratio was observed in the eighth week of control treatments (32.34%) and the lowest in the sixth week (30.58%).

Hatchability trials were conducted three times:-first, with the eggs obtained at the beginning of the experiments; second, with the eggs obtained in the middle of the experiments; and third, with the eggs obtained at the end. Effects of Panax ginseng supplementations into quail diets on hatchability characteristics (fertile egg ratio, hatchability, embryo mortality rate, hatching weight, and first-week live weight) are provided in Table 5.

In all three trials, differences in hatchability, hatching power, fertility ratio, hatching live weight, and first-week live weights of the treatment groups were not found to be significant (p>0.05). In the first trials, the greatest hatchability was seen in group H (91.7%) and the lowest in group I (51.4%); the greatest hatching power in group E (100%) and the lowest in group I (73.1%); the highest fertility ratio in groups A and H (100%) and the lowest in group B (63.0%); the greatest hatching live weight in group I (8.9 g) and the lowest in group A (8.1 g); the greatest first-week live weight in group B (22.0 g) and the lowest in group K (16.5 g).

In the second trial, the greatest hatchability was seen in groups A, C, and G (100.0%) and the lowest in group I (66.7%); the greatest hatching power in groups A, C, and G (100%) and the lowest in group I (66.7%); the highest fertility ratio in group F (100%) and the lowest in group I (34.6%); the greatest hatching live weight in group B (9.6 g) and the lowest in group G (8.2 g); the greatest first-week live weight in group B (17.5 g) and the lowest in group K (12.6 g).

In the third trial, the greatest hatchability was seen in group H (76.9%) and the lowest in group E (40.0%); the greatest hatching power in groups C, E, G, H, I, and L (100%) and the lowest in group D (73.7%); the highest fertility ratio in group H (76.9%) and the lowest in group E (40.0%); the greatest hatching live weight in group I (9.6 g) and the lowest in group E (7.6 g); the greatest 1st-week live weight in group H (24.3 g) and the lowest in group J (19.0 g).

The effects of Panax ginseng supplementations in quail diets on embryonic mortality rates are provided in Table 6. Ginseng supplementations did not significantly affect embryonic mortality rates (p>0.05).

In the first trials, the highest early embryonic mortality rate was seen in group B (11.8%) and the

Table 4. Effects of ginseng supplementations on egg external quality traits

	2nd week	3rd week	4th week	6th week	7th week	8th week	General
				Albumen Ratio			
G	60.55	61.27	60.59	60.79	60.64	59.56	61.15
C	60.31	60.10	60.76	60.56	59.74	58.96	60.39
SEM	0.412	0.435	0.430	0.327	0.216	0.199	0.207
P	0.716	0.071	0.996	0.652	*0.006*	0.059	*0.011*
				Yolk Ratio			
G	31.26	31.12	31.17	30.99	30.60	32.03	31.14
C	31.33	31.46	31.45	30.58	31.54	32.34	31.50
SEM	0.169	0.164	0.174	0.224	0.229	0.182	0.100
P	0.669	0.374	0.481	0.150	*0.016*	0.304	0.138

G: Ginseng, C: Control group, SEM: Standard Error of Mean, p: Probability

Table 5. Effects of Panax ginseng supplementations on hatchability characteristics

Groups	Gender		Hatchability (%)	Hatching Power (%)	Fertility Ratio (%)	Hatching LW (g)	1st week LW (g)
	Male	Female					
			1st Trials				
A	G	2G	86.4	86.4	100.0	8.1	18.1
B	G	2C	55.6	88.2	63.0	8.8	22.0
C	G	3G	84.9	96.6	87.9	8.4	18.3
D	G	3C	61.9	92.9	66.7	8.9	19.9
E	G	4G	74.4	100.0	74.4	8.7	18.3
F	G	4C	74.6	82.0	90.9	8.6	18.0
G	C	2G	82.1	95.8	85.7	8.2	17.8
H	C	2C	91.7	91.7	100.0	8.8	19.7
I	C	3G	51.4	73.1	72.2	9.2	21.4
J	C	3C	84.6	89.2	94.9	8.8	18.4
K	C	4G	67.9	85.7	79.2	8.5	16.5
L	C	4C	66.1	78.7	83.9	8.2	18.9
			2nd Trials				
A	G	2G	100.0	100.0	94.1	8.7	14.5
B	G	2C	93.3	93.3	88.2	9.6	17.5
C	G	3G	100.0	100.0	80.0	8.8	14.1
D	G	3C	90.5	90.5	75.0	8.4	14.2
E	G	4G	93.5	93.5	88.6	8.7	13.0
F	G	4C	90.0	90.0	100.0	8.3	12.6
G	C	2G	100.0	100.0	85.0	8.2	14.3
H	C	2C	95.0	95.0	95.2	9.1	13.9
I	C	3G	66.7	66.7	34.6	9.2	14.5
J	C	3C	88.9	88.9	84.4	8.9	13.8
K	C	4G	88.9	88.9	87.1	8.5	12.8
L	C	4C	92.9	92.9	87.5	8.3	13.1
			3rd Trials				
A	G	2G	50.0	80.0	62.5	8.4	23.7
B	G	2C	58.3	77.8	75.0	8.7	21.7
C	G	3G	65.2	100.0	65.2	8.3	20.7
D	G	3C	51.9	73.7	70.4	8.7	21.2
E	G	4G	40.0	100.0	40.0	7.6	21.7
F	G	4C	70.6	94.7	74.5	8.9	19.7
G	C	2G	73.7	100.0	73.7	8.4	19.9
H	C	2C	76.9	100.0	76.9	8.4	24.3
I	C	3G	66.7	100.0	66.7	9.6	22.3
J	C	3C	76.0	100.0	76.0	9.0	19.0
K	C	4G	48.6	94.7	51.4	8.5	22.8
L	C	4C	50.0	100.0	50.0	8.7	20.5

C: Control, G: Ginseng, LW: Live Weight.

Table 6. Effects of ginseng supplementations on embryonic mortality rates

	Gender		1st Trials			2nd Trials			3rd Trials		
Groups	**Male**	**Female**	**EEM**	**MEM**	**LEM**	**EEM**	**MEM**	**LEM**	**EEM**	**MEM**	**LEM**
A	**G**	**2G**	0.0	4.5	0.0	0.0	0.0	0.0	0.0	10.0	10.0
B	**G**	**2C**	11.8	0.0	0.0	0.0	0.0	6.7	0.0	5.6	5.6
C	**G**	**3G**	3.4	3.4	0.0	0.0	0.0	0.0	0.0	0.0	6.7
D	**G**	**3C**	7.1	0.0	3.6	0.0	4.8	4.8	5.3	0.0	10.5
E	**G**	**4G**	0.0	3.4	3.4	3.2	0.0	3.2	0.0	0.0	0.0
F	**G**	**4C**	2.0	4.0	2.0	2.5	0.0	5.0	0.0	0.0	0.0
G	**C**	**2G**	8.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H	**C**	**2C**	0.0	4.2	4.2	5.0	0.0	0.0	0.0	0.0	0.0
I	**C**	**3G**	11.5	0.0	11.5	22.2	0.0	11.1	0.0	0.0	0.0
J	**C**	**3C**	5.4	5.4	0.0	3.7	0.0	7.4	0.0	0.0	0.0
K	**C**	**4G**	2.4	4.8	4.8	7.4	0.0	3.7	0.0	10.5	0.0
L	**C**	**4C**	6.4	0.0	4.3	0.0	0.0	7.1	0.0	0.0	18.2

EEM: Early Embryonic Mortality, **MEM**: Mid-term Embryonic Mortality, **LEM**: Late Embryonic Mortality, **C**: Control, **G**: Ginseng.

lowest in groups A, E, and H (0.0%); the highest mid-term embryonic mortality rate in group J (5.4% and the lowest in groups B, D, G, I and L (0.0%); the highest late embryonic mortality rate in group I (11.5%) and the lowest in groups A, B, C, G, J and I (0.0%). In the second trials, the highest early embryonic mortality rate was seen in group I (22.2%) and the lowest in groups A, B, C, D, G and L (0.0%); the highest mid-term embryonic mortality rate in group D (4.8%) and the lowest in the other groups (0.0%); the highest late embryonic mortality rate in group I (11.1%) and the lowest in groups A, C, G and H (0.0%). In the third trial, the highest early embryonic mortality rate was seen in group D (5.3%) and the lowest in the other groups (0.0%); the highest mid-term embryonic mortality rate in group K (10.5%) and the lowest in the other groups A and B (0.0%); the highest late embryonic mortality rate in group L (18.2%) and the lowest in groups E, F, G, H, I, J and K (0.0%).

The effects of Panax ginseng supplementations into quail diets on blood serum parameters are provided in Table 7. Ginseng supplementations did not significantly affect blood cholesterol, glucose, total protein, and triglyceride levels (p>0.05).

DISCUSSION

This study focused on the effects of adding Panax ginseng root powder to laying quail diets on characteristics such as egg production, egg quality traits, egg fertility rate, hatchability performance, and serum biochemistry parameters.

The addition of Panax ginseng root powder to

Table 7. Effects of ginseng supplementations on blood serum parameters

	Blood Serum Parameters			
Treatments	**Cholesterol (mg/dl)**	**Glucose (mg/dl)**	**Total Protein (g/dl)**	**Triglyceride (mg/dl)**
Ginseng (G)	220.78	296.82	1.71	244.21
Control (C)	232.87	307.90	1.64	234.42
SEM	10.542	5.827	0.041	29.068
P	0.445	0.324	0.096	0.843

SEM: Standard Error of Mean, **p**: Probability level.

the diet did not have a significant effect on egg production. When examining the results among groups created by different stocking densities and different interactions, no statistically significant differences were found between groups in terms of egg production for all weeks and weekly averages. Ao et al. (2011) reported that fermented red ginseng extract added to laying hen diets did not affect egg production. Yıldırım et al. (2013) found that adding Panax ginseng to the diet did not affect chicken egg production. Kim et al. (2015) determined that red ginseng extract added to laying hen diets did not influence egg production.

These findings are consistent with the current research. However, it has been reported that Panax ginseng root extract added to Japanese quail diets increased egg production (Osfor, 1995; Özcan, 2016). Jang et al. (2007) reported that adding fermented wild ginseng by-productsto laying hen diets at 2.5% and 5% increased egg weight and production. Kim et al. (2002) reported that in their study, where they added 5% Panax ginseng leaves to domestic broiler diets, there were no differences between treatments regarding live weight, feed consumption, feed conversion ratio, carcass weight, and carcass yield.

The reasons for differences among studies may be primarily due to variations in Panax ginseng levels or the origins, processing procedures, and compositions of herbal products, as well as animal species, age, and environmental factors (Windisch et al., 2008; Ao et al., 2011). In the study, feed as the main factor did not significantly affect egg weight for all weeks of the trial and the overall average of weeks. When examining the results between groups formed by different stocking densities and various interactions, no statistically significant differences were found in egg weight between groups for all weeks and the average of weeks. Adding 1% wild ginseng (WG) to breeder quail rations did not statistically affect egg mass for all weeks of the trial and the overall average of weeks. The results were similar to those of other studies (Choi et al., 2015; Ao et al., 2011; Kang, 2016; Kim et al., 2015; Yıldırım et al., 2013).

Some studies have reported that adding different ratios of Panax ginseng to Japanese quail feed increased egg weight (Osfor, 1995;Özcan, 2016). Similarly, Jang et al. (2007) reported that adding 2.5% and 5% fermented wild ginseng extract to laying hen rations increased egg weight. The effect of ginseng addition on feed consumption in laying quails was not statistically significant for all weeks of the trial and the overall average of weeks. When examining the results between groups formed by different stocking densities and various interactions, no statistically significant differences were found in daily feed consumption between groups for all weeks and the average of weeks.

When examining the effect of adding 1% YG to breeder quail rations on feed conversion ratio (g), it was found to be statistically insignificant for all weeks and the average of weeks, except for the seventh week of the experiment. The findings of this study are consistent with those reported in studies investigating various ginseng products, which indicate no positive effects on feed conversion ratio in laying hens fed with various levels of commercial Panax ginseng (Catalan, 2011) and Panax ginseng root extract (Yıldırım et al., 2013).

A study conducted on Japanese quails reported that Panax ginseng powder extract improved the feed conversion ratio (Osfor, 1995). Jenkins and Atwal (1994) suggested that saponins found in ginseng structure negatively affect the growth performance and feed intake of poultry due to their bitter taste. The effect of ginseng addition was statistically significant for all weeks and the overall average of weeks, except for the sixth week. When examining the groups formed by interactions, it was found to be statistically significant for all weeks and the overall average of weeks in terms of shape index, except for the third, fourth, and seventh weeks. The shape index of eggs obtained from treatment groups was greater than 76%, thus falling into the normal shape index category. The values reported by Yıldırım et al. (2013) for the shape index of laying hens fed with Panax ginseng root extract added to their feed (76.17-77.36) were similar to the findings of this study.

Kang et al. (2016) reported that adding red ginseng by-product to laying hen feed did not affect eggshell strength, thickness, egg yolk color, or shape index. A study by Ao et al. (2011) reported that red ginseng extract did not affect egg quality characteristics. However, Jang et al. (2007) reported that additional red ginseng could improve egg quality compared to the control group. The effect of adding 1% YG to breeder quail rations on egg surface area was found to be statistically insignificant except for the sixth, seventh, and overall average of weeks. In the study, the effect of adding 1% YG to quail rations on shell weight per unit area (mg/cm2) was insignificant for all weeks and the overall average of weeks, except for the sixth week. When examining the results between groups created by different stocking densities, all weeks and the average weeks were statistically insignificant regarding BAKA. When examining the statistical significance between groups formed by different interactions, BAKA was statistically significant for all weeks and the overall average of weeks, except for the second week.

The effect of adding 1% YG to breeder quail rations on eggshell thickness (mm) did not statistically affect the eggshell thickness for all weeks of the experiment and the overall average of weeks. The effect of adding 1% YG to the rations of experimental groups on shell ratio (%) was found to be statistically insignificant except for the sixth week and the overall average of weeks. When examining the significance between groups formed by different interactions, all weeks and the overall average of weeks were statistically significant, except for the second and fourth weeks.

The effect of adding 1% YG to the rations of quails used in the experiment on egg width (mm) was insignificant for all weeks and the overall average of weeks, except for the sixth and seventh weeks. When examining the results between groups created by different stocking densities, all weeks were statistically insignificant regarding egg width, except for the fourth, sixth, and overall average of weeks.

The effect of adding 1% YG to breeder quail rations on egg length (mm) statistically affected egg weight ($P<0.05$) except for the 2nd, third, and sixth weeks of the experiment. When examining the results between groups created by different stocking densities, all weeks and the average weeks were statistically significant regarding egg length, except for the second, third, and sixth weeks. When examining the significance between groups formed by different interactions, the effect on egg length was significant except for the third, seventh, and sixth weeks.

Our current results are consistent with studies reporting that the addition of different ginseng extracts to laying hen rations had no significant effect on eggshell weight, shell thickness, and shell ratio (Jang et al., 2007; Catalan, 2011; Ao et al., 2011; Yan et al., 2011; Yıldırım et al., 2013; Şen Mutlu, M. I., 2014).

Although genetic factors play an essential role in the formation of shell structure, calcium, phosphorus, manganese, and vitamin D levels in the feed, the age of the animal, care and feeding conditions, disease, season, and other environmental conditions also affect shell quality (Stadelman, 1995; Şen Mutlu, M. I., 2014).Losses due to shell cracks in egg poultry farming occupy a significant place. Oderkirk reports 6-8%, Roland 13-20%, Harms et al. 6.5%, and Keshavarz 6-16% as the proportion of eggs that cannot be sold due to shell cracks among produced eggs (Oderkirk, 1982; Roland Sr., 2001; Keshavarz, 2000; Harms et al., 1996). Hunton states that in a facility with a capacity of 100,000, each 1% increase in cracks leads to an annual loss of $10,000 in earnings (Hunton, 1995; Çetin & Gürcan, 2006).

When examining the effect of adding 1% YG to the rations of treatment groups on egg white ratio (%), feed as the main factor was found to be statistically insignificant for all weeks except the seventh week and the overall average of weeks.

Adding 1% YG to breeder quail rations did not significantly affect the egg yolk ratio (%) for all weeks and the overall average of weeks, except for the seventh week. It has been reported that different ratios of Panax ginseng added to laying hen feeds did not affect the albumen index and yolk index (Yıldırım et al., 2013; Şen Mutlu, 2014). However, Şen Mutlu (2014) reported that different ratios of Panax ginseng leaf extract in laying hens increased in groups given 50 mg/kg, while the albumen index tended to decrease with increasing amounts of Panax ginseng added to the feed. Choi et al. (2015) reported that it did not affect egg yolk color in a study to preserve egg freshness in laying hens. The differences between treatment groups in hatchability, hatching power, fertility rate, hatching live weight, and first-week live weight of the quails used in the experiment were statistically insignificant at the beginning of the trial. The study with the addition of Panax Ginseng Leaf Extract to the compound feed of laying hens showed similarities in hatchability and embryonic deaths (Şen Mutlu, 2014).

In conclusion,the findings obtained from quails and the Panaxginseng plant extract added to the rations of laying quails during the initial laying period may contribute to the lack of information on poultry feeding and may apply to other poultry. Definitive confirmation of this will be possible through studies on other poultry.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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